

## TRASSANING SUVGA TO'YINGAN UCHASTKALARIDA YOTQIZILADIGAN YER OSTI QUVURO'TKAZGICHLARINI HISOBLASH

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**Annotatsiya.** Ushbu maqola "Gruntlarni suvga to'yinganlik darajasining yer osti quvurlarining kuchlanganlik-deformatsiya holatiga ta'siri" tadqiqotlari natijalaridan iborat. Maqolada suvli uchastkalarda yotqizilgan yer osti quvurlarining kuchlanganlik-deformatsiyalanganlik holatini baholash uchun ishlab chiqilgan dasturlar kompleksi yoramida quvurning o'zaro ta'sir xarakterini, uning ballastirovkasini xamda gruntning suvga to'yiZnganlik darajasini hamda uning siljishga qarshiligi bilan bog'liq xususiyatlari hisoblangan.

**Kalit so'zlar:** gruntlar, suvga to'yinish koeffitsenti, suv o'tkazuvchi quvurlar, deformatsiya, kuchlanganlik.

## РАСЧЕТ ПОДЗЕМНЫХ ТРУБ, ПОДЛЕЖАЩИХ ОТОПЛЕНИЮ НА ВОДОНАСЫЩЕННЫХ УЧАСТКАХ ДОРОГИ

**Аннотация.** В государстве представлены результаты исследования "Влияние уровня водонасыщенности грунта на напряженно-деформированное состояние подженных труб". В государстве с использованием комплексной программы, разработанных для оценки напряженно- деформированных подземных труб, проложенных и водоемакс.

**Ключевые слова:** грунты, коэффициент водонасыщения, водопроводы, деформация, прочность.

## CALCULATION OF UNDERGROUND PIPES TO BE HEATED ON WATER-FUSED ROAD SECTIONS

**Abstract.** The article presents the results of the study "Influence of the level of water saturation of the soil on the stress-strain state of underground pipes". In the article, using a set of programs developed to assess the stress-strain of underground pipes laid in reservoirs.

**Keywords:** soils, water saturation coefficient, water pipelines, deformation, strength.

## KIRISH

Trassaning suvga to'yingan uchastkalarida yotqiziladigan yer osti quvuro'tkazgichlarga qo'shimcha tarzda suvni siqib chiqaruvchi kuch ham ta'sir etadi, va suv bilan to'yingan gruntning quvurning ko'ndalang va bo'ylama surilishlariga qarshiligi kamayadi. Shuning uchun, mineral gruntlarda yotqiziladigan quvuro'tkazgichlar uchun ham barqarorligini saqlash maqsadida qo'shimcha mustahkamlash choralarni amalga oshirish zarur. Eksploatatsiya tajribasidan shu ko'rinadiki, bunday quvuro'tkazgichlarni haqiqiy ish sharoitlarini hisobga olib hisoblashning ahamiyati katta.

Gruntning quvuro'tkazgich siljishiga qarshiligi kichik bo'lganida, u ancha katta siljishlarga moyilligini hisobga olib, hamma uchastkalarida barcha kuchlar va ta'sirlar natijasida quvurlardagi yuzaga keladigan deformatsiyalarni tekshirib turish darkor. Bu, ayniqsa,

quvuro'tkazgichning boshidan vertikal tekislikda egilgan yoki gorizontal tekislikdagi burilish burchaklari nisbatan katta bo'lgan uchastkalarga tegishli.

Suvga to'yingan uchastkalardan o'tadigan yer osti quvuro'tkazgichlarning zo'riqish-deformatsiyalanish holatini baholash uchun dasturlar majmui ishlab chiqish quvuro'tkazgichning grunt bilan o'zaro ta'sirini o'ziga xos tomonlarini, quvuro'tkazgichni ballastlanish, hamda geometrik va fizik jihatdan nochiziqiligi bilan bog'liq xususiyatlarini hisobga olishga imkon beradi.

