

**O‘ZBEKISTON RESPUBLIKASI
OLIY VA O‘RTA MAXSUS TA’LIM VAZIRLIGI**

Farg‘ona politexnika instituti

Qurilish fakulteti

**“Bino va inshootlar qurilishi”
kafedrası**

**“Metall konstruksiyalari”
fanidan**

KURS LOYIHASI

Bajardi:

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KIRISH

To'sinlar – jamoat va turar-joy binolarining sinchini yaratishda, ishlab chiqarish maydonchalarini qurishda qavatlararo yopmalarida, ko'priklarda va boshqa bir qator sohalarda qo'llaniladi. To'sinlardan keng ko'lamda foydalanishning asosiy sabablaridan biri to'sin konstruksiyasining oddiyligi va undan foydalanishning ishonchliligidir. Konstruktiv shakli qulay, balandligi uncha katta emas. Statik sxemasi bo'yicha to'sinlar bir oraliq va ko'p oraliqli bo'lishi mumkin, hamda konsolli bo'ladi.

To'sinlarga tushadigan yukka va tayanchlar ora masofasiga ko'ra to'sinlar yaxlit yoki yig'ma kesimli bo'lishi mumkin. Yig'ma to'sinlar payvandli yoki boltli bo'ladi.

Yopmalarda, ishlab chiqarish maydonchalarda, ko'priklarda qurilmaning yuk ko'taruvchi qismini to'sinlar tizimi tashkil etadi. Har xil to'sinlardan foydalanib yopilgan tomni to'sinli katak deydilar, to'sinlar joylashtirilishi, ta'sir etayotgan yuk miqdori va tarxdagi o'lchamlariga qarab, uch xil bo'lishi mumkin: oddiy normal va murakkab.

Oddiy joylashtirishda yopmaga qo'yilgan yuk to'shama orqali to'shama to'sinlarga, to'shama to'sinlari orqali devorlarga uzatiladi.

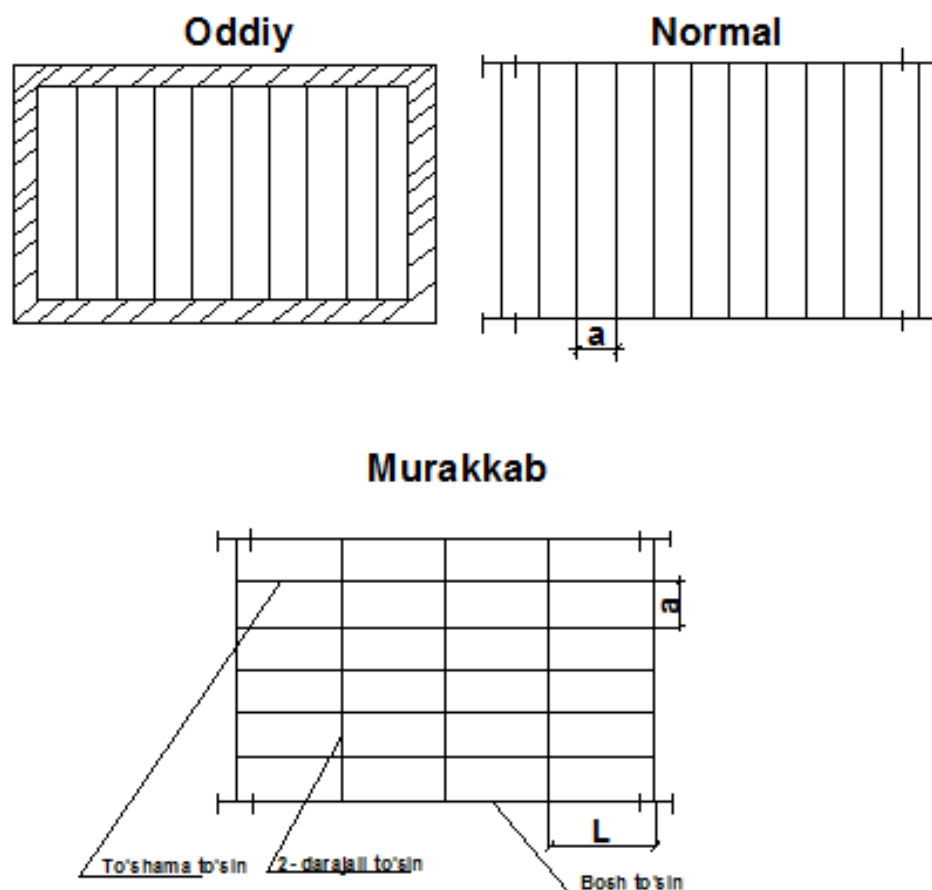
Normal joylashtirish usulida yuk to'shama to'sinlari orqali bosh to'sinlariga uzatiladi, bosh to'sinlar esa, o'z navbatida qabul qilgan yukni ustunlarga uzatadi.

Murakkab joylashtirishda to'shama to'sinlari qabul qilingan yuk birin-ketin yordamchi bosh to'sinlarga va undan keyin ustunlarga uzatiladi

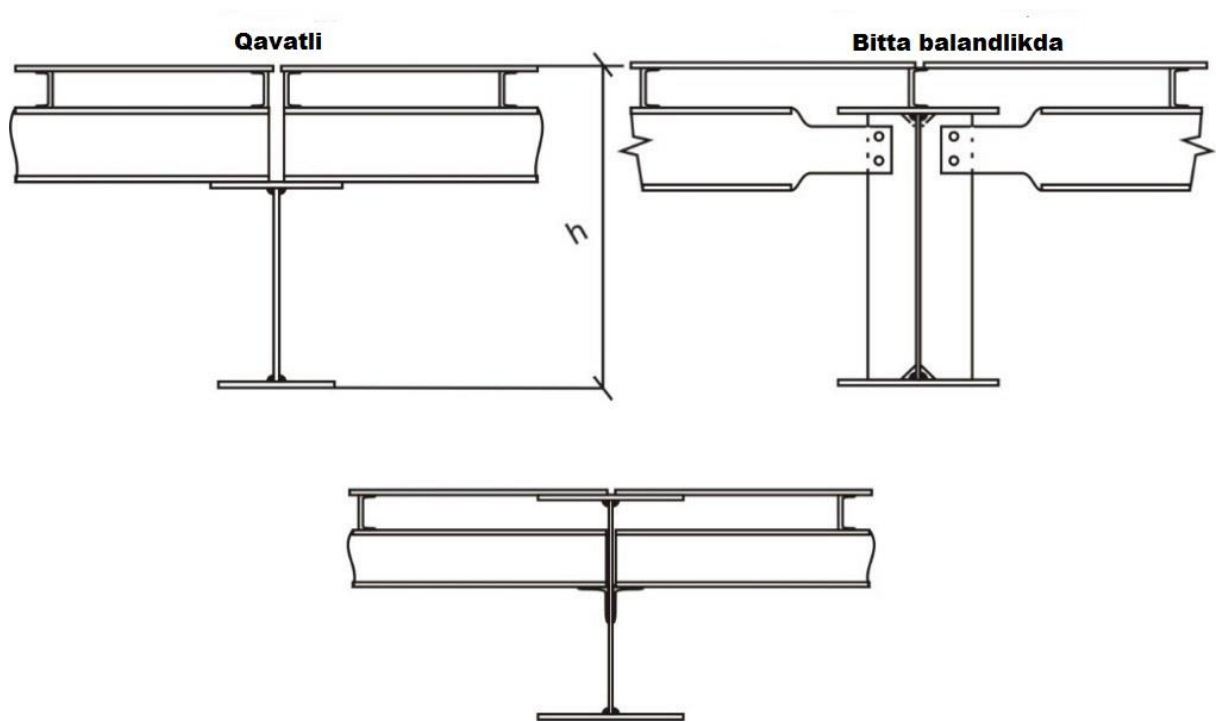
To'sinlarning o'zaro tutashishi qavatli, bir xil balandlikda va pasaytirilgan bo'lishi mumkin. Qavatli to'sinlar tizimi tez va oson yig'iladi lekin qurilish balandligi katta ustivorligini tekshirish lozim. Bitta balandlikdagi to'sinlar tizimini yig'ish uchun ancha vaqt va mehnat sarflash kerak, lekin konstruksiyasi ustivorligini ta'minlaydi. Pasaytirilgan to'sinli katakda eng past balandlikka ega bo'lgan to'sinli katak hosil bo'ladi ustivorligi ta'minlanadi yig'ish uchun mehnat sarfi qavatliga qaraganda ko'proq bitta balandlikdan kamroq sarflanadi. Bosh to'sinlar odatda ustunlarga tayanadi va ustunlari orasidagi katta masofalari bo'ylab

joylashtiriladi. To'shamani bevosita ushlab turuvchi to'sinlar (to'shama to'sinlari) bo'lib ularni orasidagi masofa «a» xarfi bilan belgilanadi va u 0,6÷1,4 m teng qilib olinadi.

Ikkinchi darajali to'sinlarni orasidagi masofa 2m dan – 5m gacha bo'lishi mumkin.



1-rasm. To'sinli kataklarni tizimi



2-rasm. Murakkab to'sinli katakda to'sinlarni bir – biriga biriktirilishi.

I.KOMPONOVKA QISMI

- 1.To'shamani qalinligini topish.
- 2.To'shama to'sinini hisoblash va uni mustahkamligini, bikrligini tekshirish.
- 3.Ikkinchi darajali to'sinni hisoblash va uning mustahkamligini, bikrligini tekshirish.

Berilgan vazifada quyidagi o'lchamlar ma'lum:

L - bosh to'sin uzunligi

l - ikkinchi darajali to'sin uzunligi

H - ustun balandligi

q^H - tashqi ta'sir etayotgan yuk kN/m^2 .

Hisoblash tartibi

To'sinli katakni ishini bajarishda hamma ko'taruvchi elementlarni mustahkamlik bo'yicha hisoblaymiz va tejamli chiqishi uchun variant loyihalash orqali yechamiz.

1 - variant. Normal to'sinli katak.

