VIII BOB
SUV OQIMINING OCHIQ O‘ZANLARDAGI BARQAROR HARAKATI

8. 1. SUV OQIMINING OCHIQ O‘ZANLARDAGI BARQAROR HARAKATI VA UNING KO‘RINISHLARI. PRIZMATIK (SILINDRIK) VA NOPRIZMATIK (NOTSILINDRIK) O‘ZANLAR

Aziz o‘quvchi, biz Gidravlika, ya’ni, texnik gidrodinamika asoslarini o‘rganish jarayonida suyuqlik oqimining barqaror harakati bilan tanishgan edik. Suyuqliklar turkumiga kiruvchi, tabiatimizning eng oliy ne’mati hisoblanmish – suv oqimi uchun ham barqaror harakat $Q = const$ sarfning o‘z harakati davomida va vaqt o‘zgarishi bilan o‘zgarmasligi bilan xarakterlanadi. Garchand,suv oqimi harakati barqaror bo‘lsada ochiq o‘zanlarda o‘zanning geometrik o‘lchamlari oqim bo‘ylab o‘zgarishi (kengayishi, torayishi, o‘zan tubi balandligi belgisining keskin o‘zgarishi va boshqa holatlar) harakatdagi kesimning deformatsiyalanishiga olib kelishi tabiiy. Bu o‘zgarish oqimning barqaror tekis harakatini notekis harakatga aylantiradi.

Bu vaziyatni inobatga olib, biz ushbu bo‘limda suv oqimining ochiq o‘zanlardagi barqaror harakati va uning ko‘rinishlari bilan tanishamiz. Umuman, gidrotexnika amaliyotida suv oqimining barqaror harakati amalga oshadigan o‘zanlar oqim bo‘ylab o‘z geometrik o‘lchamlarini o‘zgartirishi yoki o‘zgartirmasliklari mumkin.

Agar o‘zanning geometrik o‘lchamlari uzunlik bo‘ylab o‘zgarmasa, tabiiyki, oqimning geometrik o‘lchamlari ham o‘zgarmaydi. Bunday o‘zanlar *prizmatik (yoki silindrik) o‘zanlar* deb yuritilishi bizga ma’lum (8. 1-rasm).

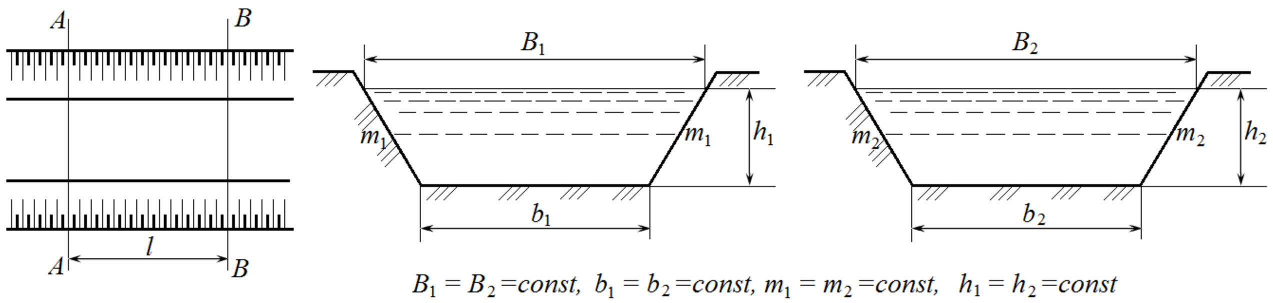
Bunday o‘zanlarda oqimning naporsiz, barqaror tekis harakati amalga oshadi. Albatta,ochiq o‘zanlarda harakat naporsiz $(p_a = p_0)$bo‘ladi.

Agar o‘zanning geometrik o‘lchamlari uzunlik bo‘ylab o‘zgarsa, oqimning geometrik o‘lchamlari ham oqim bo‘ylab o‘zgaradi. Bunday kanallar *noprizmatik (yoki notsilindrik*) *o‘zanlar*deb yuritiladi (8. 2-rasm). Noprizmatik o‘zanlarda suv oqimining barqaror notekis harakati amalga oshishi kuzatiladi.

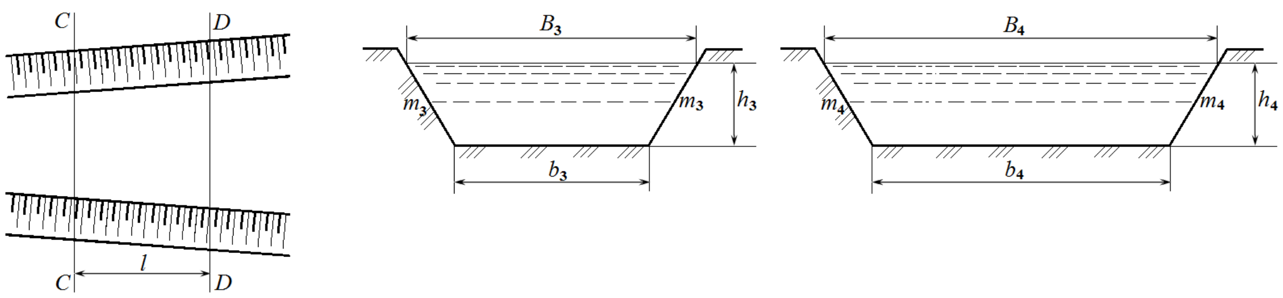
Prizmatik o‘zanlarda, harakatdagi kesim chuqurlikka funksional bog‘liq bo‘lsa, ya’ni $\omega = f(h)$ noprizmatik o‘zanlarda oqimning harakatdagi kesimi oqim chuqurligi va uzunlikka ham funksiyaga bog‘liq bo‘ladi:

$$\omega = f(h,l)$$

Demak, prizmatik kanallar uchun $\frac{\omega}{\partial l} = 0$, noprizmatik kanallar $\frac{\omega}{\partial l} \neq 0$.



8. 1-rasm. Prizmatik (silindrik) o‘zan



8. 2-rasm. Noprizmatik (notsilindrik) o‘zan

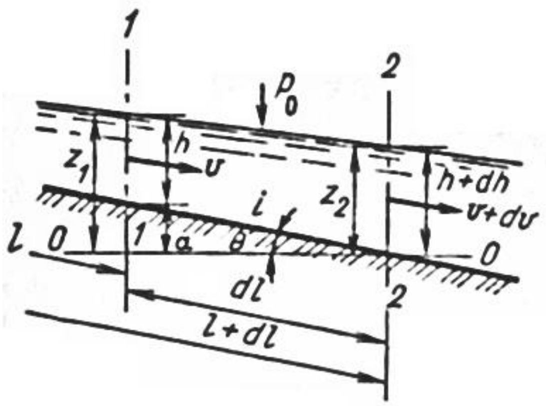
Suv oqimining ochiq prizmatik o‘zanlardagi barqaror harakati o‘zgarmasdan tekis amalga oshsa, noprizmatik o‘zanlardagi harakati notekis amalga oshadi. Barqaror harakatlanayotgan o‘rtacha tezligi, chuqurligi, harakatdagi kesimi o‘zgarmasdan amalga oshadigan harakatni *tekis harakat* deb qabul qilsak, yuqorida qayd etilgan parametrlarning o‘zgarishi bilan amalga oshadigan harakatni *notekis harakat* deb qabul qilamiz.

Notekis harakat ham o‘z navbatida sekin o‘zgaruvchan va keskin o‘zgaruvchan harakat ko‘rinishlariga ega ekanligini yuqoridagi mavzularda e’tirof etganmiz. Bu harakatlarning amalga oshish shartlariochiq o‘zanlarda barqaror naporsiz harakatlanayotganoqim uchun napor ostidagi barqarorharakatlanayotgan suyuqlik oqimi uchun bir-biriga yaqin bo‘ladi.

8. 2. SUV OQIMINING OCHIQ O‘ZANLARDAGI BARQAROR HARAKATI DIFFERENSIAL TENGLAMASI

Suv oqimining ochiq o‘zanlardagi barqaror harakati differensial tenglamasini dastlab notekis harakatning sekin o‘zgaruvchan ko‘rinishi uchun keltirib chiqaramiz va uninghususiy holati sifatida,oqimningnaporsiz, barqaror tekisharakati uchun ham yozamiz. Buning uchun quyidagi hisoblash sxemasidan foydalanamiz.

Faraz qilaylik, ochiq o‘zantubining nishabligi $i > 0$ bo‘lib, unda notekis sekin o‘zgaruvchan harakat amalga oshmoqda (8. 3-rasm).



8. 3-rasm. Suv oqimining barqaror harakati differensial tenglamasini keltirib chiqarish uchun xisobiy sxema

Ushbu o‘zanda I–I va II–II kesimlaroralig‘idagi elementar dl uzunlikdagi sohani o‘rganamiz. Bu sohada suv oqimining barqaror notekis sekin o‘zgaruvchan harakati amalga oshmoqda deb qaraymiz (8. 3-rasm). Bu sxemada quyidagi belgilashlarni qabul qilamiz:

$i = \sin\alpha$ – o‘zan tubining uzunlik bo‘yicha nishabligi;

$p_0 = p_a$ – oqim erkin sirtidagi bosim, atmosfera bosimi;

ω– oqimning harakatdagi kesim yuzasi;

$Q = const$ – oqim sarfi;

h – oqimning qaralayotgan I-I kesimdagi eng katta qiymatli chuqurligi, II-II kesimda h–dh ga o‘zgarmoqda;

α – harakatdagi kesim bo‘ylab tezlik taqsimlanishining bir xil emasligini inobatga oluvchi Koriolis koeffitsienti – kinetik energiyatuzatmasi, korrektivi;

$\upsilon = Q/\omega$ – oqimning o‘rtacha tezligi;

J_e – gidravlik nishablik, ochiq o‘zanlarda, suv oqimi erkin sirti nishabligi, ya’ni J_p – pezometrik nishablikka teng $\left(J_e = J_p\right)$ deb qabul qilinadi;

$a = il$ – taqqoslash tekisligidan I-I kesim tubigacha bo‘lgan masofa.

Tanlangan kesimlar uchun 0-0 taqqoslash tekisligiga nisbatan Bernulli tenglamasini yozamiz:

$$h + idl + \frac{p_a}{\rho g} + \frac{\alpha \upsilon^2}{2g} = h + dh + \frac{p_a}{\rho g} + \frac{\alpha(\upsilon - d\upsilon)^2}{2g} + dh_l \qquad (8.\ 1^1)$$

Ta'kidlash lozimki, ushbu tenglamani yozishda notekis harakat sekin o'zgaruvchan bo'lganligi sababli, mahalliy tezliklarning oqim harakatdagi kesimi bo'ylab, bo'ylama tashkil etuvchilari inobatga olinadi va gidrodinamik bosimning harakatdagi kesim bo'ylab taqsimlanishi gidrostatik qonuniyatga bo'ysunadi deb qaraymiz. Napor yo'qolishini esa tekis harakatdagi kabi aniqlashni qabul qilamiz, ya'ni $h_f \approx h_l$ chunki, barqaror harakat uchun

$$h_м \approx 0 \qquad (8.\ 2)$$

$$J_e = \frac{dh_l}{dl} = \frac{\upsilon^2}{C^2 R} \qquad (8.\ 3)$$

$$dh_l = \frac{\upsilon^2 dl}{C^2 R} \qquad (8.\ 4)$$

$$h + idl + \frac{\alpha \upsilon^2}{2g} = h + dh + \frac{\alpha \upsilon^2}{2g} - \frac{2\alpha \upsilon \cdot d\upsilon}{2g} + \frac{\alpha \upsilon^2}{2g} + \frac{\upsilon^2 dl}{C^2 R} \qquad (8.\ 5)$$

yoki

$$idl + \frac{\alpha \upsilon^2}{2g} = dh - \frac{\alpha \upsilon \cdot d\upsilon}{g} + \frac{\alpha \upsilon^2}{2g} + \frac{\upsilon^2}{C^2 R} dl \qquad (8.\ 6)$$

Ushbu tenglamada, nihoyatda kichik bo'lganligi sababli, $\alpha d\upsilon^2 \approx 0$ deb qabul qilsak,

$$idl = dh - \frac{\alpha \upsilon \cdot d\upsilon}{g} + \frac{\upsilon^2}{C^2 R} dl \qquad (8.\ 7)$$

Tenglamaning barcha hadlarini dS – qaralayotgan elementar soha uzunligiga bo'lamiz:

$$i = \frac{dh}{dl} - \frac{\alpha \upsilon}{g} \frac{d\upsilon}{dl} + \frac{\upsilon^2}{C^2 R} \qquad (8.\ 8)$$

Bu tenglamada

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[1] Bu tenglamada o'zanda xarakatlanayotgan suv oqimi chuqurligining oshishi, tezlikning kamayishiga olib kelishini e'tirof etamiz.

$$\upsilon = \frac{Q}{\omega} \qquad (8.\ 9)$$

munosabatni inobatga olamiz:

$$\frac{d\upsilon}{dl} = \frac{d(Q/\omega)}{dl} = -\frac{Q}{\omega^2}\frac{d\omega}{dl} \qquad (8.\ 10)$$

Demak,

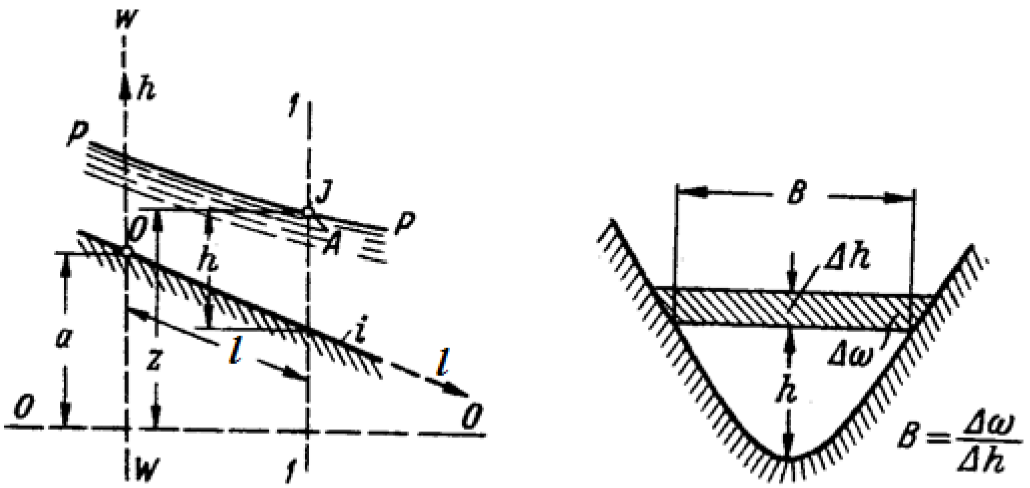
$$i = \frac{dh}{dl} + \frac{\alpha Q^2}{\omega^3 g}\frac{d\omega}{dl} + \frac{Q^2}{\omega^2 C^2 R} \qquad (8.\ 11)$$

Bu 8. 4-rasmda harakatdagi kesimning chuqurlik bo‘yicha o‘zgarishini ko‘rsatuvchi hususiy hosila, o‘zan ko‘ndalang kesimining sath bo‘yicha kengligiga teng bo‘ladi. Biz bu holda, notsilindrik o‘zanlarni ko‘rayotganligimiz uchun ω harakatdagi kesim yuzasi – h va l koordinatalarga bog‘liqdir:

$$\omega = f(h,l) \qquad (8.\ 12)$$

Buni hisobga olsak, quyidagini yozishimiz mumkin:

$$\frac{d\omega}{dl} = \left(\frac{\partial\omega}{\partial l} + \frac{\partial\omega}{\partial h}\frac{dh}{dl}\right) = \left(\frac{\partial\omega}{\partial l} + B\frac{dh}{dl}\right) \qquad (8.\ 13)$$



8. 4 rasm. Notekis harakatda sath o‘zgarishi

Demak, bunda *B* – o‘zan ko‘ndalang kesimining kengligi

$$i-\frac{dh}{dl}=-\frac{\alpha Q^2}{g}\frac{1}{\omega^3}\frac{\partial\omega}{\partial l}\frac{dh}{dl}-\frac{\alpha Q^2}{g}\frac{1}{\omega^3}\frac{\partial\omega}{\partial l}\frac{dh}{dl}+\frac{Q^2}{\omega^2C^2R} \tag{8. 14}$$

$$i-\frac{Q^2}{\omega^2C^2R}+\frac{\alpha Q^2}{g}\frac{1}{\omega^3}\frac{\partial\omega}{\partial l}=\frac{dh}{dl}\left(1-\frac{\alpha Q^2}{g}\frac{1}{\omega^3}B\right) \tag{8. 15}$$

$$\frac{dh}{dl}=\frac{i-\frac{Q^2}{\omega^2C^2R}\left(1-\frac{\alpha C^2R}{g\omega}\frac{\partial\omega}{\partial l}\right)}{1-\frac{\alpha Q^2}{g}\frac{B}{\omega^3}} \tag{8. 16}$$

Ushbu differensial tenglama suv oqimining barqaror notekis sekin o‘zgaruvchan harakati ***differensial tenglamasi*** deb yuritiladi.

Ushbu tenglama o‘zanning prizmatik holatida quyidagi ko‘rinishda mavjud bo‘ladi, ya’ni $\frac{\partial\omega}{\partial l}=0$ holat uchun:

$$\frac{dh}{dl}=\frac{i-\frac{Q^2}{\omega^2C^2R}}{1-\frac{\alpha Q^2}{g}\frac{B}{\omega^3}} \tag{8. 17}$$

Ushbu tenglamada, barqaror tekis harakatda,

$$\frac{dh}{dl}=0 \tag{8. 18}$$

deb qabul qilinsa,

$$i-\frac{Q^2}{\omega^2C^2R}=0 \tag{8. 19}$$

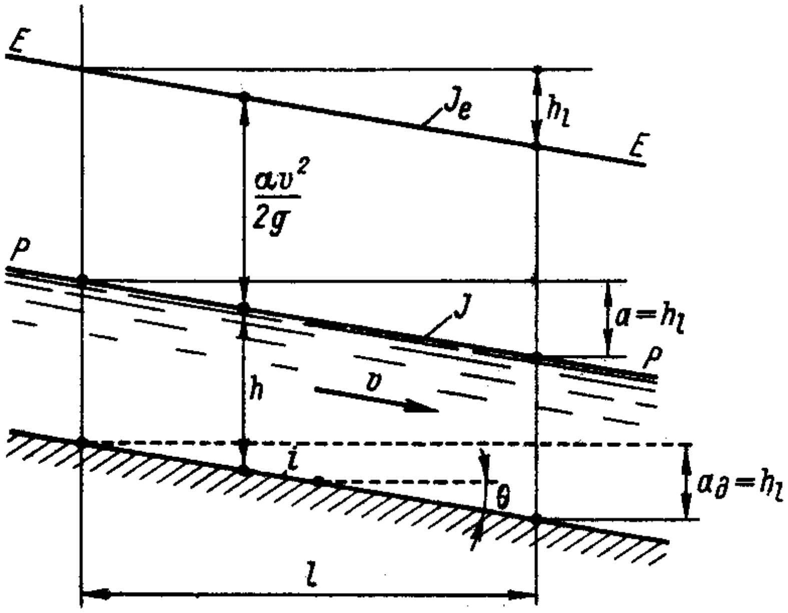
Bundan,

$$Q=\omega C\sqrt{Ri} \tag{8. 20}$$

Butenglama suv oqimining barqaror *tekis harakati tenglamasi* deb yuritiladi.

8. 3. BARQAROR TEKIS HARAKATNING AMALGA OSHISHI SHARTLARI VA ASOSIY FORMULALAR

Ma'lumki, oqimningbarqaror tekis naporsiz harakatida $p_0 = p_a$, $h = const$, $Q = const$, $\upsilon = const$ shart bajariladi, ya'ni oqim harakatdagi kesimining bir tomoni atmosfera bosimi bilan tutashib, oqim erkin sirtga ega bo'ladi, oqimning harakati uzunlik bo'ylab uning sarfi, o'rtacha tezligi va chuqurligi o'zgarmasdan amalga oshadi,bunday harakat *barqaror tekis naporsiz harakat* deyiladi.



8. 5-rasm. Suv oqimining kanaldagi tekis harakati sxemasi

Demak, ochiq o'zanlardagi oqim harakati barqaror tekis naporsiz bo'lishi uchun quyidagi shartlar bajarilishi kerak:

a) o‘zanning ko‘ndalang kesimi uzunlik bo‘ylab o‘zgarmas bo‘lishi, ya’ni o‘zan prizmatik (silindrsimon) ko‘rinishda bo‘lishi $\left(\frac{\partial\omega}{\partial l}=0\right)$;

b) o‘zan devorlari g‘adir-budirligi (*n=const*) o‘zgarmas bo‘lishi;

c) mahalliy napor yo‘qolishi o‘zan uzunligi bo‘ylab mavjud bo‘lmasligi; $h_M \approx 0$;

d) sarf, o‘rtacha tezlik va chuqurlik o‘zgarmas bo‘lishi, ya’ni (*Q=const*), *(h=const*).

Amaliyotda, asosan kanallarda suv oqimining turbulent harakati mavjud bo‘lib, tekis barqaror harakatdagi kvadrat qarshiliklar sohasida amalga oshganligi sababli, shu holat bilan tanishamiz (8. 5-rasm). Kanallarning gidravlik hisoblarida, asosan quyidagi bog‘liqliklardan foydalaniladi:

$$Q=\omega\upsilon=const \text{ (oqim bo‘ylab)} \qquad (8.\quad 21)$$

$$i=\sin\theta \qquad (8.\quad 22)$$

bunda, Q– oqim sarfi, m^3/s;

ω– harakatdagi kesim yuzasi, m^2;

υ– oqimning o‘rtacha tezligi; m/s;

i–kanal tubining nishabligi.

Bizga ma’lumki, qaralayotgan harakatda naporning uzunlik bo‘yicha yo‘qolishi Darsi-Veysbax formulasiga asosan quyidagicha aniqlanadi:

$$h_l=\lambda\frac{l}{D}\frac{\upsilon^2}{2g}$$

Bundan oqimning o‘rtacha tezligini aniqlasak,

$$\upsilon^2=\frac{h_l}{l}\frac{D2g}{\lambda}$$

bunda

$$\frac{h_l}{l} = J$$

$$\upsilon^2 = J\frac{2gD}{\lambda}$$

yoki

$$\upsilon = \sqrt{\frac{2g}{\lambda}}\sqrt{DJ}$$

$$C = \sqrt{\frac{2g}{\lambda}}, \left(\frac{м^{0,5}}{сек}\right)$$

$$\upsilon = C\sqrt{Ri} \qquad (8.\ 23)$$

Bu formula *Shezi formulasi* deb yuritilishi oldingi mavzularda e'tirof etilgan, bunda *S* - Shezi koeffitsienti.

Shezikoeffitsienti – gidravlik qarshilik yoki Darsi koeffitsientiga bog'liq bo'lib, nazariy asoslangan aniq bir formula asosidaaniqlash formulasi hozirgacha taklif etilmagan. Shuning uchun Shezi koeffitsientining kattaligi tadqiqotlar natijasida olingan eksperimental – empirik formulalar bilan aniqlanishi mumkin. Quyida turbulent tartibda harakatlanayotgan suv oqimi uchun uning son qiymatini aniqlash imkoniyatini beradigan tajriba-tadqiqotlar natijasiga asosan tuzilgan formulalarni keltiramiz:

1. Manning formulasi

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

2. N. N. Pavlovskiy formulasi :

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

bunda

$$y = 2{,}5\sqrt{n} - 0{,}13 - 0{,}75\sqrt{R}\left(\sqrt{n} - 0{,}10\right)$$

($R < 1$ *m* bo'lganda $y \approx 1{,}5\sqrt{n}$, $R > 1$ *m* bo'lganda $y \approx 1{,}3\sqrt{n}$).

3. I. I. Agroskin formulasi:

$$C = \frac{1}{n} + 17{,}72 \lg R$$

4. Forxgeymer formulasi:

$$C = \frac{1}{n} R^{0{,}2}$$

5. Bazen formulasi:

$$C = \frac{87}{1 + \frac{\gamma}{\sqrt{R}}}$$

bunda R– gidravlik radius, $m;\gamma$–o‘zan tubi va devorlarining g‘adir-budirligiga bog‘liq bo‘lib, quyidagi jadvalga asosan aniqlanishi mumkin.

8. 1-jadval

Nihoyatda silliq devorlar (suvoqli yoki silliqlangan taxtali)	0,06
Silliq devorlar	0,16
Tabiiy holatdagi tuproqli devorlar	1,35
G‘adir-budir tuproqli devorlar	1,75

6. Gangile-Kutter formulasi:

$$C = \frac{23 + \frac{1}{n} + \frac{0{,}00155}{i}}{1 + \left(23 + \frac{0{,}00155}{i}\right)\frac{n}{\sqrt{R}}}$$

7. A. D. Altshul formulasi:

$$C = 25\left[\frac{R}{(80n)^6 + \frac{0{,}025}{\sqrt{RI}}}\right]^{\frac{1}{6}}$$

Ushbu formula muallifi fikriga asosan turbulent tartibdagi oqim harakatining silliq o‘zanlar, kvadrat qarshilikkacha va kvadrat qarshilik sohalari uchun ham o‘rinli hisoblanadi.

Laminar tartibdagi harakat gidrotexnika amaliyotida amaliy jihatdan uchramaydi. Lekin shunga qaramasdan, ushbu tartibdagi harakat uchun ham Shezi koeffitsientini aniqlash formulalari olingan. Masalan, Xopf formulasini keltirish mumkin:

$$C = 1{,}81\left[\sqrt{1 - 0{,}315\frac{h}{b}}\right]\sqrt{\mathrm{Re}}$$

bunda, Re – Reynolds soni.

Barcha keltirilganformulalarda g‘adir-budirlik koeffitsienti qatnashayotganligiga e’tiborni qaratsak, bu kattalikni aniqlash ham ancha murakkab masala hisoblanadi. Tabiiy o‘zanlar va kanallar uchun bu kattalik o‘zan g‘adir-budirligiga, o‘zanning ko‘ndalang kesim shakli o‘zgaruvchanligiga, o‘zanlarda turli suv o‘simliklari borligiga, loyqa qatlamlari miqdoriga, ularning geometrik o‘lchamlariga va boshqa omillarga bog‘liqdir.

Tadqiqotlar natijasi bu kattalikni nafaqat uzunlik bo‘yicha, balki, aynan bir sohada suv sathi o‘zgarishi bilan boshqa qiymat qabul qilishini tasdiqlagan. Agar o‘zan suv bosadigan qirg‘oqli bo‘lsa,g‘adir-budirlik koeffitsienti keskin o‘zgaruvchan xarakterga ega bo‘ladi. Shuning uchun bu koeffitsient kattaligini aniqlashda har bir o‘zan uchun alohida yondashish maqsadga muvofiqdir. Oldingi mavzularda bu masalaga batafsil to‘xtalganmiz. Gidrotexnika amaliyotida suv oqimining ortiqcha kinetik energiyasini kamaytirib,uning buzuvchanlik qobiliyatini pasaytirish uchun o‘zanning g‘adir-budirligi sun’iy ravishda oshirilishi qo‘llaniladi. Bu mavzuga o‘z o‘rnida batafsil to‘xtalamiz.