### TADQIQOT MATERIALLARI VA METODOLOGIYASI

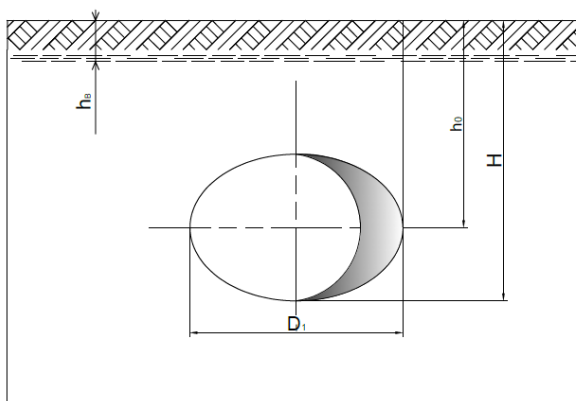
Suvning itarib chiqarish kuchidan quvuro'tkazgichga ta'sir etuvchi ko'ndalang yuk quvurga nisbatan suvning sathiga bog'liq bo'ladi. Agar quvuro'tkazgich egriligini e'tiborga olmasa, uzunligini birligiga ta'sir etuvchi itarib chiqaruvchi kuch quyidagi formuladan topiladi:

$$q_{\epsilon} = \gamma_{\epsilon} F_{o\delta\epsilon}; F_{o\delta\epsilon} = \frac{D_H}{8} (\alpha - \sin \alpha);$$

bu yerda  $\gamma_{\epsilon}$  – suvning erigan va muallaq moddalar hisobga olingandagi solishtirma og'irligi;  $D_H$ – quvurning izolyatsiyalovchi qoplamasi va futerovkasi hisobga olingan tashqi diametri;  $\alpha$ – quvur o'qiga nisbatan suv sathini ifodalovchi burchak.

$$\alpha = \left\{ \begin{array}{l} 2\pi - \text{agar} - h_b \leq h \\ 2\pi - \text{ac} \cos \frac{2(h_0 - h_b)}{D_H}; -\text{agar} - h \leq h_b \\ 2 \arccos \frac{2(h_0 - h_b)}{D_H}; -\text{agar} - h_0 \leq h_b \leq H; 0 - \text{agar} - h_b \geq H; \end{array} \right\}$$

bu yerda  $h_{\epsilon}$  – to'kilgan grunt tepasidan suv sathigacha bo'lgan masofa;  $h, h_0, H$  – tegishlicha to'kilgan grunt tepasidan quvurning yuqori va pastki tashkil etuvchi o'qlarigacha bo'lgan masofasi (1-rasm).



O'tkazilgan tajribalardan ko'rinadiki, suvga to'yingan uchastkalardagi yer osti quvuro'tkazgichlarni hisoblashda oddiy sharoitlarda joylashgan quvuro'tkazgichlarning grunt modellariga o'xshash modellardan foydalanish mumkin. Bunda faqat modeldan son parametrlari o'zgaradi. O'tkazilgan tajribalar asosida gruntning chekli tutib turish qobiliyatini aniqlash uchun empirik formulalar ishlab chiqildi. Suvning sathiga qarab quvurning ko'ndalangigi vertikal siljishiga gruntning chekli qarshiligi quyidagi formula bo'yicha hisoblab topiladi:  $A/g$  da

$$q_{np.zp} = D_H \left[ \gamma_{zp} H_\epsilon + \gamma_{\epsilon 3\epsilon} \left( h - h_0 - \frac{\pi}{8} D_H \right) \right] + k \left\{ \left[ \gamma_{zp} H_\epsilon 2h_0 + hb \right] + \gamma_{\epsilon 3\epsilon} (h - h_\epsilon) \operatorname{tg} 0.7 \varphi_{zp} + \frac{0.7 h_0 c_{zp}}{\cos 0.7 \varphi_{zp}} \right\};$$

