

**O'ZBEKISTON RESPUBLIKASI QISHLOQ VA SUV XO'JALIGI
VAZIRLIGI**

TOSHKENT IRRIGASIYA VA MELIORASIYA INSTITUTI

«Gidravlika» kafedrası



GIDRAVLIKA

fanidan kurs loyixasi (ishi)ni bajarishga doir metodik ko'rsatma

Toshkent – 2011 y.

Metodik ko'rsatma institute Ilmiy-metodik Kengashining "9" aprel 2011 yildagi 1-sonli majlisida kurib chiqilgan va chop etishga tavsiya etilgan

Ushbu uslubiy ko'rsatma «Gidravlika» fanining dasturi asosida tuzilgan bulib, unda ochiq o'zanlardagi suv oqimining tekis va notekis harakati davomida oqim elementlarini gidravlik hisobini bajarish uslublari yoritilgan.

Ko'rsatma «Suv xo'jaligi va meliorasiya», «Gidrotexnika qurilishi», «Gidrotexnika inshootlari va nasos stansiyalaridan foydalanish», «Suv resurslari va suvdan foydalanish» "Sug'oriladigan erlardan meliorativ tizim", "Qishloq va yaylovlar suv ta'minoti", "Suv omborlar gidrologiyasi", bakalavriat ta'lim yo'nalishlarida tahsil olayotgan talabalar uchun mo'ljallangan. Ko'rsatmadan soxa yunalishi buyicha ta'lim olayotgan magistratura mutaxassisligi magistrantlari va soxa mutaxassislari ham foydalanishlari mumkin. Ko'rsatmada fan sohasida erishilgan sungi yutuqlar ham o'z aksini topgan.

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KIRISH

«Ta'lim to'g'risidagi» qonun, Kadrlar tayyorlash milliy dasturida belgilangan vazifalarni amalga oshirish, o'quv jarayonini o'quv adabiyotlar bilan ta'minlashni taqazo etadi.

Qishloq va suv xo'jaligida amalga oshirilayotgan islohotlar yangi gidrotexnik inshootlarni yaratish, mavjudlarini takomillashtirish, suv resurslaridan oqilona foydalanishni talab etadi.

Bu vazifalarni amalga oshirish uchun ochiq o'zanlardagi oqimning tekis va notekis harakati bilan bog'liq bo'lgan jarayonlarni o'rganish va gidravlik elementlarini hisoblash zaruratini vujudga keltiradi.

Ochiq o'zanlardagi suv oqimining tekis va notekis harakatiga bag'ishlangan ushbu qo'llanma mualliflarning bu yunalishdagi kup yillik pedagogik faoliyatining maxsulidir.

Oqimlarning ochiq o'zanlardagi, gidrotexnik inshootlardagi tekis va notekis harakatini o'rganish, bu jarayonlarni matematik ifodalash va hisoblash formulalarini keltirib chiqarish ancha murakkab bo'lib, talabalardan bu mavzuni o'rganish uchun yetarli darajada ko'nikma talab qiladi.

Mavjud adabiyotlarda tekis va notekis harakat gidravlik elementlarini hisoblashga doir qo'llanmalar etarli emasligi, mavjudlarida bu jarayonlar batafsil bayon etilmaganligi hamda bu soxada fanning sungi yutuqlari bilan talabalarni yaqindan tanishtirish ushbu qo'llanmani yozishga turtki bo'ldi.

Qo'llanmada prizmatik va noprizmatik o'zanlarda oqim sathining egriligini qurish va uning ta'sir doirasini aniqlash usullari keltirilgan.

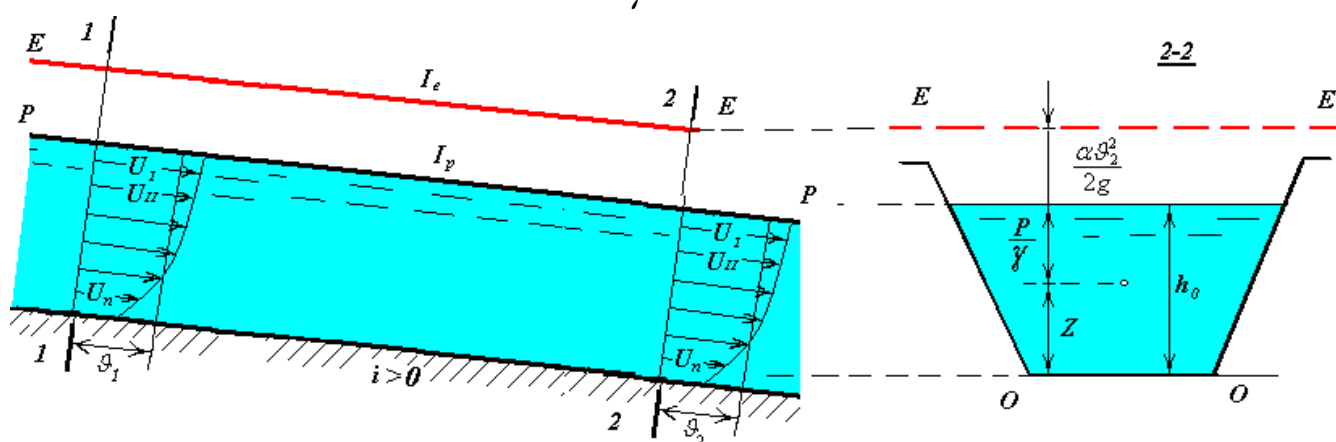
Qo'llanmada qator masalalarni echishning yangi uslublari va EXMdan foydalanib echish imkoniyatlari keng bayon etilgan. Qo'llanmadan gidravlik elementlarini hisoblash masalalari bo'yicha shug'ullanuvchi magistrantlar, ilmiy tadqiqotchilar ham foydalanishlari mumkin.

I. OCHIQ O'ZANLARDA (KANALLARDA) SUV OQIMINING TEKIS HARAKATI

1.1.SUV OQIMINING TEKIS HARAKATI. Shezi formulasi

Suv oqimining barcha tirik kesimlarida tezlik epyurasi bir xil yuzaga va bir xil shaklga ega bo'lsa, bunday oqim harakati *tekis harakat* deyiladi. Tekis harakatda suyuqlik qatlamlari o'zaro parallel harakat chizig'iga ega bo'ladi va tirik kesimning turli nuqtalari uchun Z va $\frac{P}{\gamma}$ ning qiymatlari turlicha, ammo ularning yig'indisi o'zgarmasdir (1-rasm).

$$z + \frac{P}{\gamma} = const$$



1- rasm. Suv oqimining kanaldagi tekis harakati sxemasi.

Tekis harakat alomatlari:

1) $\alpha = const_{(l)}$

2) $\mathcal{G} = const_{(l)}$

Tekis harakatning asosiy tenglamasi

$$h_e = \frac{\tau \cdot l}{\gamma \cdot R}$$

bu erda: τ -ichki ishqalanish kuchi;

γ -solishtirma og'irlik;

l -kanal uzunligi;

R -gidravlik radius.

Shezining taklifiga ko'ra tekis harakatda τ/γ - kattalik tezlik kvadratiga proporsional

$$\frac{\tau}{\gamma} = \frac{1}{C^2} \mathcal{G}^2, \text{ yoki}$$

$$h_e = \frac{\mathcal{G}^2 l}{C^2 R},$$

Bu ifodada $C = \sqrt{\frac{\lambda}{8g}}$ ekanligini inobatga olsak, Darsi-Veysbax tenglamasi

hosil bo'ladi.

Keyingi ifodani tezlikga nisbatan yozsak, quyidagi formula hosil bo'ladi:

$$g = C\sqrt{R \cdot I}$$

bu erda $I_e = \frac{h_e}{l}$ - gidravlik nishablik.

Bu formula *Shezi formulasi* deyiladi va koeffisient S – Shezi koeffisienti deb ataladi. Ochiq o'zanlardagi suvning erkin sathida bosim doimiy bo'lib odatda atmosfera bosimi qaror topadi, shu sababli pьezometrik nishablik suvning erkin sathi nishabligiga teng bo'ladi:

$$I_p = i_c.$$

Oqimning tekis harakatida $\frac{\alpha g^2}{2g}$ - ifoda o'zgarmas bo'lganligi uchun:

$$I_p = I_e$$

Tekis harakatda oqimning chuqurligi o'zgarmas bo'lishi zarur, shu sababli faqat tekis harakatda o'zandagi barcha nishabliklar o'zaro teng bo'ladi:

$$I_e = I_p = i_c = i,$$

bu erda: i – kanal tubining nishabligi ($i = \sin \alpha$).

Oqim tekis harakati mavjudlik shartlari quyidagicha:

1. o'zanda suvning sarfi o'zgarmas $Q = \text{const}_{(l)}$;
2. o'zan uzunlik (l) bo'yicha prizmatik bo'lishi kerak (demak tirik kesim shakli va gidravlik kattaliklari o'zgarmas bo'lishi kerak);
3. oqimning chuqurligi o'zan bo'ylab o'zgarmas (uzunlik (l) bo'yicha):

$$h = \text{const}_{(l)};$$

4. o'zanning nishabligi o'zgarmas uzunlik (l) bo'yicha:

$$(i = \sin \alpha = \text{const}) \quad i > 0;$$

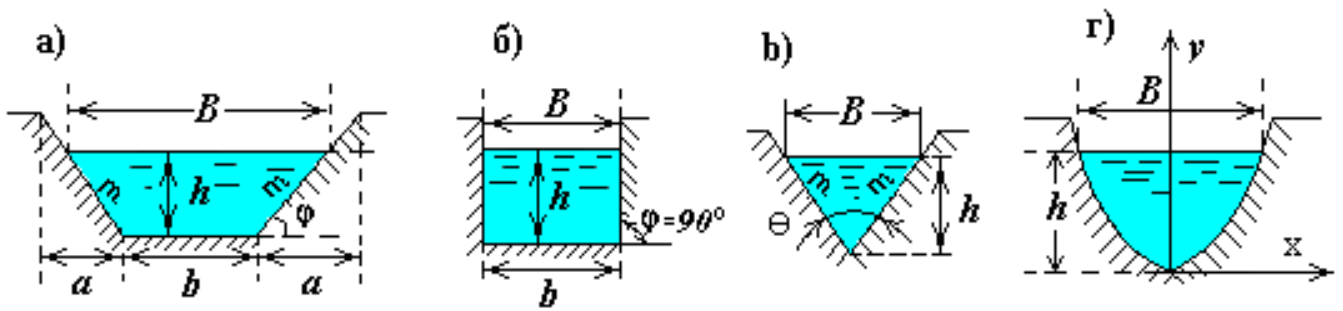
5. o'zanning g'adir-budirligi o'zgarmas (bir xil) uzunlik (l) bo'yicha:

$$(n = \text{idem}).$$

I.2 Oqim tirik kesimining gidravlik elementlari

Oqim tirik kesimining shakli o'zan ko'ndalang kesimi shakliga bog'liq bo'ladi va turli xil shakllarga ega bo'lishi mumkin (2-rasm):

- a) - trapesiya shaklida;
- b) - to'g'ri burchakli to'rtburchak shaklida;
- v) - uchburchak shaklida;
- g) - parabola shaklida va hokazo.



2- rasm. Kanallarning ko'ndalang kesim shakllari.

Bu erda: b – o'zan tubining kengligi (eni);
 B – o'zandagi suvning erkin sathidagi kengligi;
 h – o'zandagi suv oqimining chuqurligi;
 m – o'zan qirg'og'ining qiyaligi yoki qiyalik koeffitsienti,
 $m = ctg \varphi$.

Trapeziya shaklidagi kanalning gidravlik elementlari

1. Oqim erkin sathining kengligi (eni):

$$B = b + 2mh .$$

2. Harakatdagi (tirik) kesimning yuzasi:

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

3. Kesimning ho'llangan perimetri:

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

bu formulada $m' = \sqrt{1 + m^2}$.

4. Kesimning gidravlik radiusi:

$$R = \frac{\omega}{\chi} .$$

Parabola shaklidagi kesimning gidravlik elementlari.

Parabolaning tenglamasi:

$$x^2 = 2py ,$$

r – parabolaning parametri.

1. Erkin sathining kengligi:

$$B = 2\sqrt{2ph} = 2\sqrt{ah}; \quad a = 2p .$$

2. Tirik (harakatdagi) kesim yuzasi:

$$\omega = \frac{2}{3} h \cdot B = \frac{4}{3} h \sqrt{a \cdot h} .$$

3. Kesimning ho'llangan perimetri:

$$\chi = \frac{a}{2} \left[\sqrt{2\tau(1+2\tau)} + 2,3 \lg(\sqrt{2\tau} + \sqrt{1+2\tau}) \right],$$

bu formulada $\tau = \frac{h}{p} = \frac{2h}{a}$ yoki $\chi = \frac{a}{2} \Pi$, $\Pi = f(\tau)$ - qiymatlarini quyidagi jadvaldan olish mumkin.

$\Pi = f(\tau)$ qiymatlarining jadvali

1- jadval

τ	P	τ	P	τ	P	τ	P
0,001	0,09	0,15	1,15	0,55	2,44	0,95	3,48
0,005	0,20	0,20	1,34	0,60	2,58	1,00	3,61
0,01	0,28	0,25	1,54	0,65	2,71	1,05	3,72
0,02	0,40	0,30	1,71	0,70	2,83	1,10	3,84
0,04	0,51	0,35	1,85	0,75	2,97	1,15	3,97
0,06	0,71	0,40	2,02	0,80	3,10	1,20	4,08
0,08	0,82	0,45	2,16	0,85	3,23	1,25	4,19
0,10	0,93	0,50	2,30	0,90	3,34		

I.3 Kanalning ishchi xarakteristikasi

Kanaldagi suv sarfining suv chuqurligiga mos ravishda o'zgarish grafigiga $Q = f(h)$ kanalning ish xarakteristikasi deyiladi. Bu grafikni tuzish uchun suv chuqurligiga h – bir nechta qiymatlar berib, ularga mos bo'lgan suv sarflarini tekis harakatning asosiy tenglamasidan aniqlaymiz:

$$Q = \omega \cdot C \sqrt{R \cdot i}, \quad (m^3/c, l/c).$$

Bu erda:

$\omega = (b + mh)h$ – tirik (harakatdagi) kesim yuzasi, m^2 ;

b, m – kanal tubining kengligi va qiyalik koeffisienti;

C – SHEzi koeffisienti, $m^{0.5}/s$;

$R = \frac{\omega}{\chi}$ – gidravlik radius, m ;

$\chi = b + 2h\sqrt{m^2 + 1}$ – xo'llangan perimetr;

i – kanal tubining nishabligi.

SHEzi koeffisientini Manning formulasi bilan aniqlash mumkin:

shuni alohida qayd etish kerakki, SHEzi koeffisienti tajriba asosida aniqlanadi:

$$C = \frac{1}{n} R^{\frac{1}{6}}$$

bu formulada n - g'adur-budurlik koeffisienti.

N.N.Pavlovskiy formulasi bilan SHEzi koeffisienti quyidagicha aniqlanadi:

$$C = \frac{1}{n} R^y$$

$y \approx 1,5\sqrt{n}$ - gidravlik radius $R > 1 m$ bo'lganda;

$y \approx 1,3\sqrt{n}$ - gidravlik radius $R < 1 m$ bo'lsa.

SHEzi koeffisientini quyidagi grafiklardan foydalanib aniqlasa ham bo'ladi:
CHugaev R.R. «Gidravlika», 1975 y., 186 bet.

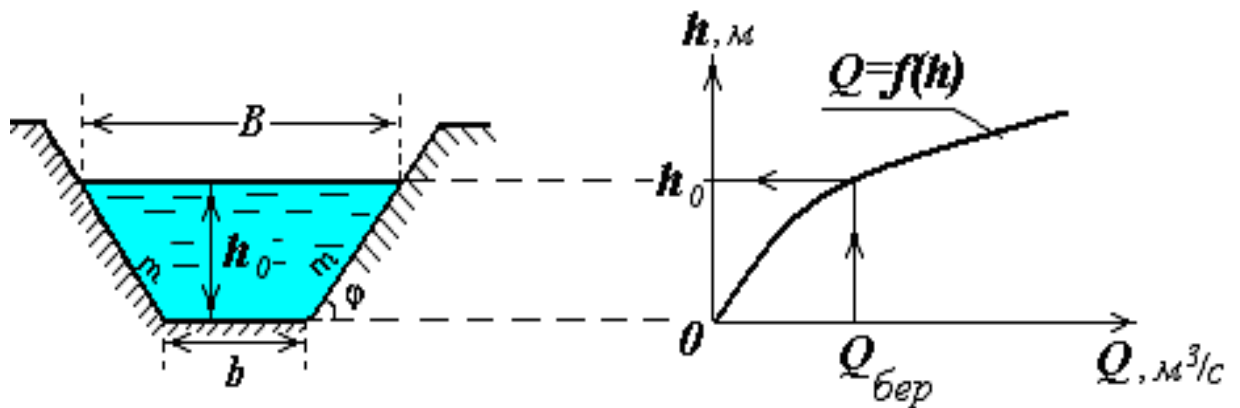
Hisob natijalarini jadvalda keltiramiz:

2 – jadval

$h, (m)$	$\omega, (m^2)$	$\chi, (m)$	$R, (m)$	$S, (m^{0.5}/s)$	$Q, (m^3/c)$
h_1					
h_2					
h_3					

Kanal uchun berilgan gidravlik element qiymatlari b, m, n, i – dan foydalanib, kanaldagi xar bir qabul qilingan suv chuqurligi qiymatiga mos keladigan suv sarflarini aniqlab, 2- jadvalga tushiramiz va jadvaldagi ma'lumotlar asosida $Q = f(h)$ - kanal

ish xarakteristikasi grafigini chizamiz. Bu grafikdan berilgan sarfga mos keluvchi chuqurlik h_0 qiymati tanlanadi.



3- rasm - Kanalning ishchi xarakteristikasi

Gorizontal masshtab: 1 sm - « » m^3/s

Vertikal masshtab: 1 sm - « » m.

Izoh: Suvning chukurligi – h - ning qiymatlari tanlanganda, xosil bulgan Q – sarflarning qiymatlari berilgan $Q = Q_{MK}$ qiymatidan kichik va katta sonlar bo'lishi zarur.

SHuni aloxida qayd etish kerakki, hozirgi kunda kanalning ishchi xarakteristikasi EHM yordamida ham aniqlanadi. Buning uchun maxsus dastur ishlab chiqilgan.

I.4 Parabola shaklidagi kanalning o'lchamlarini aniqlash

Parabola shaklidagi kesim uchun qo'yidagi formuladan foydalanimiz:

$$x^\alpha = ay,$$

bu formulada α - parabola ko'rsatkichi;

a – parabola parametri.

Kanalning o'lchamlarini aniqlash uchun R.M. Karimov usulidan foydalanamiz (R.M.Karimov “Gidravlicheskiy raschet kanalov” yoki ilovadagi 2,3 jadvaldan, yil).

Hisob quyidagi tartibda bajariladi:

1. $0,159 \frac{Qn}{\sqrt{i}}$ ifodani hisoblab, qiymatini aniqlaymiz.

2. Jadvaldan (ilovadagi 2 - jadval) $0,159 \frac{Qn}{\sqrt{i}}$

qiymatiga mos keluvchi R_0 va $\vartheta_0 \frac{n}{\sqrt{i}}$ qiymatlari olinadi va ϑ_0 - ning qiymati aniqlanadi.

3. Parabolaning parametri « a » va ko'rsatkichi « α » jadvaldan aniqlangan R_0 - qiymatlariga asosan:

$$\frac{a^{\frac{1}{\alpha-1}}}{R_0}$$

ifodaning qiymatini aniqlaymiz.

4. **Ilova 3-jadvaldan) quyidagi** jadvalda ko'rsatilgan ifodalarning qiymatlari olinadi:

3 – jadval

$\beta = \frac{B}{h_h}$	$\bar{\chi}$	$\frac{h_0}{R_0}$	$\frac{B}{R_0}$	$\frac{a^{\frac{1}{\alpha-1}}}{R_0}$

Bu jadvalga asosan quyidagi elementlarni aniqlash mumkin: oqim erkin sathining kengligini B , oqim chuqurligini h , normal chuqurligini h_0 , ho'llangan perimetrni $\chi = \frac{P}{2}$, tirik kesim yuzasini:

$$\omega = \frac{\alpha}{\alpha + 1} \beta \cdot h_0.$$

Hisob-kitoblarning aniqligi quyidagi shart bilan tekshiriladi:

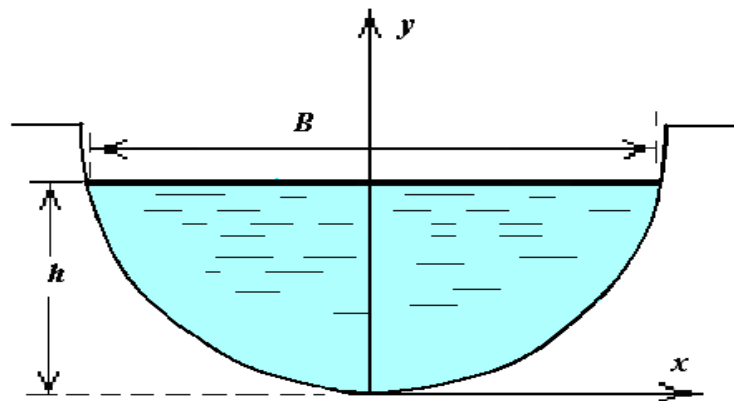
$$\left(\frac{B}{2}\right)^\alpha = a \cdot h_0.$$

5. Kanalning ko'ndalang kesimi quyidagi tenglama asosida quriladi:

$$x^\alpha = ay$$

4-jadval

x						
u						



4-rasm - Parabola shaklidagi kanalning ko'ndalang kesimi.

Masala. Parabola shaklidagi kanalning suv chuqurligi aniqlansin, agar $Q=9,8$ m^3/c , $\alpha =2$, shu kanal quyidagi tenglama bilan yozilgan bo'lsa: $x^2 = 2py$ bu erda $2p = 29m$.

Echish: Kanaldagi suv sarfining suv chuqurligiga mos ravishda o'zgarish grafigini $Q = f(h)$ quramiz. Bu grafikni tuzish uchun suv chuqurligiga – h – bir nechta qiymatlar berib, ularga mos bo'lgan suv sarflarini quyidagi tartibda aniqlaymiz:

1. Kanal sathidagi kengligi $B = 2\sqrt{2ph}$.
2. Harakatdagi kesim yuzasi $\omega = \frac{2}{3}h \cdot B$.
3. Xo'llangan perimetri $\chi = p \cdot \Pi$, bu erda $\Pi = f\left(\frac{h}{p}\right)$,
shu qullanmaning 1-jadvaldan olinadi.
4. Mos keladigan suv sarfini aniqlaymiz:

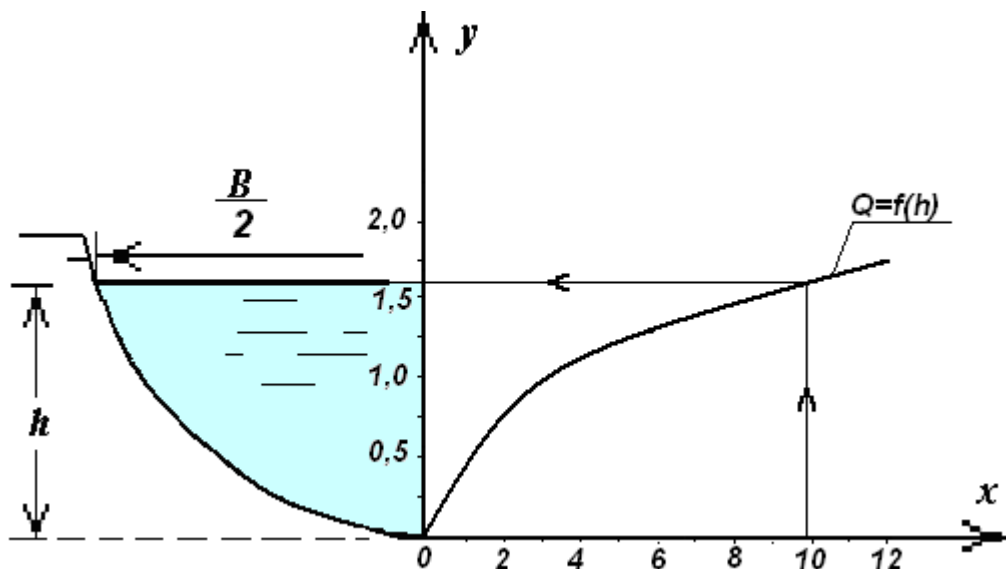
$$Q = \frac{\omega \cdot R^{2/3}}{N}$$

bu erda $N = \frac{n}{\sqrt{i}}$

Xisoblash natijalarini jadvalda keltiramiz

$h,$ m	$V,$ m	ω m^2	$\frac{h}{p}$	P	$\chi,$ m	$R,$ m	$R^{2/3}$	$Q,$ m^3/s
1,25	12,04	10,03	0,086	0,85	12,33	0,814	0,872	5,76
1,50	13,19	13,19	0,103	0,04	13,63	0,968	0,968	8,50
1,75	14,25	14,25	0,121	1,03	14,94	1,112	1,073	11,75

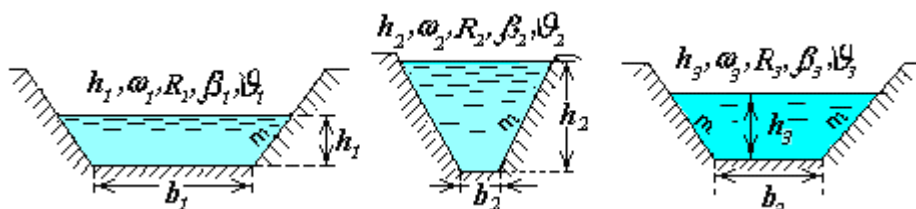
Jadvaldagi qiymatlar asosida kanal ishchi xarakteristika grafigini $Q = f(h)$ quramiz.



Berilgan sarf $Q=9,8$ m^3/s ga mos keladigan suv chuqurligi $h=1,6m$.

1.5 Kanallarni loyihalashda vujudga keladigan ba'zi masalalarning echish tartibi

Tabiiy tuproqda qurilgan kanallarning ko'ndalang kesimi trapesiya, parabola va poligonal shaklida bo'lishi mumkin. Kanal ko'ndalang kesimning yuzasi harakat (jonli) kesimi faqat yarim aylana uchun bitta parametrga bog'lik. Boshqa kesimlar uchun kamida ikkita parametrlarga bog'lik. Shuning uchun shunday kanal kesimni topish mumkin, maksimum sarfni o'tkazish imkoniyatiga ega bo'lsa, bunday kesimga gidravlik jixatdan eng maqbul (qulay) kesim (GEQK) deb aytiladi.



Gidravlik hisoblashda kanalning nisbiy kengligi (kanal tubining kengligini undagi suvning chuqurligiga nisbati) degan tushuncha ishlatiladi va quyidagicha yoziladi:

$$\beta = \frac{b}{h}.$$

Trapesiya shaklidagi kanalning gidravlik elementlarini β orqali yozish mumkin: harakatdagi kesim yuzasi: $\omega = h^2(\beta + m)$;

ho'llangan perimetr: $\chi = h(\beta + 2\sqrt{1+m^2})$;

gidravlik radius: $R = h \frac{(\beta + m)}{\beta + 2\sqrt{1+m^2}}$.

O'rtacha tezlikni Shezi-Manning tenglamasi orqali yozish mumkin:

$$g = C\sqrt{R \cdot i} = \frac{1}{n} R^{1/6} \cdot R^{1/2} \sqrt{i} = \frac{\sqrt{i}}{n} R^{2/3} = \frac{1}{N} R^{2/3}, \quad (1)$$

bu erda $N = \frac{n}{\sqrt{i}}, \quad (2)$

$$R = h \cdot \frac{\beta + m}{\beta + 2m'} \quad (3)$$

va
$$R^{2/3} = \left| \frac{h(\beta + m)}{\beta + 2m'} \right|^{2/3} = \left| \frac{h^2(\beta + m)^2}{(\beta + 2m')^2} \right|^{1/3} = \left| \frac{\omega(\beta + m)}{(\beta + 2m')^2} \right|^{1/3} = \left| \frac{Q}{g} \cdot \frac{\beta + m}{(\beta + 2m')^2} \right|^{1/3} \quad (4)$$

(4)-chi tenglamadagi qiymatni (1)-chi tenglamaga qo'ysak, quyidagini yozishimiz mumkin:

$$g = \frac{1}{N} \left(\frac{Q}{g} \cdot \frac{\beta + m}{(\beta + 2m')^2} \right)^{1/3}, \quad (5)$$

Bu yerdan
$$g^{4/3} = \frac{1}{N} \left(Q \cdot \frac{\beta + m}{(\beta + 2m')^2} \right)^{1/3},$$

va

$$g = \frac{1}{N^{\frac{3}{4}}} \cdot \left| Q \cdot \frac{\beta + m}{(\beta + 2m')^2} \right|^{\frac{1}{4}} = \frac{1}{N^{\frac{3}{4}}} \cdot \frac{N^{\frac{1}{4}}}{N^{\frac{1}{4}}} \cdot \left| Q \cdot \frac{\beta + m}{(\beta + 2m')^2} \right|^{\frac{1}{4}} = \frac{1}{N} \cdot \left| N \cdot Q \cdot \frac{\beta + m}{(\beta + 2m')^2} \right|^{\frac{1}{4}} \quad (6)$$

Demak, kanaldagi berilgan Q , m , n i i uchun o'rtacha tezligining qiymati g qabul qilingan tub kengligiga mos keladigan harakatdagi kesim shakli bilan bog'langan (6-chi tenglamadan), yoki $g = f(\beta)$,

bu erda:
$$\beta = F(Q, m, n, i, b) \quad (7)$$

va
$$f(\beta) = \frac{\beta + m}{(\beta + 2m')^2} \quad (8)$$

1.5.1 Gidravlik eng qulay (maqbul) kesim elementlarini hisoblash

Ma'lum bo'lgan Q , m , n , i uchun bir nechta ixtiyoriy o'lchamlik ko'ndalang kesimlarni loyixalash mumkin xar hil b va tirik (harakat) kesimlari bilan. Bu kesimlarning ichida shunday variant bo'lishi kerakki, unda oqimning ko'ndalang kesimi bo'yicha o'rtacha tezligi eng katta bo'lsin, ya'ni g_{\max} , kanal ko'ndalang kesimining yuzasi (maydoni) esa eng kichik bo'lsin, ya'ni ω_{\min} . Bu shart bajarilsa, bunday ko'ndalang kesim - kanalning *gidravlik eng qulay kesimi* deyiladi.

$$g = g_{\max} = \frac{1}{N} \left[\frac{Q \cdot N}{4 \cdot M} \right]^{1/4}$$

bundan

$$R_{\max} = \left| \frac{Q \cdot N}{4M} \right|^{3/8}$$

$N = \frac{n}{\sqrt{i}}$ - SHEzi-Manning parametri;

O'zan tubining kengligiga nisbatan (GEQK) ning nisbiy kengligini $\beta_{z.k.}$ belgi bilan belgilasak, u holda:

$$\beta = \beta_{z.k.} = \left(\frac{b}{h} \right)_{z.k.} = 2(\sqrt{1+m^2} - m) = 2m' - 2m.$$

$M = 2m' - m$ - quyidagi belgilashni kiritsak, yozishimiz mumkin:

$$\beta_{g,q} = M - m.$$

SHEzi - Manning tenglamasini quyidagicha yozishimiz mumkin:

$$Q = \omega C \sqrt{Ri} = \omega \cdot \frac{1}{n} \cdot R^{1/6} \cdot R^{1/2} \cdot \sqrt{i} = \frac{\omega \cdot R^{2/3}}{N};$$

$$Q = \frac{1}{N} \omega \cdot R^{2/3} \text{ - SHEzi-Manning formulasi.}$$

Gidravlik eng qulay kesimning gidravlik parametrlari:
 harakatdagi kesim yuzasi:

$$\omega_{\rho.K} = (2\sqrt{1+m^2} - m) \cdot h_{\rho.K}^2 = (2m' - m) \cdot h_{\rho.K}^2 ;$$

kanal tubining kengligi: $b_{\rho.K} = 2 \cdot h(\sqrt{1+m^2} - m) ;$

kanaldagi suv chuqurligi: $h_{\rho.K} = \frac{b_{\rho.K}}{\beta_{\rho.K}} = 2 \cdot \left| \frac{N \cdot Q}{4 \cdot M} \right|^{\frac{3}{8}} = 2 \cdot R_{\max} ;$

kanal sathdagi eni: $B_{\rho.K} = \beta_{\rho.K} (\beta_{\rho.K} + 2m') \cdot \frac{R_{\max}}{\beta_{\rho.K} + m} = 2 \cdot (M - m) \cdot \left| \frac{N \cdot Q}{4 \cdot M} \right|^{\frac{3}{8}} .$

1.5.2 Gidravlik mustahkam kanal uchun statistik bog'lanishlar. S.A.Girshkan formulalari

Kanal tubining eni quyidagi S.A.Girshkan statistik bog'lanishlari orqali aniqlanishi mumkin:

$$b_{\Gamma.M.} = AQ^x ,$$

Agar $Q = 0,5 \div 1,5 \text{ m}^3 / \text{c}$, unda $b_{\Gamma.M.} = 1,4Q^{0,85}$;

Agar $Q = 1,5 \div 50 \text{ m}^3 / \text{c}$, unda $b_{\Gamma.M.} = 1,5Q^{2/3}$;

Agar $Q > 50 \text{ m}^3 / \text{c}$, unda $b_{\Gamma.M.} = 1,3Q^{2/3}$.

Kanalning nisbiy eni: $\beta_{\Gamma.M.} = 3\sqrt[4]{Q} - m$;

Kanalning chuqurligi: $h_{\Gamma.M.} = 0,85Q^{1/3}$.

1.5.3 Masalalarning echish tartibi

1 – masala

Trapesiya shakldagi kanallarda Q, m, n, b va \mathcal{G} berilgan bo'lsa, suvning chuqurligi h va kanal tubining nishabligi i aniqlansin.

Echish tartibi:

1. Quyidagi qiymatni aniqlaymiz: $2m' = 2\sqrt{1+m^2}$.
2. Harakatdagi (tirik) kesim yuzasi: $\omega = \frac{Q}{\mathcal{G}}$.
3. Kalandagi suvning chuqurligini aniqlash uchun quyidagi tenglamadan foydalanamiz:

$$\omega = m \cdot h^2 + b \cdot h$$

unda:

$$h = \frac{1}{2m} (-b + \sqrt{b^2 - 4m \cdot \omega}).$$

4. Xo'llangan perimetr: $\chi = b + 2m'h$.

5. Hidravlik radius: $R = \frac{\omega}{\chi}$.

6. Kanal tubining nishabligi: $i = \left| \frac{\mathcal{G} \cdot n}{R^{\frac{2}{3}}} \right|^2$.

2 – masala

Trapesiya kesimli kanallarda Q, m, n, i berilgan bo'lib, $\mathcal{G} = K \cdot \mathcal{G}_{\max}$ bo'lsa, oqimning tirik kesimi o'lchamlari b va h aniqlansin.

Echish tartibi:

1. Shezi - Manning parametrning qiymatni aniqlaymiz: $N = \frac{n}{\sqrt{i}}$.
2. Quyidagini hisoblaymiz: $M = 2m' - m = 2\sqrt{1+m^2} - m$.
3. Kanaldagi maksimal oqim tezligini aniqlaymiz:

$$\mathcal{G}_{\max} = \frac{1}{N} \left| \frac{N \cdot Q}{4M} \right|^{\frac{1}{4}}.$$

4. Kanaldagi suv oqimning o'rtacha tezligi: $\mathcal{G} = 0,95 \cdot \mathcal{G}_{\max}$.

5. Tirik kesim yuzasi: $\omega = \frac{Q}{\mathcal{G}}$.

6. Hidravlik radius: $R = |N \cdot \mathcal{G}|^{3/2}$.

7. Xo'llangan perimetr: $\chi = \frac{\omega}{R}$.

8. Quyidagi tenglamalarning tizimidan:

$$mh^2 + bh - \omega = 0$$

$$2m'h + b - \chi = 0$$

a) kanaldagi suv chuqurligi: $h = \frac{\chi \pm \sqrt{\chi^2 - 4M \cdot \omega}}{2M}$;

v) kanal tubining eni: $b = \chi - 2m'h$;

yoki

$$h = \frac{\omega}{2MR} \left(1 \pm \sqrt{1 - 4M \frac{R^2}{\omega}} \right)$$

bu formulada $1 - 4M \frac{R^2}{\omega} \geq 0$ sharti bajarilishi lozim.

Izoh: h va b - ning ikkita qiymati bo'lishi mumkin:

Agar $\left(\frac{m}{2m'}\right)^2 < \frac{R^2}{\omega} < \frac{1}{4M}$ bo'lsa, birinchi h va b ,

va $\frac{R^2}{\omega} < \frac{m}{(2m')^2}$ bo'lsa, ikkinchi h va b .

3 – masala

Trapeziya kesimli kanallarda Q, m, n, i berilgan bo'lib, $R = K \cdot R_{\max}$ bo'lsa, oqimning tirik kesimi o'lchamlari h va b aniqlansin.

Echish tartibi:

1. Shezi-Manning parametrni aniqlaymiz: $N = \frac{n}{\sqrt{i}}$.

2. Quyidagi qiymatni aniqlaymiz: $M = 2m' - m$.
3. Gidravlik radiusning maksimal qiymatini hisoblaymiz:

$$R_{\max} = \left| \frac{N \cdot Q}{4M} \right|^{\frac{3}{8}}.$$

4. Kanaldagi gidravlik radius: $R = K \cdot R_{\max}$.

5. O'zandagi suv oqimining o'rtacha tezligi: $\mathcal{G} = \frac{R^{\frac{2}{3}}}{N}$.

6. Tirik kesim yuzasi: $\omega = \frac{Q}{\mathcal{G}} = (b + mh) \cdot h$.

7. Xo'llangan perimetri: $\chi = \frac{\omega}{R} = b + 2h\sqrt{m^2 + 1}$.

8. Kanaldagi suv oqimining chuqurligi: $h = \frac{\chi \pm \sqrt{\chi^2 - 4M \cdot \omega}}{2M}$.

9. Kanal tubining eni: $b = \chi - 2m' \cdot h$.

4 – masala

Trapesiya kesimli kanallarda Q, m, n, i belgilangan bo'lib, β ning quyidagi ifodalari asosida $\beta_r = 3\sqrt[4]{Q} - m$, $\beta_u = 2,5 + \frac{m}{2}$, $\beta_{ch} = M - m$, oqimning tirik kesimi o'lchamlari: b va h topilsin.

Echish tartibi:

1. Shezi-Manning parametrni aniqlaymiz: $N = \frac{n}{\sqrt{i}}$.
2. Kanal nisbiy kengligini aniqlaymiz: $\beta_r = 3\sqrt[4]{Q} - m$.
3. Gidravlik radius: $R = \left| N \cdot Q \frac{\beta + m}{(\beta + 2m')^2} \right|^{\frac{3}{8}}$.
4. Tirik kesim yuzasi: $\omega = R^2 \frac{(\beta + 2m')^2}{\beta + m}$.
5. Kanaldagi suv chuqurligi: $h = \sqrt{\frac{\omega}{\beta + m}}$.
6. Kanal tubining eni: $b = \beta \cdot h$.

1.6. Kanaldagi ruxsat etilgan tezliklar

Kanallarni loyihalashda kanaldagi o'rtacha tezlik ma'lum qiymatga ega bo'lishi lozim. Kanalda ruxsat etilgan tezlik quyidagicha bo'lishi kerak:

$$\mathcal{G}_l < \mathcal{G} < \mathcal{G}_{yu}$$

Bu erda: \mathcal{G}_l - loyqa bosish tezligi (loyqa bosmaslik tezligi) – kanalda ruxsat etilgan tezlikning eng kichik (\mathcal{G}_{\min}) qiymati, ya'ni loyqa bosmaydigan tezlik;

\mathcal{G}_{yu} - yuvilish tezligi (yuvilmaslik tezligi) – kanalda ruxsat etilgan tezlikning (maksimum) eng katta qiymati, ya'ni yuvilmaydigan tezlik.

1.6.1 Yuvilmaydigan magistral kanalni loyihalash

a) Qurilish me'yorlari va qoidalari (QM va Q) asosida kanalni loyihalash.

Loyihalash tartibi:

1. Kanal asosini tashkil qiluvchi tuproq (berilgan C yoki $d_{o'r}$) va kanalning sarfiga mos keluvchi g'adir–budurlik koeffitsienti “ n ” va qiyalik koeffitsientini “ m ” – QM va Q-2.06.03.97 asosida aniqlaymiz (ilova, 5-7-chi jadvallar).

2. Magistral kanal tubining kengligini S.A.Girshkan formulasi yordamida aniqlaymiz:

$$b_G = AQ^x$$

Agar $Q < 1,5 \text{ m}^3/\text{c}$ bo'lsa, $A = 1,4$; $x = 0,85$;

Agar $Q = (1,5 \dots 50) \text{ m}^3/\text{c}$, $A = 1,5$; $x = 2/3$;

Agar $Q > 50 \text{ m}^3/\text{c}$ bo'lsa, $A = 1,3$; $x = 2/3$.

Aniqlangan b_G qiymatini eng yaqin bo'lgan b_{st} standart qiymatigacha yaxlitlanadi.

Standart qiymatlar b_{st} :

0,2 m; 0,4 m; 0,5 m; 0,6 m; 0,8 m; 1,0 m; 1,2 m; 1,5 m; 1,8 m; 2,0 m; 2,5 m; 3,0 m; 3,5 m; 4,0 m; 5,0 m; 6,0 m va hokazo har 1 m-dan.

3. QM va K dan kanal tuprog'iga mos keluvchi oqim chuqurligining bir necha qiymatlari uchun ($h=0,5$; 1,0; 3,0; 5,0 m) ruxsat etiladigan yuvilmaydigan oqim tezliklarining qiymatlarini “ \mathcal{G}_{yu} ” yozib olamiz (ilova, 8-10 jadvallar).

4. Suvning o'rtacha tezliklari QM va Q - da berilgan xar bir suv chukurliklari uchun ($h=0,5$; 1,0; 3,0; 5,0 m) quyidagi formula yordamida hisoblanadi:

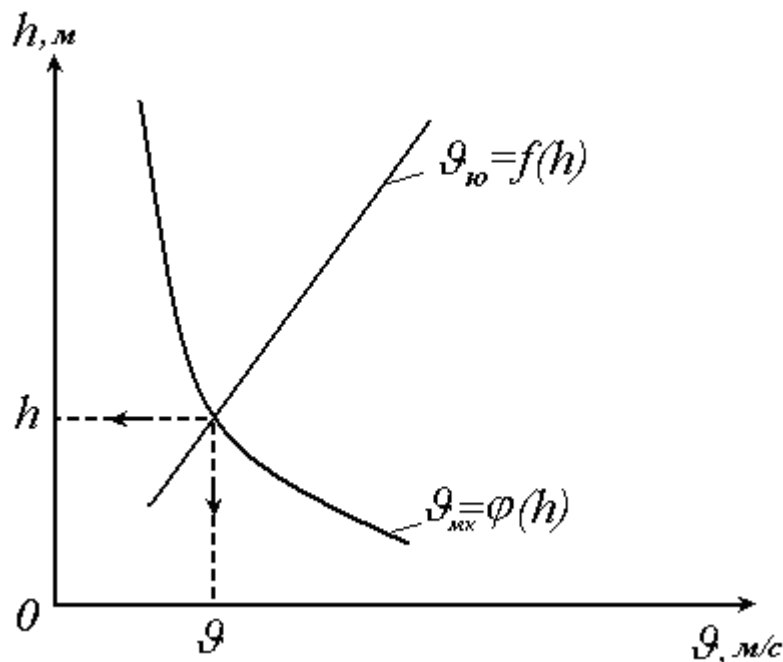
$$\mathcal{G}_{MK} = \frac{Q}{\omega}; \quad \omega = (b + m \cdot h) \cdot h.$$

Hisoblarini jadval ko'rinishida yozamiz:

5- jadval

h, m	$g_{10}, m/s$	ω, m^2	$g_{MK}, m/s$
0,5			
1,0			
3,0			
5,0			

5. QM va Q bo'yicha olingan suv tezliklari $g_{10} = f(h)$ va formula yordamida hisoblangan suvning o'rtacha tezligining suv chuqurligiga bog'liqlik $g_{MK} = \varphi(h)$ grafiklari quriladi. Ikkala grafikning kesishish nuqtasiga mos keluvchi tezlik - g - kanaldagi yuvilmaydigan suv tezligi aniqlanadi.



5- rasm. Kanalda yuvilmaydigan tezlikni aniqlash grafigi.

6. Grafikdan olingan suv tezligi g va suvning chuqurligi h asosida kanal tubining nishabligi quyidagi formula yordamida hisoblanadi:

$$i = \frac{g^2}{C^2 R}$$

b) A.A.CHerkasov usuli bilan loyihalash

O'zandagi ruxsat etiladigan yuvilmaydigan oqim tezligining qiymati A.A.CHerkasov formulasiga asosan aniqlanadi:

$$g_{yu} = g_0 R^{1/3}$$

Bu yerda: \mathcal{G}_0 – tuproq turiga bog'liq bo'lgan eng yuqori yuvilmaydigan tezlikning gidravlik radius $R = 1$ m bo'lgandagi qiymati, jadvaldan olinadi.

Echish tartibi:

1. Kanaldagi suv sarfi va tuproq turiga mos keluvchi \mathcal{G}_0, m, n – qiymatlari jadvaldan yozib olinadi (ilovada: 5-11 jadvallar).

2. Kanal tubining kengligi S.A.Girshkan formulasi yordamida aniqlanib, unga eng yaqin bo'lgan standart qiymatgacha yaxlitlanadi:

$$b = AQ^x.$$

3. Kanalning nishabligini va suvning chuqurligini aniqlashda ikkita tenglamani birgalikda echishga to'g'ri keladi. Cherkasov formulasi bo'yicha suv sarfi:

$$Q = \omega \cdot \mathcal{G}_0 \cdot R^{1/3} \quad (1)$$

Shezi-Manning tenglamasidan:

$$Q = \omega \cdot C \sqrt{R \cdot i} = \frac{\omega \cdot R^{2/3} \sqrt{i}}{n} \quad (2)$$

1 va 2 tenglamalarni h – ning funksiyasi sifatida yozib olamiz:

$$\frac{Q}{\mathcal{G}_0} = \omega \cdot R^{1/3}$$

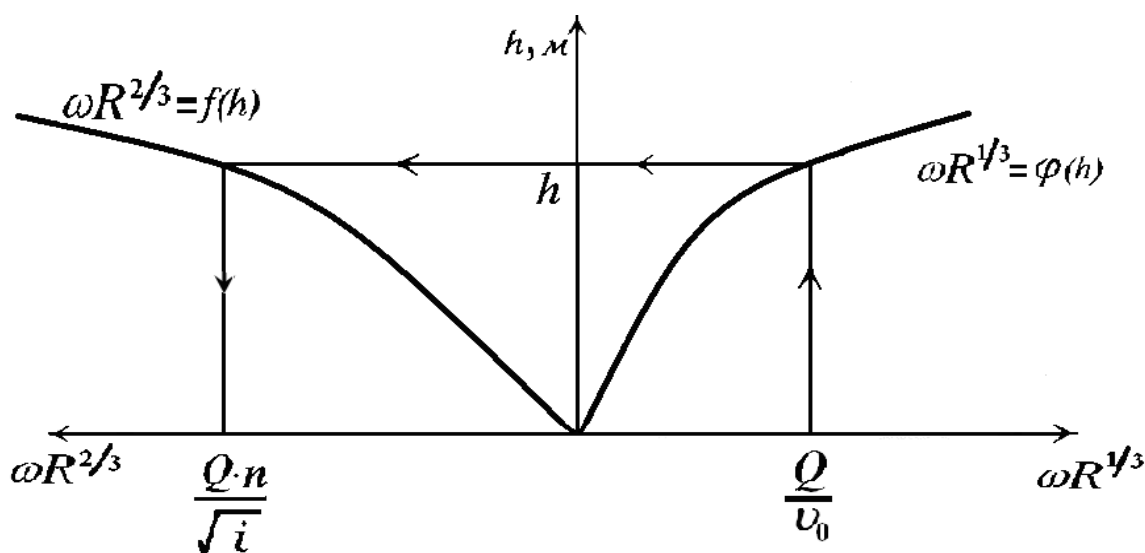
$$\frac{Q \cdot n}{\sqrt{i}} = \omega \cdot R^{2/3}$$

h -ga ixtiyoriy qiymatlar berib $\omega \cdot R^{1/3} = f(h)$ va $\omega \cdot R^{2/3} = \varphi(h)$ funksiyalarini hisoblaymiz. Hisobni jadvalda keltiramiz.