Tekis harakat shartiga asosan,quyidagi tenglik o‘rinli hisoblanadi

$$J = i \tag{8. 24}$$

Bunda *J*– gidravlik qiyalik;

Veysbax formulasiga asosan

$$i = \frac{\upsilon^2}{C^2 R} \tag{8. 25}$$

$$h_l = il = \frac{\upsilon^2}{C^2 R} l \tag{8. 26}$$

$$Q = \omega C \sqrt{Ri} \tag{8. 27}$$

Bu formula yuqoridagi mavzuda keltirib chiqarilgan,oqim *naporsiz barqaror tekis harakatining hisoblanish formulasidir*.

Bundan tashqari,naporsiz barqaror tekis harakatni o‘rganishda sarf va tezlik moduli tushunchalaridan foydalaniladi:

$$\left.\begin{aligned} K &= \omega C \sqrt{R} \\ K &= \frac{Q}{\sqrt{i}} \end{aligned}\right\} \qquad \left.\begin{aligned} W &= C \sqrt{R} \\ W &= \frac{\upsilon}{\sqrt{i}} \end{aligned}\right\} \tag{8. 28}$$

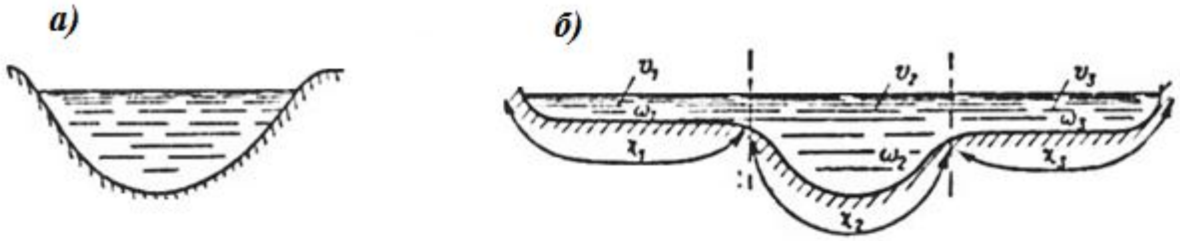
$$Q = K\sqrt{i} \qquad \upsilon = W\sqrt{i} \tag{8. 29}$$

$$i = \frac{Q^2}{K^2}; \qquad i = \frac{\upsilon^2}{W^2} \tag{8. 30}$$

bunda, *K* – sarf moduli; *W* – tezlik moduli.

8. 4. TABIIY O‘ZAN VA KANALDA HARAKATLANAYOTGAN OQIM HARAKATDAGI KESIMINING ASOSIY GIDRAVLIK ELEMENTLARI

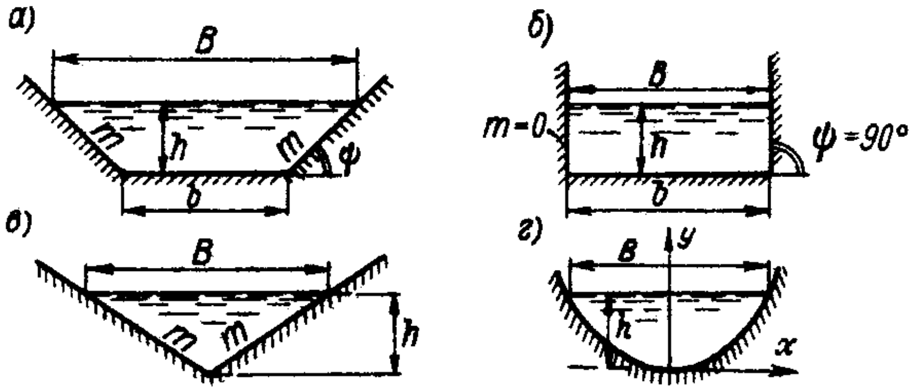
Tabiatda daryo o‘zanlari jamlangan va poymali bo‘lishi mumkin. Jamlangan o‘zan 8. 6, *a*-rasm) li daryolar bir o‘zandan iborat bo‘ladi. Poymali daryolar (8. 6, *b*-rasm) daryodagi suvning miqdoriga bog‘liq holda bir necha irmoqlarga bo‘linib oqishi quzatiladi. Bunga Amudaryo yoki Sirdaryo yaqqol misol bo‘lishi mumkin. Masalan, Amudaryoning Qarshi Magistral kanaliga suv olish sohasida kuz va qish davrlarida ikki yoki uch irmoq bo‘lib oqishi kuzatilsa, suv sarfi katta davrlar bahor va yozda bitta o‘zanni kuzatishimiz mumkin.



8. 6-rasm. a) jamlangan o‘zan, b) poymali daryo

Tabiiy o‘zanlarning gidravlik elementlari o‘zan tubi nishabligi,oqim sarfi va gidrografi,o‘zan shakli, o‘zan bilan oqim o‘rtasidagi murakkab munosabat bilan asoslanadi. Suyuqlik oqimi dinamikasini o‘rganishga katta hissa qo‘shgan olim M. A. Velikanov oqim tarkibida harakatlanuvchi qattiq jism zarrachalari o‘rtasidagi murakkab bog‘liqliklar– iqlimga va daryo morfologik xarakteristikasiga bog‘langan holda maxsus eksperimental morfometrik formulalar yordamida aniqlanishini e’tirof etgan va bunday formulalarni Rossiya Federatsiyasining Evropa xududidagi daryolar uchun tavsiya etgan. Markaziy Osiyodagi Amudaryo va Sirdaryo daryolari uchun, dala tadqiqot materiallari asosida M. A. Velikanov formulasini o‘zgartirilgan ko‘rinishini professor X. A. Ismagilov tavsiya etgan. Ushbu formulalar maxsus ilmiy adabiyotlarda keltiriladi.

Gidrotexnika amaliyotida ko‘p uchraydigan kanallarning ko‘ndalang kesimi shakllari 8. 7-rasmda tasvirlangan.



8. 7-rasm. Kanallarning ko‘ndalang kesim shakllari

Simmetrik trapetsiadal ko‘ndalang kesim (8. 7, a-rasm). Bunda *b* – kanal tubining kengligi; *h* – kanaldagi oqimning chuqurligi; *m* – kanalyon devorining qiyalik koeffitsienti:

$$m = ctg\,\psi \tag{8. 31}$$

Kanaldagi oqim harakatdagi kesimining sath bo‘yicha kengligi

$$B = b + 2mh \tag{8. 32}$$

Harakatdagi kesim yuzasi – ω va xo‘llangan perimetr – χ kattaligini quyidagi geometrik ifodalar yordamida aniqlash mumkin.

$$\omega = (b + mh)h \tag{8. 33}$$

$$\chi = b + 2h\sqrt{1 + m^2} \tag{8. 34}$$

Gidravlik radiusni esa quyidagi formula yordamida aniqlash mumkin:

$$R = \frac{\omega}{\chi} \tag{8. 35}$$

Bundan tashqari, bu kanallarning parametrlarini aniqlashda *kanal tubining nisbiy kengligi* deb ataluvchi nisbiy tushunchadan foydalaniladi:

$$\beta = \frac{b}{h} \tag{8. 36}$$

Bu ifodani inobatga olgan holda ω va χ kattaliklar quyidagicha aniqlanishi mumkin:

$$\omega = h^2(\beta + m) \quad (8.\ 37)$$

$$\chi = h\left(\beta + 2\sqrt{1+m^2}\right) \quad (8.\ 38)$$

Uchburchak shakldagi kesimli kanallar uchun $\omega = \beta h^2$; $\chi = h(\beta + 2)$.

Ko‘ndalang kesimi to‘rtburchak shaklda bo‘lganda, yuqorida keltirilgan gidravlik parametrlarni aniqlashda quyidagi ifodalardan foydalaniladi (8. 7, b-rasm):

$$\left.\begin{array}{ll} B = b; & m = ctg 90^0 = 0 \\ \omega = bh; & \chi = b + 2h \end{array}\right\} \quad (8.\ 39)$$

Agar o‘zan juda keng to‘g‘ri to‘rtburchakli bo‘lsa,

$$\chi \approx b \quad (8.\ 40)$$

*Ko‘ndalang kesimi uchburchak (*8. 7, *v*-rasm).

$$\left.\begin{array}{ll} b = 0; & B = 2mh \\ \omega = mh^2; & \chi = 2h\sqrt{1+m^2} \end{array}\right\} \quad (8.\ 41)$$

Agar kanalning chuqurligi uning kengligiga nisbatan juda katta bo‘lmasa,oqimning o‘rtacha tezligi va sarfi quyidagi formulalar yordamida aniqlanishi mumkin:

$$\upsilon = C\sqrt{\frac{1}{2}hi}$$

$$Q = \frac{Bh}{2}C\sqrt{\frac{1}{2}hi}$$

Ko‘ndalang kesimi parabola shaklida bo‘lganda, parabola tenglamasi quyidagi ko‘rinishda ifodalanadi:

$$x^2 = 2py \quad (8.\ 42)$$

bunda *r* – parabola perimetri; *x*, *u* – o‘qlar 8. 7, g-rasmda ko‘rsatilgan.

Oqimning sath bo‘yicha kengligi B,gidravlik radius R,harakatdagi kesim yuzasi ω quyidagi formulalar asosida aniqlanishi mumkin:

$$B = \sqrt{8ph}$$

$$R = \frac{2}{3}h$$

$$\omega = \frac{2}{3}Bh \qquad (8.\ 43)$$

$$\left.\begin{array}{lll} \chi \approx B .... & agar & (h:B) \leq 0{,}15 \\ \chi \approx B\left[1 + \frac{8}{3}\left(\frac{h}{B}\right)^2\right] .... & agar & (h:B) \leq 0{,}33 \\ \chi \approx 1{,}78h + 0{,}61B .... & agar & 0{,}33 < (h:B) < 2{,}00 \\ \chi \approx 2h .... & agar & 2{,}00 \leq (h:B) \end{array}\right\} \qquad (8.\ 44)$$

Agar kanalning chuqurligi uning kengligiga nisbatan juda katta bo‘lmasa,oqimning o‘rtacha tezligi va sarfi quyidagi formulalar yordamida aniqlanishi mumkin:

$$\upsilon = C\sqrt{\frac{2}{3}hi}$$

$$Q = 1{,}523\sqrt{p}Ch^2\sqrt{i}$$

Keng va chuqur bo‘lmagan daryo o‘zanlari. Nisbiy kengligi $\beta = \frac{B}{h} < 20$ bo‘lgan daryolar uchun $R \approx h;\ \ \omega \approx Bh;\ \ \chi = B$ deb qabul qilinib,quyidagi formulalardan foydalanish mumkin:

$$\upsilon = C\sqrt{hi}$$

$$Q = CBh\sqrt{hi}$$

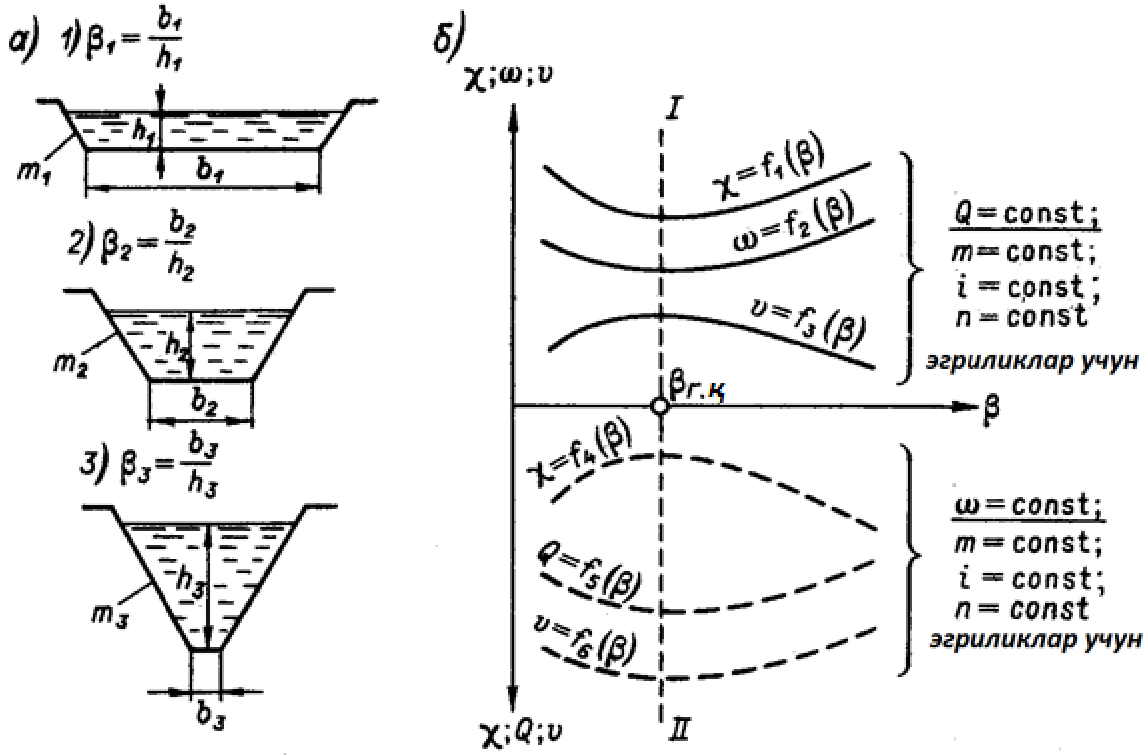
8. 5. TRAPETSIADAL KESIMLI KANALNING ENG QULAY GIDRAVLIK PROFILI

Faraz qilaylik, kanalning ko‘ndalang kesim shakli trapetsiadal bo‘lib, $m = m_0, i = i_0, n = n_0, Q = Q_0$ kattaliklar berilgan. Kanal ko‘ndalang kesimining geometrik o‘lchamlarini aniqlash kerak bo‘lsin (8. 8, *a*-rasmga qarang).

Bu masala bir necha echimga ega.

$$\left.\begin{aligned} m_1 = m_2 = m_3 = \ldots = m_0 = const \\ i_1 = i_2 = i_3 = \ldots = i_0 = const \\ n_1 = n_2 = n_3 = \ldots n_0 = const \\ Q_1 = Q_2 = Q_3 = \ldots = Q_0 = const \end{aligned}\right\} \quad (8.\ 45)$$

bunda 1,2,3-indekslar har xil variantdagi kanallar uchun.



8. 8-rasm. Trapetsiadal kanalda β nisbiy kenglikning o‘zgarishi natijasida χ, ω, υ, Q harakatdagi kesim elementlarining o‘zgarishi

Faraz qilaylik, agar kanal ko‘ndalang kesimida nihoyatda kichik chuqurlik bo‘lsa, kerakli sarfni o‘tkazish uchun u juda keng bo‘lishi, yoki aksincha, kichik o‘lchamdagi kenglik bo‘lsa, juda katta chuqurlik mavjud bo‘lishi kerak.

Bu variantlar uchun,

$$\upsilon = \upsilon_{макс} \tag{8. 46}$$

$$\omega = \omega_{мин} \tag{8. 47}$$

talabga mos keluvchi o‘lchamlar $(b:h)$ mavjud bo‘ladi.

Demak, berilgan *m, i, n, Q* kattaliklar uchun eng kichik ko‘ndalang kesimga va eng yuqori oqim tezligiga ega bo‘lgan kesim mavjud bo‘ladi. Bunday kesim *eng qulay gidravlik kesim* deyiladi.

Eng qulay gidravlik kesimning nisbiy kengligi quyidagicha aniqlanadi.

$$\beta_{г.э.к} = \left(\frac{b}{h}\right)_{г.э.к} \tag{8. 48}$$

8. 8, b-rasmdagi I-II vertikal funksiyalar $\chi = f_1(\beta)$; $\omega = f_2(\beta)$ va $\upsilon = f_3(\beta)$ eng katta qiymatlarg a ega bo‘ladi, ya’ni

$$\left.\begin{array}{l} \dfrac{d\omega}{d\beta} = 0 \\ \dfrac{d\chi}{d\beta} = 0 \end{array}\right\} \tag{8. 49}$$

deb yozish mumkin.

(8. 37) va (8. 38) ifodalarni differensiallaymiz

$$\frac{d\omega}{d\beta} = 2h\beta_{г.э.к}\left(\frac{dh}{d\beta}\right)_{г.э.к} + h^2 + 2mh\left(\frac{dh}{d\beta}\right)_{г.э.к} = 0 \tag{8. 50}$$

$$\frac{d\chi}{d\beta} = \beta_{г.э.к}\left(\frac{dh}{d\beta}\right)_{г.э.к} + h + 2\sqrt{1+m^2}\left(\frac{dh}{d\beta}\right)_{г.э.к} = 0 \tag{8. 51}$$

Bu tenglamani echsak,

$$\beta_{г.э.к} = \left(\frac{b}{h}\right)_{г.э.к} = 2\left(\sqrt{1+m^2} - m\right) \tag{8. 52}$$

Gidrotexnika amaliyotida kanalning qurilish tannarxini arzonlashtirish uchun $\beta = \beta_{г.э.к}$ shartning bajarilishi loyiha jarayonida ta’minlanadi.

Lekin, ta'kidlash lozimki, ko'pincha eng qulay gidravlik kesimli kanallarda, ko'pgina hollarda, chuqurlik katta qiymatga ega bo'ladi. Bu esa kanallar qurishni va ekspluatatsiya jarayonini qiyinlashtiradi. Shu sababli, bu kesimdan 3÷4 % ga farq qiluvchi eng qulay amaliy kesimning nisbiy kengligi $\beta^{0}_{г.э.к}$ degan tushunchasidan foydalaniladi.

$$\beta_{г.э.к} \le \beta^{0}_{г.э.к} \le \left(\beta_{г.э.к}\right)_{чег}$$

$$\left(\beta_{г.э.к}\right)_{чег} = 2{,}5 + \frac{m}{2} \qquad (8.53)$$

8. 6. KANALAR O'ZANINI GIDRAVLIK LOYIHALASHDA FOYDALANILADIGAN ASOSIY FORMULALAR VA MASALALAR

Gidrotexnik inshoatlarning gidravlik hisoblarini bajarishda ko'pgina hosilaviy formulalardan keng foydalaniladi. Ulardan ayrimlarini keltiramiz.

1. Oqim gidravlik radiusining eng katta-maksimal qiymati:

$$R_{\max} = \left|\frac{QN}{4M}\right|^{3/8} \qquad (8.54)$$

2. Oqim o'rtacha tezligining minimal qiymati:

$$\upsilon_{\min} = 0{,}826\upsilon_{\max} \qquad (8.55)$$

3. Kanalo'zani yon devori qiyalik koeffitsientiga bog'liq bo'lgan hosilaviy kattaliklar:

$$m' = 2\sqrt{1+m^2} \qquad (8.56)$$

$$M = 2m' - m \qquad (8.57)$$

4. Kanal o'zani g'adir-budirligi va tubi nishabligiga bog'liq kattalik:

$$N = \frac{n}{\sqrt{i}} \qquad (8.58)$$

5. Kanal o'zanining gidravlik eng qulay kesimi nisbiy kengligi:

$$\beta_{г.э.к} = 2\sqrt{1+m^2} - m = M - m \qquad (8.59)$$

$$\beta_{\max} = 2M - m \qquad (8.60)$$

6. Oqimning o‘rtacha tezligi eng katta – maksimal qiymati:

$$\upsilon_{мax} = \frac{1}{N}\left|\frac{N\cdot Q}{4M}\right|^{1/4} \qquad (8.61)$$

7. Loyihalashtirilayotgan kanal o‘zani tubining kengligini aniqlash uchun S. A. Girshkan formulasi

$$b_Г = 3\sqrt[4]{Q} - m \qquad (8.62)$$

a) agar $Q < 1{,}5$ $м^3/c$ bo‘lsa, $b_Г = 1{,}5Q^{0{,}83}$

b) agar $Q = 1{,}5 \div 50$ $м^3/c$ bo‘lsa, $b_Г = 1{,}5Q^{2/3}$

c) agar $Q > 50$ $м^3/c$ bo‘lsa, $b_Г = 1{,}4Q^{2/3}$.

8. Gidravlik radiusning eng kichik qiymati

$$R_{\min} = 0{,}733R_{\max} \qquad (8.63)$$

$$R^2 = h^2\left(\frac{\beta+m}{\beta+2m'}\right)^2 \Rightarrow R^2\left(\frac{(\beta+2m')^2}{\beta+m}\right) = h^2(\beta+m) = \omega \qquad (8.64)$$

9. Sheziva Manning formulalarini birgalikda gidravlik radiusga nisbatan hisoblasak:

$$C = \frac{1}{n}R^{1/6} \Rightarrow R^{1/6} = Cn \qquad (8.65)$$

$$\upsilon = C\sqrt{Ri} \Leftrightarrow C = \frac{\upsilon}{\sqrt{Ri}} \qquad (8.66)$$

$$R^{1/6} = Cn = \frac{\upsilon}{\sqrt{Ri}}n \Leftrightarrow R^{1/6}R^{1/2} = R^{2/3} = \frac{\upsilon n}{\sqrt{i}} = \upsilon N \Leftrightarrow R = (\upsilon N)^{3/2} \qquad (8.67)$$

Olingan formula Shezi-Manning formulasi deb yuritiladi:

$$R = (\upsilon N)^{3/2} \qquad (8.68)$$

10. Shezi-Manning formusiga asoslanib, gidravlik radiusni aniqlash. Yuqoridagi olinganformulaga oqimning uzluksizlik tenglamasini qo‘yib,quyidagi arifmetik amallarni bajaramiz:

$$R=(N\upsilon)^{3/2}=\left(N\frac{Q}{\omega}\right)^{3/2}=\left(N\frac{Q}{R^2\left(\frac{(\beta+2m')^2}{\beta+m}\right)}\right)^{3/2}=\left(NQ\frac{\beta+m}{(\beta+2m')^2}\right)^{3/8} \quad (8.69)$$

Demak,gidravlik radiusni quyidagicha aniqlashimiz mumkin:

$$R=\left(NQ\frac{\beta+m}{(\beta+2m')^2}\right)^{3/8} \quad (8.70)$$

11. Kanal ko‘ndalang kesimi tubi kengligining standart qiymatlari $b_{cm}=$0,2; 0,3; 0,4; 0,5; 0,6; 0,7; 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*dan keyin har bir metrdan keyingi qiymat qabul qilinishi mumkin.

Yuqoridagi mavzularga asosan xulosa qilish mumkinki,gidrotexnika amaliyotida kanallarni eng qulay ko‘rinishi yarim aylana bo‘lib,bunday kanallar to‘g‘ri gidravlik loyihalashtirilganda – ular uzoq vaqt deformatsiyasiz (loyqa bosish yoki yuvilish) ishlashi mumkin. Lekin hozirgi gidrotexnika qurilishi amaliyoti uchun ishlab chiqilgan texnikalar bunday kesimli o‘zanga ega kanallarni qurish imkoniyatini bermaydi. Shu sababli,hozirgi davrda asosan bu shaklga yaqin bo‘lgan trapetsiadal shaklli kanallarni qurish amaliyotda keng qo‘llaniladi. Trapetsiadal kesimli kanallar asosan quyidagi olti asosiy elementlar bilan xarakterlanadi. *b, h, m* – kanal ko‘ndalang kesimini xarakterlovchi elementlar va *n, i, Q* – kattaliklar. Bu olti elementni ma’lum bo‘lishi – kanallarni gidravlik loyihalashtirishning birinchi bosqichi bajarilganligini bildiradi. Bu kattaliklarning barchasini aniqlash gidravlik masalaning mohiyatini tashkil qiladi.

I. Berilgan: kanal – trapetsiadal

h, b, m, i, n

Aniqlash kerak:

Q -?

Hisoblash tartibi:

1. Harakatdagi kesim va ho‘llangan perimeter kattaligi hisoblanadi:

$$\omega = (b + mh)h; \qquad \chi = b + 2h\sqrt{1 + m^2}$$

2. Gidravlik radius hisoblanadi:

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

3. Manning formulasidan foydalanib, Shezi koeffitsienti hisoblanadi:

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

4. Oqimning o‘rtacha tezligi hisoblanadi:

$$\upsilon = C\sqrt{Ri}$$

5. Oqim sarfi hisoblanadi:

$$Q = \omega\upsilon$$

II. Berilgan: kanal – trapetsiadal

b, h, m, n, Q

Aniqlash kerak

i - ? υ - ?

Hisoblash yuqoridagi tartibda davom etadi. Faqat oqimning o‘rtacha tezligi quyidagicha hisoblanadi:

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

Keyin kanal tubining nishabligi hisoblanadi:

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

III. Berilgan: kanal – trapetsiadal

m, b, n, i, Q

Aniqlash kerak:

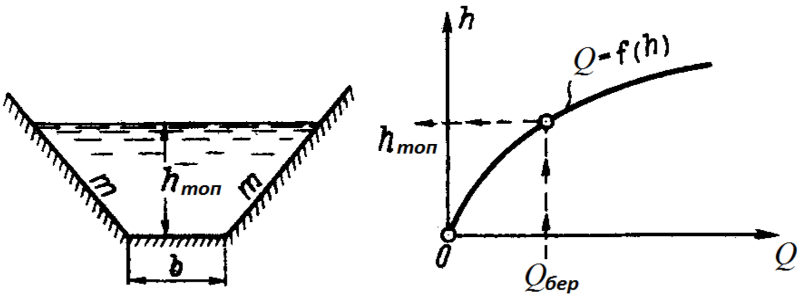
h- ?

Hisoblash “tanlash” usulida olib boriladi:

8. 2-jadval

№	Hisoblash formulalari	O‘lchov birlik-lari	Ixtiyoriy tanlangan chuqurliklar				Izoh
1	h	m	h_1	h_2	h_3	$\dots$	
2	mh	m	$\dots$	$\dots$	$\dots$	$\dots$	$m = \dots$
3	$b + mh$	m	$\dots$	$\dots$	$\dots$	$\dots$	$b = \dots$
4	$\omega = (b + mh)h$	m^2	$\dots$	$\dots$	$\dots$	$\dots$	
5	$2h\sqrt{1 + m^2}$	m	$\dots$	$\dots$	$\dots$	$\dots$	$2\sqrt{1 + m^2} = \dots$
6	$\chi = b + 2h\sqrt{1 + m^2}$	m	$\dots$	$\dots$	$\dots$	$\dots$	
7	$R = \omega / \chi$	m	$\dots$	$\dots$	$\dots$	$\dots$	
8	$C = \frac{1}{n} R^{1/6}$	$м^{0,5}/с$	$\dots$	$\dots$	$\dots$	$\dots$	- Manning formulasi
9	$Q = \omega C \sqrt{Ri}$	$м^3/с$	$\dots$	$\dots$	$\dots$	$\dots$	

1) Chuqurlikka ixtiyoriy qiymatlar berilib, yuqoridagi jadvalda keltirilgan tartibda hisoblash bajarilib, shu qiymatga mos keluvchi sarf topiladi.
2) Chuqurlikka kamida 3 ta qiymat berib, hisoblash $Q_1 < Q < Q_3$ yoki $Q_1 > Q > Q_3$ shart bajarilguncha bajariladi.



8. 9-rasm. $Q = f(h)$ grafigi

3) yuqoridagi hisoblashlarga asosan $Q = f(h)$ grafigi qurilib, bu grafikdan berilgan sarfga mos keluvchi chuqurlik qiymati tanlanadi (8. 9-rasm).

Umuman, kanallarning loyihalashtirilishi bo‘yicha gidravlik hisoblar bajarishda Toshkent irrigatsiya va qishloq xo‘jaligini mexanizatsiyalash injenerlari institutining «Gidravlika» kafedrasi olimlari tomonidan keng miqyosda ish olib borilganligini ta’kidlash o‘rinlidir.