bu yerda  $D_H$  – quvurning tashqi diametri;  $\gamma_{zp}$  – gruntning tabiiy suvga to'yinmagan holatidagi hajmiy og'irligi;  $\gamma_{\epsilon 3\epsilon}$  – gruntning muallaq holatidagi hajmiy og'irligi;  $k$  – siqib chiqarish prizmasi xususiyatlarini ifodalovchi koeffitsient, u shartli diametri 100 sm va undan katta bo'lgan quvuro'tkazgichlar uchun birga teng, undan kichik diametrlil quvuro'tkazgichlar uchun esa birdan kam deb qabul qilinadi, ( $k=D_H/100$ );  $\varphi_{zp}$  – gruntning ichki ishqalanish burchagi;  $c_{zp}$  – gruntning ilashish qobiliyati;  $F_{o\delta\epsilon}$  – suvlangan quvur kesimining maydoni.

Muallaq holatdagi gruntning hajmiy og'irligi quyidagiga teng:

$$\gamma_{\epsilon 3\epsilon} = \frac{\gamma_y - \gamma_\epsilon}{1 + e};$$

bu yerda  $\gamma_y$  – grunt (skelet) ni solishtirma og'irligi,  $\gamma_\epsilon$  – suvni solishtirma og'irligi;  $e$  – g'ovaklilik koeffitsienti.

Quvuro'tkazgichning hisoblanayotgan uchastkasini suvga to'yingan sathini belgilashda nafaqat bevosita quvuro'tkazgich uchun bajarilgan qidiruv ishlari ma'lumotlaridan kelib chiqish, balki suvning gidrogeologik sharoitlari hamda vaqt bo'yicha o'zgarishlari bilan bog'liq va prognozlash mumkin bo'lgan sathini hisobga olish darkor. Suvlanmagan gruntning hajmiy og'irligini belgilashda, quyi qatlamlardan kapillyarlar orqali suvni shimilishi hisobiga namligi o'zgarishini hisobga olish lozim.

$$q_{np.zp} = D_H \left[ \gamma_{zp} h_\epsilon + \gamma_{\epsilon 3\epsilon} \left( h - h_0 - \frac{\pi}{8} D_H \right) \right] + k \left\{ \left[ \gamma_{zp} h_\epsilon (2h_0 + hb) + \gamma_{\epsilon 3\epsilon} (h_0 - h_\epsilon)^2 \right] \operatorname{tg} 0.7 \varphi_{zp} + \frac{0.7 h_0 c_{zp}}{\cos 0.7 \varphi_{zp}} \right\};$$

$$q_{np.zp} = \gamma_{zp} \left( h_\epsilon D_H - \frac{\pi D_H^2}{4} + F_{o\delta\epsilon} \right) + \gamma_{\epsilon 3\epsilon} \left[ (h_0 - h_\epsilon) D_H + \frac{\pi D_H^2}{8} - F_{o\delta\epsilon} \right] + k \left[ \gamma_{zp} h_\epsilon (2h_0 + h_\epsilon) \operatorname{tg} 0.7 \varphi_{zp} + \gamma_{\epsilon 3\epsilon} (h_0 - h_\epsilon)^2 \operatorname{tg} 0.7 \varphi_{zp} + \frac{0.7 h_0 c_{zp}}{\cos 0.7 \varphi_{zp}} \right];$$

$$q_{np.zp} = \gamma_{zp} D_H \left( h_0 - \frac{\pi}{8} D_H \right) + k \left[ \gamma_{zp} h_0^2 \operatorname{tg} 0.7 \varphi_{zp} + \frac{0.7 h_0 c_{zp}}{\cos 0.7 \varphi_{zp}} \right];$$