6- jadval

$h,$ m	$\omega,$ m^2	$\chi,$ m	$R,$ m	$R^{1/3}$	$R^{2/3}$	$\omega \cdot R^{1/3}$	$\omega \cdot R^{2/3}$

Jadvaldagi qiymatlar asosida $\omega \cdot R^{1/3} = f(h)$ va $\omega \cdot R^{2/3} = \varphi(h)$ grafiklarni chizamiz va oqim chuqurligi (h)-ga mos $\frac{Qn}{\sqrt{i}}$ parametrning qiymatini topamiz.



6 -rasm. $\omega \cdot R^{1/3} = f(h)$ va $\omega \cdot R^{2/3} = \varphi(h)$ grafiklari.

4. Grafikdan $\frac{Q \cdot n}{\sqrt{i}}$ - ning olingan qiymati orqali kanal tubi nishabligini hisoblaymiz:

$$\frac{Q \cdot n}{\sqrt{i}} = A \quad \Rightarrow \quad i = \left(\frac{Q \cdot n}{A} \right)^2$$

1.6.2 Kanalni loyqa bosishga qarshi tekshirish

Kanaldagi suv oqimining tezligi juda kichik bo'lsa, kanalni loyqa bosish xavfi paydo bo'ladi. Shu sababli kanalni loyqa bosish mumkin bo'lgan chegaraviy tezlikni aniqlab, kanaldagi suv oqimining o'rtacha tezligi bilan solishtirish zarur.

Shuni alohida qayd etish kerakki, O'zbekiston sharoitida foydalanilayotgan va loyihalashtirilayotgan kanallar uchun loyqa bosish tezligini aniqlash katta amaliy ahamiyatga ega. Chunki O'zbekistondagi kanallar asosan Amudaryo va Sirdaryolardan suv oladilar. Amudaryo va Sirdaryo daryolarda juda ko'p miqdorda cho'kindilar oqadi.

Kanallardagi loyqa bosish tezligi oqimning loyqa uzatish qobiliyatiga bog'liqdir.

Oqimning loyqa uzatish qobiliyati. Dinamik mustahkam kanallar.

Kanallarni loyihalashda \mathcal{G}_{yu} - yuvilish tezligi qiymati tuproq turiga qarab, QM va Q lardan olinadi (bu xaqda yuqorida aytib o'tildi).

Kanallarda ma'lum darajada loyqa miqdori harakatlanishi mumkin. Ular ma'lum joylarda cho'kib, yana harakatga kelishlari mumkin. Bunday jarayonlar kechadigan kanallarni dinamik mustahkam kanal deyiladi.

Bu jarayonlarni aniq ifodalash uchun oqimning loyqa uzatish qobiliyatini bilish lozim.

Loyqa uzatish qobiliyati deb – oqimning ma'lum loyqalik miqdorini cho'ktirmasdan olib yurish imkoniyatiga aytiladi.

Kanalning loyqa bosish tezligi, oqimning loyqa uzatish qobiliyati bilan bog'liqdir.

Hozirgi kunda loyqa uzatish qobiliyatini aniqlash uchun bir necha formulalar mavjud:

1. E.A.Zamarin formulasi:

$$S = 0,022 \frac{g}{W_0} \sqrt{\frac{R \cdot I \cdot g}{\bar{W}}}$$

bu erda: S - oqimning loyqa uzatish qobiliyati;

W_0 - gidravlik kattalik-tinch suvdagi loyqa zarrachalarining cho'kish tezligi, (mm/s);

\bar{W} - o'rtacha gidravlik kattalik, (mm/s). (ilovada 13-jadval).

2. Tabiiy va laboratoriya sharoitida o'tkazilgan tajribalarni umumlashtirib, loyqa uzatish qobiliyatini hisoblash uchun S.X.Abal'yans quyidagi formulani keltirib chiqargan:

$$S = 0,018 \frac{g^3}{R \cdot W_0}$$

bu erda: \bar{W} - o'rtacha gidravlik kattalik, (mm/s).

3. Oqimdagi cho'kindilarni har xil o'lchamlarga ega ekanligini hisobga olib, A.M.Arifjanov tomonidan oqimning loyqa uzatish qobiliyatini hisoblash uchun quyidagi formula taklif qilingan:

$$S = \alpha \frac{g^3}{g \cdot R \cdot \bar{W}}$$

bu erda:

$$\alpha = \left(\frac{d_0}{d_1} \right)^3 \quad \text{yoki} \quad \alpha = \sqrt[4]{\frac{W_0}{\bar{W}}}; \quad W_0 = 0,069 \text{ mm} / c$$

d_1 - cho'kindi diametri, (mm);

d_0 - «optimal» diametr, ya'ni, tezligi oqim tezligiga teng bo'lgan cho'kindi zarrachalari diametri, (mm).

YUqoridagi formulalar asosida oqimning loyqa bosish chegaraviy tezligini quyidagicha aniqlash mumkin:

1. E.A.Zamarin formulasi asosida:

$$g_n = \sqrt[5]{\frac{A^3}{n^2} R^{1/3}}$$

$A = 0,0127 \sqrt[3]{S^2 W_0^2 \bar{W}}$ - koeffitsient;

S - oqimning loyqaligi, ($\kappa g/m^3$);

\bar{W} - loyqa zarrachalarining o'rtacha gidravlik kattaligi, (m/s);

$W_0 = \bar{W}$, $0,002 \leq \bar{W} \leq 0,008$ m/c .

$W_0 = 0,002$, $0,0004 \leq \bar{W} \leq 0,002$ m/c .

2. S.X.Abal'yan formulasi asosida:

$$g_n = a \sqrt[3]{R}$$

bu erda: $a = 0,382 \sqrt[3]{\rho \bar{W}}$ - tuzatuvchi koeffitsient.

3. A.Arifjanov formulasi asosida:

$$v = \alpha_0 \cdot \sqrt[3]{\rho g R \bar{W}};$$

$$\alpha_0 = \sqrt[4]{\frac{\bar{W}}{W_0}};$$

Gidravlik kattalik (W) miqdori QM va Q 2.06.03-97 – «Sug'orish tizimlari, loyihalash me'yorlaridan» olinadi (ilovada 13-jadval).

Kanaldagi suv oqimining o'rtacha tezligini aniqlaymiz:

$$g = \frac{Q}{\omega}$$

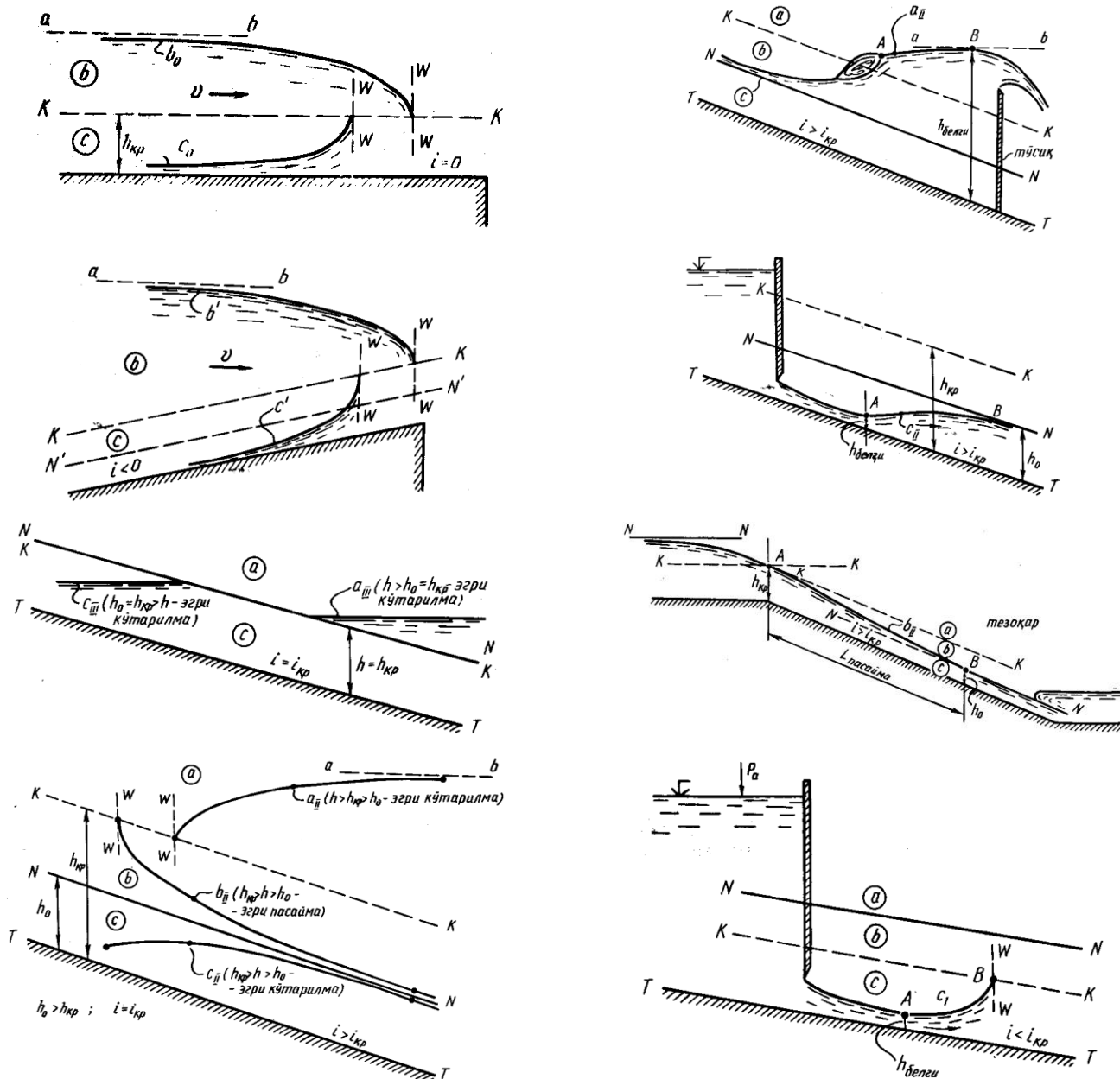
Tezliklarni solishtiramiz, agar $g > g_n$ bo'lsa, kanalni loyqa bosmaydi.

II. SUV OQIMINING OCHIQ O'ZANDAGI NOTEKIS HARAKATI

II.1. Notekis harakat. Asosiy tushunchalar

Amaliy masalalarni echishda oqimning notekis harakati bilan bog'liq jarayonlarni o'rganishga to'g'ri keladi. Bunday jarayonlar quyidagi holatlarda vujudga keladi (7-rasm): $h \neq (const)_e$, $Q \neq (const)_e$, $i \neq J_p \neq J_e$.

Ochiq o'zandagi suvning notekis harakatiga misollar.



7-rasm - Ochiq o'zandagi suvning notekis harakatiga misollar.

Oqim notekis harakatini to'la ifodalash uchun bir necha tushunchalarni kiritamiz:

1. Kesim solishtirma energiyasi:

$$\mathfrak{E} = h + \frac{\alpha \mathfrak{G}^2}{2g} \text{ yoki } \mathfrak{E} = h + \frac{\alpha Q^2}{2g\omega^2}$$

bu erda: h – oqim chuqurligi;

$\alpha = 1,0 \dots 1,1$ – Koriolis koeffisienti;

ω - kanal harakat (tirik) kesimi yuzasi;

\mathfrak{G} - o'rtacha tezlik: $\mathfrak{G} = \frac{Q}{\omega}$.

2. Kritik chuqurlik (h_{kp}) – oqimning eng kichik (minimum) energiyasiga mos keluvchi chuqurlik. Kritik chuqurlikni aniqlashning bir necha usullari mavjud bo'lib, u haqda keyingi bo'limlarda batafsil to'xtalamiz. O'zanda kritik chuqurlikka mos suv sathini «K-K» bilan belgilaymiz (7-rasm).

3. Kritik nishablik (i_{kp}) – oqim kritik holatiga mos keluvchi nishablik:

$$i_{kp} = \frac{Q^2 n^2}{\omega_{kp}^2 R_{kp}^{4/3}} = \left| \frac{Qn}{\omega_{kp} R_{kp}^{2/3}} \right|^2,$$

bu erda: ω_{kp} va R_{kp} - kritik chuqurlik (h_{kp}) uchun hisoblangan kanal tirik kesim yuzasi va gidravlik radiusi.

Oqimning kritik holat tenglamasini keltirib chiqarish uchun ifodadan foydalanamiz:

$$\mathfrak{E} = h + \frac{\alpha Q^2}{2g\omega^2}$$

$$\frac{\omega_{kp}^3}{B_{kp}} = \frac{\alpha Q^2}{g},$$

bu erda: ω_{kp} - kritik holatdagi harakat kesimi yuzasi;

Q – oqim sarfi;

B_{kp} - kritik holatdagi oqim sathining eni.

4. Kinetiklik parametri (Π_k) yoki Frud soni. Oqimning energetik holatini ifodalovchi parametr bo'lib, ikkilangan kinetik energiyaning potensial energiyaga nisbati:

$$B = \frac{d\omega}{dh},$$

$$F_r = \frac{\alpha \mathcal{G}^2}{gh}; \quad \mathcal{G} = \frac{Q}{\omega} \text{ ekanligidan foydalanib:}$$

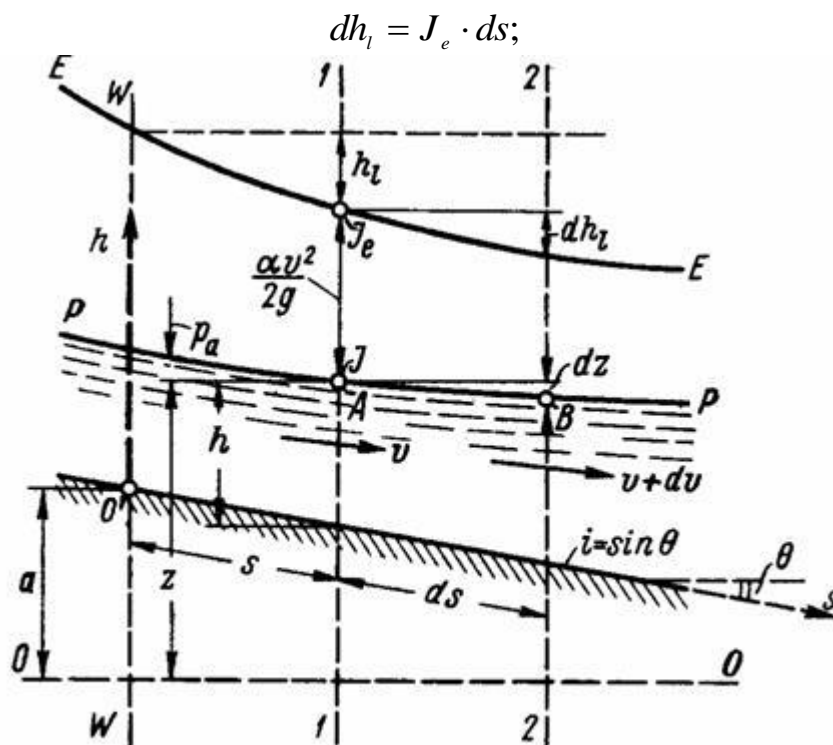
$$\Pi_\kappa = \frac{\alpha \mathcal{G}^2}{gh} = \frac{\alpha Q^2}{g} \cdot \frac{B}{\omega^3} = \frac{\alpha Q^2}{g\omega^2} \cdot \frac{B}{\omega}$$

- $\Pi_\kappa = 1,0$ – oqimning kritik holati;
- $\Pi_\kappa < 1,0$ – oqimning sokin (tinch) holati;
- $\Pi_\kappa > 1,0$ – oqimning notinch holati.

5. Normal chuqurlik (h_0) – oqimning tekis harakatiga mos keluvchi chuqurlik. O'zanda normal chuqurlikka mos keladigan suv sathini - «N-N» bilan belgilaymiz (7 - rasm).

II.2 Barqaror notekis harakat differensial tenglamasi

Barqaror notekis harakat differensial tenglamasining bir necha ko'rinishlari mavjud bo'lib, qaralayotgan gidravlik jarayonga bog'liq ravishda quyidagilarcha ifodalash mumkin.



Gidravlik nishablik $J_e = \frac{dh}{ds} = \frac{d}{ds} \left(z + \frac{p}{\gamma} + \frac{\alpha \vartheta^2}{2g} \right) = \frac{d\vartheta}{ds};$
 $J_e = \frac{dz}{ds} + \frac{d}{ds} \left(\frac{\alpha Q^2}{2g\omega^2} \right);$

$$\boxed{J_e = i + \frac{d}{ds} \left(\frac{\alpha \vartheta^2}{2g} \right)} \quad \text{- Notekis harakat differensial tenglamasi (I).}$$

Oqim bo'yicha (s) energiyaning o'zgarishi:

$$\frac{d\vartheta}{ds} = \frac{dh}{ds} + \frac{d}{ds} \left(\frac{\alpha Q^2}{2g\omega^2} \right), \text{ yoki}$$

$$\frac{d\vartheta}{ds} = i - J_e,$$

bu erda: s – oqim uzunligi; ϑ – oqimning solishtirma energiyasi; i – oqim tubining nishabligi; J_e – gidravlik nishablik.

$$\frac{d}{ds} \left(\frac{1}{\omega^2} \right) = \frac{-2}{\omega^3} \frac{d\omega}{ds} = \frac{-2}{\omega^3} \left(\frac{d\omega}{dh} \frac{dh}{ds} + \frac{\partial \omega}{\partial s} \frac{ds}{ds} \right).$$

$d\omega = Bdh$ ekanligidan foydalanib

$$\boxed{\frac{dh}{ds} = \frac{i - J_e + \frac{\alpha Q^2}{g\omega^3} \frac{\partial \omega}{\partial s}}{1 - \frac{\alpha Q^2 B}{g\omega^3}}}$$

- Notekis harakat differensial tenglamasi (II).

Prizamatik kanallar uchun notekis harakat differensial tenglamasi (II)ni quyidagicha ezish mumkin : Prizamatik kanallar uchun $\omega = f(h)$; ekanligidan

(II) tenglamadan $\frac{\partial \omega}{\partial s} = 0$ deb qabul qilamiz, u xolda

$$\frac{dh}{ds} = \frac{i - J_e}{1 - \frac{\alpha Q^2 B}{g\omega^3}};$$

yoki

$$\frac{dh}{ds} = \frac{i - J_e}{1 - II_K};$$

Bu erda: II_K - kinetiklik parametri;

$$\omega^2 C^2 R = K^2; \quad J_e = \frac{Q^2}{\omega^2 C^2 R}; \quad K_0 = \frac{Q}{\sqrt{i}}; \text{ ekanligidan foydalanib,}$$

notekis harakat differensial tenglamasining Π -ko'rinishini quyidagicha yozish ($\frac{dh}{ds} = \frac{dh}{dl}$) mumkin:

$i > 0$ bo'lganda:

$$\frac{dh}{dl} = \frac{i \left(1 - \frac{K_0^2}{K^2} \right)}{1 - \Pi_\kappa}; \quad (1)$$

$i = 0$ bo'lganda:

$$\frac{dh}{dl} = \frac{Q^2}{K^2 \Pi_\kappa - 1}; \quad (2)$$

$i < 0$ bo'lganda:

$$\frac{dh}{dl} = \frac{|i| + \frac{Q^2}{K^2}}{\Pi_\kappa - 1}, \quad (3)$$

bu erda:

$$K = \omega \cdot C \sqrt{R};$$

K – sarf moduli;

C – Shezi koeffisienti;

R – gidravlik radius.

II.3. Erkin sirt egriligining shakli

Oqimning notekis harakati bilan bog'liq bo'lgan jarayonlarni o'rganishda erkin sirt egriligining shaklini aniqlash katta ahamiyatga ega.

Adabiyotlarda bu tushuncha – erkin egri suv sathi chizig'i (EESSCH) deb ham yuritiladi.

Erkin sirt egriligini aniqlashda prizmatik kanallar guruh va sinflarga ajratiladi (8 - rasm).

O'zan tubining nishabligiga qarab A, B, C – guruhlar mavjud:

1) $i > 0$ bo'lganda A -guruh;

2) $i = 0$ bo'lganda B -guruh;

3) $i < 0$ bo'lganda C -guruh.

A -guruh o'z navbatida quyidagi sinflarga ajratiladi (8-rasm):

1) $i < i_{kr}; \quad h_0 > h_{kr}$ bo'lganda 1 – sinf;

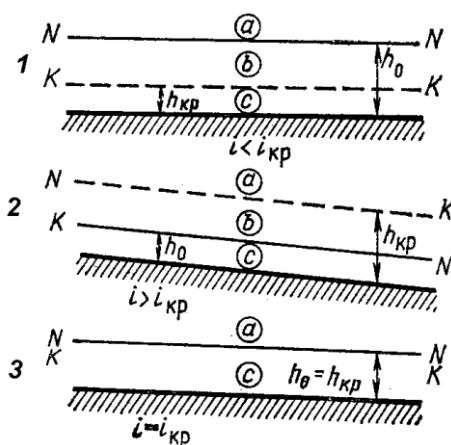
2) $i > i_{kr}$; $h_0 < h_{kr}$ bo'lganda 2– sinf;

3) $i = i_{kr}$; $h_0 = h_{kr}$ bo'lganda 3 – sinf,

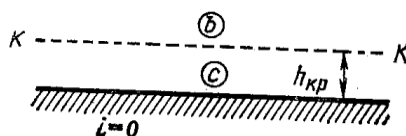
bu erda: h_0 – normal chuqurlik;

h_{kr} -kritik chuqurlik.

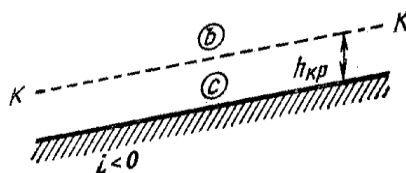
1) A guruh



2) B guruh



3) C guruh



8 - rasm. Erkin sirt egriliklarini prizmatik kanallarda guruh va sinflarga ajratilishi

Har xil guruhlardagi kanallarda oqayotgan suv yana a , b , c sohalarga ajraladi (9 - rasm). Rasmdagi $N-N$ chizig'i – normal chuqurlikka mos keladigan chiziq; $K-K$ chizig'i – kritik chuqurlikka mos keladigan chiziq. $N-N$ va $K-K$ chiziqlar kanal tubiga parallel o'tkaziladi.

Sohalarning joylashishi quyidagicha:

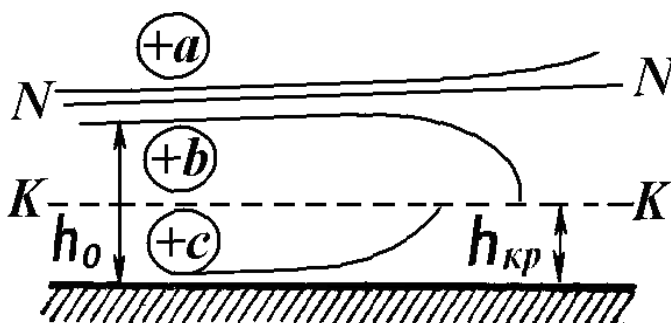
a – soha $K-K$ va $N-N$ chiziqlardan yuqorida: $h > h_0 > h_{kr}$;

b –soha $N-N$ va $K-K$ chiziqlarining orasida: $h_0 > h > h_{kr}$ yoki $h_{kr} > h > h_0$;

c – soha $N-N$ va $K-K$ chiziqlaridan pastda: $h < h_{kr} < h_0$ yoki $h < h_0 < h_{kr}$.

Erkin sirt egriligini aniqlash quyidagi tartibda amalga oshiriladi:

1. Kanalning gidravlik elementlari asosida kanal guruhi va sinfi aniqlanadi.
2. Kanalning kritikalik va normal chuqurliklari aniqlanadi.
3. Berilgan chuqurlik uchun erkin sirt egriligi sohasi, shakli aniqlanadi.



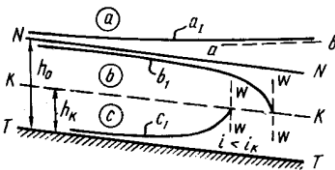
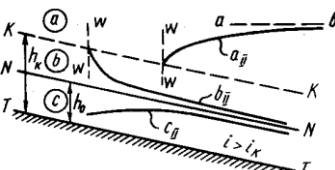
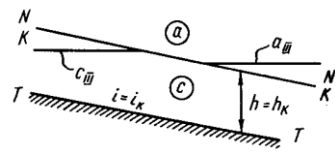
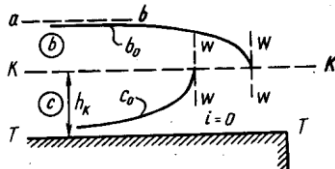
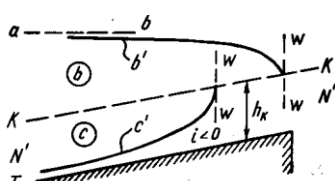
9 - rasm A - guruhdagi o'zan sxemasi

Buning uchun quyidagi xulosalarga amal qilinadi:

1. $N-N$ - chizig'iga erkin suv sathi assimpotik yaqinlashib boradi.
2. $K-K$ - chizig'iga erkin suv sathi normal bo'yicha yaqinlashadi.
3. Chuqurlik h chegarasiz kattalashgan sari, egri sathlar assimpotik gorizontaal chiziqqacha yaqinlashib boradilar.
4. Kritik chuqurliklar chizig'ini kesib o'tganda, teoretik ekstrapolyasiya yordami bilan chizilgan egri chiziq sathlari kritik chuqurliklar chizig'iga ($K-K$) normal bo'yicha (90° burchagi bilan) yo'nalgan.
5. A - guruhdagi o'zanalarda «a» sohada faqat ko'tarilma (oshib boruvchi) egri sirtlari mavjud bo'ladi: « $(+a_1)$ », « $(+a_2)$ », « $(+a_3)$ » (2.1 -jadval).
6. «b» sohalarda faqat pasayma (kamayib boruvchi) egri chiziq sirtlari bo'ladi: « $(-b_1)$ », « $(-b_2)$ », « $(-b_0)$ », « $(-b^1)$ ».
7. «s» sohada esa faqat ko'tarilma egri chiziq sirtlari bo'ladi: « $(+c_1)$ », « $(+c_2)$ », « $(+c_0)$ », « $(+c^1)$ ». (2.1 -jadval)

Erkin sirt egriligining shakllari

8 - jadval

Oqim chuqur-ligi	O'zan tubi nishabligi		Sohalar	Kattaliklar			EESSCH shakli	EESSCH shaklining ko'rinishi
				$1 - \left(\frac{K_0}{K}\right)^2$	$1 - \Pi_\kappa$	$\frac{dh}{dl}$		
1	2	3	4	5	6	7	8	9
$h_0 > h_{kp}$	$i > 0$	$i < i_{kp}$	a_I	> 0	> 0	> 0	Egri ko'tarilma	
			b_I	< 0	> 0	< 0	Egri pasayma	
			c_I	< 0	< 0	> 0	Egri ko'tarilma	
$h_0 < h_{kp}$		$i > i_{kp}$	a_{II}	> 0	> 0	> 0	Egri ko'tarilma	
			b_{II}	> 0	< 0	> 0	Egri pasayma	
			c_{II}	< 0	< 0	> 0	Egri ko'tarilma	
$h_0 = h_{kp}$		$i = i_{kp}$	a_{III}	> 0	> 0	> 0	Egri ko'tarilma	
			c_{III}	< 0	< 0	> 0	Egri ko'tarilma	
$h = \infty$		$i = 0$	b_0	--	> 0	< 0	Egri pasayma	
	c_0		--	< 0	> 0	Egri kutarilma		
$h = \infty$	$i < 0$	b'	--	> 0	< 0	Egri pasayma		
		c'	--	< 0	> 0	Egri ko'tarilma		

II.4 Notekis harakat differensial tenglamasini integrallash

II.4.1 B.A. Baxmetev usuli

Notekis harakat differensial tenglamasini (1) quyidagi holatlarda integrallashni ko'rib chiqamiz:

1. A-guruh: $i > 0$ bo'lganda:

$$1 - \Pi_k = 1 - \frac{\alpha Q^2}{g} \cdot \frac{B}{\omega^3} = \dots = 1 - \frac{\alpha i C^2 B}{g \chi} \cdot \left(\frac{K_0^2}{K^2} \right)$$

$$j = \frac{\alpha \cdot i C^2 B}{g \chi}$$

bu erda: C – Shezi koeffisienti: $C = \frac{1}{n} \cdot R^{1/6}$ bo'lganda

$$j = \frac{\alpha \cdot i}{g n^2} \cdot R^{1/3} \cdot \frac{B}{\chi}$$

χ - xo'llangan perimetr.

U holda notekis harakat differensial tenglamasi (1) ni quyidagicha yozamiz:

$$\frac{dh}{dl} = i \frac{1 - \frac{K_0^2}{K^2}}{1 - j \frac{K_0^2}{K^2}} = i \frac{\frac{K^2}{K_0^2} - 1}{\frac{K^2}{K_0^2} - j}$$

yoki

$$\frac{dl}{dh} = \frac{1}{i} \cdot \frac{\frac{K^2}{K_0^2} - j}{\frac{K^2}{K_0^2} - 1}, \quad (4)$$

bu erda $K=f(h)$: $j=f(h)$ $dl=f(h)dh$, ya'ni tenglamadagi (4) barcha ifodalar - h chuqurlik funksiyasidir.

$$\int_{l_1}^{l_2} dl = \int_{h_1}^{h_2} f(h) dh$$

B.Baxmetevning ko'rsatkichli funksiyasidan foydalanib:

$$\left(\frac{K}{K_0} \right)^2 = \left(\frac{h}{h_0} \right)^x, \quad (5)$$

x -uzanning gidravlik ko'rsatkichi:

$$x \approx 2 \frac{\lg \frac{K}{K_0}}{\lg \frac{h}{h_0}} \approx const$$

(4) formulani (5) asosida quyidagicha yozamiz:

$$idl = \frac{\eta^x - j}{\eta^x - 1} dh$$

bu erda: $\eta = \frac{h}{h_0}$ - nisbiy chuqurlik,

$$dh = h_0 d\eta$$

$$\frac{idl}{h_0} = d\eta - (1 - \bar{j}) \frac{d\eta}{1 - \eta^x} \quad \int \frac{d\eta}{1 - \eta^x} = \varphi(\eta) + C$$

U holda $i > 0$ holat uchun (4) tenglama quyidagi ko'rinishga ega:

$$\frac{il}{h_0} = \eta_2 - \eta_1 - (1 - \bar{j}) \cdot [\varphi(\eta_2) - \varphi(\eta_1)], \quad (6)$$

bu erda:

$$\bar{j} = \frac{\overline{aiC^2B}}{g\chi}, \quad (7)$$

$$\bar{h} = \frac{h_1 - h_2}{2}, \quad (8)$$

$\varphi(\eta)$ funksiya qiymati maxsus jadvallarda keltirilgan (R.R.Chugaev, P-4 jadval, 573 bet, yoki shu qo'llanmaning ilovadagi 14-jadvalidan).

Misol: Kanalning quyidagi elementlari berilgan: $b; m; n; i; h_0; h_1; h_2$. Egri sirt egriligini va uzunligini aniqlang: l ?

Echish: (6) tenglamadan

$$l = \frac{h_0}{i} (A_2 - A_1);$$

$$A_2 = \eta_2 - (1 - \bar{j})\varphi(\eta_2),$$

$$A_1 = \eta_1 - (1 - \bar{j})\varphi(\eta_1)$$

(7), (8) ifodalardan foydalanib, l -ni aniqlaymiz.

2. B-guruh: $i=0$ holat uchun:

$$\left| \frac{K}{K_k} \right|^2 = \left| \frac{h}{h_k} \right|^x$$

u holda yuqorida bajarilgan tartib asosida $i=0$ holat uchun (2) tenglama quyidagi ko'rinishga ega bo'ladi:

$$\frac{i_k \cdot l}{h_k} = (\bar{j} - 1)(\xi_2 - \xi_1) - [\varphi(\xi_2) - \varphi(\xi_1)]$$

$$\xi = \frac{h}{h_{kp}}; \quad \bar{j}_k = \frac{\alpha i_k \cdot \bar{C}^2 \cdot \bar{B}}{g \bar{\chi}}; \quad x = \frac{2 \lg \frac{\bar{K}}{K_k}}{\lg \frac{\bar{h}}{h_k}}.$$

3. C-guruh: $i < 0$ holat uchun:

$$\left| \frac{K}{K_0^1} \right|^2 = \left| \frac{h}{h_0^1} \right|^2$$

u holda $i < 0$ holat uchun (3) tenglama quyidagi ko'rinishga ega:

$$\frac{i^I \cdot l}{h_0^I} = -(\xi_2 - \xi_1) + (1 + \bar{j}^I) [\varphi(\xi_2) + \varphi(\xi_1)]$$

$$\xi = \frac{h}{h_0^I}; \quad \bar{j}^I = \frac{\alpha i \bar{C}^2 \bar{B}}{g \bar{\chi}}; \quad x = \frac{2 \lg \left(\frac{\bar{K}^I}{K_0^I} \right)}{\lg \left(\frac{\bar{h}}{h_0^I} \right)}$$

bu erda i^I - absolyut nishablik, h_0^I - faraz qilingan normal chuqurlik.

$$K_0^I = \frac{Q}{\sqrt{i^I}}.$$

II.4.2 To'suvchi to'g'on inshoot oldidagi erkin sirt egri chizig'i uzunligini aniqlash

Masala: O'zanda harakat notekis bo'lgan holda, suv oqimining chuqurliklari oshib yoki kamayib borishi mumkin. Oqimning erkin sirt chizig'i egri sirt shaklida bo'ladi. Agar o'zanda chuqurliklar oshib ketadigan bo'lsa – unda erkin sirt *egri ko'tarilma* chizig'i deb aytiladi.

Magistral kanalda to'suvchi to'g'on inshooti oldida suv oqimining harakati notekis bo'lib, kanaldagi suv chuqurligi ma'lum foizga oshadi deb olamiz.

Gidravlik hisoblashning asosiy maqsadi – erkin sirt chizig'ining turini aniqlash va uni B.A.Baxmetev usuli bilan qurish.

A. Masalani echish tartibi

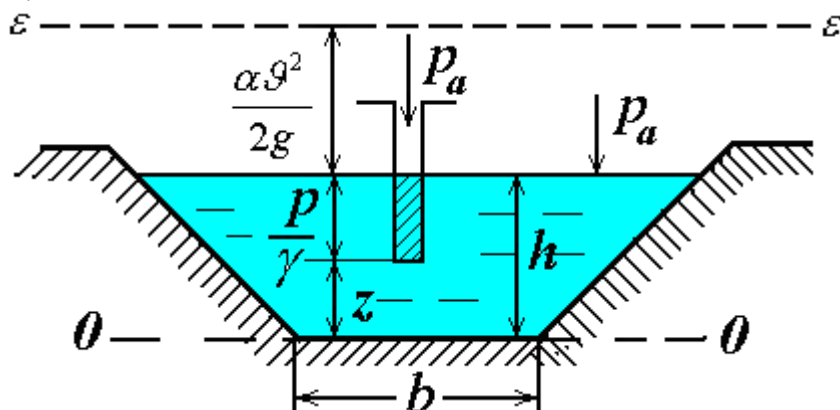
Kanalning quyidagi elementlari berilgan bo'lsin: kanaldagi suv sarfi Q_{MK} , kanal tubining eni b_{cm} , qiyalik koeffisienti m ; g'adir-budirlik koeffisienti n ; to'g'on inshooti oldidagi suv chuqurligi $h_{ber}=(1,15\dots 1,20)h_0$.

I Magistral kanal tubining bo'ylama qirqimi va planini masshtabda chizamiz (masala shartiga qarab).

II. Magistral kanaldagi erkin egri sirt chizig'i turini aniqlaymiz
Buning uchun avval kanaldagi kritik chuqurlikni hisoblab topishimiz kerak.
Kritik chuqurlikni aniqlashni bir necha usullarini ko'rib chiqamiz.

a) **Birinchi usul:** Kritik chuqurlikni *kesimning solishtirma energiyasi grafigi* yordami bilan aniqlash.

Kesimning solishtirma energiyasi “ \mathcal{E} ” – o'zan kesimining eng pastda joylashgan nuqtadan o'tkazilgan taqqoslash tekisligiga nisbatan hisoblangan to'la solishtirma energiyadir.



$$\mathcal{E} = z + \frac{P}{\gamma} + \frac{\alpha v^2}{2g} = h + \frac{\alpha v^2}{2g}$$

Kesimning solishtirma energiyasi eng kichik qiymatiga mos kelgan chuqurlikka **kritik chuqurlik** deb aytiladi.

$$\mathcal{E} = h + \frac{\alpha \mathcal{Q}^2}{2g} \quad \text{yoki} \quad \mathcal{E} = h + \frac{\alpha Q^2}{2g\omega^2}$$

bu erda: $\alpha = 1,0 \dots 1,1$ – Koriolis koeffitsienti;

$\omega = (b + mh)h$ - trapesiya shaklidagi kanal ko'ndalang kesimi yuzasi;

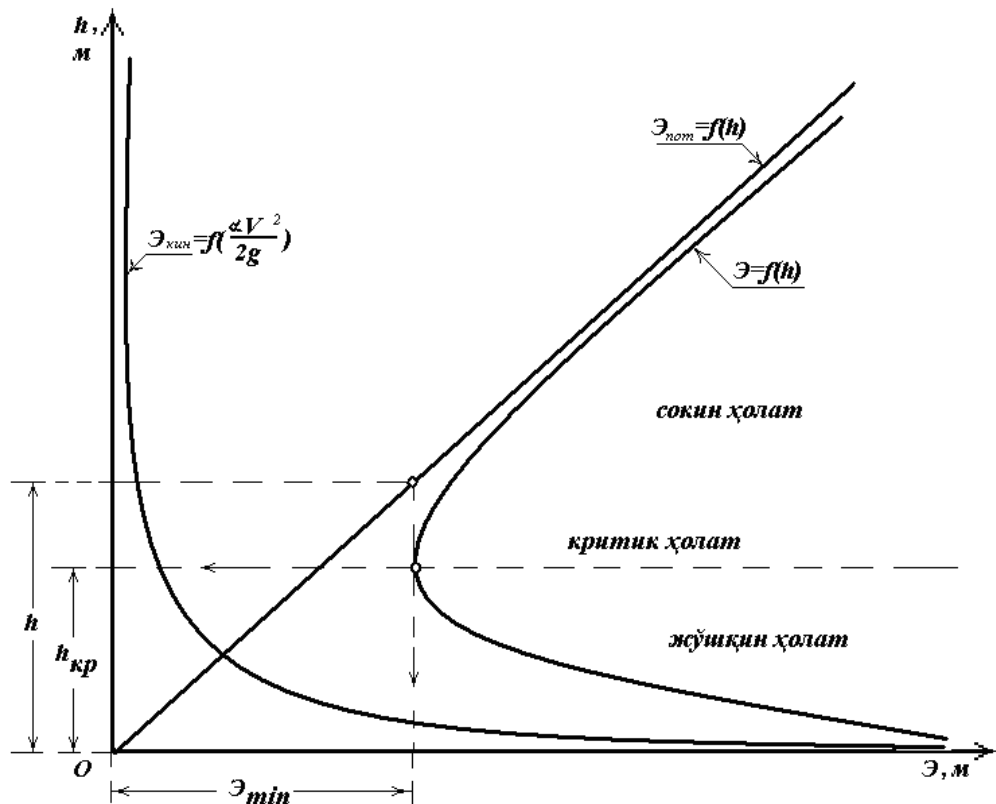
$\mathcal{Q} = \frac{Q}{\omega}$ - kanalda suv oqimining o'rtacha tezligi.

Hisoblashni jadvalda tanlash usuli yordamida o'tkazamiz. Oqim chuqurligiga bir necha qiymatlar berib, ularga mos keladigan kesim solishtirma energiyasini hisoblaymiz:

9 - jadval

$h,$ m	$\omega,$ m	$\mathcal{Q},$ m/s	$\frac{\alpha \mathcal{Q}^2}{2g},$ m	$\mathcal{E} = h + \frac{\alpha \mathcal{Q}^2}{2g},$ m

Jadvalga asosan $\mathcal{E} = f(h)$ grafigini tuzamiz. Bu grafikda energiyaning eng kichik qiymati \mathcal{E}_{\min} -ga to'g'ri keluvchi chuqurlik - kritik chuqurlik h_{kr} bo'ladi.



10-rasm - Kesimning solishtirma energiyasi grafigi

b) *Ikkinchi usul* – suv oqimining *kritik holat grafigidan*.

Oqimning kritik holat tenglamasi quyidagicha yoziladi:

$$\frac{\alpha Q^2}{g} = \frac{\omega_{kp}^3}{B_{kp}} \quad (1)$$

Bu tenglama tanlash usulida echiladi. Suv chuqurligiga har xil qiymatlar berilib, ular uchun quyidagi nisbatni aniqlaymiz:

$$\frac{\omega^3}{B},$$

bu erda: $\omega = (b + mh)h$ - kanal tirik kesimi yuzasi;

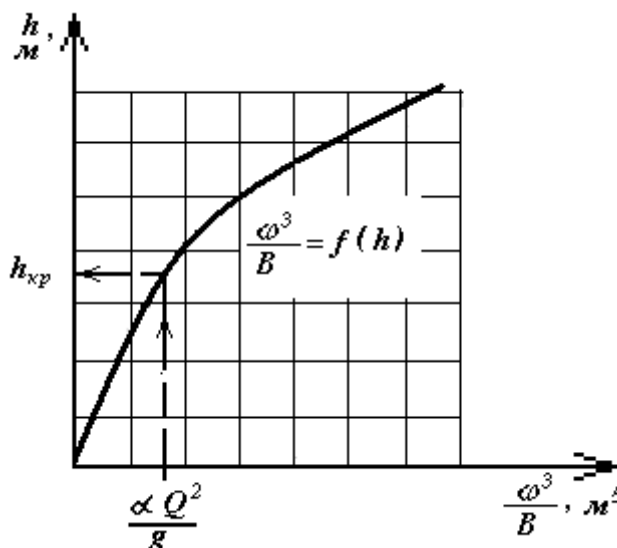
$B = b + 2mh$ - berilgan chuqurlikda oqim tirik kesim sathidagi kanalning kengligi.

Hisobni jadvalda keltiramiz:

10 - jadval

$h,$ m	$\omega,$ m^2	$V,$ m	$\omega^3,$ m^6	$\frac{\omega^3}{B},$ m^5	$\frac{\alpha Q^2}{g},$ m^5

Jadvaldagi aniqlangan kattaliklarga qarab, $\frac{\omega^3}{B} = f(h)$ grafigi chiziladi:



11 – rasm - Kritik holat grafigi

Kritik holat shartiga ko'ra $\frac{\omega_{kp}^3}{B_{kp}} = \frac{\alpha \cdot Q^2}{g}$, demak ma'lum bo'lgan $\frac{\alpha \cdot Q^2}{g}$ ga

qarab kritik chuqurlik qiymati h_{kp} grafikdan olinadi (11-rasm).

v) **Uchinchi usul**: – I.I. Agroskin usuli.

Hisoblash formulasi:

$$h_{kp} = K \cdot h_{KII}$$

Trapeziya shaklidagi kanallar uchun kritik chuqurlikni quyidagi tartibda aniqlaymiz:

1. To'g'ri to'rtburchak shaklidagi kanal uchun kritik chuqurlik:

$$h_{KII} = \sqrt[3]{\frac{\alpha Q^2}{b^2 g}}$$

2. Yordamchi koefitsient:

$$\sigma_n = \frac{m h_{KII}}{b_{cm}}$$

m va b_{sm} - magistral kanal uchun olinadi.

3. $K = 1 - \frac{\sigma_n}{3} + 0.105 \sigma_n^2$ (yoki R.R. Chugaev kitobidan, 239 - betdagi 7-16

chizmadan « σ_n » -ga qarab, « K » qiymatini olamiz).

11 - jadval

σ_n	0.01	0.02	0.04	0.06	0.08
K	0.997	0.993	0.987	0.980	0.973

4. Magistral kanaldagi kritik chuqurligini aniqlaymiz:

$$h_{kp} = K \cdot h_{KII}$$

g) **Turtinchi usul** - TIMI "Gidravlika" kafedrasida ishlab chiqilgan usul (A.M. Arifjanov usuli):

$$h_{kp} = \frac{b}{4M} \left(\sqrt{1 + \frac{8 \cdot m \cdot h_{KII}}{b}} - 1 \right).$$

$$M = m^2 / \sqrt{1 + m^2}$$

III. Magistral kanaldagi berilgan tub nishabligini ($i > 0$) kritik nishablik bilan solishtiramiz. SHunda erkin sirt egri chiziqning guruhini va sinfini aniqlaymiz.

Magistral kanal berilgan tubining nishabligi kritik nishablikdan kichkina bo'lsa (demak $i_{MK} < i_{kp}$), magistral kanal "A" guruh, 1-chi sinfga kiradi.

Berilish bo'yicha magistral kanaldagi to'suvchi inshoot oldidagi suv chuqurligi oshib boradi, demak berilgan chuqurlik $h_{\text{ber}} > h_0 > h_{\text{kp}}$, demak magistral kanaldaning erkin sirtida - **egri ko'tarilma** chizig'i hosil bo'ladi: $+a_I$.