IV. Berilgan: kanal – trapetsiadal

Berilgan:

$b = 0{,}7\,m,\ h = 1{,}0\,m,\ m = 1{,}25,\ n = 0{,}030,\ \upsilon = 0{,}53\ м/с.$

Aniqlash kerak:

Q - ?i - ?

Hisoblash:

1) Harakatdagi kesim yuzasini aniqlaymiz:

$$\omega = (b + mh)h = (0{,}7 + 1{,}25 \cdot 1{,}0) \cdot 1{,}0 = 1{,}95\,m^2;$$

2) Sarfni hisoblaymiz:

$$Q = \upsilon\omega = 0{,}53 \cdot 1{,}95 = 1{,}035\ м^3/с;$$

3) Ho‘llangan perimetrni aniqlaymiz:

$$\chi = b + 2h\sqrt{1 + m^2} = 0{,}7 + 2 \cdot 1{,}0\sqrt{1 + (1{,}25)^2} = 3{,}7\,m;$$

4) Gidravlik radiusni aniqlaymiz:

$$R = \frac{\omega}{\chi} = \frac{1,95}{3,7} = 0,53 \ m;$$

5) Shezi koeffitsienti quyidagicha aniqlanadi:

$$C = \frac{1}{n} R^{1/6} = 29 \ м^{0,5}/с;$$

6) O‘zan nishabligini aniqlaymiz:

$$i = \frac{Q^2}{C^2 \omega^2 R} = \frac{(1,035)^2}{29^2 \cdot (1,95)^2 \, 0,53} = 0,0006.$$

V. Berilgan: kanal – trapetsiadal

$b = 6,0\,m, m = 1,0$, $n = 0,012$, $Q = 19,1 \ м^3/с, \upsilon = 1,06 \ м/с$.

Hisoblash:

Harakatdagi kesimni quyidagi ikki formulaga asosan aniqlash mumkinligidan foydalanib,ular bilan matematik amallarni bajarib, kvadrat tenglamaga ega bo‘lamiz:

1) $\omega = \frac{Q}{\upsilon} = \frac{19,91}{1,06} = 1,88\,m^2;$

2) $\omega = (b + mh)h \Rightarrow mh^2 + bh - \omega = 0;$

3) Bu tenglamani echib,undan chuqurlikni aniqlaymiz:

$$h_{1,2} = \frac{-b \pm \sqrt{b^2 + 4\omega m}}{2m} = \frac{-6 \pm \sqrt{6^2 + 4 \cdot 1 \cdot 1,88}}{2 \cdot 1} = \frac{-6 \pm 6,6}{2} \Rightarrow h = \frac{0,6}{2} = 0,3m.$$

Izoh o‘rnida ta’kidlab o‘tamizki,ildizning faqat musbat qiymatinigina qabul qilamiz.

4) Ho‘llangan perimetrni hisoblaymiz:

$$\chi = b + 2h\sqrt{1 + m^2} = 6 + 2 \cdot 0,3\sqrt{1 + 1^2} = 6,85\,m;$$

5) Gidravlik radiusni hisoblaymiz:

$$R = \frac{\omega}{\chi} = \frac{1,88}{6,85} = 0,27\,m;$$

6) Shezi koeffitsientini Pavlovskiy grafigidan foydalanib, aniqlaymiz:

$$C = 69\ \text{м}^{0,5}/c\,;$$

7) O‘zan tubi nishabligini aniqlaymiz

$$i = \frac{\upsilon^2}{C^2 R} = \frac{(1,06)^2}{(69)^2\,0,27} = 0,0009$$

VI. Berilgan: kanal – trapetsiadal

$h = 6{,}0\, m,\ m = 1{,}75,\ n = 0{,}018, Q = 190\ м^3/с, \upsilon = 1{,}36\ м/с$.

Aniqlash kerak

b- ? *i* - ?

Hisoblash:

1) Harakatdagi kesim yuzasini hisoblaymiz:

$$\omega = \frac{Q}{\upsilon} = \frac{190}{1{,}36} = 139{,}7\, m^2;$$

2) Tezlik modulini quyidagicha aniqlashimiz mumkin:

$$W = \frac{\upsilon}{\sqrt{i}} = \frac{1{,}36}{\sqrt{0{,}000064}} = 170;$$

3) Kanal tubining kengligini hisoblaymiz:

$$\omega = (b + mh)h \Rightarrow b = \frac{\omega - mh^2}{h} = \frac{139{,}7 - 1{,}75 \cdot 6}{6} = 21{,}5\, m;$$

4) Kanal tubi kengligining standart qiymatlaridan foydalanib, standart kenglikni qabul qilamiz: $b_{cm} = 22м$.

5) Kanalning tubini uzunlik bo‘yicha nishabligini aniqlaymiz:

$$i = \frac{\upsilon^2}{W^2} = \left(\frac{1{,}36}{170}\right)^2 = 0{,}000064$$

VII. Berilgan: kanal – trapetsiadal

$b = 6{,}0\, m, m = 1{,}0,\ n = 0{,}012, Q = 19{,}91\, м^3/с, \upsilon = 1{,}06\ м/с$.

Aniqlash kerak

h-?*i*-?

Hisoblash:

1) Quyidagi kattalikni hisoblaymiz:

$$m' = 2\sqrt{1+m^2} = 2\sqrt{1+1^2} = 2{,}83;$$

2) Harakatdagi tezlikni hisoblaymiz:

$$\omega = \frac{Q}{\upsilon} = \frac{19{,}91}{1{,}06} = 1{,}88\, m^2;$$

3) $\omega = (b + mh)h \Rightarrow mh^2 + bh - \omega = 0$

4) $h_{1,2} = \dfrac{-b \pm \sqrt{b^2 + 4\omega m}}{2m} = \dfrac{-6 \pm \sqrt{6^2 + 4 \cdot 1 \cdot 1{,}88}}{2 \cdot 1} = \dfrac{-6 \pm 6{,}6}{2} \Rightarrow h = \dfrac{0{,}6}{2} = 0{,}3\, m;$

5) Ho‘llangan perimetrni hisoblaymiz:

$$\chi = b + hm' = 6 + 0{,}3 \cdot 2{,}83 = 6{,}85\, m;$$

6) Gidravlik radiusni hisoblaymiz:

$$R = \frac{\omega}{\chi} = \frac{1{,}88}{6{,}85} = 0{,}27\, m;$$

7) Shezi-Manning formulalariga asoslanib,nishablikni quyidagicha aniqlashimiz mumkin:

$$i = \left(\frac{\upsilon n}{R^{2/3}}\right)^2 = \left(\frac{1{,}06 \cdot 0{,}012}{0{,}27^{2/3}}\right)^2 = 0{,}0009$$

VIII. Berilgan: kanal – trapetsiadal

$\omega = 34\, m^2$, R = 1,65 m; m = 1,0.

Aniqlash kerak

b - ? h - ?

Hisoblash:

1) Ho‘llangan perimetrni hisoblaymiz:

$$\chi = \frac{\omega}{R} = \frac{34}{1{,}65} = 20{,}61\, m;$$

2) Bizga ma’lum bo‘lgan quyidagi munosabatlarni yozib, ularni ikki noma’lumli tenglamalar sistemasi sifatida qabul qilamiz va ulardan ikkinchisidan noma’lum parametrni aniqlash formulasini yozamiz va

birinchisiga qo‘yamiz hamda chuqurlikni aniqlash imkoniyatini beradigan kvadrat tenglamaga ega bo‘lamiz va uni chuqurlikka nisbatan echamiz:

$$\omega = (b + mh)h \Rightarrow mh^2 + bh - \omega = 0$$

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

bundan, $mh^2 + (\chi - 2m'h)h - \omega = 0$ yoki $(m - 2m')h^2 + \chi h - \omega = 0$;

$(2m' - m)h^2 - \chi h + \omega = 0$ bunda, $M = 2m' - m$ munosabatni inobatga olsak,

$$Mh^2 - \chi h + \omega = 0$$

3) $M = 2\sqrt{1+1^2} - 1 = 1{,}83$

$$h = \frac{\chi \pm \sqrt{\chi^2 - 4M\omega}}{2M} = \frac{20{,}61 \pm \sqrt{(20{,}61)^2 - 4 \cdot 2{,}83 \cdot 34}}{2 \cdot 1{,}83} = \frac{20{,}61 \pm 6{,}32}{3{,}66}\, m;$$

Shu o‘rinda ta’kidlab o‘tish kerakki,

a) agar $\frac{m}{(2m')^2} < \frac{R^2}{\omega} < \frac{1}{4M}$ shart bajarilsa, *h* va *b* kattaliklar ikkitadan echimga ega bo‘ladi;

b) agar $\frac{m}{(2m')^2} > \frac{R^2}{\omega}$, shart bajarilsa u holda *h* va *b* kattaliklar bittadan echimga ega bo‘ladi;

c) agar $\frac{R^2}{\omega} > \frac{1}{4M}$ bo‘lsa,bu gidravlik masalaning echimi mavjud bo‘lmaydi.

3) shartlarni tekshiramiz:

$$\frac{m}{(2m')^2} = \frac{1}{(2 \cdot 1{,}83)^2} = 0{,}075 > \frac{R^2}{\omega} = \frac{(1{,}65)^2}{34} = 0{,}08 < \frac{1}{4 \cdot 1{,}83} = 0{,}14$$

Demak, gidravlik masalamiz ikkinchi (*b*) shart bajarilganligi sababli bitta echimga ega bo‘ladi:

$$h_1 = \frac{20{,}61 + 6{,}32}{3{,}66} = 7{,}36\text{м}; \Rightarrow b_1 = \chi - 2m'h_1 = 20{,}61 - 2 \cdot 1{,}83 \cdot 7{,}36 = -6{,}32\, m;$$

Kenglik manfiy kattalik bo‘lishi mumkin emas:

$$h_1 = \frac{20{,}61 - 6{,}32}{3{,}66} = 3{,}90\text{м}; \Rightarrow b_1 = \chi - 2m'h_1 = 20{,}61 - 2 \cdot 1{,}83 \cdot 3{,}90 = 6{,}34\,m.$$

IX. Berilgan: kanal – trapetsiadal

Q= 3,5 $м^3/c$, $\upsilon = 0{,}84\upsilon_{\max}$, m = 1,0, n = 0,025, i = 0,000064.

Aniqlash kerak:

b - ?h - ?

Hisoblash:

1) Hosilaviy kattalikni hisoblaymiz:

$$N = \frac{n}{\sqrt{i}} = \frac{0{,}025}{\sqrt{0{,}000064}} = 3{,}13;$$

2) Hosilaviy kattalikni hisoblaymiz:

$$M = 2m' - m = 2\sqrt{1 + m^2} - m = 2\sqrt{1 + (1{,}0)^2} - 1 = 1{,}83;$$

3) Kanaldagi suv oqimining maksimal tezligini hisoblaymiz:

$$\upsilon_{мax} = \frac{1}{N}\left|\frac{NQ}{4M}\right|^{1/4} = \frac{1}{3{,}13}\left|\frac{3{,}13 \cdot 15{,}3}{4 \cdot 1{,}83}\right|^{1/4} = 0{,}51 m/s;$$

4) Oqim o‘rtacha tezligini hisoblaymiz:

$$\upsilon = 0{,}84\upsilon_{мax} = 0{,}84 \cdot 0{,}51 = 0{,}43 m/s;$$

5) Harakatdagi kesim yuzasini hisoblaymiz:

$$\omega = \frac{Q}{\upsilon} = \frac{15{,}3}{0{,}43} = 35{,}58\,m^2;$$

6) Gidravlik radiusni Shezi formulasiga asosan hisoblaymiz:

$$R = (\upsilon N)^{3/2} = (0{,}43 \cdot 3{,}13)^{3/2} = 1{,}61 m;$$

7) Ho‘llangan perimetrni hisoblaymiz:

$$\chi = \frac{\omega}{R} = \frac{35{,}58}{1{,}61} = 40{,}15\,m;$$

8) $h = \dfrac{\chi \pm \sqrt{\chi^2 - 4M\omega}}{2M} = \dfrac{40{,}15 \pm \sqrt{(40{,}15)^2 - 4\cdot 1{,}83\cdot 35{,}58}}{2\cdot 1{,}83} = \dfrac{40{,}15 \pm 36{,}77}{3{,}66}\,m;$

9) Shartlarni bajarilishini tekshiramiz:

$$\frac{m}{(2m')^2} = \frac{1}{(2\cdot 1{,}83)^2} = 0{,}075 > \frac{R^2}{\omega} = \frac{(1{,}61)^2}{35{,}58} = 0{,}072 < \frac{1}{4\cdot 1{,}83} = 0{,}14$$

Demak,masala birinchi (*b*) shart bajarilganligi sababli, bir echimga ega bo‘ladi:

$$h_1 = \frac{40{,}15 - 36{,}77}{3{,}66} = 0{,}92 \Rightarrow b_1 = \chi - 2m'h = 40{,}15 - 2{,}83\cdot 0{,}92 = 37{,}54\,m.$$

Javob:h = 0,92 *m*, b = 38 *m.*

X. Berilgan: kanal – trapetsiadal

m = 1,0,n = 0,012, Q = 19,1 $м^3/c$, $\upsilon = 1{,}06$ $м/c$, i = 0,00007,R=0,8R_{max}

Aniqlash kerak:

b - ? , h - ?

Hisoblash:

1) Hosilaviy kattalikni hisoblaymiz:

$$N = \frac{n}{\sqrt{i}} = \frac{0{,}012}{\sqrt{0{,}00007}} = 1{,}5;$$

2) Hosilaviy kattalikni hisoblaymiz:

$$M = 2m' - m = 2\sqrt{1+m^2} - m = 2\sqrt{1+(1{,}0)^2} - 1 = 1{,}83;$$

3) $R_{max} = \left|\dfrac{N\cdot Q}{4\cdot M}\right|^{\frac{3}{4}} = \left|\dfrac{1{,}5\cdot 19{,}1}{4\cdot 1{,}83}\right|^{\frac{3}{4}} = 0{,}49\,m;$

4) Gidravlik radiusni hisoblaymiz:

R = 0,8R_{max}= 0,4 *m*;

5) Harakatdagi kesim yuzasini hisoblaymiz:

$$\omega = \frac{Q}{\upsilon} = \frac{19{,}1}{1{,}06} = 18{,}02\,m^2;$$

6) Ho‘llangan perimetrni hisoblaymiz:

$$\chi = \frac{\omega}{R} = \frac{18{,}02}{0{,}4} = 45{,}05\,m;$$

7) $h = \frac{\chi \pm \sqrt{\chi^2 - 4M\omega}}{2M} = \frac{45{,}05 \pm \sqrt{(45{,}05)^2 - 4 \cdot 1{,}83 \cdot 18{,}02}}{2 \cdot 1{,}83} = \frac{45{,}05 \pm 43{,}5}{3{,}66}\,m;$

Shartlarni bajarilishini tekshiramiz:

$$\frac{m}{(2m')^2} = \frac{1}{(2 \cdot 1{,}83)^2} = 0{,}075 > \frac{R^2}{\omega} = \frac{(0{,}4)^2}{18{,}02} = 0{,}008 < \frac{1}{4 \cdot 1{,}83} = 0{,}14$$

Demak, masala ikkinchi (*b*) shart bajarilganligi sababli, bitta echimga ega bo‘ladi.

8) $h_1 = \frac{45{,}01 - 43{,}5}{3{,}66} = 0{,}43\,m; b_1 = \chi - 2m'h_1 = 45{,}01 - 2 \cdot 1{,}83 \cdot 0{,}43 = 39{,}44\,m;$

XI. Berilgan: kanal – trapetsiadal

Q = 2,6 $м^3/c$, m = 1,25, n = 0,030, i = 0,0004, $\beta_Г = 1{,}5Q^{2/3}$

Aniqlash kerak:

b - ?h - ?

Hisoblash:

1) Hosilaviy kattalikni hisoblaymiz:

$$N = \frac{n}{\sqrt{i}} = \frac{0{,}030}{\sqrt{0{,}0004}} = 1{,}5;$$

2) Girshkan formulasidan foydalanib,nisbiy kenglikni hisoblaymiz:

$$\beta_Г = 1{,}5Q^{2/3} = 1{,}5 \cdot (2{,}6)^{2/3} = 1{,}91m;$$

3) Gidravlik radiusni aniqlaymiz:

$$R = \left(NQ \frac{\beta + m}{(\beta + 2m')^2} \right)^{\frac{3}{8}} = \left(1{,}5 \cdot 2.6 \cdot \frac{1{,}91 + 1{,}25}{\left(1{,}91 + 2\sqrt{1 + 1{,}25}\right)^2} \right)^{\frac{3}{8}} = 0{,}88\,м;$$

4) Harakatdagi kesimni hisoblaymiz:

$$R^2 = h^2\left(\frac{\beta+m}{\beta+2m'}\right)^2 \Rightarrow R^2\left(\frac{(\beta+2m')^2}{\beta+m}\right) = h^2(\beta+m) = \omega$$

$$\omega = R^2\left(\frac{(\beta+2m')^2}{\beta+m}\right) = 0{,}88^2\left(\frac{\left(1{,}91+2\sqrt{1+1{,}25}\right)^2}{1{,}91+1{,}25}\right) = 10{,}61m^2;$$

5) Kanalda harakatlanayotgan oqimning chuqurligini hisoblaymiz:

$$h = \sqrt{\frac{\omega}{\beta+m}} = \sqrt{\frac{10{,}61}{1{,}91+1{,}25}} = 1{,}83m;$$

6) Kanal tubining kengligini aniqlaymiz:

$$b = \beta h = 1{,}91\cdot 1{,}83 = 3{,}50m;$$

Gidravlika fani rivoji uchun salmoqli hissa qo‘shgan yetuk olim I. I. Agroskin tomonidan kanallarning ko‘ndalang kesimi profile bilan uning shu shakldagi eng qulay kesimini taqqoslash orqali ularning gidravlik hisobini bajarishni qulay usuli taklif qilingani Gidravlika o‘quv qo‘llanmalarida keltirilgan. Bu olimning taniqli o‘quvchisi,O‘zbekistonda xizmat ko‘rsatgan irrigator,mamlakatimizda birinchi o‘zbekgidravlikasi asoschilaridan biri R. M. Karimov tomonidan bu usul umumlashtirilib, taqqoslash uchun to‘liq absolyut eng qulay kesim – yarim aylana etalon sifatida qabul qilingan. Bu usulning yana bir qulay tomoni shundan iboratki,bunda asosan hisoblash formulalari o‘lchov birliksiz ko‘rinishda keltiriladi. Keyingi mavzuda bu usul bilan batafsil tanishamiz.

KANALLARNI LOYIHALASHTIRISHDAGI GIDRAVLIK HISOB BAJARISHDA QO‘LLANILADIGAN R. M. KARIMOV USULI

8.7. ASOSIY HISOBLASH FORMULALARI

Tekis barqaror harakatni hisoblash formulasi:

$$Q = \omega C\sqrt{Ri} \qquad (8.71)$$

Endi bu formulaga ho‘llanganlik perimetrining o‘lchov birliksiz kattaligini kiritamiz:

$$\bar{\chi} = \frac{\chi}{R} = \frac{\omega}{R^2} = \frac{\chi^2}{\omega} \qquad (8.72)$$

8.34-ifodaga $\bar{\chi}$ o‘lchov birliksiz kattalikni kiritib,quyidagi ko‘rinishda ham ifodalash mumkin:

$$Q = \bar{\chi} C R^{2,5}\sqrt{i} \qquad (8.73)$$

Bu formulaga tezlik darajasi uchun akademik Pavlovskiy yoki Manning formulalarini qabul qilib hamda $\omega = \frac{Q}{\upsilon}$ munosabatlarni inobatga olib, gidravlik radius – R,ho‘llanganlik perimetri – χ ,harakatdagi kesim yuzasi – ω va o‘rtacha tezlik – υ kattaliklar uchun quyidagi ifodalarni yozish mumkin:

$$R = \left(\frac{Qn}{\bar{\chi}\sqrt{i}}\right)^{\frac{1}{2,5+y}} \qquad (8.74)$$

$y = \frac{1}{6}$ bo‘lgan holda

$$R = \sqrt[8]{\left(\frac{Qn}{\bar{\chi}\sqrt{i}}\right)^3} \qquad (8.74')$$

$$\chi = \left(\bar{\chi}^{1,5+y}\frac{Qn}{\sqrt{i}}\right)^{\frac{1}{2,5+y}} \qquad (8.75)$$

$y = \frac{1}{6}$ bo‘lgan holda

$$\chi = \sqrt[8]{\bar{\chi}^5 \left(\frac{Qn}{\sqrt{i}} \right)^3} \qquad (8.75')$$

$$\omega = \left[\bar{\chi}^{0,5+y} \left(\frac{Qn}{\sqrt{i}} \right)^2 \right]^{\frac{1}{2,5+y}} \qquad (8.76)$$

$y = \frac{1}{6}$ bo‘lgan holda

$$\omega = \sqrt[4]{\bar{\chi} \left(\frac{Qn}{\sqrt{i}} \right)^3} \qquad (8.76')$$

$$\upsilon = \frac{\sqrt{i}}{n} \left(\frac{Qn}{\bar{\chi}\sqrt{i}} \right)^{\frac{0,5+y}{2,5+y}} \qquad (8.77)$$

$y = \frac{1}{6}$ bo‘lgan holda

$$\upsilon = \sqrt[4]{\frac{Q\sqrt{i^3}}{n^3 \bar{\chi}}} \qquad (8.77')$$

Harakatdagi kesim yuzasini quyidagicha ifodalash mumkin:

$$\omega = \omega_{l=1} l^2 \qquad (8.78)$$

bunda l – harakatdagi kesimning ixtiyoriy chiziqli kattaligi (chuqurlik,kenglik,ho‘llanganlik perimetri va x. k.); $\omega_{l=1}$ – $l = 1,0$ bo‘lgan holda harakatdagi kesim yuzasi.

(8. 76) formulaga asosan ixtiyoriy shakldagi harakatdagi kesimning chiziqli kattaligini quyidagicha ifodalash mumkin:

$$l = \frac{1}{\sqrt{\omega_{l=1}}} \left(\bar{\chi}^{\frac{0,5+y}{2}} \frac{Qn}{\sqrt{i}} \right)^{\frac{1}{2,5+y}} \qquad (8.79)$$

yoki $y = \frac{1}{6}$ bo‘lgan holda

$$l = \sqrt[8]{\frac{\overline{\chi}}{\omega_l^4}\left(\frac{Qn}{\sqrt{i}}\right)^3} \qquad (8.\ 79')$$

Gidravlik radiusi $R = r/2$ va ho‘llanganlik perimetri $\overline{\chi} = 2\pi$ bo‘lgan gidravlik eng qulay kesim – yarim aylana shakl uchun (8. 73) formula quyidagi ko‘rinishda bo‘ladi:

$$Q = 2\pi\left(CR^{2,5}\right)_0 \sqrt{i} \qquad (8.\ 80)$$

bundan

$$\left(CR^{2,5}\right)_0 = \frac{Q_0}{2\pi\sqrt{i}}\frac{K_0}{2\pi}$$

8. 80-ifodaga asosan Shezi koeffitsienti uchun $C = \frac{1}{n}R^y$ formulani qabul qilsak,

$$R_0 = \left(\frac{Qn}{2\pi\sqrt{i}}\right)^{\frac{1}{2,5+y}} \qquad (8.\ 81)$$

$$\omega_0 = \left[(2\pi)^{0,5+y}\left(\frac{Qn}{\sqrt{i}}\right)^2\right]^{\frac{1}{2,5+y}} = 2\pi R_0^2 \qquad (8.\ 82)$$

$$\chi_0 = \left[(2\pi)^{1,5+y}\frac{Qn}{\sqrt{i}}\right]^{\frac{1}{2,5+y}} = 2\pi R_0 \qquad (8.\ 83)$$

$$\upsilon_0 = \frac{\sqrt{i}}{n}\left(\frac{Qn}{2\pi\sqrt{i}}\right)^{\frac{0,5+y}{2,5+y}} = \frac{\sqrt{i}}{n}R_0^{0,5+y} \qquad (8.\ 84)$$

$$l_0 = \frac{1}{\sqrt{\omega_{l_0=1}}}\left[(2\pi)^{\frac{0,5+y}{2}}\frac{Qn}{\sqrt{i}}\right]^{\frac{1}{2,5+y}} = \sqrt{\frac{2\pi}{\omega_{l_0=1}}}R_0 \qquad (8.\ 85)$$

$y = \frac{1}{6}$ bo‘lgan holda

$$R_0 = 0{,}5\sqrt[8]{\left(\frac{Qn}{\sqrt{i}}\right)^3} \qquad (8.\ 81')$$

$$\omega_0 = 1{,}58\sqrt[4]{\left(\frac{Qn}{\sqrt{i}}\right)^3} = 2\pi R_0^2 \qquad (8.\ 82')$$

$$\chi_0 = 3{,}16\sqrt{\left(\frac{Qn}{\sqrt{i}}\right)^3} = 2\pi R_0 \qquad (8.\ 83')$$

$$\upsilon_0 = 0{,}63\frac{\sqrt{i}}{n}\sqrt[4]{\frac{Qn}{\sqrt{i}}} = \frac{\sqrt{i}}{n}R_0^{2/3} \qquad (8.\ 84')$$

$$l_0 = \sqrt[8]{\frac{2\pi}{\omega_{l_0=1}^4}\left(\frac{Qn}{\sqrt{i}}\right)^3} = \frac{2}{\sqrt{\omega_{l_0=1}}}R_0 \qquad (8.\ 85')$$

bunda

$$\omega_{l_0} = \frac{\omega_0}{l_0^2} \qquad (8.\ 86)$$

$$\omega_{b_0=1} = \frac{\pi}{8} \qquad (8.\ 86')$$

$$\omega_{h_0=1} = \frac{\pi}{2} \qquad (8.\ 86'')$$

(8. 81) formula bizga gidravlik radiusni hech qanday maxsus jadval va grafiklarsiz aniq hisoblash imkoniyatini beradi. Bunda o‘zgaruvchan ko‘rsatkichni to‘g‘ri tanlash muammosi paydo bo‘ladi. (8.81) formuladagi ildiz ko‘rsatkichi 2,5 dan katta holda bu formulada y ko‘rsatkichni doimiy deb qabul qilib, foydalanish imkonini beradi.

Bu fikrimizning isboti uchun ε nisbiy xatolikni ko‘rib chiqamiz.

R_0 kattalikni hisoblashda (8. 81) formulaga asosan

$$y = y_{ucm} \pm \Delta y$$

demak, (8. 81) formulani hisobga olsak,

$$R_0 = \left(\frac{Qn}{2\pi\sqrt{i}} \right)^{\frac{1}{2,5+y}}$$

to‘liq xato

$$\Delta R_0 = -\left(\frac{Qn}{2\pi\sqrt{i}} \right)^{\frac{1}{2,5+y}} \ln \frac{Qn}{\sqrt{i}} \frac{\Delta y}{(2,5+y)^2}$$

nisbiy xato

$$\varepsilon = \frac{\Delta R_0}{R_0} = -\frac{\Delta y}{(2,5+y)^2} \ln \frac{Qn}{\sqrt{i}} = -\frac{2,3\Delta y}{(2,5+y)^2} \lg \frac{Qn}{\sqrt{i}} \qquad (8.\ 87)$$

$y = \frac{1}{6}$ va $y = 0,2$ doimiy ko‘rsatkich kattaliklarini qabul qilamiz. Amaliyotda bu kattalik farqi $\Delta y = \pm 0,05$ ligi aniqlangan.