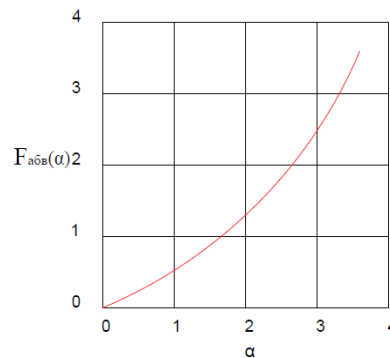
bu yerda  $D_H$  – quvurning tashqi diametri;  $\gamma_{zp}$  – gruntning tabiiy (suvga to'yinmagan) holatidagi hajmiy og'irligi;  $\gamma_{\epsilon 3\epsilon}$  – gruntning muallaq holatidagi hajmiy og'irligi;  $k$  – itarib chiqarish prizmasi xususiyatlarini ifodalovchi koeffitsient, u shartli diametri 100 sm va undan katta bo'lgan quvuro'tkazgichlar uchun birga teng deb, undan kichik diametrlil quvuro'tkazgichlar uchun esa birdan kam deb qabul qilinadi  $k=D_H/100$ ;  $\varphi_{zp}$  – gruntning ichki ishqalanish burchagi;  $c_{zp}$  – gruntning ilashish qobiliyati;  $F_{o\delta\epsilon}$  – suv bosgan quvur kesimi maydoni. Muallaq holatdagi gruntning hajmiy og'irligi quyidagiga teng:

$$\gamma_{\text{636}} = \frac{\gamma_y - \gamma_{\text{6}}}{1 + e};$$

## TADQIQOT NATIJALARI

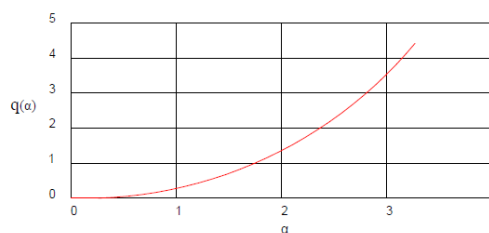
Trassaning suvga to'yingan uchastkalarida yotqiziladigan yer osti quvuro'tkazgichlarga qo'shimcha tarzda suvni itarib chiqaruvchi kuchi ham ta'sir etadi, va suv bilan to'yingan gruntning quvurning ko'ndalang va bo'ylama surilishlariga qarshiligi kamayadi. Shuning uchun, mineral gruntlarda yotqiziladigan quvuro'tkazgichlar uchun ham barqarorligini saqlash maqsadida qo'shimcha mustahkamlash choralarni amalga oshirish zarur. Eksploatatsiya tajribasidan ko'rinadiki, bunday quvuro'tkazgichlarni haqiqiy ish sharoitlarini hisobga olib hisoblashning ahamiyati katta ekan. Gruntning quvuro'tkazgich siljishiga qarshiligi kichik bo'lganida, u ancha katta siljishlarga moyilligini hisobga olib, hamma uchastkalarida barcha kuchlar va ta'sirlar natijasida quvurlardagi yuzaga keladigan deformatsiyalar tekshirib turish darkor. Bu, ayniqsa, quvuro'tkazgichning boshidan vertikal tekislikda egilgan yoki gorizontal tekislikdagi burilish burchaklari nisbatan katta bo'lgan uchastkalarga tegishli. Suvga to'yingan uchastkalardan o'tadigan yer osti quvuro'tkazgichlarning zo'riqish-deformatsiyalanish holatini baholash uchun, dasturlar majmui ishlab chiqildi. Bu dasturlarning algoritmi quvuro'tkazgichning grunt bilan o'zaro ta'sirini o'ziga xos tomonlarini, quvuro'tkazgichni ballastlanish, hamda geometrik va fizik jihatdan nochiziqiligi bilan bog'liq xususiyatlarini hisobga olishga imkon beradi.

