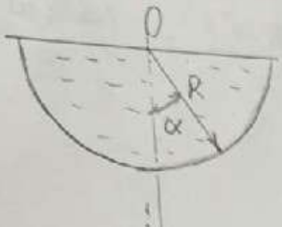
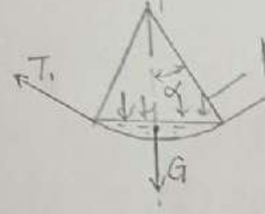
Ян Бо

30

№.1.





Рассмотрим: часть полусферы

вес жидкости: $G = \rho g V$.

$p = \rho g \cdot R\cos\alpha$ $V = \frac{\pi R^3}{3}(2-3\cos\alpha+\cos^3\alpha)$.

уравнение равновесия: $\Sigma F_y = 0$. давление?

$T_1 \cdot 2\pi r \sin\alpha - G = 0$.

$r = R\sin\alpha$

получим: $T_1 = \frac{\pi R^3 \rho g}{6\pi R \sin\alpha}(2-3\cos\alpha+\cos^3\alpha)$

$$T_1 = \frac{R^2\rho g}{6\sin\alpha}(2-3\cos\alpha+\cos^3\alpha)$$

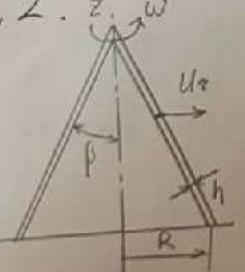
для жидкости: $P_з = P_{жид} = \rho g h = \rho g \cdot R\cos\alpha$

из уравнения Лапласа: $\frac{T_1}{R_1}+\frac{T_2}{R_2} = P_з$

$$T_2 = P_з R_2 - \frac{T_1 R_2}{R_1} = P_з R - T_1$$

$$= \rho g R^2\left[\cos\alpha - \frac{1}{6\sin\alpha}(2-3\cos\alpha+\cos^3\alpha)\right]$$

№.2.



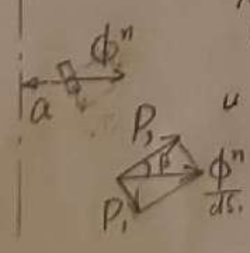
Сила инерции для вращающегося элемента.

$\Phi^n = \rho h dS_1 \cdot a^n$

$= \rho h dS_1 \omega^2 r$

Из части оболочки, построим уравнение равновесия: $\Sigma F_y = 0$.

получим: $T_1 = 0$.

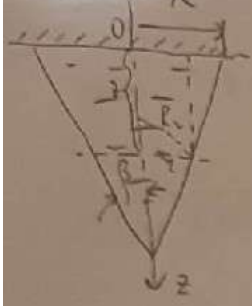


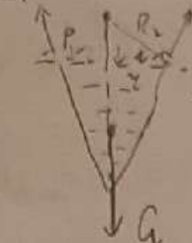
и поэтому: $T_2 = P_з R_2$

где $P_з = \frac{\Phi^n}{dS_1}\cos\beta$ $R_2 = \frac{r}{\cos\beta}$

СМ1-85Б Сун Тяньюэ

№ 2.





$$p = \rho g z$$

$$G = \rho \cdot V = \rho \cdot \frac{\pi}{3}\left(\frac{R}{\tan\beta} - z\right)^3 tg^2\beta$$

$$\Sigma F_z = 0, \quad -2\pi r T_1 \cos\beta + \rho g \frac{\pi}{3}\left(\frac{R}{\tan\beta} - z\right)^3 tg^2\beta + \rho g z \cdot \pi r^2 = 0$$

$$r = \cancel{R\,tg} \; R - z\,tg\beta$$

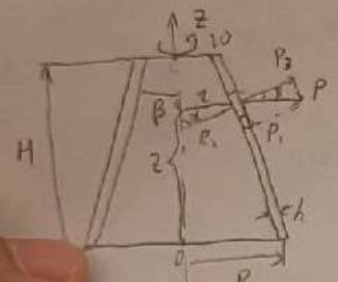
~~то $T_1 =$~~

$$\text{то.} \quad T_1 = \frac{1}{2\pi r \cos\beta}\left[\rho \cdot \frac{\pi}{3}\left(\frac{R}{tg\beta} - z\right)^3 tg^2\beta + \rho g z \cdot \pi (R - z\,tg\beta)^2\right]$$

$$T_2 = p R_2 = \rho g z \cdot \frac{r}{\cos\beta} = \frac{\rho g z}{\cos\beta}(R - z\,tg\beta) \quad \checkmark$$