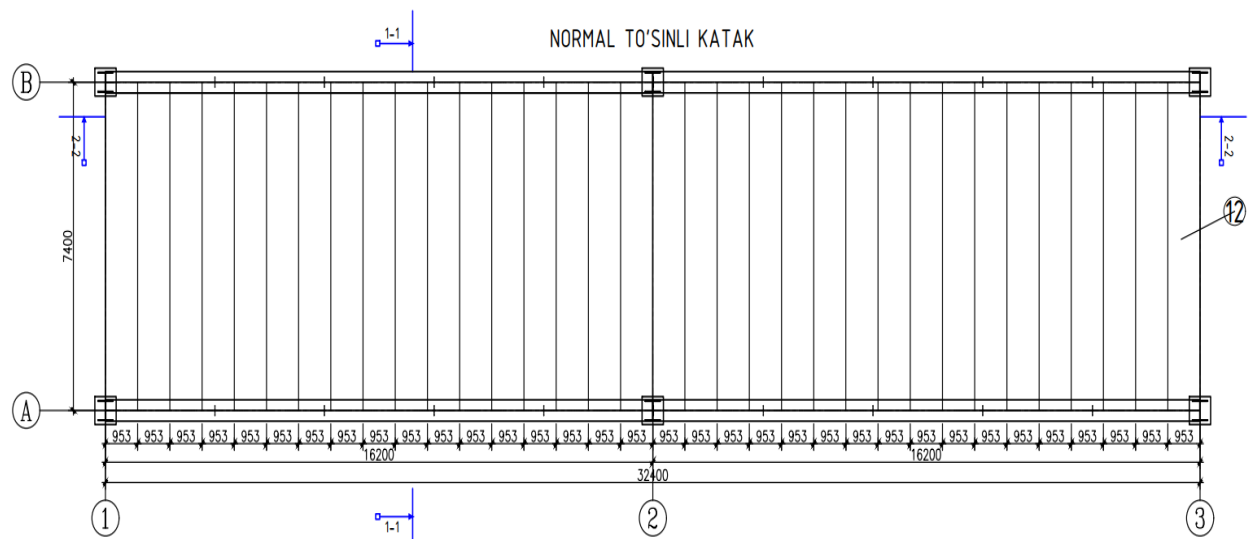
Masalaning shartlari quyidagicha berilgan:

$$L = 16,2 \text{ m}$$

$$l = 7,4 \text{ m}$$

$$H = 5,9 \text{ m}$$

$$q^H = 27 \text{ kN/m}^2$$



To'sinlar qadamini aniqlaymiz.

$$a = \frac{L}{n} = \frac{16,5}{17} = 0,95294m \quad \text{To'shamani hisobi}$$

To'shama uchun varaqsimon qalinligi 6-14 mm gacha bo'lgan po'lat prokati ishlatiladi. To'shamani qalinligini o'rnatish uchun metall konstruksiyalari kitobidagi Leyts grafigidan foydalanamiz. To'shamani nisbiy egiluvchanligini belgilab, shu grafikdan tayanch oralig'ini qalinligiga bo'lgan nisbatini topib olamiz.

Bizning masalamiz uchun

$$\frac{l_t}{t_t} = 124$$

$$\text{to'shamani nisbiy egiluvchanligini } \left[\frac{f}{l} \right] = \frac{1}{120} \text{ da.}$$

To'shama qalinligi

$$t_t = \frac{a}{\frac{l_t}{t_t}} = \frac{0,95294}{124} = 0,7685sm$$

To'shama qalinligini $t_t = 8 \text{ mm}$ deb qabul qilamiz.

1. To'shama to'sinini hisoblash.

a) To'shama to'siniga ta'sir etayotgan hisobiy yoyma yukni aniqlaymiz.

$$q = (q^H \cdot \gamma_f + q_{t.o'.o} \cdot \gamma_f) \cdot a = (27 \cdot 1,2 + 0,628 \cdot 1,05) \cdot 0,95294 = 31,5037 \text{ kN / m}$$

Bu yerda: $\gamma_f = 1,2 \div 1,3$ vaqtinchalik yuk uchun ishonch koeffitsienti.

1,05- doimiy yuk uchun ishonch koeffitsienti.

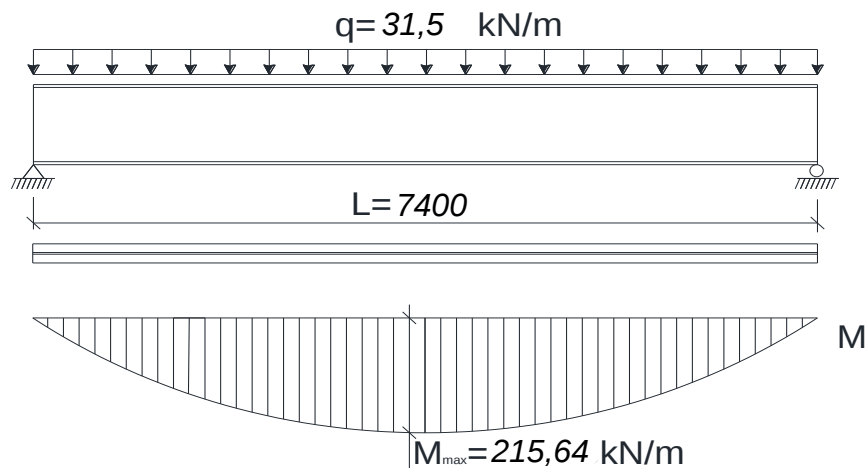
$q_{t.o'.o}$ - to'shamani o'z og'irligi, u quyidagi formula orqali aniqlanadi:

$$q_{t.o'.o} = t_t \cdot \rho = 0,008_m \cdot 78,5 \text{ kN / m}^3 = 0,628 \text{ kN / m}^2$$

bu yerda: $\rho = 7,85 \text{ t/m}^3 = 78,5 \text{ kN/m}^3$ po'latning hajmiy og'irligi.

b) tashqi yukdan to'shama to'sinida hosil bo'layotgan eng katta eguvchi momentni topamiz.

$$M_{\max} = \frac{q \cdot l^2}{8} = \frac{31,5037 \cdot 7,4^2}{8} = 215,643 \text{ kN} \cdot \text{m}$$



v) talab qilingan qarshilik momentini topamiz. Po'lat materiali elastik holatda ishlaganda:

$$W_{t.q.} = \frac{M_{\max}}{R_y \cdot \gamma_c} = \frac{215,643 \cdot (100)}{23,5 \cdot 1} = 917,628 \text{ sm}^3$$

Bu yerda: R_y - element materialining oquvchanligi bo'yicha hisobiy qarshiligi.

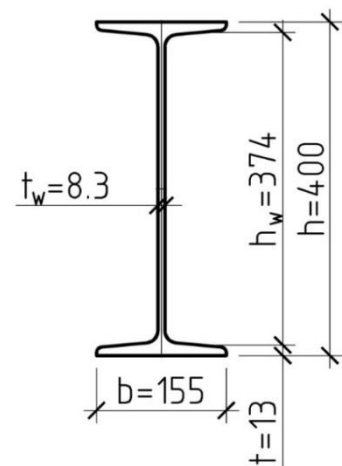
γ_c - ishlash sharoitini e'tiborga oluvchi koeffitsient.

Po'lat materiali elastik va plastik holatda ishlaganda:

$$W_{t.q.} = \frac{M_{\max}}{C_1 \cdot R_y \cdot \gamma_c} = \frac{215,643 \cdot (100)}{1,1 \cdot 23,5 \cdot 1} = 834,208 \text{ sm}^3$$

Bu yerda: c_1 – plastik deformatsiyani e'tiborga oladigan koeffitsient.

Qo'shtavr sortamentidan geometrik tavsifnomalariga asoslanib yuza tanlab olamiz, qarshilik momenti $W_x=953 \text{ sm}^3$, № 40 inersiya momenti $I_x=19062 \text{ sm}^4$, statik moment $S_x=545 \text{ sm}^3$, $q_{t.t.o'.o}=57 \text{ kg/m}$, devorning qalinligi $t_w=0,83 \text{ sm}$, tokchani uzunligi $b=15,5 \text{ sm}$.



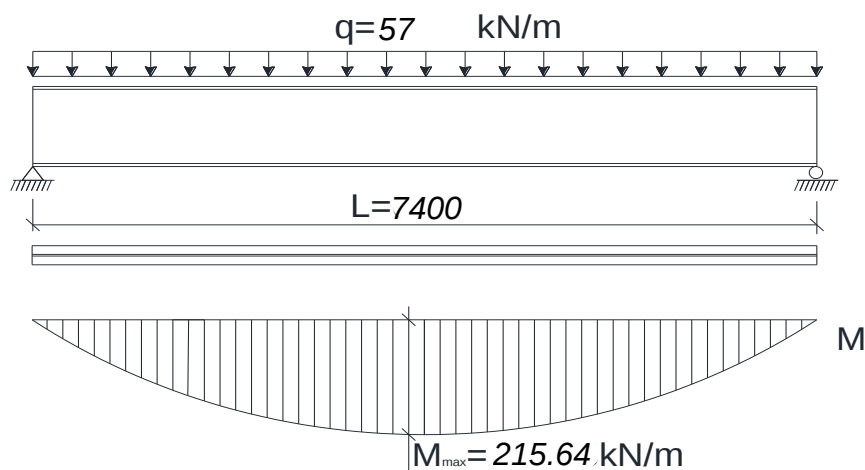
Tanlab olingan to'sinni mustahkamligini o'z og'irligini e'tiborga olib tekshiramiz.

Tanlab olingan to'sinni mustahkamligini o'z og'irligini e'tiborga olib tekshiramiz.

$$\sigma = \frac{M_{\max} + M_{tto'o}}{W_x \cdot \gamma_c} = \frac{215,643 \cdot 100 + 409,673}{953 \cdot 1} = 23.0576 \text{ kN} / \text{sm}^2 \leq R_y \cdot \gamma_c$$

To'sinni o'z og'irligidan hosil bo'layotgan momentni quyidagi formula orqali aniqlaymiz.

$$M_{tto'o} = \frac{q_{tto'o} \cdot \gamma_f \cdot l^2}{8} = \frac{57 \cdot 1,05 \cdot 7.4^2}{8} = 409,673 \text{ kg} \cdot \text{m}$$



Kuchlanish bilan po'latni oquvchanligi bo'yicha hisobiy qarshiligi orasidagi farq

$$\frac{R_y - \sigma}{R_y} = \frac{23,5 - 23,0576}{23,5} \cdot 100\% = 1,88238\% \leq 5\% \quad \text{tashkil qiladi.}$$