Quvurning zo'riqish-deformatsiyalanish holatini EHM hisoblash natijalari quyidagi grafiklarda keltirilgan



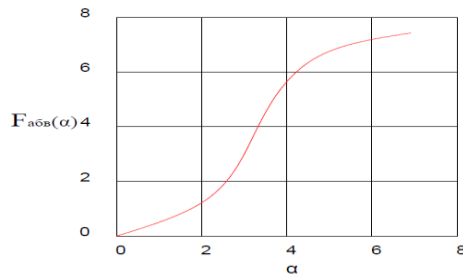
1-grafik.  $\alpha$  burchagiga muvofiq quvurning suv bosgan qismi maydonini o'zgarishi

$$D_H = 3(h \geq h_{\text{6}});$$



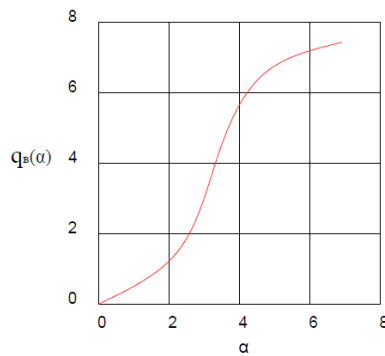
2-grafik.  $\alpha$  burchagiga muvofiq suvning itarib chiqaruvchi kuchining o'zgarishi

$$D_H = 3(h \geq h_{\text{6}});$$



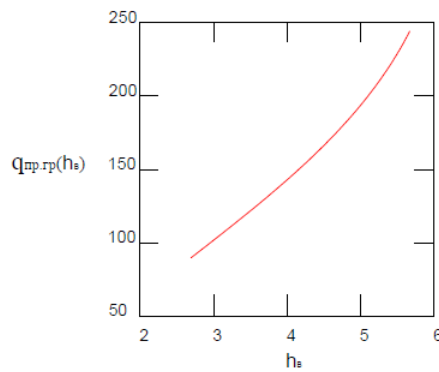
3-grafik.  $\alpha$  burchagiga muvofiq quvurning suv bosgan qismi maydonini o'zgarishi

$$D_H = 3(h \leq h_e \leq H);$$



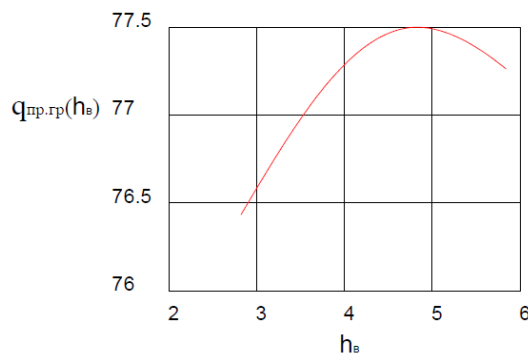
4-grafik.  $\alpha$  burchagiga muvofiq suvning itarib chiqaruvchi kuchining o'zgarish grafiki

$$D_H = 3(h \leq h_e \leq H);$$



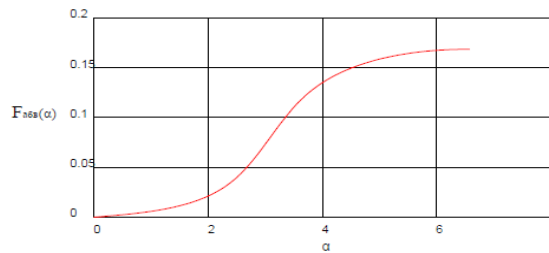
5-grafik. Suvlanish sathi  $h_e$  ga ko'ra quvur siljishiga grunt qarshiligining o'zgarishi

$$D_H = 3(h \leq h_e \leq H);$$



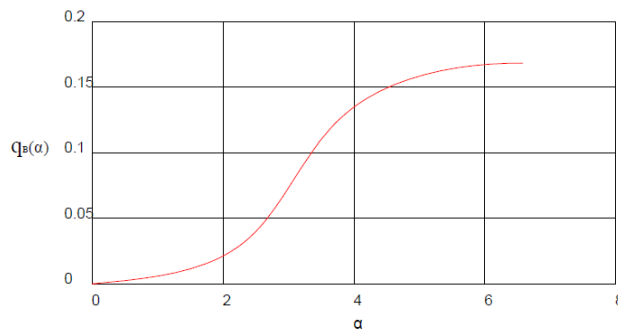
6-grafik. Suvlanish sathi  $h_e$  ga ko'ra quvur siljishiga grunt qarshiligining o'zgarishi