№ 13

Переписать T_1!



$$p = \rho h r \omega^2$$

$$p_1 = p \sin\beta$$

$$p_3 = p\cos\beta \; \checkmark$$

$$T_1 = \frac{C}{r\sin\alpha} + \frac{1}{r\sin\alpha}\int (p_3\cos\alpha - p_1 \sin\alpha)\, r\, ds_1$$

$$= \frac{C}{r\cos\beta} + \frac{1}{r\cos\beta}\int (p_3 \sin\beta - p_1\cos\beta)\, r\, ds_1$$

$$= \frac{C}{r\cos\beta} + \frac{1}{r\cos\beta}\int (p\sin\beta\cos\beta \mp p\sin\beta\cos\beta)\, r\, ds_1$$

$$= \frac{C}{r\cos\beta} + \frac{1}{r\cos\beta}\cdot 2\rho h \omega^2 \sin\beta\cos\beta \cdot \int r^2\, ds_1$$

$$0.$$

$$\text{а} \quad r = R - H\,\cancel{\sin\beta}\,tg\beta \; (H - z)\,tg\beta = R \; \cancel{+ (z - H)} + z \; tg\beta.$$

~~то. $T_1 = \dfrac{C}{r[R + (z - H)\,tg\beta]}$.~~ ~~$\dfrac{C}{(R + z\,tg\beta)\cos\beta}$~~

а $\dfrac{dr}{ds_1} = \sin\beta$, то $ds_1 = \dfrac{dr}{\sin\beta}$

$$\text{То.} \quad T_1 = \frac{C}{r\cos\beta} + \frac{2}{3}\rho h \omega^2 r^2 = \frac{C}{(R + z\,tg\beta)\cos\beta} + \frac{2}{3}\rho h \omega^2 (

№ 17. Шао Хуайтой СМ1-11-85Б

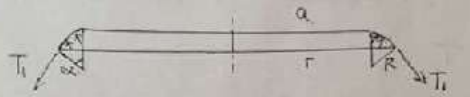
Чжан Сяоис

35

уравнение равновесия:

$$T_1 \sin\alpha \cdot 2\pi r = \pi P (r^2 - a^2)$$

$$T_1 = \frac{P(r^2-a^2)}{2r\sin\alpha}$$



$$r = a + R_1 \sin\alpha \qquad \frac{r-a}{R_1} = \sin\alpha$$

$$T_1 = \frac{P(r^2-a^2)}{2r\frac{r-a}{R}} = \frac{PR_1(r+a)}{2r}$$

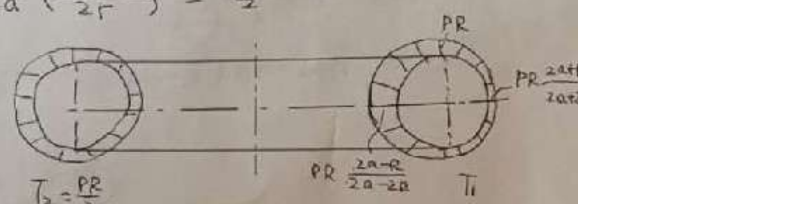
$$\frac{T_1}{R_1} + \frac{T_2}{R_2} = P \qquad T_2 = R_2\left(P - \frac{T_1}{R}\right) \quad R_2 = \frac{r}{\sin\alpha} = \frac{rR_1}{r-a}$$

$$T_2 = \frac{rR_1}{r-a}\left(P - \frac{P(r+a)}{2r}\right) = \frac{PrR_1}{r-a}\left(\frac{r-a}{2r}\right) = \frac{PR_1}{2}$$