To'sinni tayanchida hosil bo'layotgan urinm kuchlanish

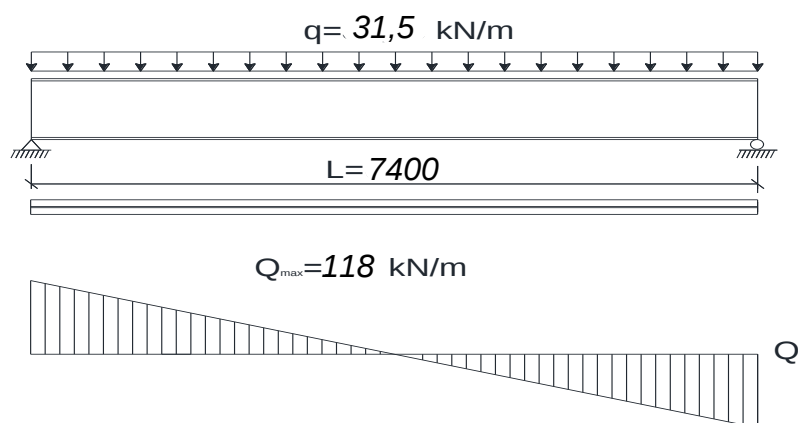
$$\tau = \frac{Q_{\max} \cdot S_x}{I_x \cdot t_w} = \frac{118,778 \cdot 545}{19062 \cdot 0,38} = 4,09153 \text{ kN / sm} < R_s$$

R_s - po'latning qirg'ilishga bo'lgan hisobiy qarshiligi

$$R_s = 0,58 \cdot R_y = 0,58 \cdot 23,5 = 13,63 \text{ kN / sm}^2$$

Eng katta qiruvchi kuch quyidagi formula orqali aniqlanadi.

$$Q_{\max} = \frac{(q + q_{t.t.o'.o.} \cdot \gamma_f) \cdot l}{2} = \frac{(31,5037 + 0,57 \cdot 1,05) \cdot 7,4}{2} = 118,778 \text{ kN}$$



Tanlab olingan to'sinni bikrligini ham tekshiramiz

$$\frac{f}{l} = \frac{5 \cdot q^n \cdot l^3}{384 \cdot I_x \cdot E} = \frac{5 \cdot 26,8979 \cdot 740^3}{384 \cdot 19062 \cdot 2100000} = 0,00355$$

q^n - normativ yoyma yuk quyidagi formula bilan topiladi.

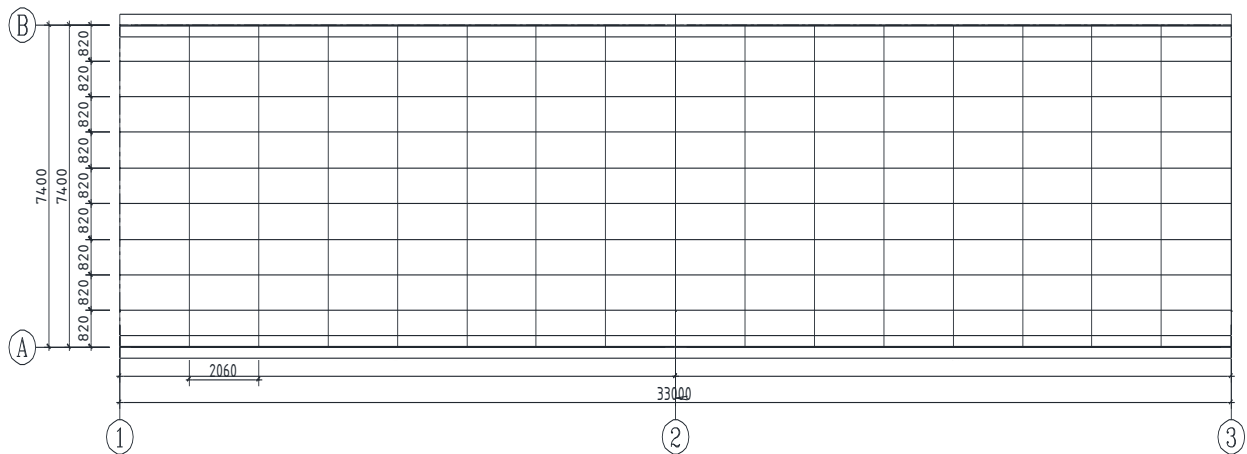
$$q^n = (q^H + q_{t.o'.o.}) \cdot a + q_{t.t.o'.o.} = (27 + 0,628) \cdot 0,95294 + 0,57 = 26,8979 \text{ kN / m}$$

Tanlab olingan to'sin mustahkamligi va bikrligi bo'yicha qo'yilgan talablarga javob beradi.

1 - variant bo'yicha 1 m^2 to'sinli katakni qurish uchun ketadigan po'latning og'irligini aniqlaymiz.

$$q_1 = q_{t.o'.o.} + \frac{q_{t.t.o'.o.}}{a} = 0,628 + \frac{0,57}{0,95294} = 122,61 \text{ kN / m}^2$$

2 – variant. Murakkab to'sinli katak.



To'sinlar qadamini aniqlaymiz.

$$\ell_1 = \frac{L}{n} = \frac{16,2}{4} = 4,05m$$

Ikkinchi darajali to'sinni qadamini aniqlaymiz.

$$a = \frac{l}{n} = \frac{7,4}{6} = 1,233333m$$

1. To'shamaning qalinligini aniqlaymiz:

$$\frac{l_t}{t_t} = 108 \text{ to'shamani nisbiy egiluvchanligi } \left[\frac{f}{l} \right] = \frac{1}{120} \text{ da to'shama qalinligi}$$

$$t_t = \frac{a}{\frac{l_t}{t_t}} = \frac{123,333}{124} = 0,00995sm, \text{ to'shama qalinligini } t_t = 8 \text{ mm deb qabul qilib olamiz.}$$

To'shama to'sinini hisobi.

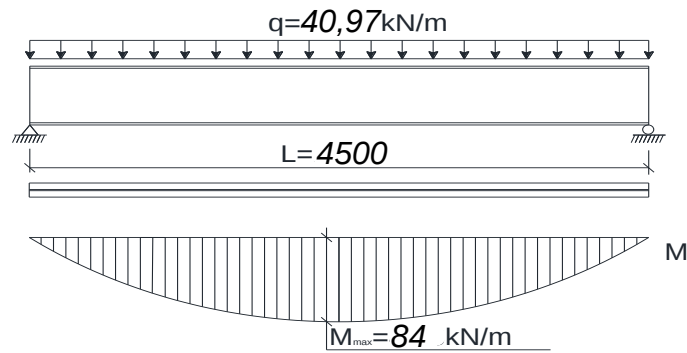
To'shama to'sinini 1 p.m. ta'sir etayotgan hisobiy yoyma yukni aniqlaymiz.

$$q = (q^H \cdot \gamma_f + q_{t.o'.o} \cdot \gamma_f) \cdot a = (27 \cdot 1,2 + 0,785 \cdot 1,05) \cdot 1,23333 = 40,9765 kN / m$$

$$\text{To'shamani o'z og'irligi } q_{t.o'.o} = t_t \cdot \rho = 0,01 \cdot 78,5 kN / m^3 = 0,785 kN / m^2$$

Tashqi ta'sir etayotgan yuklardan to'sinda hosil bo'ladigan eng katta eguvchi momentni topamiz.

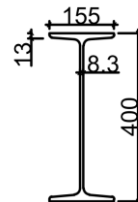
$$M_{\max} \frac{q \cdot l_1^2}{8} = \frac{40,9765 \cdot 4,05^2}{8} = 84,0146 kN \cdot m$$



Talab qilgan qarshilik momentini topamiz.

$$W_{t.k.} = \frac{M_{\max}}{R_y \cdot \gamma_c} = \frac{84,0146 \cdot (100)}{23,5 \cdot 1} = 357,507 \text{ sm}^3$$

TO'SHAMA TO'SIN



Qo'shtavr sortamentidan yuza tanlab olamiz.

I № 27 qarshilik momenti $W_x=371 \text{ sm}^3$ ga teng bo'lgan.

$I_x=3460 \text{ sm}^4$, $S_x=210 \text{ sm}^3$, $t_w=0,6 \text{ sm}$, $q_{t.t.o.o}=31,5 \text{ kg/m}$.

v) tanlangan to'sinni mustahkamligini tekshiramiz o'z og'irligini e'tiborga olib.

v) tanlangan to'sinni mustahkamligini tekshiramiz o'z og'irligini e'tiborga olib.

$$\sigma = \frac{M_{\max} + M_{t.t.o.o}}{W_x \cdot \gamma_c} = \frac{8401,46 + 67,8}{371 \cdot 1} = 22,7304 \text{ kN} / \text{sm}^2 \leq R_y \cdot \gamma_c$$

O'z og'irligidan hosil bo'layotgan momentni topamiz.

$$M_{t.t.o.o} = \frac{q_{t.t.o.o} \cdot \gamma_f \cdot l_1^2}{8} = \frac{31,5 \cdot 1,05 \cdot 4,05^2}{8} = 67,8 \text{ kg} \cdot \text{m}$$

Kuchlanish bilan po'latni oquvchanligi bo'yicha hisobiy qarshiligi orasidagi farq

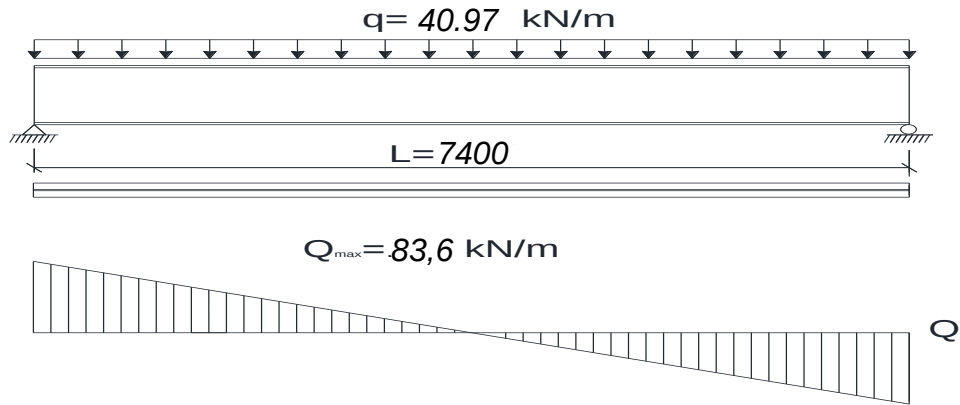
$$\frac{R_y - \sigma}{R_y} = \frac{23,5 - 22,7304}{23,5} \cdot 100\% = 3,1\% \leq 5\% \text{ tashkil qiladi.}$$

To'sinni tayanchidagi hosil bo'ladigan urinma kuchlanish:

$$\tau = \frac{Q_{\max} \cdot S_x}{I_x \cdot t_w} = \frac{83,6472 \cdot 210}{3460 \cdot 0,6} = 5,84362 \text{ kN} / \text{sm}^2 < R_s$$

Eng katta qirquvchi kuch quyidagi formula orqali aniqlanadi.