$$D_H = 0.46m \text{ } (h \leq h_e \leq H);$$



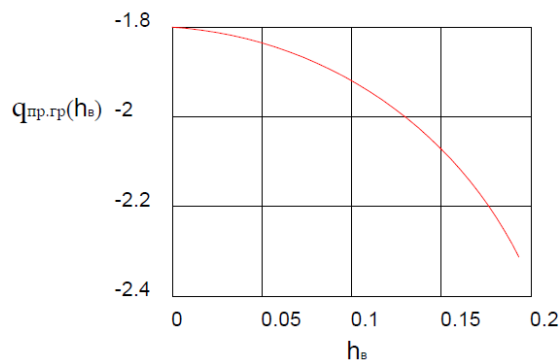
7-grafik.  $\alpha$  burchagiga muvofiq quvurning suv bosgan qismi maydonini o'zgarishi

$$D_H = 3m, h \leq h_e \leq H;$$



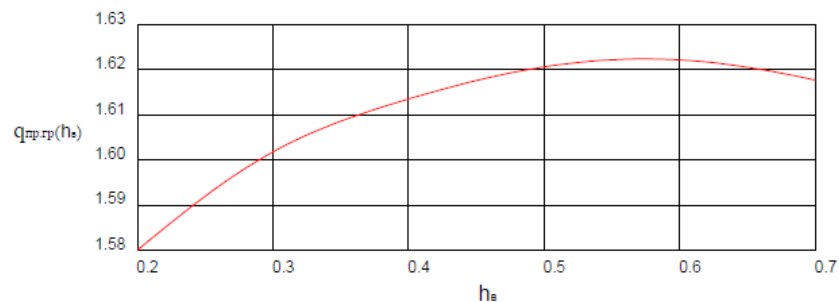
8-grafik.  $\alpha$  burchagiga muvofiq suvning itarib chiqaruvchi kuchining o'zgarishi

$$D_H = 0,46m, (h_e \geq h);$$



9-grafik. Suvlanish sathi  $h_e$  ga ko'ra quvur siljishiga grunt qarshiligining o'zgarishi

$$h_e, (h \leq h_e);$$



10-grafik. Suvlanish sathi  $h_e$  ga ko'ra quvur siljishiga grunt qarshiligining o'zgarishi

$$h_e, h \leq h_e \leq H;$$

## MUHOKAMA

Olingan natijalar tahlili 1 va 2-grafiklardan ko'rinadiki, quvurning suvlangan qismi maydonini kamayishi bilan quvurning diametridan qat'iy nazar  $h_e \leq h$ . bo'lgan holatlarda suvning itarib chiqarish kuchi oshib boradi.

3 va 4- grafiklarda keltirilgan egri chiziqlar quvurning suvlangan qismining maydoni kamayishi bilan itarib chiqaruvchi kuch  $h \leq h_e \leq H$  oralig'ida kattalashadi, so'ng esa kamaya borishini ko'rsatadi.

5-grafikdan ko'rinadiki, quvurning suvlangan qismining  $h \leq h_e \leq H$  oralig'ida kattalashishi  $D_n=3$  da gruntning quvurni siljishiga qarshiligini oshishiga olib kelar ekan.

6-grafikda keltirilgan egri chiziq quvurning suvlangan qismining kamayishi bilan, suvlanish sathi quvur tagiga qadar pasayganda, quvurni siljishiga gruntning qarshiligi oshib borishini ( $D_n = 0,46m : (h \leq h_e \leq H)$ ) ko'rsatadi.

8-grafikdan ko'rinadiki, diametri  $D_n = 0,46m$  teng quvurning suvlangan qismi kamayganda, ( $h_e \geq h$ ) oraliqda suvning itarib chiqaruvchi kuchi oshar ekan.