при $r = a \quad T_1 = PR$

$r = a+R \quad T_1 = PR\left(\frac{2a+R}{2a+2R}\right)$

$r = a-R \quad T_1 = PR\left(\frac{2a-R}{2a-2R}\right)$



В точке A: $T_1 = PR\left(\frac{2a+R}{2a+2R}\right) \quad T_2 = \frac{PR_1}{2} \quad r = a+R$

$$U_r = \frac{r}{Eh}(T_2 + \mu T_1) = \frac{a+R}{Eh}\left(\frac{PR}{2} + \mu PR\frac{2a+R}{2a+2R}\right)$$

$$= \frac{PR}{2Eh}\left(a+R+\mu(2a+R)\right)$$

$$= \frac{PR}{2Eh}\left(a(1+2\mu) + R(1+\mu)\right)$$

В точке B: $T_1 = PR\left(\frac{2a-R}{2a-2R}\right) \quad T_2 = \frac{PR}{2} \quad r = a-R$

$$U_r = \frac{r}{Eh}(T_2 + \mu T_1) = \frac{a-R}{Eh}\left(\frac{PR}{2} + \mu PR\frac{2a-R}{2a-2R}\right)$$

$$= \frac{PR}{2Eh}\left(a-R+\mu(2a-R)\right)$$

$$= \frac{PR}{2Eh}\left(a(1+2\mu) - R(1+\mu)\right)$$

Коническая №5 Переписать СМ1-И-85Б

$$\frac{u_r}{r} = \frac{1}{Eh}(T_2 - \mu T_1)$$

в точке A. $r = a+R$, радиальное перемещение u_{rA}

$$u_{r_A} = \frac{r}{Eh}(T_2 - \mu T_1)$$

$$= \frac{r}{Eh}\cdot\omega^2 r^2 \rho h = \frac{\rho}{E}\omega^2 r^3 = \frac{\rho}{E}\omega^2 (a+R)^3$$

в точке B. $r = a-R$, радиальное перемещение u_{rB}

$$u_{rB} = \frac{r}{Eh}(T_2 - \mu T_1) = \frac{r}{Eh}\omega^2 r^2 \rho h = \frac{\rho}{E}\omega^2 r^3 = \frac{\rho}{E}\omega^2 (a-R)^3$$

1. Пак

Группа СМ1-85Б   Дун Сюэзян

Чжан Сяоси
...-85Б

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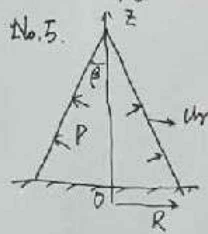
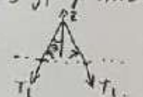
No.5.



решение: 1) ур. равновесия:



$$2\pi r T_1 \cos\beta = \pi r^2 p$$

2). $T_1 = \dfrac{p r}{2\cos\beta}$

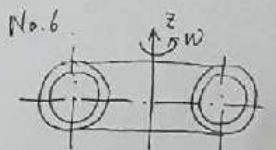
$$T_2 = R_2\left(p - \frac{T_1}{R_1}\right) = R_2 p = \frac{p r}{\cos\beta}$$

3) радиальные перемещения: U_r:

$$\frac{U_r}{r} = \frac{1}{Eh}(T_2 - \mu T_1) = \frac{1}{Eh}\left[\frac{pr}{\cos\beta}\left(1-\mu\frac{1}{2}\right)\right]$$

$$\Rightarrow U_r = \frac{p r^2}{Eh\cos\beta}\left(1-\frac{\mu}{2}\right)$$

No.6



решение:

1) $a^n = \omega^2 r$

$\Phi^n = \rho h \omega^2 r$

$P_3 = -\rho h \omega^2 r \cancel{\sin\alpha}$ $\sin\alpha$

$P_1 = \rho h \omega^2 r \cos\alpha$

?