IV. Magistral kanaldagi kritik nishabligini ($h=h_{\text{kr}}$) suv oqimining tekis holatdagi tenglamasidan aniqlash mumkin:

$$i_{\text{kp}} = \frac{Q^2}{\omega_{\text{kp}}^2 C_{\text{kp}}^2 R_{\text{kp}}} \quad \text{yoki} \quad i_{\text{kp}} = \left| \frac{Qn}{\omega_{\text{kp}} R_{\text{kp}}^{2/3}} \right|^2$$

bu erda: $\omega_{\text{kp}}, \chi_{\text{kp}}, R_{\text{kp}}, C_{\text{kp}}$ va B_{kp} - kritik chuqurlik uchun hisoblangan kanalning gidravlik elementlari.

$$C = \frac{1}{n} R_{\text{kp}}^{1/6} \quad \cdot \text{SHezi koeffisienti (Manning formulasi), } (m^{0,5}/s);$$

$$\omega = (b + mh_{\text{kp}})h_{\text{kp}} \quad - \text{tirik kesim yuzasi, } (m^2);$$

$$\chi_{\text{kp}} = b + 2h_{\text{kp}}\sqrt{1+m^2} \quad - \text{xo'llangan perimetr, } (m);$$

$$R_{\text{kp}} = \frac{\omega_{\text{kp}}}{\chi_{\text{kp}}} \quad - \text{gidravlik radius, } (m).$$

YOki suv oqimining kritik holat tenglamasidan:

$$B_{\text{kp}} = b + 2mh_{\text{kp}} \quad \Rightarrow \quad i_{\text{kp}} = \frac{g \cdot \chi_{\text{kp}}}{\alpha \cdot C_{\text{kp}}^2 \cdot B_{\text{kp}}}$$

V. **Kinetiklik parametri** (Π_{κ}) – ikkilangan kinetik energiyaning potensial energiyaga bo'lgan nisbati:

$$\Pi_{\kappa} = \frac{\alpha \cdot Q^2}{g} \cdot \frac{B}{\omega^3} = \frac{\alpha \cdot Q^2}{g \cdot \omega^2} \cdot \frac{B}{\omega} = \frac{\alpha \cdot \mathcal{G}^2}{g \cdot h_{\text{yp}}}$$

bu erda: $h_{\text{yp}} = \frac{\omega}{B}$.

Agar: $h = h_{\text{kp}}$ bo'lsa, $\Pi_{\kappa} = 1,0$ – kritik holat;

$h > h_{\text{kp}}$ bo'lsa, $\Pi_{\kappa} < 1,0$ – tinch (sokin) holat;

$h < h_{\text{kp}}$ bo'lsa, $\Pi_{\kappa} > 1,0$ – notinch (jo'shqin) holat.

Bu parametr oqimning holatini aniqlaydi, oqimning kinetiklik darajasini ko'rsatadi.

VI. Suv oqimining normal chuqurligini aniqlaymiz (h_0). Tekis harakatdagi chuqurlikka **normal chuqurlik** deb aytiladi.

Normal chuqurlikni aniqlash usullari kullanmaning 1-kismida batafsil yozilgan.

II.4.2.1 Egri ko'tarilma chiziqning uzunligini aniqlash va qurish

Yuqoridagi gidravlik hisoblarni bajarib qo'yilgan masalani echish uchun B.A. Baxmetev (6) tenglamasidan foydalanamiz:

$$\frac{il}{h_0} = \eta_1 - \eta_2 - (1 - \bar{j}_{yp})[\varphi(\eta_2) - \varphi(\eta_1)]$$

Bu tenglamani aniqlashi kerak bo'lgan « l »-ga nisbatan hisoblasak, quyidagi hisoblash tenglamasini olamiz:

$$l = \frac{h_0}{i} \{[\eta_2 - (1 - \bar{j})\varphi(\eta_2)] - [\eta_1 - (1 - \bar{j})\varphi(\eta_1)]\} = (A_2 - A_1) \frac{h_0}{i}$$

bu erda: $A_1 = \eta_1 - (1 - \bar{j})\varphi(\eta_1)$;

$$A_2 = \eta_2 - (1 - \bar{j})\varphi(\eta_2)$$

l – ikkita kesim orasidagi masofa (har bittasining chuqurliklari mos ravishda h_1 va h_2).

Kesimlarning va chuqurliklarning tartib raqamlari yuqoridan boshlab, oqimning yo'nalishi bo'yicha belgilanadi.

$$\eta_1 = \frac{h_1}{h_0}; \eta_2 = \frac{h_{21}}{h_0} - 1-1 \text{ va } 2-2 \text{ kesimlardagi nisbiy chuqurliklar;}$$

i, h_0 – kanal tubining nishabligi va normal chuqurligi;

$$\bar{j}_{yp} = \frac{\alpha i \bar{C}^2 \bar{B}}{g \bar{\chi}} - \text{o'rtacha ishqalanish nishabligi, suv chuqurligining o'rtacha}$$

qiymati uchun hisoblanadi:

$$\bar{h}_{o'r} = \frac{h_1 + h_2}{2},$$

$\bar{C}, \bar{B}, \bar{\chi}, \bar{\omega}$ - o'rtacha chuqurlik $\bar{h}_{o'r}$ uchun hisoblangan kanalning gidravlik elementlari:

$$\bar{B} = b + 2m\bar{h}; \quad \bar{\omega} = (b + m\bar{h})\bar{h}; \quad \bar{\chi} = b + 2\bar{h}\sqrt{1 + m^2}; \quad \bar{R} = \frac{\bar{\omega}}{\bar{\chi}};$$

$\alpha = 1,1$ – kinetik energiyaning korrektivi – Koriolis koeffisienti, oqimning tirik kesim bo'yicha tezliklarning notekis taqsimlanishini hisobga oluvchi koeffisient;

$\varphi(\eta_1), \varphi(\eta_2)$ - nisbiy chuqurlik funksiyalari, jadvallardan o'zanning gidravlik ko'rsatkichi “ x ”-ga qarab olinadi (CHugaev R.R., 573-579 bet, yoki shu qo'llanmani ilovadagi 14-jadvaldan).

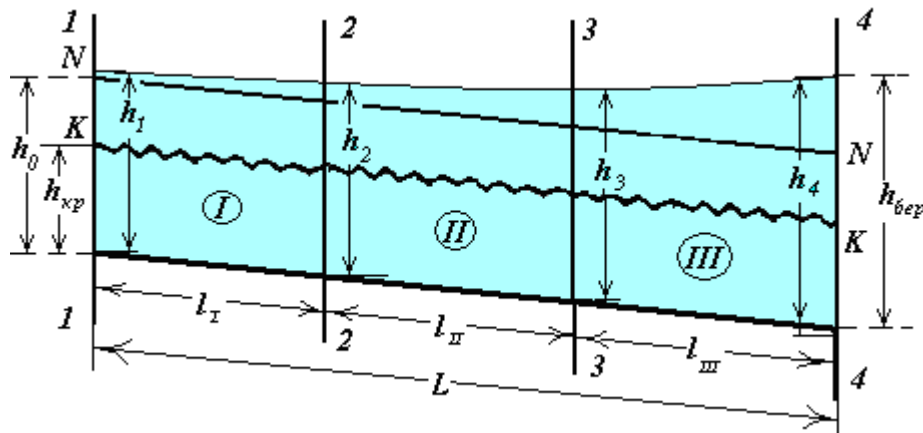
Gidravlik ko'rsatkichni aniqlash formulasi:

$$x = \frac{2(\lg \bar{K}_{o'r} - \lg K_0)}{\lg \bar{h}_{o'r} - \lg h_0} = 2 \frac{\lg \frac{\bar{K}_{o'r}}{K_0}}{\lg \frac{\bar{h}_{o'r}}{h_0}};$$

Bu erda $\bar{K}_{o'r}, K_0$ - mos ravishda $\bar{h}_{o'r}$ va h_0 uchun hisoblangan sarf modullari:

$$\bar{K}_{o'r} = \bar{\omega}_{o'r} \bar{C}_{o'r} \sqrt{\bar{R}_{o'r}} = \frac{\bar{\omega}_{o'r} \bar{R}_{o'r}^{2/3}}{n}$$

$$K_0 = \frac{\omega_0 R_0^{2/3}}{n}$$



11 –rasm - B.A. Baxmetev usulida sath egriligini aniqlash sxemasi

B.A.Baxmetev usuli bilan echish uchun magistral kanal hisoblash sxemasini tuzishimiz va bir necha kesimlarga bo'lishimiz kerak (kesimlarning tartib raqamlari oqim bo'yicha tepadan pastga qarab belgilanadi). Shu chizmada normal va kritik chuqurliklar chiziqlarini belgilaymiz $K-K, N-N$ (11 -rasm).

Gidravlik ko'rsatkich « x » va o'rtacha ishqalanish nishabligi « \bar{j} » qiymatini kanalning butun uzunligi bo'yicha bir xil deb qabul qilishimiz mumkin, demak o'rtacha chuqurlik:

$$\bar{h}_{yp} = \frac{h_0 + h_{ber}}{2};$$

bu erda: $h_{ber} = 1,2h_0$ –to'suvchi inshoot oldidagi berilgan chuqurlik.

Gidravlik ko'rsatkich « x » trapesiya shaklidagi kanallar uchun:

$$x = 3,4 \left(1 + \frac{m}{\beta + m}\right) - 1,4 \frac{m''}{\beta + m''}$$

bu erda: $\bar{\beta} = \frac{b}{\bar{h}_{yp}}$ - kanalning nisbiy kengligi;

$$m'' = 2\sqrt{1 + m^2}.$$

Aniqlangan o'zanning gidravlik ko'rsatkichi « χ » eng yaqin bo'lgan jadvaldagi qiymatgacha yaxlitlanadi.

Hisoblash oxirgi bo'limdan (kanal to'suvchi inshoot oldidan) boshlanadi.

Berilgan chuqurlikdan boshlab ($h_{ber}=h_4$), egri chiziqli sathning ko'rinishiga qarab, 3-3 kesimdagi chuqurlikka qiymatni beramiz.

Bizning misolda ko'tarilma (dimlangan) egri chiziqli sath hosil bo'ladi, demak yuqoriga borgan sari chuqurlik kamayadi:

$$h_3 = h_4 - \Delta h.$$

Δh – ikkita kesimlarning chuqurlik orasidagi farq ($\Delta h=0.02\dots 0.1$ metrgacha qabul qilinadi).

Keyin III qismi uchun B.A.Baxmetev formulasi orqali shu chuqurlik qaysi masofada hosil bo'lishini aniqlaymiz (l_{III}):

$$l_{III} = \frac{h_0}{i} \left\{ \eta_4 - \eta_3 - (1 - \bar{j}_{yp}) [\varphi(\eta_4) - \varphi(\eta_3)] \right\}$$

Avval $\frac{h_0}{i}$ ni hisoblab, keyin tenglamadagi qolgan qiymatlar jadvaldan olinib, hisoblanadi.

Undan keyin 3-3 kesimdagi chuqurlik ma'lum deb qabul qilinib, 2-2 kesimdagi chuqurlikka qiymatini beramiz.

$$h_2 = h_3 - \Delta h$$

II-chi qismi uchun o'rtacha chuqurlikni $\bar{h} = \frac{h_3 + h_2}{2}$ va shu qiymat uchun $\bar{\omega}$, $\bar{\chi}$, \bar{R} , \bar{B} - lar hisoblanadi.

Xuddi III-chi qismi uchun aniqlangan uzunlikka o'xshab, II qismidagi masofini (l_{II}) B.A.Baxmetev tenglamasi yordami bilan aniqlaymiz. SHu hisoblashni I-chi qism uchun ham qaytaramiz.

2-2 kesimdagi chuqurlik ma'lum deb, 1-1 kesimdagi chuqurlikni aniqlaymiz:

$$h_1 = h_2 - \Delta h$$

Hisoblash natijalarini jadvalda keltiramiz:

12 - jadval

No	\bar{h}_{yp}	$\bar{\omega}_{yp}$	$\bar{\chi}_{yp}$	\bar{R}_{yp}	χ	kesim lar №№	h	η	$\varphi(\eta)$	\bar{h}	$\bar{\omega}$	$\bar{\chi}$	\bar{R}	\bar{B}	\bar{j}	$1 - \bar{j}$	A	$A_2 - A_1$	l
III						4 3													
II						3 2													
I						2													

						1													
--	--	--	--	--	--	---	--	--	--	--	--	--	--	--	--	--	--	--	--

Bu erda:

$$\bar{h}_{\bar{y}p} = \frac{h_0 + h_{\sigma ep}}{2}$$

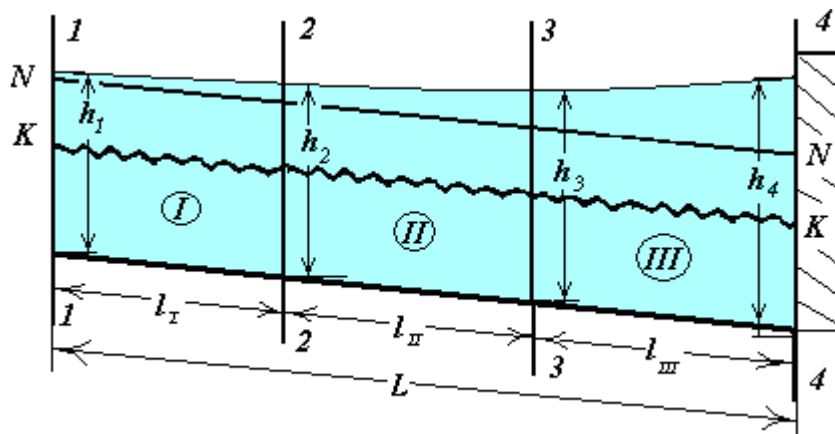
$\bar{h}_{\bar{y}p}$ - magistral kanaldagi ko'tarilma egri chiziqli sath hosil bo'ladigan soha uchun o'rtacha suv chuqurligi (*I-I* kesimdan to *4-4* kesimgacha).

$\bar{\omega}_{\bar{y}p}$, $\bar{\chi}_{\bar{y}p}$, $\bar{R}_{\bar{y}p}$ - shu o'rtacha chuqurlik $\bar{h}_{\bar{y}p}$ uchun hisoblangan kanalning gidravlik elementlari.

Ko'tarilma egri chiziqli sirtning umumiy uzunligi

$$l = l_I + l_{II} + l_{III}$$

$$\bar{h} = \frac{h_1 + h_2}{2}; \bar{j} = \frac{\alpha \cdot i \cdot \bar{C}^2 \cdot \bar{B}}{g \cdot \bar{\chi}} = \frac{\alpha \cdot i \cdot \bar{R}^{1/3} \cdot \bar{\beta}}{g \cdot n^2 \cdot \bar{\chi}}; \bar{B} = b + 2 \cdot m \cdot \bar{h}.$$



12 -rasm. Sath egri chizig'ini qurish.

Jadval natijalariga asosan magistral kanalda to'suvchi inshoot oldidagi erkin sirt egriligini chizamiz (12 -rasm).

Misol: Magistral kanalda to'suvchi inshoot oldidagi erkin sirt egriligini chizing, quyidagi parametrlar berilgan bo'lsa: $Q = 47,66 \text{ m}^3 / \text{c}$; $b=12 \text{ m}$; $m=1,5$; $n=0,025$; $l=8000\text{m}$; $i=0,002$; $h_{ber}=4,0 \text{ m}$. Kanalda suv oqimining normal chuqurligi $h_0=3,0 \text{ m}$.

Echish tartibi:

1. Kanaldagi normal chuqurligi:

$$h_0=3,0 \text{ m}.$$

2. Kritik chuqurlikni h_{kr} aniqlaymiz

a) Agroskin usuli:

Oldin to'g'ri to'rtburchak shaklidagi kanal uchun kritik chuqurlikni aniqlaymiz:

$$h_{kn} = 0,482 \cdot q^{2/3} = 0,482 \cdot \left(\frac{47,66}{12} \right)^{2/3} = 1,21 \text{ m}$$

yordamchi koeffisient $\sigma_{II} = \frac{m \cdot h_{kn}}{b} = \frac{1,5 \cdot 1,21}{12} = 0,152$

R.R. Chugaev kitobidan, 239 - betdagi 7-16 $K = f(\sigma_{II})$ chizmadan « σ_n » -ga qarab, « K » qiymatini grafikdan olamiz:

$$K = 0,955.$$

Demak $h_k = K \cdot h_{kn} = 0,955 \cdot 1,21 = 1,175 \approx 1,2 \text{ m}.$

b) TIMI “Gidravlika” kafedrasida ishlab chiqilgan usul asosida (A.M.Arifjanov usuli):

$$h_{kp} = \frac{b}{4M} \left(\sqrt{1 + \frac{8 \cdot m \cdot h_{kII}}{b}} - 1 \right).$$

$$M = m^2 / \sqrt{1 + m^2}$$

$$h_{kp} = 1,16 \text{ m}.$$

3. Oqim erkin satx egrilikning shaklni aniqlaymiz.

Kanal tub nishabligi $i=0,002>0$ bo'lganligi uchun, kanal “A” guruhga kiradi. Kanaldagi suv oqimining normal chuqurligi kritik chuqurligidan katta bo'lgani ($h_0 = 3,0 \text{ m} > h_{kp} = 1,2 \text{ m}$), va tub nishabligi $i < i_{kp}$ sababli kanal 1-chi sinfiga qarashli. Berilgan chuqurlik $h_{ber}=4,0 \text{ m} > h_0=3,0 \text{ m}$ bo'lganligi uchun erkin sirtning egriligi “a” sohada joylashgan va uning shakli – egri ko'tarilma +**a**₁ bo'ladi.

4. O'zanning gidravlik ko'rsatkichini aniqlaymiz “x”:

Aniqlangan “a” sohadagi o'rtacha chuqurlik:

$$\bar{h}_c = \frac{h_0 + h_{sep}}{2} = \frac{3,0 + 4,0}{2} = 3,5 \text{ m},$$

$$\bar{\beta}_c = \frac{b}{\bar{h}_c} = \frac{12}{3,5} = 3,43.$$

O'zanning gidravlik ko'rsatgichi R.R.CHugaev formulasiga asosan:

$$x = 3,4 \cdot \left| 1 + \frac{m}{\beta_c + m} \right| - 1,4 \cdot \frac{2 \cdot m'}{\beta_c + 2 \cdot m'} = 3,4 \cdot \left| 1 + \frac{1,5}{3,43 + 1,5} \right| - 1,4 \cdot \frac{2 \cdot 1,803}{3,43 + 2 \cdot 1,803} = 3,67$$

bu erda $m' = \sqrt{1 + m^2} = \sqrt{1 + 1,5^2} = 1,803$.

Shu qiymatga eng yaqin bo'lgan jadvaldagi qiymatini qabul qilamiz $x=3,75$.

5. Endi $h_{ber}=4,0m$ - dan kichik va $h_0=3,0m$ - dan kattaroq bo'lgan bir nechta h qiymatlarini qabul qilamiz, va har bittasi uchun nisbiy chuqurliklar qiymatlarini aniqlaymiz. Misol uchun $h_I=3,8m$ bo'lganda:

$$\eta_2 = \frac{h_{\sigma ep}}{h_0} = \frac{4,0}{3,0} = 1,33$$

$$\eta_1 = \frac{h_1}{h_0} = \frac{3,8}{3,0} = 1,267$$

Ilovadagi 14-jadvaldan, aniqlangan η_1 va η_2 $x=3,75$ uchun $\varphi(\eta_1)$ va $\varphi(\eta_2)$ qiymatlarini qabul qilamiz:

$(\eta_1)_{\text{oc}} = 1,267$ uchun o'ziga mos bo'lgani yuq ekan, eng yaqin bo'lgan jadvaldagi qiymatlar –

kattaroq bo'lgan $(\eta_2)_{\text{oc}} = 1,27$ - $\varphi(\eta_2)_{\text{oc}} = 0,233$

kichikroq bo'lgan $(\eta_1)_{\text{oc}} = 1,26$ - $\varphi(\eta_1)_{\text{oc}} = 0,240$

ularning farqi: $0,01^* - 0,007$

Demak interpolyasiya usulini qo'llab, bizga kerakli bo'lgan qiymatni aniqlaymiz:

$$\varphi(\eta_2) = 0,24 + (1,267 - 1,26) \cdot \frac{(-0,007)}{0,01} = 0,2351$$

$(\eta_2)_{\text{oc}} = 1,33$ uchun jadvaldan $\varphi(\eta_1) = \varphi(1,333) = 0,1955$ olamiz.

6. Har bir qism uchun suv chuqurligining o'rtacha qiymatini aniqlaymiz:

$$\bar{h} = \frac{h_1 + h_2}{2}.$$

Misol uchun, suv oqimi o'rtacha chuqurligi $\bar{h} = 3,5$ m uchun:

tirik kesim yuzasi: $\bar{\omega} = \bar{h} \cdot (b + m \cdot \bar{h}) = 3,5 \cdot (12 + 1,5 \cdot 3,5) = 60,38 m^2$;

xo'llangan perimetr: $\bar{\chi} = b + 2 \cdot \bar{h} \cdot \sqrt{1 + m^2} = 12 + 2 \cdot 3,5 \cdot \sqrt{1 + 1,5^2} = 24,6 m$;

$$\text{gidravlik radius: } \bar{R} = \frac{\bar{\omega}}{\bar{\chi}} = \frac{60,38}{24,6} = 2,454\text{m};$$

$$\text{o'zan sathidagi oqim kengligi: } \bar{B} = b + 2 \cdot m \cdot \bar{h} = 12 + 2 \cdot 1,5 \cdot 3,5 = 22,50\text{m}.$$

$$\text{Unda o'rtacha ishqalanish nishabligi: } \bar{j} = \frac{\alpha \cdot i}{g \cdot n^2} \cdot \bar{R}^{1/3} \cdot \frac{\bar{B}}{\bar{\chi}} = 0,047, \text{ va } 1 - \bar{j} = 0,953.$$

7. Xamma aniqlangan kattaliklarni jadvalga yig'ib, hisoblaymiz:

13- jadval

Uchastkalar ning №№	№№ kesimla rning	h	η	$\varphi(\eta)$	\bar{h}	$\bar{\omega}$	$\bar{\chi}$	\bar{R}	\bar{B}	\bar{j}	Izoh
3	4	4,00	1,333	0,1955	3,9	69,62	26,04	2,67	23,7	0,0453	$x=3,75$ $i=0,002$ $n=0,025$ $\bar{j} = \frac{\alpha \cdot i}{g \cdot n^2} \cdot \bar{R}^{1/3} \cdot \frac{\bar{B}}{\bar{\chi}}$ $\frac{\alpha \cdot i}{g \cdot n^2} = 0,0399$
	3	3,80	1,267	0,2351							
2	3	3,80	1,267	0,2351	3,7	64,94	25,34	2,56	23,1	0,0448	
	2	3,60	1,200	0,292							
1	2	3,60	1,200	0,292	3,5	60,38	24,6	2,45	22,5	0,0442	
	1	3,40	1,133	0,3792							

8. Xar bir qismning uzunligini qu yidagi formula bo'yicha aniqlaymiz:

$$\ell = \frac{h_0}{i} \cdot (A_2 - A_1),$$

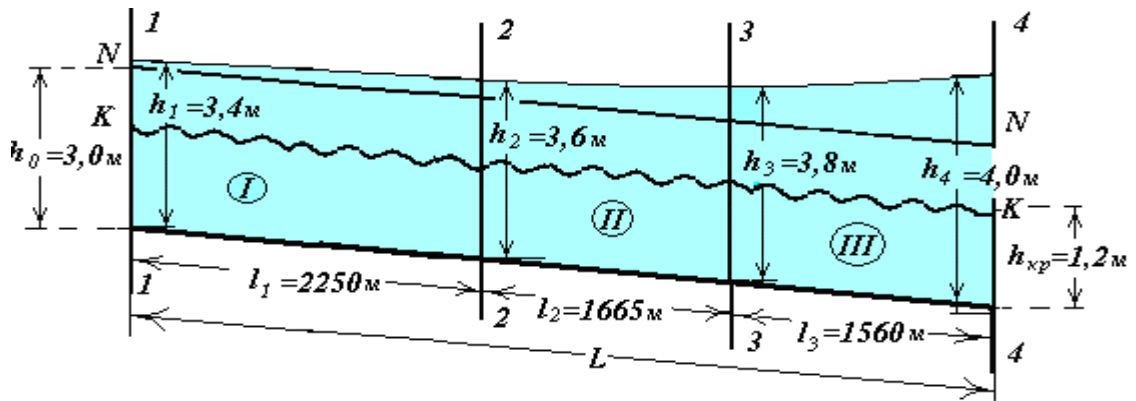
$$\text{bu erda } A_2 = \eta_2 - (1 - \bar{j}) \cdot \varphi(\eta_2) \quad \text{va} \quad A_1 = \eta_1 - (1 - \bar{j}) \cdot \varphi(\eta_1).$$

Xisoblash natijalarini quyidagi jadvalga tushiramiz:

14- jadval

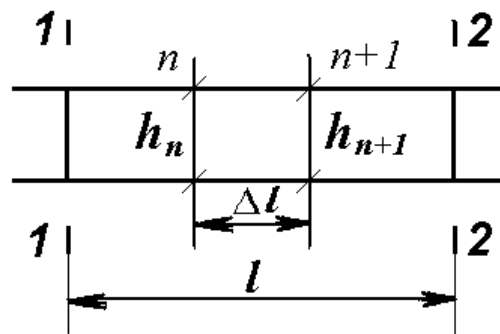
Uchastkalar ning №№	A_2	A_1	$A_2 - A_1$	ℓ	Izoh
3	1,146	1,042	0,104	1560	$\frac{h_0}{i} = 15000$
2	1,032	0,921	0,111	1665	
1	0,921	0,771	0,150	2250	

Jadval asosidagi qiymatlar bo'yicha a_1 grafisini tuzamiz.



II.5 Charnomskiy usulida notekis harakat differensial tenglamasini integrallash

Bu usulda o'zan bir necha (n) kichik qismlarga ajratiladi. U holda Bernulli tenglamasidan foydalanib oqim energiyasining o'zgarishi aniqlanadi.



$$\frac{\Delta \mathcal{E}}{\Delta l} = i - \bar{J}_e; \quad \Delta l = \frac{\Delta \mathcal{E}}{i - J_e} = \frac{\mathcal{E}_2 - \mathcal{E}_1}{i - J_e}$$

$$\Delta \mathcal{E} = \left(h_{n+1} + \frac{\alpha \mathcal{G}_{n+1}^2}{2g} \right) - \left(h_n + \frac{\alpha \mathcal{G}_n^2}{2g} \right)$$

bu erda: Δl - kesimlar orasidagi masofa;

$\mathcal{E}_2, \mathcal{E}_1$ - 1-1 va 2-2 kesimlardagi oqimning solishtirma energiyasi;

h_n, h_{n+1} - n va $n+1$ qismlardagi suv oqimining chuqurligi;

$\mathcal{G}_n, \mathcal{G}_{n+1}$ - n va $n+1$ qismlardagi oqim tezligi.

Har bir qism (n) uchun sath egrilik uzunligi aniqlanadi:

$$l = \sum_{n=1}^m \frac{\Delta \mathcal{E}}{i - \bar{J}_{bn}};$$

$$\bar{J}_e = \frac{\bar{\mathcal{G}}^2}{C^2 R}, \text{ agar } C = \frac{1}{n} R^{1/6} \text{ bo'lsa, u holda}$$

$$\bar{J}_e = \left| \frac{\bar{g} \cdot n}{\bar{R}^{\frac{2}{3}}} \right|^2 = \left| \frac{Q \cdot n}{\bar{\omega} \cdot \bar{R}^{\frac{2}{3}}} \right|^2$$

bu erda: $\bar{\omega}, \bar{R}$ - bir qismidagi gidravlik elementlarning o'rtacha qiymatlari, o'rtacha chuqurlik \bar{h} uchun hisoblangan.

II.5.1. Erkin sirt egri chizig'i uzunligini aniqlash

Masala. Trapesiya shakldagi kanalda erkin egri suv sathi chizig'i - egri pasayma kuzatiladi. CHarnomskiy usulini qo'llab, shu chiziqni quyidagi kattaliklar uchun qurish kerak: $Q=47,66 \text{ m}^3/\text{s}$; $h_0=3,0 \text{ m}$ (kanal normal chuqurligi); $b=12 \text{ m}$ (kanal tubidagi eni); $m=1,5$; $n=0,025$; $i=0,0002$; $\ell=12000 \text{ m}$ (kanal uzunligi); $h_2=2,4 \text{ m}$ (kanal so'ngi qesimdagi suv chuqurligi).

Echish tartibi:

Kanal so'ngi kesimdagi suv chuqurligi bizga ma'lum bo'lganligi uchun erkin egri suv sathi chizig'igining nuqtalarini aniqlanishini shu chuqurlikdan boshlaymiz.

1. Berilgan chuqurlik $h_2=2,4\text{m}$ uchun bizga kerakli bo'lgan gidravlik elementlarni hisoblaymiz:

$$\text{tirik kesim yuzasi: } \omega_2 = (b + m \cdot h_2) \cdot h_2 = (12 + 1,5 \cdot 2,4) \cdot 2,4 = 37,44 \text{ m}^2;$$

$$\text{kanaldagi suv oqimining o'rtacha tezligi: } g_2 = \frac{Q}{\omega_2} = \frac{47,66}{37,44} = 1,27 \text{ m/s};$$

$$\text{xo'llangan perimetr: } \chi_2 = b + 2 \cdot h_2 \cdot \sqrt{1 + 1,5^2} = 12 + 2 \cdot 2,4 \cdot \sqrt{1 + 1,5^2} = 20,64 \text{ m};$$

$$\text{gidravlik radius: } R_2 = \frac{\omega_2}{\chi_2} = \frac{37,44}{20,64} = 1,81 \text{ m};$$

$$\text{kesim solishtirma energiyasi: } \mathcal{E}_2 = h_2 + \frac{\alpha \cdot Q^2}{2 \cdot g \cdot \omega_2^2} = 2,4 + \frac{1,1 \cdot 47,66^2}{2 \cdot 9,81 \cdot 37,44^2} = 2,49 \text{ m}.$$

2. $h_1=2,5\text{m}$ deb qabul qilamiz. Unda xuddi yuqorida ko'rsatilgandakka:

$$\omega_1 = 39,38 \text{ m}^2; g_1 = 1,21 \text{ m/s}; \chi_1 = 21,0 \text{ m}; R_1 = 1,87 \text{ m}; \mathcal{E}_1 = 2,58 \text{ m}.$$

3. Chuqurligi $h_1=2,5\text{m}$ teng bo'lgan 1-1 kesimdan to chuqurligi $h_2=2,4\text{m}$ teng bo'lgan 2-2 kesimgacha solishtirma energiyalarning o'zgarishi bo'ladi:

$$\Delta \mathcal{E} = \mathcal{E}_2 - \mathcal{E}_1 = 2,49 - 2,58 = -0,091 \text{ m}.$$

4. Ko'rilayotgan uchastka uchun g va R o'rtacha qiymatlarni aniqlaymiz:

$$\bar{g} = \frac{g_1 + g_2}{2} = \frac{1,21 + 1,27}{2} = 1,24 \text{ m/s};$$

$$\bar{R} = \frac{R_1 + R_2}{2} = \frac{1,87 + 1,81}{2} = 1,84 \text{ m.}$$

Demak
$$\bar{I}_e = \left| \frac{\bar{g} \cdot n}{\bar{R}^{2/3}} \right|^2 = \left| \frac{1,24 \cdot 0,025}{1,84^{2/3}} \right|^2 = 0,00042.$$

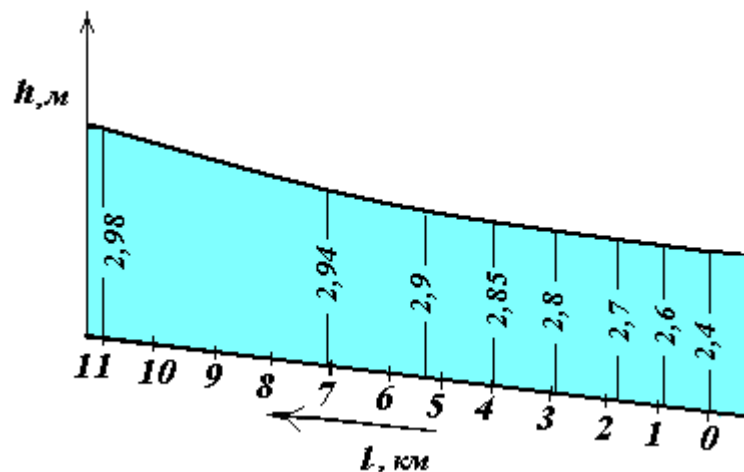
5. Tenglamadan $\Delta \ell$ ni aniqlaymiz:

$$\Delta \ell = -\frac{\Delta \mathcal{E}}{i - \bar{I}_e} = -\frac{0,091}{0,0002 - 0,00042} = 404 \text{ m.}$$

Suv chuqurligi uchun h_1 bir necha qiymatlarni berib, hisoblashni yuqorida qo'rsatilgan tartibda olib borib, natijalarni jadvalga tushiramiz.

h	ω	\mathcal{G}	\bar{g}	χ	R	\bar{R}	E	$\Delta \mathcal{E}$	$\bar{I}_e \cdot 10^{-4}$	$\Delta \ell$	ℓ
2,40	37,44	1,273		20,84	1,814		2,491				0
			1,242			1,845		-0,091	4,23	404	
2,50	39,38	1,120		21,00	1,875		2,582				404
			1,182			1,905		-0,092	3,65	554	
2,60	41,34	1,153		21,36	1,935		2,674				958
			1,127			1,965		-0,094	3,17	804	
2,70	43,34	1,100		21,72	1,995		2,768				1762
			1,076			2,025		-0,094	2,77	1221	
2,80	45,36	1,051		22,08	2,054		2,862				2989
			1,040			2,069		-0,047	2,50	940	
2,85	46,38	1,028		22,26	2,084		2,909				3923
			1,017			2,098		-0,048	2,35	1372	
2,90	47,42	1,005		22,44	2,113		2,957				5295
			0,997			2,125		-0,038	2,21	1810	
2,94	48,25	0,988		22,58	2,136		2,995				7105
			0,978			2,148		-0,038	2,10	3800	
2,98	49,08	0,971		22,73	2,100		3,033				10905

Jadval asosida erkin egri sath chizig'ini quramiz:

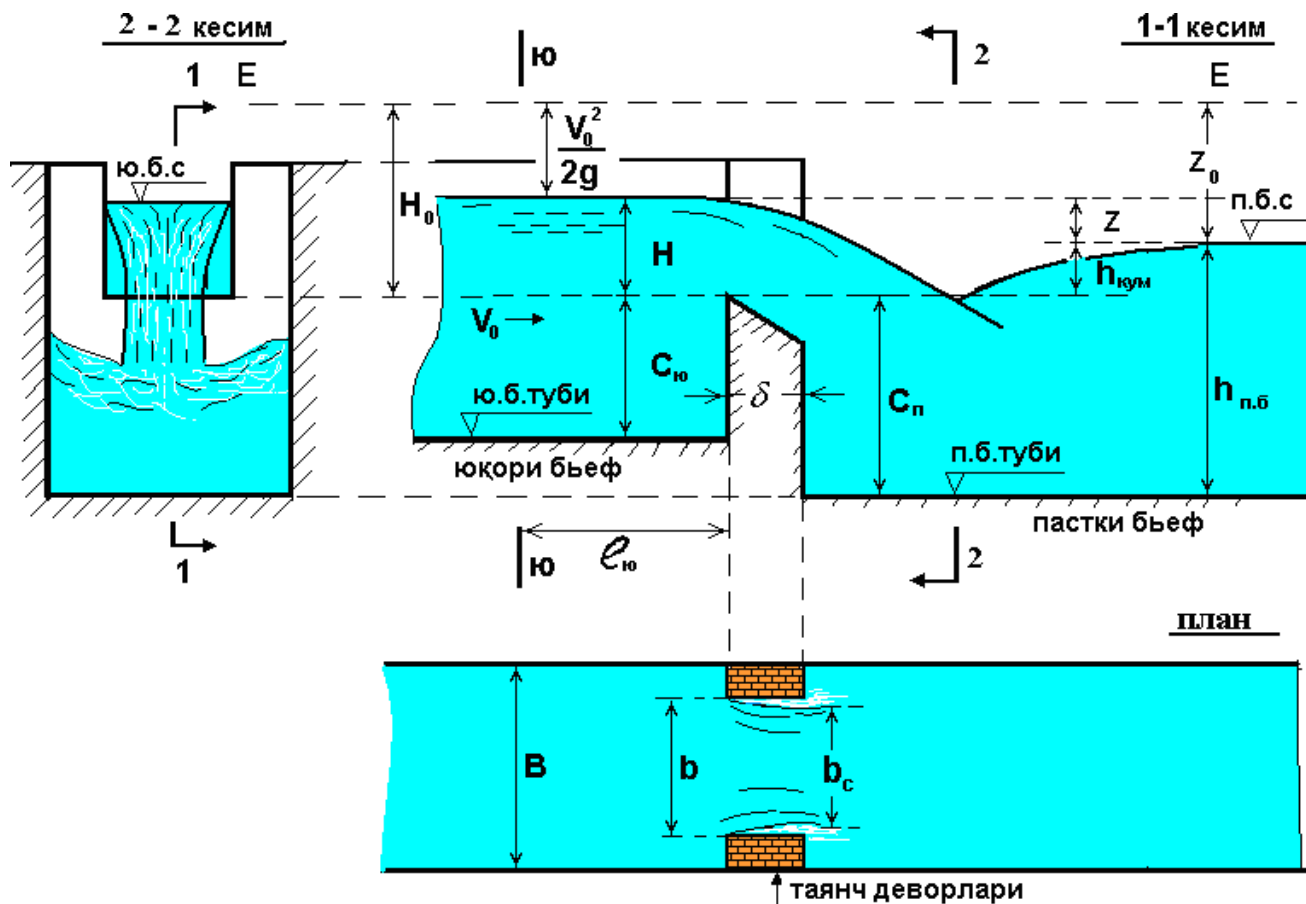


III. GIDROTEKNIK INSHOATLAR GIDRAVLIKASI

III. 1. SUV O'TKAZGICHLAR

Asosiy tushunchalar va suv o'tkazgichlar tasnifi

Suv o'tkazgichlar deb, oqim harakati yo'lga qurilgan tusiqqa (devor)ga aytiladi. Devorning suv oshib o'tayotgan qismi *suv o'tkazgich devori* deb ataladi.



13-rasm - Suv o'tkazgich sxemasi

Suv o'tkazgich devorigacha bo'lgan soha - yuqori бьеф (YUB), devordan keyingi soha - pastki бьеф (PB) deb ataladi.

Quyidagi belgilashlarni kiritamiz:

$\frac{\text{ю.б.с}}{\nabla}$ – yuqori бьефдagi suv sathining belgisi;

$\frac{\text{п.б.с}}{\nabla}$ – pastki бьефдagi suv sathining belgisi.

b - suv o'tkazgich devorning kengligi;

δ - suv o'tkazgich devorning qalinligi;

S_{yu} va S_{n} – suv o'tkazgich devorning yuqori va pastki бьефлар tomonidan balandliklari;

B_0 – suv o'tkazgich qurilgan o'zan kengligi;

Z - suv o'tkazgichdagi geometrik farq, ya'ni yuqori va pastki b'eflardagi suv oqimi sathlari farqi;

$$Z_0 - \text{suv o'tkazgichdagi to'liq farq: } Z_0 = Z + \frac{\alpha \mathcal{G}_0^2}{2g};$$

\mathcal{G}_0 - $YU-YU$ kesimdagi oqimning o'rtacha tezligi, yoki yaqinlashish tezligi

$$\mathcal{G}_0 = \frac{Q}{\omega};$$

ω - ($YU-YU$) kirish qismidagi tirik kesim yuzasi;

H - suv o'tkazgichdagi geometrik napor, bu suv o'tkazgich devoridan suv sathigacha bo'lgan masofa;

H_0 - suv o'tkazgich oldidagi to'liq napor:

$$H_0 = H + \frac{\alpha \mathcal{G}_0^2}{2g}$$

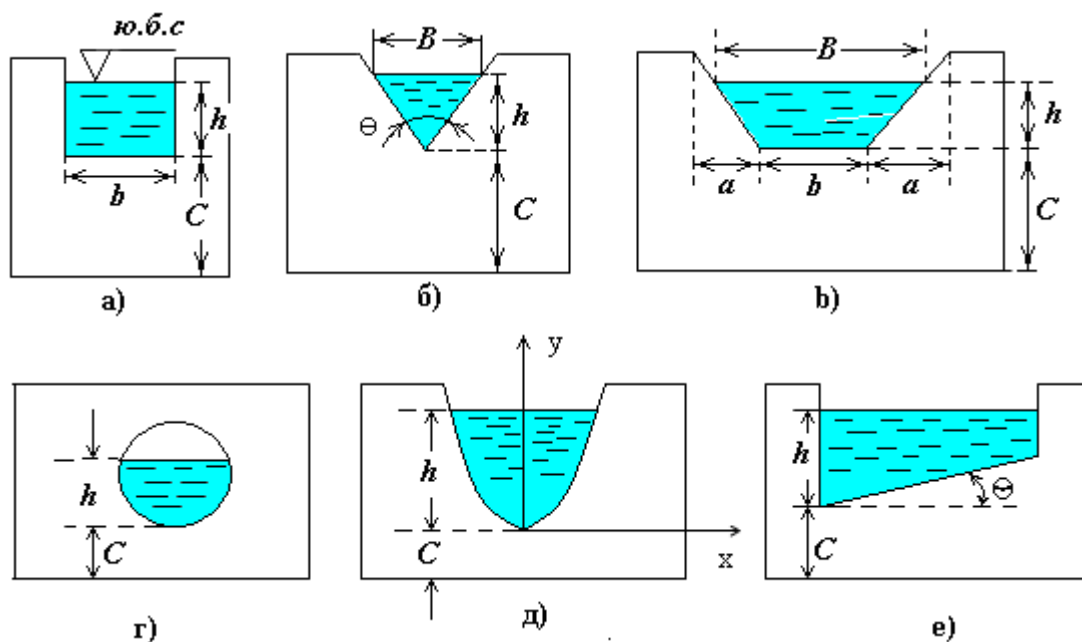
$h_{\text{кычм}}$ - suv o'tkazgichdagi ko'milish chuqurligi $h_{\text{кычм}} = h_{\text{н.б}} - C_n$;

l_{yu} - suv oqimi sathi egrilanib tushishi boshlanadigan $YU-YU$ kesimgacha bo'lgan masofa, tajribalar natijasiga asosan quyidagicha aniqlanadi:

$$l_{\text{ю}} = (3 \div 5)H .$$

Suv o'tkazgichlar tasnifi

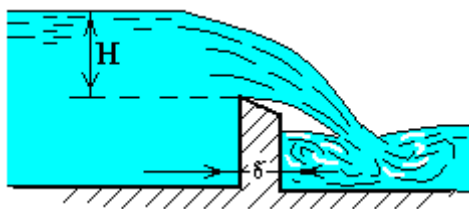
1. Cuv o'tkazgich **qirqimining shakli bo'yicha** (14 -rasm): a) tug'ri to'rtburchakli; b) uchburchakli; v) trapesiya ko'rinishida; g) aylana; d) parabola; e) qiya ostonali.



14 – rasm - Suv o'tkazgich qirqimining shakllari

2. Suv o'tkazgich devorning ko'ndalang kesim shakli va **kengligi bo'yicha**:

a) *yupqa devorli suv o'tkazgichlar* (15 – rasm).



15 – rasm. YUppqa devorli suv o'tkazgich

Bunday o'tkazgichlarda oqimning harakatiga faqat suv o'tkazgich devorning yuqori ostonasi ta'sir ko'rsatadi. Bunday suv o'tkazgichlarda ostonaning kengligi:

$$\delta \leq (0,1 \div 0,67)H$$

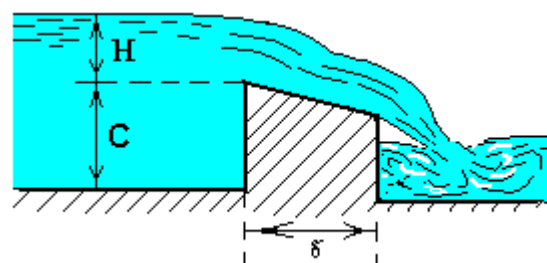
shart bajariladi.

b) *amaliy profilli suv o'tkazgichlar* (16–rasm).

Bunday suv o'tkazgichlarda

$$0,67 \cdot H < \delta < 2 \cdot H$$

shart bajariladi.



16–rasm. Amaliy profilli suv o'tkazgichlar

v) *keng ostonali suv o'tkazgichlar* (17 – rasm).

Bunday suv o'tkazgichlarda δ kenglik quyidagi ikki shartni qanoatlantirishi kerak:

1) δ uzunligida energiyaning uzunlik bo'yicha yo'qolishi hisobga olmasa ham bo'ladigan darajada kichik bo'lishi kerak;

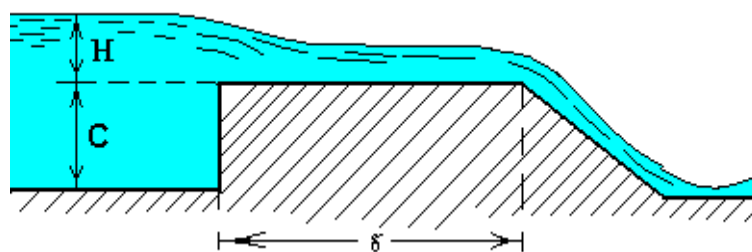
2) δ - uzunlik ma'lum qismida oqimning tekis o'zgaruvchan harakati kuzatilishi kerak, bunda

$$2H \leq \delta \leq 8H$$

shart bajariladi.

$\delta > 8H$ bo'lganda suv o'tkazgich emas, kanal bo'lishi mumkin,

$\delta < 2H$ bo'lganda esa suv oqimining tekis o'zgaruvchan harakati amalga oshmaydi.

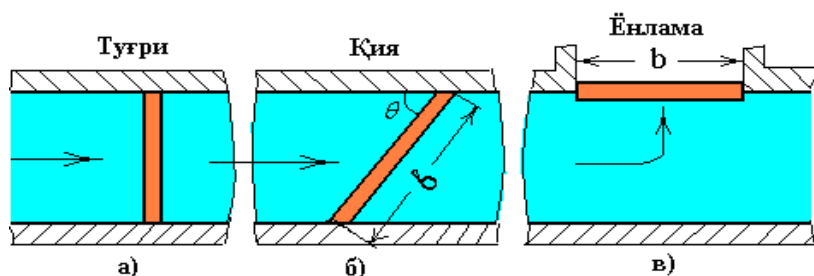


17–rasm. Keng ostonali suv o'tkazgichlar

3. **Planda** suv o'tkazgich devorining joylashishiga qarab:

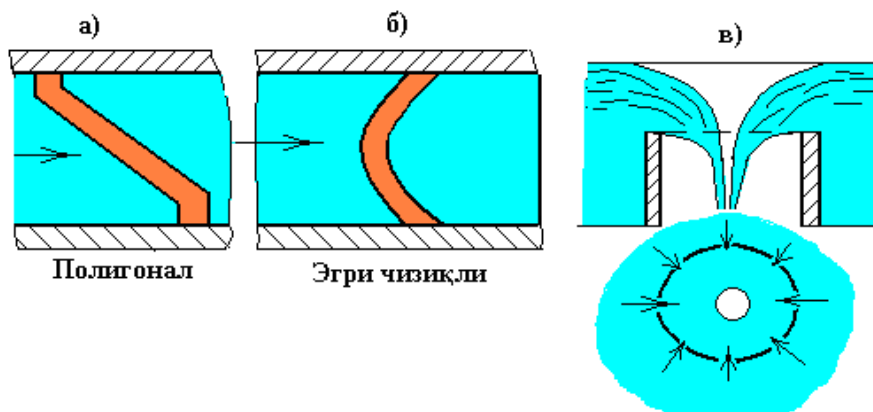
a) *to'g'ri, yoki oqimga perpendikulyar suv o'tkazgichlar* (18-rasm):

Chizmada suv oqimiga tug'ri (a), qiya (б), va yon tomondan (в) joylashgan suv utkazgichlar keltirilgan.