$$Q_{\max} = \frac{(q + q_{tto'o} \cdot \gamma_f) \cdot \ell_1}{2} = \frac{(40,9765 + 0,315 \cdot 1,05) \cdot 4,05}{2} = 83,6472 \text{ kN}$$



Tanlab olingan to'sinni bikrligini ham tekshiramiz:

$$\frac{f}{l} = \frac{5 \cdot q^n \cdot \ell_1^3}{384 \cdot I_x \cdot E} = \frac{5 \cdot 34,5831 \cdot 405^3}{384 \cdot 3460 \cdot 2100000} = 0,00284 \leq \left[\frac{1}{250} \right]$$

$$q^n = (q^H + q_{t.o'.o.}) \cdot a + q_{t.t.o'.o.} = (27 + 0,785) \cdot 1,23333 + 0,315 = 34,8531 \text{ kN} / \text{m}$$

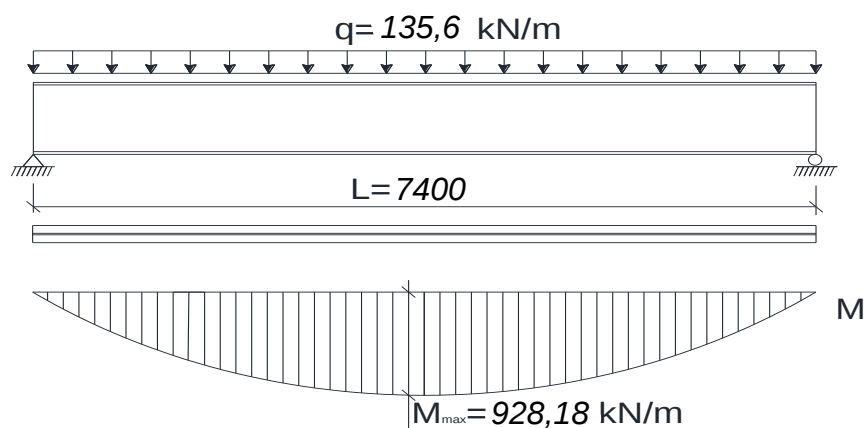
Ikkinchi darajali to'sinni hisobi

Ikkinchi darajali to'singa ta'sir etayotgan hisobiy yukni aniqlaymiz

$$q = [q^H \cdot \gamma + (q_{t.o'.o.} + \frac{q_{t.t.o'.o.}}{a}) \cdot \gamma_f] \cdot \ell_1 = [27 \cdot 1,2 + (0,785 + \frac{0,315}{1,23333}) \cdot 1,05] \cdot 4,05 = 135,6 \text{ kN} / \text{m}$$

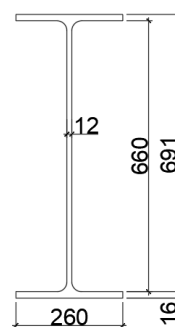
Tashqi ta'sir etayotgan yuklardan to'sinda hosil bo'ladigan eng katta eguvchi momentni topamiz.

$$M_{\max} = \frac{q \cdot l^2}{8} = \frac{135,6 \cdot 7,4^2}{8} = 928,182 \text{ kN} \cdot \text{m}$$



Talab qilgan qarshilik momentni aniqlaymiz.

$$W_{t.q} = \frac{M_{\max}}{R_y \cdot \gamma_c \cdot c_1} = \frac{928,182 \cdot (100)}{23,5 \cdot 1 \cdot 1,1} = 3590,65 \text{ sm}^3$$



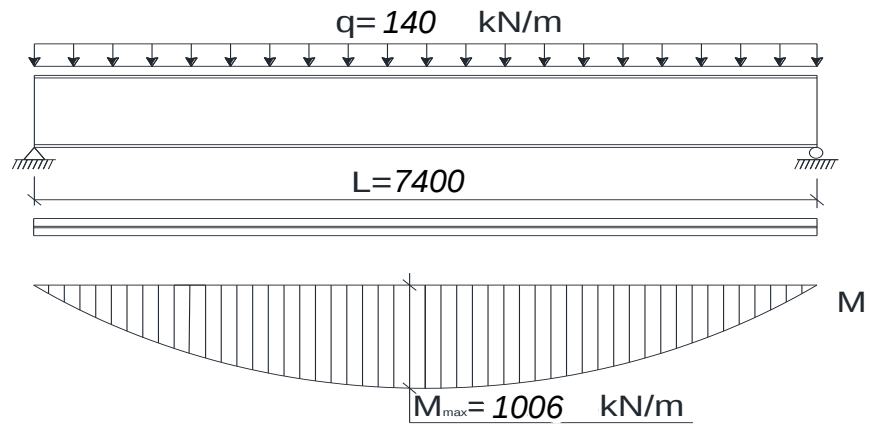
Qo'shtavr sortamentidan geometrik tavsifnomalarga qarab № 70B 1 nomerli yuzani tanlab olamiz. Qarshilik momenti $W_x=3630 \text{ sm}^3$, inersiya momenti $I_x=146000 \text{ sm}^4$, $q_{2.t.o'.o.}=140 \text{ kg/m}$, devorning qalinligi $t_w=1,15 \text{ sm}$, tokchani uzunligi $b=26 \text{ sm}$, qo'shtavr umumiy balandligi $h=69,36 \text{ sm}$.

Tanlab olingan to'sinni o'z og'irligini e'tiborga olib mustahkamligini tekshiramiz.

$$\sigma = \frac{M_{\max} + M_{2q.t.o'.o.}}{W_x \cdot \gamma_c \cdot c_1} = \frac{92818,2 + 1006}{3630 \cdot 1 \cdot 1,1} = 23,4972 \text{ kN/sm}^2 \leq R_y$$

O'z og'irligidan hosil bo'ladigan momentni quyidagi formula bilan aniqlaymiz.

$$M_{2q.t.o'.o.} = \frac{q_{2.t.o'.o.} \cdot \gamma_f \cdot \ell^2}{8} = \frac{140 \cdot 1,05 \cdot 7,4^2}{8} = 1006 \text{ kg} \cdot \text{m}$$



Kuchlanish bilan po‘latni oquvchanligi bo‘yicha hisobiy qarshiligi orasidagi farq

$$\frac{R_y - \sigma}{R_y} \cdot 100\% = \frac{23,5 - 23,4972}{23,5} \cdot 100\% = 0,01191\% \leq 10\%$$

tashkil qiladi.

To‘sin yuzasini statik momenti quyidagi formula orqali topiladi.

$$S_x = A_f \cdot \frac{h_w + t_f}{2} + \frac{h_w t_w}{2} \cdot \frac{h_w}{4} = 40,3 \cdot 1,54 \cdot \frac{66,26 + 1,55}{2} + \frac{66,26 \cdot 1,15}{2} \cdot \frac{66,26}{4} = 2104,2121 + 631,4039 = 2735,61 \text{ sm}^2$$

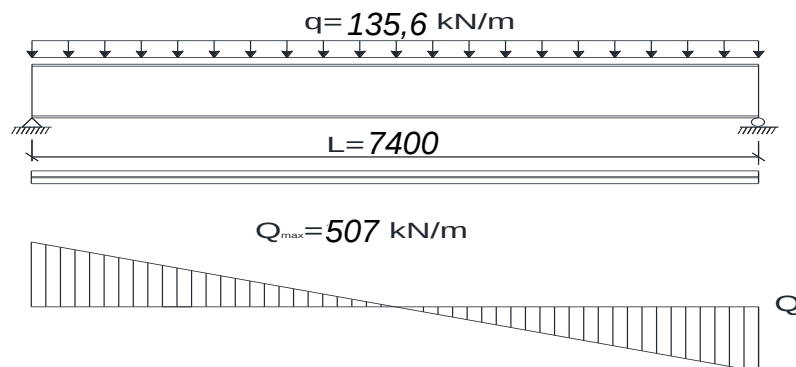
A_f - tokchani yuzasi, h_w - qo‘sh-tavr devorining balandligi.

To‘sin tayanchida hosil bo‘layotgan urinma kuchlanish

$$\tau = \frac{Q_{\max} \cdot S_x}{I_x \cdot t_w} = \frac{507,159 \cdot 2735,61}{146000 \cdot 1} = 8,26 \text{ kN / sm}^2 < R_s$$

Eng katta qiruvchi kuch quyidagi formula orqali topiladi.

$$Q_{\max} = \frac{(q + q_{2.t.o'.o.} \cdot \gamma_f) \cdot \ell}{2} = \frac{(135,6 + 1,4 \cdot 1,05) \cdot 7,4}{2} = 507,159 \text{ kN}$$



To‘sinni bikrlikka ham tekshiramiz.

$$\frac{f}{l} = \frac{5q^n \cdot \ell^3}{384 \cdot I_x \cdot E} = \frac{5 \cdot 115 \cdot 740^3}{384 \cdot 146000 \cdot 2100000} = 0,00197 < \left[\frac{1}{250} \right]$$

To'sinni bir metriga ta'sir etayotgan normativ yuk

$$q^n = (q^H + q_{t.o'.o} + \frac{q_{t.t.o'.o.}}{a}) \cdot \ell_1 + q_{2.t.o'.o.} = (27 + 0,785 + \frac{0,315}{1,23333}) \cdot 4,05 + 1,4 = 115 kN / m$$

2-variant bo'yicha to'sinli katakni 1 m² ni tayyorlash uchun sarflanadigan po'latni og'irligini aniqlaymiz.

$$q_2 = q_{t.o'.o.} + \frac{q_{t.t.o'.o.}}{a} + \frac{q_{2.t.o'.o.}}{\ell_1} = 78,5 + \frac{31,5}{1,23333} + \frac{140}{4,05} = 138,6 kg / m^2$$

Variantlarni solishtirib to'sinli katakni tayyorlash uchun kamroq po'lat sarflanadigan variantni aniqlaymiz.

$$q_1 = 122 kg/m^2, \quad q_2 = 138,6 kg/m^2..$$

II BOSH TO'SIN HISOBI

Tanlab olingan kesim yuza tashqi ta'sir etayotgan yuklarni ko'tarish qobiliyatiga ega, mustahkamligi va bikrligi yetarli darajada, umumiy ustivorligi va alohida elementlarni turg'unligi ta'minlangan bo'lishi shart. Iqtisodiy jihatdan tejamli bo'lishi kerak.

Bosh to'singa ta'sir etayotgan normativ va hisobiy yuklarni aniqlaymiz.