2) $T_1 = 0$ очевидно

?

$$T_2 = R_2 P = \rho h \omega^2 r \sin\alpha \cdot \frac{r}{\sin\alpha} = \rho h \omega^2 r^2$$

точка A: $r = a + R$ $\Rightarrow T_{2A} = \rho h \omega^2 (a+R)^2$

точка B: $r = a - R$ $\Rightarrow T_{2B} = \rho h \omega^2 (a-R)^2$

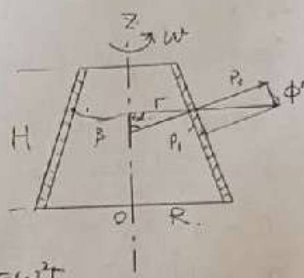
3) $\dfrac{U_r}{r} = \dfrac{1}{Eh}(T_2 - \mu T_1)$.

$$U_{rA} = \frac{r}{Eh}\rho h \omega^2 (a+R)^2 = \frac{1}{Eh}\rho h \omega^2 (a+R)^3$$

$$U_{rB} = \frac{1}{Eh}\rho h \omega^2 (a-R)^3$$

№ 13.

$$T_1 = \frac{1}{r\sin\alpha}\int (P_3\cos\alpha - P_1\sin\alpha)\, r\, ds_1 + \frac{C}{r\sin\alpha}$$



$P_1 = \Phi_n\cos\alpha \quad P_3 = \Phi_n\sin\alpha$

$T_1 = 0.$

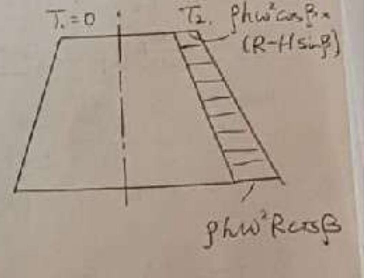
$T_2 = \left(P_3 - \frac{T_1}{R_1}\right)R_2 . \quad R_1 \to \infty \quad \frac{T_1}{R_1} \to 0 \quad a = \omega^2 r.$

$T_2 = P_3 \cdot R_2 = \rho h \omega^2 r \sin\alpha = \rho h \omega^2 r \cos\beta$

$R - r_{min} = H\sin\beta$

$r_{min} = -H\sin\beta + R$

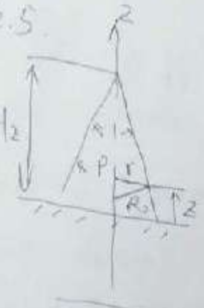
$T_{2min} = \rho h \omega^2 \cos\beta\,(R - H\sin\beta)$ ✓

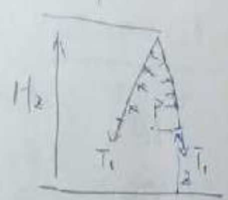


СМIИ-85Б Вон Чжоныой

36 Ткн

№5





$$R_1 = \infty$$

$$R_2 = \frac{(H_k - z)R}{H_k \cos\beta}$$

$$r = \frac{(H_k - z)R}{H_k} = (H_k - z)\,tg\beta$$

$$tg\beta = \frac{R}{H_k}$$

$$P\pi (H_k - z)^2 \frac{tg\beta}{\cos\beta}\sin\beta - T_1\, 2\pi r \cos\beta = 0.$$

$$T_1 = \frac{p(H_k - z)H_k \sin^2\beta}{2R\cos^3\beta.}$$

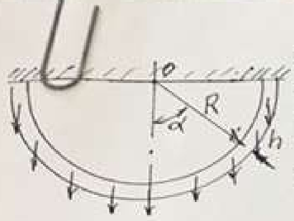
$$T_2 = R_2\left(P_3 - \underbrace{\frac{T_1}{R_1}}_{\to 0}\right) \qquad P_3 = P$$

$$= \frac{(H_k - z)Rp}{H_k \cos\beta}$$

$$\frac{u_r}{r} = \frac{1}{Eh}(T_2 - \mu T_1)$$

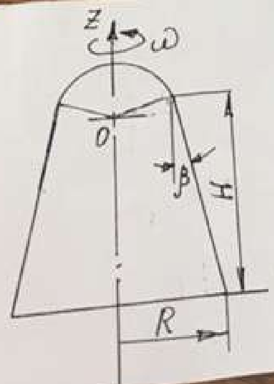
$$u_r = \frac{(H_k - z)^2 PR}{H_k Eh\cos\beta}\left(\frac{R}{H_k} - \mu\frac{H_k\, tg\beta}{2R}\right). \checkmark$$