Bunda (8. 87) formula o‘rniga

$y = \frac{1}{6}$ uchun

$$|\varepsilon| = 0,0162 \left(\lg Q + \lg \frac{n}{\sqrt{i}} \right)$$

$y = 0,2$ uchun

$$|\varepsilon| = 0,0158 \left(\lg Q + \lg \frac{n}{\sqrt{i}} \right)$$

Endi $|\varepsilon|$ kattalik bilan noqulay vaziyatlar uchun, ya’ni $n = 0,0275$ va $i = 0,0002$ holat uchun aniqlaymiz

$y = \frac{1}{6}$ uchun

$$|\varepsilon_{\text{макс}}| = 0,0162(\lg Q + 0,301)$$

$y = 0,2$ uchun

$$|\varepsilon_{\text{макс}}| = 0,0158(\lg Q + 0,301)$$

bu ifodadagi xatolarning chegaraviy qiymatlari quyidagi 8. 3-jadvalda keltirilgan.

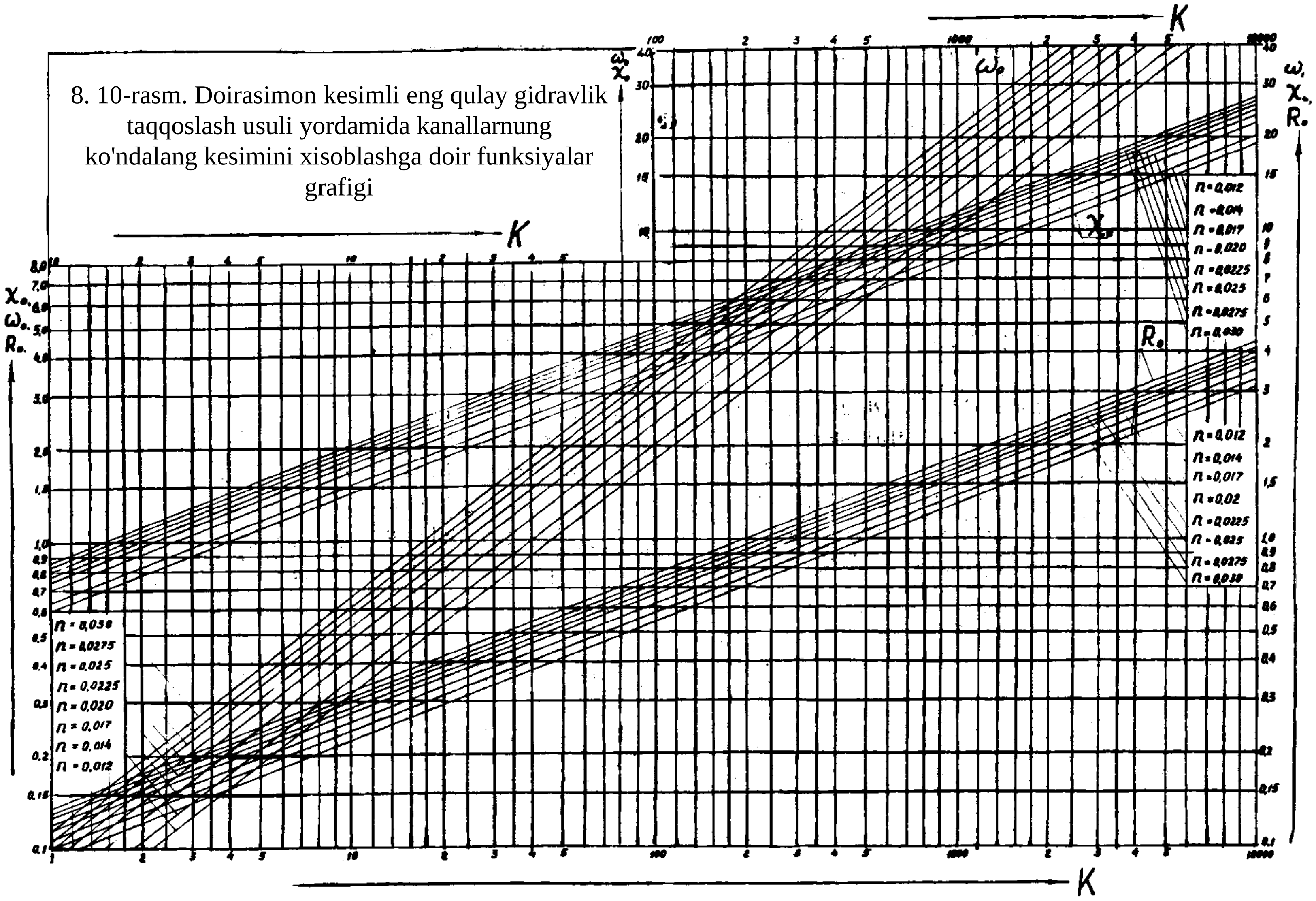
8. 3-jadval

Q, $м^3/с$	0,25	1	5	10	25	50	100
$y=\frac{1}{6}\lvert\varepsilon_{max}\rvert$	0,00486	0,00486	0,0162	0,021	0,0274	0,0324	0,0372
$y=0{,}2\lvert\varepsilon_{max}\rvert$	0,00475	0,00475	0,0158	0,0206	0,0268	0,0316	0,0363

R_0, χ_0 va ω_0 kattaliklar yuqorida keltirilgan jadvallar va grafik yordamida aniqlanishi mumkin. Namuna tariqasida 8. 10-rasm va 8. 4-jadvalni keltiramiz

8. 10-rasm – R_0, χ_0 va ω_0 kattaliklarni $K=Q/\sqrt{i}$ funksiyasi sifatida $y=\frac{1}{6}$ holat uchun aniqlash imkoniyatini beradi.

8. 4-jadval esa $y=0{,}2$ va (Q, $i$va$n$) kattaliklarning ma'lum qiymatlari uchun υ_0 va R_0 kattaliklarning masshtab qiymatlarini aniqlash imkoniyatini beradi.



8. 10-rasm. Doirasimon kesimli eng qulay gidravlik taqqoslash usuli yordamida kanallarnung ko'ndalang kesimini xisoblashga doir funksiyalar grafigi

$0{,}159 = \frac{Qn}{\sqrt{i}}$ funksiyadagi R_0 va $\upsilon_0 \frac{n}{\sqrt{i}}$ kattaliklar qiymatlari,

bunda $0{,}159 = \frac{Qn}{\sqrt{i}}$

8. 4-jadval

R_0	$0{,}159\frac{Qn}{\sqrt{i}}$	$\upsilon_0 \frac{n}{\sqrt{i}}$	R_0	$0{,}159\frac{Qn}{\sqrt{i}}$	$\upsilon_0 \frac{n}{\sqrt{i}}$
0,025	0,000047	0,07561	1,10	1,294	1,069
0,030	0,000077	0,08590	1,12	1,358	1,083
0,035	0,000117	0,09569	1,14	1,424	1,096
0,040	0,000168	0,1053	1,16	1,493	1,110
0,045	0,000232	0,1141	1,18	1,563	1,123
0,050	0,000307	0,1228	1,20	1,636	1,136
0,055	0,000397	0,1313	1,22	1,711	1,149
0,060	0,000502	0,1395	1,24	1,788	1,163
0,065	0,000624	0,1476	1,26	1,866	1,176
0,070	0,000762	0,1554	1,28	1,948	1,189
0,075	0,000918	0,1631	1,30	2,031	1,202
0,080	0,00109	0,1707	1,32	2,116	1,215
0,085	0,00129	0,1781	1,34	2,204	1,227
0,090	0,00150	0,1853	1,36	2,294	1,240
0,095	0,00174	0,1925	1,38	2,386	1,253
0,100	0,00200	0,1995	1,40	2,481	1,266
0,110	0,00258	0,2133	1,42	2,577	1,278
0,120	0,00326	0,2257	1,44	2,677	1,291
0,130	0,00405	0,2398	1,46	2,778	1,303
0,140	0,00495	0,2525	1,48	2,882	1,316
0,150	0,00596	0,2650	1,50	2,988	1,328

R_0	$0{,}159\frac{Qn}{\sqrt{i}}$	$\upsilon_0\frac{n}{\sqrt{i}}$	R_0	$0{,}159\frac{Qn}{\sqrt{i}}$	$\upsilon_0\frac{n}{\sqrt{i}}$
0,160	0,00710	0,2773	1,55	3,265	1,359
0,170	0,00836	0,2893	1,60	3,557	1,390
0,180	0,00976	0,3011	1,65	3,866	1,420
0,190	0,01129	0,3127	1,70	4,190	1,450
0,200	0,01297	0,3241	1,75	4,531	1,480
0,210	0,01479	0,3354	1,80	4,889	1,509
0,220	0,01677	0,3465	1,85	5,265	1,638
0,230	0,01891	0,3575	1,90	5,658	1,567
0,240	0,02121	0,3683	1,95	6,069	1,596
0,250	0,02368	0,3789	2,00	6,498	1,625
0,260	0,02633	0,3895	2,05	6,946	1,653
0,270	0,02915	0,3999	2,10	7,412	1,681
0,280	0,03216	0,4102	2,15	7,899	1,709
0,290	0,03536	0,4204	2,20	8,405	1,737
0,30	0,03875	0,4305	2,25	8,931	1,764
0,31	0,04233	0,4405	2,30	9,477	1,792
0,32	0,04612	0,4504	2,35	10,144	1,819
0,33	0,05012	0,4602	2,40	10,631	1,846
0,34	0,05432	0,4699	2,45	11,240	1,873
0,35	0,05875	0,4796	2,50	11,870	1,899
0,36	0,06339	0,4891	2,55	12,522	1,926
0,37	0,06826	0,4986	2,60	13,196	1,952
0,38	0,07335	0,5080	2,65	13,892	1,978
0,39	0,07868	0,5173	2,70	14,611	2,004
0,40	0,08425	0,5266	2,75	15,353	2,030
0,41	0,09006	0,5357	2,80	16,119	2,056

R_0	$0{,}159\frac{Qn}{\sqrt{i}}$	$\upsilon_0\ \frac{n}{\sqrt{i}}$	R_0	$0{,}159\frac{Qn}{\sqrt{i}}$	$\upsilon_0\ \frac{n}{\sqrt{i}}$
0,42	0,09611	0,5449	2,85	16,908	2,082
0,43	0,1024	0,5539	2,90	17,721	2,107
0,44	0,1085	0,5629	2,95	18,558	2,132
0,45	0,1158	0,5718	3,00	19,419	2,158
0,46	0,1229	0,5807	3,10	21,217	2,208
0,47	0,1302	0,5895	3,20	23,116	2,257
0,48	0,1378	0,5982	3,30	25,118	2,307
0,49	0,1457	0,6069	3,40	27,227	2,355
0,50	0,1539	0,6156	3,50	29,443	2,404
0,52	0,1711	0,6327	3,60	31,770	2,451
0,54	0,1894	0,6497	3,70	34,209	2,499
0,56	0,2090	0,6664	3,80	36,763	2,546
0,58	0,2298	0,6830	3,90	39,434	2,583
0,60	0,2518	0,6994	4,00	42,224	2,439
0,62	0,2751	0,7156	4,20	48,170	2,731
0,64	0,2997	0,7317	4,40	54,616	2,821
0,66	0,3257	0,7476	4,60	61,581	2,910
0,68	0,3530	0,7634	4,80	69,080	2,998
0,70	0,3817	0,7791	5,00	77,129	3,085
0,72	0,4119	0,7946	5,25	87,989	3,192
0,74	0,4435	0,8100	5,50	99,755	3,298
0,76	0,4767	0,8252	5,75	112,49	3,402
0,78	0,5113	0,8404	6,00	126,18	3,505
0,80	0,5475	0,8554	6,25	140,89	3,607
0,82	0,5852	0,8703	6,50	156,63	3,707
0,84	0,6245	0,8851	6,75	173,42	3,806

R_0	$0{,}159\frac{Qn}{\sqrt{i}}$	$\upsilon_0\ \frac{n}{\sqrt{i}}$	R_0	$0{,}159\frac{Qn}{\sqrt{i}}$	$\upsilon_0\ \frac{n}{\sqrt{i}}$
0,86	0,6655	0,8998	7,00	191,32	3,905
0,88	0,7081	0,9144	7,25	210,34	4,002
0,90	0,7724	0,9289	7,50	230,50	4,098
0,92	0,7984	0,9433	7,75	251,83	4,193
0,94	0,8461	0,9676	8,00	274,37	4,287
0,96	0,8956	0,9718	8,50	323,17	4,473
0,98	0,9469	0,9860	9,00	377,10	4,656
1,00	1,0000	1,0000	9,50	436,37	4,835
1,02	1,055	1,040	10,00	501,19	5,012
1,04	1,112	1,028			
1,06	1,170	1,042			
1,08	1,231	1,055			

8. 8. SOLISHTIRMA HO‘LLANGAN PERIMETR FUNKSIYASI SIFATIDA OQIM GIDRAVLIK ELEMENTLARINING NISBIY O‘ZGARISHI

Berilgan *Q,n,i,*va *u* kattaliklar uchun oqimning berilgan o‘zan kesimi va gidravlik eng qulay kesim – yarim aylana ko‘rinishidagi kattaliklari bilan taqqoslab, (8. 74÷8. 77) va (8. 81÷8. 84) nisbiy elementlar uchun quyidagi o‘lchov birliklarsiz formulalarni olamiz:

$$\frac{R}{R_0}=\left(\frac{2\pi}{\overline{\chi}}\right)^{\frac{1}{2{,}5+y}} \qquad (8.\ 88)$$

$y=\frac{1}{6}$ holat uchun

$$\frac{R}{R_0} = \frac{2}{\sqrt[8]{\overline{\chi}^3}} \qquad (8.\ 88')$$

$$\frac{\omega}{\omega_0} = \left(\frac{\overline{\chi}}{2\pi}\right)^{\frac{0,5+y}{2,5+y}} \qquad (8.\ 89)$$

$y = \frac{1}{6}$ holat uchun

$$\frac{\omega}{\omega_0} = 0,632\sqrt[4]{\overline{\chi}} \qquad (8.\ 89')$$

$$\frac{\chi}{\chi_0} = \left(\frac{\overline{\chi}}{2\pi}\right)^{\frac{1,5+y}{2,5+y}} \qquad (8.\ 90)$$

$y = \frac{1}{6}$ holat uchun

$$\frac{\chi}{\chi_0} = 0,316\sqrt[8]{\overline{\chi}^5} \qquad (8.\ 90')$$

$$\frac{\upsilon}{\upsilon_0} = \left(\frac{2\pi}{\overline{\chi}}\right)^{\frac{0,5+y}{2,5+y}} \qquad (8.\ 91)$$

$y = \frac{1}{6}$ holat uchun

$$\frac{\upsilon}{\upsilon_0} = \frac{1,582}{\sqrt[4]{\overline{\chi}}} \qquad (8.\ 91')$$

Yuqorida keltirilgan $y = \frac{1}{6}$ holat uchun (8. 88÷8. 91) formulalardan foydalanishni soddalashtirish maqsadida 8. 11-rasm keltirilgan.

Yuqorida ta'kidlanganidek, R_o kattalik masshtab kattalik sifatida qabul qilinadi.

O‘lchov birliksiz gidravlik ko‘rsatkichlarni quyidagi ko‘rinishda yozib olamiz:

$$\frac{R}{R_0}=\left(\frac{2\pi}{\overline{\chi}}\right)^{\frac{1}{2,5+y}} \tag{8. 92}$$

$y=0,2$ holat uchun

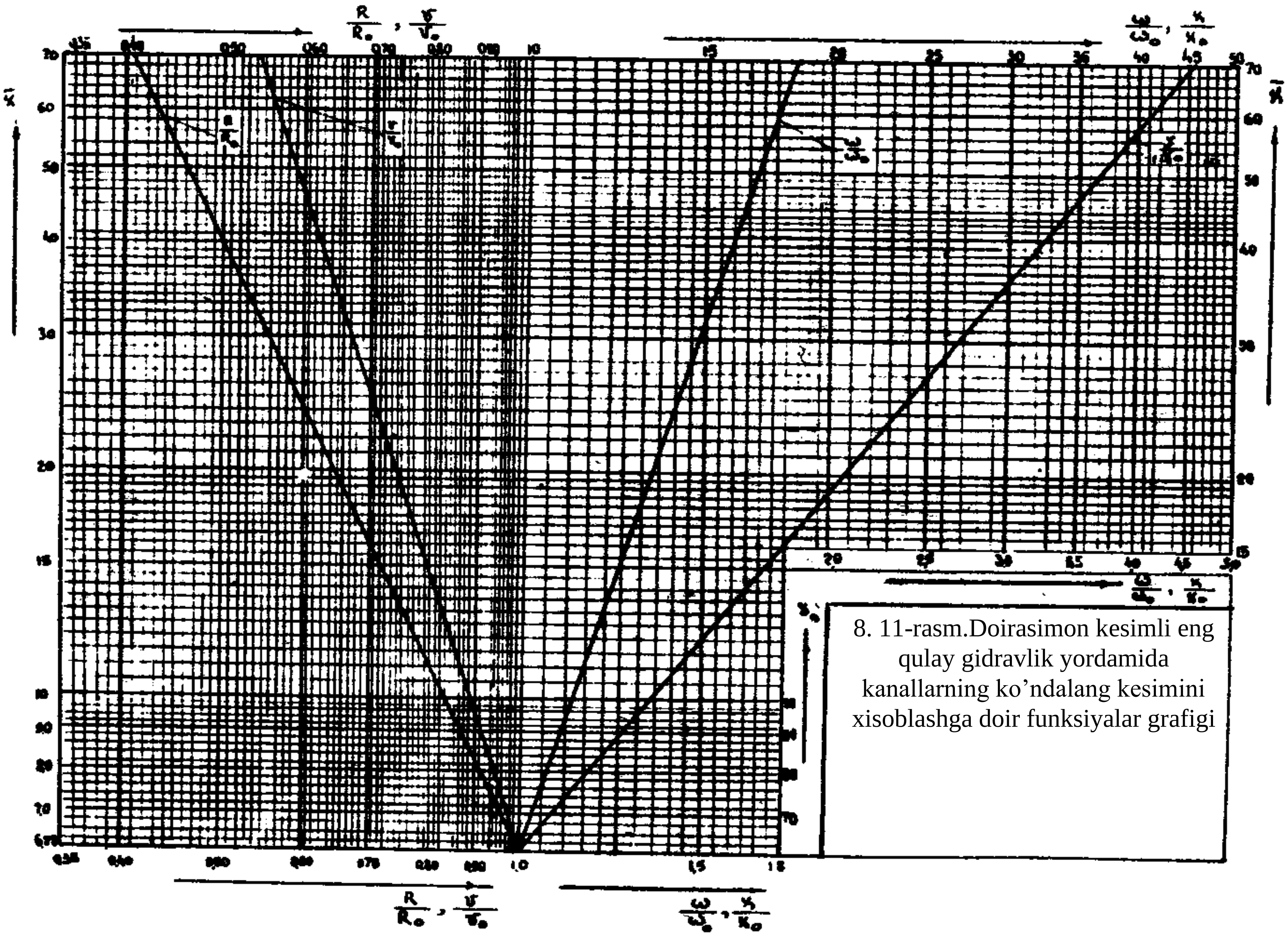
$$\frac{R}{R_0}=\left(\frac{2\pi}{\overline{\chi}}\right)^{\frac{1}{2,7}} \tag{8. 92′}$$

$$\frac{\omega}{R_0^2}=\left[\left(2\pi^2\right)\overline{\chi}^{\,0,5+y}\right]^{\frac{1}{2,5+y}} \tag{8. 93}$$

$y=0,2$ holat uchun

$$\frac{\omega}{R_0^2}=\left[\left(2\pi^2\right)\overline{\chi}^{\,0,7}\right]^{\frac{1}{2,7}} \tag{8. 93′}$$

$$\frac{\chi}{R_0}=\left(2\pi\overline{\chi}^{\,1,5+y}\right)^{\frac{1}{2,5+y}} \tag{8. 94}$$



8. 11-rasm.Doirasimon kesimli eng qulay gidravlik yordamida kanallarning ko'ndalang kesimini xisoblashga doir funksiyalar grafigi

$y = 0,2$ holat uchun

$$\frac{\chi}{R_0} = \left(2\pi\overline{\chi}^{1,7}\right)^{\frac{1}{2,7}} \qquad (8.\ 94')$$

$$\frac{\upsilon}{\upsilon_0} = \left(\frac{2\pi}{\overline{\chi}}\right)^{\frac{0,5+y}{2,5+y}} \qquad (8.\ 95)$$

$y = 0,2$ holat uchun

$$\frac{\upsilon}{\upsilon_0} = \left(\frac{2\pi}{\overline{\chi}}\right)^{\frac{0,7}{2,7}} \qquad (8.\ 95')$$

$y = 0,2$ holat uchun (8. 92÷8. 95) formulalardan foydalanish maqsadida 8.5-jadval keltirilgan.

Bu formulalar asosida $y = 0,2$ ko‘rsatkich qiymati uchun berilgan *Q, n,i*va *y* kattaliklarga mos keluvchi *R, ω, χ* va *υ* kattaliklarning har qanday shakldagi kesimlarga ega bo‘lgan kanallar uchun $\overline{\chi}$ kattalik bilan xarakterlanuvchi qiymatlari aniqlanishi mumkin.

$\overline{\chi}$ funksiyada R/R_0, υ/υ_0, ω/R_0^2 va χ/R_0 nisbiy kattaliklar

8. 5-jadval

$\overline{\chi}$	R/R_0	υ/υ_0	ω/R_0^2	χ/R_0
6,28	1,000	1,000	6,283	6,283
6,30	0,999	0,999	6,288	6,294
6,40	0,993	0,995	6,313	6,357
6,50	0,988	0,991	6,338	6,418
6,60	0,982	0,987	6,364	6,481

$\bar{\chi}$	R/R_0	υ/υ_0	ω/R_0^2	χ/R_0
6,70	0,976	0,983	6,389	6,547
6,80	0,971	0,980	6,413	6,604
6,90	0,966	0,976	6,438	6,665
7,00	0,961	0,972	6,462	6,725
7,10	0,956	0,969	6,486	6,786
7,20	0,951	0,965	6,509	6,846
7,30	0,946	0,962	6,532	6,905
7,40	0,941	0,958	6,555	6,965
7,50	0,937	0,955	6,579	7,024
7,60	0,932	0,952	6,601	7,083
7,70	0,927	0,949	6,623	7,141
7,80	0,923	0,945	6,645	7,200
7,90	0,919	0,943	6,665	7,255
8,00	0,914	0,939	6,689	7,315
8,10	0,910	0,936	6,711	7,373
8,20	0,906	0,933	6,732	7,430
8,30	0,902	0,930	6,753	7,487
8,40	0,898	0,927	6,774	7,543
8,50	0,894	0,925	6,796	7,600
8,60	0,890	0,922	6,816	7,656
8,70	0,886	0,919	6,836	7,712
8,80	0,883	0,916	6,856	7,768
8,90	0,879	0,914	6,877	7,823
9,00	0,875	0,911	6,897	7,879
9,10	0,872	0,908	6,917	7,934
9,20	0,868	0,906	6,936	7,988
9,30	0,865	0,903	6,956	8,043

$\bar{\chi}$	R/R_0	υ/υ_0	ω/R_0^2	χ/R_0
9,40	0,861	0,901	6,975	8,097
9,50	0,858	0,898	6,994	8,151
9,60	0,855	0,896	7,013	8,206
9,70	0,851	0,894	7,032	8,259
9,80	0,848	0,891	7,051	8,312
9,90	0,845	0,889	7,069	8,366
10,00	0,842	0,886	7,088	8,419
10,20	0,836	0,882	7,124	8,524
10,40	0,830	0,878	7,150	8,630
10,60	0,824	0,873	7,196	8,734
10,80	0,818	0,869	7,230	8,837
11,00	0,813	0,865	7,265	8,939
11,20	0,807	0,861	7,299	9,042
11,40	0,802	0,857	7,332	9,143
11,60	0,797	0,853	7,366	9,256
11,80	0,792	0,849	7,398	9,343
12,00	0,787	0,846	7,430	9,443
12,20	0,782	0,842	7,463	9,542
12,40	0,777	0,838	7,494	9,640
12,60	0,773	0,835	7,525	9,737
12,80	0,768	0,832	7,556	9,834

13,00	0,764	0,828	7,587	9,931
13,20	0,760	0,825	7,617	10,027
13,40	0,755	0,822	7,647	10,123
13,60	0,751	0,819	7,676	10,217
13,80	0,747	0,815	7,505	10,311
14,00	0,743	0,812	7,734	10,405
14,20	0,739	0,809	7,762	10,499
14,40	0,736	0,807	7,791	10,592
14,60	0,732	0,804	7,818	10,684
14,80	0,728	0,801	7,846	10,746
15,00	0,724	0,798	7,874	10,868
15,20	0,721	0,795	7,900	10,958
15,40	0,717	0,793	7,927	11,049
15,60	0,714	0,790	7,953	11,138
15,80	0,711	0,787	7,980	11,228
16,00	0,707	0,785	8,006	11,312
16,20	0,704	0,782	8,032	11,407
16,40	0,701	0,780	8,057	11,495
16,60	0,698	0,777	8,083	11,583
16,80	0,695	0,775	8,108	11,671
17,00	0,692	0,773	8,133	11,758
17,20	0,689	0,770	8,158	11,846
17,40	0,686	0,768	8,207	11,914
17,60	0,683	0,766	8,207	12,019
17,80	0,680	0,763	8,231	12,104
18,00	0,677	0,761	8,254	12,189
18,20	0,674	0,759	8,278	12,274

18,40	0,672	0,757	8,301	12,358
18,60	0,669	0,755	8,325	12,444
18,80	0,666	0,753	8,348	12,528
19,00	0,664	0,751	8,371	12,661
19,20	0,661	0,749	8,393	12,694
19,40	0,659	0,747	8,416	12,778
19,60	0,656	0,745	8,438	12,860
19,80	0,654	0,743	8,461	12,943
20,00	0,651	07,41	8,483	13,025
20,25	0,648	0,738	8,510	13,127
20,50	0,645	0,736	8,537	13,229
20,75	0,642	07,34	8,564	13,331
21,00	0,640	0,731	8,589	13,427
21,25	0,637	0,729	8,618	13,533
21,50	0,634	0,727	8,644	13,633
21,75	0,631	0,725	8,669	13,732
22,00	0,629	0,723	8,695	13,831
22,25	0,626	0,720	8,721	13,930
22,50	0,623	0,718	8,746	14,028
22,75	0,621	0,716	8,771	14,127
23,00	0,618	0,714	8,796	14,224
23,25	0,616	0,712	8,821	14,321
23,50	0,614	0,710	8,845	14,417
23,75	0,611	0,708	8,870	14,514
24,00	0,609	0,706	8,893	14,610
24,25	0,606	0,705	8,917	14,704
24,50	0,604	0,703	8,941	14,801
24,75	0,602	0,701	8,964	14,895

25,00	0,600	0,699	8,988	14,990
25,50	0,595	0,695	9,037	15,178
26,00	0,591	0,692	9,071	15,364
26,50	0,587	0,689	9,125	15,550
27,00	0,583	0,685	9,169	15,734
27,50	0,579	0,682	9,213	15,917
28,00	0,575	0,679	9,256	16,099
28,50	0,571	0,676	9,299	16,279
29,00	0,568	0,673	9,341	16,458
29,50	0,564	0,670	9,382	16,636
30,00	0,560	0,667	9,423	16,813

Agar harakatdagi kesimlar geometrik o‘xshash bo‘lsa, bunda $\overline{\chi}$ kattalik bir xil bo‘ladi.