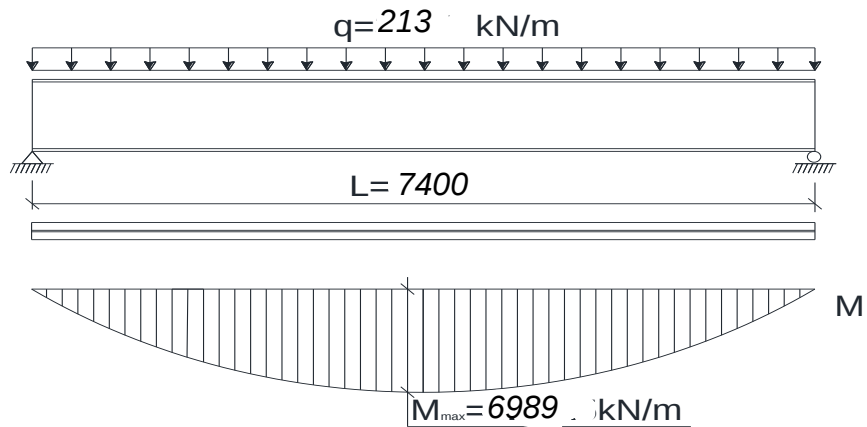
$$q^n = (q^H + q_{t.o'.o.} + \frac{q_{t.t.o'.o.}}{a}) \cdot \ell \cdot 1,02 = (27 + 0,628 + \frac{0,57}{0,95294}) \cdot 7,4 \cdot 1,02 = 213,05 kN / m$$

$$q = \left[q^H \cdot \gamma_f + (q_{t.o'.o.} + \frac{q_{t.t.o'.o.}}{a}) \cdot \gamma_f \right] \cdot l \cdot 1,02 = \left[27 \cdot 1,2 + \left(0,628 + \frac{0,57}{0,95294} \right) \cdot 1,05 \right] \cdot 7,4 \cdot 1,02 = 254,27921 kN / m$$

Ta'sir etayotgan yuklardan to'sinda hosil bo'layotgan eguvchi momentlarni aniqlaymiz.

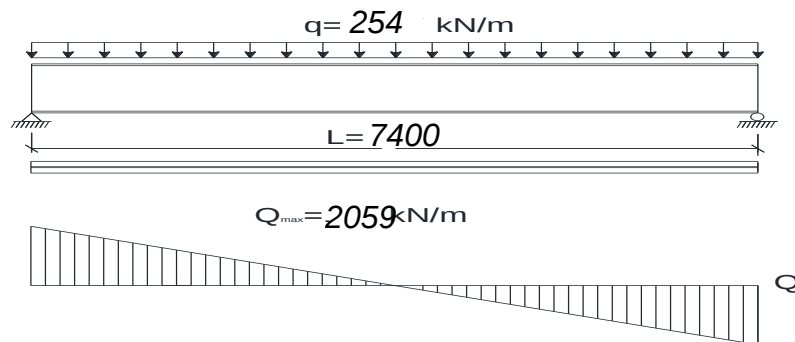
$$M_{\max}^n = \frac{q^n \cdot L^2}{8} = \frac{213,05 \cdot 16,2^2}{8} = 6989,10525 kN \cdot m$$

$$M_{\max} = \frac{q \cdot L^2}{8} = \frac{254,27921 \cdot 16,2^2}{8} = 8341,62948 kN \cdot m$$



To'sinni tayanchida hosil bo'ladigan qirquvchi kuchni aniqlaymiz.

$$Q_{\max} = \frac{q \cdot L}{2} = \frac{254,27921 \cdot 16,2}{2} = 2059,66 \text{ kN}$$



Talab qilingan qarshilik momentini topamiz.

$$W_{t,q} = \frac{M_{\max}}{R_y \cdot \gamma_c} = \frac{8341,62948 \cdot (100)}{23,5 \cdot 1} = 35496 \text{ sm}^3$$

Qulay yuza topish uchun bosh to'sinni balandligini to'g'ri qabul qilib olishimiz lozim:

Birinchi navbatda to'sinni eng kichik balandligini aniqlaymiz, ruhsat etilgan egiluvchanligini e'tiborga olib:

$$h_{\min} = \frac{5}{24} \cdot \frac{R_y \cdot L}{E \cdot \left[\frac{f}{l} \right]} \cdot \frac{M^n}{M_{\max}} = \frac{5 \cdot 23,5 \cdot 1620 \cdot 6989,10525}{24 \cdot 2100000 \cdot \left[\frac{1}{400} \right] \cdot 8341,62948} = 126,575 \text{ sm}$$

Ikkinchidan to'sinni optimal balandligini aniqlaymiz.

$$h_{\text{opt}} = \sqrt{\frac{3W_{t,q}}{2t_w}} = \sqrt{\frac{3 \cdot 35496,2957}{2 \cdot 1,2}} = 210,6427 \text{ sm}$$

t_w – bosh to'sin devorning qalinligi.

Devorning qalinligini imperik formuladan foydalanib topamiz:

$$t_w = 7 + \frac{3 \cdot h_{\min}}{1000} = 7 + \frac{3 \cdot 12,6576 \cdot 100}{1000} = 10,79728 \text{ mm}$$

devorning qalinligini $t_w=1,2\text{sm}$ qilib qabul qilamiz. Bosh to'sinning balandligini $h=200\text{sm}$ qabul qilamiz.

Bosh to'sin tokchasining talab qilingan yuzasini aniqlaymiz:

$$A_{f.t.q} = \frac{W_{t.q}}{h} - \frac{h \cdot t_w}{6} = \frac{35496,2957}{200} - \frac{200 \cdot 1,2}{6} = 137,481479 \text{ sm}^2$$

Varaqsimon prokatli po'latdan $56 \times 3,2$ qabul qilamiz yuzasi $A_f=179,2 \text{ sm}^2$ shunday olsak, to'sinning umumiy turg'unligi ta'minlanishi tokchaning kengligini to'sinning kesim yuzasini balandligi nisbatiga ham bog'liq.

$$b_f \approx \left(\frac{1}{3} \div \frac{1}{5} \right) \cdot h$$

Siqilishga ishlayotgan tokcha normal kuchlanishlar tasiri ostida o'z tur/unligini yo'qotmasligi uchun $\frac{b_f}{t_f} \leq 30$ qoniqtirishi kerak.

$$\frac{48}{3} = 16 \leq 30 \text{ shart bajarildi.}$$

Tokchaning kengligi har qanday holda ham 200 mm dan kichik bo'lmasligi kerak. Tokchaning qalinligi 8.....40 mm atrofida bo'lishi kerak, lekin bu qalinlik $t_w \leq t_f \leq 3 \cdot t_w$ oraliqda bo'lishi lozim. $1,2 \leq 3,2 \leq 3,6$ shart bajarildi.

Qabul qilib olingan bosh to'sin yuzasini geometrik tavsifnomalarini aniqlaymiz.

$$I_x = \frac{h_w^3 \cdot t_w}{12} + 2 \cdot A_f \cdot \left(\frac{h_w + t_f}{2} \right)^2 + \frac{t_f^3 \cdot b_f}{12} \cdot 2 = \frac{194^3 \cdot 1,2}{12} + 2 \cdot 144 \cdot \left(\frac{194 + 3}{2} \right)^2 + \frac{3^3 \cdot 48}{12} \cdot 2 = 730138,4 + 2794248 + 216 = 3525124,4 \text{ sm}^4$$

$$W_x = \frac{2 \cdot I_x}{h} = \frac{2 \cdot 3525124,4}{200} = 36341,4887 \text{ sm}^3$$

$$S_x = A_f \cdot \frac{h_w + t_f}{2} + \frac{h_w \cdot t_w}{2} \cdot \frac{h_w}{4} = 144 \cdot \frac{194 + 3}{2} + \frac{194 \cdot 1,2}{2} \cdot \frac{194}{4} = 14184 + 5645,4 = 19829,4 \text{ sm}^3$$

Bosh to'sinni 1 m uzunligini og'irligini aniqlaymiz.

$$q_{b.t.o'.o.} = (2 \cdot A_f + A_w) \cdot \rho = (2 \cdot 0,0144 + 0,0232) \cdot 78,5 = 4,08828 \text{ kN} / \text{m}$$

A_w - bosh to'sinning devorining yuzasi.

Qabul qilingan bosh to'sinni normal kuchlanish bo'yicha mustahkamlikka tekshiramiz.

$$\sigma = \frac{M_{max}}{W_x \cdot \gamma_c} = \frac{8341,62948 \cdot (100)}{36341,4837 \cdot 1} = 22,9534 \text{ kN} / \text{sm}^2 \leq R_y = 23,5 \text{ kN} / \text{sm}^2$$

Kuchlanish bilan po'latni oquvchanligi bo'yicha hisobiy qarshiligi orasidagi farq

$$\frac{R_y - \sigma}{R_y} \cdot 100\% = \frac{23,5 - 22,9534}{23,5} \cdot 100\% = 2,32\% \leq 5\%$$

tashkil qiladi.

To'sin tayanchida hosil bo'ladigan urinma kuchlanishni aniqlaymiz:

$$\tau = \frac{Q_{max} \cdot S_x}{I_x \cdot t_{\omega}} = \frac{2059,16616 \cdot 19829,4}{3525124,4 \cdot 1,2} = 9,654943 \text{ kN} / \text{sm}^2 < R_s$$

Bikrligini ham tekshiramiz

$$\frac{f}{l} = \frac{5 \cdot M^n \cdot L}{48 \cdot E \cdot I_x} = \frac{5 \cdot 6989,10252 \cdot 1620}{48 \cdot 21000 \cdot 3525124,4} = 0,00159 < \left[\frac{1}{400} \right]$$

Bosh to'sinning umumiy turg'unligini tekshiramiz. Agar quyidagi talablar, shartlar bajarilsa:

- ta'sir etayotgan yuk uzluksiz mustahkam to'shama orqali katta to'sinni tepa tokchasiga ta'sir etsa,
- bosh to'sinni hisobiy uzunligini tokchasini eng bo'lgan nisbati quyidagi shartni bajarsa

$$\frac{a}{b_f} \leq \left[0,41 + 0,0032 \frac{b_f}{t_f} + (0,73 - 0,016 \frac{b_f}{t_f}) \frac{b_f}{h} \right] \cdot \sqrt{\frac{E}{R_y}}$$

$$\frac{0,95294 \cdot 100}{48} < \left[0,41 + 0,0032 \frac{48}{3} + (0,73 - 0,016 \frac{48}{3}) \frac{48}{200} \right] \sqrt{\frac{21000}{23,5}}$$

$$1,9852 < [0,41 + 0,0512 + 0,474] \cdot 29,8934$$

$$1,9852 < 27,9$$

Unda bosh to'sinining umumiy turg'unligini tekshirishga hojat yo'q.