№7



Полусферическая оболочка радиуса R и толщиной h подвешена за основание (рис.) и нагружена собственным весом. Плотность материала, из которого изготовлена оболочка ρ. Определить меридиональное T_1 и окружное T_2 усилие в оболочке.

№24



Усечённая коническая оболочка с углом полураствора конуса β и плавным сферическим скруглением в верхней части (рис.) вращается вокруг вертикальной оси z с угловой скоростью ω. Высота и радиус большого основания конуса H и R соответственно. Плотность материала, из которого изготовлена оболочка ρ, толщина оболочки h. Определить меридиональное T_1 и окружное T_2 усилие в конической … частях оболочки.

Хисамов
СМ1-8

$$\frac{T_1}{R_1}+\frac{T_2}{R_2}=P_3 \Rightarrow \frac{T_2}{R_2}=P_3-\frac{T_1}{R_1} \Rightarrow$$

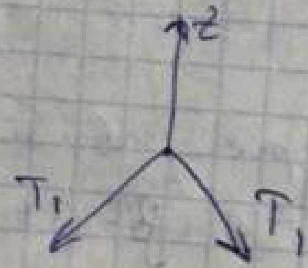
$$\Rightarrow T_2=\left(P_3-\frac{T_1}{R_1}\right)R_2 \Rightarrow P_3 R - T_1 \Rightarrow$$

$$\Rightarrow T_2=\left(\rho g R\cos\beta-\frac{G-\rho\pi R^2\sin^2\beta}{2\pi R^2\sin^2\beta}\right)R=$$

$$=\rho g R^2\cos\beta-\frac{G-\rho\pi R^2\sin^2\beta}{2\pi R\sin^2\beta}.$$

№2.

1) ур-е равн-я:



$$2\pi r T_1\cos\beta=\pi r^2 p.$$

2) $T_1=\frac{pr}{2\cos\beta}$; $T_2=R_2\left(p-\frac{T_1}{R_1}\right)=R_2 p=\frac{pr}{\cos\beta}$

3) $\frac{u_r}{r}=\frac{1}{Eh}\left(T_2-\mu T_1\right)=\frac{1}{Eh}\left(\frac{pr}{\cos\beta}\left(1-\mu\frac{1}{2}\right)\right)$

$$u_r=\frac{pr^2}{Eh\cos\beta}\left(1-\frac{\mu}{2}\right).$$

полуволн образуется по короткой стороне пластины, сжатой вдоль длинной?

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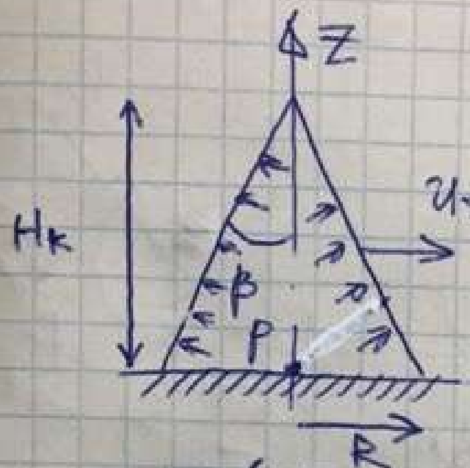
№5