18-rasm. Qirradi tug'ri chiziqli bo'lgan suv o'tkazgichlar

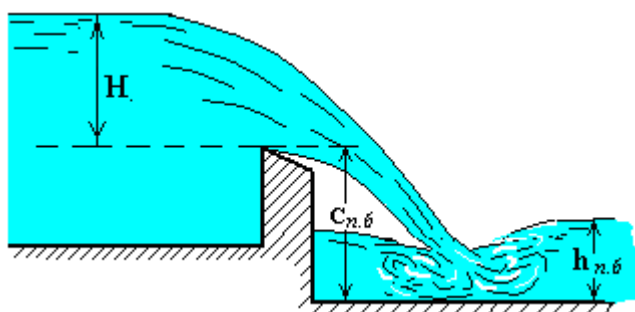
b) *qirradi egri devorli suv o'tkazgichlar* (19- rasm):



Chizmada poligonal (a, egri chiziqli (б), yopiq, xususan aylana shaklda (в) suv o'tkazgichlar ko'rsatilgan.

19-rasm. Planda qirradi egri chiziq bo'lgan suv o'tkazgichlar.

4. Oqim harakatiga **pastki b'ef ta'siriga** qarab:



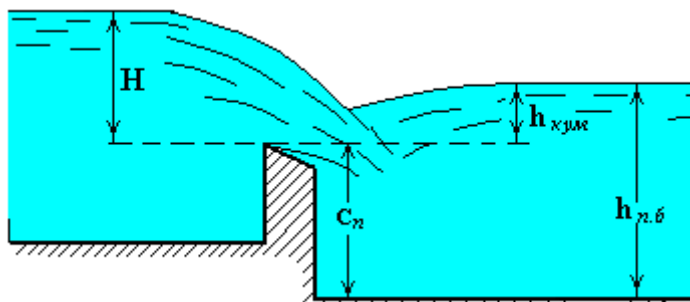
20-rasm. Ko'milmagan suv o'tkazgich

a) *Ko'milmagan suv o'tkazgichlar.*

Bunda yuqori b'efdagi oqim sarfi (Q), napor (H) va pastki b'efdagi $h_{p.b}$ chuqurlikka bog'liq emas, demak

$$h_{n.б} \leq C_n \text{ yoki } h_{\text{к\у\м}} = h_{n.б} - C_n < 0$$

bu erda C_p - suv o'tkazgich devorining pastki b'ef tomonidan balandligi.



21-rasm - Ko'milgan suv o'tkazgich

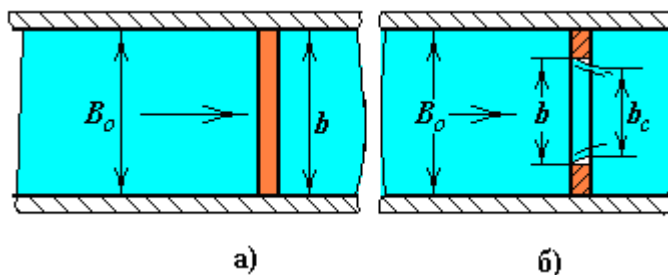
b) *Ko'milgan suv o'tkazgich* (21-rasm).

Bunda b'efdagi oqim sarfi (Q), napor (H) va pastki b'efdagi $h_{p.b}$ chuqurligiga bog'liq.

$$h_{n.б} > C_n \text{ yoki } h_{\text{к\у\м}} = h_{n.б} - C_n > 0$$

5. Suv oqimining **plandagi siqilishiga qarab**: (b va B_o kattaliklar munosabati bilan tasniflanadi).

a) $b=B_o$ bo'lgan holda, yon tomonidan oqimning siqilishi bo'lmagan suv o'tkazgichlar (22-rasm -a).

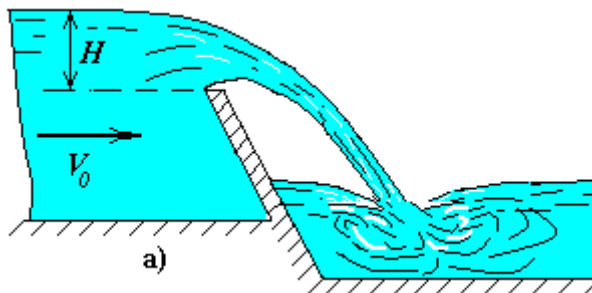


b) $b < B_o$ bo'lganda, oqimning yon tomonidan siqilishi bor bo'lgan suv o'tkazgichlar (22-rasm -b).

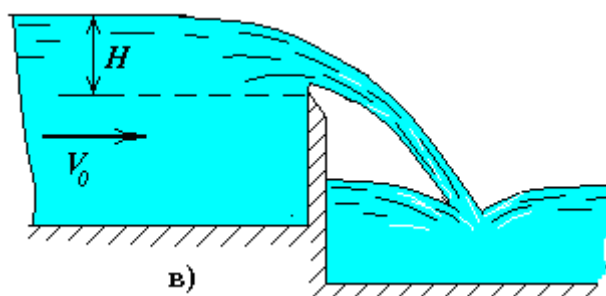
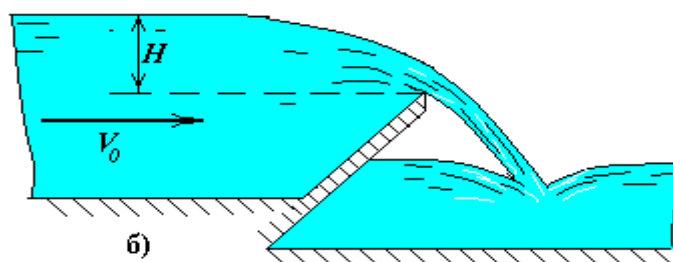
22-rasm - Oqim yon tomonidan siqilmagan va siqilgan holatdagi suv o'tkazgichlar

6. Suv o'tkazgichlarni **oldingi qirrasini qiyaligi** bo'yicha:

a) oldingi qirrasining qiyaligi yuqori b'ef tomoniga;



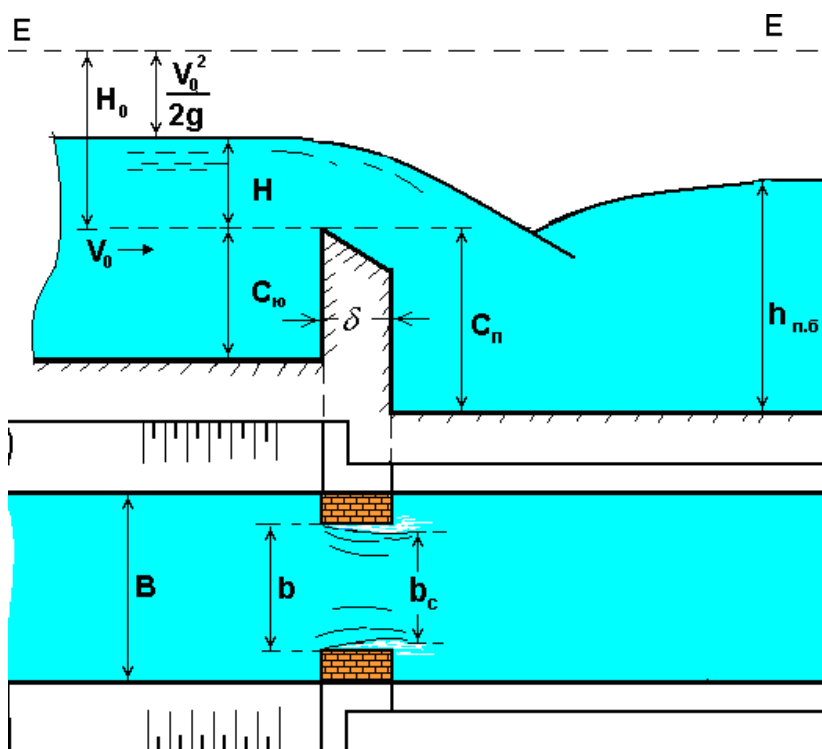
b) oldingi qirrasini qiyaligi pastki b'ef tomoniga;



v) oldingi qirrasini vertikal.

III.2 Suv o'tkazgichlarning asosiy hisoblash formulasi

Suv o'tkazgichlarning asosiy hisoblash formulasini (23-rasm) keltirib chiqarish uchun quyidagi bog'lanishlardan foydalanamiz:



$$Q = \omega \cdot g$$

$$\omega :: b, H$$

$$g :: \sqrt{2gH}$$

$$Q :: (b, H) \cdot (\sqrt{2gH})$$

$$Q = m \cdot b \cdot H \cdot \sqrt{2gH}$$

Bunda "m" – proporsionallik koeffitsienti–suv o'tkazgichning *sarf koeffitsienti* deb ataladi.

Tenglamani quyidagi ko'rinishda yozish mumkin:

$$Q = m \cdot b \cdot \sqrt{2g} \cdot H^{3/2}$$

yoki oxirgi ko'rinishda

$$Q = m \cdot b_c \cdot \sqrt{2g} \cdot H^{3/2}$$

23-rasm – Suv o'tkazgichning plan va sxemasi

1. Bunda $H_o = H + \frac{\alpha \cdot g_0^2}{2g}$ - suv oqimining yaqinlashish tezligini hisobga olgan holda.

2. YOn siqilishini hisobga olish:

$$b_c = \varepsilon \cdot b ,$$

bu erda ε - yon siqilish koeffitsienti.

3. Suv o'tkazgich ostonasining yuqori b'ef tomonidan shaklini hisobga olganda - sarf koeffitsienti m orqali.
4. Pastki b'ef tomonidan ko'milishini (σ_{kym} - ko'milish koeffitsienti) hisobga olganda σ_{kym} - koeffitsient Bazan formulasi orqali aniqlanadi:

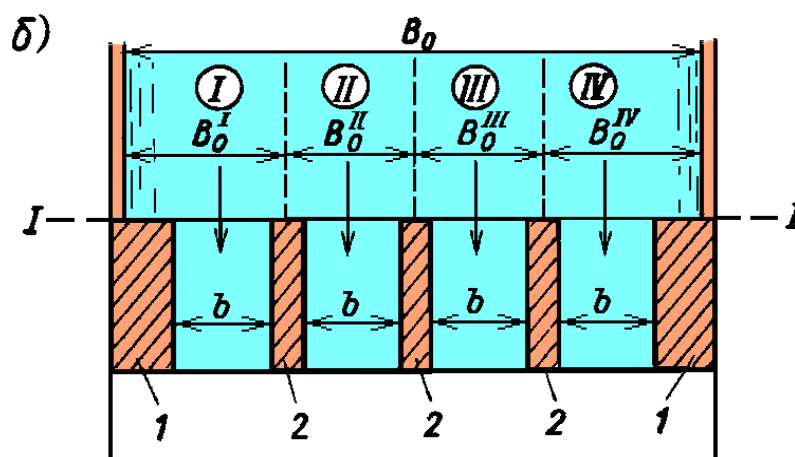
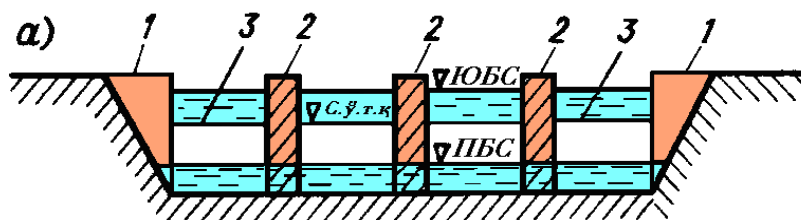
$$\sigma_{kym} = 1,05 \cdot \left(1 + 0,2 \frac{H_{kym}}{C}\right) \cdot \sqrt[3]{\frac{Z}{H}}$$

U holda suv o'tkazgichlarning asosiy hisoblash formulasi:

$$Q = \sigma_{kym} \cdot m \cdot \varepsilon \cdot b \cdot \sqrt{2g} \cdot H_o^{3/2}$$

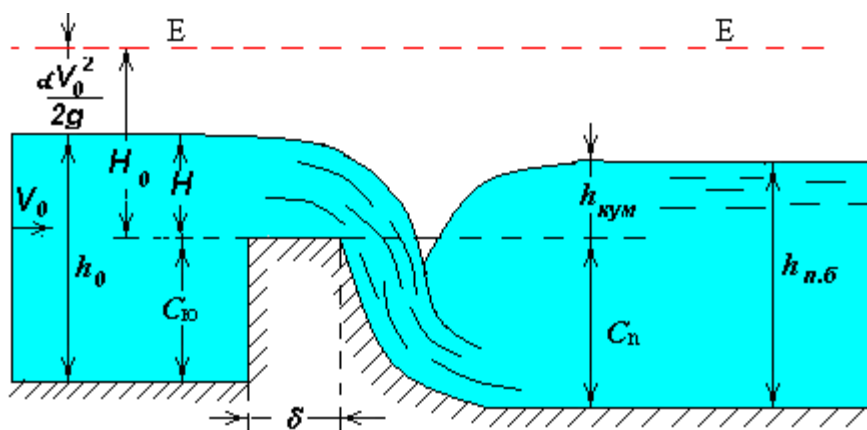
III.3 AMALIY PROFILLI SUV O'TKAZGICHLAR

Amaliy devorli suv o'tkazgichlar gidrotexnik inshootlarning elementlari sifatida juda ko'p qo'llaniladi. Ostona kengligi bu xil suv o'tkazgichlarda (24 –rasm) quyidagicha bo'ladi: $0,67 \cdot H < \delta < 2 \cdot H$.



Cuv o'tkazgichdan o'tayotgan sarf formulasi:

$$Q = \sigma_{\text{кым}} \cdot \varepsilon \cdot m \cdot b \cdot \sqrt{2g} \cdot H_0^{3/2}$$



Formuladagi hadlarni aniqlaymiz:

1. **YAqinlashish tezligini** hisobga olish shartlari:

a) Agar $\mathcal{G}_0 \geq 0,361\sqrt{H}$ bo'lsa

$$\left(\mathcal{G}_0 = \frac{Q}{\omega_0} \right)$$

$$H_0 = H + \frac{\alpha \cdot \mathcal{G}_0^2}{2 \cdot g},$$

24 –rasm - Amaliy profilli suv o'tkazgichlar

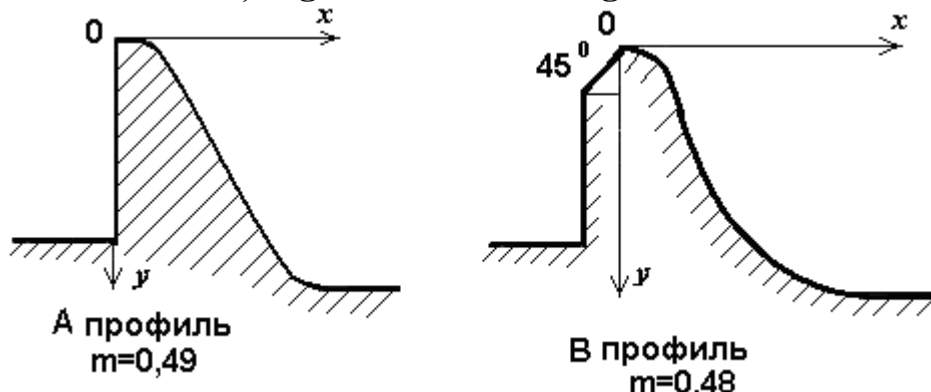
$\alpha = 1$ deb qabul qilamiz (Koriolis koeffisienti).

b) Agar $\mathcal{G}_0 \leq 0,361\sqrt{H}$ bo'lsa, unda $H_0 = H$ bo'ladi.

2. Suv o'tkazgichni **kirish qismini hisobga olish** (sarf koeffisientini m aniqlash).

Bu holda suv o'tkazgichlarning quyidagicha qo'shimcha tasnifini e'tiborga olishga to'g'ri keladi.

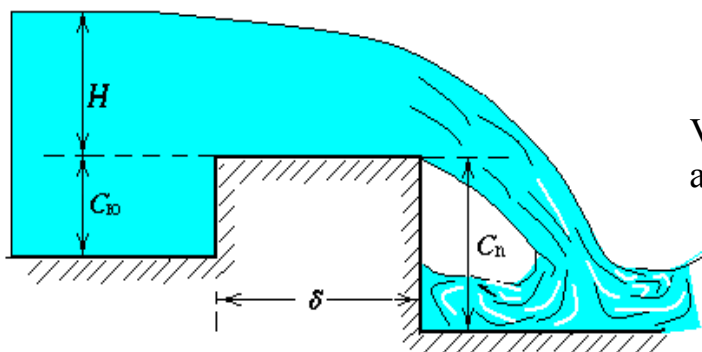
a) Egri sirtli suv o'tkazgichlar:



A profil' - vakuumsiz suv o'tkazgichlar uchun sarf koeffitsienti $m=0,49$ teng. Bunda oqim ostidagi bosim atmosfera bosimi bilan deyarli bir hil bo'ladi.

B profil' uchun sarf koeffitsienti $m=0,48$, suv o'tkazish qobiliyati ko'payadi, lekin kavitatsiya xodisasi mavjud bo'ladi.

b) Poligonal suv o'tkazgichlar



25-rasm - Poligonal to'rburchak shaklidagi suv o'tkazgich sxemasi

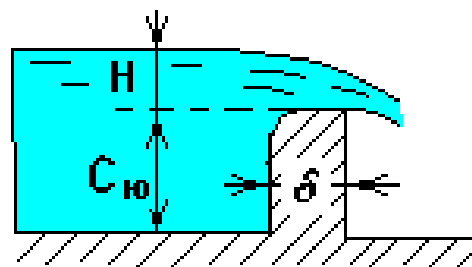
Sarf koeffitsientini (m) V.A.Bo'lyshakov formulasi asosida aniqlaymiz:

agar $\delta > 0,6 \cdot H$ (25 -rasm)

$$m = 0,42 \cdot \left(0,7 + 0,185 \cdot \frac{H}{\delta} \right)$$

agar $0,5 \cdot H < \delta < 2 \cdot H$ va kirish qismidagi qirradi egri shaklda bo'lsa(26-rasm):

$$m = 0,44 \left(0,7 + 0,185 \cdot \frac{H}{\delta} \right)$$



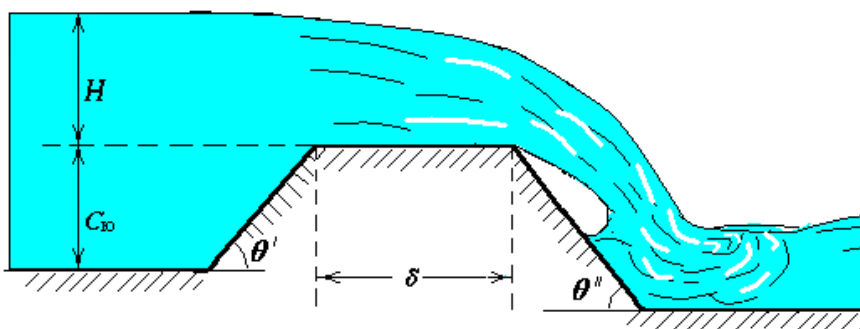
26-rasm - Kirish qismidagi qirradi aylana shakildagi suv o'tkazgich

c) **Trapesiya shaklidagi suv o'tkazgichlar (27- rasm).**

$$\operatorname{ctg} \theta' = S' \quad \operatorname{ctg} \theta'' = S''$$

$$m = f\left(\frac{H}{\delta}; S'; S''\right)$$

$$2H < C_{10} < 3H$$

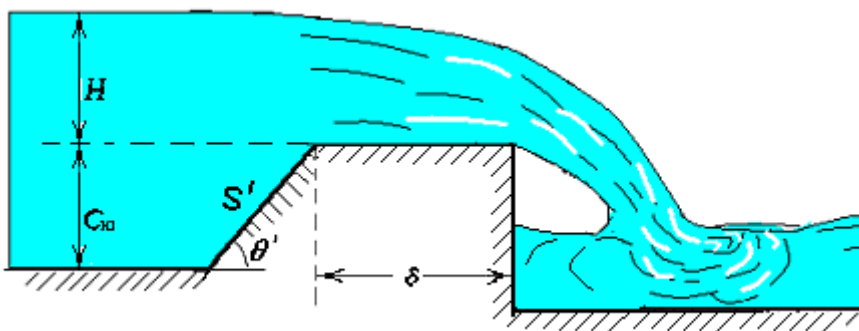


27- rasm - Trapesiya shakldagi suv o'tkazgich sxemasi

Devor balandligiga qarab, amaliy profilli suv o'tkazgichlar quyidagicha tasniflanadi:

1. *Past devorli suv o'tkazgichlar* ($0,5 < \frac{C_{10}}{H} < 2$) 28 va 29 rasmlarda ko'rsatilgan

shakllar uchun sarf koeffisienti (m) quyidagicha aniqlanadi:



28 –rasm - Kirish qismidagi qirrasini trapesiya shakldagi suv o'tkazgich

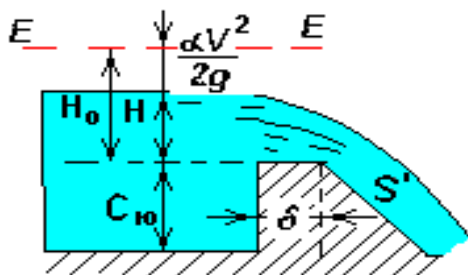
$$m = \frac{\frac{\delta}{H_0}}{B \frac{\delta}{H_0} - C}$$

Formuladagi “B” va “C” qiymatlarini, yuqori b'ef tomondagi suv o'tkazgich qirrasining gorizontga bo'lgan

burchakning kotangensi bilan bog'langan holda quyidagi jadvaldan aniqlanadi:

15 -jadval

S	1	2	3	5	10
B	2,9	2,81	2,79	2,77	2,72
C	0,27	0,21	0,2	0,17	0,09



29- rasm – Pastki b'ef tomondagi qirrasini trapesiya shakldagi suv o'tkazgich

29-rasmdagi poligonal suv o'tkazgichlar uchun sarf koeffisienti « m » qiymatlari pastki tomondagi suv o'tkazgich qirrasining gorizontga bo'lgan burchakning kotangensi S' va δ/H_0 -ga bog'liq holda quyidagi jadvaldan aniqlanadi (16-jadval):

S'	Sarf koeffisienti « m » qiymatlari: δ/H_0 asosida						
	0,3	0,5	0,7	1,0	1,5	2,0	2,5
1	0,46	0,415	0,395	0,37	0,35	0,34	0,335
2	0,445	0,42	0,4	0,375	0,345	0,33	0,33
3	0,42	0,4	0,38	0,36	0,335	0,325	0,325
5	-	0,38	0,365	0,35	-	-	-
10	-	0,35	-	-	-	-	-

a-sarf koeffisienti huddi keng ostonali suv o'tkazgichlar uchun qabul qilingandek olinadi.

2. O'rta devorli suv o'tkazgichlar ($2 < \frac{C_v}{H} < 3$ va $S = S' = 1 \div 2$)

Agar $\frac{\delta}{H} < 0,5$ bo'lsa, sarf koeffisienti $m=0,445$ qabul qilinishi mumkin.

Agar $0,5 \leq \frac{\delta}{H} < 2$ bo'lsa, sarf koeffisienti “ m ” quyidagi formuladan topiladi:

$$m = \frac{1}{\sqrt{4,5 + 2 \frac{\delta}{H_0}}}$$

S' va S''	H/δ			
	0,5	1,0	1,5	2,0
	0,36	0,39	0,4	0,44
$S' = 1 \quad S' = 2$	0,37	0,40	0,41	0,44
$S'' = 1$	0,33	0,37	0,41	0,42
$S'' = 2$	0,33	0,36	0,40	0,41

3. Baland devorli ($C_v \geq 3 \cdot H$ va $S = S' = 1 \div 2$) suv o'tkazgichlar uchun $\delta/H < 0,5$ bo'lganda sarf koeffisienti $m=0,445$ teng deb qabul qilinadi. $0,5 < \delta/H < 2$ bo'lganda esa, sarf koeffisienti quyidagi formula yordami bilan aniqlanadi:

$$m = \frac{1}{\sqrt{4,2 + 2,5 \frac{\delta}{H_0}}}$$

$S' \text{ va } S''$	H / δ			
	0,5	1,0	1,5	2,0
$S' = 3$	0,37	0,40	0,41	0,42
$S' = 5$	0,37	0,39	0,40	0,41
$S' = 10$	0,37	0,39	0,39	0,40
$S'' = 3$	0,34	0,36	0,38	0,40
$S'' = 5$	0,34	0,35	0,37	0,38
$S'' = 10$	0,34	0,35	0,36	0,36

3. Amaliy profilli suv o'tkazgichlar uchun *yon siqilish koeffisientini* aniqlash

$$b_c = \varepsilon \cdot b$$

ε - yon siqilish koeffisienti: tayanch va oraliq devorlarning (ustun) plandagi shakliga qarab, quyidagi formula orqali aniqlanadi:

$$\varepsilon = 1 - 0,2 \frac{\xi_y + (N - 1) \cdot \xi_\sigma}{N} \cdot \frac{H_0}{b},$$

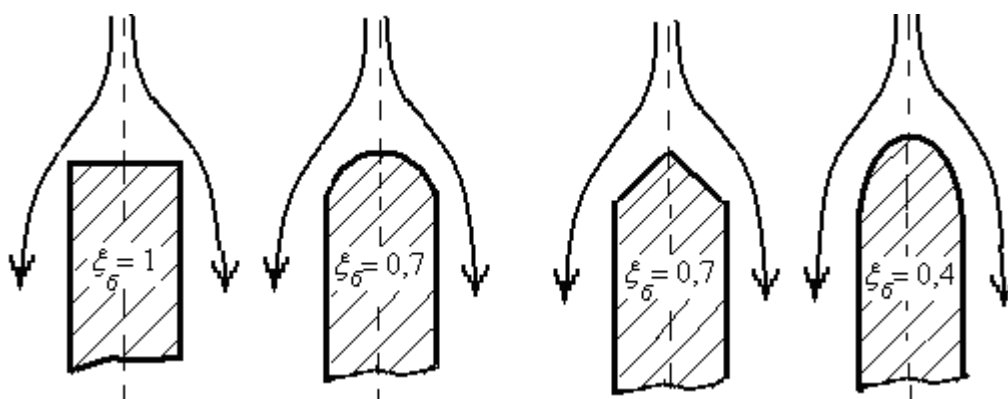
bunda: N - bo'limlar (oraliqlar) soni;

ξ_y - torayish koeffisienti bo'lib, tayanch devorlarining kirish qismi shakliga bog'liq,

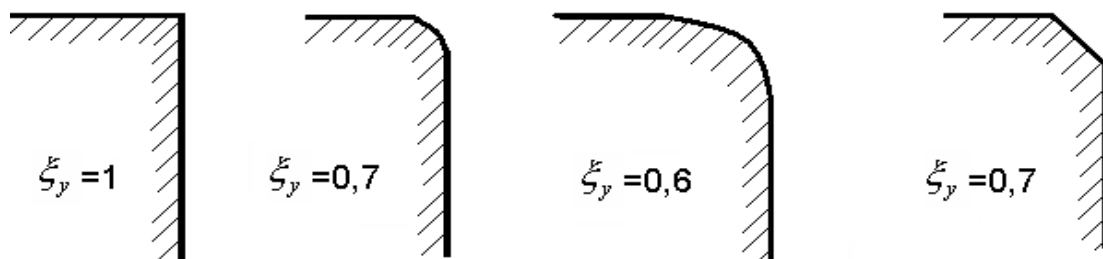
ξ_σ - torayish koeffisienti bo'lib, oraliqdagi tik devorning plandagi shakliga bog'liq;

b - bir oraliq kengligi.

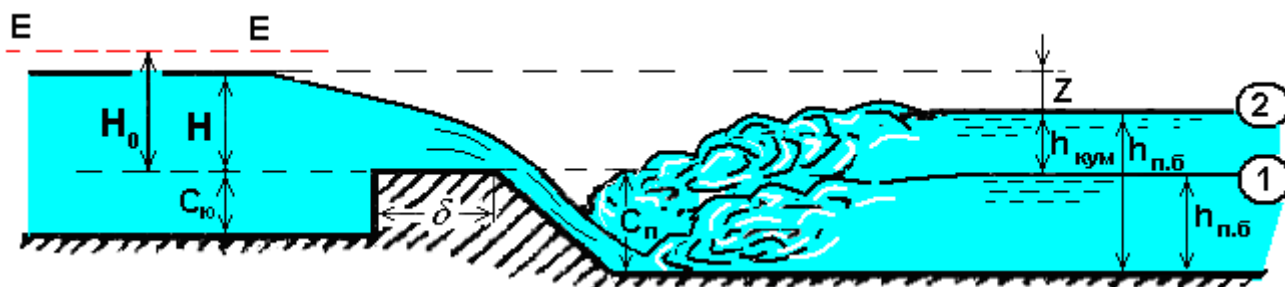
Oraliq ustunning turli ko'rinishlari



Tayanch devorlarning turli ko'rinishlari



4. Amaliy profilli suv o'tkazgichlarda *ko'milish koeffisientini* aniqlash.



30-rasm - Amaliy profilli suv o'tkazgich sxemasi.

$$h_{kym} = h_{n\delta} - C_n$$

$$Z = H_0 - h_{kym}$$

Quyidagi ikki shart bir vaqtda bajarilganda, suv o'tkazgichlar ko'milgan hisoblanadi:

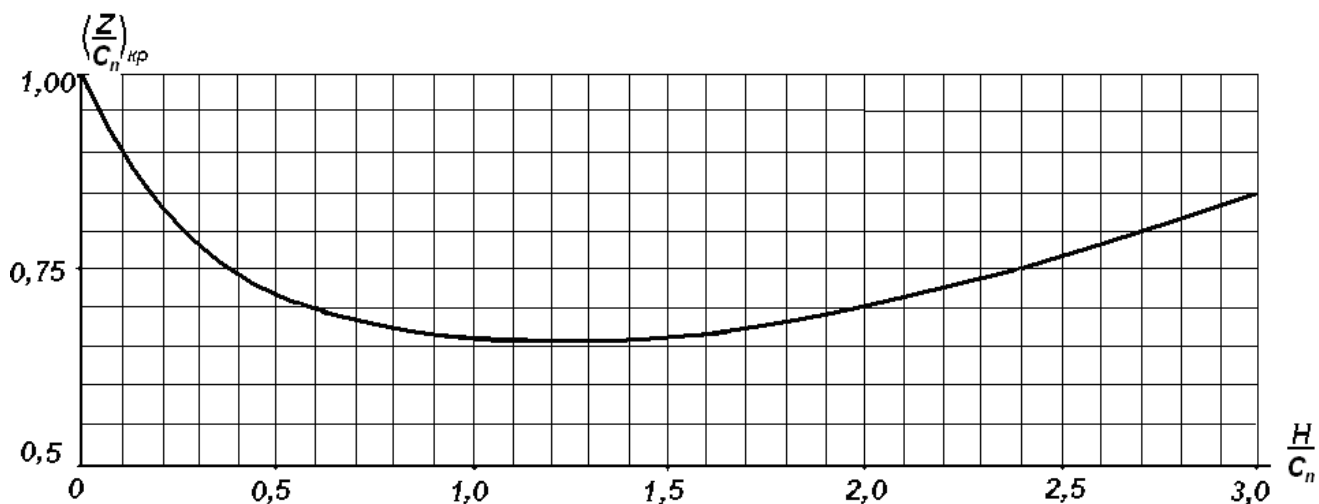
- 1) pastki b'efdagi suv satxi o'tkazgich qirrasidan yuqori bo'lsa, $h_{kym} > 0$;
- 2) pastki b'efda oqimning tinch holatdagi harakati mavjud bo'lsa.

Agar oqim harakati notinch bo'lsa, pastki b'efda haydalgan gidravlik sakrash ro'y beradi va shu sababli suv o'tkazgich ko'milmagan bo'ladi. [30-rasmdagi 1-chi vaziyat]. $B=B_0$ bo'lgan hususiy holda pastki b'efda oqimning tinch harakati mavjud bo'lishi uchun quyidagi shart bajarilishi kerak:

$$\frac{Z}{C_n} = \left(\frac{Z}{C_n}\right)_{kp},$$

unda $\sigma_{kym} < 1$.

Bunda sathlar orasidagi farqni (Z) suv o'tkazgich devorining pastki b'efdagi balandligiga nisbatining kritik qiymati maxsus tajribalar asosida tuzilgan grafikdan topiladi (31- rasm).



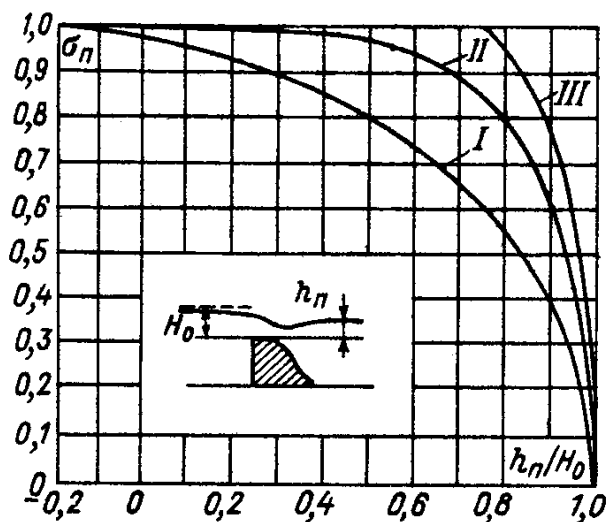
31- rasm- $\left(\frac{Z}{C_n}\right)_{kp} = f\left(\frac{H}{C_n}\right)$ egriligi grafigi.

SHu grafikdan ko'rinib turibdiki, $\left(\frac{Z}{C_n}\right)_{kp}$ qiymati asosan 0,5 ÷ 0,75 oralig'ida o'zgaradi.

Agar suv o'tkazgich ko'milgan bo'lsa $\left(\frac{Z}{C_n}\right) \leq \left(\frac{Z}{C_n}\right)_{kp}$ bo'ladi, ko'milish koeffisienti σ_{kym} qiymatini G.D. Deryugin formulasi orqali aniqlasa bo'ladi:

$$\sigma_{kym} = \sqrt{1 - \left[1 - \left(1 - \frac{h_{kym}}{H_0}\right) \cdot \frac{1}{1 - \left(1 - \frac{m}{0,59}\right)^{\frac{2}{5}}}\right]^2}$$

Ko'milish koeffisientining kattaligi tajribalar asosida qurilgan grafik yordamida ham aniqlanishi mumkin.



Grafikda uchta egrilik ifodalangan:

- a) I egrilik – vakuumli suv o'tkazgichlar uchun;
- b) II egrilik – normal ko'rinishdagi vakuumsiz suv o'tkazgichlar uchun;
- v) III egrilik – keng ostonali suv o'tkazgichlarga o'xshash bo'lgan vakuumsiz keng qirrali suv o'tkazgichlar uchun.

YOki quyidagi jadvaldan qabul qilishimiz mumkin.

Suv o'tkazgichlarning ko'milish koeffitsient $\sigma_{\text{к\у\text{M}}}$ aniqlash jadvali

19 - jadval

$\frac{h_{\text{к\у\text{M}}}}{H}$	0	0,1	0,2	0,3	0,4	0,5	0,6	0,65	0,7	0,75	0,8	0,85	0,9	0,95	1,0
$\sigma_{\text{к\у\text{M}}}$	1	0,998	0,996	0,991	0,983	0,972	0,957	0,947	0,933	0,9-0,8	0,76	0,70	0,59	0,41	0

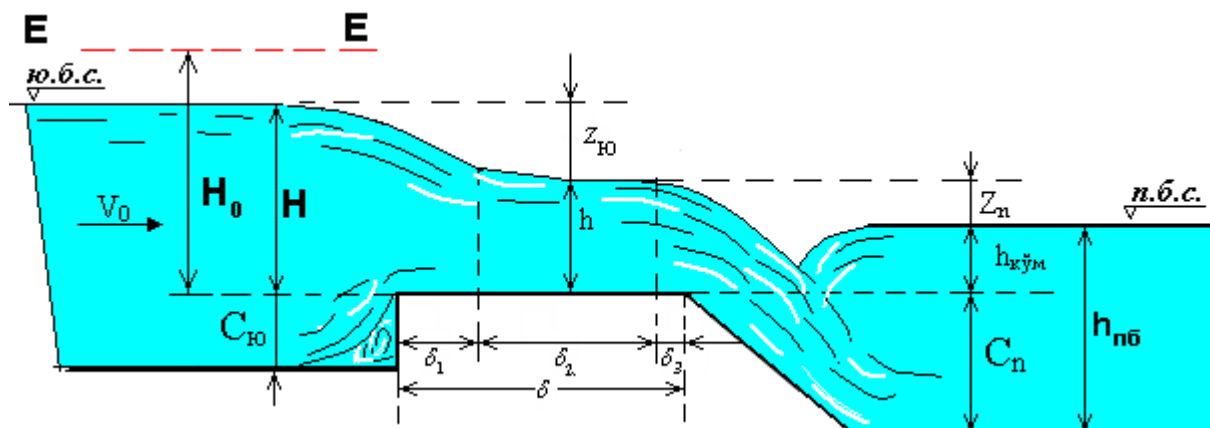
(Andrevskaya A.V. Zadachnik po gidravlike. 1970, 284-285 betlar, 8-4 jadval)

Agar shu shartlardan aqalli bittasi bajarilmasa, suv o'tkazgich ko'milmagan bo'lib, $\sigma_{\text{к\у\text{M}}} = 1$ bo'ladi.

III.4 KENG OSTONALI SUV O'TKAZGICHLAR

Keng ostonali (devorli) suv o'tkazgichlar gidrotexnik inshootlarning asosiy elementlari sifatida juda keng tarqalgan. **Uning gorizontal ostonasining eni $(2...3)H \leq \delta \leq (8...10)H$ oraliqda bo'ladi, unda:**

- a) shu uzunlikda yo'qolish juda kichkina bulishi kerak;
- b) ostonaga ustidagi oqimning tinch holatdagi harakati gorizontal soxada mavjud bo'lishi shart.



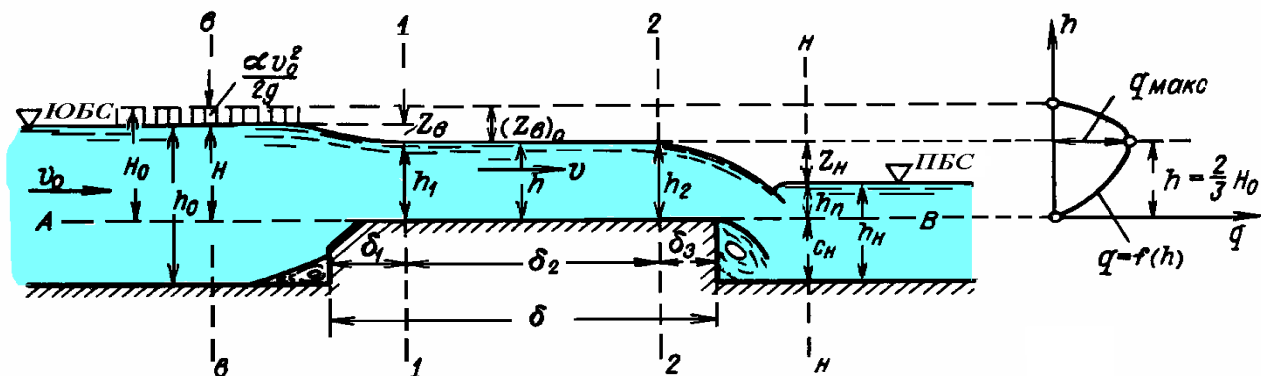
33- rasm - Keng ostonali ko'milgan suv o'tkazgich sxemasi

Bu erda: $Z_{\text{Ю}}$, Z_{II} - keng ostonali ko'milgan suv o'tkazgichlarda suv sathining pasayishi.

Ostonadagi gorizontal sohaning boshlanishi va tugashi uzunligini quyidagi tajribaviy qiymatlarga teng deb qabul qilish mumkin: $\delta_1 = 2H$; $\delta_3 = (0 \div 1)H$.

Suv o'tkazgichda ostonaning ko'tarilganligi hisobiga harakatdagi kesim yuzasi kichiklashadi (chuqurlik kamaygani uchun). Buning natijasida, tezlik oshib, oqimning

kinetik energiyasi oshadi va potensial energiya kamayadi. Potensial energiyaning kamayishi esa, o'z navbatida, oqimning erkin sirt egriligi pasayishiga olib keladi.



To'g'riburchakli, ko'milmagan yon tomondan siqilishi yo'q bo'lgan keng devorli suv o'tkazgichlarning asosiy sarfini topish formulasi.

D.Bernulli tenglamasini 1-1 va 2-2 kesimlarga 0-0 solishtirish tekisligiga nisbatan yozsak, quyidagi formula kelib chiqadi (33-rasm).

$$Z_1 + \frac{P_1}{\rho g} + \frac{\alpha \mathcal{G}_1^2}{2g} = Z_2 + \frac{P_2}{\rho g} + \frac{\alpha \mathcal{G}_2^2}{2g} + h_{W_{1-2}} \quad (1)$$

Bunda: $Z=H$, $P_1=P_{atm}$, $\mathcal{G}_1=\mathcal{G}_0$, $Z_2=h$, $P_2=P_{atm}$, $\mathcal{G}_2=\mathcal{G}$;

$$h_{W_{1-2}} = h_m = \xi_{c,y} \frac{\mathcal{G}^2}{2g} \text{ bo'ladi.}$$

Ushbu qiymatlarni (1)tenglamaga qo'ysak, bundan

$$\mathcal{G} = \frac{1}{\sqrt{\alpha + \xi_{c,y}}} \cdot \sqrt{2g(H_0 - h)} \text{ bo'ladi.}$$

Qayerda: $\varphi = \frac{1}{\sqrt{\alpha + \xi_{c,y}}}$ - tezlik koeffisienti;

$$\mathcal{G}_0 \leq 0,361\sqrt{H} \text{ bo'lsa, } H_0=H \text{ deb qarash mumkin.}$$

$$H_0 = H + \frac{\alpha \mathcal{G}_0^2}{2g} \text{ - to'la napor (dam) balandligi, xuddi amaliy profilli suv}$$

o'tkazgichlar uchun hisobga olganday aniqlanadi.

$$\text{Unda sarf } Q = \varphi \cdot \omega \cdot \sqrt{2 \cdot g(H_0 - h)} = \varphi \cdot b \cdot h \cdot \sqrt{2 \cdot g(H_0 - H)} .$$

$$\text{Agar } k = \frac{h}{H_0} \text{ deb belgilasak, } Q = \varphi \cdot k \cdot \sqrt{1-k} \cdot b \cdot \sqrt{2 \cdot g \cdot H_0^{\frac{3}{2}}} \text{ bo'ladi.}$$

$m = \varphi \cdot k \cdot \sqrt{1-k}$ - sarf koeffisienti deb belgilansa (ostonaning kirish qismining balandligi va shakli bilan bog'langan):

$$Q = m \cdot b \sqrt{2g} \cdot H_0^{3/2}$$

Agar keng devorli suv o'tkazgichlar yonboshdan siqilsa va ko'milgan (dimlangan) bo'lsa, siqilish koeffisienti ε va ko'milish koeffisienti σ_{kym} -lar alohida hisobga olinadilar.

Unda sarf formulasi umumiy ko'rinishi quyidagicha bo'ladi.

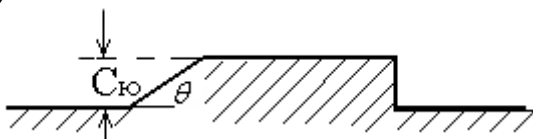
$$Q = m \cdot \sigma_{kym} \cdot \varepsilon \cdot b \cdot \sqrt{2g} \cdot H_0^{3/2}$$

ε - yon siqilish koeffisienti, yon va o'tkazgich (o'rta) devorlarining (ustunlarining) plandagi shakllari bilan bog'langan.

1. Sarf koeffisientini aniqlash.

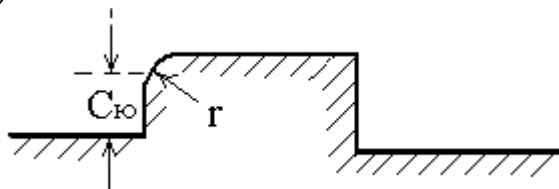
Sarf koeffisientni D.I. Kumin usulida aniqlaymiz (R.R.Chugaev, 366 bet).

A)



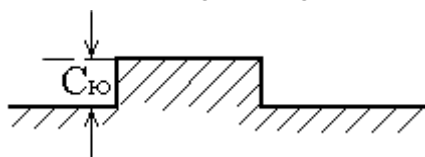
$$m = f\left(\frac{C_{10}}{H_0}; \text{ctg}\theta\right)$$

S)



B)

$$m = f\left(\frac{C_{10}}{H_0}; \frac{r}{H_0}\right)$$



B.A.Baxmetev ilmiy izlanishlariga asosan

B –sxema uchun:

1) $\varphi=0,85$; $m=0,32$; $K=0,59$

2) $\varphi=0,92$; $m=0,35$; $K=0,63$

S-sxema uchun:

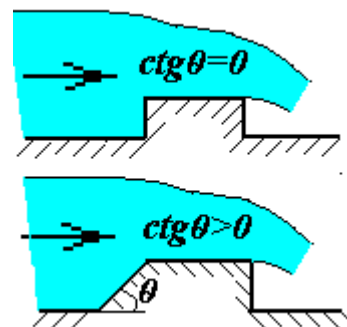
$$1) m = 0,32 + 0,01 \frac{3 - \frac{C_{10}}{H}}{0,46 + 0,75 \frac{C_{10}}{H}} ; \quad 0 \leq \frac{C_{10}}{H} \leq 3 \text{ agar } \frac{C_{10}}{H} \geq 3$$

$$2) m = 0,36 + 0,01 \frac{3 - \frac{C_{10}}{H}}{1,2 + 1,5 \frac{C_{10}}{H}}; \quad 0 \leq \frac{C_{10}}{H} \leq 3 \text{ agar } \frac{C_{10}}{H} \geq 3; \frac{r}{H} = 0,2..0,4$$

Yon tomondan siqilmagan keng ostonali suv o'tkazgichlarda sarf ko'effisienti "m"-ni qiymatlari (R.R.CHugaev kitobidan 421 bet 11-1, 11-2 jadvallar) jadvallardan olinadi.