Har qanday kanalning chiziqli l elementini eng qulay gidravlik kesimli yarim aylana chiziqli element bilan taqqoslab, kesim nisbiy chiziqli elementlarining aniqlash formulalariga ega bo‘lish mumkin.

$$\frac{l}{R_0} = \sqrt{\frac{\overline{\chi}}{\omega_{l=1}}}\left(\frac{2\pi}{\overline{\chi}}\right)^{\frac{1}{2,5+y}} \qquad (8.\,96)$$

$y = \frac{1}{6}$ holat uchun

$$\frac{l}{R_0} = 2\sqrt[8]{\frac{\overline{\chi}}{\omega_{l=1}^4}} \qquad (8.\,96')$$

$y = 0,2$ holat uchun

$$\frac{l}{R_0} = \sqrt{\frac{\overline{\chi}}{\omega_{l=1}}}\left(\frac{2\pi}{\overline{\chi}}\right)^{\frac{1}{2,7}} \qquad (8.\,96'')$$

$$\frac{l}{l_0} = \sqrt{\frac{\omega}{\omega_{l=1}}}\left(\frac{\overline{\chi}}{2\pi}\right)^{\frac{0,5+y}{5+2y}} \quad (8.\ 97)$$

8. 9. KANALLARNI GIDRAVLIK ENG QULAY KESIM BILAN TAQQOSLASH ORQALI HISOBLASH

Kanallarni hisoblashda o‘n xil ko‘rinishdagi masalalar bo‘lishi mumkin. Bu masalalarning ko‘rinishi va hisoblanish tartibi 8. 6-jadvalda keltirilgan.

Bu masalalarning hisoblanish tartibini alohida keltiramiz.

Bundan keyin *Q*, *n* va *i* kattaliklarni berilgan deb hisoblab, quyidagi ketma-ketlik tartibida ko‘rib chiqamiz:

a) berilgan β kattalik uchun

b) berilgan υ kattalik uchun

c) berilgan h kattalik uchun

d) berilgan *B*va*b* kattaliklari uchun

8.6-жадвал

№	Берилган	Топиш керак	Хисоблаш тартиби						
1	Q, υ, i	l, β	$\omega = \frac{Q}{\upsilon}$	$K = \frac{Q}{\sqrt{i}}$	$R_0 = f(x, n)$	$\overline{\chi} = f\left(\frac{\omega}{R_0^2}\right)$	$\beta = f(\overline{\chi})$	$\frac{l}{R_0} = f(\beta)$	$l = R_0 f(\beta)$
2	Q, i, l	υ, β	$K = \frac{Q}{\sqrt{i}}$	$R_0 = f(x, n)$	$\beta = f\left(\frac{l}{R_0}\right)$	$\omega_{i=1} = f(\beta)$	$\omega = \omega_{i=1} l^2$	$\upsilon = \frac{Q}{\omega}$	
3	Q, i, β	υ, l	$K = \frac{Q}{\sqrt{i}}$	$R_0 = f(x, n)$	$\frac{l}{R_0} = f(\beta)$	$l = R_0 f(\beta)$	$\omega_{i=1} = f(\beta)$	$\omega = \omega_{i=1} l^2$	$\upsilon = \frac{Q}{\omega}$
4	υ, [illegible], l	Q, β	$R = \left(\frac{\upsilon n}{\sqrt{i}}\right)^{\frac{1}{0,5+y}}$	$\beta = f\left(\frac{l}{R}\right)$	$\omega_{i=1} = f(\beta)$	$\omega = \omega_{i=1} l^2$	$Q = \upsilon\omega$		
5	υ, i, β	Q, l	$R = \left(\frac{\upsilon n}{\sqrt{i}}\right)^{\frac{1}{0,5+y}}$	$\overline{\chi} = f(\beta)$	$\frac{R}{R_0} = f(\overline{\chi})$	$R_0 = \frac{R}{f(\overline{\chi})}$	$K = f(R_0, n)$	$Q = K\sqrt{i}$	$l = R_0 f(\beta)$
6	[illegible], l, β	Q, υ	$\omega_{i=1} = f(\beta)$	$\omega = \omega_{i=1} l^2$	$\frac{l}{R_0} = f(\beta)$	$R_0 = \frac{l}{f(\beta)}$	$K = f(R_0, n)$	$Q = K\sqrt{i}$	$\upsilon = \frac{Q}{\omega}$
7	Q, υ, β	[illegible], l	$\omega_{i=1} = f(\beta)$	$\omega = \frac{Q}{\upsilon}$	$l = \sqrt{\frac{\omega}{\omega_{i=1}}}$	$\frac{l}{R_0} = f(\beta)$	$R_0 = \frac{l}{f(\beta)}$	$K = f(R_0, n)$	$i = \frac{Q^2}{K^2}$
8	Q, υ, l	i, β	$\omega = \frac{Q}{\upsilon}$	$\omega_{i=1} = \frac{\omega}{l^2}$	$\beta = f(\omega_{i=1})$	$\frac{l}{R_0} = f(\beta)$	$R_0 = \frac{l}{f(\beta)}$	$K = f(R_0, n)$	$i = \left(\frac{Q}{K}\right)^2$
9	Q, l, β	i, υ	$\omega_{i=1} = f(\beta)$	$\omega = \omega_{i=1} l^2$	$\upsilon = \frac{Q}{\omega}$	$\frac{l}{R_0} = f(\beta)$	$R_0 = \frac{l}{f(\beta)}$	$K = f(R_0, n)$	$i = \left(\frac{Q}{K}\right)^2$
10	υ, l, β	Q, i	$\omega_{i=1} = f(\beta)$	$\omega = \omega_{i=1} l^2$	$Q = \upsilon\omega$	$\frac{l}{R_0} = f(\beta)$	$R_0 = \frac{l}{f(\beta)}$	$K = f(R_0, n)$	$i = \left(\frac{Q}{K}\right)^2$

UMUMLASHTIRILGAN GIDRAVLIK HISOBLASH USULINING ANIQ KO‘RINISHDAGI KESIMGA EGA BO‘LGAN KANALLAR UCHUN QO‘LLANILISHI

8. 10. TRAPETSIADAL KESIMLI KANALLARNING GIDRAVLIK HISOBI

Umumiy ifodalarni yozib olamiz:

8. 12-rasmdagi kesim uchun

$$B = b + 2mh = (\beta' + 2m)h = \beta h \qquad (8.\,98)$$

bunda $\beta' = \frac{b}{h}$; $\beta = \frac{B}{h} = \beta' + 2m$; $\beta' = \beta - 2m$

Sath bo‘yicha kengligi uchun

$$\omega = (b + mh)h = (\beta' + m)h^2 = (\beta - m)h^2 \qquad (8.\,99)$$

Harakatdagi kesim yuzasi $h = 1$, $b = 1$ yoki $B = 1$ holat uchun

$$\omega_{h=1} = (\beta' + m) = \beta - m; \omega_{b=1} = \frac{\beta' - m}{\beta'^2}; \omega_{B=1} = \frac{\beta - m}{\beta^2} \qquad (8.\,100)$$

Ho‘llangan perimetr

$$\chi = b + 2h\sqrt{1 + m^2} = (\beta' + m')h = (\beta + m' - 2m)h \qquad (8.\,101)$$

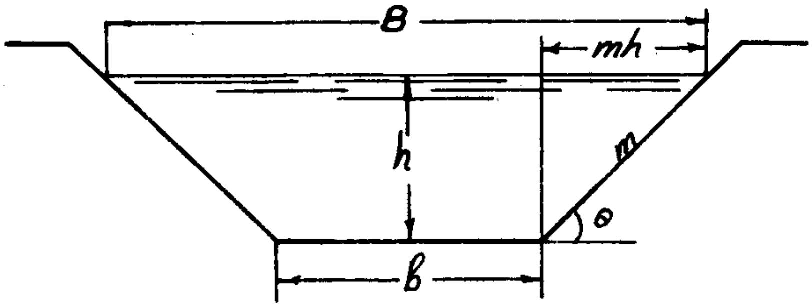
Gidravlik radius

$$R = \frac{(\beta' + m)}{\beta' + m'}h = \frac{(\beta - m)}{\beta + m' - 2m}h \qquad (8.\,102)$$

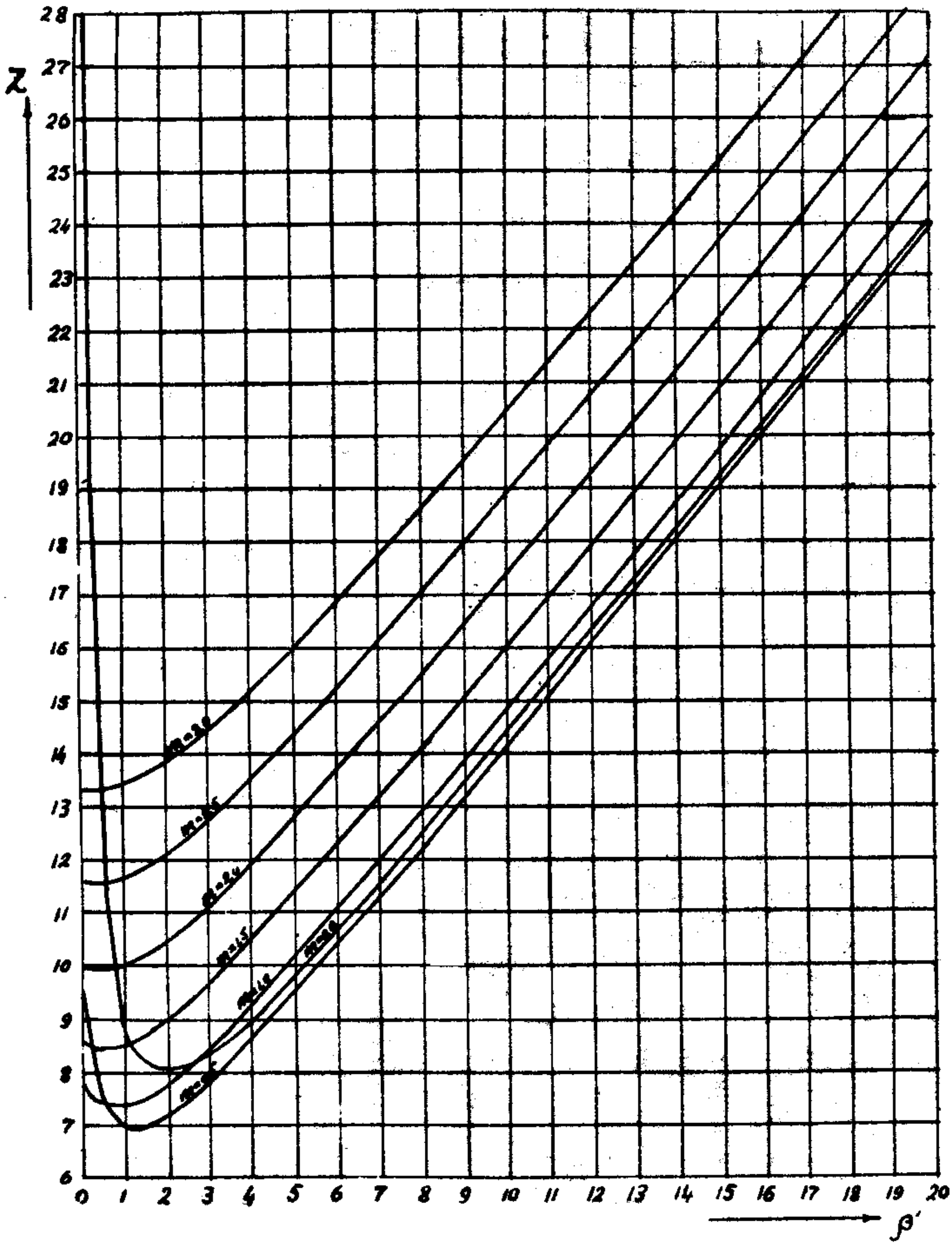
Solishtirma ho‘llangan perimetr

$$\bar{\chi} = \frac{(\beta' + m')^2}{\beta' + m} = \frac{(\beta + m' - 2m)^2}{\beta - m} \qquad (8.\,103)$$

$f = f(\beta', m)$ bog‘liqlik 8. 13-rasmda grafik ko‘rinishida va 8. 7-jadvalda ifodalangan. $\overline{\chi} = f(\beta, m)$ holat uchun esa 8. 8-jadva ltuzilgan.



8. 12-rasm. (8. 98÷ 8. 103) ifodalargadoir



8. 13-rasm. $\overline{\chi} = f(\beta', m)$ grafigi

(8. 96) formuladan $y=0{,}2$ va $y=\frac{1}{6}$ holatlar uchun o‘lchov birliksiz kattaliklarni keltiramiz: $y=0{,}2$ holat uchun

$$\frac{h}{R_0}=\sqrt{\frac{\overline{\chi}}{\omega_{h=1}}\left(\frac{2\pi}{\overline{\chi}}\right)^{\frac{1}{2,7}}}=f_1(\beta',m) \qquad (8.\ 104)$$

$y=\frac{1}{6}$ holat uchun

$$\frac{h}{R_0}=2\sqrt[8]{\frac{\overline{\chi}}{\omega_{h=1}^4}}=f_1(\beta',m) \qquad (8.\ 104')$$

$y=0{,}2$ holat uchun

$$\frac{b}{R_0}=\sqrt{\frac{\overline{\chi}}{\omega_{b=1}}\left(\frac{2\pi}{\overline{\chi}}\right)^{\frac{1}{2,7}}}=f_2(\beta',m) \qquad (8.\ 105)$$

$y=\frac{1}{6}$ holat uchun

$$\frac{b}{R_0}=2\sqrt[8]{\frac{\overline{\chi}}{\omega_{b=1}^4}}=f_2(\beta',m) \qquad (8.\ 105')$$

(8. 104′) va (8. 105′) formulalar asosida 8. 14-rasmdagi grafik tuzilgan.

(8. 104) va (8. 104) formulalar uchun 8. 9-jadval keltirilgan, bunda $y=0{,}2$ uchun $\frac{R}{R_0}=f(\overline{\chi})$, $\frac{\omega}{R_0^2}=f(\overline{\chi})$, $\frac{\chi}{R_0}=f(\overline{\chi})$, $\frac{\upsilon}{\upsilon_0}=f(\overline{\chi})$, $\frac{h}{R_0}=f(\overline{\chi})$, $\frac{b}{R_0}=f(\overline{\chi})$.

Gidravlik eng qulay trapetsiadal kesim

Bu kesim solishtirma ho‘llangan perimetrning eng kichik qiymatida mavjud bo‘ladi.

Demak,

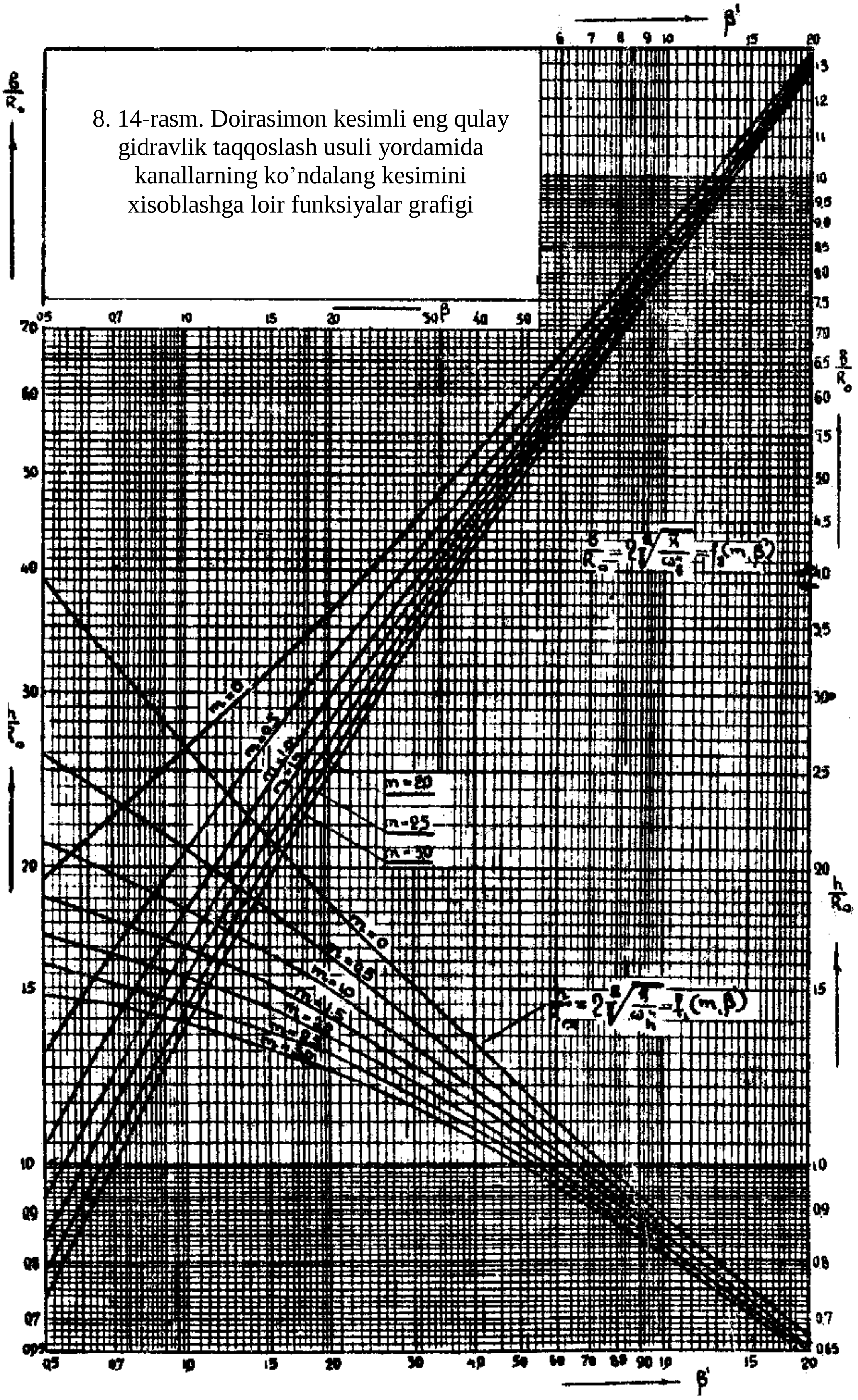
$$\frac{d\bar{\chi}}{d\beta'} = \frac{2(\beta' + m)(\beta' + m) - (\beta' + m')^2}{(\beta' + m)^2}$$

bundan

$$\beta'_{\min} = \beta'_{г.э.к} = m' - 2m \qquad (8.\ 106)$$

bunda

$$\bar{\chi}_{\min} = \bar{\chi}_{г.э.к} = 4(m' - m) \qquad (8.\ 107)$$



8. 14-rasm. Doirasimon kesimli eng qulay gidravlik taqqoslash usuli yordamida kanallarning ko’ndalang kesimini xisoblashga loir funksiyalar grafigi

Trapetsiadal kesimlar uchun $\overline{\chi} = f(\beta', m)$ funksiya qiymatlari

8. 7-jadval

$\beta' = \frac{b}{h}$	$\overline{\chi}$ - belgi						
	$m=0$	$m=0{,}5$	$m=1{,}0$	$m=1{,}5$	$m=2{,}0$	$m=2{,}5$	$m=3{,}0$
0	-	10,0	8,0	8,67	10,00	11,60	13,33
0,2	24,20	8,48	7,64	8,52	9,92	11,55	13,30
0,4	14,40	7,72	7,44	8,45	9,89	11,54	13,30
0,6	11,27	7,31	7,35	8,42	9,90	11,55	13,32
0,8	9,80	7,09	7,31	8,44	9,93	11,59	13,36
1,0	9,00	6,98	7,33	8,48	9,98	11,65	13,41
1,2	8,53	6,95	7,38	8,55	10,05	11,72	13,48
1,4	8,26	6,96	7,45	8,64	10,14	11,80	13,56
1,6	8,10	7,01	7,54	8,74	10,24	11,90	13,65
1,8	8,02	7,08	7,65	8,85	10,35	12,01	13,75
2,0	8,00	7,20	7,77	8,98	10,47	12,12	13,86
2,5	8,10	7,48	8,11	9,32	10,80	12,43	14,16
3,0	8,33	7,84	8,49	9,70	11,17	12,78	14,49
3,5	8,64	8,23	8,90	10,10	11,56	13,16	16,85
4,0	9,00	8,64	9,33	10,52	11,96	13,55	15,23
5,0	9,80	9,52	10,21	11,39	12,82	14,38	16,03
6,0	10,67	10,43	11,13	12,30	13,71	15,25	16,88
7,0	11,57	11,37	12,07	13,23	14,62	16,15	17,76
8,0	12,50	12,33	13,03	14,18	15,56	17,06	18,65
9,0	13,44	13,29	13,99	15,13	16,50	17,99	19,57
10,0	14,40	14,26	14,96	16,10	17,45	18,94	20,50
15,0	19,30	19,10	19,80	20,90	22,24	23,65	25,26
20,0	24,15	24,00	24,75	25,80	27,13	28,50	30,12

Trapetsiadal kesimlar uchun $\overline{\chi} = f(\beta, m)$ funksiya qiymatlari

8. 8-jadval

$\beta' = \frac{B}{h}$	$\overline{\chi}$ - belgi						
	$m=0$	$m=0{,}5$	$m=1{,}0$	$m=1{,}5$	$m=2{,}0$	$m=2{,}5$	$m=3{,}0$
2,0	8,00	6,98	-	-	-	-	-
2,5	8,10	6,99	7,39	-	-	-	-
3,0	8,33	7,20	7,33	8,67	-	-	-
3,5	8,64	7,48	7,50	8,43	-	-	-
4,0	9,00	7,84	7,77	8,48	10,00	-	-
5,0	9,80	8,64	8,49	8,98	9,98	11,60	-
6,0	10,67	9,52	9,33	9,70	10,47	11,65	13,33
7,0	11,57	10,43	10,21	10,52	11,17	12,12	13,41
8,0	12,50	11,37	11,13	11,39	11,96	12,78	13,86
9,0	13,44	12,33	12,07	12,30	12,82	13,55	14,49
10,0	14,40	13,29	13,03	13,23	13,71	14,38	15,23
11,0	15,36	14,26	13,99	14,18	14,62	15,25	16,03
12,0	16,33	15,24	14,96	15,13	15,56	16,15	16,88
13,0	17,31	16,22	15,95	16,10	16,50	17,06	17,76
14,0	18,29	17,20	16,93	17,08	17,45	17,99	18,65
15,0	19,27	18,20	17,91	18,05	18,39	18,94	19,57

Trapetsiadal kanallarning hisobiga doir

8. 9-jadval

$\overline{\chi}$	R/R_0	υ/υ_0	ω/R_0^2	χ/R_0	$m = 0{,}0$	$m = 0{,}5$

					h/R_0	b/R_0	h/R_0	b/R_0
1	2	3	4	5	6	7	8	9
6,94	0,964	0,974	6,450	6,690			1,924	2,382
7,00	0,961	0,972	6,462	6,725			1,764	2,781
7,10	0,956	0,969	6,486	6,786			1,665	3,063
7,20	0,951	0,965	6,509	6,846			1,600	3,268
7,30	0,946	0,962	6,532	6,905			1,550	3,439
731	0,945	0,961	6,536	6,913			-	-
7,40	0,941	0958	6,555	6,965			1,509	3,594
7,50	0,937	0,955	6,579	7,024			1,472	3,732
7,60	0,932	0,952	6,601	7,083			1,441	3,862
7,70	0,927	0,949	6,623	7,141			1,413	3,983
7,80	0,923	0,945	6,645	7,200			1,386	4,098
7,90	0,919	0,943	6,665	7,255			1,363	4,210
8,00	0,914	0,939	6,689	7,315	18,29	3,658	1,342	4,316
8,10	0,910	0,936	6,711	7,373	1,638	4,096	1,322	4,419
8,20	0,906	0,933	6,732	7,430	1,568	4,295	1,302	4,516
8,30	0,902	0,930	6,753	7,487	1,516	4,456	1,285	4,616
8,40	0,898	0,927	6,774	7,543	1,475	4,596	1,268	4,707
8,42	0,897	0,927	6,778	7,557	-	-	-	-
8,50	0,894	0,925	6,796	7,600	1,440	4,723	1,253	4,800
8,60	0,890	0,922	6,816	7,656	1,408	4,839	1,237	4,889
8,70	0,886	0,919	6,836	7,712	1,381	4,950	1,223	4,976
8,80	0,883	0,916	6,856	7,768	1,357	5,056	1,209	5,061
8,90	0,879	0,914	6,877	7,823	1,334	5,156	1,197	5,148
9,00	0,875	0,911	6,897	7,879	1,313	5,252	1,185	5,233
9,10	0,872	0,908	6,917	7,934	1,294	5,346	1,173	5,311

$\bar{\chi}$	R/R_0	υ/υ_0	ω/R_0^2	χ/R_0	$m = 0,0$		$m = 0,5$	
					h/R_0	b/R_0	h/R_0	b/R_0
1	2	3	4	5	6	7	8	9
9,20	0,868	0,906	6,936	7,978	1,276	5,439	1,162	5,393
9,30	0,865	0,903	6,956	8,043	1,259	5,526	1,150	5,468
9,40	0,861	0,901	6,975	8,097	1,243	5,611	1,141	5,550
9,50	0,858	0,898	6,994	8,151	1,228	5,694	1,130	5,625
9,60	0,855	0,896	7,012	8,206	1,210	5,791	1,120	5,698
9,70	0,851	0,894	7,032	8,259	1,198	5,845	1,111	5,777
9,80	0,848	0,891	7,051	8,312	1,185	5,953	1,102	5,849
9,89	0,845	0,889	7,067	8,363	-	-	-	-
9,90	0,845	0,889	7,069	8,366	1,175	6,013	1,093	5,921
10,00	0,842	0,886	7,088	8,419	1,164	6,092	1,084	5,994
10,20	0,836	0,882	7,124	8,524	1,142	6,243	1,068	6,136
10,40	0,830	0,878	7,160	8,630	1,121	6,388	1,053	6,277
10,60	0,824	0,873	7,196	8,734	1,102	6,532	1,038	6,411
10,80	0,818	0,869	7,230	8,837	1,084	6,667	1,024	6,547
11,00	0,813	0,865	7,265	8,939	1,068	6,805	1,012	6,682
11,20	0,807	0,861	7,299	9,042	1,053	6,941	0,999	6,806
11,40	0,802	0,857	7,332	9,143	1,038	7,070	0,987	6,933
11,54	0,798	0,854	7,355	9,216	-	-	-	-
11,60	0,797	0,853	7,366	9,246	1,024	7,021	0,975	7,060
11,80	0,792	0,849	7,398	9,343	1,010	7,324	0,954	7,184
12,00	0,787	0,846	7,430	9,443	0,998	7,448	0,955	7,310
12,20	0,782	0,842	7,463	9,542	0,986	7,568	0,944	7,427
12,40	0,777	0,838	7,494	9,640	0,974	7,689	0,936	7,554
12,60	0,773	0,835	0,725	9,737	0,964	7,812	0,926	7,670