2.1. Alohida elementlarni turg'unligini tekshirish.

1. Siqilishga ishlayotgan bosh to'sinni tokchasini turg'unligini tekshiramiz.

$$\frac{b_f - t_w}{t_f \cdot 2} \leq 0,5 \sqrt{\frac{E}{R_y}} = 0,5 \sqrt{\frac{21000}{23,5}} = 14,9467$$

$$\frac{48 - 1,2}{2 \cdot 3} = 7,8 \quad 7,8 < 14,9467$$

Shunday qilib tokchani turg'unligi bajarilgan.

Bosh to'sinni devorini turg'unligini tekshirish uchun keltirilgan shartli egiluvchanligini aniqlaymiz.

$$\bar{\lambda}_w = \frac{h_w}{t_w} \sqrt{\frac{R_y}{E}} = \frac{200}{1,2} \sqrt{\frac{23,5}{21000}} = 5,40786 > 3,5$$

To'sin devorchasining mahalliy turg'unligini oshirish uchun bikirlik qovurg'alar hisoblash va o'rnatish.

Devorni turg'unligini oshirish uchun ko'ndalang kesim bo'yicha qovurg'alar qo'yiladi. Qovurg'alarni masofasi $h_w \cdot 2$ dan oshib ketmasligi kerak bu shart bo'yicha bizning variantimizda $194 \times 2 = 388 \text{ sm}$. Bikirlik qovurg'alari orasidagi masofa

$$a = \frac{L}{5} = \frac{16,2}{5} = 3,24 \text{ m}$$

Qovurg'alarni eni quyidagi formula orqali topiladi.

$$b_q = \frac{h}{30} + 40 = \frac{2000}{30} + 40 = 106,66667 \text{ mm}$$

Qovurg'alarni eni $b_q = 110 \text{ mm}$ deb qabul qilamiz.

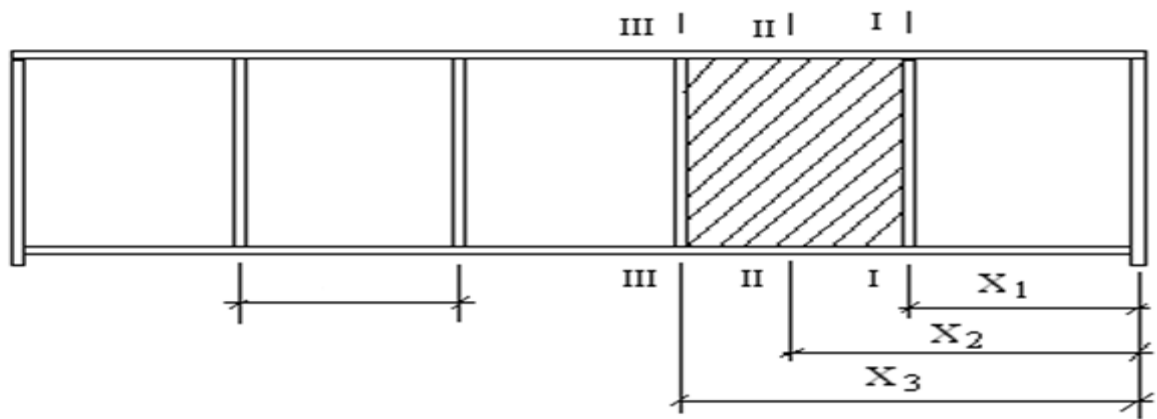
Qovurg'aning qalinligi quyidagi nisbatdan topiladi:

$$t_q = 2 \cdot b_q \sqrt{\frac{R_y}{E}} = 2 \cdot 110 \sqrt{\frac{23,5}{21000}} = 7,359 \text{ mm}$$

Qovurg'ani qalinligini 8 mm qilib olamiz. Qovurg'ali bosh to'sin devorini turg'unligi quyidagi formula orqali tekshiriladi

$$\sqrt{\left(\frac{\sigma}{\sigma_{sch}} + \frac{\sigma_{los}}{\sigma_{los.sch}}\right)^2 + \left(\frac{\tau}{\tau_{sch}}\right)^2} \leq \gamma_c$$

τ ; σ - qurilayotgan katakdagi tashqi yuklar ta'sirida yuzada hosil bo'ladigan kuchlanishlar.



$$\sigma = \frac{M_{o'rt\alpha}}{W_x \cdot \gamma_c} = \frac{6782,7}{36521 \cdot 1} = 18,7 \text{ kN} / \text{sm}^2$$

$$M_{o'rt\alpha} = \frac{M_I + M_{II} + M_{III}}{3} = \frac{5338,64286 + 7006,96876 + 8007,96435}{3} = 6784,52533 \text{ kNm}$$

$$x_1 = a$$

$$M_I = R_{\theta} \cdot x_1 - \frac{q x_1^2}{2} = 2059,6616 \cdot 3,24 - \frac{254,27921 \cdot 4,05^2}{2} = 5338,64286 \text{ kNm}$$

Tayanch reaksiyasi:

$$R_{\theta} = \frac{q \cdot L}{2} = \frac{254,2791 \cdot 16,2}{2} = 2059,6616 \text{ kN}$$

$$x_2 = a + \frac{a}{2} = 3,24 + \frac{3,24}{2} = 4,86 \text{ sm}$$

$$M_{II} = R_{\theta} \cdot x_2 - \frac{q \cdot x_2^2}{2} = 2059,6616 \cdot 4,86 - \frac{254,27921 \cdot 4,86^2}{2} = 7006,96878 \text{ kNm}$$

$$x_3 = a \cdot 2 = 3,24 \cdot 2 = 6,48 \text{ sm}$$

$$M_{III} = R_{\theta} \cdot x_3 - \frac{q \cdot x_3^2}{2} = 2059,6616 \cdot 6,48 - \frac{254,27921 \cdot 6,48^2}{2} = 8007,96435 \text{ kNm}$$

Mahalliy kuchdan hosil bo'ladigan kuchlanish aniqlaymiz.

$$\sigma_{los} = \frac{N}{l_{ef} \cdot t_w} = \frac{129,87}{21,5 \cdot 1,2} = 5,03372 \text{ kN} / \text{sm}^2$$

Mahalliy kuch (to'shama to'sinni tayanch reaksiyasi)

$$N = \frac{q_{T.T} \ell}{2} = \frac{35,1 \cdot 7,4}{2} = 129,87 \text{ kN}$$

Hisobiy uzunligi

$$l_{ef} = b + 2t_f = 15,5 + 2 \cdot 3 = 21,5 \text{ sm}$$

$$\tau = \frac{Q_{o'rt} \cdot S_x}{I_x \cdot t_w} = \frac{823,86464 \cdot 19829,4}{3525124,4 \cdot 1,2} = 3,86197754 \text{ kN} / \text{sm}^2$$

$$Q_{o'rt} = \frac{Q_I + Q_{II} + Q_{III}}{3} = \frac{1235,79696 + 823,86464 + 411,93232}{3} = 823,86464 \text{ kN}$$

$$Q_I = R_g - q \cdot x_1 = 2059,6616 - 254,27921 \cdot 3,24 = 1235,79696 \text{ kN}$$

$$Q_{II} = R_g - q \cdot x_2 = 2059,6616 - 254,27921 \cdot 4,86 = 823,86464 \text{ kN}$$

$$Q_{III} = R_g - q \cdot x_3 = 2059,6616 - 254,27921 \cdot 6,48 = 411,93232 \text{ kN}$$

$$\sigma_{sch} = \frac{C_{sch} \cdot R_y}{\lambda_w^2} = \frac{32,4 \cdot 23,5}{5,40786^2} = 27,803 \text{ kN} / \text{sm}^2$$

C_{sch} - koefitsient qiymatini 2.03.05-97 QMQning 9.1 jadvaldan olamiz δ - parametriga qarab.

$$\delta = \beta \cdot \frac{b_f}{h} \cdot \left(\frac{t_f}{t_w} \right)^3 = 0,8 \cdot \frac{48}{200} \cdot \left(\frac{3}{1,2} \right)^3 = 1,2$$

β – koefitsient qiymati QMQning 9.2 jadvaldan olinadi.

$$\sigma_{los.sch} = \frac{C_1 R_y}{\lambda_w^2} = \frac{39,3 \cdot 23,5}{5,04786^2} = 36,24 \text{ kN} / \text{sm}^2$$

C_1 - koefitsient qiymati QMQning 9.3 jadvaldan olinadi δ va $\frac{a}{h}$ qarab.

$$\frac{a}{h} = \frac{324}{200} = 1,6201 \text{ sm}$$

Devori ko‘ndalang qovurg‘alar bilan ustuvorligi oshirilgan to‘sidan hosil bo‘ladigan kritik urunma kuchlanish quyidagi formula orqali aniqlanadi.

$$\tau_{sch} = 10,3 \cdot \left(1 + \frac{0,76}{\left(\frac{a}{h} \right)^2} \right) \cdot \frac{R_s}{\lambda_w^2} = 10,3 \cdot \left(1 + \frac{0,76}{1,6201^2} \right) \cdot \frac{13,63}{5,04786^2} = 7,01 \text{ kN} / \text{sm}^2$$

$$\sqrt{\left(\frac{\sigma}{\sigma_{sch}} + \frac{\sigma_{los}}{\sigma_{los.sch}} \right)^2 + \left(\frac{\tau}{\tau_{sch}} \right)^2} = \sqrt{\left(\frac{18,667}{27,804} + \frac{5,03372}{36,24} \right)^2 + \left(\frac{3,86977}{7,01} \right)^2} =$$

$$= \sqrt{(0,671 + 0,138)^2 + (0,55)^2} = \sqrt{0,565448 + 0,3025} = 0,9781 < \gamma_c = 1$$

2.2.Bosh to'sinni tejamkor usulda hisoblash.

2.2.1. Bosh to'sin kesimini uzunligi bo'yicha kamaytirish.

Kesimni tayanchlardan boshlab $x = \left(\frac{1}{5} \div \frac{1}{6}\right)L$ oraliqda o'zgartirish maqsadga muvofiq xisoblanadi. To'sinning ko'ndalang kesimini o'zgartirishning bir necha usullari mavjud. Bu usullar orasida tokchalarning kengligini o'zgartirish ancha qulay hisoblanadi. Chunki bu usulda to'sin yuqori tokchasining sirti tekisligicha qoladi va uning ustiga boshqa elementlarni o'rnatish oson bo'ladi. O'zgartirilgan kesimda tokchalar tutashgan joyning payvand choki to'g'ri yoki qiyshiq bo'lishi mumkin. Cho'zilishga ishlaydigan tokcha chokini qiyshiq qilib bajargan ma'qul, chunki bu holda chokning mustahkamligi yuqoriroq bo'ladi.