20 -jadval

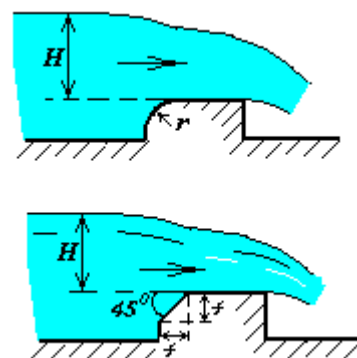
$\eta = \frac{C_{10}}{H}$	Vertikal qirralari $ctg\theta = 0$	$ctg\theta$			
		0,5	1,0	1,5	>2,5
0.0	0.385	0.385	0.385	0.385	0.385
0.2	0.366	0.372	0.377	0.380	0.382
0.4	0.366	0.365	0.373	0.377	0.381
0.6	0.350	0.361	0.370	0.376	0.380
0.8	0.45	0.327	0.368	0.375	0.379
1.0	0.342	0.355	0.367	0.374	0.378
2.0	0.333	0.349	0.363	0.371	0.377
4.0	0.327	0.345	0.361	0.370	0.376
8.0	0.324	0.343	0.360	0.369	0.376
∞	0,32	0,340	0,358	0,368	0,375



A.R.Berezovskiy formulasi: $K = \frac{2}{3} - \frac{0,385 - m}{0,95 - 2m}$, $\varphi = 1 - \frac{0,385 - m}{\frac{1}{m} - 1,8}$

21 -jadval

$\eta = \frac{C_{10}}{H}$	$\frac{r}{H}$ yoki $\frac{f}{H}$		$\frac{r}{H}$		
	0,025	0,05	0,2	0,6	>1,0
0	0.385	0.385	0.385	0.385	0.385
0.2	0.372	0.374	0.377	0.380	0.382
0.4	0.365	0.368	0.374	0.377	0.381
0.6	0.361	0.364	0.370	0.376	0.380
0.8	0.357	0.361	0.368	0.375	0.379
1.0	0.355	0.359	0.366	0.374	0.378
2.0	0.349	0.354	0.363	0.371	0.377
6.0	0.344	0.349	0.359	0.361	0.376
∞	0.340	0.346	0.357	0.368	0.375

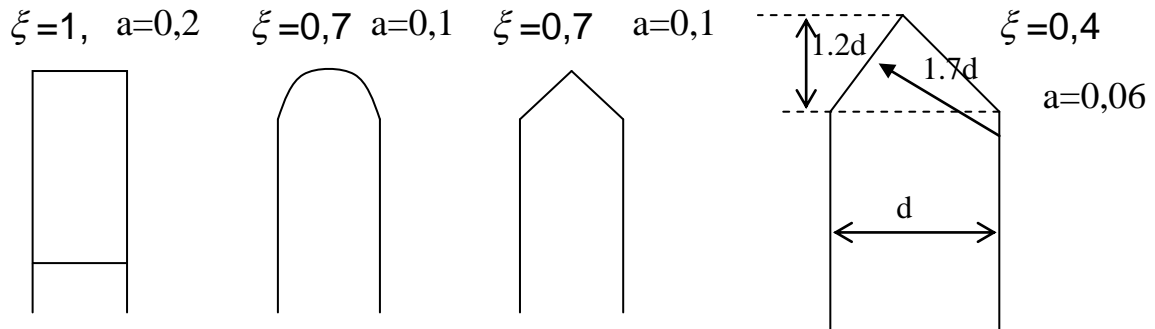


2. Yon siqilish ko'effisientini aniqla:

Yon tomondan siqilish ko'effisienti ε -ni qiymati taxminan quyidagi oraliqda o'zgaradi $\varepsilon=0,85.....0,95$.

$$\varepsilon = 1 - 2\xi \frac{H_0}{b} \text{ - Frejis formulasi}$$

$$\varepsilon = 1 - a \frac{H}{H + b} \quad \text{E.A.Zamarin formulasi}$$



3. Suv o'tkazgich ko'milishini hisobga olish.

Keng devorli suv o'tkazgichlar ko'milgan hisoblanadi, agar $h_k > 0,8 H_0$ bo'lsa, bunda ko'milish koeffisienti σ_{kym} - ni quyidagicha topiladi $\sigma_{kym} = f\left(\frac{h_{kym}}{H_0}\right)$

(R.R. Chugaev jadval 6-24 va 6-25 Berezinskiy qiymatlari).

G.K.Deryugin formulasi:

$$\sigma_{kym} = \sqrt{1 - \left[1 - \left(1 - \frac{h_{kym}}{H_0} \right) \cdot \frac{1}{1 - \left(1 - \frac{m}{0,59} \right)} \right]^2};$$

$$\frac{h_k}{H_0} > \left(1 - \frac{m}{0,59} \right)^{0,4};$$

$$\sigma_k < 1,0 \quad (0,85 \dots 0,75)$$

III.5. YUPQA DEVORLI SUV O'TKAZGICHLAR

Suv o'tkazgichlarning suv o'tkazish qobiliyatini aniqlashda quyidagilar hisobga olinishi shart: suv o'tkazgich devorlarining shakli, kirish tezligi, yonboshdan siqilishi, ko'milishi, planda suv o'tkazgichlar qirrasining ko'rinishi, qiyaligi va hokazolar.

YUpqa devorli suv o'tkazgichlar – suv o'lchagichlar tariqasida keng tarqalgan va aniq suv o'lchashga qobiliyatli va gidrotexnik inshootlar elementlari sifatida (shondorlar, suv o'lchagich devorlar va boshqalar) keng tarqalgan.

YUpqa devorli suv o'tkazgichlar erkin deb qaraymiz, oqimda pastki b'efdan havo kirib turadi.

1. To'g'ri to'rtburchakli vertikal devorli suv o'tkazgichlarning asosiy tenglamasi:

$$A) \text{ ko'milmagan suv o'tkazgichlar uchun sarf: } Q = mb\sqrt{2g}H_0^{\frac{3}{2}},$$

$$m - \text{Bazen formulasi asosida quyidagiga teng: } m = 0,405 + \frac{0,0027}{H}.$$

$$\text{R.R.Chugaev formulasi: } C_{10} \geq 0,5H \text{ va } H \geq 0,1 \text{ bo'lganda } m = 0,40 + 0,05 \frac{H}{C_{10}}.$$

Kirish tezligini e'tiborga olinadigan bo'lsa, Bazen formulasi quyidagicha yoziladi:

$$m = \left(0,405 + \frac{0,0027}{H}\right) \cdot \left[1 + 0,55\left(\frac{H}{H + P_1}\right)^2\right].$$

Yon tomondan siqilish inobatga olinsa,

$$m = \left[0,405 + \frac{0,0027}{H} - 0,03\left(1 - \frac{b}{B}\right)\right] \cdot \left[1 + 0,55\left(\frac{b}{B}\right)^2 \cdot \left(\frac{H}{H + P}\right)^2\right],$$

bu erda P - suv o'tkazgichdagi yuqori va pastki b'ef tomonlardagi tub belgilarning farqi.

Ko'milgan suv o'tkazgichlarda sarf:

$$Q = m \cdot \sigma_{\text{ккм}} \cdot b \cdot \sqrt{2 \cdot g} \cdot H_0^{\frac{3}{2}}$$

$$\text{Ko'milish koeffisienti } \sigma_k = 1,05 \cdot \left(1 + 0,2 \frac{h_k}{C_n}\right) \cdot \sqrt[3]{\frac{Z}{H}} \text{ formulasidan, yoki}$$

$\sigma_k = f\left(\frac{h_k}{P}; \frac{Z}{P}\right)$ qiymatlari orqali grafik yoki jadvaldan ham topilishi mumkin.

Suv o'lchaydigan suv o'tkazgichlar

Tasnifi:

I. Suv o'tkazgich devorining xolatiga qarab:

- a) vertikal devorli;
- b) burchak ostidagi devorli.

II. Oqimni suv o'tkazgichdan o'tishiga qarab:

- a) suv erkin oqib o'tadi;
- b) suv erkin bo'lmay oqib o'tadi;

Normal suv o'tkazgichdan o'tayotgan suv sarfi :

$$Q = m_{0H} \cdot b \cdot \sqrt{2g} \cdot H^{3/2}.$$

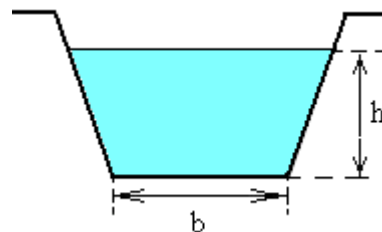
Ko'milgan suv o'tkazgichdan o'tayotgan suv sarfi :

$$Q = \sigma_{\text{квм}} \cdot m_{0H} \cdot \sqrt{2g} \cdot H^{3/2}.$$

Ko'milmagan suv o'tkazgichlar uchun hisoblash formulasi quyidagi ko'rinishga ega:

$$Q = m_0 \cdot tg \frac{\theta}{2} \sqrt{2g} \cdot H^{5/2}$$

1^o Trapesiya shaklidagi suv o'lchagich suv o'tkazgichlar:



Bunday suv o'tkazgichlarda sarf quyidagicha aniqlanadi :

$$Q = m_0 \cdot b_{\text{yp}} \sqrt{2g} \cdot H^{3/2} = m \cdot \varepsilon(b_0 + 0,8 \cdot n \cdot H) \sqrt{2g} H^{3/2}.$$

Agar $tg\theta = m = 0,25$ ($\theta = 14^\circ$) bo'lganda CHipoletti $m_0 = 0,42$ ekanligini tajribalar asosida aniqlagan. SHu sababli, **Chipoletti suv o'tkazgichi** deb ataluvchi bunday suv o'tkazgichlarda sarf quyidagicha aniqlanadi:

$$Q = 1,865 \cdot b \cdot H^{\frac{3}{2}} \quad \text{- CHipoletti formulasi.}$$

Suv sarfi o'lchanganda $N=(0,05 \dots 1,0)m$, $b=(3 \dots 4)m$; $\mathcal{G}_0 \leq 0,5$ m/s bo'lganda aniqlik katta bo'ladi.

$tg\alpha = 1$ bo'lganda, $\mathcal{G}_0 \leq 0,6$ m/s bo'lsa, suv o'tkazgichlardan o'tadigan sarf qiymatini A.I.Ivanov formulasi orqali topish mumkin:

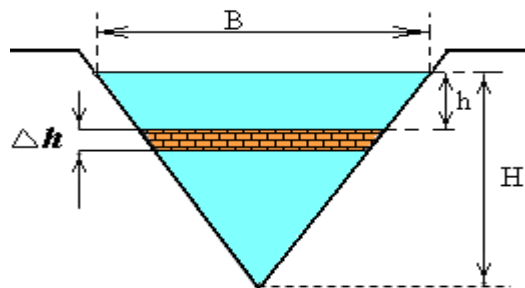
$$Q = 1,86 \frac{b + H}{b + 0,25 \cdot H} \cdot b \cdot H^{\frac{3}{2}}$$

Suv o'tkazgichlar $P_1 > 0$ balandlikka ega bo'lishlari kerak, shunda kirishda oqim kerakli siqilishga ega bo'ladi.

2^o. Uchburchak shaklidagi suv o'lchaydigan suv o'tkazgichlar.

Ko'milmagan suv o'tkazgichlar uchun hisoblash formulasi quyidagi ko'rinishga ega:

$$Q = m_0 \cdot \operatorname{tg} \frac{\theta}{2} \sqrt{2g} \cdot H^{5/2}$$



Tomson tajribasiga asoslanib, $\theta = 90^\circ$ va $H = (0.05 \div 0.25) m$ shartlar bajarilganda $m_0 \cdot \operatorname{tg} \frac{\theta}{2} = 0,316$ deb yozish mumkin, bu holda **Tomson suv o'tkazgichi** deb ataluvchi bu o'tkazgich uchun $g=9,81 m/s^2$ bo'lgan holda quyidagini yozish mumkin:

$$Q = 1,4 \cdot H^{\frac{5}{2}} - \text{Tomson formulasi .}$$

$$Q = 1,343 \cdot H^{2,47} - \text{King formulasi.}$$

3^o. Parabola shaklidagi suv o'tkazgich:

$$Q = M \cdot H^2; \quad M = 2,768 \cdot \sqrt{P} .$$

III. 6 Inshootlar bo'g'inini (gidrouzel)ni hisobi

1- masala Keng ostonali suv o'tkazgichlarning hisobiga doir masala

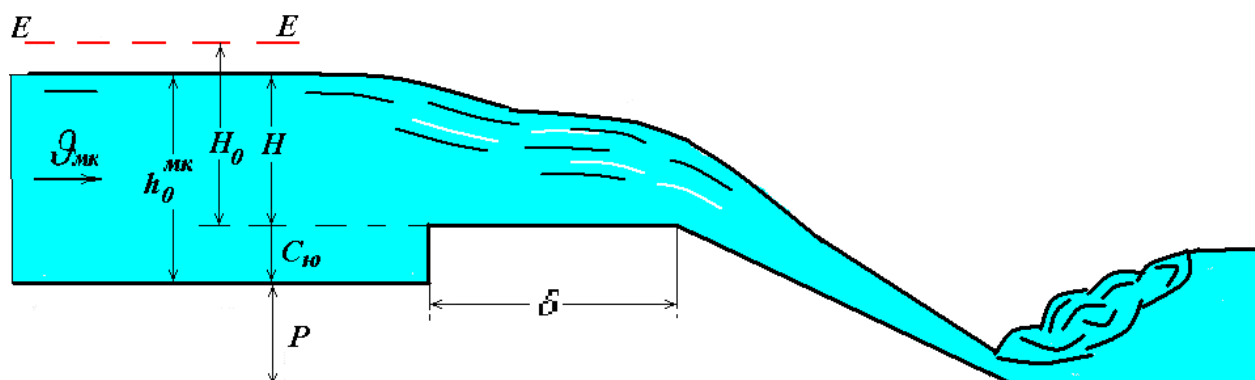
Magistral kanaldagi (MK) to'suvchi inshoot keng ostonali suv o'tkazgich shaklida qurilgan (ostonaning kengligi $2H < \delta < 8H$, bu erda H – ostona oldidagi napor).

Ostona kirish qismining shakli (ko'rinishi) va yuqori b'efdagi balandligi (C_{yu}) berilgan (kurs ishidagi dastlabki ma'lumotlar bo'yicha olinadi). To'suvchi inshoot magistral kanaldan o'tadigan sarfni o'tkazish uchun hisoblanadi.

Berilgan ma'lumotlar: Sharshara tubining nishablighi i , yuqori va pastki b'ef tublari belgilarining farqi (P). Yon va o'rta ustunlarning (o'rta devorlarning) shakllari talaba ixtiyori bo'yicha tanlab olinadi.

Tezoqar-sharshara qurilganligi uchun MKni to'sadigan inshoot keng ostonali ko'milmagan suv o'tkazgich kabi ishlaydi (demak, ko'milish koeffisienti $\sigma_{ko'm} = 1$).

Ostonaning bir oraliq kengligi berilgan $b/H = A$ nisbat orqali aniqlanadi, oraliqlar soni esa magistral kanalda o'tadigan sarf (bir oraliqdan o'tadigan sarf nisbati)ga asosan hisoblanadi.



35-rasm - Keng ostonali suv o'tkazgich sxemasi

Hisoblash tartibi:

1. Suv o'tkazgich oldidagi geometrik naporni aniqlaymiz:

$$H = h_0^{MK} - C_{10}$$

Bu erda: h_0^{MK} – MK - dagi suv oqimining normal chuqurligi;

C_{yu} – suv o'tkazgichning yuqori b'efdagi balandligi.

2. Berilgan $b/H = A$ nisbatga asosan, bir oraliq kengligini aniqlaymiz va unga eng yaqin bo'lgan standart qiymatini qabul qilamiz:

$$b = AH \Rightarrow b_{st}$$

Standart qiymatlar: $b_{cm} : 0,2; 0,4; 0,5; 0,6; 0,8; 1,0; 1,2; 1,5; 1,8; 2,0; 2,5; 3,0; 3,5; 4,0; 4,5; 5,0; 6,0; 7,0$ m va xokazo har 1 m dan.

Suv o'tkazgichdagi to'la naporni aniqlaymiz:

Agar $\mathcal{G}_{MK} \geq 0,361\sqrt{H}$ bo'lsa, unda to'la napor $H_0 = H + \frac{\alpha \cdot \mathcal{G}_{MK}^2}{2 \cdot g}$.

Agar $\mathcal{G}_{MK} < 0,361\sqrt{H}$ bo'lsa, unda to'la napor $H_0 = H$.

bu erda: \mathcal{G}_{MK} – magistral kanaldagi oqimning o'rtacha tezligi (yaqinlashish tezligi):

$$\mathcal{G}_{MK} = \frac{Q_{MK}}{\omega_{MK}} = \frac{Q_{MK}}{(b_{MK} + mh_0^{MK})h_0^{MK}}.$$

3. Ostonaning pastki b'efdagi balandligini aniqlaymiz:

$$C_n = P + C_{\text{ю}}, C_n > h_0.$$

4. Ostonaning shakliga qarab, sarf koeffisientini m aniqlaymiz (shu qo'llanmadagi 8-jadval).

m – sarf koeffisienti, ustunning shakliga bog'liq

$$\eta = \frac{C_{\text{ю}}}{H}.$$

Qirg'oqdagi ustunlarning shaklini tanlab, ularga mos tayanch devorlarining kirish qismi shakliga bog'liq bo'lgan torayish koeffisienti ζ_y qiymatini qabul qilamiz, (shu qo'llanmada 31-rasm). Keyin bir oraliq uchun yon siqilish koeffisienti qiymati aniqlanadi:

$$\varepsilon = 1 - 0,2\zeta_y \frac{H_0}{b},$$

bu erda: H_0 – to'la napor;

$b = b_{st}$ – bir oraliq (bo'linma) kengligi.

O'rta devor (ustun) – to'suvchi inshootning o'rtasida joylashgan devor, **tayanch ustunlar** – inshootning qirg'oqlarida joylashgan devorlar.

5. To'suvchi inshootning bir oralig'idan o'tadigan sarfni aniqlaymiz (bir oraliqning suv o'tkazish qobiliyatini aniqlaymiz):

$$Q_1 = m \cdot \varepsilon \cdot b_{cm} \sqrt{2 \cdot g \cdot H_0^{3/2}}$$

6. Bo'linmalarning (oraliklarning) sonini aniqlaymiz:

$$N = \frac{Q_{MK}}{Q_1}$$

hisoblangan songa eng yaqin bo'lgan butun sonni qabul qilamiz.

Agar $N > 1$ bo'lsa, o'rta ustunlarning shaklini va ularga mos bo'lgan oraliq tik ustunning plandagi ko'rinish shakliga bog'liq torayish koeffisienti ζ_{σ} (shu qo'llanmada 31-rasm) aniqlab, yon siqilish koeffisientiga aniqlik kiritamiz:

$$\varepsilon = 1 - 0,2 \frac{\zeta_y + (N-1)\zeta_{\sigma}}{N} \cdot \frac{H_0}{b}$$

Natijada suv o'tkazish qobiliyatini aniqlaymiz:

$$Q = m \cdot \varepsilon \cdot N \cdot b_{cm} \sqrt{2 \cdot g \cdot H_0^{3/2}} \quad (\sigma_{\text{кв}} = 1)$$

Aniqlangan sarfning qiymati berilgan Q_{mk} -dan kichik bo'lishi mumkin emas: $Q \geq Q_{mk}$.

Agar kichik bo'lib chiqsa, qirg'oqdagi ustunlarning va o'rta devorlarning shaklini o'zgartirish kerak yoki oraliqlarning sonini ko'paytirish kerak.

7. Inshootdan keyin tezoqar-sharshara qurilgan (ko'ndalang kesimi trapesiya shaklida bo'lib), uning oxiridagi kengligi

$$b_{m.u.} = 0,8B_{m.u.}$$

bu erda: $B_{m.u.}$ – to'suvchi inshoot kengligi.

$$B_{m.u.} = N \cdot b + (N - 1)t$$

bu erda: $t=(0.7 \dots 1,2)$ m – o'rta devorning eni.

Amaliy profilli suv o'tkazgichni hisobiga doir masalalar.

2-masala. Taqsimlagich (T-1) kanalning suv o'tkazish qobiliyatini aniqlash.

T – 1 kanaldagi to'suvchi inshoot amaliy profilli suv o'tkazgich shaklida qurilgan, demak ($0,67N < \delta < 2H$).

Suv o'tkazgich trapesiya shaklida ishlangan bo'lib, ostonaning yuqori va pastki b'eflardagi balandliklari (S_{yu} va S_p), oraliqlarning soni (N) va bir oraliqning kengligi (b) berilgan bo'lsin.

Suv o'tkazgichning suv o'tkazish qobiliyatini amaliy profili suv o'tkazgichlarni hisoblash tenglamasidan tug'ridan-to'g'ri aniqlash murakkab.

$$Q = \sigma_{к\gamma\mu} \cdot m \cdot b_x \sqrt{2g} H_0^{3/2},$$

Tenglamada m, b_x va H_0 parametrlarni berilgan qiymatlar asosida aniqlash uchun kanaldagi suvning chuqurligini aniqlash lozim. Chunki suv o'tkazgich ko'milgan-ko'milmaganligini bilish kerak. Shuning uchun bu masalani grafik usulda echishga to'g'ri keladi. Buning uchun (T-1) kanalning ishchi xarakteristika grafigini $Q_{T-1} = f(h)$ va suv o'tkazgichning suv o'tkazish qobiliyati grafigi $Q_{S.O.} = \varphi(h_{n.o.})$ bilan bog'liq ravishda qurish kerak. Pastki b'efdagi suv oqimi chuqurligiga bir necha qiymat beramiz va shu qiymatlar uchun suv o'tkazgichdan o'tadigan sarfni Q va T – 1 kanaldagi suv sarflarini Q_{T-1} aniqlaymiz. Hisoblashni to ular bir-biriga teng bo'lmaguncha davom ettiramiz. Ikki chiziqning kesilish nuqtasi bizga suv o'tkazgichdan o'tadigan suv sarfini beradi.

B) – Agar $\frac{Z}{C_n} \leq \left(\frac{Z}{C_n}\right)_{кр}$ bo'lsa, suv o'tkazgich ko'milgan ($\sigma_{к\у\м} \neq 1$), (chizmada 2-chi vaziyati).

Bu erda: Z – yuqori va pastki bеflardagi suv sathlarining farqi:

$$Z = H - h_{к\у\м}$$

C_n – ostonaning pastki bеf tomonidagi balandligi;

$h_{к\у\м}$ – ko'milish chuqurligi:

$$h_{к\у\м} = h_{n.б} - C_n .$$

Agar suv o'tkazgich ko'milgan bo'lsa $\frac{Z}{C_n} \leq \left(\frac{Z}{C_n}\right)_{кр}$, ko'milish koeffisientni $\sigma_{к\у\м}$ G.D.

Deryugin formulasi orqali aniqlanadi:

$$\sigma_{к\у\м} = \sqrt{1 - \left[1 - \left(1 - \frac{h_{к\у\м}}{H_0} \right) \cdot \frac{1}{1 - \left(1 - \frac{m}{0,59} \right)^{2/5}} \right]^2}$$

Suv sarfini quyidagicha aniqlanadi:

$$Q = \sigma_{к\у\м} \cdot \varepsilon \cdot m \cdot b \cdot N \sqrt{2g} H_0^{3/2} \quad \text{yoki} \quad Q = A \cdot \sigma_{к\у\м}$$

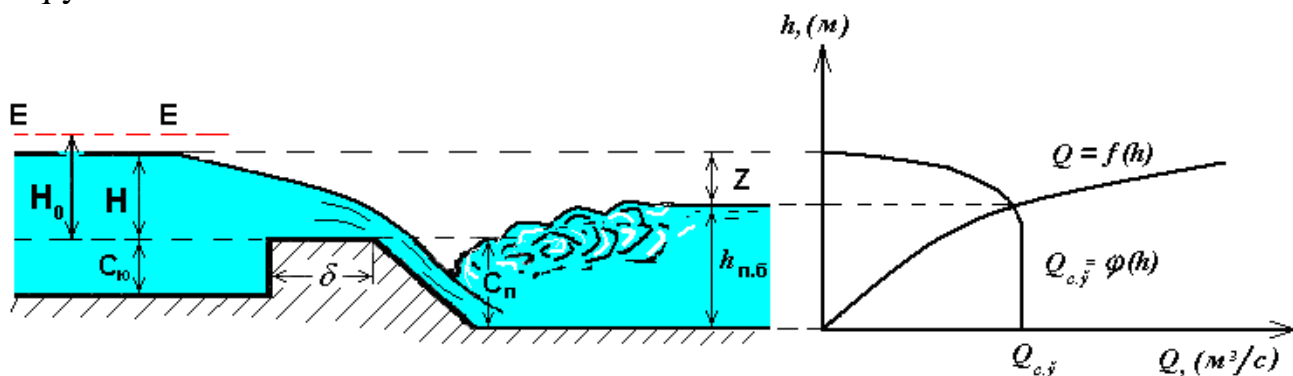
bu erda: $A = \varepsilon \cdot m \cdot b \cdot N \sqrt{2g} H_0^{3/2}$,

Hisoblashni jadvalda keltiramiz:

23 -jadval

$h_{T-1, m}$	$Q_{T-1}, m^3/c$	$h_{n.б}, m$	$h_{к\у\м}, m$	Z, m	$\frac{z}{C_n}$	$\left(\frac{z}{C_n}\right)_{кр}$	$\frac{h_{к\у\м}}{H_0}$	$\sigma_{к\у\м}$	$A, m^3/s$	$Q = A \cdot \sigma_{к\у\м}, m^3/s$

6. Jadvaldagi qiymatlar bo'yicha **suv o'tkazgichning suv o'tkazish qobiliyati grafigi** $Q_{s.o.} = \varphi(h_{n.б.})$ chiziladi va unga $T-1$ kanalning **ishchi xarakteristikasi** $Q_{T-1} = f(h)$ grafigi quyiladi. Ularning kesishish nuqtasi suv o'tkazgichdan o'tadigan sarf qiymatini beradi.



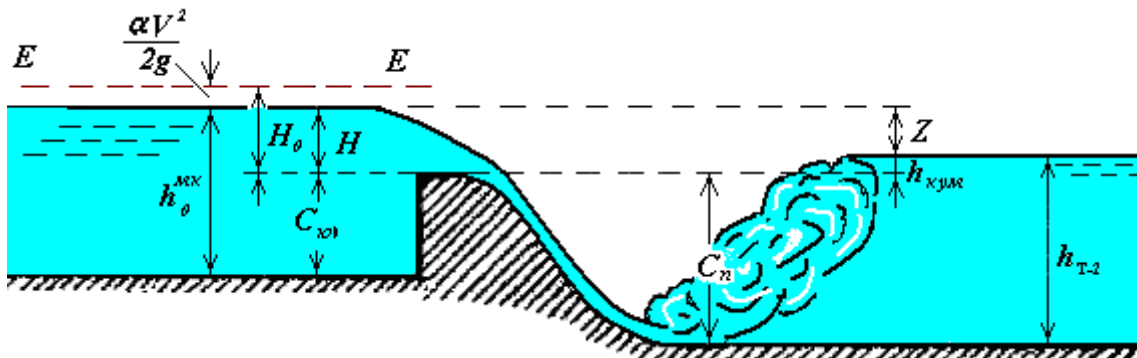
3-masala. Taqsimlagich (T-2) kanalidagi suv o'tkazgich ostonasidagi naporni va ostonaning yuqori b'efidagi balandligini aniqlash

T-2 kanalidagi suv o'tkazgich egri chiziqli amaliy profilli suv o'tkazgich shaklida qurilgan. U holda *A* yoki *B* profil qabul qilinadi va har biriga mos keladigan sarf koeffitsienti olinadi (*m*). Pastki b'ef tomonidan ostonani balandligi (*S_p*), oraliqlarning kengligi (*b*) va soni (*N*) berilgan bo'lsin.

Suv o'tkazgich ostonadagi naporni aniqlash uchun yaqinlashish usulidan foydalaniladi, chunki ko'milish koeffitsienti ($\sigma_{\text{кум}}$) va oqimning yon siqilish koeffitsienti (ε) qiymatlari napor (*H*) qiymati bilan bog'langan.

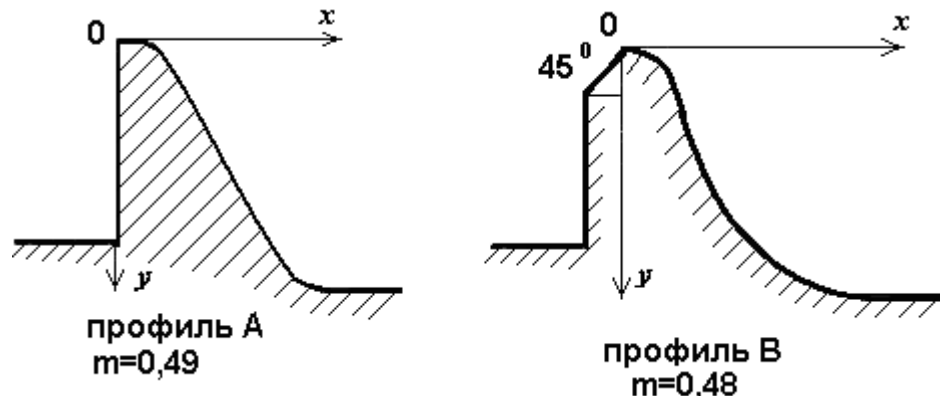
Hisoblash tartibi:

1. Sxema masshtabda chiziladi.



38 -rasm - Egri chiziqli amaliy profilli suv o'tkazgich sxemasi

2. Berilgan egri chiziqli suv o'tkazgichning turiga qarab, sarf koeffitsienti qabul qilinadi:



3. Suv o'tkazgichni ko'milmagan ($\sigma_{\text{кум}}=1$) va yon siqilishi yo'q deb ($\varepsilon=1$) ostonadagi naporni birinchi ko'rinishda aniqlaymiz.

$$H'_0 = \left(\frac{Q}{\sigma_{\text{кум}} \cdot m \cdot \varepsilon \cdot b \cdot N \cdot \sqrt{2g}} \right)^{2/3}$$

Bu erda: Q – T-2 kanalidagi suv sarfi.

4. Hisobga aniqlik kiritamiz. Tanlangan qirg'oqdagi ustunlarning va o'rta devorlarning shakliga qarab koefitsientlarni qabul qilamiz (ζ_y , ζ_σ) va yon siqilish koefitsientini aniqlaymiz:

$$\varepsilon = 1 - 0,2 \frac{\zeta_y + (N-1)\zeta_\sigma}{N} \frac{H'_0}{b}$$

5. Amaliy devorli suv o'tkazgich ko'milagan yoki ko'milmaganligini aniqlaymiz:

$$Z = (H'_0 + C_n) - h_{T-2}$$

bu erda: h_{T-2} - T-2 kanalidagi suvning normal chuqurligi.

$\left(\frac{Z}{C_n}\right)_{kp}$ qiymati grafikdan (qo'llanmada 61-betdagi 31-rasmdan) $\frac{H'_0}{C_n}$ qiymatiga qarab

olinadi.

Agar $\frac{Z}{C_n} < \left(\frac{Z}{C_n}\right)_{kp}$ bo'lsa, suv o'tkazgich **ko'milgan** va σ_{kym} G.D. Deryugin

formulasidan aniqlanadi.

Agar $\frac{Z}{C_n} > \left(\frac{Z}{C_n}\right)_{kp}$ bo'lsa, - suv o'tkazgich **ko'milmagan** va $\sigma_{kym} = 1,0$.

6. Ostonadagi haqiqiy naporni aniqlaymiz:

$$H_0 = \left(\frac{Q}{\sigma_{kym} \cdot m \cdot \varepsilon \cdot b \cdot N \sqrt{2g}} \right)^{2/3} .$$

7. YUqori b'ef tomonidan ostonaning balandligi

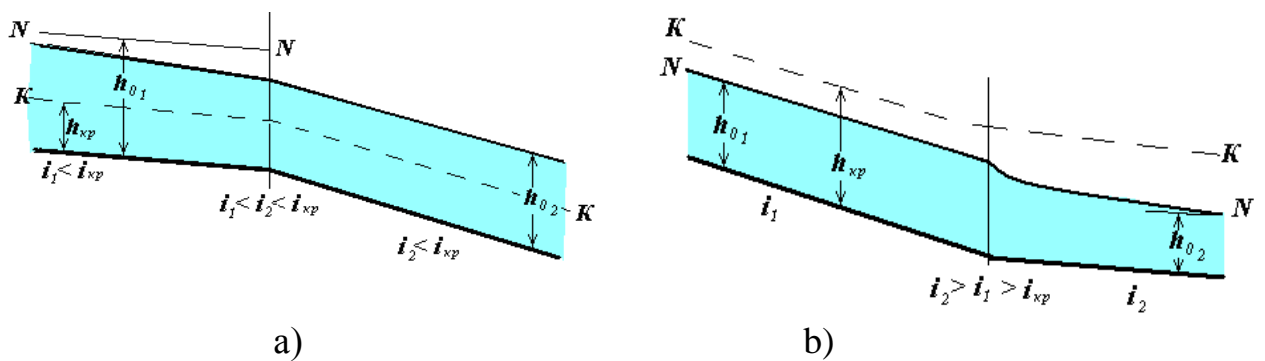
$$C_{ю} = h_0^{MK} - H_0 .$$

IV B'yeftlarni tutashtirish

Suv oqimining yuqori b'efdan pastki b'efga o'tishiga *b'eftlarning tutashtirishi* deyiladi. Amaliyotda b'eftlarni tutashtirishni ikki hilga ajratiladi - tub nishabligi o'zgarganda va inshoot-to'g'onlardan suvni oshib o'tishi.

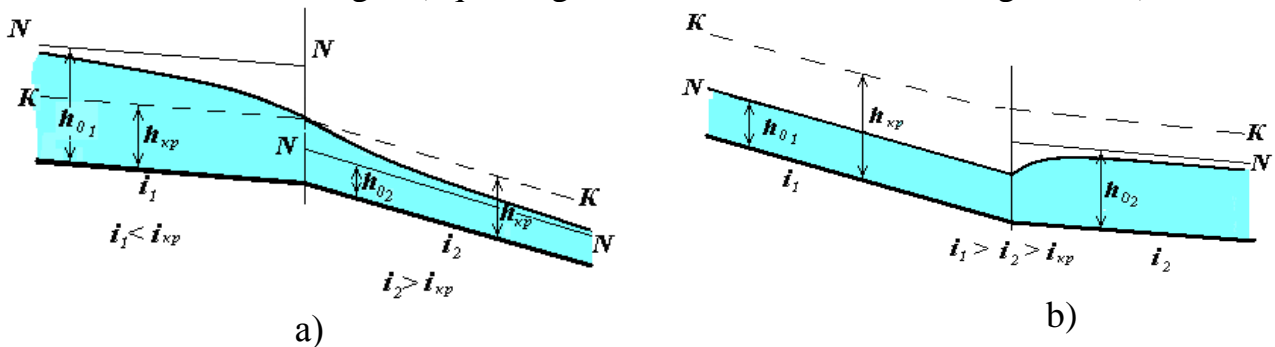
IV.1 Tub nishabligi o'zgarganda b'eftlarni tutashtirish

Ma'lumki, xar hil tub nishabligi uchun o'zandagi suv oqimining normal chuqurligi (h_0) xar hil bo'ladi - nishablik kamaygan sari, normal chuqurlik oshib boradi. Shuning uchun, pastki b'efdagi tub nishabligi yuqoridagindan kichikroq bo'lsa, erkin egri suv sathining chizig'i egri ko'tarilma egriligi sodir (mavjud) bo'ladi (40 - rasim -a), aksincha bo'lsa - egri pasayma chizig'i (40 - rasm - b).



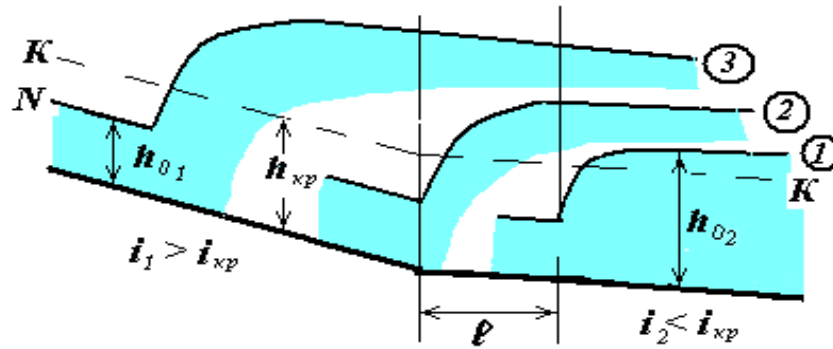
40- rasm - Tub nishabligi o'zgarganda b'eftlarni tutashtirish

Tub nishabliklari $i < i_{kp}$ - dan $i > i_{kp}$ - gacha o'zgarganda b'eftlarni tutashtirishi 41-a rasmda ko'rsatilgan (oqimning tinch holatdan notinch xolatga o'tishi).



41 -rasm - Tub nishabligi o'zgarganda b'eftlarni tutashtirish

Tub nishabliklari $i > i_{kp}$ - dan - $i < i_{kp}$ gacha o'zgarganda (suv oqimi notinch holatdan tinch holatga o'tishi) b'eftlarning tutashtirishi 43-b rasmda ko'rsatilgan. Bu xolatda b'eftlarning tutashishi gidravlik sakrash orqali amalga oshadi. 44 - rasmda sakrashlarning holatlari keltirilgan.



42– rasm - Sakrash orqali bʻeflarni tutashtirish

Gidravlik sakrash vaziyatini aniqlash uchun siqilgan kesimdagi suv chuqurligiga bogʻliq boʻlgan ikkinchi tutashtiruvchi chuqurlik qiymatini aniqlab, pastki bʻefdagi suv chuqurligi (h_o) bilan solishtirimiz. 42 -rasmda gidravlik sakrashning bir nechta vaziyatlari koʻrsatilgan:

- $h_c'' > h_o$ - sakrash xaydalgan boʻladi (1- vaziyat);
- $h_o = h_c''$ - sakrash siqilgan kesimda boʻladi (2- vaziyat);
- $h_c'' < h_o$ - sakrash koʻmilgan holda sodir boʻladi (3- vaziyat).

IV.2 Inshoot–toʻgʻonlardan suvni oʻshib oʻtishida bʻeflarni tutashtirish

Bunda quyidagi holatlarni kuzatish mumkin:

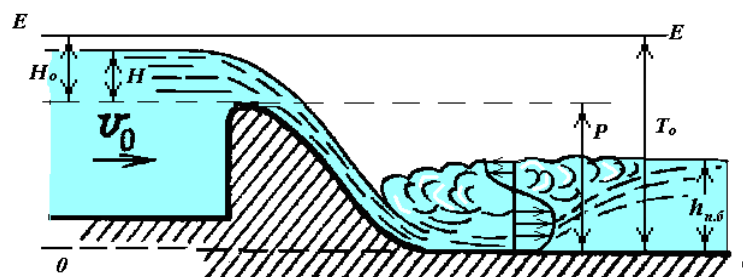
- inshoot ustidan suvni oʻshib oʻtishi (43- rasm);
- darvoza (zatvor) ostidan (teshikdan) suvni oʻtishi (44- rasm);
- inshootga oʻrnatilgan darvoza (zatvor) ostidan suvni oʻtishi (45-rasm).

Bʻeflarni tutashtirishida uchraydigan asosiy gidravlik masalalar:

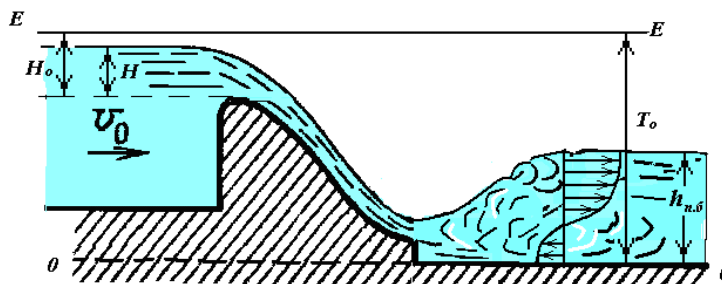
- pastki bʻefda tutashtirish turini aniqlash;
- inshoot quyi qismidan gidravlik sakrash haydalgan masofani aniqlash;
- oqim zarbini kamaytirish uchun energiya soʻndiruvchi inshootlarni gidravlik hisobi.

Inshoot ustidan suv oqimi oʻshib oʻtishida bʻeflarning tutashishi quyidagicha sodir boʻlishi mumkin:

- Oqim tubi bilan (eng katta tezlik qiymatlari tubga yaqin boʻladi):



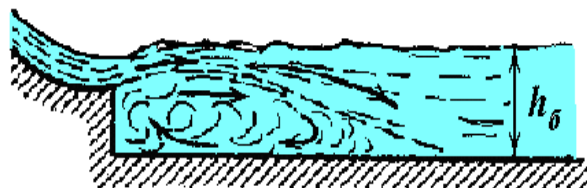
2. Oqim usti bilan (eng katta tezlik qiymatlari suv sathiga yaqin bo'ladi):



3. Aralashgan holatda:



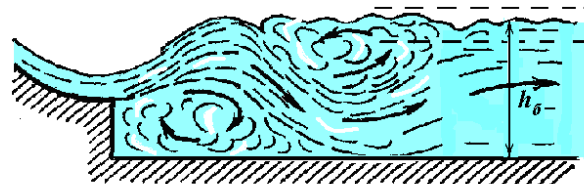
Tub tartibida



Ustki erkin

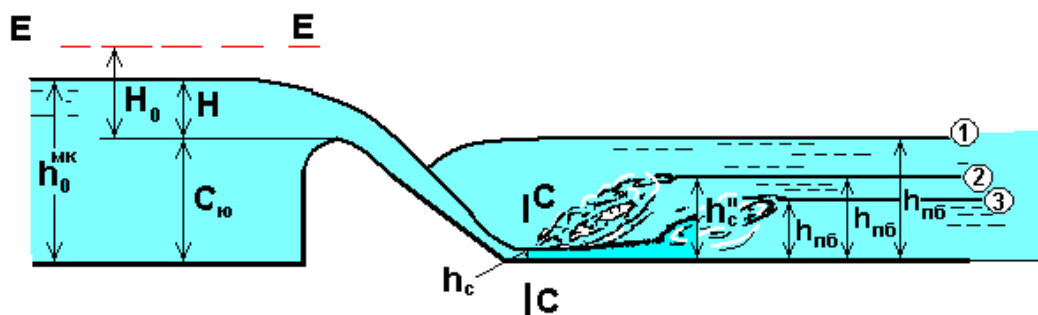


Ustki kumilgan



Ustki-tubdagi tartibda

IV.2.1 Inshoot ustidan suvni oshib o'tishi



43-rasm - Suv o'tkazgich orqali b'eflarni tutashtirish

Suv o'tkazgich orqali b'eflarni tutashtirishda inshoot quyi qismidagi kesimning chuqurligini aniqlash zarur. Chunki, keyinchalik ikkinchi tutashgan h_c'' oqim chuqurligini aniqlash kerak bo'ladi. Siqilgan kesimdagi chuqurlikni (43-rasm) quyidagi ifoda yordamida aniqlash mumkin.

$$T_0 = h_c + \frac{\alpha Q^2}{2 \cdot g \cdot \varphi^2 \cdot \omega_c^2},$$

bunda: h_c - siqilgan kesimdagi suv chuqurligi;

ω_c – siqilgan kesim yuzasi;

T_0 – pastki bʻef tubiga nisbatan yuqori bʻefdagi oqimning solishtirma energiyasi;

φ – toʻgʻon turiga bogʻliq boʻlgan tezlik koeffisienti.

Siqilgan kesimdagi chuqurlikni aniqlashda tezlik koeffisientini φ qiymatini N.N. Pavlovskiy formulasi boʻyicha aniqlash mumkin.

Gidrotexnik inshootlarning pastki bʻefida notinch oqimning tinch oqim bilan tutashishining quyidagi shakllarini kuzatish mumkin.

1) sakrash, agar $h_c'' > h_{\sigma}$ boʻlsa gidravlik sakrash siqilgan kesimga nisbatan oqimning quyi qismida joylashadi – haydalgan sakrash (43- rasmda 3- vaziyat);

2) sakrashning chegaraviy joylashishi agar $h_c'' = h_{\sigma}$ boʻlsa, sakrashning boshlanishi siqilgan kesimda joylashadi (43 - rasmda 2- vaziyat);

3) agar $h_c'' < h_{\sigma}$ boʻlsa, koʻmilgan sakrash boʻladi, bunda gidravlik sakrashning boshlanishi siqilgan kesimga nisbatan oqimning yuqori qismida joylashadi (43 – rasmdagi 1- vaziyat).

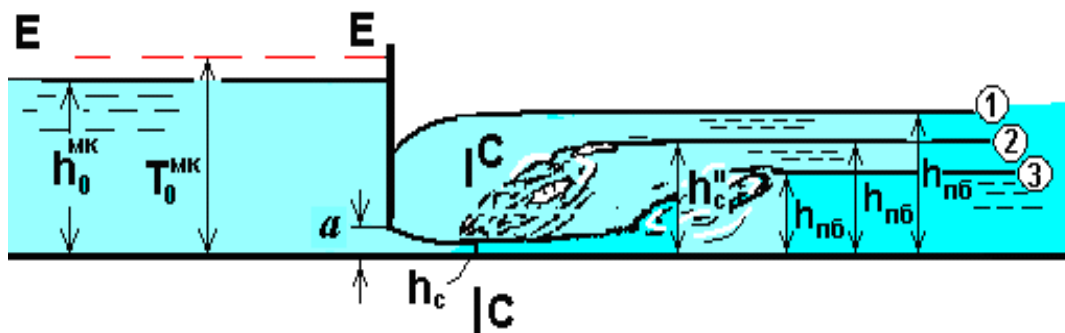
Agar oʻzan tubi nishabligi kritik qiymatdan katta, yaʼni $i > i_{kp}$ boʻlsa, u holda mavjud chuqurlik $h_{\sigma} < h_{kp}$ boʻladi va pastki bʻefdagi oqim bilan tutashish sakrachsiz sodir boʻladi.

IV.2.1 Hidrotexnik inshootlardagi darvozalar (zatvor)dan oʻtayotgan suv sarfini hisoblash

Gidrotexnik inshootlarga oʻrnatilgan «zatvor»larni boshqarish orqali, ulardan oʻtayotgan suv miqdorini tartibga solish mumkin.

«Zatvor»larni maʼlum darajaga koʻtarish yoki tushirish orqali suv sarfi boshqariladi va aniqlanadi. «Zatvor»lar inshootlarda quyidagicha oʻrnatilgan boʻlishi mumkin (44-rasm):

IV.2.2 Oqimni to'suvchi devor(zatvor) ostidan oqib chiqishi



47– rasm. To'suvchi devor orqali bʻeflarni tutashtirish

Bunda oqib chiqishning bir nechta turlari bo'lishi mumkin:

1) agar pastki bʻefdagi oqim sathi darvoza teshigidan chiqayotgan sarf qiymatiga ta'sir qilmasa, oqib chiqish erkin deyiladi (47 – rasmdagi 2-chi va 3–chi vaziyatlar);

2) agar pastki bʻefdagi oqim sathi darvoza teshigidan chiqayotgan sarfga ta'sir qilsa, erkin bo'lmagan yoki ko'milgan oqib chiqish deyiladi (47 - rasmdagi 1-chi vaziyat).

Oqib chiqish quyidagi sharoitlarda erkin bo'ladi:

a) agar pastki bʻefdagi oqim notinch holatda bo'lsa $i > i_{kp}$ va $h_{n\bar{o}} < h_{xp}$;

b) agar pastki bʻefdagi oqim tinch holatda $h_{n\bar{o}} > h_{xp}$ bo'lib, to'siq ostidan oqib chiqayotgan notinch oqimni tutashishi gidravlik sakrash orqali sodir bo'lsa $h_c'' > h_{n\bar{o}}$ (47 – rasmda 3- vaziyat), yoki sakrash siqilgan kesimdagi $h_c'' = h_{n\bar{o}}$ sodir bo'ladi (47 – rasmda 2- vaziyat).