$\bar{\chi}$	R/R_0	υ/υ_0	ω/R_0^2	χ/R_0	$m = 0{,}0$		$m = 0{,}5$	
					h/R_0	b/R_0	h/R_0	b/R_0
1	2	3	4	5	6	7	8	9
12,80	0,768	0,832	7,556	9,834	0,954	7,932	0,917	7,785
13,00	0,764	0,828	7,587	9,931	0,943	8,042	0,908	7,903
13,20	0,760	0,825	7,617	10,027	0,934	8,162	0,900	8,018
13,30	0,757	0,823	7,632	10,077	-	-	-	-
13,40	0,755	0,822	7,647	10,123	0,925	8,278	0,892	8,131
13,60	0,751	0,819	7,776	10,217	0,915	8,385	0,884	8,235
13,80	0,747	0,815	7,705	10,311	0,906	8,495	0,877	8,351
14,00	0,743	0,812	7,734	10,405	0,899	8,611	0,870	8,464
14,20	0,739	0,809	7,762	10,499	0,891	8,724	0,863	8,575
14,40	0,736	0,807	7,791	10,592	0,883	8,742	0,856	8,686
14,60	0,732	0,804	7,818	10,684	0,875	8,845	0,850	8,793
14,80	0,728	0,801	7,846	10,776	0,868	9,041	0,844	8,907
15,00	0,724	0,798	7,874	10,868	0,861	9,144	0,838	9,019
15,20	0,721	0,795	7,900	10,958	0,854	9,249	0,832	9,123
15,40	0,717	0,793	7,927	11,049	0,847	9,349	0,826	9,226
15,60	0,714	0,790	7,959	11,138	0,841	9,457	0,820	9,327
15,80	0,711	0,787	7,980	11,228	0,835	9,561	0,814	9,425
16,00	0,707	0,785	8,006	11,312	0,829	9,664	0,808	9,518
16,20	0,704	0,782	8,032	11,437	0,823	9,763	0,802	9,613
16,40	0,701	0,780	8,057	11,495	0,817	9,860	0797	9,715
16,60	0,697	0,777	8,083	11,583	0,811	9,954	0,792	9,816
16,80	0,696	0,775	8,108	11,671	0,806	10,059	0,787	9,915
17,00	0,692	0,772	8,133	11,758	0,801	10,160	0,782	10,005
17,20	0,689	0,770	8,158	11,847	0,796	10,260	0,777	10,105

$\bar{\chi}$	R/R_0	υ/υ_0	ω/R_0^2	χ/R_0	$m = 0{,}0$		$m = 0{,}5$	
					h/R_0	b/R_0	h/R_0	b/R_0
1	2	3	4	5	6	7	8	9
17,40	0,686	0,768	8,170	11,914	0,791	10,358	0,772	10,197
17,60	0,683	0,766	8,207	12,019	0,786	10,453	0,767	10,286
17,80	0,680	0,763	8,231	12,104	0,781	10,547	0,763	10,387
18,00	0,677	0,761	8,254	12,189	0,776	10,638	0,759	10,489
18,20	0,674	0,759	8,278	12,274	0,771	10,727	0,755	10,585
18,40	0,672	0,757	8,301	12,358	0,766	10,813	0,751	10,681
18,60	0,659	0,755	8,325	12,444	0,762	10,912	0,747	10,776
18,80	0,666	0,753	8,348	12,528	0,758	11,010	0,743	10,869
19,00	0,664	0,751	8,371	12,611	0,754	11,105	0,739	10,965
19,20	0,661	0,749	8,393	12,694	0,750	11,199	0,735	11,050
19,40	0,659	0,747	8,416	12,778	0,746	11,291	0,731	11,137
19,60	0,656	0,745	8,438	12,860	0,742	11,382	0,727	11,224
19,80	0,654	0,743	8,461	12,943	0,738	11,470	0,723	11,309
20,00	0,651	0,741	84,83	13,025	0,734	11,558	0,720	11,412
20,25	0,648	0,738	8,510	13,127	0,729	11,664	0,716	11,524
20,50	0,645	0,736	8,537	13,228	0,724	11,768	0,712	11,640
20,75	0,642	0,734	8,564	13,331	0,720	11,886	0,708	11,755
21,00	0,640	0,731	8,589	13,427	0,716	12,001	0,704	11,865
21,25	0,637	0,729	8,618	13,533	0,711	12,098	0,700	11,976
21,50	0,634	0,727	8,644	13,633	0,707	12,208	0,696	12,082
21,75	0,631	0,725	8,669	13,732	0,703	12,318	0,692	12,187
22,00	0,629	0,723	8,695	13,831	0,699	12,427	0,688	12,298
22,25	0,626	0,720	8,721	13,930	0,695	12,460	0,684	12,392
22,50	0,623	0,718	8,746	14,028	0,691	12,632	0,680	12,490

$\bar{\chi}$	R/R_0	υ/υ_0	ω/R_0^2	χ/R_0	$m = 0{,}0$		$m = 0{,}5$	
					h/R_0	b/R_0	h/R_0	b/R_0
1	2	3	4	5	6	7	8	9
22,75	0,621	0,716	8,771	14,127	0,686	12,733	0,677	12,606
23,00	0,618	0,714	8,796	14,224	0,684	12,850	0,674	12,720
23,25	0,616	0,712	8,821	14,321	0,680	12,968	0,670	12,834
23,50	0,614	0,710	8,845	14,417	0,676	12,042	0,667	12,924
23,75	0,611	0,708	8,870	14,514	0,673	13,154	0,664	13,034
24,00	0,609	0,706	8,893	14,610	0,670	13,269	0,661	13,130
24,25	0,606	0,705	8,917	14,705	0,666	13,354	0,658	13,227
24,50	0,605	0,703	8,941	14,801	0,663	13,461	0,654	13,330
24,75	0,602	0,701	8,964	14,895	0,660	13,567	0,651	13,433
25,00	0,600	0,699	8,988	14,990	0,657	13,609	0,648	13,539
25,50	0,595	0,695	9,034	15,178	0,651	13,879	0,643	13,745
26,00	0,591	0,692	9,071	15,364	0,645	14,078	0,637	13,948
26,50	0,587	0,689	9,125	15,550	0,639	14,263	0,632	14,144
27,00	0,583	0,685	9,169	15,734	0,634	14,471	0,626	14,332
27,50	0,579	0,682	9,213	15,917	0,628	14,649	0,621	14,528
28,00	0,575	0,679	9,256	16,099	0,623	14,825	0,616	14,721
28,50	0,571	0,676	9,299	16,279	0,618	15,038	0,611	14,910
29,00	0,568	0,673	9,341	16,458	0,614	15,239	0,606	15,161
29,50	0,564	0,970	9,382	16,636	0,608	15,401	0,602	15,294
30,00	0,560	0,667	9,423	16,813	0,604	15,600	0,598	15,484
30,50	0,557	0,664	9,464	16,989	0,599	15,784	0,593	15,671
31,00	0,554	0,661	9,504	17,164	0,595	15,970	0,589	15,855

8. 9-jadvalning davomi

$\bar{\chi}$	$m = 1{,}0$		$m = 1{,}5$		$m = 2{,}0$		$m = 2{,}5$		$m = 3{,}0$	
	h/R_0	b/R_0	h/R_0	b/R_0	h/R_0	b/R_0	h/R_0	b/R_0	h/R_0	b/R_0
1	10	11	12	13	14	15	16	17	18	19
6,94										
7,00										
7,10										
7,20										
7,30										
731	1,890	1,567								
7,40	1,678	2,225								
7,50	1,605	2,492								
7,60	1,552	2,705								
7,70	1,508	2,887								
7,80	1,470	3,048								
7,90	1,439	3,199								
8,00	1,409	3,337								
8,10	1,384	3,469								
8,20	1,360	3,593								
8,30	1,338	3,711								
8,40	1,317	3,825								
8,42	-	-	1,792	1,086						
8,50	1,298	3,934	1,632	1,715						
8,60	1,281	4,041	1,556	2,043						
8,70	1,264	4,143	1,504	2,289						
8,80	1,249	4,246	1,463	2,495						
8,90	1,234	4,343	1,428	2,677						
9,00	1,219	4,436	1,397	2,842						
9,10	1,207	4,531	1,370	2,995						
9,20	1,194	4,623	1,346	3,139						

$$\bar{\chi} = \frac{(\beta' + m')^2}{\beta' + m}$$

$\overline{\chi}$	$m=1{,}0$		$m=1{,}5$		$m=2{,}0$		$m=2{,}5$		$m=3{,}0$	
	h/R_0	b/R_0	h/R_0	b/R_0	h/R_0	b/R_0	h/R_0	b/R_0	h/R_0	b/R_0
1	10	11	12	13	14	15	16	17	18	19
9,30	1,181	4,711	1,323	3,273						
9,40	1,169	4,796	1,302	3,400						
9,50	1,158	4,885	1,284	3,523						
9,60	1,147	4,968	1,267	3,642						
9,70	1,137	5,052	1,249	3,753						
9,80	1,126	5,134	1,423	3,865						
9,89	-	-	-	-	1,691	0,996				
9,90	1,116	5,212	1,219	3,971	1,634	1,056				
10,00	1,107	5,291	1,206	4,075	1,523	1,608				
10,20	1,090	5,449	1,179	4,273	1,423	2,162				
10,40	1,073	5,601	1,156	4,464	1,366	2,509				
10,60	1,056	5,749	1,134	4,644	1,308	2,880				
10,80	1,042	5,895	1,114	4,820	1,268	3,167				
11,00	1,029	6,040	1,096	4,993	1,234	3,424				
11,20	1,015	6,175	1,078	5,055	1,203	3,662				
11,40	1,008	6,315	1,062	5,317	1,176	3,883				
11,54	-	-	-	-	-	-	1,595	0,613		
11,60	0,991	6,450	1,046	5,473	1,151	4,094	1,487	1,234		
11,80	0,979	6,581	1,032	5,624	1,129	4,293	1,379	1,917		
12,00	0,968	6,713	1,018	5,774	1,109	4,485	1,317	2,355		
12,20	0,957	6,842	1,005	5,918	1,090	4,670	1,269	2,707		
12,40	0,947	6,966	0,993	6,061	1,072	4,843	1,228	3,005		
12,60	0,937	7,088	0,981	6,200	1,056	5,016	1,210	3,318		
12,80	0,928	7,216	0,970	6,338	1,040	5,181	1,170	3,536		
13,00	0,919	7,338	0,959	6,473	1,026	5,343	1,144	3,768		
13,20	0,910	7,456	0,949	6,609	1,012	5,498	1,122	3,989		

$$\overline{\chi}=\frac{(\beta'+m')^2}{\beta'+m}$$

$\bar{\chi}$	$m=1,0$		$m=1,5$		$m=2,0$		$m=2,5$		$m=3,0$	
	h/R_0	b/R_0	h/R_0	b/R_0	h/R_0	b/R_0	h/R_0	b/R_0	h/R_0	b/R_0
1	10	11	12	13	14	15	16	17	18	19
13,30	-	-	-	-	-	-	-	-	1,514	0,492
13,40	0,902	7,577	0,939	6,671	0,997	5,669	1,101	4,194	1,390	1,333
13,60	0,894	7,696	0,929	6,867	0,987	5,805	1,082	4,493	1,308	1,947
13,80	0,886	7,813	0,921	6,998	0,975	5,948	1,064	4,582	1,255	2,374
14,00	0,879	7,927	0,911	7,119	0,964	6,093	1,048	4,767	1,215	2,723
14,20	0,871	8,040	0,903	7,243	0,954	6,238	1,032	4,942	1,182	3,030
14,40	0,864	8,148	0,894	7,364	0,943	6,372	1,018	5,113	1,153	3,305
14,60	0,857	8,262	0,887	7,488	0,933	6,508	1,004	5,278	1,127	3,556
14,80	0,850	8,375	0,880	7,610	0,924	6,644	0,991	5,437	1,105	3,791
15,00	0,844	8,486	0,872	7,697	0,915	6,776	0,979	5,995	1,084	4,012
15,20	0,838	8,597	0,865	7,845	0,906	6,904	0,968	5,754	1,067	4,229
15,40	0,832	8,706	0,858	7,960	0,898	7,035	0,957	5,905	1,051	4,436
15,60	0,826	8,813	0,851	8,072	0,890	7,162	0,946	6,049	1,035	4,628
15,80	0,820	8,917	0,844	8,180	0,882	7,285	0,936	6,192	1,019	4,809
16,00	0,814	9,021	0,838	8,298	0,874	7,407	0,926	6,333	1,003	4,978
16,20	0,808	9,118	0,832	8,402	0,867	7,529	0,917	6,473	0,991	51,57
16,40	0,803	9,225	0,826	8,519	0,860	7,650	0,908	6,608	0,979	5,328
16,60	0,798	9,330	0,820	8,626	0,853	7,767	0,899	6,740	0,967	5,490
16,80	0,793	9,435	0,814	8,731	0,846	7,881	0,891	6,874	0,955	5,644
17,00	0,778	9,533	0,809	8,840	0,809	8,005	0,883	7,006	0,944	5,795
17,20	0,783	9,635	0,803	8,493	0,834	8,119	0,875	7,129	0,934	5,951
17,40	0,778	9,731	0,798	9,052	0,828	8,234	0,868	7,259	0,924	6,098
17,60	0,773	9,927	0,793	9,159	0,822	8,346	0,861	73,86	0,915	6,246
17,80	0,769	9,932	0,788	9,263	0,816	8,455	0,854	7,508	0,906	6,388
18,00	0,765	10,030	0,783	9,362	0,811	8,568	0,847	7,630	0,897	6,523
18,20	0,760	10,125	0,778	9,464	0,805	8,675	0,840	7,744	0,889	6,665

$\overline{\chi}$	$m=1{,}0$		$m=1{,}5$		$m=2{,}0$		$m=2{,}5$		$m=3{,}0$	
	h/R_0	b/R_0	h/R_0	b/R_0	h/R_0	b/R_0	h/R_0	b/R_0	h/R_0	b/R_0
1	10	11	12	13	14	15	16	17	18	19
18,40	0,755	10,212	0,773	9,561	0,800	8,788	0,834	7,866	0,881	6,801
18,60	0,751	10,310	0,768	9,656	0,795	8,898	0,828	7,986	0,873	6,932
18,80	0,747	10,407	0,764	9,763	0,790	9,005	0,822	8,102	0,865	7,059
19,00	0,743	10,508	0,760	9,867	0,785	9,106	0,816	8,213	0,858	7,186
19,20	0,739	10,595	0,756	9,969	0,780	9,214	0,810	8,325	0,851	7,316
19,40	0,735	10,687	0,752	10,070	0,775	9,315	0,804	8,433	0,844	7,440
19,60	0,731	10,777	0,748	10,169	0,770	9,414	0,799	8,548	0,837	7,560
19,80	0,728	10,881	0,744	10,262	0,765	9,510	0,794	8,662	0,831	7,685
20,00	0,725	10,981	0,740	10,359	0,761	9,621	0,789	8,776	0,825	7,810
20,25	0,720	11,089	0,735	10,479	0,756	9,749	0,783	8,910	0,818	7,961
20,50	0,716	11,208	0,730	10,593	0,751	9,877	0,777	9,045	0,811	8,110
20,75	0,712	11,326	0,725	10,706	0,746	10,003	0,771	9,176	0,804	8,256
21,00	0,708	11,433	0,721	10,830	0,741	10,172	0,766	9,312	0,797	8,396
21,25	0,704	11,555	0,716	10,937	0,736	10,247	0,760	9,441	0,790	8,532
21,50	0,700	11,666	0,712	11,056	0,731	10,364	0,754	9,561	0,784	8,675
21,75	0,696	11,775	0,708	11,174	0,726	10,479	0,749	9,693	0,778	8,814
22,00	0,692	11,874	0,704	11,291	0,722	10,601	0,744	9,825	0,772	8,950
22,25	0,688	11,988	0,700	11,403	0,717	10,716	0,739	9,945	0,756	9,082
22,50	0,684	12,091	0,696	11,514	0,713	10,838	0,734	10,068	0,760	9,211
22,75	0,681	12,210	0,692	11,623	0,709	10,958	0,729	10,187	0,756	9,349
23,00	0,667	12,312	0,689	11,745	0,705	11,076	0,725	10,324	0,750	9,485
23,25	0,673	12,426	0,685	11,874	0,701	11,215	0,720	10,458	0,745	9,644
23,50	0,670	12,519	0,681	11,956	0,697	11,305	0,715	10,544	0,740	9,744
23,75	0,667	12,631	0,678	12,075	0,693	11,417	0,711	10,668	0,735	9,869
24,00	0,664	12,727	0,675	12,183	0,689	11,528	0,707	10,796	0,730	9,991
24,25	0,660	12,831	0,671	12,290	0,685	11,634	0,703	10,909	0,725	10,113

$\overline{\chi}$	$m=1{,}0$		$m=1{,}5$		$m=2{,}0$		$m=2{,}5$		$m=3{,}0$	
	h/R_0	b/R_0	h/R_0	b/R_0	h/R_0	b/R_0	h/R_0	b/R_0	h/R_0	b/R_0
1	10	11	12	13	14	15	16	17	18	19
24,50	0,657	12,938	0,667	12,385	0,681	11,739	0,699	11,026	0,720	10,230
24,75	0,654	13,044	0,664	12,497	0,673	11,860	0,695	11,141	0,716	10,359
25,00	0,651	13,152	0,661	12,604	0,675	11,971	0,692	11,269	0,712	10,490
25,50	0,645	13,359	0,655	12,820	0,668	12,192	0,684	11,493	0,704	10,731
26,00	0,639	13,558	0,649	13,032	0,661	12,407	0,677	11,712	0,696	10,964
26,50	0,634	13,759	0,643	13,234	0,655	12,624	0,670	11,938	0,688	11,201
27,00	0,628	13,953	0,637	13,437	0,649	12,868	0,663	12,156	0,681	11,431
27,50	0,623	14,150	0,632	13,637	0,643	13,049	0,657	12,378	0,674	11,666
28,00	0,618	14,351	0,626	13,840	0,638	13,254	0,651	12,595	0,668	11,874
28,50	0,613	14,545	0,621	14,035	0,632	13,460	0,645	12,808	0,661	12,110
29,00	0,608	14,734	0,616	14,234	0,627	13,658	0,639	13,015	0,654	12,321
29,50	0,604	14,935	0,611	14,438	0,622	13,863	0,634	13,228	0,648	12,537
30,00	0,600	15,129	0,607	14,637	0,617	14,062	0,628	13,436	0,642	12,748
30,50	0,594	15,316	0,602	14,823	0,612	14,261	0,623	13,636	0,636	12,963
31,00	0,591	15,498	0,597	15,009	0,6,7	14,453	0,618	13,838	0,631	13,172

$\overline{\beta}$, $\overline{\chi}_{г.э.к}$, $\frac{h_{г.э.к}}{R_0}$, $\frac{B_{г.э.к}}{R_0}$ va $\frac{b_{г.э.к}}{R_0}$ kattaliklarining miqdorlari quyidagi jadvalda keltirilgan:

8. 10-jadval

m	$\beta'_{г.э.к}$	$\beta_{г.э.к}$	$\overline{\chi}_{г.э.к}$	$\frac{h_{г.э.к}}{R_0}$	$\frac{b_{г.э.к}}{R_0}$	$\frac{B_{г.э.к}}{R_0}$
0,0	2,00	2,00	8,00	1,834	3,668	3,668
0,5	1,24	2,24	6,94	1,923	2,380	4,303
1,0	0,828	2,83	7,31	1,900	1,573	5,373

1,5	0,606	3,61	8,42	1,800	1,090	6,490
2,0	0,472	4,47	9,89	1,695	0,800	7,580
2,5	0,385	5,39	11,54	1,600	0,615	8,615
3,0	0,325	6,33	13,30	1,515	0,491	9,581

Umuman, $\overline{\chi} > \overline{\chi}_{г.э.к}$ uchun β' qiymat quyidagicha hisoblanadi:

$$\beta_1' = \frac{\overline{\chi} - 2m' \pm \sqrt{\chi[\overline{\chi} - 4(m' - m)]}}{2} \qquad (8.\ 108)$$

bunda $\overline{\chi} < \left(\frac{4m'}{m}\right)^2$ holat uchun chegaralanuvchi qiymatlar mavjud

$$0 < \beta' < \beta'_{г.э.к} \text{ va } \beta'_{г.э.к} < \beta_2' < \frac{2m'}{m}\beta'_{г.э.к}$$

$\overline{\chi} > \left(\frac{4m'}{m}\right)^2$ holat uchun

$$\beta' < \frac{2m'}{m}\beta'$$

Namunaviy masalalar.

1-masala. Kanaldagi b va h kattalikni berilgan Q = $25\,м^3/c$, i = 0,0007, $\beta' = 5{,}3$, m = 1,5,n= 0,025 qiymatlar uchun aniqlaymiz.

I. Jadval va grafik yordamida hisoblash.

a) $\overline{\chi}$ kattalikni (8. 103) formulaga asosan hisoblaymiz:

$$\overline{\chi} = \frac{(\beta' + m'^2)}{\beta' + m} = \frac{\left(5{,}3 + 2\sqrt{1 + 1{,}5^2}\right)^2}{5{,}3 + 1{,}5} = \frac{79{,}21}{6{,}8} = 11{,}65;$$

b) quyidagilarni hisoblaymiz:

$$0{,}159\frac{Qn}{\sqrt{i}} = 0{,}159\frac{25\cdot 0{,}025}{\sqrt{0{,}0007}} = 3{,}76\,;$$

c) qidirilayotgan kattaliklarni aniqlaymiz:

8. 13-rasmdagi grafikka asosan $h = 1{,}05R_0 = 1{,}05\cdot 1{,}62 = 1{,}70\,m;$

$b = 5{,}55R_0 = 5{,}55\cdot 1{,}62 = 9{,}0\,m;$

8. 9-jadvalga asosan $h = 1{,}043\cdot 1{,}63 = 1{,}70\,m;$

$b = 5{,}51\cdot 1{,}63 = 9{,}0\,m.$

II. Jadval va grafiklarsiz hisoblash.

a) R_0 kattalikni (8. 81′) formulaga asosan hisoblaymiz:

$$R_0 = 0{,}5\sqrt[8]{\left(\frac{Qn}{\sqrt{i}}\right)^3} = 0{,}5\sqrt[8]{\left(\frac{25\cdot 0{,}025}{\sqrt{0{,}0007}}\right)^3} = 1{,}62\,m;$$

b) (8. 103) formuladan foydalanib,

$$\omega_{h=1} = \beta' + m = 5{,}3 + 1{,}5 = 6{,}8\,m^2;$$

$$\omega_{b=1} = \frac{\beta' - m}{\beta'^2} = \frac{5{,}3 - 1{,}5}{5{,}3^2} = 0{,}135\,m^2;$$

c) Endi (8. 104′) formulaasosidao‘lchovbirliksizchuqurlikni (8. 105′) formulayordamidao‘lchovbirliksiztubbo‘yichakengliklarnianiqlaymiz:

$$\frac{h}{R_0}2\sqrt[8]{\frac{\overline{\chi}}{\omega_{h=1}^4}} = \frac{2}{\sqrt{6{,}8}}\sqrt[8]{11{,}65} = 1{,}05\,;$$

$$\frac{b}{R_0} = \frac{2}{\sqrt{\omega_{b=1}}}\sqrt[8]{\overline{\chi}} = \frac{2}{\sqrt{0{,}135}}\sqrt[8]{11{,}65} = 5{,}55\,;$$

yoki

$$\frac{b}{R_0} = \beta'\frac{h}{R_0} = 5{,}3\cdot 1.05 = 5{,}55\,;$$

d) qidirilayotgan kattaliklarni aniqlaymiz:

h = 1,05 m; $R_0 = 1{,}05\cdot 1{,}62 = 1{,}7\,m;$

$b = 5{,}55\ m;\quad R_0 = 5{,}55 \cdot 1{,}62 = 9{,}0\, m;$

2-masala. Trapetsiadal kesimli kanaldagi chuqurlikni $Q = 5\, м^3/c$, $i = 0{,}0004$, $b = 5{,}3\, m$, $m = 1{,}0$, $n = 0{,}0225$ qiymatlar uchun aniqlaymiz.

a) quyidagi kattaliklarni aniqlaymiz:

$$0{,}159\frac{Qn}{\sqrt{i}}\, 0{,}159\frac{5 \cdot 0{,}0225}{\sqrt{0{,}0004}} = 0{,}895$$

b) 8. 4-jadvaldan $0{,}159\frac{Qn}{\sqrt{i}} = 0{,}895$ kattalikka mos keluvchi $R_0 = 0{,}96\, m$ ni aniqlaymiz:

c) b va R_0 orasidagi munosabatni aniqlaymiz:

$$\frac{b}{R_0} = \frac{3{,}0}{0{,}96} = 3{,}13$$

d) 8. 9-jadvaldan $b/R_0 = 3{,}13$ va $m = 1{,}0$ ga mos keluvchi $h/R_0 = 1{,}46$ munosabatni aniqlaymiz.

e) qidirilayotgan kattalikni aniqlaymiz.

$$h = 1{,}46 R_0 = 1{,}46 \cdot 0{,}96 = 1{,}4\, m;$$

3-masala. $b = 5{,}0\, m$, $h = 1{,}5\, m$, $i = 0{,}0003$, $m = 1{,}5$, $n = 0{,}025$ kattaliklarga mos keluvchi Q sarfni aniqlash.

a) $\overline{\chi}$ kattalikni (8. 103) formulaga asosan aniqlaymiz:

$$\chi' = \frac{(\beta' + m')^2}{\beta + m} = \frac{(3{,}33 + 3{,}6)^2}{3{,}33 + 1{,}5} = \frac{48}{4{,}83} = 9{,}96$$

bunda

$$\beta_1 = \frac{b}{h} = \frac{5{,}0}{1{,}5} = 3{,}33$$

b) 8. 9-jadvaldan $m = 1{,}5$ ga mos keluvchi $\overline{\chi} = 9{,}96$, $h/R_0 = 1{,}212$ va $b/R_0 = 4{,}025$ kattaliklarni aniqlaymiz.

c) bundan R_0 kattalikni aniqlaymiz.

$$R_0 = \frac{h}{1{,}212} = \frac{1{,}5}{1{,}212} = 1{,}24\,m;$$

yoki

$$R_0 = \frac{b}{4{,}025} = \frac{5{,}0}{4{,}025} = 1{,}24\,m;$$

d) 8. 4-jadvaldan $R_0 = 1{,}24$ ga $0{,}159\frac{Qn}{\sqrt{i}} = 1{,}788$ mos keladi.

Demak,

$$Q = \frac{1788\sqrt{i}}{0{,}159} = 11{,}26\frac{\sqrt{0{,}0003}}{0{,}025} = 7{,}8\ м^3/c$$

8. 11. KO‘NDALANG KESIMI PARABOLA KO‘RINISHIDAGI O‘ZANNING GIDRAVLIK HISOBI

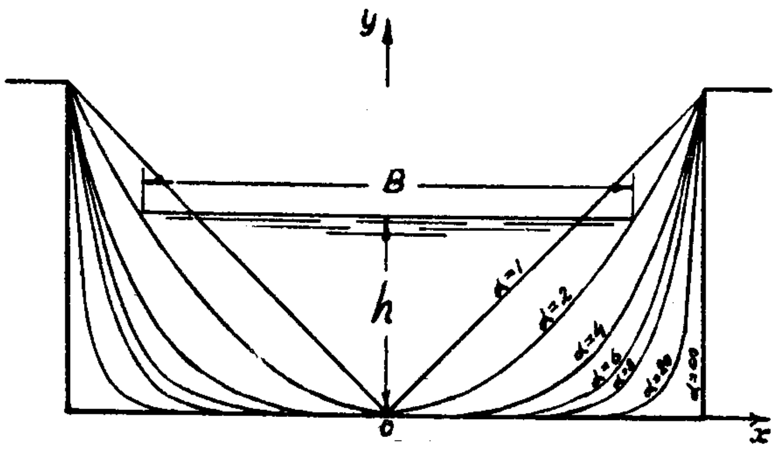
8. 15-rasmda parabola ko‘rinishidagi kesimning turli daraja ko‘rsatkichli turlari keltirilgan.

$$x^{\alpha} = ay \qquad (8.\ 109)$$

bunda $\sqrt[\alpha-1]{\frac{a}{2}} = P$, P – parabola perimetri.