To'sinlarning kesimini tayanchdan $X=L/5$ masofada o'zgartirish maqsadga muvofiq bo'ladi.

$$X = \frac{L}{5} = \frac{15,4}{5} = 3,24m$$

O'zgargan kesimning eguvchi momentini topamiz.

$$M_1 = \frac{q \cdot x \cdot (L - x)}{2} = \frac{254,27921 \cdot 3,24 \cdot (16,2 - 3,24)}{2} = 5338,64285kN \cdot m = 533864,285kN \cdot sm$$

O'zgargan kesimning qirquvchi kuchni aniqlaymiz.

$$Q_1 = q \cdot \left(\frac{L}{2} - x\right) = 254,27921 \cdot \left(\frac{16,2}{2} - 3,24\right) = 1244,69673kN$$

O'zgartirilgan kesimning talab qilingan qarshilik momenti topamiz.

$$W_{t.q} = \frac{M_1}{R_{wy}} = \frac{5338,64285}{0,85 \cdot 23,5} = 26726,6225sm^3$$

Bu yerda: R_{wy} - payvandlangan birikmadagi chokning cho'zilishga va siqilishga hisobiy qarshiligi

$$R_{wy} = 0.85 \cdot R_y$$

O'zgartirilgan kesim uchun tokchanning talab qilingan kesim yuzasi quyidagi formulaga asosan aniqlanadi.

$$A_{f.t.q} = \frac{W_{t.q}}{h} - \frac{h \cdot t_w}{6} = \frac{26726,6225}{200} - \frac{200 \cdot 1.2}{6} = 93,6331sm^2$$

$$b_f = \frac{A_f}{t_f} = \frac{93,6331}{3} = 31,2110 \text{ sm}$$

Demak, $b_f = 42 \text{ sm}$ qabul qilamiz.

$$A_f = t_f \cdot b_f = 3 \cdot 42 = 126 \text{ sm}^2$$

Varaqsimon prokatli po‘latdan 42x3 qabul qilamiz yuzasi $A_f = 126 \text{ sm}^2$ shunday olsak, to‘sinning umumiy turg‘unligi taminlanishi tokchaning kengligini to‘sinning kesim yuzasini balandligi nisbatiga ham bo‘liq.

$$b_f \approx \left(\frac{1}{3} \div \frac{1}{5} \right) \cdot h$$

Siqilishga ishlayotgan tokcha normal kuchlanishlar tasiri ostida o‘z turg‘unligini yo‘qotmasligi uchun $\frac{b_f}{t_f} \leq 30$ qoniqtirishi kerak.

$$\frac{42}{3} = 12,67 \leq 30 \quad \text{shart bajarildi.}$$

Tokchaning kengligi har qanday holda ham 200 mm dan kichik bo‘lmasligi kerak. Tokchaning 8.....40 mm atgofida bo‘lishi kerak, lekin bu qalinlik $t_w \leq t_f \leq 3 \cdot t_w$ oraliqda bo‘lishi lozim. $1,2 \leq 3,2 \leq 3,6$ shart bajarildi. O‘zgartirilgan kesimning geometrik xarakteristikalarini aniqlaymiz.

$$I_1 = \frac{h_w^3 \cdot t_w}{12} + 2 \cdot A_f \cdot \left(\frac{h_w + t_f}{2} \right)^2 + \frac{t_f^3 \cdot b_f}{12} \cdot 2 = \frac{194^3 \cdot 1,2}{12} + 2 \cdot 126 \cdot \left(\frac{194 + 3}{2} \right)^2 + \frac{3^3 \cdot 42}{12} \cdot 2 = 3175294,4 \text{ sm}^4$$

$$W_1 = \frac{2 \cdot I_1}{h} = \frac{2 \cdot 3175294,4}{200} = 31752,944 \text{ sm}^3$$

$$\sigma_{\max} = \frac{M_1}{W_1} = \frac{5338,64285}{31752,944} = 16,8 \text{ kN / sm}^2 \leq R_{wy} = 0,85 \cdot 23,5 = 19,975 \text{ kN / sm}^2$$

2.2.2. Devor yuzasini kamaytirish bo'yicha hisoblash.

O'zgargan kesimning eng kichik balandligini topamiz.

$$h_{\min} = \frac{5}{24} \cdot \frac{R_y \cdot L \cdot M^{n\wedge}}{E \cdot \left[\frac{f}{l} \right] \cdot M_1} = \frac{5 \cdot 2350 \cdot 1620 \cdot 4473,03}{24 \cdot 2100000 \cdot \left[\frac{1}{400} \right] \cdot 5338,64} = 126,57 \text{ sm}$$

O'zgargan kesim uchun eguvchi momentni topamiz

$$M^{n\wedge} = \frac{q^n \cdot x \cdot (L - x)}{2} = \frac{213,05 \cdot 3,24 \cdot (16,2 - 3,24)}{2} = 4473,03 \text{ kN} \cdot \text{m}$$

Optimal balandligini topamiz.

$$h_{opt} = \sqrt{\frac{3 \cdot W_{t,q}}{2 \cdot t_w}} = \sqrt{\frac{3 \cdot 31752,944}{2 \cdot 1,2}} = 199 \text{ sm}$$

$$h_w = h - t_f \cdot 2 = 186 - 6 = 180 \text{ sm}$$

$$A_f = b_f \cdot t_f = 48 \cdot 3 = 144 \text{ sm}^2$$

$$I_1 = \frac{h_w^3 \cdot t_w}{12} + 2 \cdot A_f \cdot \left(\frac{h_w + t_f}{2} \right)^2 + \frac{t_f^3 \cdot b_f}{12} \cdot 2 = \frac{180^3 \cdot 1,2}{12} + 2 \cdot 144 \cdot \left(\frac{180 + 3}{2} \right)^2 + \frac{3^3 \cdot 48}{12} \cdot 2 = 2994624 \text{ sm}^4$$

$$W_1 = \frac{2 \cdot I_1}{h} = \frac{2 \cdot 2994624}{186} = 32200,26 \text{ sm}^3$$

$$W_{t,q} = 31752,944 < W_1 = 32200,26 \text{ sm}^3$$

O'zgargan kesimning mustahkamligini tekshiramiz.

$$\sigma_{\max} = \frac{M_1}{W_1} = \frac{5338,64 \cdot (100)}{32200,26} = 16,58 \text{ kN} / \text{sm}^2$$

$$\sigma_{\max} = 16,58 \text{ kN} / \text{sm}^2 \leq R_{wy} = 19,9 \text{ kN} / \text{sm}^2$$

III. MARKAZIY SIQILGAN USTUN HISOBI.

3.1.Ustunni hisobi

Ustunga ta'sir etayotgan kuchni aniqlaymiz:

$$N = 2 \cdot Q_{b.t.} = 2 \cdot 2059,6616 = 4119,3232kN$$

Ustunning egiluvchanligini $\lambda=40$ deb belgilab, jadvaldan φ -ko'ndalang egiluv chanlik koeffitsientni aniqlab, talab qilingan yuzasini quyidagi formula orqali topamiz.

$$A_{t.q.} = \frac{N}{\varphi \cdot R_y} = \frac{4119,3232}{0,894 \cdot 23,5} = 196,07sm^2$$

Hisobiy uzunlikni topish $l_{ef} = H \cdot 0,7 = 5,9 \cdot 0,7 = 4,13m$

Ustunning talab qilingan inersiya radiusi quyidagi ifoda orqali aniqlanadi.

$$i_{t.q.} = \frac{l_{ef}}{\lambda} = \frac{413}{0,43} = 10,325sm$$

Ustunning kesim yuzasini talab qilingan tomonlarini jadvaldan foydalanib aniqlaymiz:

$$h_{t.q.} = \frac{i_{t.q.}}{\alpha_1} = \frac{10,325}{0,43} = 24,01sm$$

$$b_{t.q.} = \frac{i_{t.q.}}{\alpha_2} = \frac{10,325}{0,24} = 43,02sm$$

Ustunning $A_{t.q.}$ yuzasini, enini, balandligini o'lchamlariga qarab alohida elementlardan tashkil topgan qo'shtavr formasiga ega bo'lgan yuzani jihozlaymiz. Devorini o'lchamlari $h_w=45sm$ $t_w=1.4sm$. Tokchalarni o'lchamlari: $b_f=45sm$, $t_f=1,6sm$. Devorini kesim yuzasi $A_w=h_w \cdot t_w=(45-2 \cdot 1,6) \cdot 1,4=58,52 sm^2$. Tokchani kesim yuzasi $A_f=b_f \cdot t_f=45 \cdot 1,6=72sm^2$. Ustunning umumiy kesim yuzasi $A=2 \cdot A_f+A_w=2 \cdot 72+58,52=202,52sm^2$ ga teng. Tanlab olingan yuzani geometrik tavsifnomalarini aniqlaymiz.

$$I_x = \frac{h_w^3 \cdot t_w}{12} + 2 \cdot b_f \cdot t_f \cdot \left(\frac{h_w + t_f}{2}\right)^2 = \frac{41,8^3 \cdot 1,2}{12} + 2 \cdot 45 \cdot 1,6 \cdot \left(\frac{1,4+1,6}{2}\right)^2 = 76328,8671sm$$

$$I_y = \frac{b_f^3 \cdot t_f}{12} \cdot 2 + \frac{t_w^3 \cdot h_w}{12} = \frac{45^3 \cdot 1,6}{12} \cdot 2 + \frac{1,2^3 \cdot 45}{12} = 24309,5583sm^4$$

$$i_x = \sqrt{\frac{I_x}{A}} = \sqrt{\frac{76328,8671}{202,52}} = 19,41sm$$

$$i_y = \sqrt{\frac{I_y}{A}} = \sqrt{\frac{24309,5583}{202,52}} = 10,95 \text{ sm}$$

X va Y o'qlari bo'yicha egiluvchanligini aniqlaymiz:

$$\lambda_x = \frac{\ell_{efx}}{i_x} = \frac{413}{19,41} = 21,27$$

$$\lambda_y = \frac{\ell_{efy}}{i_y} = \frac{413}{10,95} = 37,71$$

Katta egiluvchanligiga qarab shartli egiluvchanligini aniqlaymiz

$$\bar{\lambda} = \lambda_y \sqrt{\frac{R_y}{E}} = 37,71 \sqrt{\frac{23,5}{21000}} = 1,26 < 2,5 \quad \text{va} \quad \varphi \quad \text{koeffitsientni} \quad \text{hisoblab,}$$

$$\varphi = 1 - \left(0,073 - 5,53 \frac{R_y}{E} \right) \cdot \bar{\lambda} \sqrt{\bar{\lambda}} = 1 - \left(0,073 - 5,53 \cdot \frac{23,5}{21000} \right) \cdot 1,26 \sqrt{1,26} = 1 - 0,094 = 0,906$$

Tanlab olingan yuzani mustahkamlikka tekshiramiz:

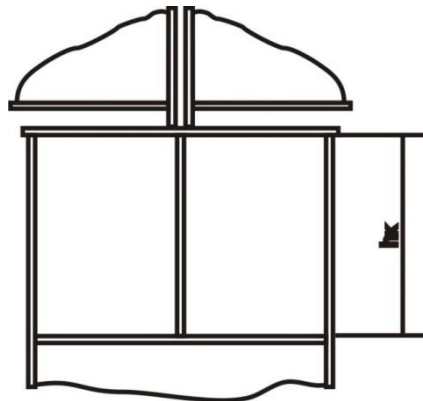
$$\sigma = \frac{N}{\varphi \cdot A} = \frac{4119,3232}{0,906 \cdot 202,52} = 22,45 \text{ kN / sm}^2$$

Kuchlanish bilan po'latni oquvchanligi bo'yicha hisobiy qarshiligi orasidagi farq $\frac{R_y - \sigma}{R_y} \cdot 100\% = \frac{23,5 - 22,45}{23,5} \cdot 100\% = 4,4\% \leq 5\%$

tashkil qiladi.