Siqilgan kesim chuqurligi (48-rasm) “zatvor”ning ochilish balandligi orqali ifodalanadi:

$$h_c = \varepsilon a$$

bunda ε – vertikal siqilish koeffisienti,

$$\varepsilon = f\left(\frac{a}{H}\right)$$

ε - ning qiymatlari 26-jadvaldagi N.E.Jukovskiy tenglamasi orqali hisoblanadi yoki A.D.Al'tshul' formulasi orqali:

$$\varepsilon = 0,57 + \frac{0,043}{1,1 + \frac{a}{H}}$$

Darvoza ostidan o'tayotgan suv sarfi quyidagicha aniqlanadi (47-rasmdagi 2 va 3 vaziyatlar):

$$Q = \varphi \sqrt{2g(H_0 - h_c)}$$

$$Q = \varphi \cdot b \cdot h_c \sqrt{2g(H_0 - h_c)} = \mu \cdot b \cdot a \sqrt{2g(H_0 - \varepsilon \cdot a)}$$

bunda: ϑ – siqilgan kesimdagi tezlik;

a – darvozaning ko'tarilish balandligi;

b – darvoza eni;

μ – sarf koeffisienti ($\mu = \varphi \cdot \varepsilon$);

ε – vertikal siqilish koeffisienti;

H_0 – to'la napor, $\left(H_0 = H + \frac{\alpha \vartheta_0^2}{2g} \right)$.

Agar $\vartheta_0 \leq 0,885 \sqrt{H - h_c}$ m/c bo'lsa (48-rasm), $H = H_0$.

φ - tezlik koeffisienti quyidagicha qabul qilinadi:

o ostonasiz uchun $\varphi = 0,95 \div 0,97$ (47-rasm);

o keng ostonasiz tirqishlar uchun $\varphi = 0,85 \div 0,95$ (45-rasm - a,b,s).

Darvozaning ochilish balandligini aniqlashga doir

26-jadval

$\frac{a}{H}$	ε	$\Phi(\tau_c)$	$\tau_c = \varepsilon \frac{a}{H}$	$\frac{a}{H}$	ε	$\Phi(\tau_c)$	$\tau_c = \varepsilon \frac{a}{H}$
0,10	0,615	0,264	0,062	0,45	0,638	1,060	0,284
0,15	0,618	0,388	0,092	0,50	0,645	1,182	0,323
0,20	0,620	0,514	0,124	0,55	0,650	1,265	0,356
0,25	0,622	0,633	0,156	0,60	0,660	1,364	0,395
0,30	0,625	0,750	0,188	0,65	0,675	1,457	0,440
0,35	0,628	0,865	0,220	0,70	0,690	1,538	0,482
0,40	0,630	0,967	0,252	0,75	0,705	1,611	0,529

Amaliy profilli suv o'tkazgich qirrasiga o'rnatilgan tekis darvozadan oqib chiqayotgan oqim sarfi quyidagi formula bo'yicha hisoblanadi (47 rasm, b,c):

$$Q = \varphi \cdot \varepsilon \cdot a \cdot b \sqrt{2g \cdot H_0} = \mu \cdot a \cdot b \sqrt{2g \cdot H_0} ,$$

bunda H_0 – yaqinlashish tezligini e'tiborga olgandagi suv o'tkazgich qirrasining ustidagi geometrik napor.

Tezlik koeffisienti φ -ning qiymatlari:

1) amaliy profilli suv o'tkazgich qirrasidagi tekis darvozadan oqib chiqishda: $\varphi = 0,95$;

2) sharshara oldidagi ostonasiz darvozadan oqib chiqishda: $\varphi = 0,97$ (44-rasm, b, c).

Agar $C_{10} > h_0^{MK}$, unda suv o'tkazgich ko'milgan bo'ladi (49-rasm).

3. Bir oraliqdan o'tadigan sarfni aniqlaymiz:

$$\bar{Q} = \frac{Q}{N}$$

N – oraliqlar soni.

4. Tekis darvozani ko'tarilish balandligini quyidagi formuladan aniqlaymiz:

$$Q = \mu \cdot a \cdot b \cdot N \sqrt{2g(H_0 - \varepsilon \cdot a)}$$

bu erda: $\varepsilon = 0,57 + \frac{0,043}{1,1 - \frac{a}{H}}$ - vertikal siqilish koeffisienti.

Vertikal siqilish koeffisient (ε) quyidagi $\left(\frac{a}{H}\right)$ nisbat bilan bog'langanligi tufayli, uni N.E.Jukovskiy jadvalidan aniqlasa bo'ladi (qullanmada 27-jadval).

(Jukovskiy N.E. jadvali, Shterenlixt D.A. «Gidravlika», 179 bet, 23.1 jadval, M.1991).

N.E.Jukovskiy jadvali $\varepsilon = f\left(\frac{a}{H}\right)$

27 - jadval

$\frac{a}{H_0}$	ε	$\frac{a}{H_0}$	ε	$\frac{a}{H_0}$	ε	$\frac{a}{H_0}$	ε	$\frac{a}{H_0}$	ε
0,00	0,611	0,25	0,622	0,45	0,638	0,65	0,675	0,85	0,745
0,10	0,615	0,30	0,625	0,50	0,645	0,70	0,690	0,90	0,780
0,15	0,618	0,35	0,628	0,55	0,650	0,75	0,705	0,95	0,885
0,20	0,620	0,40	0,630	0,60	0,660	0,80	0,720	1,0	1,0

$\varphi = 0,85 \dots 0,97$ – tezlik koeffisienti;

a – darvozani ko'tarilish balandligi;

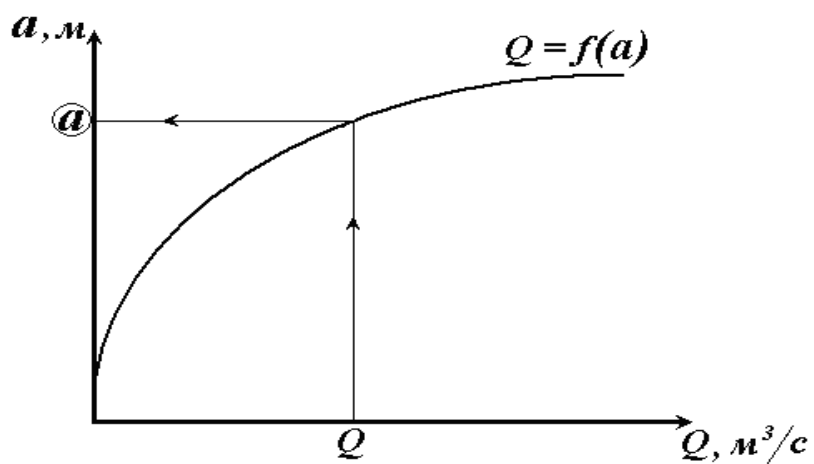
$\mu = \varepsilon\varphi$ - sarf koeffisienti.

Darvozaning ochilish balandligi tanlash usulida aniqlanadi. Darvozani ko'tarilish balandligi « a »-ga bir necha qiymat berib, shu qiymatlar uchun sarf Q aniqlanadi va $Q = f(a)$ grafigi quriladi. SHu grafikdan berilgan $\bar{Q} = Q_{MK} - Q_{T-1}$ sarf uchun darvozani ko'tarilish balandligi qiymatini aniqlaymiz. Hisob natijalarini jadvalda keltiramiz:

28 - jadval

a, m	$\frac{a}{H_0}$	ε	$\varepsilon a, m$	μ	$\sqrt{2g(H_0 - \varepsilon a)}$	$Q, \frac{m^3}{c}$

Jadvaldagi qiymatlarga asosan $Q = f(a)$ grafigini quramiz va berilgan sarf uchun $Q = Q_{MK} - Q_{T-1}$ darvozani ko'tarilish balandligini aniqlaymiz.

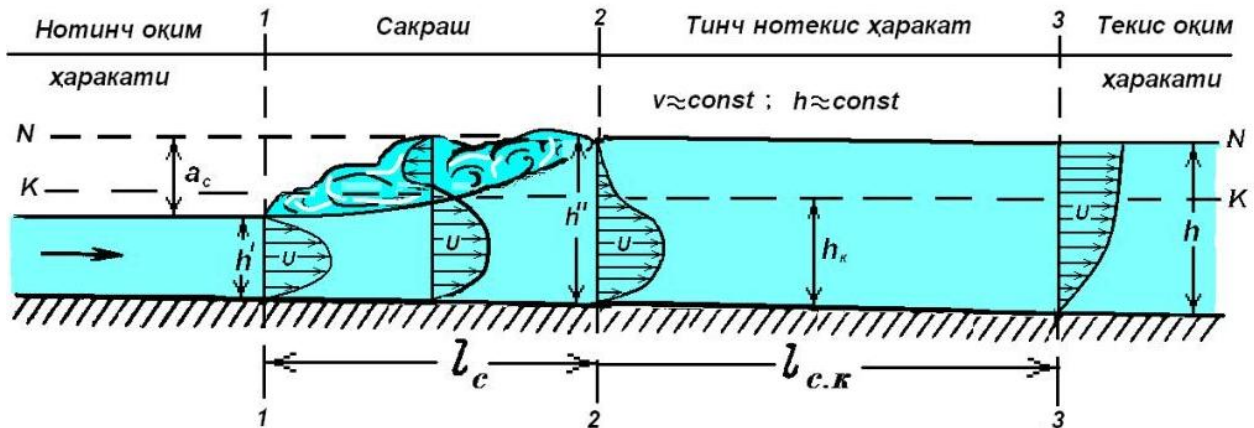


50- rasm - $Q = f(a)$ funksiyasi grafigi.

V GIDRAVLIK SAKRASH

V.1 Gidravlik sakrash va uning elementlari

Suv oqimining notinch holatdan tinch holatga o'tishi gidravlik sakrash orqali amalga oshadi. Shunga asosan, unga quyidagicha ta'rif berish mumkin: *suv oqimining kritik chuqurlikdan kichik bo'lgan h' chuqurligini undan katta bo'lgan h'' chuqurlikka keskin o'tishi hodisasi gidravlik sakrash deyiladi.*



51-rasm - Gidravlik sakrash sxemasi

h' - gidravlik sakrashdan oldingi oqim chuqurligi;

h'' - gidravlik sakrashdan keyingi oqim chuqurligi;

$a = h'' - h'$ - gidravlik sakrash balandligi;

l_c - gidravlik sakrash uzunligi;

$l_{c.k}$ - gidravlik sakrashdan keyingi uchastkaning uzunligi.

Gidravlik sakrash turlari

1. Mukammal, aylana girdob harakat qismi bor bo'lgan sakrashga aytiladi (51-rasm):

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

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

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

Gidrotexnik inshootga nisbatan:

1. Gidravlik sakrash boshlang'ich holatda:

$$h_c'' = h_0,$$

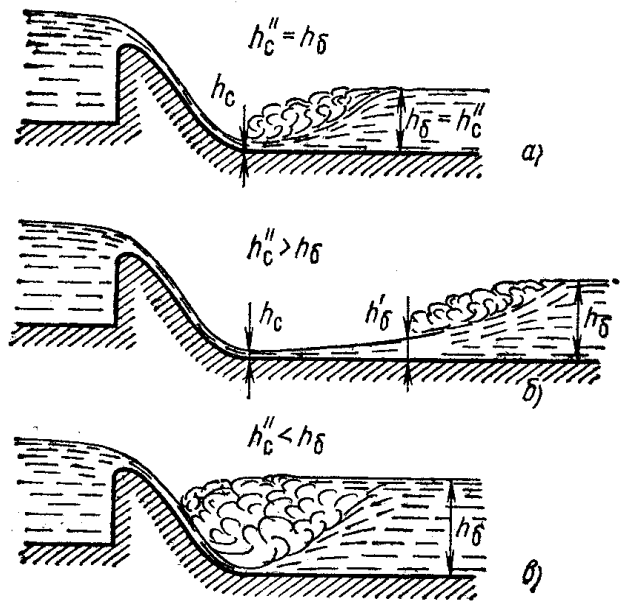
h_0 - kanaldagi chuqurlik.

2. Gidravlik sakrash – uzoqlashgan xolatda – xaydalgan gidravlik sakrash:

$$h_c'' > h_0,$$

3. Gidravlik sakrash – ko'milgan holatda:

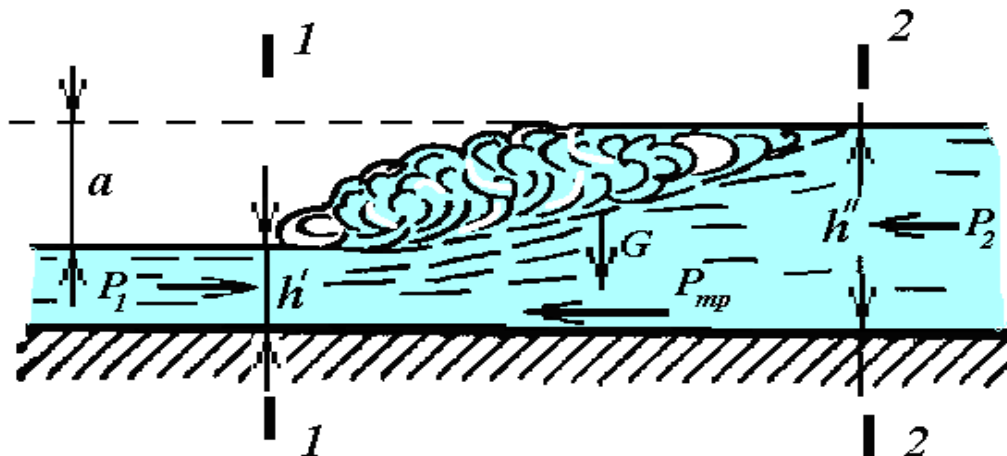
$$h_c'' < h_0.$$



V.2 Gidravlik sakrash asosiy tenglamasi

Tutash chuqurliklar (h' va h'') orasidagi bog'liqliklar prizmatik o'zanlar uchun, quyidagi formula orqali aniqlanadi. Harakat miqdorining o'zgarishi haqidagi teoremadan:

$$\int_{\omega} \rho(ud\omega)u = \rho \int_{\omega} u^2 d\omega = \alpha \mathcal{G}^2 \rho \omega = \underline{\rho \alpha \mathcal{G} Q}$$



Rasm 52 – Gidravlik sakrash sxemasi

1-1 va 2-2 kesimlar uchun:

$$i = 0; \quad Q = const;$$

$$\rho \alpha Q (\mathcal{G}_2 - \mathcal{G}_1) = P_1 - P_2,$$

$P_1 = \rho g h'_c \omega_1$; $P_2 = \rho g h''_c \omega_2$; ekanligini inobatga olib, gidravlik sakrash funksiyasini quyidagicha ezamiz:

$$\frac{\alpha Q^2}{g \omega_1} + \omega_1 h'_c = \frac{\alpha Q^2}{g \omega_2} + \omega_2 h''_c$$

gde : ω_1, ω_2 – gidravlik sakrashdan oldingi va keyingi harakatdagi kesimlarning yuzalari;

To'rtburchak kanallar uchun $h_c = \frac{h}{2}$, h'_c, h''_c — harakatdagi kesim og'irlik markazining chuqurligi (52-rasm).

Trapesiya shakldagi kanallar uchun: $h_c = \frac{h}{6} \cdot \frac{36 + 2mh}{b + mh}$.

V.3 Gidravlik sakrash funksiyasi

Gidravlik sakrash funksiyasi: $\Pi(h) = \frac{\alpha Q^2}{g \omega} + \omega h_c$;

$$\Pi(h_I) = \Pi(h_{II}).$$

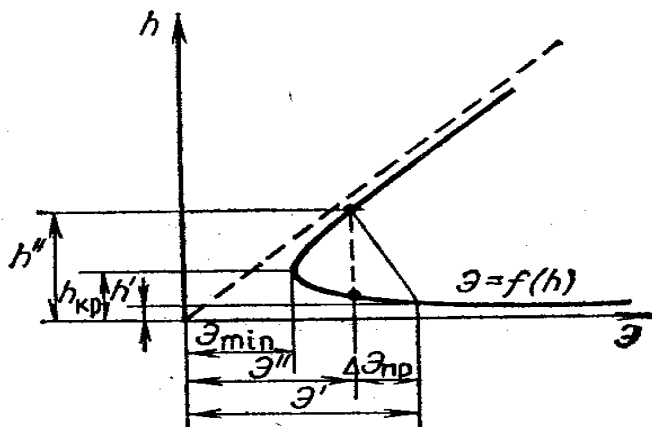
Bu erda: $\Pi(h)$ – sakrash funksiyasi, $\dim P(h) = L^3(m^3)$;

Q – suv sarfi;

ω – tegishli chuqurlikdagi oqimning harakatdagi kesimi yuzasi;

h_c – harakatdagi kesim og'irlik markazining chuqurligi.

To'g'ri burchakli kanallar uchun:



$$h'' = 0,5h' \left[\sqrt{1 + 8 \left(\frac{h_{kp}}{h'} \right)^3} - 1 \right];$$

$$h' = 0,5h'' \left[\sqrt{1 + 8 \left(\frac{h_{kp}}{h''} \right)^3} - 1 \right].$$

Sakrashdan oldingi h' va sakrashdan keyingi h'' chuqurliklar o'zaro bog'liq bo'lgan tutash chuqurliklar deyiladi. Tutash chuqurliklar uchun sakrash funksiyalari

hamisha bir-biriga teng. Sakrash funksiyasi eng kichik qiymatiga ega bo'ladi $\mathcal{E} = \mathcal{E}_{\min}$, agar kanaldagi suv chuqurligi kritik qiymatiga h_k teng bo'lganda.

Gidravlik sakrash uzunligini aniqlash

A. To'g'ri to'rtburchak kanallar uchun:

1. M.D.Chertousov formulasi: $l_c = 10,3h'(\sqrt{\Pi_\kappa} - 1)^{0,81}$

$$\Pi_\kappa = \left(\frac{h_{kp}}{h'} \right)^2.$$

2. F.I.Pikalov formulasi: $l_c = 4h'\sqrt{1 + 2\Pi_{\kappa 1}}$;

3. N.N.Pavlovskiy formulasi (1937 y.): $l_c = 2,5(1,9h'' - h')$;

4. Sarantsev formulasi: $l_c = 4,5h''$;

5. B.Baxmetev va Matske formulasi: $l_c = 5(h'' - h')$;

Kanal tub nishabligi katta bo'lgan holda G.N.Kostyakova formulasi qo'llanadi:

$$CH_3 \geq (i > i_\kappa) \quad \ell'_n = \ell_n(1 + 3i).$$

B. Trapesiya shakldagi kanallar uchun:

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

bu erda: B_1 i B_2 - sakrashdan oldingi va keyingi kesimdagi sathdagi kengliklari.

M.D.Chertousov sakrashdan keyingi uchastkani uzunligini quyidagi formula orqali aniqlashni tavsiya qiladi:

$$\ell_{s,\kappa} = (13 \div 15,6)h_b,$$

bu erda: h_b –pastki b'efdagi suv chuqurligi.

Gidravlik sakrashda yo'qolgan energiya (napor)

Kanal tubining nishabligi $i=0$ bo'lganda, gidravlik sakrashda yo'qolgan solishtirma energiyani quyidagi formula orqali aniqlanadi:

$$\mathcal{E}_1 - \mathcal{E}_2 = h_c$$

\mathcal{E}_1 - gidravlik sakrashdan oldingi kesimdagi solishtirma energiya:

$$\mathcal{E}_1 = h' + \frac{\alpha \cdot (\mathcal{Q}_1)^2}{2g}$$

\mathcal{E}_2 - gidravlik sakrashdan keyingi kesimdagi solishtirma energiya:

$$\mathcal{E}_2 = h'' + \frac{\alpha \cdot (\mathcal{Q}_2)^2}{2g}.$$

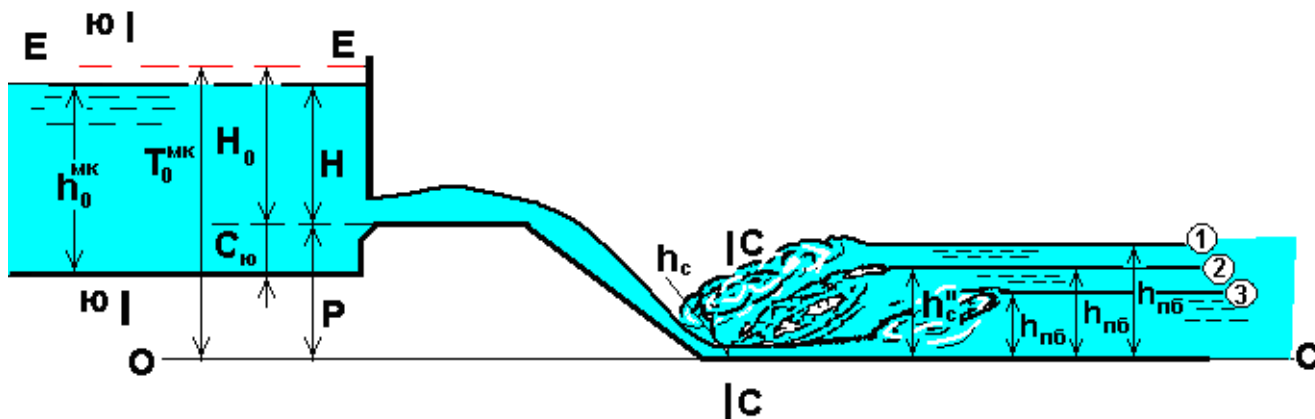
Tug'ri to'rtburchak shakldagi kesimda sakrashda yo'qolgan solishtirma energiyani quyidagi formula orqali aniqlanadi:

$$\Theta_u = \frac{a^3}{4h'h''}$$

V.4 Gidravlik sakrash parametrlarini hisobi

Gidravlik sakrashlar 3 xil bo'lishi mumkin:

1. Sakrash ko'milgan $h_c'' < h_{kym}$, (54 - chizmadagi sathning 1-chi holati).
2. Sakrash siqilgan kesimda $h_c'' = h_{kym}$, (54 - chizmadagi sathning 2-chi holati).
3. Sakrash haydalgan $h_c'' > h_{kym}$, (54 - chizmadagi sathning 3-chi holati).



53 – rasm - Gidravlik sakrashning hisoblash sxemasi.

Gidravlik sakrashning vaziyatini aniqlash uchun siqilgan kesimdagi suv chuqurligini aniqlaymiz (h_c) (C-C – siqilgan kesim). Siqilgan kesimdagi chuqurlikni (h_c) birinchi (C-C) tutashtirish chuqurlik deb qabul qilamiz h_c' , demak sakrash siqilgan kesimda bo'ladi deb qabul qilamiz. Sakrashning ikkinchi tutashtirish chuqurligini (h_c'') aniqlab, pastki b'efdagi chuqurligi h_0 bilan solishtiramiz (53 - rasm).

1. Tezoqar - sharshara oxiridagi siqilgan kesimdagi suv chuqurligini aniqlash h_c' .

Hisoblash tartibi:

1. Sxemani masshtabda chizamiz (53 -rasm).
2. Kesimlarni (YU-YU va C-C) va taqqoslash tekisligini (O-O) belgilaymiz.
3. D.Bernulli tenglamasini pastki b'efdagi kanal tubidan o'tkazilgan taqqoslash tekisligiga (O-O) nisbatan yozamiz:

$$Z_{y0} + \frac{P_{y0}}{\gamma} + \frac{\alpha \mathcal{G}_{y0}^2}{2g} = Z_c + \frac{P_c}{\gamma} + \frac{\alpha \mathcal{G}_c^2}{2g} + h_{f(y0-c)}$$

Tenglamani har bir hadini aniqlab, tenglamani quyidagi ko'rinishda yozamiz:

$$P + h_0^{MK} + \frac{\alpha \mathcal{G}^2}{2g} = h_c + \frac{\alpha \mathcal{G}_c^2}{2g} + \xi \frac{\mathcal{G}_c^2}{2g}$$

Tenglamani quyidagicha yozish mumkin:

$$T_0^{n\sigma} = h_c + (\alpha + \xi) \frac{g_c^2}{2g};$$

Agar quyidagi belgilashlarni kiritsak:

$$\alpha + \xi = \frac{1}{\varphi^2}, \text{ bu erda } (\varphi = 0,9)$$

Unda

$$T_0^{n\sigma} = h_c + \frac{g_c^2}{2g\varphi^2} = h_c + \frac{Q_{MK}^2}{2g\varphi^2\omega_c^2}; \quad (1)$$

Bu erda: T_0^{MK} - taqqoslash tekisligiga (O-O-ga) nisbatan hisoblaganda YU-YU kesimdagi to'la solishtirma energiya qiymatini quyidagicha aniqlash mumkin:

$$T_0^{MK} = P + h_0^{MK} + \frac{\alpha g_0^2}{2g} \quad (2)$$

P – MK -ning yuqori va pastki bʼeflarning tublari belgilarining farqi;

g_0 - yuqori bʼefdagi yaqinlashish tezligi;

h_c - siqilgan kesimdagi suv oqimining chuqurligi;

g_c - siqilgan kesimdagi suv oqimining o'rtacha tezligi, $g_c = \frac{Q_{MK}}{\omega_c}$;

ω_c - harakatdagi kesim yuzasi, $\omega_c = h_c (b + mh_c)$;

$m = 1$ - tezoqar- sharsharaning qiyalik koeffisienti;

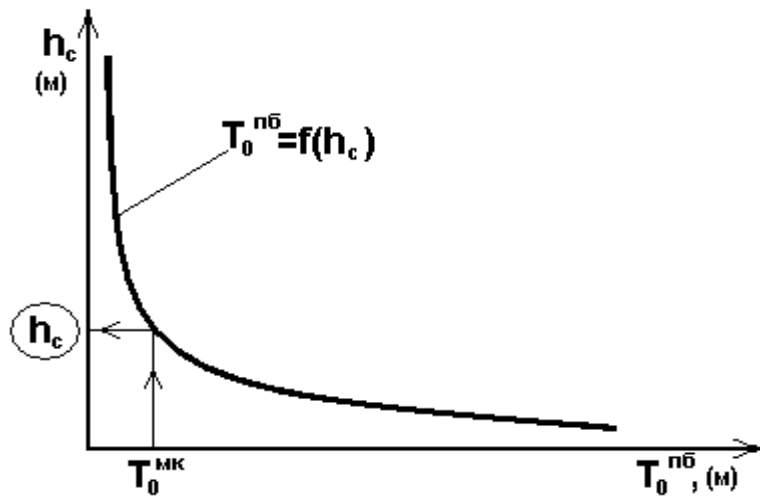
φ - tezlik koeffisienti;

$h_{f(HO-C)}$ - kesimlar orasida yo'qotilgan napor.

YUqori bʼefdagi to'la solishtirma energiyaning T_0^{MK} qiymati ma'lum va siqilgan kesimdagi suv chuqurligini (h_c) tanlash usulida aniqlasa bo'ladi. h_c -ga bir necha qiymatlarni berib, (1) tenglamaning o'ng tomonini hisoblaymiz. Hisoblash natijalarni jadvalda keltiramiz:

29 -jadval

h_c, m	ω_c, m^2	$T_0^{n\sigma}, m$	T_0^{MK}, m



54-rasm - Kesimning to'la solishtirma energiya grafigi

Jadvaldagi qiymatlar asosida $T_0^{no} = f(h_c)$ grafigini quramiz.

Quyidagi qiymat o'zgarmasdir: $\frac{\alpha Q_{MK}^2}{2g\omega_{MK}^2\varphi^2} = const$. Grafikdan ma'lum bo'lgan yuqori b'efdagi to'la solishtirma energiyaning T_0^{MK} qiymatiga qarab h_c - ning qiymatini olamiz.

2. Sakrashning ikkinchi tutashtirish chuqurligini aniqlash.

Siqilgan kesimdagi suv chuqurligini birinchi tutashtirish chuqurligi deb qabul qilib ($h_c = h'$), ikkinchi tutash chuqurligini aniqlaymiz:

$$h_c = h' \longrightarrow h''$$

a) **Sakrash funksiyasi grafigi** orqali $\Pi(h) = f(h)$

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

bu erda: h_{ozup} - kesim og'irlik markazining chuqurligi:

$$h_{ozup} = \frac{h(B+2b)}{3(B+b)};$$

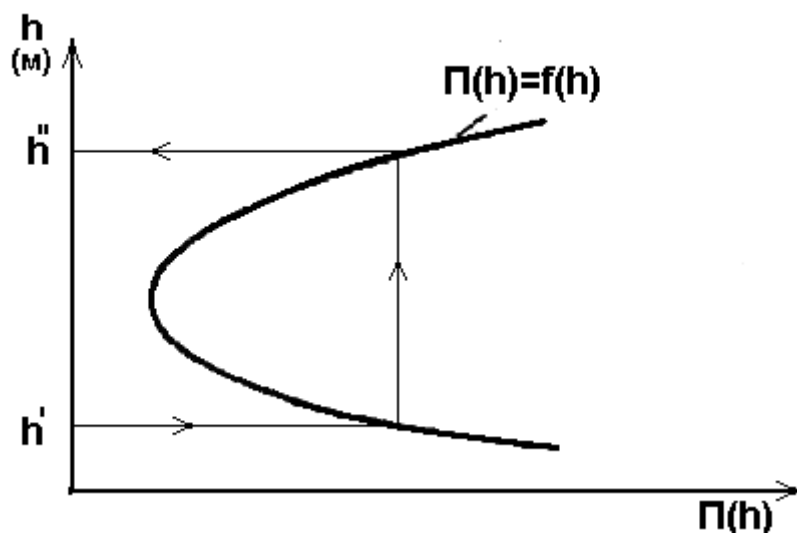
$B = b + 2mh$ - kesimining suv sathidagi kengligi.

Suv chuqurlikga (h) bir necha qiymat berib, $P(h)$ -ni aniqlaymiz.

30 - jadval

h, m	ω, m^2	$\frac{\alpha Q^2}{g\omega}$	h_{ozup}, m	$h_{ozup}\omega$	$\Pi(h)$

Jadval asosida sakrash funksiyasi grafigini $\Pi(h) = f(h)$ quramiz:



55 – rasm - Gidravlik sakrash funksiyasi $\Pi(h) = f(h)$ grafigi

Ma'lum bo'lgan h'_c qiymatiga mos ravishda pastki qismi bilan kesishguncha gorizontal chiziq o'tkazamiz. Grafikdan h''_c qiymatini aniqlaymiz.

b) *A.N.Raxmanov formulalari* yordami bilan:

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

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

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

3. Gidravlik sakrashning xolatini aniqlash

$h''_c < h_{kym}$ bo'lsa, gidravlik sakrash ko'milgan;

$h''_c = h_{kym}$ bo'lsa, gidravlik sakrash siqilgan kesimda;

$h''_c > h_{kym}$ bo'lsa, gidravlik sakrash xaydalgan bo'ladi.

4. Sakrashning uzunligini aniqlaymiz:

$$l_n = 5h''_c \left(1 + 4 \sqrt{\frac{B_2 - B_1}{B_1}} \right)$$

$B_1 = b + 2mh'_c$ - birinchi tutashtiruvchi chuqurlik (h'_c) -dagi tirik kesimning suv sathidagi kengligi;

$B_2 = b + 2mh''_c$ - ikkinchi tutashtiruvchi chuqurlik (h''_c) -dagi tirik kesimning suv sathidagi kengligi.

5. Sakrash balandligini aniqlaymiz: $a = h''_c - h'_c$

VI Suv zarbini kamaytiruvchi inshootlar. Oqim energiyasini so'ndirgichlar

VI.1 Energiyani so'ndiruvchi xovuz.

Agar sakrash xaydalgan bo'lsa, pastki b'efga oqim zarbini kamaytirish uchun energiya so'ndiruvchi devor (to'siq) yoki hovuz qullaniladi.

Buning uchun suv o'tkazgich oxirining tubi « d » chuqurlikka pasaytiriladi. Unda siqilgan chuqurlik h_c kamayib borib, u bilan bog'langan h_c'' ko'payib boradi. Natijada sakrash siqilgan kesimga suriladi va pastki b'efga ta'sir kamayadi.

Hovuzning chuqurligi (d)-ni quyidagicha aniqlanadi. Sakrash ayni siqilgan kesimda bo'lishi sharti bajarilishi uchun quyidagi tenglamani yozamiz:

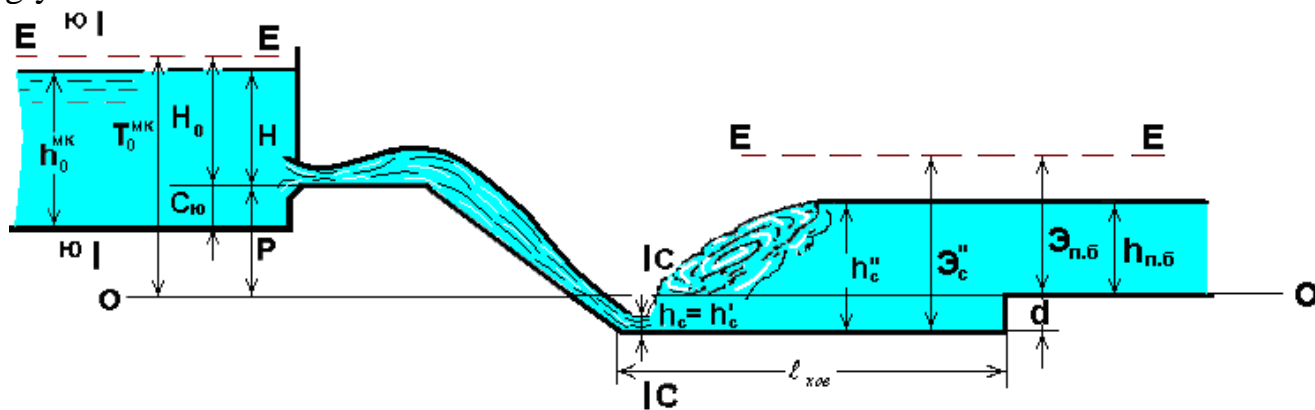
$$\mathfrak{E}_c'' = \mathfrak{E}_{n.\delta} + d \quad (1)$$

bu erda

$$\mathfrak{E}_c'' = h_c'' + \frac{\alpha(g_c'')^2}{2g}; \text{ yoki } \mathfrak{E}_c'' = h_c'' + \frac{\alpha Q_{MK}^2}{2g\omega^2}$$

$$\mathfrak{E}_{n.\delta} = h_{n.\delta} + \frac{\alpha(g_{n.\delta}'')^2}{2g};$$

\mathfrak{E}_c'' va $\mathfrak{E}_{n.\delta}$ - sakrashdan keyingi va pastki b'efdagi kesimlarning solishtirma energiyalari.



56 - rasm - Energiya so'ndiruvchi hovuz sxemasi

Hovuzning uzunligini quyidagicha aniqlash mumkin:

M.R.Chertousov formulasi:

$$l_{xos} = (0,7...0,8)l_{sakar};$$

$l_{sakar} = 2,5(1,9h_c'' - h_c')$ - gidravlik sakrashning uzunligi.

N.N.Pavlovskiy formulasi:

$$l_{xos} = (0,7...0,8)l_{sakar}; \quad l_{sakar} = 2,5(1,9h_c'' - h_c').$$

Hisoblash tartibi:

1. Pastki b'efdagi kesimning solishtirma energiyasi aniqlanadi:

$$\mathfrak{E}_{n.\bar{o}.} = h_{\text{кызм}} + \frac{\alpha Q^2}{2g\omega_{\text{кызм}}^2};$$

bu erda: $h_{\text{кызм}}$ - ko'milish chuqurligi;

$$\omega_{\text{кызм}} = h_{\text{кызм}} (b_{\text{муу}} + mh_{\text{кызм}});$$

$b_{\text{муу}}$ - tezoqar sharshara quyi qismining kengligi.

m - qiyalik koeffisienti.

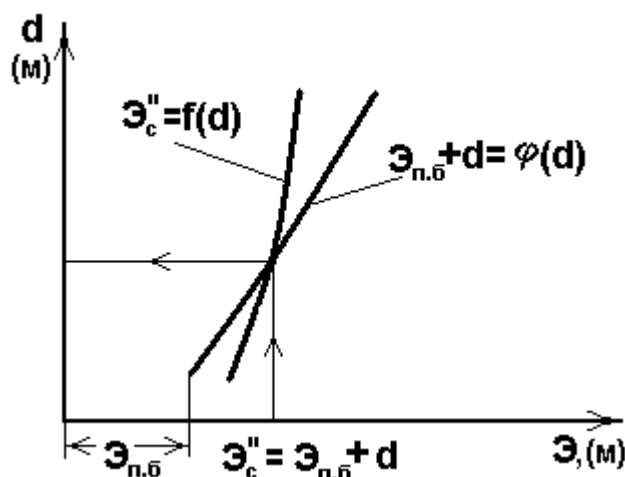
2. Hisoblash tanlash usulida bajariladi. Hovuz chuqurligiga bir necha qiymat berib, $h_c = f(T_0^{n\bar{o}.})$ grafikdan siqilgan kesimdagi chuqurlikni aniqlaymiz.

3. Hisoblash natijalarini jadvalda keltiramiz:

31 –jadval

$d,$ m	$(T_0^{n\bar{o}.} + d),$ m	$h_c,$ m	$h_c'',$ m	$\omega_c'',$ m^2	$\frac{\alpha Q_{MK}^2}{2g\omega_c^2},$ m	$\mathfrak{E}_c'',$ m	$\mathfrak{E}_{n.\bar{o}.} + d,$ m
1	2	3	4	5	6	7	8

SHu jadvaldagi qiymatlarga qarab, $\mathfrak{E}_c'' = f(d)$ va $\mathfrak{E}_{n.\bar{o}.} + d = \varphi(d)$ grafiklarni quramiz (57 – rasm).



57 – rasm – Energiya so'ndiruvchi hovuz chuqurligini aniqlash grafigi

Sakrash siqilgan kesimda bo'lishini ta'minlovchi hovuzning chuqurligi (d)-ni shu grafikdan olamiz.

4. Hovuzning uzunligini N.N.Pavlovskiy formulasi bo'yicha aniqlaymiz:

$$l_{xoe} = (0,7...0,8)l_{caxp}; \quad l_{caxp} = 2,5(1,9h_c'' - h_c')$$

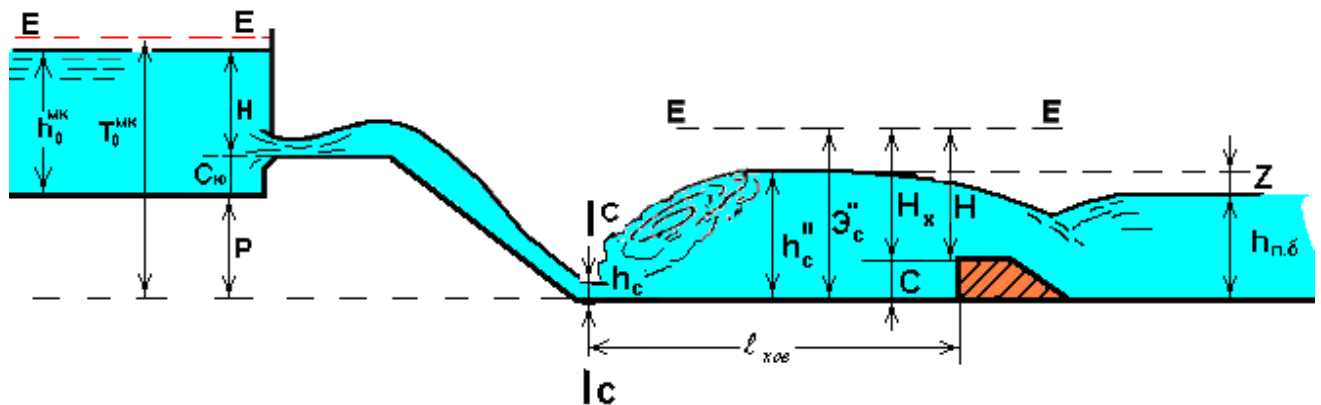
VI.2 Energiya so'ndiruvchi devor (to'siq)

Suv zarbini kamaytirish uchun amaliyotda energiya so'ndiruvchi devor ham keng qo'llaniladi.

Gidravlik sakrashni siqilgan kesimda hosil qilish uchun ushbu devorning balandligini (C) va devor bilan tashkil qilingan hovuz uzunligi (l_{xoe}) ni aniqlash kerak.

Xisoblash tartibi:

1. Sxema masshtabda chiziladi.



58 – rasm - Energiya so'ndiruvchi devor sxemasi

Energiya so'ndiruvchi devor sakrashni xaydalishiga yo'l bermaydi.

Energiya so'ndiruvchi devor amaliy profildagi suv o'tkazgichga o'xshab ishlaydi. Bu holda sarf koeffisienti:

$$m \approx 0,40...0,44 \approx 0,42$$

Sakrash siqilgan kesimda sodir bo'lishi uchun quyidagi shart bajarilishi kerak:

$$\mathfrak{E}_c'' = H_x + c$$

Shu shartni bajarish uchun energiya so'ndiruvchi devorning balandligi (C) tanlash usulida aniqlanadi.

Devor ustidagi hisobiy napor (H_x) ko'milmagan amaliy profildagi suv o'tkazgichlarning hisoblash tenglamasidan aniqlanadi.

H_x - suv o'tkazgichdagi hisobiy napor:

$$H_x = \left(\frac{Q}{mb_x \sqrt{2g}} \right)^{2/3}$$

Trapesiya shaklidagi kanalda devor ustidagi hisoblash kengligi quyidagi formula orqali aniqlanadi:

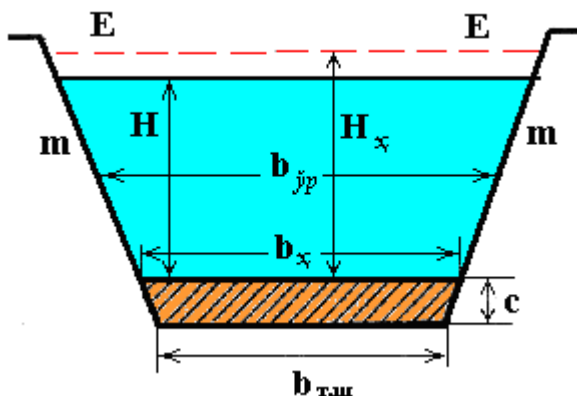
$$b_x = b_{mu} + 2 \cdot m \cdot c + 0,8 \cdot m \cdot H$$

bu erda m - suv urilma qismining qiyalik koeffisienti;

H - devor oldidagi geometrik napor:

$$H = h_c'' - c$$

b_{mu} - tezoqar- sharshara quyi qismining kengligi.



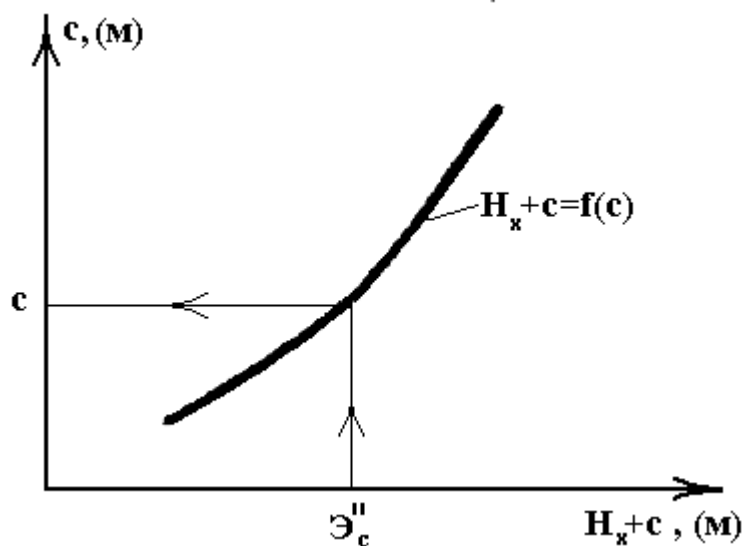
59 –rasm – Energiya so'ndiruvchi devor oldidagi oqim ko'ndalang kesimi

Masala tanlash usulda echiladi. Devorning balandligi (C)-ga bir necha qiymatlar beramiz va $H_x + c = f(c)$ grafigini quramiz va ϑ_c'' qiymatiga qarab, grafikdan « C » qiymatini olamiz.

Hisoblash natijalarini jadvalda keltiramiz:

32 - jadval

s	N	b_h	H_h	$H_h + C$



60 – rasm - Energiya so'ndiruvchi devor balandligini aniqlash grafigi

Energiya so'ndiruvchi devor hosil qilgan hovuzning uzunligi:

$$l_{xov} = (0,7...0,8)l_{cakp}; \quad l_{cakp} = 2,5(1,9h_c'' - h_c')$$

TOSHKENT IRRIGASIYA VA MELIORASIYA INSTITUTI



«GIDRAVLIKA» KAFEDRASI

_____ fakul'teti
 ___ bosqich _____ guruh talabasi _____ ga

Gidravlika fanidan kurs ishini bajarish uchun TOPSHIRIQ

Kurs ishining mazmuni:

Magistral kanalda (MK) gidrotexnik inshootlar bandi loyixalashtirilmoqda. Bu inshootlar bandiga: to'suvchi inshoot, T-1 va T-2 taqsimlagich kanallar va kanal bosh qismidagi inshootlar kiradi.

Boshlang'ich ma'lumotlar quyidagicha:

I. Kanallar bo'yicha:

Kanallar nomi	Suv sarfi Q , m^3/s	G'adir- budurlik koeff. n	Kanal tubining eni b , m	Kanal nishab- ligi i	Kanal qirg'og'ining qiyalik koeff. m	Parabolik kanallar darajasi α va para- metri « α »	Tuproq turi
Magistral kanal (MK)							
Taqsimlagich T-1	$0,4Q_{MK}$						
Taqsimlagich T-2	$0,3Q_{MK}$						

II. Inshootlar bo'yicha:

Inshootlar	Suv o'tkazish qobiliyati Q , m^3/s	Suv o'tkazgich turi	Ostonaning shakli	Ostonaning balandligi		Bo'limlar soni N	Bo'limlar kengligi b , m
				S_{yu}	S_p		
To'suvchi inshoot		keng ostonali					
T-1 kanaliga suv o'tkazgich		amaliy devorli	trapesiya				
T-2 kanaliga suv o'tkazgich		amaliy devorli	egri chiziqli				

Inshootlar yon va o'rta devorlarining kirish qismini plandagi shakli ixtiyoriy qabul qilish taklif etiladi.

To'suvchi to'g'on-inshootning yuqori va pastki b'eflaridagi magistral kanal tublari farqi $R = \underline{\hspace{2cm}}$ m.

Tezoqar-sharshara trapesiya shaklida ($m = \underline{\hspace{2cm}}$), noprizmatik, (sharshara pastki tubining eni $V_{t,i} = 0,8b_{t,sh}$), nishabligi $i = \underline{\hspace{2cm}}$ qabul qilinadi.

SHarshara-tezoqardan keyin suv zarbini kamaytiruvchi inshoot o'rnatilgan. Uning ko'ndalang kesimi trapesiya shaklida $m = \underline{\hspace{2cm}}$.

TALAB QILINADI:

I. Suvning harakati barqaror va qarshiliklarning kvadrat qismida deb faraz qilinib, kanallarning quyidagi hisoblari qilinsin:

A. Kanaldagi suv harakati tekis bo'lganda:

(Bu bo'lim masalalarini echishda analitik, EXMdan, R.M.Karimov grafiklari va jadvallaridan foydalanilsin).

1. Taqsimlagich T-1 kanalning ish grafigi $Q = f(h)$ qurilsin, grafikni qurish uchun $Q = 0,4Q_{MK}$ qabul qilinsin.

2. Taqsimlagich T-2 kanalning gidravlik elementlari aniqlansin.

3. YUVilmaydigan magistral kanal quyidagi shartlar asosida loyihalansin:

a) QM va Q bo'yicha $\mathcal{G} = \mathcal{G}_{IO}$, $C = \underline{\hspace{2cm}}$, $d_{op} = \underline{\hspace{2cm}}$ mm yoki

b) A.A.CHerkasov formulasi bo'yicha $\mathcal{G} = \mathcal{G}_{IO}$, $\mathcal{G}_0 = \underline{\hspace{2cm}}$ m/s qabul qilinib loyihalansin.