Kvadrat parabola uchun

$$a = 2P$$



8. 15-rasm.

Bu tenglama orqali ifodalangan parabola $(\alpha = 1{,}0)$ ko‘rsatkichda uchburchak shaklidan $(\alpha = \infty)$ ko‘rsatkichda to‘rtburchak shakligacha o‘zgarishi mumkin. (8. 109) tenglama asosida tuzilgan parabola shaklidagi kesimlar uchun $y = h$, $2x = B$ va $\frac{B}{h} = \beta$ ga teng.

Sath bo‘yicha kenglik

$$\beta = 2\sqrt[\alpha]{ah} \qquad (8.\ 110)$$

Harakatdagi kesim yuzasi

$$\omega = \frac{\alpha}{\alpha + 1}\beta h^2 \qquad (8.\ 111)$$

$h = 1m,\ B = 1m,\ a = 1$ holatlar uchun

$$\omega_{h=1} = \frac{\alpha}{\alpha + 1}\beta;\ \omega_{B=1} = \frac{\alpha}{\alpha + 1}\frac{1}{\beta};\ \omega_{a=1} = \frac{\alpha}{\alpha + 1}\frac{4^{\frac{\alpha}{\alpha-1}}}{\beta^{\frac{\alpha+1}{\alpha-1}}} \qquad (8.\ 112)$$

Yon devor qiyalik koeffitsienti

$$m = ctg\theta = \frac{1}{2\alpha}\beta \qquad (8.\ 113)$$

Ho‘llangan perimetr

$$\chi = 2\int_0^{B/2} \sqrt{1+\frac{\alpha^2}{a^2} x^{2(\alpha-1)}}dx \qquad (8.\ 114)$$

Parabola shaklidagi kesimlarning gidravlik hisobidagi ho‘llangan perimetrni aniqlashda parabolaning egrilik balandligi – integral uzunligini faqat parabolaning ikkinchi darajasi uchungina hisoblash mumkin. Yuqori darajadagi parabolaning egrilik balandligini aniqlash, ya’ni ho‘llangan perimetr va uning hosilaviy birliklarini (solishtirma ho‘llangan perimetri, gidravlik radiusi) uchun taqribiy integrallash usullaridan foydalaniladi.

Uslub muallifi bu masalani amaliy nuqtai-nazardan qabul qilib, (8. 114) formulani Gaussning taqribiy usulidan foydalanib echishni taklif etgan.

Gauss formulasining ko‘rinishi quyidagicha:

$$\int_a^b f(x)dx = (b-a)[A_1 f(x_1) + A_2 f(x_2) + \ldots + A_n f(x_n)] \qquad (8.\ 115)$$

bunda $x_i = a + (b-a)x_i$

(8. 114) formulani Gauss formulasiga qo‘llash uchun qulay ko‘rinishga keltirilgan: $b = \frac{b}{2}$; $B = \sqrt{\frac{\alpha-1}{\alpha}\beta}\sqrt{\omega}$ uchun

$$\chi = \sqrt{\frac{\alpha+1}{\alpha}\beta}\sqrt{\omega}\sum_{i=1}^{i=n} A_i \sqrt{1+\frac{4\alpha^2}{\beta^2} x_i^{2(\alpha-1)}} \qquad (8.\ 116)$$

bunda A_i va x_i – $n = 8$ qiymat uchun Gauss formulasining 8 ta ordinatasining absissa va koeffitsientlari

$A_1 = A_8 = 0{,}05061427$ $\quad x_1 = 0{,}1985507$ $\quad x_5 = 0{,}59171732$

$A_2 = A_7 = 0{,}11119052$ $\quad x_2 = 0{,}10166676$ $\quad x_6 = 0{,}76276621$

$A_3 = A_6 = 0{,}15685332$ $\quad x_3 = 0{,}23723379$ $\quad x_7 = 0{,}89833324$

$A_4 = A_5 = 0{,}18134189$ $\quad x_4 = 0{,}40828268$ $\quad x_8 = 0{,}98014493$

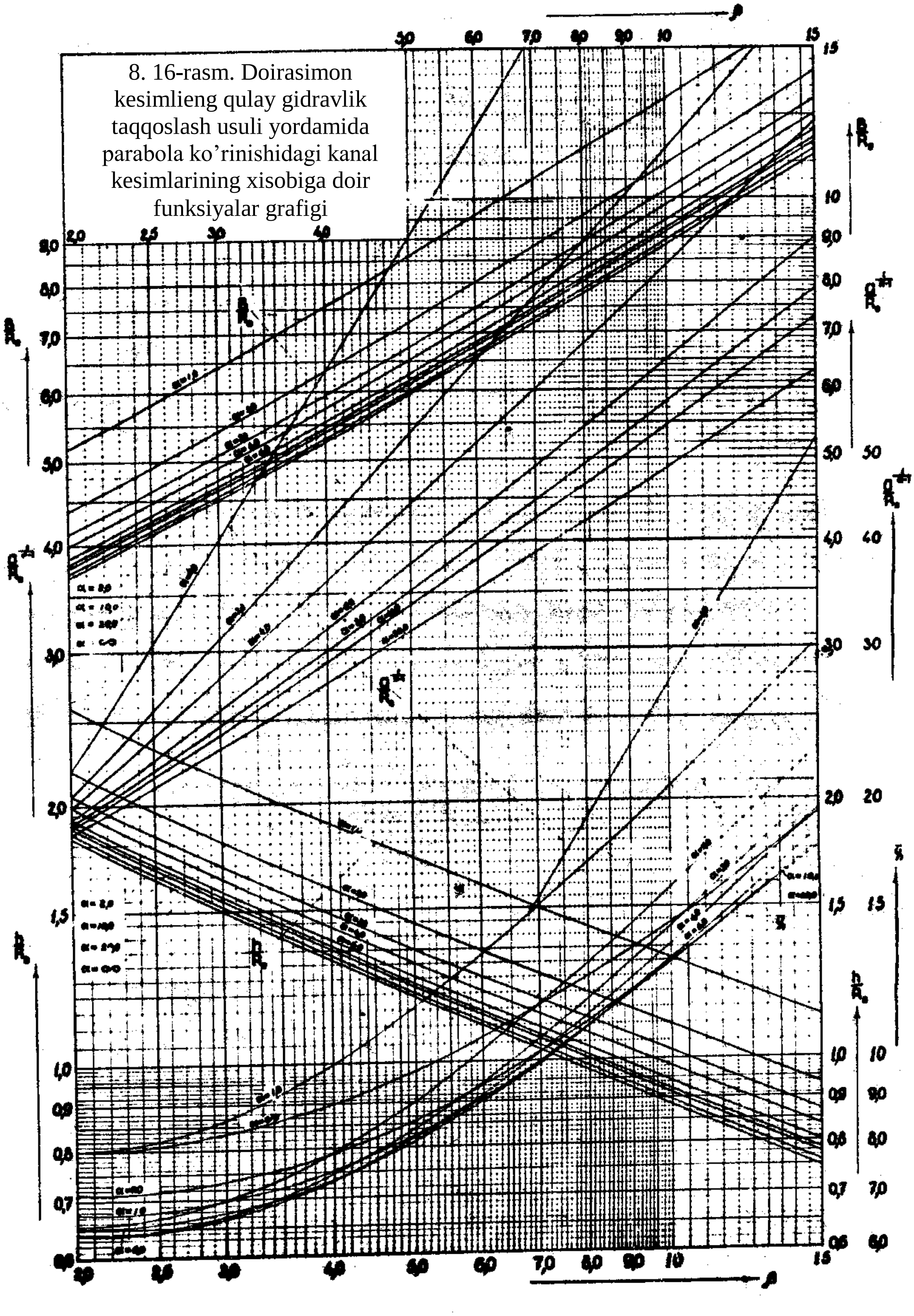
Ho‘llangan perimetr

$$\overline{\chi} = \frac{\alpha+1}{\alpha}\beta\left[\sum_{i=1}^{i=8} A_1\sqrt{1+\frac{4\alpha^2}{\beta^2}x_i^{2(\alpha-1)}}\right]^2 = f(\beta,\alpha) \qquad (8.\ 117)$$

(8. 96′ va 8. 112) formulalarga asosan o‘lchov birliksiz kattaliklar aniqlanadi:

$$\begin{cases} \dfrac{h}{R_0} = 2\sqrt[8]{\dfrac{\overline{\chi}}{\omega_{h=1}^4}} = f_1(\beta,\alpha) \\ \dfrac{B}{R_0} = 2\sqrt[8]{\dfrac{\overline{\chi}}{\omega_{B=1}^4}} = f_2(\beta,\alpha) \\ \dfrac{a^{\frac{1}{\alpha-1}}}{R_0} = 2\sqrt[8]{\dfrac{\overline{\chi}}{\omega_{\alpha=1}^4}} = f_3(\beta,\alpha) \end{cases} \qquad (8.\ 81)$$

Bu formulalar asosida O‘zbekiston Respublikasi Fanlar Akademiyasi V. N. Romanovskiy nomidagi matematika institute hisoblash markazida α va β kattaliklarning turli qiymatlari uchun $\overline{\chi}$; $\frac{h}{R_0}$; $\frac{B}{R_0}$; $\frac{a^{\frac{1}{\alpha-1}}}{R_0}$ funksiyalar hisoblanib, 8. 11-jadval uchun $\overline{\chi} = f(\beta,\alpha)$ va 8. 16-rasmdagi $\overline{\chi} = f(\beta,\alpha)$; $\frac{h}{R_0} = f_1(\beta,\alpha)$; $\frac{B}{R_0} = f_2(\beta,\alpha)$; $\frac{\alpha^{\frac{1}{\alpha-1}}}{R_0} = f_3(\beta,\alpha)$ funksiyalar uchun tuzilgan. Bu kattaliklar parabola shaklidagi kesimli kanallar uchun asosiy kattaliklardir.



8. 16-rasm. Doirasimon kesimlieng qulay gidravlik taqqoslash usuli yordamida parabola ko’rinishidagi kanal kesimlarining xisobiga doir funksiyalar grafigi

Parabola ko‘rinishidagi kanallarning hisobiga doir

8. 11-jadval

β	$\overline{\chi}$	$\frac{h}{R_0}$	$\frac{B}{R_0}$	β	$\overline{\chi}$	$\frac{h}{R_0}$	$\frac{B}{R_0}$
$\alpha = 1{,}0$							
2,00	8,000	2,594	5,187	8,00	17,00	1,425	11,40
2,20	8,036	2,474	5,444	8,20	17,38	1,411	11,57
2,40	8,133	2,373	5,694	8,40	17,75	1,398	11,74
2,60	8,277	2,285	5,940	8,60	18,13	1,385	11,92
2,80	8,457	2,207	6,181	8,80	18,51	1,373	12,08
3,00	8,667	2,139	6,417	9,00	18,89	1,361	12,25
3,20	8,900	2,078	6,650	9,20	19,27	1,350	12,42
3,40	9,153	2,023	6,878	9,40	19,65	1,339	12,58
3,60	9,422	1,973	7,103	9,60	20,03	1,328	12,75
3,80	9,705	1,928	7,325	9,80	20,42	1,317	12,91
4,00	10,000	1,886	7,544	10,00	20,80	1,307	13,07
4,20	10,30	1,847	7,559	10,20	21,18	1,297	13,23
4,40	10,62	1,812	7,971	10,40	21,57	1,288	13,39
4,60	10,94	1,778	8,181	10,60	21,95	12,78	13,55
4,80	11,27	1,747	8,388	10,80	22,34	1,269	13,71
5,00	11,00	1,718	8,592	11,00	22,73	1,260	13,86
5,20	11,60	1,700	8,794	11,20	23,11	1,251	14,02
5,40	12,28	1,665	8,993	11,40	23,50	1,243	14,17
5,60	12,63	1,641	9,190	11,60	23,89	1,235	14,32
6,00	12,98	1,618	9,585	12,00	24,88	1,222	14,63
6,20	13,69	1,575	9,768	12,20	25,05	1,211	14,78
6,40	14,05	1,556	9,956	12,40	25,45	1,204	14,93
6,60	14,41	1,537	10,14	12,60	25,83	1,196	15,07
6,80	14,78	1,519	10,33	12,80	26,23	1,189	15,22
7,00	15,14	1,501	10,51	13,00	26,62	1,182	15,37
7,20	15,51	1,485	10,69	13,20	27,01	1,175	15,52
7,40	15,88	1,469	10,87	13,60	27,40	1,169	15,65
7,60	16,25	1,454	11,05	13,60	27,79	1,162	15,81
7,80	16,63	1,439	11,23	13,80	28,18	1,156	15,95

β	$\overline{\chi}$	$\frac{h}{R_0}$	$\frac{B}{R_0}$	$\frac{a^{\frac{1}{\alpha-1}}}{R_0}$	β	$\overline{\chi}$	$\frac{h}{R_0}$	$\frac{B}{R_0}$	$\frac{a^{\frac{1}{\alpha-1}}}{R_0}$
$\alpha = 2,0$									
2,056	6,560	2,161	4,442	2,284	8,00	12,98	1,193	9,546	19,09
2,20	6,573	2,090	4,597	2,529	8,20	13,26	1,182	9,690	19,86
2,40	6,629	2,003	4,807	2,884	8,40	13,54	1,171	9,833	20,65
2,60	6,720	1,928	5,012	3,258	8,60	13,82	1,160	9,974	21,44
2,80	6,838	1,861	5,212	3,649	8,80	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
3,20	7,138	1,751	5,602	4,482	9,20	14,66	1,130	10,39	23,90
3,40	7,312	1,703	5,792	4,923	9,40	14,94	1,120	10,58	24,75
3,60	7,499	1,661	5,979	5,381	9,60	15,22	1,111	10,67	25,60
3,80	7,697	1,622	6,163	5,854	9,80	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
4,20	8,120	1,553	6,522	6,848	10,20	16,08	1,085	11,07	28,23
4,40	8,343	1,522	6,698	7,368	10,40	16,36	1,077	11,20	29,13
4,60	8,572	1,494	6,872	7,903	10,60	16,65	1,069	11,33	30,04
4,80	8,806	1,467	7,044	8,452	10,80	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
5,20	9,290	1,419	7,380	9,594	11,20	17,51	1,047	11,72	32,83
5,40	9,537	1,397	7,546	10,19	11,40	17,80	1,040	11,85	33,78
5,60	9,788	1,377	7,709	10,79	11,60	18,08	1,033	11,98	34,74
5,80	10,04	1,357	7,871	11,41	11,80	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
6,20	10,56	1,321	8,189	12,69	12,20	18,95	1,013	12,36	37,69
6,40	10,82	1,304	8,346	13,35	12,40	19,24	1,007	12,48	38,70
6,60	11,09	1,288	8,501	14,03	12,60	19,53	1,001	12,61	39,71
6,80	11,35	1,273	8,654	14,71	12,80	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
7,20	11,89	1,244	8,957	16,12	13,20	20,40	0,983	12,97	42,81
7,40	12,16	1,231	9,106	16,85	13,40	20,69	0,977	13,10	43,87
7,60	12,44	1,218	9,254	17,58	13,60	20,98	0,972	13,22	44,93
7,80	12,71	1,205	9,400	18,33	13,80	21,28	0,966	13,34	46,01

$\alpha = 3{,}0$									
2,112	6,381	2,003	4,231	2,174	8,00	11,82	1,112	8,894	8,894
2,20	6,385	1,963	4,319	2,265	8,20	12,06	1,101	9,027	9,140
2,40	6,422	1,881	4,514	2,472	8,40	12,30	1,090	9,160	9,386
2,60	6,489	1,809	4,704	2,682	8,60	12,54	1,080	9,291	9,633
2,80	6,581	1,747	4,891	2,893	8,80	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
3,20	6,823	1,641	5,252	3,322	9,20	13,28	1,052	9,678	10,38
3,40	6,965	1,596	5,428	3,538	9,40	13,52	1,043	9,805	10,63
3,60	7,120	1,556	5,600	3,757	9,60	13,77	1,034	9,931	10,87
3,80	7,285	1,518	5,770	3,977	9,80	14,02	1,026	10,06	11,13
4,00	7,458	1,484	5,938	4,198	10,00	14,27	1,018	10,18	11,38
4,20	7,639	1,453	6,102	4,422	10,20	14,52	1,010	10,30	11,64
4,40	7,827	1,424	6,265	4,646	10,40	14,77	1,003	10,43	11,89
4,60	8,020	1,397	6,425	4,872	10,60	15,02	0,995	10,55	12,14
4,80	8,219	1,372	6,584	5,100	10,80	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
5,20	8,630	1,326	6,894	5,559	11,20	15,77	0,974	10,91	12,91
5,40	8,841	1,305	7,047	5,790	11,40	16,02	0,967	11,03	13,17
5,60	9,056	1,285	7,198	6,022	11,60	16,28	0,961	11,15	13,42
5,80	9,274	1,267	7,347	6,256	11,80	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
6,20	9,718	1,232	7,641	6,727	12,20	17,04	0,942	11,50	14,20
6,40	9,944	1,216	7,785	6,964	12,40	17,29	0,937	11,61	14,46
6,60	10,17	1,201	7,929	7,202	12,60	17,55	0,931	11,73	14,72
6,80	10,40	1,187	8,070	7,441	12,80	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
7,20	10,87	1,160	8,350	7,921	13,20	18,31	0,914	12,07	15,50
7,40	11,10	1,147	8,488	8,163	13,40	18,57	0,909	12,18	15,76
7,60	11,34	1,135	8,624	8,406	13,60	18,83	0,904	12,29	16,03
7,80	11,58	1,123	8,760	8,650	13,80	19,08	0,899	12,40	16,29

$\alpha = 4{,}0$									
2,147	6,390	1,924	4,130	2,112	8,00	11,32	1,071	8,566	6,799
2,20	6,392	1,901	4,182	2,159	8,20	11,54	1,060	8,693	6,957
2,40	6,419	1,821	4,370	2,322	8,40	11,77	1,050	8,820	7,115
2,60	6,475	1,751	4,554	2,485	8,60	11,99	1,040	8,945	7,273
2,80	6,555	1,690	4,733	2,647	8,80	12,22	1,031	9,070	7,431
3,00	6,654	1,636	4,908	2,809	9,00	12,44	1,021	9,193	7,589
3,20	6,768	1,588	5,080	2,971	9,20	12,67	1,013	9,316	7,747
3,40	6,896	1,544	5,249	3,132	9,40	12,90	1,004	9,437	7,904
3,60	7,034	1,504	5,414	3,293	9,60	13,12	0,996	9,558	8,061
3,80	7,182	1,468	5,577	3,454	9,80	13,35	0,988	9,678	8,219
4,00	7,339	1,434	5,737	3,614	10,00	13,58	0,980	9,797	8,377
4,20	7,502	1,404	5,895	3,775	10,20	13,81	0,972	9,916	8,534
4,40	7,672	1,375	6,051	3,935	10,40	14,05	0,965	10,03	8,691
4,60	7,848	1,349	6,204	4,095	10,60	14,28	0,968	10,15	8,846
4,80	8,028	1,324	6,356	4,255	10,80	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
5,20	8,402	1,279	6,653	4,574	11,20	14,98	0,937	10,50	9,319
5,40	8,595	1,259	6,799	4,734	11,40	15,21	0,931	10,61	9,476
5,60	8,791	1,240	6,944	4,893	11,60	15,45	0,924	10,72	9,637
5,80	8,980	1,222	7,086	5,053	11,80	15,68	0,918	10,84	9,790
6,00	9,192	1,205	7,227	5,212	12,00	15,92	0,912	10,95	9,946
6,20	9,396	1,188	7,367	5,371	12,20	16,15	0,906	11,06	10,10
6,40	9,603	1,173	7,505	5,530	12,40	16,39	0,901	11,17	10,26
6,60	9,812	1,158	7,642	5,689	12,60	16,63	0,895	11,28	10,42
6,80	10,02	1,144	7,778	5,848	12,80	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
7,20	10,45	1,117	8,045	6,065	13,20	17,34	0,879	11,61	10,88
7,40	10,67	1,105	8,177	6,324	13,40	17,58	0,874	11,71	11,04
7,60	10,88	1,093	8,308	6,482	13,60	17,81	0,869	11,82	11,20
7,80	11,10	1,082	8,437	6,641	13,80	18,05	0,864	11,93	11,35

$\alpha = 5{,}0$									
2,165	6,446	1,881	4,072	2,078	8,00	11,08	1,046	8,371	5,919
2,20	6,446	1,865	4,102	2,100	8,20	11,29	1,036	8,494	6,044
2,40	6,469	1,786	4,286	2,243	8,40	11,51	1,026	8,617	6,168
2,60	6,520	1,718	4,466	2,384	8,60	11,72	1,016	8,739	6,292
2,80	6,593	1,657	4,641	2,524	8,80	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
3,20	6,791	1,556	4,980	2,800	9,20	12,36	0,989	9,099	6,663
3,40	6,910	1,513	5,144	2,937	9,40	12,58	0,981	9,218	6,786
3,60	7,040	1,474	5,305	3,073	9,60	12,79	0,972	9,335	6,909
3,80	7,178	1,438	5,464	3,208	9,80	1301	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
4,20	7,478	1,374	5,774	3,475	10,20	13,45	0,949	9,683	7,275
4,40	7,635	1,347	5,925	3,608	10,40	13,67	0,942	9,797	7,397
4,60	7,803	1,321	6,075	3,741	10,60	13,89	0,935	9,911	7,519
4,80	7,973	1,296	6,222	3,818	10,80	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
5,20	8,325	1,252	6,511	4,134	11,20	14,55	0,915	10,25	7,882
5,40	8,507	1,232	6,653	4,264	11,40	14,77	0,909	10,36	8,002
5,60	8,691	1,213	6,794	4,394	11,60	15,00	0,902	10,47	8,122
5,80	8,879	1,195	6,982	4,523	11,80	15,22	0,896	10,58	8,242
6,00	9,69	1,175	7,070	4,652	12,00	15,45	0,890	10,69	8,362
6,20	9,262	1,162	7,205	4,780	12,20	15,67	0,885	10,79	8,482
6,40	9,458	1,147	7,347	7,340	12,40	15,90	0,879	10,90	8,601
6,60	9,655	1,132	7,473	5,036	12,60	16,12	0,874	11,01	8,720
6,80	9,854	1,118	7,605	5,153	12,80	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
7,20	10,26	1,092	7,864	5,416	13,20	16,80	0,858	11,33	9,077
7,40	10,46	1,080	7,993	5,543	13,40	17,03	0,853	11,43	9,193
7,60	10,67	1,068	8,120	5,668	13,60	17,25	0,848	11,53	9,313
7,80	10,88	1,057	8,246	5,794	13,80	17,48	0,843	11,64	9,431

$\alpha = 6{,}0$									
2,176	6,513	1,851	4,027	2,048	8,00	10,97	1,030	8,242	5,438
2,20	6,513	1,841	4,050	2,064	8,20	11,17	1,020	8,364	5,545
2,40	6,533	1,763	4,232	2,194	8,40	11,37	1,010	8,484	5,652
2,60	6,581	1,696	4,408	2,323	8,60	11,55	1,000	8,604	5,759
2,80	6,651	1,636	4,581	2,450	8,80	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
3,20	6,839	1,536	4,914	2,699	9,20	12,19	0,974	8,957	6,077
3,40	6,953	1,493	5,076	2,822	9,40	12,40	0,965	9,073	6,182
3,60	7,077	1,454	5,250	2,944	9,60	12,61	0,957	9,188	6,285
3,80	7,211	1,419	5,391	3,065	9,80	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
4,20	7,498	1,355	5,695	3,303	10,20	13,24	0,934	9,529	6,600
4,40	7,652	1,328	5,844	3,421	10,40	13,45	0,927	9,641	6,703
4,60	7,810	1,302	5,991	3,538	10,60	13,67	0,920	9,752	6,806
4,80	7,973	1,278	6,135	3,656	10,80	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
5,20	8,311	1,234	6,419	3,885	11,20	14,31	0,900	10,08	7,115
5,40	8,486	1,214	6,558	4,000	11,40	14,52	0,894	10,19	7,217
5,60	8,664	1,196	6,696	4,113	11,60	14,74	0,888	10,30	7,319
5,80	8,844	1,178	6,832	4,227	11,80	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
6,20	9,212	1,145	7,100	4,451	12,20	15,39	0,870	10,62	7,623
6,40	9,400	1,130	7,232	4,563	12,40	15,60	0,865	10,72	7,723
6,60	9,560	1,115	7,362	4,674	12,60	15,82	0,859	10,83	7,824
6,80	9,781	1,102	7,491	4,784	12,80	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
7,20	10,17	1,076	7,746	5,004	13,20	16,48	0,844	11,14	8,124
7,40	10,37	1,064	7,842	5,113	13,40	16,69	0,839	11,24	8,224
7,60	10,56	1,052	7,996	5,222	13,60	16,91	0,834	11,35	8,323
7,80	10,76	1,041	8,120	5,330	13,80	17,13	0,829	11,45	8,422

$\alpha = 7{,}0$									
2,181	6,580	1,833	3,998	2,028	8,00	10,91	1,019	8,152	5,136
2,20	6,580	1,824	4,013	2,039	8,20	11,10	1,009	8,272	5,233
2,40	6,599	1,747	4,193	2,161	8,40	11,30	0,999	8,391	5,329
2,60	6,645	1,680	4,368	2,282	8,60	11,50	0,989	8,509	5,425
2,80	6,712	1,621	4,539	2,400	8,80	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
3,20	6,896	1,522	4,829	2,633	9,20	12,10	0,963	8,857	5,711
3,40	7,006	1,479	5,029	2,747	9,40	12,30	0,954	8,971	5,805
3,60	7,127	1,440	5,186	2,860	9,60	12,51	0,946	9,085	5,899
3,80	7,257	1,405	5,340	2,971	9,80	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
4,20	7,537	1,342	5,640	3,191	10,20	13,12	0,924	9,421	6,180
4,40	7,686	1,315	5,787	3,300	10,40	13,33	0,916	9,531	6,273
4,60	7,840	1,290	5,932	3,408	10,60	13,53	0,910	9,641	6,365
4,80	7,999	1,266	6,075	3,514	10,80	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
5,20	8,328	1,222	6,355	3,726	11,20	13,16	0,890	9,966	6,640
5,40	8,497	1,202	6,492	3,830	11,40	14,37	0,884	10,07	6,731
5,60	8,670	1,184	6,628	3,939	11,60	14,58	0,878	10,18	6,822
5,80	8,845	1,166	6,762	4,038	11,80	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
6,20	9,204	1,133	7,026	4,242	12,20	15,21	0,860	10,49	7,093
6,40	9,386	1,118	7,156	4,343	12,40	15,42	0,855	10,60	7,183
6,60	9,571	1,104	7,285	4,444	12,60	15,63	0,849	10,70	7,272
6,80	9,757	1,090	7,412	4,545	12,80	15,85	0,844	10,80	7,361
7,00	9,945	1,077	7,538	4,644	13,00	16,06	0,836	10,91	7,450
7,20	10,13	1,064	7,653	4,744	13,20	16,27	0,834	11,01	7,539
7,40	10,33	1,052	7,787	4,842	13,40	16,48	0,829	11,11	7,626
7,60	10,52	1,041	7,910	4,941	13,60	16,70	0,824	11,21	7,715
7,80	10,71	1,030	8,032	5,038	13,80	16,91	0,820	11,31	7,803