3.2. Ustunning tepa qismini konstruktiv elementlarini tanlash, hisoblash va joylashtirish.

Ustunning tepa qismi to'sinlardan tushuvchi yukni qabul qilib oladigan plitadan va bo'ylama, ko'ndalang qovurg'alardan iborat.



Rasm. Ustunning tepa qismi

Ustunning tepa qismidagi plita qalinligini konstruktiv talablarga ko'ra 20, 25 mm olinadi.

Bo'yi bo'yicha qovurg'ani uzunligini hisoblaymiz

$$h_q = \frac{N}{4 \cdot K_f \cdot \beta_f \cdot R_{wf} \cdot \gamma_c} = \frac{4119,3232}{4 \cdot 1 \cdot 0,7 \cdot 16,28 \cdot 1} = 90,36 \text{ sm}$$

K_f - QMQ 11-23-81 jadval 36 bo'yicha $K_f=1$

β_f - 1va β_z - 2 payvand usuliga bog'liq bo'lgan koeffitsientlarni qiymatini QMQ 2.03.05-97 jadvaldan olinadi.

Eritilgan po'lat chokning hisobiy qarshiligi

$$R_{\omega f} = 0,55 \cdot \frac{R_{\omega un}}{\gamma_m} = 0,55 \cdot \frac{37}{1,25} = 16,28 \text{ kN / sm}^2$$

R_{wun} - po'latning ezilishga hisob qarshiligi.

γ_m - chok materiali bo'yicha koeffitsient.

Bo'ylama bo'yicha qovurg'aning uzunligini 92 sm qabul qilamiz.

Bo'ylama bo'yicha qovurg'aning qalinligini aniqlash.

$$t_q = \frac{N}{b_f \cdot 2 \cdot 2 \cdot R_{wun}} = \frac{4119,3232}{42 \cdot 2 \cdot 2 \cdot 37} = 0,662 \text{ sm}$$

Ustunning tepa qismidagi plita qalinligini 2 sm qabul qilib olamiz.

Bo'ylama bo'yicha qovurg'aning qalinligini $t_q=1$ sm olamiz.

Bo'ylama bo'yicha hosil bo'layotgan urinma kuchlanishni aniqlaymiz.

$$\tau = \frac{0,5 \cdot N}{2 \cdot h_q \cdot t_q} = \frac{0,5 \cdot 4119,3232}{2 \cdot 92 \cdot 1} = 11,19 \text{ kN / sm}^2 < R_s$$

R_s - po'latning qirqilishga bo'lgan hisobiy qarshiligi

$$R_s = 0,58 \cdot R_y = 0,58 \cdot 23,5 = 13,63 \text{ kN / sm}^2$$

3.3.Ustun tayanchini hisoblash va loyihalash.

Ustunning asoslari sterjendan kelgan yukni poydevorga bir tekis taqsimlashga xizmat qiladi. Ustun asoslari uch xil bo'lishi mumkin. Traversa bilan, tayanch plita bilan, va sharnirli tayanchi bilan.

Ustundan tushadigan bosim katta bo'lganda plitaning qalinligini kamaytirish maqsadida bo'ylama hisobiy kuch plitaga ustunning sterjeni va traversalar orqali

uzatiladi. Traversalar ustundan keladigan kuchning plita yuzasi bo'ylab tekis taqsimlanishiga imkoniyat beradi.

Sharnirli tayanch plitadan iborat bo'lgan ustunlar ideal hisobiy sxemaga javob beradi, lekin ularni o'rnatish biroz qiyin kechadi.

Tayanch plitaning o'lchamlari quyidagi formula orqali aniqlanadi.

Poydevor betoni markasi 150; $R_{pr}=7 \text{ MPA}=0,7 \text{ kN/sm}^2$

tayanch plitasining talab qilinayotgan maydonni aniqlash:

$$A_{pl.t.q} = \frac{N}{R_{pr} \cdot \gamma} = \frac{4119,3232}{0,7 \cdot 1,5} = 3923,164 \text{ sm}^2$$

$\gamma=1,5$ koeffitsient.

640x640 mm o'lchamli plitani qabul qilamiz, uni yuzasi $A_{pl}=63 \times 63=3969 \text{ sm}^2$.

Tayanch plita ostidagi asosga tushayotgan yukni aniqlaymiz:

$$q = \frac{N}{A_{pl}} = \frac{4119,3232}{3969} = 1,03 \text{ kN / sm}^2$$

Ustun asosini 12mm qalinlikdagi traversalar bilan loyihalaymiz, ularni ustun tokchalariga va plitaga burchakli choklar bilan payvandlaymiz. Plita qalinligini tanlash uchun turli uchastkalar uchun eguvchi momentlarni hisoblaymiz:

1-uchastka.

Tomonlar nisbati $b/a=419/218=1,91$ ($\alpha=0,094$ jadvaldan olinadi)

$$M_{pl} = \alpha \cdot q \cdot a^2 = 0,098 \cdot 1,03 \cdot 21,8^2 = 47,97 \text{ kN} \cdot \text{sm}$$

2. uchastka, konsolli, nisbat $b/a < 2$:

$$M_2 = \frac{q \cdot l^2}{2} = \frac{1,03 \cdot 9^2}{2} = 41,72 \text{ kN} \cdot \text{sm}$$

3-uchastkani 2- uchustkadan kichik bo'lganligi uchun hisoblashga hojat yo'q.

Plita qalinligini maksimal momenti bo'yicha qabul qilamiz:

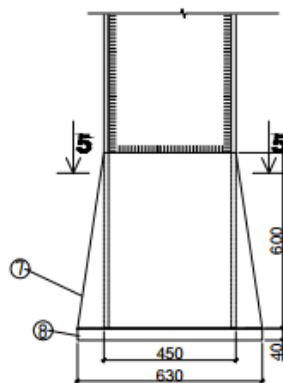
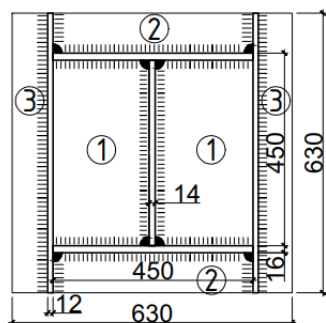
$$t_{pl} = \sqrt{\frac{6 \cdot M_{\max}}{R_y}} = \sqrt{\frac{6 \cdot 47,97}{23,5}} = 3,51 \text{ sm}$$

Plita qalinligi $t_{pl}=40 \text{ mm}$ qabul qilamiz.

Traversa ustunga yarim avtomatlashtirilgan payvandlash usulida uglekisliy gaz muhitida payvandlovchi sim yordamida mahkamlanadi.

Traversa qalinligini $t_{tr}=12\text{mm}$, balandligini $h_{tr}=600\text{ mm}$ qabul qilamiz. Markaziy siqilgan ustunlarda $d=24\text{ mm}$ diametrli anker boltlari qo'llaniladi (konstruktiv).

ASOS PLITASI 5-5



Rasm Ustun asoslari

Adabiyotlar

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XULOSA.

Men bu kurs ishi loyihasidan to'sinlarga tushadigan yukka va tayanchlar ora masofasiga ko'ra to'sinlar yaxlit yoki yig'ma kesimli bo'lishi mumkin. Yig'ma to'sinlar payvandli yoki boltli bo'ladi. Yopmalarda, ishlab chiqarish maydonchalarda, ko'priklarda qurilmaning yuk ko'taruvchi qismini to'sinlar tizimi tashkil etadi. Har xil to'sinlardan foydalanib yopilgan tomni to'sinli katak deyilar, to'sinlar joylashtirilishi, ta'sir etayotgan yuk miqdori va tarxdagi o'lchamlariga qarab, uch xil bo'lishi mumkin: oddiy normal va murakkab. Oddiy joylashtirishda yopmaga qo'yilgan yuk to'shama orqali to'shama to'sinlarga, to'shama to'sinlari orqali devorlarga uzatiladi. Normal joylashtirish usulida yuk

to'shama to'sinlari orqali bosh to'sinlariga uzatiladi, bosh to'sinlar esa, o'z navbatida qabul qilgan yukni ustunlarga uzatadi. Murakkab joylashtirishda to'shama to'sinlari qabul qilingan yuk birin-ketin yordamchi bosh to'sinlarga va undan keyin ustunlarga uzatiladi. To'sinlarning o'zaro tutashishi qavatli, bir xil balandlikda va pasaytirilgan bo'lishi mumkin. Ustunning asoslari sterjendan kelgan yukni poydevorga bir tekis taqsimlashga xizmat qiladi. Ustun asoslari uch xil bo'lishi mumkin. Traversa bilan, tayanch plita bilan, va sharnirli tayanchi bilan. Ustundan tushadigan bosim katta bo'lganda plitaning qalinligini kamaytirish maqsadida bo'ylama hisobiy kuch plitaga ustunning sterjeni va traversalar orqali uzatiladi. Traversalar ustundan keladigan kuchning plita yuzasi bo'ylab tekis taqsimlanishiga imkoniyat berishini o'rgandim.