4. Magistral kanalda sarf $Q = Q_{MK}$, loyqalik $\rho = \underline{\hspace{2cm}}$ kgk/m³ va loyqa zarrachalarining o'rtacha gidravlik kattaligi $\bar{W} = \underline{\hspace{2cm}}$ mm/s bo'lganda, V.A.Zamarin, S.X. Abal'yan, A.Arifjanov formulalari va QM va Q da keltirilgan formulalardan foydalanib, kanal loyqa bosishi tekshirilsin.

B. Suv oqimining kanallardagi notekis harakati:

5. To'suvchi to'g'on inshoot oldidagi suv chuqurligi 15-20 foizga oshganda erkin sirt egriligi chizig'i qurilsin va uzunligi aniqlansin (B.A.Baxmetev usuli bilan).

II. Inshootlar bandining gidravlik hisobi bajarilsin:

1. To'suvchi to'g'on inshoot bo'linmalarini eni va soni aniqlansin, bunda bo'linma eni bosim balandligiga nisbati $b/N = \underline{\hspace{2cm}}$ qabul qilinsin.

2. T-1 kanalidagi suv o'tkazgichning suv o'tkazish qobiliyati aniqlansin.

3. T-2 kanalidagi suv o'tkazgich ostonasidagi bosim balandligi va ostonaning yuqori b'efdagi balandligi aniqlansin.

4. To'suvchi to'g'on inshoot tekis darvozasini (zatvor) ko'tarilish balandligi sarf $Q = \underline{\hspace{2cm}}$ bo'lganda aniqlansin.

III. Sarf $Q = Q_{MK}$ bo'lganda, inshoot b'eflarini tutashtirish hisobi bajarilsin va energiya so'ndirgich inshootining o'lchamlari aniqlansin.

1. Noprizmatik o'zanda V.I.CHarnomskiy usuli bo'yicha erkin sath egrilik chizig'i qurilsin, ko'muvchi chuqurlik aniqlansin.

2. Gidravlik sakrash elementlari hisoblansin va b'eflarni tutashtirish shakli aniqlansin.

3. Energiya so'ndiruvchi hovuz yoki devor turidagi energiya so'ndirgich hisoblansin.

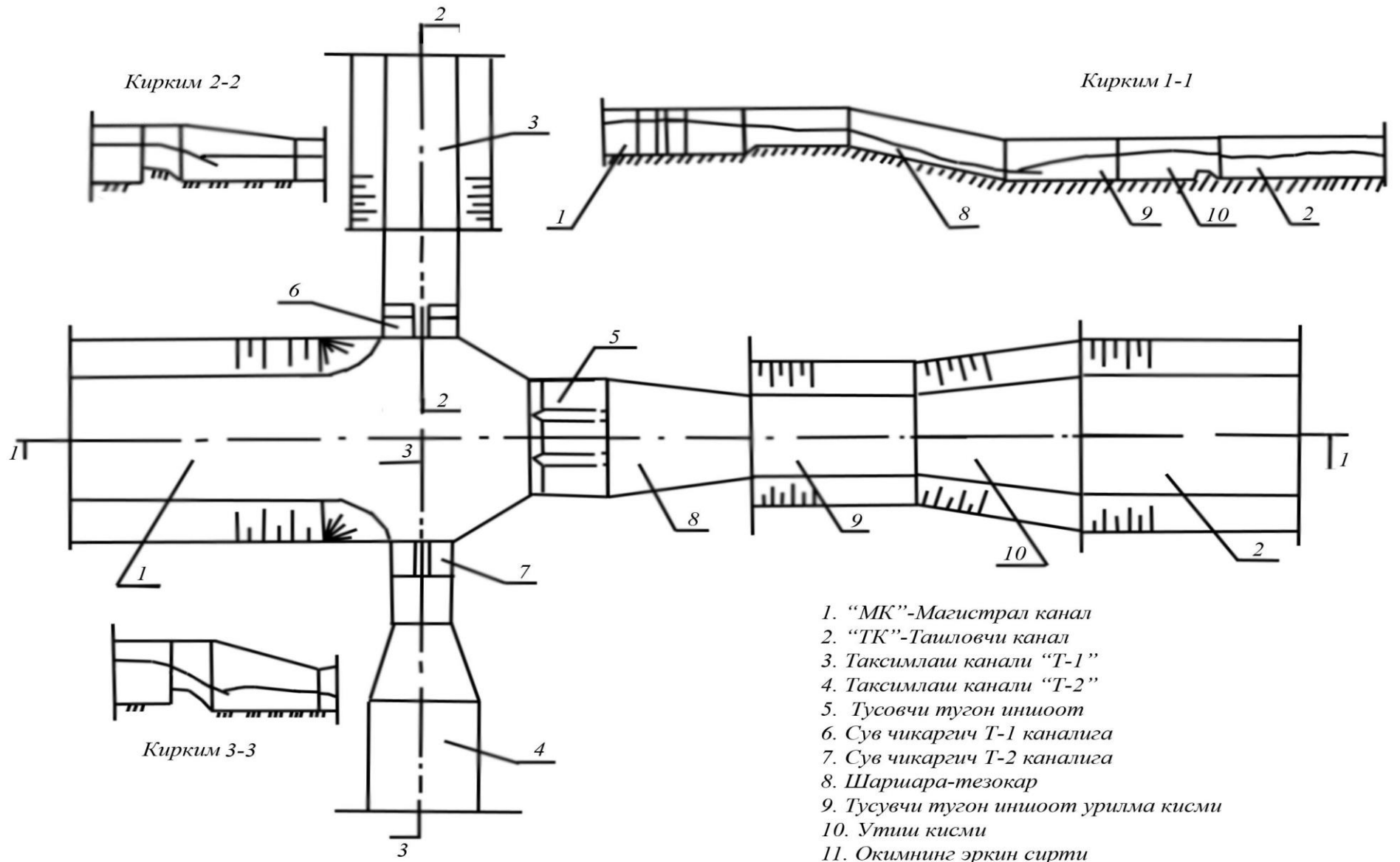
KURS ISHI BO'YICHA HISOBOT MATERIALLARI

A. To'rt bo'limdan iborat tushuntirish qismi:	Baho
1. Tekis harakatda kanallar hisobi.	
2. Notekis harakatda magistral kanalda oqim erkin sirt egriligi chizig'ini qurish.	
3. Inshootlarning hisobi.	
4. To'suvchi to'g'on-inshoot b'eflarini tutashtirish hisobi.	

B. Hisoblash sxemalari:	Baho
1. To'suvchi inshootning kengligini aniqlash (inshootning plani va bo'ylama qirqimi).	
2. T-1 kanalidagi suv o'tkazgichning suv o'tkazish qobiliyatini aniqlash (T-1 kanalidagi suv o'tkazgichning plani va bo'ylama qirqimi).	
3. T-2 kanalidagi suv o'tkazgich ostonasida bosim balandligini aniqlash (T-2 kanalidagi suv o'tkazgichning plani va bo'ylama qirqimi).	
4. To'suvchi inshoot to'sig'idan suv oqib chiqishni hisoblash (bo'ylama qirqimi).	
5. B'eflarni tutashtirish va energiyani so'ndirish inshootlarini hisoblash (To'suvchi inshootning suv urilma qismi va tezoqar-sharshara plani va bo'ylama qirqimi).	
6. Kanaldagi inshootlar bandining plani.	

Inshootlarning faqat suv bilan bog'liq qismi ko'rsatiladi.

V. Grafik qismi:	Baho
1. T-1 kanali uchun $Q=f(h)$ grafigi.	
2. Magistral kanal uchun $g = f(h)$, $g_{10} = \varphi(h)$ va $\omega R^{1/3} = f(h)$, $\omega R^{2/3} = \varphi(h)$ grafiglari.	
3. Magistral kanaldagi erkin sirt egri chizig'i.	
4. T-1 kanaliga suv chiqargichning suv o'tkazish qobiliyatini ifodalovchi grafik.	
5. To'suvchi inshootda to'siq qisman tushirilganda uning suv o'tkazish qobiliyati grafigi.	
6. To'suvchi inshootning urilma qismi uchun sakrash funksiyasi grafigi.	
7. O'tish bo'limida oqim erkin sirt egri chizig'i.	
8. Energiya so'ndiruvchini hisoblash uchun grafik.	



ILOVA

Ilova, I - jadval

Suvning kinematik yopishqoqlik ko'ffisienti ν , cm^2 / sek , haroratga bog'liq xolda

t^0	ν	t^0	ν	t^0	ν
1	0,017321	11	0,012740	22	0,009892
2	0,016740	12	0,012396	24	0,009186
3	0,016193	13	0,012067	26	0,008774
4	0,015676	14	0,011756	28	0,008394
5	0,015188	15	0,011463	30	0,008032
6	0,014726	16	0,011177	35	0,007251
7	0,014289	17	0,010888	40	0,006587
8	0,013873	18	0,010617	45	0,006029
9	0,013479	19	0,010356	50	0,005558
10	0,013101	20	0,010105	55	0,005147
				60	0,004779

Парабола шаклдаги каналлар ҳисобидаги функциялардаги R_0 и $g_0 \frac{n}{\sqrt{i}}$ қийматлари

Ilova, 2- jadval

R_0	$0,159 \frac{Qn}{\sqrt{i}}$	$g_0 \frac{n}{\sqrt{i}}$	R_0	$0,159 \frac{Qn}{\sqrt{i}}$	$g_0 \frac{n}{\sqrt{i}}$	R_0	$0,159 \frac{Qn}{\sqrt{i}}$	$g_0 \frac{n}{\sqrt{i}}$
0,025	0,000047	0,07561	0,25	0,02368	0,3789	0,60	0,2518	0,6994
30	0,000077	0,08590	26	0,02633	0,3895	62	0,2751	0,7156
35	0,000117	0,09569	27	0,02915	0,3999	64	0,2997	0,7317
40	0,000168	0,1053	28	0,03216	0,4102	66	0,3257	0,7476
45	0,000232	0,1141	29	0,03536	0,4204	68	0,3530	0,7634
0,050	0,000307	0,1228	0,30	0,03875	0,4305	0,70	0,3817	0,7791
55	0,000397	0,1313	31	0,04233	0,4405	72	0,4119	0,7946
60	0,000502	0,1395	32	0,04612	0,4504	74	0,4435	0,8100
65	0,000624	0,1476	33	0,05012	0,4602	76	0,4767	0,8252
70	0,000762	0,1554	34	0,05432	0,4699	78	0,5113	0,8404
0,075	0,000918	0,1631	0,35	0,05875	0,4796	0,80	0,5475	0,8554
80	0,00109	0,1707	36	0,06339	0,4891	82	0,5852	0,8703
85	0,00129	0,1781	37	0,06826	0,4986	84	0,6245	0,8851
90	0,00150	0,1853	38	0,07335	0,5080	86	0,6655	0,8998
95	0,00174	0,1925	39	0,07868	0,5173	88	0,7081	0,9144
0,100	0,00200	0,1995	0,40	0,08425	0,5266	0,90	0,7724	0,9289
11	0,00258	0,2133	41	0,09006	0,5357	92	0,7984	0,9433
12	0,00326	0,2257	42	0,09611	0,5449	94	0,8461	0,9676
13	0,00405	0,2398	43	0,1024	0,5539	96	0,8956	0,9718
14	0,00495	0,2525	44	0,1085	0,5629	98	0,9469	0,9860
0,15	0,00596	0,2650	0,45	0,1158	0,5718	0,00	0,0000	0,0000
16	0,00710	0,2773	46	0,1229	0,5807	02	0,055	0,04

2-jadval davomi								
R_0	$0,159 \frac{Qn}{\sqrt{i}}$	$g_0 \frac{n}{\sqrt{i}}$	R_0	$0,159 \frac{Qn}{\sqrt{i}}$	$g_0 \frac{n}{\sqrt{i}}$	R_0	$0,159 \frac{Qn}{\sqrt{i}}$	$g_0 \frac{n}{\sqrt{i}}$
17	0,00836	0,2893	47	0,1302	0,5895	04	0,112	0,028
18	0,00976	0,3011	48	0,1378	0,5982	06	0,170	0,042
19	0,01129	0,3127	49	0,1457	0,6069	08	0,231	0,055
0,20	0,01297	0,3241	0,50	0,1539	0,6156	0,10	0,294	0,069
21	0,01479	0,3354	52	0,1711	0,6327	12	0,358	0,083
22	0,01677	0,3465	54	0,1894	0,6497	14	0,424	0,096
23	0,01891	0,3575	56	0,2090	0,6664	16	0,493	0,110
24	0,02121	0,3683	58	0,2298	0,6830	18	0,563	0,123

Парабола шаклдаги каналларнинг ҳисобига доир жадвал

Ilova, 3 - jadval
 $\alpha = 1.0$

β	χ	$\frac{h}{R_0}$	$\frac{B}{R_0}$	β	χ	$\frac{h}{R_0}$	$\frac{B}{R_0}$
2.00	8.000	2.594	5.187	8.00	17.00	1.425	11.40
20	8.036	2.474	5.444	20	17.38	1.411	11.57
40	8.133	2.373	5.694	40	17.75	1.398	11.74
60	8.277	2.285	5.940	60	18.13	1.385	11.92
80	8.457	2.207	6.181	80	18.51	1.373	12.08
3.00	8.667	2.139	6.417	9.00	18.89	1.361	12.25
20	8.900	2.078	6.650	20	19.27	1.350	12.42
40	8.153	2.023	6.878	40	19.65	1.339	12.58
60	9.422	1.973	7.103	60	20.03	1.328	12.75
80	9.705	1.928	7.325	80	20.42	1.317	12.91
4.00	10.000	1.886	7.544	10.00	20.80	1.307	13.07
20	10.30	1.841	7.759	20	21.18	1.297	13.23
40	10.62	1.812	7.971	40	21.57	1.288	13.39
60	10.94	1.778	8.181	60	21.95	1.278	13.55
80	11.27	1.747	8.388	80	22.34	1.269	13.71
5.00	11.00	1.718	8.592	11.00	22.73	1.260	13.86
20	11.60	1.7	8.794	20	23.11	1.251	14.02
40	12.28	1.665	8.993	40	23.50	1.243	14.17
60	12.63	1.641	9.190	60	23.89	1.235	14.32
6.00	12.98	1.618	9.588	12.00	24.88	1.229	14.68
20	13.69	1.575	9.768	20	25.05	1.211	14.78
40	14.05	1.556	9.956	40	25.45	1.204	14.93
60	14.41	1.537	10.14	60	25.83	1.196	15.07
80	14.78	1.519	10.33	80	26.23	1.189	15.22
7.00	15.14	1.501	10.51	13.00	26.62	1.182	15.37
20	15.51	1.485	10.69	20	27.01	1.175	15.52
40	15.88	1.469	10.87	40	27.40	1.169	15.65
60	15.25	1.454	11.05	60	27.79	1.162	15.81
80	15.63	1.439	11.23	80	28.18	1.156	15.95

β	χ	$\frac{h}{R_o}$	$\frac{B}{R_0}$	$\frac{1}{a^{\alpha-1} R_0}$	β	χ	$\frac{h}{R_o}$	$\frac{B}{R_0}$	$\frac{1}{a^{\alpha-1} R_0}$
2.056	6.560	2.161	4.442	2.284	8.00	12.98	1.193	9.546	19.09
20	6.573	2.090	4.597	2.529	20	13.26	1.182	9.695	19.86
40	6.629	2.003	4.807	2.884	40	13.54	1.171	9.833	20.65
60	6.720	1.928	5.012	3.258	60	13.82	1.160	9.974	21.44
80	6.838	1.861	5.212	3.649	80	14.10	1.149	10.11	22.25
3.00	6.979	1.803	5.409	4.057	9.00	14.38	1.139	10.25	23.07
20	7.138	1.751	5.602	4.482	20	14.66	1.130	10.39	23.90
40	7.312	1.703	5.792	4.923	40	14.94	1.120	10.58	24.75
60	7.499	1.661	5.979	5.381	60	15.22	1.111	10.67	25.60
80	7.697	1.622	6.163	5.854	80	15.51	1.102	10.80	26.47
4.00	7.905	1.586	6.344	6.344	10.00	15.79	1.094	10.94	27.34
20	8.120	1.553	6.522	6.848	20	16.08	1.085	11.07	28.23
40	8.343	1.522	6.698	7.368	40	16.36	1.077	11.20	29.13
60	8.572	1.494	6.872	7.903	60	16.65	1.069	11.33	30.04
80	8.806	1.467	7.044	8.452	80	16.93	1.062	11.47	30.96
5.00	9.046	1.443	7.213	9.016	11.00	17.22	1.054	11.60	31.89
20	9.290	1.419	7.380	9.594	20	17.51	1.047	11.72	32.83
40	9.537	1.397	7.546	10.19	40	17.80	1.040	11.85	33.78
60	9.788	1.377	7.709	10.79	60	18.08	1.033	11.98	34.74
80	10.04	1.357	7.871	11.41	80	18.37	1.026	12.11	35.72
6.00	10.30	1.338	8.031	12.05	12.00	18.66	1.019	12.23	36.70
20	10.56	1.321	8.189	12.69	20	18.95	1.013	12.36	37.69
40	10.82	1.304	8.346	13.35	40	19.24	1.007	12.48	38.70
60	11.09	1.288	8.501	14.03	60	19.53	1.001	12.61	39.71
80	11.35	1.273	8.654	14.71	80	19.82	0.995	12.73	40.74
7.00	11.62	1.258	8.806	15.41	13.00	20.11	0.999	12.85	41.77
20	11.89	1.244	8.957	16.12	20	20.40	0.983	12.97	42.81
40	12.16	1.231	9.106	16.85	40	20.69	0.977	13.10	43.87
60	12.44	1.218	9.254	17.58	60	20.98	0.972	13.22	44.93
80	12.71	1.205	9.400	18.33	80	21.28	0.966	13.34	46.01

β	χ	$\frac{h}{R_o}$	$\frac{B}{R_0}$	$\frac{1}{a^{\alpha-1} R_0}$	β	χ	$\frac{h}{R_o}$	$\frac{B}{R_0}$	$\frac{1}{a^{\alpha-1} R_0}$
2.112	6.381	2.003	4.231	2.174	8.00	11.82	1.112	8.894	8.894
20	6.385	1.963	4.319	2.265	20	12.06	1.101	9.027	9.140
40	6.422	1.881	4.514	2.472	40	12.30	1.090	9.160	9.386
60	6.489	1.809	4.704	2.682	60	12.54	1.080	9.291	9.633
80	6.581	1.747	4.891	2.893	80	12.79	1.071	9.421	9.880
3.00	6.694	1.691	5.073	3.107	9.00	13.03	1.061	9.550	10.13
20	6.823	1.641	5.252	3.322	20	13.28	1.052	9.678	10.38
40	6.965	1.596	5.428	3.538	40	13.52	1.045	9.805	10.63
60	7.120	1.556	5.600	3.757	60	13.77	1.034	9.931	10.87
80	7.285	1.518	5.770	3.977	80	14.02	1.026	10.06	11.13
4.00	7.458	1.484	5.938	4.196	10.00	14.27	1.018	10.18	11.38
20	7.639	1.453	6.102	4.422	20	14.52	1.010	10.30	11.64
40	7.827	1.424	6.265	4.646	40	14.77	1.003	10.43	11.89
60	8.020	1.397	6.425	4.872	60	15.02	0.995	10.55	12.14
80	8.219	1.372	6.584	5.100	30	15.27	0.988	10.67	12.40
5.00	8.422	1.348	6.740	5.328	11.00	15.52	0.981	10.79	12.65
20	8.630	1.326	6.894	5.559	20	15.77	0.974	10.91	12.91
40	8.841	1.305	7.047	5.790	40	16.02	0.967	11.03	13.17
60	9.056	1.285	7.198	6.022	60	16.28	0.961	11.15	13.42
80	9.274	1.267	7.347	6.256	80	16.53	0.955	11.26	13.68
6.00	9.495	1.249	7.495	6.491	12.00	16.78	0.948	11.38	13.94
20	9.718	1.232	7.641	6.727	20	17.04	0.942	11.50	14.20
40	9.944	1.216	7.735	6.964	40	17.29	0.937	11.61	14.46
60	10.17	1.201	7.929	7.202	60	17.55	0.931	11.73	14.72
80	10.40	1.187	8.070	7.441	80	17.80	0.925	11.84	14.98
7.00	10.63	1.173	8.211	7.680	13.00	18.06	0.920	11.96	15.24
20	10.87	1.160	8.350	7.921	20	18.31	0.914	12.07	15.50
40	11.10	1.147	8.488	8.163	40	18.57	0.909	12.16	15.76
60	11.34	1.135	8.624	8.406	60	18.83	0.904	12.29	16.03
80	11.58	1.123	8.760	8.650	80	19.08	0.899	12.40	16.29

3-jadval davomi
 $\alpha = 4.0$

β	χ	$\frac{h}{R_0}$	$\frac{B}{R_0}$	$\frac{1}{a^{\alpha-1} R_0}$	β	χ	$\frac{h}{R_0}$	$\frac{B}{R_0}$	$\frac{1}{a^{\alpha-1} R_0}$
2.147	6.390	1.924	4.130	2.112	8.00	11.32	1.071	8.566	6.799
20	6.392	1.901	4.182	2.159	20	11.54	1.060	8.693	6.957
40	6.419	1.821	4.370	2.322	40	11.77	1.050	8.820	7.115
60	6.475	1.751	4.554	2.485	60	11.99	1.040	8.945	7.273
80	6.555	1.690	4.733	2.647	80	12.22	1.031	9.070	7.431
3.00	6.654	1.636	4.908	2.309	9.00	12.44	1.021	9.193	7.589
20	6.768	1.588	5.080	2.971	20	12.67	1.013	9.316	7.747
40	6.896	1.544	5.249	3.132	40	12.90	1.004	9.437	7.904
60	7.034	1.504	5.414	3.293	60	13.12	0.996	9.558	8.061
80	7.182	1.468	5.577	3.454	80	13.35	0.938	9.678	8.219
4.00	7.339	1.434	5.737	3.614	10.00	13.58	0.980	9.797	8.377
20	7.502	1.404	5.895	3.775	20	13.81	0.972	9.916	8.534
40	7.672	1.375	6.051	3.935	40	14.05	0.965	10.03	8.691
60	7.848	1.349	6.204	4.095	60	14.28	0.968	10.15	8.846
80	8.028	1.324	6.356	4.255	80	14.51	0.951	10.27	9.005
5.00	8.213	1.301	6.506	4.415	11.00	14.74	0.944	10.38	9.162
20	3.402	1.279	6.653	4.574	20	14.98	0.937	10.50	9.319
40	8.595	1.259	6.799	4.734	40	15.21	0.931	10.61	9.476
60	8.791	1.240	6.944	4.893	60	15.45	0.924	10.72	9.637
80	8.980	1.222	7.086	5.053	80	15.68	0.918	10.84	9.790
6.00	9.192	1.205	7.227	5.312	12.00	15.92	0.912	10.95	9.946
20	9.396	1.138	7.367	5.371	20	16.15	0.906	11.06	10.10
40	9.603	1.173	7.505	5.530	40	16.39	0.901	11.17	10.26
60	9.812	1.158	7.642	5.689	60	16.63	0.895	11.28	10.42
80	10.02	1.144	7.778	5.848	80	16.86	0.890	11.39	10.57
7.00	10.24	1.130	7.912	6.007	13.00	17.10	0.884	11.50	10.73
20	10.45	1.117	8.045	6.065	20	17.34	0.879	11.61	10.88
40	10.67	1.105	8.177	6.324	40	17.58	0.874	11.71	11.04
60	10.88	1.093	8.308	6.482	60	17.81	0.869	11.82	11.20
80	11.10	1.082	8.437	6.641	80	18.05	0.864	11.93	11.35

3-jadval davomi
 $\alpha = 5.0$

β	χ	$\frac{h}{R_o}$	$\frac{B}{R_0}$	$\frac{\frac{1}{a^{\alpha-1}}}{R_0}$	β	χ	$\frac{h}{R_o}$	$\frac{B}{R_0}$	$\frac{\frac{1}{a^{\alpha-1}}}{R_0}$
2.165	6.446	1.881	4.072	2.078	8.00	11.08	1.046	8.371	5.919
20	6.446	1.865	4.102	2.100	20	11.29	1.036	8.494	6.044
40	6.469	1.786	4.286	2.243	40	11.51	1.026	8.617	6.168
60	6.520	1.718	4.466	2.384	60	11.72	1.016	8.739	6.292
80	6.593	1.657	4.641	2.524	80	11.93	1.007	8.860	6.416
3.00	6.685	1.604	4.812	2.663	9.00	12.14	0.998	8.980	6.540
20	6.791	1.556	4.980	2.800	20	12.36	0.989	9.099	6.663
40	6.910	1.513	5.144	2.937	40	12.58	0.981	9.218	6.786
60	7.040	1.474	5.305	3.073	60	12.79	0.972	9.335	6.909
80	7.178	1.438	5.464	3.208	80	13.01	0.964	9.452	7.031
4.00	7.325	1.405	5.620	3.342	10.00	13.23	0.967	9.568	7.164
20	7.478	1.374	5.774	3.475	20	13.45	0.949	9.683	7.275
40	7.635	1.347	5.925	3.608	40	13.67	0.942	9.797	7.397
60	7.803	1.321	6.075	3.741	60	13.89	0.935	9.911	7.519
80	7.973	1.296	6.222	3.818	80	14.11	0.929	10.02	7.640
5.00	8.147	1.274	6.368	4.003	11.00	14.33	0.921	10.14	7.761
20	8.325	1.252	6.511	4.134	20	14.55	0.915	10.25	7.882
40	8.507	1.232	6.653	4.264	40	14.77	0.909	10.36	8.002
60	8.691	1.213	6.794	4.394	60	15.00	0.902	10.47	8.122
80	8.679	1.195	6.982	4.523	80	15.22	0.896	10.58	8.242
6.00	9.069	1.175	7.070	4.652	12.00	15.45	0.890	10.69	8.362
20	9.262	1.162	7.205	4.780	20	15.67	0.885	10.79	8.482
40	9.458	1.147	7.340	4.908	40	15.90	0.879	10.90	8.601
60	9.655	1.132	7.473	5.036	60	16.12	0.874	11.01	8.720
80	9.854	1.118	7.605	5.153	80	16.35	0.868	11.11	8.839
7.00	10.06	1.105	7.735	5.290	13.00	16.57	0.863	11.22	8.958
20	10.26	1.092	7.864	5.416	20	16.80	0.858	11.33	9.077
40	10.46	1.080	7.993	5.543	40	17.03	0.853	11.43	9.193
60	10.67	1.068	8.120	5.668	60	17.25	0.848	11.53	9.313
80	10.88	1.057	8.246	5.794	80	17.48	0.843	11.64	9.431

β	χ	$\frac{h}{R_o}$	$\frac{B}{R_0}$	$\frac{\frac{1}{a^{\alpha-1}}}{R_0}$	β	χ	$\frac{h}{R_o}$	$\frac{B}{R_0}$	$\frac{\frac{1}{a^{\alpha-1}}}{R_0}$
2.176	6.513	1.851	4.027	2.048	8.00	10.97	1.030	8.242	5.438
20	6.513	1.841	4.050	2.064	20	11.17	1.020	8.364	5.545
40	6.533	1.763	4.232	2.194	40	11.37	1.010	8.484	5.652
60	6.581	1.696	4.408	2.323	60	11.55	1.000	8.604	5.759
80	6.651	1.636	4.581	2.450	80	11.78	0.991	8.722	5.865
3.00	6.738	1.583	4.749	2.575	9.00	11.99	0.982	8.840	5.971
20	6.839	1.536	4.914	2.699	20	12.19	0.974	8.957	6.077
40	6.953	1.493	5.076	2.822	40	12.40	0.965	9.073	6.182
60	7.077	1.454	5.250	2.944	60	12.61	0.957	9.188	6.285
80	7.211	1.419	5.391	3.065	80	12.82	0.949	9.303	6.392
4.00	7.351	1.386	5.544	3.184	10.00	13.03	0.942	9.416	6.496
20	7.498	1.355	5.695	3.303	20	13.24	0.934	9.529	6.600
40	7.652	1.328	5.844	3.421	40	13.45	0.927	9.641	6.703
60	7.810	1.302	5.991	3.538	60	13.67	0.920	9.752	6.806
80	7.973	1.278	6.135	3.656	80	13.88	0.913	9.863	6.910
5.00	8.140	1.256	6.278	3.770	11.00	14.09	0.907	9.973	7.012
20	8.311	1.234	6.419	3.885	20	14.31	0.900	10.08	7.115
40	8.486	1.214	6.558	4.000	40	14.52	0.894	10.19	7.217
60	8.664	1.196	6.696	4.113	60	14.74	0.888	10.30	7.319
80	8.844	1.178	6.832	4.227	80	14.95	0.882	10.41	7.420
6.00	9.027	1.151	6.967	4.339	12.00	15.17	0.876	10.51	7.522
20	9.212	1.145	7.100	4.451	20	15.39	0,870	10.62	7.623
40	9.400	1.130	7.232	4.563	40	15.60	0.865	10.72	7.723
60	9.590	1.115	7.362	4.674	60	15.82	0.859	10.83	7.824
80	9.781	1.102	7.491	4.784	80	16.04	0.854	10.93	7.924
7.00	9.975	1.088	7.619	4.894	13.00	16.27	0.849	11.04	8.024
20	10.17	1.076	7.746	5.004	20	16.48	0.844	11.14	8.124
40	10.37	1.064	7.842	5.113	40	16.69	0.839	11.24	8.224
60	10.56	1.052	7.996	5.222	60	16.91	0.834	11.35	8.323
80	10.76	1.041	8.120	5.330	80	17.13.	0.829	11.45	8.422

β	χ	$\frac{h}{R_0}$	$\frac{B}{R_0}$	$\frac{1}{a^{\alpha-1} R_0}$	β	χ	$\frac{h}{R_0}$	$\frac{B}{R_0}$	$\frac{1}{a^{\alpha-1} R_0}$
2.181	6.580	1.833	3.998	2.028	8.00	10.91	1.019	8.152	5.136
20	6.580	1.824	4.013	2.039	20	11.10	1.009	8.272	5.233
40	6.599	1.747	4.193	2.161	40	11.30	0.999	8.391	5.329
60	6.645	1.680	4.368	2.282	60	11.50	0.989	8.509	5.425
80	6.712	1.621	4.539	2.400	80	11.70	0.980	8.626	5.521
3.00	6.797	1.569	4.706	2.517	9.00	11.90	0.971	8.742	5.616
20	6.896	1.522	4.829	2.633	20	12.10	0.963	8.857	5.711
40	7.006	1.479	5.029	2.747	40	12.30	0.954	8.971	5.805
60	7.127	1.440	5.186	2.860	60	12.51	0.946	9.085	5.899
80	7.257	1.405	5.340	2.971	80	12.71	0.939	9.197	5.993
4.00	7.393	1.373	5.491	3.082	10.00	12.92	0.931	9.309	6.087
20	7.537	1.342	5.640	3.191	20	13.12	0.924	9.421	6.180
40	7.686	1.315	5.787	3.300	40	13.33	0.916	9.531	6.273
60	7.840	1.290	5.932	3.408	60	13.53	0.910	9.641	6.365
80	7.999	1.266	6.075	3.514	80	13.74	0.903	9.750	6.457
5.00	8.161	1.243	6.216	3.621	11.00	13.95	0.896	9.858	6.549
20	8.328	1.222	6.355	3.726	20	13.16	0.890	9.966	6.640
40	8.497	1.202	6.492	3.830	40	14.37	0.884	10.07	6.731
60	8.670	1.184	6.628	3.939	60	14.58	0.878	10.18	6.822
80	8.845	1.166	6.762	4.058	80	14.79	0.872	10.28	6.913
6.00	9.023	1.149	6.895	4.140	12.00	15.00	0.866	10.39	7.003
20	9.204	1.133	7.026	4.242	20	15.21	0.860	10.49	7.093
40	9.386	1.118	7.156	4.343	40	15.42	0.855	10.60	7.183
60	9.571	1.104	7.285	4.444	60	15.63	0.849	10.70	7.272
80	9.757	1.090	7.412	4.545	80	15.85	0.844	10.80	7.361
7.00	9.945	1.077	7.538	4.644	13.00	16.06	0.839	10.91	7.450
20	10.13	1.064	7.653	4.744	20	16.27	0.834	11.01	7.539
40	10.33	1.052	7.787	4.842	40	16.48	0.829	11.11	7.627
60	10.52	1.041	7.910	4.941	60	16.70	0.824	11.21	7.715
80	10.71	1.030	8.932	5.038	80	16.91	0.320	11.31	7.803

3-jadval davomi
 $\alpha = 8.0$

β	χ	$\frac{h}{R_o}$	$\frac{B}{R_0}$	$\frac{1}{a^{\alpha-1} R_0}$	β	χ	$\frac{h}{R_o}$	$\frac{B}{R_0}$	$\frac{1}{a^{\alpha-1} R_0}$
2.183	6.643	1.819	3.971	2.010	8.00	10.89	1.011	8.086	4.929
20	6.643	1.812	3.987	2.021	20	11.08	1.001	8.205	5.019
40	6.661	1.736	4.165	2.138	40	11.27	0.991	8.322	5.108
60	6.706	1.669	4.339	2.252	60	11.47	0.981	8.439	5.197
80	6.772	1.610	4.508	2.365	80	11.66	0.972	8.554	5.285
3.00	6.856	1.558	4.674	2.476	9.00	11.86	0.963	8.669	5.374
20	6.953	1.511	4.836	2.586	20	12.06	0.955	8.783	5.461
40	7.061	1.469	5.994	2.694	40	12.25	0.946	8.896	5.544
60	7.180	1.430	5.150	2.800	60	12.45	0.938	9.008	5.63S
80	7.307	1.395	5.302	2.906	80	12.65	0.931	9.120	5.722
4.00	7.442	1.363	5.452	3.010	10.00	12.85	0.923	9.231	5.803
20	7.582	1.333	5.600	3.113	20	13.05	0.916	9.341	5.894
40	7.729	1.306	5.746	3.215	40	13.26	0.909	9.450	5.980
60	7.880	1.280	5.889	3.317	60	13.46	0.902	9.558	6.066
80	8.035	1.256	6.030	3.417	80	13.66	0.895	9.666	6.150
5.00	8.195	1.234	6.170	3.516	11.00	13.86	0.888	9.773	6.234
20	8.358	1.213	6.308	3.615	20	14.07	0.882	9.880	6.318
40	8.524	1.193	6.444	3.713	40	14.27	0.876	9.986	6.402
60	8.693	1.175	6.578	3.810	60	14.48	0.870	10.09	6.486
80	8.865	1.157	6.711	3.907	80	14.69	0.864	10.20	6.569
6.00	9.040	1.140	6.842	4.003	12.00	14.89	0.858	10.30	6.652
20	9.217	1.125	6.972	4.098	20	15.10	0.853	10.40	6.735
40	9.395	1.110	7.101	4.192	40	15.31	0.847	10.51	6.817
60	9.576	1.095	7.228	4.286	60	15.51	0.842	10.61	6.899
80	9.758	1.081	7.354	4.380	80	15.72	0.837	10.71	6.981
7.00	9.943	1.068	7.479	4.472	13.00	15.93	0.832	10.81	7.062
20	10.13	1.056	7.603	4.565	20	16.14	0.827	10.91	7.144
40	10.32	1.044	7.725	4.656	40	16.35	0.822	11.01	7.225
60	10.50	1.032	6.847	4.748	60	16.56	0.817	11.11	7.306
80	10.69	1.021	7.967	4.838	80	15.77	0.812	11.21	7.386

3-jadval davomi

$\alpha = 9.0$

β	χ	$\frac{h}{R_o}$	$\frac{B}{R_0}$	$\frac{1}{\frac{a^{\alpha-1}}{R_0}}$	β	χ	$\frac{h}{R_o}$	$\frac{B}{R_0}$	$\frac{1}{\frac{a^{\alpha-1}}{R_0}}$
2.183	6.700	1.811	3.951	1.997	8.00	10.88	1.005	8.036	4.778
20	6.700	1.803	3.966	2.007	20	11.07	0.994	8.154	4.863
40	6.719	1.727	4.144	2.102	40	11.26	0.985	8.270	4.947
60	6.764	1.660	4.317	2.230	60	11.45	0.975	8.386	5.031
80	6.830	1.602	4.485	2.234	80	11.55	0.966	8.500	5.115
3.00	6.912	1.550	4.650	2.446	9.00	11.84	0.957	8.614	5.198
20	7.008	1.503	4.810	2.551	20	12.03	0.949	8.727	5.280
40	7.116	1.461	4.968	2.654	40	12.23	0.940	8.839	5.363
60	7.233	1.423	5.122	2.756	60	12.43	0.932	8.950	5.441
80	7.359	1.388	5.274	2.857	80	12.62	0.925	9.061	5.526
4.00	7.491	1.356	5.423	2.957	10.00	12.82	0.917	9.105	5.607
20	7.631	1.326	5.570	3.056	20	13.02	0.910	9.279	5.688
40	7.775	1.299	5.714	3.153	40	13.22	0.903	9.388	5.768
60	7.922	1.273	5.857	3.250	60	13.41	0.896	9.445	5.848
80	8.787	1.249	5.997	3.345	80	13.61	0.889	9.602	5.928
5.00	8.235	1.227	6.135	3.440	11.00	13.81	0.883	9.708	6.007
20	8.395	1.206	6.272	3.534	20	14.02	0.876	9.814	6.086
40	8.559	1.286	6.407	3.627	40	14.22	0.870	9.919	6.165
60	8.726	1.168	6.540	3.719	60	14.42	0.864	10.02	6.243
80	8.895	1.150	6.672	3.811	80	14.62	0.858	10.13	6.321
6.00	9.067	1.134	6.802	3.902	12.00	14.82	0.852	10.23	6.399
20	9.241	1.118	6.931	3.992	20	15.03	0.847	10.33	6.476
40	9.417	1.103	7.059	4.082	40	15.23	0.841	10.43	6.554
60	9.595	1.089	7.185	4.171	60	15.44	0.836	10.54	6.631
80	9.775	1.075	7.310	4.259	80	15.64	0.831	10.64	6.707
7.00	9.956	1.062	7.434	4.347	13.00	15.85	0.826	10.74	6.784
20	10.14	1.050	7.557	4.434	20	16.05	0.821	10.84	6.860
40	10.32	1.038	7.678	4.521	40	16.26	0.816	10.94	6.935
60	10.51	1.026	7.798	4.607	60	16.46	0.811	11.03	7.011
80	10.70	1.015	7.918	4.693	80	16.67	0.807	11.13	7.086

β	χ	$\frac{h}{R_o}$	$\frac{B}{R_0}$	$\frac{1}{\frac{a^{\alpha-1}}{R_0}}$	β	χ	$\frac{h}{R_o}$	$\frac{B}{R_0}$	$\frac{1}{\frac{a^{\alpha-1}}{R_0}}$
2.177	6.754	1.805	3.930	1.986	8.00	10.89	0.996	7.997	4.664
20	6.754	1.796	3.950	1.996	20	11.08	0.989	8.113	4.745
40	6.773	1.720	4.127	2.106	40	11.27	0.980	8.229	4.826
60	6.819	1.654	4.800	2.213	60	11.46	0.970	8.344	4.906
80	6.884	1.595	4.467	2.319	80	11.65	0.961	8.458	4.986
3.00	6.966	1.544	4.631	2.422	9.00	11.84	0.952	8.571	5.063
20	7.062	1.497	4.791	2.524	20	12.03	0.944	8.683	5.144
40	7.169	1.455	4.948	2.624	40	12.22	0.936	8.794	5.222
60	7.285	1.417	5.101	2.723	60	12.42	0.928	8.904	5.299
80	7.410	1.382	5.252	2.820	80	12.61	0.920	9.014	5.378
4.00	7.541	1.350	5.401	2.916	10.00	12.80	0.912	9.123	5.455
20	7.679	1.321	5.546	3.012	20	13.00	0.905	9.231	5.532
40	7.822	1.293	5.690	2.106	40	13.20	0.898	9.339	5.608
60	7.970	1.268	5.832	3.199	60	13.39	0.891	9.446	5.684
80	8.121	1.244	5.971	3.290	80	13.59	0.884	9.552	5.760
5.00	8.277	1.222	6.109	3.382	11.00	13.79	0.878	9.657	5.836
20	8.436	1.201	6.244	3.472	20	13.99	0.872	9.762	5.911
40	8.598	1.181	6.379	3.561	40	14.18	0.865	9.866	5.986
60	8.763	1.163	6.511	3.650	60	14.38	0.859	9.970	6.060
80	8.930	1.145	6.642	3.738	80	14.58	0.854	10.07	6.134
6.00	9.100	1.129	6.771	3.825	12.00	14.78	0.848	10.18	6.208
20	9.272	1.113	6.899	3.912	20	14.99	0.842	10.28	6.282
40	9.446	1.098	7.026	3.998	40	15.19	0.837	10.38	6.355
60	9.621	1.084	7.152	4.083	60	15.39	0.832	10.48	6.428
80	9.799	1.070	7.276	4.168	80	15.59	0.826	10.58	6.501
7.00	9.978	1.057	7.399	4.252	13.00	15.79	0.821	10.68	6.574
20	10.16	1.045	7.520	4.335	20	16.00	0.816	10.78	6.646
40	10.34	1.033	7.641	4.418	40	16.20	0.812	10.88	6.718
60	10.52	1.021	7.761	4.501	60	16.40	0.807	10.97	6.789
80	10.71	1.010	7.879	4.583	80	16.61	0.802	11.07	6.861

β	χ	$\frac{h}{R_o}$	$\frac{B}{R_0}$	$\frac{1}{a^{\alpha-1} R_0}$	β	χ	$\frac{h}{R_o}$	$\frac{B}{R_0}$	$\frac{1}{a^{\alpha-1} R_0}$
2.165	6.853	1.799	3.895	1.962	8.00	10.93	0.992	7.940	4.503
20	6.853	1.785	3.927	1.981	20	11.12	0.982	8.055	4.579
40	6.374	1.710	4.104	2.086	40	11.30	0.973	8.169	4.654
60	6.920	1.644	4.275	2.189	60	11.49	0.963	8.283	4.729
80	6.896	1.586	4.441	2.210	80	11.67	0.954	8.396	4.803
3.00	7.067	1.535	4.604	2.388	9.00	11.86	0.945	8.507	4.877
20	7.162	1.488	4.763	2.485	20	12.05	0.937	8.618	4.950
40	7.268	1.447	4.918	2.581	40	12.24	0.929	8.728	5.023
60	7.383	1.409	5.071	2.675	60	12.43	0.921	8.838	5.096
80	7.506	1.374	5.221	2.767	80	12.62	0.913	8.946	5.168
4.00	7.636	1.342	5.368	2.858	10.00	12.81	0.905	9.054	5.240
20	7.772	1.313	5.513	2.949	20	13.00	0.898	9.161	5.312
40	7.912	1.285	5.655	3.038	40	13.19	0.891	9.268	5.383
60	8.058	1.260	5.795	3.126	60	13.39	0.884	9.373	5.454
80	8.207	1.236	5.933	3.210	80	13.58	0.878	9.478	5.524
5.00	8.360	1.214	6.070	3.299	11.00	13.77	0.871	9.583	5.595
20	8.517	1.193	6.204	3.384	20	13.97	0.865	9.686	5.664
40	8.676	1.174	6.337	3.468	40	14.16	0.859	9.789	5.734
60	8.838	1.155	6.468	3.552	60	14.36	0.853	9.892	5.803
80	9.003	1.138	6.598	3.634	80	14.55	0.847	9.994	5.872
6.00	9.170	1.121	6.726	3.716	12.00	14.75	0.841	10.09	5.940
20	9.339	1.105	6.853	3.798	20	14.95	0.836	10.20	6.009
40	9.510	1.090	6.979	3.879	40	15.15	0.830	10.30	6.077
60	9.683	1.076	7.103	3.959	60	15.34	0.825	10.40	6.144
80	9.857	1.063	7.226	4.038	80	15.54	0.820	10.49	6.212
7.00	10.03	1.050	7.347	4.117	13.00	15.74	0.815	10.59	6.279
20	10.21	1.037	7.468	4.195	20	15.94	0.810	10.69	6.346
40	10.39	1.025	7.588	4.273	40	16.14	0.805	10.79	6.412
60	10.57	1.014	7.706	4.350	60	16.34	0.800	10.89	6.479
80	10.75	1.003	7.823	4.427	80	16.54	0.796	10.98	6.545

3-jadval davomi

$$\alpha = 14.00$$

β	χ	$\frac{h}{R_o}$	$\frac{B}{R_0}$	$\frac{\frac{1}{a^{\alpha-1}}}{R_0}$	β	χ	$\frac{h}{R_o}$	$\frac{B}{R_0}$	$\frac{\frac{1}{a^{\alpha-1}}}{R_0}$
2.164	6.942	1.793	3.880	1.952	8.00	10.98	0.988	7.900	4.395
20	6.945	1.778	3.912	1.970	20	11.616	0.977	8.015	4.467
40	6.964	1.703	4.088	2.075	40	11.35	0.968	8.128	4.539
60	7.009	1.638	4.258	2.172	60	11.53	0.958	8.241	4.610
80	7.075	1.580	4.424	2.270	80	11.71	0.949	8.353	4.681
3.00	7.156	1.529	4.586	2.365	9.00	11.90	0.940	8.464	4.751
20	7.250	1.482	4.744	2.459	20	12.08	0.932	8.574	4.821
40	7.355	1.441	4.899	2.551	40	12.27	0.924	8.683	4.890
60	7.469	1.405	5.050	2.642	60	12.46	0.916	8.792	4.987
80	7.590	1.368	5.199	2.731	80	12.65	0.908	8.900	5.028
4.00	7.719	1.336	5.345	2.819	10.00	12.83	0.901	9.007	5.097
20	7.853	1.307	5.489	2.906	20	13.02	0.893	9.113	5.165
40	7.992	1.280	5.631	2.991	40	13.21	0.886	9.218	5.232
60	8.136	1.254	5.770	3.076	60	13.40	0.880	9.325	5.300
80	8.284	1.231	5.908	3.158	80	13.60	0.873	9.428	5.367
5.00	8.436	1.209	6.043	3.248	11.00	13.79	0.866	9.551	5.433
20	8.591	1.188	6.177	3.324	20	13.98	0.860	9.660	5.500
40	8.749	1.168	6.309	3.405	40	14.17	0.854	9.756	5.566
60	8.909	1.150	6.439	3.485	60	14.36	0.848	9.858	5.631
80	9.072	1.132	6.563	3.564	80	14.56	0.842	9.959	5.697
6.00	9.23?	1.116	6.695	3.645	12.00	14.75	0.837	10.04	5.762
20	9.404	1.100	6.821	3.721	20	14.95	0.831	10.14	5.826
40	9.574	1.085	6.946	3.798	40	15.14	0.826	10.24	5.891
60	9.745	1.071	7.069	3.865	60	15.34	0.820	10.34	5.955
80	9.917	1.058	7.191	3.951	80	15.53	0.815	10.44	6.019
7.00	10.09	1.045	7.312	4.026	13.00	15.73	0.810	10.55	6.082
20	10.27	1.032	7.432	4.101	20	15.93	0.805	10.63	6.146
40	10.44	1.020	7.551	4.175	40	16.12	0.801	10.73	6.209
60	10.62	1.009	7.668	4.249	60	16.32	0.796	10.82	6.272
80	10.80	0.998	7.785	4.322	80	16.52	0.791	10.92	6.334