$\alpha = 8{,}0$									
2,183	6,643	1,819	3,971	2,010	8,00	10,89	1,011	8,086	4,929
2,20	6,643	1,812	3,987	2,021	8,20	11,08	1,001	8,205	5,019
2,40	6,661	1,736	4,165	2,138	8,40	11,27	0,991	8,322	5,108
2,60	6,706	1,669	4,339	2,252	8,60	11,47	0,981	8,439	5,197
2,80	6,772	1,610	4,508	2,365	8,80	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
3,20	6,953	1,511	4,836	2,586	9,20	12,06	0,955	8,783	5,461
3,40	7,061	1,469	5,994	2,694	9,40	12,25	0,946	8,896	5,549
3,60	7,180	1,430	5,150	2,800	9,60	12,45	0,938	9,008	5,635
3,80	7,307	1,395	5,302	2,906	9,80	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
4,20	7,582	1,333	5,600	3,113	10,20	13,05	0,916	9,341	5,894
4,40	7,729	1,306	5,746	3,215	10,40	13,26	0,909	9,450	5,980
4,60	7,880	1,280	5,889	3,317	10,60	13,46	0,902	9,558	6,066
4,80	8,035	1,256	6,030	3,417	10,80	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
5,20	8,358	1,213	6,308	3,615	11,20	14,07	0,882	9,880	6,318
5,40	8,524	1,193	6,444	3,713	11,40	14,27	0,876	9,986	6,402
5,60	8,693	1,175	6,578	3,810	11,60	14,48	0,870	10,09	6,486
5,80	8,865	1,157	6,711	3,907	11,80	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
6,20	9,217	1,125	6,972	4,098	12,20	15,10	0,853	10,40	6,735
6,40	9,395	1,110	7,101	4,192	12,40	15,31	0,847	10,51	6,817
6,60	9,576	1,095	7,228	4,286	12,60	15,51	0,842	10,61	6,899
6,80	9,758	1,081	7,354	4,380	12,80	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
7,20	10,13	1,056	7,603	4,565	13,20	16,14	0,827	10,91	7,144
7,40	10,32	1,044	7,725	4,656	13,40	16,35	0,822	11,01	7,225
7,60	10,50	1,032	7,847	4,748	13,60	16,56	0,817	11,11	7,306
7,80	10,69	1,021	7,967	4,838	13,80	15,77	0,812	11,21	7,386

$\alpha = 9{,}0$									
2,182	6,700	1,811	3,951	1,997	8,00	10,88	1,005	8,036	4,778
2,20	6,700	1,803	3,966	2,007	8,20	11,07	0,994	8,154	4,863
2,40	6,719	1,727	4,144	2,102	8,40	11,26	0,985	8,270	4,947
2,60	6,764	1,660	4,317	2,230	8,60	11,45	0,975	8,386	5,031
2,80	6,830	1,602	4,485	2,234	8,80	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
3,20	7,008	1,503	4,810	2,551	9,20	12,03	0,949	8,727	5,280
3,40	7,116	1,461	4,968	2,654	9,40	12,23	0,940	8,839	5,363
3,60	7,233	1,423	5,122	2,756	9,60	12,43	0,932	8,950	5,441
3,80	7,359	1,388	5,274	2,857	9,80	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
4,20	7,631	1,326	5,570	3,056	10,20	13,02	0,910	9,279	5,988
4,40	7,631	1,299	5,714	3,153	10,40	13,22	0,903	9,388	5,768
4,60	7,922	1,273	5,857	3,250	10,60	13,41	0,896	9,495	5,848
4,80	8,787	1,249	5,997	3,345	10,80	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
5,20	8,395	1,206	6,272	3,534	11,20	14,02	0,876	9,814	6,086
5,40	8,559	1,286	6,407	3,627	11,40	14,22	0,870	9,919	6,165
5,60	8,726	1,168	6,540	3,719	11,60	14,42	0,864	10,02	6,243
5,80	8,895	1,150	6,672	3,811	11,80	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
6,20	9,241	1,118	6,931	3,992	12,20	15,03	0,847	10,33	6,476
6,40	9,417	1,103	7,059	4,082	12,40	15,23	0,841	10,43	6,554
6,60	9,595	1,089	7,185	4,171	12,60	15,44	0,836	10,54	6,631
6,80	9,775	1,075	7,310	4,259	12,80	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
7,20	10,14	1,050	7,557	4,434	13,20	16,05	0,821	10,84	6,860
7,40	10,32	1,038	7,678	4,521	13,40	16,26	0,816	10,94	6,935
7,60	10,51	1,026	7,798	4,607	13,60	16,46	0,811	11,03	7,011
7,80	10,70	1,015	7,918	4,693	13,80	16,67	0,807	11,13	7,086

$\alpha = 10,0$									
2,177	6,754	1,805	3,930	1,986	8,00	10,89	0,996	7,997	4,664
2,20	6,754	1,796	3,950	1,996	8,20	11,08	0,989	8,113	4,745
2,40	6,773	1,720	4,127	2,106	8,40	11,27	0,980	8,229	4,826
2,60	6,819	1,654	4,800	2,213	8,60	11,46	0,970	8,344	4,906
2,80	6,884	1,595	4,467	2,319	8,80	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
3,20	7,062	1,497	4,791	2,524	9,20	12,03	0,944	8,683	5,144
3,40	7,169	1,455	4,948	2,624	9,40	12,22	0,936	8,794	5,222
3,60	7,285	1,417	5,101	2,723	9,60	12,42	0,928	8,904	5,299
3,80	7,410	1,382	5,252	2,820	9,80	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
4,20	7,679	1,321	5,546	3,012	10,20	13,00	0,905	9,231	5,532
4,40	7,822	1,293	5,690	2,106	10,40	13,20	0,898	9,339	5,608
4,60	7,970	1,268	5,832	3,199	10,60	13,39	0,891	9,446	5,684
4,80	8,121	1,244	5,971	3,290	10,80	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
5,20	8,436	1,201	6,244	3,472	11,20	13,99	0,872	9,762	5,911
5,40	8,598	1,181	6,379	3,561	11,40	14,18	0,865	9,866	5,986
5,60	8,763	1,163	6,511	3,650	11,60	14,38	0,859	9,970	6,060
5,80	8,930	1,145	6,642	3,738	11,80	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
6,20	9,272	1,113	6,899	3,912	12,20	14,99	0,842	10,28	6,282
6,40	9,446	1,098	7,026	3,998	12,40	15,19	0,837	10,38	6,355
6,60	9,621	1,084	7,152	4,083	12,60	15,39	0,832	10,48	6,428
6,80	9,799	1,070	7,276	4,168	12,80	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
7,20	10,16	1,045	7,520	4,335	13,20	16,00	0,816	10,78	6,646
7,40	10,34	1,033	7,641	4,418	13,40	16,20	0,812	10,88	6,718
7,60	10,52	1,021	7,761	4,501	13,60	16,40	0,807	10,97	6,789
7,80	10,71	1,010	7,879	4,583	13,80	16,61	0,802	11,07	6,861

$\alpha = 12{,}0$									
2,165	6,853	1,799	3,895	1,962	8,00	10,93	0,992	7,940	4,503
2,20	6,853	1,785	3,927	1,981	8,20	11,12	0,982	8,055	4,503
2,40	6,874	1,710	4,104	2,086	8,40	11,30	0,973	8,169	4,654
2,60	6,920	1,644	4,275	2,189	8,60	11,49	0,963	8,283	4,729
2,80	6,896	1,586	4,441	2,210	8,80	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
3,20	7,162	1,488	4,763	2,485	9,20	12,05	0,937	8,618	4,950
3,40	7,268	1,447	4,918	2,581	9,40	12,24	0,929	8,728	5,023
3,60	7,383	1,409	5,071	2,675	9,60	12,43	0,921	8,838	5,096
3,80	7,506	1,374	5,221	2,767	9,80	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
4,20	7,772	1,313	5,513	2,949	10,20	13,00	0,898	9,161	5,312
4,40	7,912	1,285	5,655	3,038	10,40	13,19	0,891	9,268	5,383
4,60	8,058	1,260	5,795	3,126	10,60	13,39	0,884	9,873	5,454
4,80	8,207	1,236	5,933	3,210	10,80	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
5,20	8,517	1,193	6,204	3,384	11,20	13,97	0,865	9,686	5,664
5,40	8,676	1,174	6,337	3,468	11,40	14,16	0,859	9,789	5,734
5,60	8,838	1,155	6,468	3,552	11,60	14,36	0,853	9,892	5,803
5,80	9,003	1,138	6,598	3,634	11,80	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
6,20	9,339	1,105	6,853	3,798	12,20	14,95	0,836	10,20	6,009
6,40	9,510	1,090	6,979	3,879	12,40	15,15	0,830	10,30	6,077
6,60	9,683	1,076	7,103	3,959	12,60	15,34	0,825	10,40	6,144
6,80	9,857	1,063	7,226	4,038	12,80	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
7,20	10,21	1,037	7,468	4,195	13,20	15,94	0,810	10,69	6,346
7,40	10,39	1,025	7,588	4,273	13,40	16,14	0,805	10,79	6,412
7,60	10,57	1,014	7,706	4,350	13,60	16,34	0,800	10,89	6,479
7,80	10,75	1,003	7,823	4,427	13,80	16,54	0,796	10,98	6,545

$\alpha = 14{,}0$									
2,164	6,942	1,793	3,880	1,952	8,00	10,98	0,988	7,900	4,395
2,20	6,943	1,778	3,912	1,970	8,20	11,16	0,977	8,015	4,467
2,40	6,964	1,703	4,088	2,073	8,40	11,35	0,968	8,128	4,539
2,60	7,009	1,638	4,258	2,172	8,60	11,53	0,958	8,241	4,610
2,80	7,075	1,580	4,424	2,270	8,80	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
3,20	7,250	1,482	4,744	2,459	9,20	12,08	0,932	8,574	4,821
3,40	7,355	1,441	4,899	2,551	9,40	12,27	0,924	8,683	4,890
3,60	7,469	1,403	5,050	2,642	9,60	12,46	0,916	8,792	4,987
3,80	7,590	1,368	5,199	2,731	9,80	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
4,20	7,853	1,307	5,489	2,906	10,20	13,02	0,893	9,113	5,165
4,40	7,992	1,280	5,631	2,991	10,40	13,21	0,886	9,218	5,232
4,60	8,136	1,254	5,770	3,076	10,60	13,40	0,880	9,323	5,300
4,80	8,284	1,231	5,908	3,158	10,80	13,60	0,873	9,428	5,367
5,00	8,436	1,209	6,043	3,248	11,00	13,79	0,866	9,531	5,433
5,20	8,591	1,188	6,177	3,324	11,20	13,98	0,860	9,860	5,500
5,40	8,749	1,168	6,309	3,405	11,40	14,17	0,854	9,736	5,566
5,60	8,909	1,150	6,439	3,485	11,60	14,36	0,848	9,838	5,631
5,80	9,072	1,132	6,568	3,564	11,80	14,56	0,842	9,939	5,697
6,00	9,237	1,116	6,695	3,643	12,00	14,75	0,837	10,04	5,762
6,20	9,404	1,100	6,821	3,721	12,20	14,95	0,831	10,14	5,826
6,40	9,574	1,085	6,946	3,798	12,40	15,14	0,826	10,24	5,891
6,60	9,745	1,071	7,069	3,865	12,60	15,34	0,820	10,34	5,955
6,80	9,917	1,058	7,191	3,951	12,80	15,53	0,815	10,44	6,019
7,00	10,09	1,045	7,312	4,026	13,00	15,73	0,810	10,53	6,082
7,20	10,27	1,032	7,432	4,101	13,20	15,93	0,805	10,63	6,146
7,40	10,44	1,020	7,551	4,175	13,40	16,12	0,801	10,73	6,209
7,60	10,62	1,009	7,668	4,249	13,60	16,32	0,796	10,82	6,272
7,80	10,80	0,998	7,785	4,322	13,80	16,52	0,791	10,92	6,334

$\alpha = 16{,}0$									
2,163	7,014	1,787	3,866	1,943	8,00	11,03	0,984	7,872	4,317
2,20	7,018	1,773	3,901	1,963	8,20	11,21	0,974	7,986	4,387
2,40	7,038	1,698	4,076	2,063	8,40	11,39	0,964	8,099	4,456
2,60	7,083	1,633	4,246	2,160	8,60	11,57	0,955	8,211	4,525
2,80	7,148	1,575	4,411	2,256	8,80	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
3,20	7,321	1,478	4,730	2,440	9,20	12,13	0,928	8,542	4,728
3,40	7,425	1,436	4,884	2,530	9,40	12,31	0,920	8,651	4,795
3,60	7,539	1,399	5,035	2,618	9,60	12,50	0,912	8,759	4,862
3,80	7,660	1,364	5,183	2,705	9,80	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
4,20	7,921	1,303	5,472	2,875	10,20	13,06	0,890	9,078	5,060
4,40	8,059	1,276	5,613	2,958	10,40	13,25	0,883	9,183	5,125
4,60	8,203	1,250	5,752	3,040	10,60	13,44	0,876	9,287	5,190
4,80	8,350	1,227	5,889	3,125	10,80	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
5,20	8,655	1,184	6,157	3,281	11,20	14,01	0,857	9,596	5,382
5,40	8,812	1,164	6,288	3,359	11,40	14,20	0,851	9,698	5,445
5,60	8,971	1,146	6,418	3,437	11,60	14,39	0,845	9,799	5,509
5,80	9,133	1,129	6,546	3,514	11,80	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
6,20	9,464	1,096	6,798	3,665	12,20	14,97	0,828	10,10	5,696
6,40	9,632	1,082	6,922	3,740	12,40	15,16	0,822	10,20	5,758
6,60	9,802	1,067	7,045	3,814	12,60	15,35	0,817	10,30	5,820
6,80	9,974	1,054	7,166	3,888	12,80	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
7,20	10,32	1,029	7,406	4,033	13,20	15,93	0,802	10,59	6,003
7,40	10,50	1,017	7,524	4,105	13,40	16,13	0,707	10,68	6,064
7,60	10,67	1,005	7,641	4,176	13,60	16,32	0,793	10,78	6,124
7,80	10,85	0,994	7,757	4,247	13,80	16,52	0,788	10,87	6,184

$\alpha = 18{,}0$									
2,163	7,072	1,784	3,859	1,938	8,00	11,08	0,981	7,850	4,259
2,20	7,077	1,769	3,892	1,957	8,20	11,26	0,971	7,964	4,327
2,40	7,097	1,695	4,067	2,055	8,40	11,44	0,961	8,076	4,394
2,60	7,141	1,629	4,236	2,151	8,60	11,62	0,952	8,188	4,461
2,80	7,205	1,572	4,401	2,245	8,80	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
3,20	7,378	1,475	4,719	2,426	9,20	12,17	0,926	8,518	4,659
3,40	7,482	1,433	4,873	2,514	9,40	12,36	0,918	8,626	4,724
3,60	7,595	1,395	5,023	2,600	9,60	12,54	0,910	8,734	4,787
3,80	7,716	1,361	5,171	2,685	9,80	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
4,20	7,977	1,300	5,459	2,851	10,20	13,10	0,887	9,052	4,981
4,40	8,115	1,273	5,600	2,933	10,40	13,29	0,880	9,156	5,044
4,60	8,258	1,247	5,738	3,013	10,60	13,48	0,874	9,260	5,107
4,80	8,405	1,224	5,874	3,091	10,80	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
5,20	8,710	1,181	6,141	3,248	11,20	14,04	0,854	9,568	5,294
5,40	8,867	1,162	6,272	3,325	11,40	14,23	0,848	9,669	5,356
5,60	9,026	1,143	6,402	3,401	11,60	14,42	0,842	9,770	5,417
5,80	9,188	1,126	6,530	3,476	11,80	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
6,20	9,518	1,094	6,781	3,624	12,20	15,00	0,825	10,07	5,599
6,40	9,686	1,079	6,904	3,697	12,40	15,19	0,820	10,17	5,659
6,60	9,855	1,065	7,027	3,769	12,60	15,38	0,815	10,26	5,719
6,80	10,03	1,051	7,148	3,841	12,80	15,57	0,809	16,36	5,778
7,00	10,20	1,038	7,268	3,912	13,00	15,77	0,804	10,46	5,838
7,20	10,37	1,026	7,386	3,982	13,20	15,96	0,800	10,55	5,897
7,40	10,55	1,014	7,504	4,052	13,40	16,15	0,795	10,65	5,955
7,60	10,72	1,003	7,620	4,121	13,60	16,35	0,790	10,75	6,014
7,80	10,90	0,992	7,736	4,190	13,80	16,54	0,786	10,84	6,072

$\alpha = 20{,}0$									
2,162	7,128	1,781	3,851	1,934	8,00	11,13	0,979	7,834	4,214
2,20	7,122	1,766	3,885	1,952	8,20	11,31	0,969	7,947	4,280
2,40	7,142	1,691	4,059	2,049	8,40	11,49	0,959	8,059	4,346
2,60	7,186	1,626	4,228	2,144	8,60	11,67	0,950	8,171	4,411
2,80	7,250	1,569	4,393	2,236	8,80	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
3,20	7,424	1,472	4,710	2,414	9,20	12,22	0,924	8,500	4,605
3,40	7,528	1,430	4,863	2,501	9,40	12,40	0,916	8,608	4,669
3,60	7,641	1,393	5,014	2,586	9,60	12,59	0,908	8,715	4,732
3,80	7,762	1,358	5,161	2,669	9,80	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
4,20	8,024	1,297	5,449	2,833	10,20	13,14	0,885	9,032	4,920
4,40	8,163	1,270	5,589	2,913	10,40	13,33	0,878	9,136	4,982
4,60	8,307	1,245	5,727	2,992	10,60	13,52	0,872	9,239	5,044
4,80	8,454	1,221	5,863	3,069	10,80	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
5,20	8,759	1,179	6,130	3,223	11,20	14,08	0,852	9,546	5,226
5,40	8,916	1,159	6,260	3,298	11,40	14,27	0,846	9,647	5,286
5,60	9,076	1,141	6,389	3,373	11,60	14,46	0,840	9,747	5,346
5,80	9,238	1,124	6,517	3,446	11,80	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
6,20	9,569	1,092	6,767	3,591	12,20	15,03	0,823	10,04	5,524
6,40	9,737	1,077	6,891	3,663	12,40	15,22	0,818	10,14	5,582
6,60	9,906	1,063	7,013	3,737	12,60	15,42	0,813	10,24	5,641
6,80	10,08	1,049	7,133	3,804	12,80	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
7,20	10,42	1,024	7,371	3,943	13,20	15,99	0,798	10,53	5,814
7,40	10,60	1,012	7,489	4,011	13,40	16,18	0,793	10,62	5,872
7,60	10,78	1,001	7,605	4,079	13,60	16,38	0,788	10,72	5,929
7,80	10,95	0,990	7,720	4,147	13,80	16,57	0,784	10,81	5,985

VIII bobga doir test-nazorat savollari

1. Kanaldagi naporsiz,barqaror tekis harakat qanday xususiyatlari bilan ajralib turadi?

a) Oqimning barqaror tekis naporsiz harakatida $p = p_a, h = const$, $Q = const$, $\upsilon = const$ (oqim bo‘ylab) shartlar bajariladi;

b) Oqimning tekis barqaror harakatida $p = p_a, h = const$, $Q = const$, $\upsilon = const$ shartlar bajarilmaydi;

c) Oqimning barqaror tekis naporsiz harakatida $h = 0$, $Q = const$, $\upsilon = const$ (oqim bo‘ylab) shartlar bajariladi;

d) Oqimning barqaror tekis naporsiz harakatida $p = p_a, h = const$, $Q \neq const$, $\upsilon = const$ (oqim bo‘ylab) shartlar bajariladi;

2. Kanalning eng qulay gidravlik kesimi deb nimaga aytiladi?

a) Kanaldagi oqimning eng katta harakatdagi kesimga va eng kichiktezligiga ega bo‘lishi;

b) Kanaldagi oqimning eng katta harakatdagi kesim va eng kattao‘rtacha tezligi mavjud bo‘lishi;

c) Kanaldagi oqimning eng kichik harakatdagi kesimga va eng katta o‘rtacha tezlikka ega bo‘lgan holati $\upsilon = \upsilon_{макс}; \omega = \omega_{мин}$;

d) Kanaldagi oqimning eng kichik harakatdagi kesimga va eng kichik o‘rtacha tezlikka ega bo‘lgan holati.

3. Tekisnaporsiz barqaror harakatning hisoblash formulasini ko‘rsating.

a) $Q = \omega C\sqrt{Ri}$;

b) $C=\sqrt{\frac{8g}{\lambda}}$;

c) $\upsilon=C\sqrt{Ri}$;

d) $Q=\omega\upsilon=const$.

4. Shezi koeffitsientining fizik mohiyatini ko‘rsatuvchi ifodani ko‘rsating.

a) $Q=\omega C\sqrt{Ri}$;

b) $C=\sqrt{\frac{8g}{\lambda}}$;

c) $\upsilon=C\sqrt{Ri}$;

d) $Q=\omega\upsilon=const$.

5. Shezi koeffitsientini hisoblashda kanalning parametri bo‘yicha bir jinsli bo‘lmagan g‘adir-budirligi hisobga olinadimi? Nima uchun?

a) Yo‘q;

b) Ha,chunki gidravlik qarshilik o‘zan g‘adir-budirligiga bog‘liq;

c) Yo‘q,chunki u tezlikka bog‘liq;

d) Ha,chunki u gidravlik qarshilikka bog‘liq emas.

6. Oqimning uzluksizlik tenglamasini ko‘rsating.

a) $Q=\omega C\sqrt{Ri}$;

b) $C=\sqrt{\frac{8g}{\lambda}}$;

c) $\upsilon=C\sqrt{Ri}$;

d) $Q=\omega\upsilon=const$.

7. Sarf va tezlik modullari qanday aniqlanadi?

a) $Q=\omega C\sqrt{Ri}$; $\upsilon=C\sqrt{Ri}$;

b) $K=\omega C\sqrt{R}$; $W=C\sqrt{R}$

c) $C=\sqrt{\frac{8g}{\lambda}}$; $Q=\omega\upsilon$;

d) $\upsilon=C\sqrt{Ri}$; $Q=\frac{W}{t}$.

8. Kanallarni loyhalashtirish uchun kerak bo‘ladigan asosiy elementlarni sanang.

a) $Q,\omega,\chi,m,n,i.$

b) $Q,b,h,m,n,i.$

c) $Q,b,h,\omega,n,i.$

d) $Q,b,h,\omega,\chi,i.$

9. Ko‘ndalang kesimi to‘g‘ri to‘rtburchak shakldagi kanal uchun suv oqimining harakatdagi kesimi va ho‘llangan perimetrini aniqlash formulalarini ko‘rsating.

a) $\omega=bh$; $\chi=b+2h$;

b) $\omega=(b+mh)h$; $\chi=b+2h\sqrt{1+m^2}$;

c) $\omega=bh$; $\chi=b+2h\sqrt{1+m^2}$;

d) $\omega=(b+mh)h$; $\chi=b+2h$;

10. Ko‘ndalang kesimi trapetsiyashakldagi kanal uchun suv oqimining harakatdagi kesimi va ho‘llangan perimetrini aniqlash formulalarini ko‘rsating.

a) $\omega=bh$; $\chi=b+2h$;

b) $\omega=(b+mh)h$; $\chi=b+2h\sqrt{1+m^2}$

c) $\omega = bh$; $\chi = b + 2h\sqrt{1+m^2}$;

d) $\omega = (b + mh)h$; $\chi = b + 2h$;

11. Ko‘ndalang kesimitrapetsiya shaklidagi kanal uchun suv oqimining harakatdagi kesimi va ho‘llangan perimetrini nisbiy kenglikka nisbatan aniqlash formulalarini ko‘rsating.

a) $\omega = h^2(\beta + m)$; $\chi = h\left(\beta + 2\sqrt{1+m^2}\right)$;

b) $\omega = h^2\beta$; $\chi = h\left(\beta + 2\sqrt{1+m^2}\right)$;

c) $\omega = h^2(\beta + m)$; $\chi = \left(\beta + 2\sqrt{1+m^2}\right)$;

d) $\omega = \beta h^2$; $\chi = h(\beta + 2)$.

12. Ko‘ndalang kesimi to‘g‘ri to‘rtburchak shaklidagi kanal uchun suv oqimining harakatdagi kesimi va ho‘llangan perimetrini nisbiy kenglikka nisbatan aniqlash formulalarini ko‘rsating.

a) $\omega = h^2(\beta + m)$; $\chi = h\left(\beta + 2\sqrt{1+m^2}\right)$;

b) $\omega = h^2\beta$; $\chi = h\left(\beta + 2\sqrt{1+m^2}\right)$;

c) $\omega = h^2(\beta + m)$; $\chi = \left(\beta + 2\sqrt{1+m^2}\right)$;

d) $\omega = \beta h^2$; $\chi = h(\beta + 2)$.

13. Ko‘ndalang kesimi uchburchakshakldagi kanal uchun suv oqimining harakatdagi kesimi va ho‘llangan perimetrini aniqlash formulalarini ko‘rsating.

a) $\omega = bh$; $\chi = b + 2h$;

b) $\omega = (b + mh)h$; $\chi = b + 2h\sqrt{1+m^2}$;

c) $\omega = bh$; $\chi = b + 2h\sqrt{1+m^2}$;

d) $\omega = (b + mh)h$; $\chi = b + 2h$;

14. Ko‘ndalang kesimi to‘g‘ri to‘rtburchak,trapetsiya vauchburchakshakllaridagikanallar uchun suv oqimining harakatdagi kesimi sath kengligini aniqlash formulalarini ko‘rsating.

a) $B = b + 2mh$, $B = b$, $B = 2mh$;

b) $B = b + 2m^2h$, $B = b$, $B = 2mh$;

c) $B = b + 2mh$, $B = bm^2$, $B = 2mh$;

d) $B = b + 2mh$, $B = bm^2$, $B = bmh$;

15. Ochiq o‘zanlarda oqimningbarqaror harakati differensial tenglamasining umumiy ko‘rinishini qo‘rsating?

a) $$\frac{dh}{ds} = \frac{i - \frac{Q^2}{\omega^2 C^2 R}\left(1 - \frac{\alpha C^2 R}{g\omega}\frac{\partial\omega}{\partial s}\right)}{1 - \frac{\alpha Q^2}{g}\frac{B}{\omega^3}};$$

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

c) $Q = \omega C\sqrt{Ri}$;

d) $\frac{\partial\omega}{\partial s} = 0$;

16. Prizmatik (silindrik) kanalni izohlang.

a) $\frac{\partial \omega}{\partial l} = 0$;   *s)* $\frac{\partial \omega}{\partial l} \neq 0$;

b) $\frac{\partial Q}{\partial t} = 0$;   *d)* $\frac{\partial Q}{\partial t} \neq 0$;

17. Noprizmatik (notsilindrik) kanalni izohlang.

a) $\frac{\partial \omega}{\partial l} = 0$;   *s)* $\frac{\partial \omega}{\partial l} \neq 0$;

b) $\frac{\partial Q}{\partial t} = 0$;   *d)* $\frac{\partial Q}{\partial t} \neq 0$;