9-grafikda suvlanish sathi  $h_e$  ga muvofiq tarzda gruntning quvur siljishiga ta'sirini ( $h_e \leq h$ ) oraliqda o'zgarishi ko'rsatilgan. Egri chiziq quvuro'tkazgich butunlay suvga to'yingan gruntga botganda, suvlanganlik ( $h_e \leq h$ ) oraliqda kamayishi bilan gruntning quvur siljishiga ta'sir etuvchi qarshilik kuchi ham kamayishini ko'rsatadi.

10-grafikda suvlanganlik sathi  $h_e$  ni ( $h \leq h_e \leq H$ ) oralig'idagi miqdoriga ko'ra gruntning quvur siljishiga qarshiligining o'zgarishi ko'rsatilgan. Egri chiziq quvuro'tkazgichning suvga to'yingan qismini ( $h \leq h_e \leq H$ ) oraliqda kamayib borishi bilan, gruntning quvur siljishiga ta'sir etuvchi qarshilik kuchi oshib borishini ko'rsatadi.

## XULOSA

1. Yer osti inshootlarni zilzilabardoshlikka hisoblashda grunt sharoitlari hamda inshootning konstruktiv xususiyatlariga ko'ra yer osti inshootlari zilzilabardoshligini statik nazariyasi inshootning va atrofidagi gruntning fizik-mexanik xususiyatlari bir-biridan uncha farq qilmagan holatlarda qo'llanishi mumkin.
2. Teshiklar atrofida kuchlanganlik konsentratsiyasini aniqlash nazariyasi hisoblash ishlari uchun qulay, ammo u inshootni grunt bilan o'zaro ta'sirining fizikaviy tabiatining mohiyatini hisobga olmaydi.
3. Inshootning ko'tarish qobiliyatini oshirish maqsadida zo'riqish (kuchlanish) larni uning qalinligi bo'yicha taqsimlanishini aniqlab bo'lmasligi.
4. Magistral neft va gaz quvuro'tkazgichlari uchun yer osti quvuro'tkazgichning ko'ndalang siljishlarga qarshilik kuchlarini aniqlanishi o'ta muhim, ammo, shu bilan birga, bosim qanday taqsimlanganligining ahamiyati o'q, faqat o'rtacha qiymati ma'lum bo'lishini o'zi kifoya.
5. Gruntlar qarshiligining siljishga bog'liqligini umumiy xususiyatlari siljish 1 sm dan 6sm gacha diapazonda o'tkazilgan tajribalarning hammasida ham bir xil.
6. Quvurlarni gorizonta (tarh bo'yicha) va vertikal (yuqoriga qarab) tekisliklar bo'ylab ko'ndalang siljishida grunt modellari orasidagi tamoyiliy farq tarh bo'yicha ko'ndalang siljishlarda chiziqli bog'lanish quvur taxminan diametrining 0.1 qiymatiga siljiganida chiziqli bog'lanish hosil bo'lishida.

7. Quvur qancha chuqur yotqizilsa, gruntga nisbatan siljish miqdori shuncha kamayadi.
8. Suvning itarib chiqarish kuchi va gruntning quvur siljishiga qarshiligi ta'siri natijasida vujudga keladigan yuklanishni hisoblash dasturi yaratildi.
9. Suvning itarib chiqarish kuchi ta'siri natijasida vujudga keladigan yuklanishlar aniqlandi.
10. Gruntning quvur siljishiga qarshilik kuchlari qiymatlari hisoblandi.
11. Quvuro'tkazgich butunlay suvga botirilgan holatlarda suvlanganlik sathi ( $h_g \leq h$ ) oraliqda kamayishi bilan, gruntning quvur siljishiga qarshiligi ham kamayadi.
12. Quvuro'tkazgichning suvga botirilgan qismi ( $h \leq h_g \leq H$ ) oraliqda kamaygan sari, gruntning quvur siljishiga qarshiligi ham kamayib boradi.

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