3-jadval davomi

$\alpha = 16.00$

β	χ	$\frac{h}{R_o}$	$\frac{B}{R_0}$	$\frac{1}{a^{\alpha-1} R_0}$	β	χ	$\frac{h}{R_o}$	$\frac{B}{R_0}$	$\frac{1}{a^{\alpha-1} R_0}$
2.163	7.014	1.787	3.866	1.943	8.00	11.03	0.984	7.872	4.317
20	7.018	1.773	3.901	1.963	20	11.21	0.974	7.986	4.387
40	7.038	1.698	4.076	2.063	40	11.33	0.964	8.099	4.456
60	7.083	1.633	4.246	2.160	60	11.57	0.955	8.211	4.525
80	7.148	1.575	4.411	2.256	80	11.76	0.946	8.322	4.593
3.00	7.228	1.524	4.572	2.349	9.00	11.94	0.937	8.432	4.661
20	7.321	1.478	4.730	2.440	20	12.13	0.928	8.542	4.728
40	7.425	1.436	4.884	2.530	40	12.31	0.920	8.651	4.795
60	7.539	1.399	5.035	2.618	60	12.50	0.912	8.759	4.862
80	7.660	1.364	5.183	2.705	80	12.68	0.905	8.866	4.928
4.00	7.787	1.332	5.329	2.791	10.00	12.87	0.897	8.972	4.994
20	7.921	1.303	5.472	2.875	20	13.06	0.890	9.078	5.060
40	8.059	1.276	5.613	2.958	40	13.25	0.883	9.183	5.125
60	8.203	1.250	5.752	3.040	60	13.44	0.876	9.287	5.190
80	8.350	1.227	5.889	3.125	80	13.63	0.870	9.391	5.254
5.00	8.501	1.205	6.024	3.202	11.00	13.82	0.863	9.494	5.318
20	8.655	1.184	6.157	3.281	20	14.01	0.857	9.596	5.382
40	8.812	1.164	6.288	3.359	40	14.20	0.851	9.698	5.445
60	8.971	1.146	6.418	3.437	60	14.39	0.845	9.799	5.509
80	9.133	1.129	6.546	3.514	80	14.58	0.839	9.899	5.571
6.00	9.298	1.112	6.673	3.590	12.00	14.77	0.833	9.999	5.634
20	9.464	1.096	6.798	3.665	20	14.97	0.828	10.10	5.696
40	9.632	1.082	6.922	3.740	40	15.16	0.822	10.20	5.758
60	9.802	1.067	7.045	3.814	60	15.35	0.817	10.30	5.820
80	9.974	1.054	7.166	3.888	80	15.55	0.812	10.39	5.881
7.00	10.15	1.041	7.287	3.961	13.00	15.74	0.807	10.49	5.942
20	10.32	1.029	7.406	4.033	20	15.93	0.802	10.59	6.003
40	10.50	1.017	7.524	4.105	40	16.13	0.707	10.68	6.064
60	10.67	1.005	7.641	4.176	60	16.32	0.793	10.78	6.124
80	10.85	0.994	7.757	4.247	80	16.52	0.780	10.87	6.184

3-jadval davomi
 $\alpha = 18.0$

β	χ	$\frac{h}{R_o}$	$\frac{B}{R_0}$	$\frac{1}{a^{\alpha-1} R_0}$	β	χ	$\frac{h}{R_o}$	$\frac{B}{R_0}$	$\frac{1}{a^{\alpha-1} R_0}$
2.163	7.072	1.784	3.359	1.938	8.00	11.08	0.981	7.850	4.259
20	7.077	1.769	5.892	1.957	20	11.26	0.971	7.964	4.327
40	7.097	1.695	4.067	2.055	40	11.44	0.961	8.076	4.394
60	7.141	1.629	4.236	2.151	60	11.62	0.952	8.188	4.461
80	7.205	1.572	4.401	2.245	80	11.80	0.943	8.299	4.527
3.00	7.285	1.521	4.562	2.336	9.00	11.90	0.934	8.409	4.593
20	7.378	1.475	4.719	2.426	20	12.17	0.926	8.518	4.659
40	7.482	1.433	4.873	2.514	40	12.36	0.918	8.626	4.724
60	7.595	1.395	5.023	2.600	60	12.54	0.910	8.734	4.787
80	7.716	1.361	5.171	2.685	80	12.73	0.902	8.840	4.853
4.00	7.843	1.329	5.316	2.769	10.00	12.91	0.895	8.946	4.917
20	7.977	1.300	5.459	2.851	20	13.10	0.887	9.052	4.981
40	8.115	1.273	5.600	2.933	40	13.29	0.880	9.156	5.044
60	8.258	1.247	5.738	3.013	60	13.48	0.874	9.260	5.107
80	8.405	1.224	5.874	3.091	80	13.66	0.867	9.363	5.170
5.00	8.556	1.202	6.009	3.171	11.00	13.85	0.861	9.466	5.232
20	8.710	1.181	6.141	3.248	20	14.04	0.854	9.568	5.294
40	8.867	1.162	6.272	3.325	40	14.23	0.848	9.669	5.356
60	9.026	1.143	6.402	3.401	60	14.42	0.842	9.770	5.417
80	9.188	1.126	6.530	3.476	80	14.61	0.836	9.870	5.478
6.00	9.352	1.109	6.656	3.550	12.00	14.80	0.831	9.969	5.539
20	9.518	1.094	6.781	3.624	20	15.00	0.825	10.07	5.599
40	9.686	1.079	6.904	3.697	40	15.19	0.820	10.17	5.659
60	9.855	1.065	7.027	3.769	60	15.38	0.815	10.26	5.719
80	10.03	1.051	7.148	3.841	80	15.57	0.809	10.36	5.778
7.00	10.20	1.038	7.268	3.912	13.00	15.77	0.804	10.46	5.838
20	10.37	1.026	7.386	3.982	20	15.96	0.800	10.55	5.897
40	10.55	1.014	7.504	4.052	40	16.15	0.795	10.65	5.955
60	10.72	1.003	7.620	4.121	60	16.35	0.790	10.75	6.014
80	10.90	0.992	7.736	4.190	80	16.54	0.786	10.84	6.072

3-jadval davomi

 $\alpha = 20,0$

β	χ	$\frac{h}{R_o}$	$\frac{B}{R_o}$	$\frac{\frac{1}{a^{\alpha-1}}}{R_o}$	β	χ	$\frac{h}{R_o}$	$\frac{B}{R_o}$	$\frac{\frac{1}{a^{\alpha-1}}}{R_o}$
2.162	7.128	1.781	3.851	1.934	8.00	11.13	0.979	7.834	4.214
20	7.122	1.766	3.885	1.952	20	11.31	0.969	7.947	4.280
40	7.142	1.691	4.059	2.049	40	11.49	0.959	8.059	4.346
60	7.186	1.626	4.228	2.144	60	11.67	0.950	8.171	4.411
80	7.250	1.569	4.393	2.236	80	11.85	0.941	8.281	4.476
3.00	7.331	1.518	4.553	2.326	9.00	12.04	0.932	8.391	4.541
20	7.424	1.472	4.710	2.414	20	12.22	0.924	8.500	4.605
40	7.528	1.430	4.963	2.501	40	12.40	0.916	8.608	4.669
60	7.641	1.393	5.014	2.586	60	12.59	0.908	8.715	4.732
80	7.762	1.358	5.161	2.669	80	12.77	0.900	8.821	4.795
4.00	7.890	1.327	5.306	2.751	10.00	12.96	0.893	8.927	4.858
20	8.024	1.297	5.449	2.833	20	13.14	0.885	9.032	4.920
40	8.163	1.270	5.589	2.913	40	13.33	0.878	9.136	4.982
60	8.307	1.245	5.727	2.992	60	13.52	0.872	9.239	5.044
80	8.454	1.221	5.863	3.069	80	13.71	0.865	9.342	5.105
5.00	8.605	1.199	5.997	3.147	11.00	13.90	0.859	9.444	5.166
20	8.759	1.179	6.130	3.223	20	14.08	0.852	9.546	5.226
40	8.916	1.159	6.260	3.298	40	14.27	0.846	9.647	5.286
60	9.076	1.141	6.389	3.373	60	14.46	0.840	9.747	5.346
80	9.238	1.124	6.517	3.446	80	14.65	0.834	9.847	5.406
6.00	9.402	1.107	6.643	3.519	12.00	14.84	0.829	9.946	5.465
20	9.569	1.092	6.767	3.591	20	15.03	0.823	10.04	5.524
40	9.737	1.077	6.891	3.663	40	15.22	0.818	10.14	5.582
60	9.906	1.063	7.013	3.737	60	15.42	0.813	10.24	5.641
80	10.08	1.049	7.133	3.804	80	15.61	0.808	10.34	5.699
7.00	10.25	1.036	7.253	3.874	13.00	15.80	0.803	10.43	5.757
20	10.42	1.024	7.371	3.943	20	15.99	0.798	10.53	5.814
40	10.60	1.012	7.489	4.011	40	16.18	0.793	10.62	5.872
60	10.78	1.001	7.605	4.079	60	16.38	0.788	10.72	5.929
80	10.95	1.990	7.720	4.147	80	16.57	0.784	10.81	5.985

Gidravlik radius $R=1m$ bo'lganda, oqimning yuvilmaydigan o'rtacha tezligi g_0 -ning qiymatlari (m/s)

Ilova, 4- jadval

a) qumli tuproqlar uchun	
1. qum va mayda o'rta zarrali	0,45-0,60
2. yirik zarrali qum	0,60-0,75
3. shag'al mayda	0,75-0,90
b) gil tuproq	0,45-0,75

Kanallarning va tabiiy suv oqarlarning g'adir-budurlik koeffisienti

Ilova, 5- jadval

Kanalda suvning sarfi, m^3/s	Er uzanli sug'orish kanallarning "n" g'adir-budurlik koeffisienti	
	O'zaro bog'liq va qumlik zamin tuproqda	SHag'al-qum aralashmali va shag'alli zamin tuproqda
25 dan yuqori	0,0200	0,0225
1-25	0,0225	0,0250
1 dan kam	0,0250	-
Doimiy shohobcha kanallari, notekis harakatli vaqtma-vaqt (notekis ishlaydigan) doimiy ishlaydigan kanallar shohobchasi	0,0275	-
Sug'orishlar	0,0300	-

Eslatma: 1 Sug'orish kanallar uchun belgilangan g'adir-budurlik koeffisientining ahamiyatiga nisbatan suv yig'uvchi-suv tashlagich kanallar uchun g'adir-budurlik koeffisientining ahamiyati 10% ga oshiriladi va jadvalda ko'rsatilgan ahamiyatga keltirib, qabul qilinadi.
2. Mavsumiy ravishda bajariladigan kanallar uchun va kanalning ko'ndalang kesimi ishlar hajmini oxiriga etkazishga bog'liqlikda g'adir-budurlik koeffisientning ahamiyati 10-20% ga oshirilib qabul uilinadi.

Kanalning soylik sirtini xarakteriskasi (xususiyati)	Qoyadagi kanallarning n g'adirlik-budirlik koeffisienti
Yaxshi ishlab chiqarilgan er sirti (er yuzasi)	0,02-0,025
O'rtacha ishlab chiqarilgan do'ngsiz er sirti	0,03-0,035
O'rtacha ishlab chiqarilgan do'ngli er sirti	0,04-0,045

Qoplamalar	Qoplamali kanallarning g'adir-budurlik koeffisienti n
Betonli yaxshi ishlangan	0,012-0,014
Betonli sifatsiz	0,015-0,017
Yig'ma temirbeton tarnovlar	0,012-0,015
Asfal't-bitum qoplamalar	0,013-0,016
CHimlantirilgan uzan	0,03-0,035

Tabiiy oqar suvlarning g'adir-budurlik koeffisienti n

Ilova , 6-jadval

O'zanning xarakteristikasi	Tabiiy oqar suvlarning g'adir-budurlik koeffisienti n	O'zanning xarakteristikasi	Tabiiy oqar suvlarning g'adir-budurlik koeffisienti n
Tabiiy o'zan, loyiqali, sharoitda, toza, to'g'ri, ifloslanmagan, er o'zanli, erkin oqishi	0,025-0,033	Daryolar bo'limlari o'simlik bilan qoplangan, sekin oqimli va chuqur yuvilgan joylar bilan	0,05-0,08
-"-, tosh bilan ham	0,03-0,04	Daryolarning bo'limlari botqoqlik turdagi o'simliklar bilan qoplanganlar	0,075-0,15
Davriy o'zgaruvchan oqim (katta va kichik), sirti va shakli yaxshi holatda	0,033	Katta va kichik daryolar, qaysilarga nisbatan ishlab chiqarilgan, o'simlik bilan qoplangan (o'tlar, butalar)	0,05
Er uzanli quruq. azimjarlar yaxshiroq. sharoitdan ko'ra pastroq. sharoitda	0,04	Past sohilni yaxshigina usimlik bosgan, sekin OQIM bilan va chuqur yuvilish bilan	0,08
O'zgaruvchan oqar suvlar o'zanlari (vaqtna-vaqt ishlaydigan), toshqin davrida ko'p miqdorda cho'kindilarni keltiruvchi, va ni yirik shag'altosh yoki o'simlik bilan qoplanganlarni. O'zgaruvchan oqar suvlar qattiq ifloslangan va kring ir-qiyshiq.	0,05	SHuning o'zi, notug'ri qiyalik oqim bilan va katta suv tarqalish bilan (aylanma suvlar).	0,1
Toza egri soy, kam sonli yuvilishlar bilan, pastlashgan chuqurliklar bilan	0,033-0,045	O'rmonli qayirlar, mahalliy chuqurliklar binlan, jonaz atrof bilan	0,133
SHuning o'zi, faqat o'zgina o'simlik bilan bostirilgan va toshlar bilan	0,035-0,05	YOpik. qayirlar, butunlay o'simlik bilan koplangan (o'rmonliklar)	0,2

Kanal qirg'og'ining qiyaligi "m"-qiyalik ko'ffisienti

Ilova, 7- jadval

Kanal asosini tashkil etuvchi tuproq	Qirg'oqning qiyaligi <i>m</i>	
	Suv osti qismi	Suv usti qismi
soz tuproq	1-1,5	0,5-1,0
qumli soz tuproq	1,25-2,0	1,0-1,5
qum	1,25-2,25	1,5

Kanallarning va ko'tarmalarning "m" ko'ffisienti

Ilova, 8-jadval

Zamin tuproq	O'zanni hosil qiluvchi zamin tuproqqa bog'liqlikda kanallarning qiyalik "m" o'tkazish ko'ffisienti		Zamin tuproq	O'zanni hosil qiluvchi zamin tuproqqa bog'liqlikda kanallarning qiyalik "m" o'tkazish ko'ffisienti	
	qiyaliklar			qiyaliklar	
	suv ostidagi	suv utidagi		suv ostidagi	suv ustidagi
Qoyalik	0,00- 0,50	0,00-0,25	Mayda qum	1,50-2,50	1,00-2,00
YArim qoyalik	0,50-1,00	0,50	CHangsimon	3,00-3,50	2,50
SHag'al-toshlik,	1,25-1,50	1,00	qum		
SHag'alli qumlar bilan					
Gil, qumoq og'ir va o'rtacha					
Qumoq engil tuproq, qumloq tuproq	1,00-1,50	0,50-1,00			
	1,25-2,00	1,00-1,50			

Ilova, 9-jadval

Zamin tuproq	YArim ko'tarmada va ko'tarmada o'rnatiladigan kanallar ko'tarmasi tashqi tomon qiyalik "m" o'tkazish ko'ffisienti	Zamin tuproq	YArim ko'tarmada va ko'tarmada o'rnatiladigan kanallar ko'tarmasi tashqi tomon qiyalik "m" o'tkazish ko'ffisienti
Gil, qumoq og'ir va o'rtacha	0,75-1,0	Qumoq tuproq	1,0-1,5
Qumoq engil tuproq	1,0-1,25	Qum	1,25-2,0

Jadvallar 1 va 2 eslatma: 1. Qiyalik o'tkazish birinchi ahamiyati suv sarfi 0,5 m³/s dan kam bo'lgan kanallar uchun, qiyalik o'tkazish ikkinchi ahamiyat esa, suv sarfi 10 m³/s dan ko'p bo'lgan kanallar uchun.
 2. Kanallarning ichki va tashqi qiyaliklarini jadvalda ko'rsatilganicha nisbatan oshirish mumkin, agar bu sharoit bo'yicha, qurilish ishlab chiqarish ishlar taraqqiyot usullarni qo'llash zarur bo'lsa.

Ruxsat etiladigan tezliklar qiymatlari, ϑ , m/s

Ilova, 10- jadval

Tuproq zarrasining o'rtacha kattaligi, d_{ur} , (mm)	Oqimning o'rtacha chuqurligi, h (m)			
	0,5	1	3	5
A. Qumsimon tuproqlar uchun				
1	0,51	0,55	0,62	0,65
3	0,73	0,8	0,91	0,96
5	0,87	0,96	1,1	1,17
B. Gil tuproqlar uchun				
YO'pishqoqligi, S	0,5	1	3	5
0,05	0,71	0,77	0,89	0,98
0,075	0,83	0,91	1,04	1,1

Yuvilishga qarshi ruxsat etilgan (yo'l qo'yilgan) tezliklar

Ilova, 11-jadval

Zamin tuproq bo'lakchalarni o'rtacha yuvish, mm	Oqimning yuvilishga qarshi yo'l qo'yilgan o'rtacha tezligi, bir tarkibli o'zaro bog'liq bo'lmagan zamin tuproq uchun ular tarkibida 0,1 kg/m ³ , m/s dan kam bo'lganda va gilli qismchalar bilan, oqimning chuqurligi 1 m dan bo'lgandagi tezlik				Zamin tuproq bo'lakchalarini o'rtacha yuvish, mm	Oqimning yuvilishga qarshi yo'l qo'yilgan o'rtacha tezligi, bir tarkibli o'zaro bog'liq bo'lmagan zamin tuproq uchun ular tarkibida 0,1 kg/m ³ , m/s dan kam bo'lganda va gilli qismchalar bilan, oqimning chuqurligi 1 m dan bo'lgandagi tezlik			
	0,5	1	3	5		0.5	1	3	5
0,05	0.52	0.55	0.60	0.62	10.00	1.10	1.23	1.42	1.51
0.15	0.36	0.38	0.42	0.44	15.00	1.26	1.42	1.65	1.76
0.25	0.37	0.39	0.41	0.45	20.00	1.37	1.55	1.84	1.96
0.37	0.38	0.41	0.46	0.48	25.00	1.46	1.65	1.93	2.12
0.50	0.41	0.44	0.50	0.52	30.00	1.56	1.76	2.10	2.26
0.75	0.47	0.51	0.57	0.59	40.00	1.68	1.93	2.32	2.50
1.00	0.51	0.55	0.62	0.65	75.00	2.01	2.35	2.89	3.14
2.00	0.64	0.70	0.79	0.83	100.00	2.15	2.54	3.14	3.46
2.50	0.69	0.75	0.86	0.90	150.00	2.35	2.84	3.62	3.96
3.00	0.73	0.80	0.91	0.96	200.00	2.47	3.03	3.92	4.31
5.00	0.87	0.96	1.10	1.17	300.00	2.90	3.32	4.40	4.94

Eslatma: Jadval 1-4 da yuvilishda qarshi yo'l qo'yilgan tezlikning miqdori. zichligi $\rho = 2650 \text{ kg/m}^3$ bor bo'lgan, ish sharoiti koeffitsienti $K \leq 1$ bo'lgan zamin tuproq uchun keltirilgan. Boshqa zichlikdagi va boshqa ish sharoitli koeffitsientidagi zamin tuproqni yuvilishga qarshi yo'l qo'yilgan tezligi jadval 1-4 da ko'rsatilgan miqdorlarni ularga teng koeffitsienti $\gamma = 1000$ ko'paytirish yo'li bilan aniqlanadi.

Qismchalarni o'rtacha kattaligi mm	Oqimlar yuvilishga qarshi yo'l qo'yilgan tezligi. bir, tarkibda va o'zaro bog'lik bo'lmagan zamin tuproq uchun m/c, kanalni to'ldirish chuqurligi 5% gacha va yuvilishchuqurligi m/s bo'lganda va kanal postini hosil qiluvchi zamin tuproq turkumining bo'g'liq koeffitsientiga bog'liq															
	K_0 -0.5				K_0 -0.3				K_0 -0.2				K_0 -0.15			
	suv oqimi chuqurligida, m															
	0.5	1	3	5	0.5	1	3	5	0.5	1	3	5	0.5	1	3	5
0.25	0.44	0.47	0.52	0.55	0.53	0.58	0.64	0.68	0.62	0.67	0.76	0.80	0.65	0.75	0.85	0.89
0.37	0.48	0.52	0.58	0.61	0.59	0.64	0.72	0.75	0.65	0.75	0.84	0.89	0.66	0.83	0.94	1.00
0.50	0.53	0.57	0.64	0.67	0.63	0.70	0.79	0.83	0.67	0.81	0.92	0.97	0.66	0.86	1.03	1.09
0.75	0.59	0.65	0.73	0.77	0.68	0.79	0.89	0.94	0.70	0.87	1.05	1.11	0.66	0.88	1.17	1.24
1.00	0.63	0.70	0.79	0.83	0.71	0.83	0.96	1.02	0.70	0.89	1.13	1.20	0.66	0.91	1.26	1.34
2.00	0.79	0.89	1.04	1.10	0.83	1.01	1.26	1.34	0.76	0.99	1.41	1.56	0.70	0.93	1.44	1.72
2.50	0.84	0.96	1.13	1.20	0.87	1.06	1.36	1.46	0.78	1.02	1.48	1.70	0.71	0.94	1.48	1.79
3.00	0.88	1.02	1.21	1.28	0.90	1.11	1.44	1.56	0.80	1.04	1.54	1.78	0.73	0.96	1.51	1.84
5.00	1.01	1.18	1.45	1.56	0.98	1.23	1.67	1.86	0.86	1.11	1.68	1.98	0.78	1.01	1.58	1.95
10.00	1.18	1.42	1.82	2.00	1.00	1.38	1.97	2.26	0.95	1.21	1.83	2.22	0.86	1.10	1.67	2.07
15.00	1.29	1.57	2.05	2.28	1.17	1.48	2.13	2.48	1.02	1.29	1.92	2.34	0.93	1.17	1.74	2.14
20.00	1.38	1.68	2.22	2.48	1.23	1.55	2.24	2.64	1.07	1.35	1.99	2.42	0.98	1.23	1.80	2.20
25.00	1.44	1.76	2.36	2.65	1.28	1.61	2.33	2.75	1.11	1.40	2.05	2.48	1.01	1.27	1.85	2.25
30.00	1.50	1.83	2.47	2.79	1.32	1.66	2.40	2.84	1.15	1.44	2.10	2.54	1.04	1.31	1.90	2.30
40.00	1.59	1.95	2.64	3.01	1.39	1.74	2.52	2.99	1.20	1.52	2.19	2.63	1.07	1.38	1.99	2.38
75.00	1.79	2.22	3.05	3.51	1.51	1.94	2.79	3.31	1.28	1.68	2.43	2.88	1.13	1.51	2.20	2.62
100.00	1.87	2.35	3.24	3.75	1.56	2.02	2.93	3.48	1.30	1.74	2.55	3.02	-	-	-	-
150.00	1.98	2.52	3.54	4.09	1.60	2.14	3.14	3.71	-	-	-	-	-	-	-	-

Eslatma: 1. 7- jadval 1 -ga eslatmani kuring.

Hisobiy solishtirma birlashish (ko'shilish) C, Pa	Oqimning yuvilishga qarshi o'rtacha tezligi, o'zaro bog'liq zamin tuproq uchun, tuproq moddasi tarkibida 0.2% dan kam tez eruvchan tuzlar, m/s, ga va oqimning chuqurligi, m ga bog'liq.				Hisobiy solishtirma birlashish (ko'shilish) C, Pa	Oqimning yuvilishga qarshi o'rtacha tezligi, o'zaro bog'liq zamin tuproq uchun, tuproq moddasi tarkibida 0.2% dan kam tez eruvchan tuzlar, m/s, ga va oqimning chuqurligi, m ga bog'liq.			
	0.5	1.0	3.0	5.0		0.5	1.0	3.0	5.0
0.005	0.39	0.43	0.49	0.52	0.175	1.21	1.33	1.52	1.60
0.01	0.44	0.48	0.55	0.58	0.20	1.28	1.40	1.60	1.69
0.02	0.52	0.57	0.65	0.69	0.225	1.36	1.48	1.70	1.80
0.03	0.59	0.64	0.74	0.78	0.25	1.42	1.55	1.78	1.88
0.04	0.65	0.71	0.81	0.86	0.30	1.54	1.69	1.94	2.04
0.05	0.71	0.77	0.89	0.98	0.35	1.67	1.83	2.09	2.21
0.075	O.KZ	0.91	1.04	1.10	0.40	1.79	1.96	2.25	2.38
0.10	0.96	1.04	1.20	1.27	0.45	1.88	2.06	2.35	2.49
0.125	1.03	1.13	1.30	1.37	0.50	1.99	2.17	2.05	2.63 .
0.15	1.13	1.23	1.41	1.49	0.60	2.16	2.38	2.72	2.83

Eslatma: 1. Jadval 1 ga eslatmani ko'ring.

2. Hisobiy solishtirma birlashishni, me'yoriy solishtirma birlashishga, bu zamin tuproqning bir turlik koefficientiga ko'paytirish bilan aniqlanishi kerak. Me'yoriy solishtirma birlashish deb, birlashishni o'rtacha ahamiyati, tajribalar (25 martadan kam bo'linmagan) natijasida olingan ma'lumotlar

bo'yicha qabul qilinishi kerak Gilli zamin tuproq bnr turilik koefficienti formula buyicha aniqlanadi $\kappa_0 = 1 - \alpha\sigma / C$

bu erda: α – eng kam ehtimollikni tavsiya qiluvchi koefficient va markaziy kanallar uchuy - 2.65 birinchi qatorli taqsimlagichlar uchun - 2.5, oxirgi qatorli taqsimlagichlar uchun-2.0

σ -egri mezon taqsimlashni (ikki darajali xatosi).

C - zamin tunroqning o'rtacha hisobiy qo'shilish ga teng.

Past qatorli taqsimlagichlar uchun, suv yig'uvchi – suv tashlama kanallar uchun va kollektorlar – zax qochirish shaxobchasi uchun hisobiy solishtirma ko'shilish ahamiyati haqidagi ma'lumot yo'q bo'lsa, qabul

qilipgan me'yoriy xujjatlarga asosan qabul qilish lozim

Hisobiy so- lishtirma birlashish (ko'shilish) C, Pa	Oqimning yuvilishga qarshi yo'l qo'yilgan o'rtacha tezligi, o'zaro bog'liq sho'rlangan zamin tuproq uchun, tuproq tarkibida 0.2-0.3% tez eruvchan tuzlar bo'lsa, m/s, va oqimning chuqurligi, m ga bog'liq.				Hisobiy so- lishtirma birlashish (ko'shilish) C, Pa	Oqimning yuvilishga qarshi yo'l qo'yilgan o'rtacha tezligi, o'zaro bog'liq sho'rlangan zamin tuproq uchun, tuproq tarkibida 0.2-0.3% tez eruvchan tuzlar bo'lsa, m/s, va oqimning chuqurligi, m ga bog'liq.			
	0.5	1.0	3.0	5.0		0.5	1.0	3.0	5.0
0.005	0.36	0.40	0.46	0.49	0.18	0.70	0.77	0.89	0.94
0.01	0.39	0.43	0.49	0.52	0.20	0.75	0.82	0.93	1.00
0.02	0.41	0.45	0.52	0.55	0.23	0.80	0.88	1.00	1.07
0.03	0.43	0.48	0.55	0.59	0.25	0.82	0.91	1.04	1.10
0.04	0.46	0.51	0.58	0.62	0.30	0.90	0.99	1.12	1.20
0.05	0.48	0.53	0.61	0.65	0.35	0.97	1.06	1.22	1.30
0.075	0.51	0.56	0.64	0.69	0.40	1.03	1.15	1.31	1.40
0.10	0.55	0.51	0.70	0.75	0.45	1.09	1.20	1.39	1.46
0.125	0.60	0.67	0.76	0.81	0.50	1.26	1.28	1.46	1.56
0.15	0.65	0.72	0.82	0.88	0.60	2.27	1.38	1.60	1.70

Eslatma: 1 Zamin tuproq tarkibida tez eruvchan tuzlar 5% ortiq bo'lsa, yuvilishga qarshi yo'l qo'yilgan tezlik maxsus izlanishlarga asoslanib o'rganilishi kerak. 2.Jadval 1-3 eslatmalarni ko'ring.

Qoplama matolar mustaxkamlik loyiha belgisi (markasi)	Monolit beton bilan qoplangan kanallar uchun yig'ma temirbeton bilan va asfal'beton bilan qoplangan, oqimni chuqurligi, m, yuvilishga qarshi yo'l qo'yilgan o'rtacha tezlik, m/s			
	0.5	1.0	3.0	5.0
50	9.6	10.6	12.3	13.0
75	11.2	12.4	14.3	15.2
100	12.5	13.8	16.0	17.0
150	14.0	15.6	18.0	19.1
200	15.6	17.3	20.0	21.2
300	19.2	21.2	24.3	26.1

Kanal o'zanining tuprog'i	O'zaro bog'liq va bog'liq bo'lmagan zamin tuproq uchun, oqim tarkibida gilli qismlar $0,1 \text{ kg/m}^3$ va ortiqroq bo'lganda, ishning sharoit koeffisienti K_c		
	markaziy kanallar va ularning tarmoqlari uchun	yuqori qatorli taqsimlagich kanallar uchun	past qatorli taqsimlagichlar uchun
Qum:			
mayda va o'rtacha yiriklidagi	1.3	1.4	1.5
yirik va shag'alli	1.5	1.6	1.7
SHag'al:			
mayda	1.5	1.6	1.7
o'rtacha	1.4	1.5	1.7
yirik	1.2	1.3	1.4
SHag'altosh	1.1	1.2	1.3
Gilli zamin tuproq mavjudlikda koloid ahvoldagi cho'kmalar tagini korroziyalovchi cho'kmalar	1.3 0.75	1.4 0.8	1.6 0.85
Tagi va qiyaliklar o'simlik bilan qoplangan			
Namlantirish etarlibo'lmagan viloyatlar uchun kanallar uzoq vaqt ishlamaganda	1.1 0.2	1.15 0.22	1.2 0.25
<p>Eslatma: 1.Kanallarning uzoq vaqt ishlanmagan qolishi zamin tuproqning qurushiga va ularni yuvilishga qarshiligini pasaytiradi.</p> <p>2.Kanallarning vaqtma-vaqt ishlashi hisobga olinmaydi va yo'l qo'yilgan tezlik kamaytirilmaydi, qachonki kanallar uchun yuvilish va qaysilarning yuvilishi meo'yoriy foydalanishga qarshilik ko'rsatmaydi (suv yig'uvchi-suv tashlama kanallar, kam ishlovchi tashlamalar</p>			

Loyqa zarrachalarining gidravlik kattaligi

Ilova, 13-jadval

d, mm	$W, \text{mm/s}$	d, mm	$W, \text{mm/s}$	d, mm	$W, \text{mm/s}$
0,005	0,0175	0,06	2,49	0,15	15,60
0,01	0,0692	0,07	3,39	0,175	18,90
0,02	0,277	0,08	4,43	0,20	21,60
0,03	0,623	0,09	5,61	0,225	24,30
0,04	1,11	0,10	6,92	0,25	27,00
0,05	1,73	0,125	10,81	0,275	29,90

Tubi to'g'ri nishabli uzanning ($i > 0$) turli gidravlik ko'rsatkich (x)lari uchun $\varphi(\eta)$ funksiyaning qiymati

η	x									
	2,00	2,50	3,00	3,25	3,50	3,75	4,00	4,50	5,00	5,50
0	0	0	0	0	0	0	0	0	0	0
0,05	0,050	0,050	0,050	0,050	0,050	0,050	0,050	0,050	0,050	0,050
0,10	0,100	0,100	0,100	0,100	0,100	0,100	0,100	0,100	0,100	0,100
0,15	0,151	0,150	0,150	0,150	0,150	0,150	0,150	0,150	0,150	0,150
0,20	0,202	0,201	0,200	0,200	0,200	0,200	0,200	0,200	0,200	0,200
0,25	0,255	0,252	0,251	0,250	0,250	0,250	0,250	0,250	0,250	0,250
0,30	0,309	0,304	0,302	0,301	0,300	0,300	0,300	0,300	0,300	0,300
0,35	0,365	0,357	0,354	0,352	0,351	0,351	0,351	0,350	0,350	0,350
0,40	0,423	0,411	0,407	0,404	0,403	0,403	0,402	0,401	0,400	0,400
0,45	0,484	0,468	0,461	0,458	0,456	0,455	0,454	0,452	0,451	0,450
0,50	0,549	0,527	0,517	0,513	0,510	0,508	0,507	0,504	0,502	0,501
0,55	0,619	0,590	0,575	0,573	0,566	0,564	0,561	0,556	0,554	0,552
0,60	0,693	0,657	0,637	0,630	0,624	0,621	0,617	0,610	0,607	0,605
0,61	0,709	0,671	0,650	0,642	0,636	0,632	0,628	0,621	0,618	0,615
0,62	0,725	0,685	0,663	0,654	0,648	0,644	0,640	0,632	0,629	0,626
0,63	0,741	0,699	0,676	0,667	0,660	0,656	0,652	0,644	0,640	0,637
0,64	0,758	0,714	0,689	0,680	0,673	0,668	0,664	0,656	0,651	0,648
0,65	0,775	0,729	0,703	0,693	0,686	0,681	0,676	0,668	0,662	0,659
0,66	0,792	0,744	0,717	0,706	0,699	0,694	0,688	0,680	0,674	0,670
0,67	0,810	0,760	0,731	0,720	0,712	0,707	0,700	0,692	0,686	0,681
0,68	0,829	0,776	0,746	0,734	0,725	0,720	0,713	0,704	0,698	0,692
0,69	0,848	0,792	0,761	0,748	0,739	0,733	0,726	0,716	0,710	0,704
0,70	0,867	0,809	0,776	0,763	0,753	0,746	0,739	0,728	0,722	0,716
0,71	0,887	0,826	0,791	0,778	0,767	0,760	0,752	0,741	0,734	0,728
0,72	0,907	0,843	0,807	0,793	0,781	0,774	0,766	0,754	0,747	0,740
0,73	0,928	0,861	0,823	0,808	0,796	0,788	0,780	0,767	0,760	0,752
0,74	0,950	0,880	0,840	0,823	0,811	0,802	0,794	0,780	0,773	0,764
0,75	0,972	0,899	0,857	0,839	0,827	0,816	0,808	0,794	0,786	0,776
0,76	0,996	0,919	0,874	0,855	0,843	0,832	0,823	0,808	0,799	0,788
0,77	1,020	0,939	0,892	0,872	0,860	0,848	0,838	0,822	0,812	0,801
0,78	1,045	0,960	0,911	0,890	0,877	0,865	0,854	0,837	0,826	0,814
0,79	1,071	0,982	0,930	0,908	0,895	0,882	0,870	0,852	0,840	0,828
0,80	1,098	1,006	0,950	0,927	0,913	0,900	0,887	0,867	0,854	0,842
0,81	1,127	1,031	0,971	0,947	0,932	0,918	0,904	0,882	0,869	0,857
0,82	1,156	1,056	0,993	0,968	0,951	0,937	0,922	0,898	0,884	0,872
0,83	1,188	1,082	1,016	0,990	0,971	0,956	0,940	0,915	0,900	0,888
0,84	1,221	1,110	1,040	1,013	0,992	0,976	0,960	0,933	0,917	0,904
0,85	1,256	1,139	1,065	1,037	1,015	0,997	0,980	0,952	0,935	0,921
0,86	1,293	1,170	1,092	1,062	1,039	1,019	1,002	0,972	0,953	0,938
0,87	1,333	1,203	1,120	1,088	1,065	1,043	1,025	0,993	0,972	0,956
0,88	1,375	1,238	1,151	1,116	1,092	1,069	1,049	1,015	0,992	0,975
0,89	1,421	1,276	1,183	1,146	1,121	1,097	1,075	1,039	1,014	0,995
0,90	1,472	1,316	1,218	1,179	1,152	1,127	1,103	1,065	1,038	1,017
0,905	1,499	1,338	1,237	1,197	1,169	1,143	1,117	1,079	1,050	1,028
0,910	1,527	1,361	1,257	1,216	1,186	1,159	1,132	1,093	1,063	1,040
0,915	1,557	1,385	1,278	1,236	1,204	1,176	1,148	1,108	1,077	1,053
0,920	1,589	1,411	1,300	1,257	1,223	1,194	1,165	1,124	1,091	1,066

η	x									
	2,00	2,50	3,00	3,25	3,50	3,75	4,00	4,50	5,00	5,50
0,925	1,622	1,439	1,323	1,279	1,243	1,214	1,184	1,141	1,106	1,080
0,930	1,658	1,469	1,348	1,302	1,265	1,235	1,204	1,159	1,122	1,095
0,935	1,696	1,501	1,374	1,326	1,288	1,257	1,225	1,178	1,139	1,111
0,940	1,738	1,535	1,403	1,352	1,312	1,280	1,247	1,198	1,157	1,128
0,945	1,782	1,571	1,434	1,380	1,338	1,305	1,271	1,219	1,176	1,146
0,950	1,831	1,610	1,467	1,411	1,367	1,332	1,297	1,241	1,197	1,165
0,955	1,885	1,653	1,504	1,445	1,399	1,362	1,325	1,265	1,220	1,186
0,960	1,945	1,701	1,545	1,483	1,435	1,395	1,356	1,292	1,246	1,209
0,965	2,013	1,756	1,591	1,526	1,475	1,432	1,391	1,324	1,275	1,235
0,970	2,092	1,820	1,644	1,575	1,521	1,475	1,431	1,362	1,308	1,265
0,975	2,184	1,895	1,707	1,632	1,575	1,525	1,479	1,407	1,347	1,300
0,980	2,297	1,985	1,783	1,703	1,640	1,587	1,537	1,460	1,394	1,344
0,985	2,442	2,100	1,881	1,795	1,727	1,666	1,611	1,525	1,455	1,400
0,990	2,646	2,264	2,018	1,921	1,844	1,777	1,714	1,614	1,538	1,474
0,995	3,000	2,544	2,250	2,137	2,043	1,965	1,889	1,770	1,680	1,605
1,000	∞	∞	∞	∞	∞	∞	∞	∞	∞	∞
1,005	2,997	2,139	1,647	1,477	1,329	1,218	1,107	0,954	0,826	0,730
1,010	2,652	2,863	1,419	1,265	1,138	1,031	0,936	0,790	0,680	0,598
1,015	2,450	1,704	1,291	1,140	1,022	0,922	0,836	0,702	0,603	0,525
1,020	2,307	1,591	1,193	1,053	0,940	0,847	0,766	0,641	0,546	0,474
1,025	2,197	1,504	1,119	0,986	0,879	0,789	0,712	0,594	0,503	0,435
1,030	2,107	1,432	1,061	0,931	0,827	0,742	0,668	0,555	0,468	0,402
1,035	2,031	1,372	1,010	0,885	0,784	0,702	0,632	0,522	0,439	0,375
1,040	1,966	1,320	0,967	0,845	0,747	0,668	0,600	0,494	0,415	0,353
1,045	1,908	1,274	0,929	0,810	0,716	0,638	0,572	0,469	0,394	0,334
1,05	1,857	1,234	0,896	0,779	0,687	0,612	0,548	0,447	0,375	0,317
1,06	1,768	1,164	0,838	0,726	0,640	0,566	0,506	0,411	0,343	0,290
1,07	1,693	1,105	0,790	0,682	0,600	0,529	0,471	0,381	0,316	0,266
1,08	1,629	1,053	0,749	0,645	0,565	0,497	0,441	0,355	0,292	0,245
1,09	1,573	1,009	0,713	0,612	0,534	0,469	0,415	0,332	0,271	0,226
1,10	1,522	0,969	0,680	0,583	0,506	0,444	0,392	0,312	0,253	0,210
1,11	1,477	0,933	0,652	0,557	0,482	0,422	0,372	0,293	0,237	0,196
1,12	1,436	0,901	0,626	0,533	0,461	0,402	0,354	0,277	0,223	0,183
1,13	1,398	0,872	0,602	0,512	0,442	0,384	0,337	0,263	0,211	0,172
1,14	1,363	0,846	0,581	0,493	0,424	0,368	0,322	0,250	0,200	0,162
1,15	1,331	0,821	0,561	0,475	0,407	0,353	0,308	0,238	0,190	0,153
1,16	1,301	0,797	0,542	0,458	0,391	0,339	0,295	0,227	0,181	0,145
1,17	1,273	0,775	0,525	0,442	0,377	0,326	0,283	0,217	0,173	0,137
1,18	1,247	0,755	0,510	0,427	0,364	0,314	0,272	0,208	0,165	0,130
1,19	1,222	0,736	0,495	0,413	0,352	0,302	0,262	0,200	0,158	0,124
1,20	1,199	0,718	0,480	0,400	0,341	0,292	0,252	0,192	0,151	0,118
1,21	1,177	0,701	0,467	0,388	0,330	0,282	0,243	0,184	0,144	0,113
1,22	1,156	0,685	0,454	0,377	0,320	0,272	0,235	0,177	0,138	0,108
1,23	1,136	0,670	0,442	0,366	0,310	0,263	0,227	0,170	0,132	0,103
1,24	1,117	0,656	0,431	0,356	0,301	0,255	0,219	0,164	0,126	0,098
1,25	1,098	0,643	0,420	0,346	0,292	0,247	0,212	0,158	0,121	0,094
1,26	1,081	0,630	0,410	0,337	0,284	0,240	0,205	0,152	0,116	0,090
1,27	1,065	0,618	0,400	0,328	0,276	0,233	0,199	0,147	0,111	0,086
1,28	1,049	0,606	0,391	0,320	0,268	0,226	0,193	0,142	0,107	0,082
1,29	1,033	0,594	0,382	0,312	0,261	0,220	0,187	0,137	0,103	0,079

η	x									
	2,00	2,50	3,00	3,25	3,50	3,75	4,00	4,50	5,00	5,50
1,30	1,018	0,582	0,373	0,307	0,254	0,214	0,181	0,133	0,099	0,076
1,31	1,004	0,571	0,365	0,297	0,247	0,208	0,176	0,129	0,095	0,073
1,32	0,990	0,561	0,357	0,290	0,241	0,202	0,171	0,125	0,092	0,070
1,33	0,977	0,551	0,349	0,283	0,235	0,197	0,166	0,121	0,089	0,067
1,34	0,964	0,542	0,341	0,277	0,229	0,192	0,161	0,117	0,086	0,064
1,35	0,952	0,533	0,334	0,271	0,224	0,187	0,157	0,113	0,083	0,061
1,36	0,940	0,524	0,328	0,265	0,219	0,182	0,153	0,109	0,080	0,058
1,37	0,928	0,516	0,322	0,259	0,214	0,177	0,149	0,106	0,077	0,056
1,38	0,917	0,508	0,316	0,253	0,209	0,173	0,145	0,103	0,074	0,054
1,39	0,906	0,500	0,310	0,248	0,204	0,169	0,141	0,100	0,072	0,052
1,40	0,896	0,492	0,304	0,243	0,199	0,165	0,137	0,097	0,070	0,050
1,41	0,886	0,484	0,298	0,238	0,195	0,161	0,134	0,094	0,068	0,048
1,42	0,876	0,477	0,293	0,233	0,191	0,157	0,131	0,091	0,066	0,046
1,43	0,866	0,470	0,288	0,229	0,187	0,153	0,128	0,088	0,064	0,045
1,44	0,856	0,463	0,283	0,225	0,183	0,150	0,125	0,085	0,062	0,044
1,45	0,847	0,456	0,278	0,221	0,179	0,147	0,122	0,083	0,060	0,043
1,46	0,838	0,450	0,273	0,217	0,175	0,144	0,119	0,081	0,058	0,042
1,47	0,829	0,444	0,268	0,213	0,171	0,141	0,116	0,079	0,056	0,041
1,48	0,821	0,438	0,263	0,209	0,168	0,138	0,113	0,077	0,054	0,040
1,49	0,813	0,432	0,259	0,205	0,165	0,135	0,110	0,075	0,053	0,039
1,50	0,805	0,426	0,255	0,201	0,162	0,132	0,108	0,073	0,052	0,038
1,55	0,767	0,399	0,235	0,184	0,147	0,119	0,097	0,065	0,045	0,032
1,60	0,733	0,376	0,218	0,170	0,134	0,108	0,087	0,058	0,039	0,027
1,65	0,703	0,355	0,203	0,157	0,123	0,098	0,079	0,052	0,034	0,023
1,70	0,675	0,336	0,189	0,145	0,113	0,090	0,072	0,046	0,030	0,020
1,75	0,650	0,318	0,177	0,134	0,104	0,083	0,065	0,041	0,026	0,017
1,80	0,626	0,303	0,166	0,124	0,096	0,077	0,060	0,037	0,023	0,015
1,85	0,605	0,289	0,156	0,115	0,089	0,071	0,055	0,033	0,020	0,013
1,90	0,585	0,276	0,147	0,108	0,083	0,066	0,050	0,030	0,018	0,011
1,95	0,567	0,264	0,139	0,102	0,078	0,061	0,046	0,027	0,016	0,009
2,0	0,550	0,253	0,132	0,097	0,073	0,057	0,043	0,025	0,015	0,008
2,1	0,518	0,233	0,119	0,086	0,064	0,049	0,037	0,021	0,012	0,007
2,2	0,490	0,216	0,108	0,077	0,057	0,043	0,032	0,018	0,010	0,006
2,3	0,466	0,201	0,098	0,069	0,051	0,038	0,028	0,015	0,008	0,005
2,4	0,444	0,188	0,090	0,063	0,046	0,034	0,024	0,013	0,007	0,004
2,5	0,424	0,176	0,082	0,057	0,041	0,031	0,021	0,011	0,006	0,003
2,6	0,405	0,165	0,076	0,052	0,037	0,028	0,019	0,0095	0,0050	0,0025
2,7	0,389	0,155	0,070	0,048	0,033	0,025	0,017	0,0084	0,0045	0,0020
2,8	0,374	0,149	0,065	0,044	0,030	0,022	0,015	0,0075	0,0040	0,0015
2,9	0,360	0,138	0,060	0,040	0,027	0,020	0,013	0,0067	0,0035	0,0010
3,0	0,346	0,131	0,056	0,037	0,025	0,0185	0,0125	0,0060	0,0030	0,00075
3,5	0,294	0,104	0,041	0,026	0,017	0,0125	0,0075	0,0035	0,0020	0,00050
4,0	0,255	0,084	0,031	0,019	0,012	0,0085	0,0050	0,0020	0,0010	0,00025
4,5	0,226	0,070	0,025	0,014	0,009	0,0065	0,0035	0,0015	0,0005	0
5,0	0,203	0,059	0,020	0,010	0,007	0,0050	0,0025	0,0010	0	0
6,0	0,168	0,047	0,014	0,007	0,004	0,0030	0,0015	0,0005	0	0
8,0	0,126	0,029	0,009	0,004	0,002	0,0015	0,0010	0,0002	0	0
10,0	0,100	0,021	0,005	0,002	0,001	0,0005	0,0005	0	0	0

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GIDRAVLIKA
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