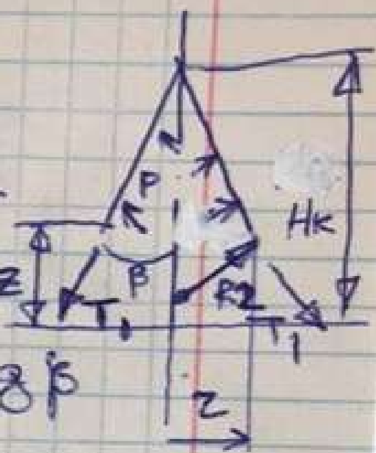
$H_к = \dfrac{R}{tg\beta}$ [illegible] В.В СМ1-8



$R_1 = \infty$

$$R_2 = \frac{(H_к - z)R}{H_к \cos\beta}$$

$$r = (H_к - z)\, tg\beta$$



$$p\pi (H_к - z)^2 \frac{tg\beta}{\cos\beta} \sin\beta - T_1 \cdot 2\pi r \cos\beta = 0$$

$$T_1 = \frac{p(H_к - z) H_к \sin^2\beta}{2R\cos^2\beta}$$

$$p_3 = p$$

$$T_2 = R_2\Big(p_3 - \cancel{\frac{T_1}{R_1}}^{\,0}\Big) = \frac{(H_к - z)Rp}{H_к \cos\beta}$$

$$\frac{u_r}{r} = \frac{1}{Eh}(T_2 - \mu T_1)$$

$$u_r = \frac{r}{Eh}\left(\frac{(H_к - z)}{H_к\cos\beta}Rp - \mu \frac{p(H_к - z)H_к \sin^2\beta}{2R\cos^2\beta}\right)$$

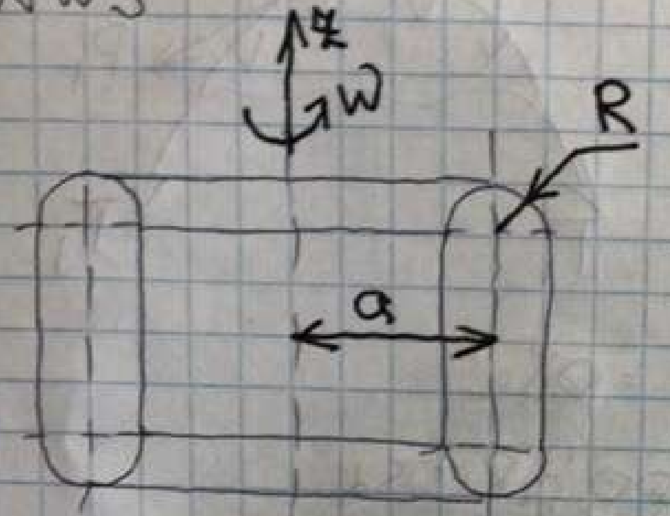
$$u_r = \frac{(H_к - z)^2 tg\beta\, p}{Eh}\left(\frac{R}{H_к\cos\beta} - \frac{\mu H_к}{2R} tg^2\beta\right)$$

$$u_r = \frac{(R - z\,tg\beta)^2 p}{Eh\,tg\beta}\left(\frac{tg\beta}{\cos\beta} - \frac{\mu}{2} tg\beta\right)$$

Яшкова Анна СМ1-82

Контрольная работа №2

№23



$$a^n = w^2 r$$

$$\Phi^n = \rho h w^2 r$$

$$P_1 = \Phi^n \cos\alpha = $$
$$= \rho h w^2 r \cos\alpha$$

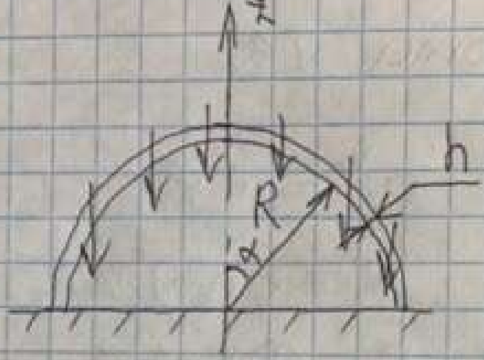
$$P_3 = \Phi^n \sin\alpha =$$
$$= \rho h w^2 r \sin\alpha$$

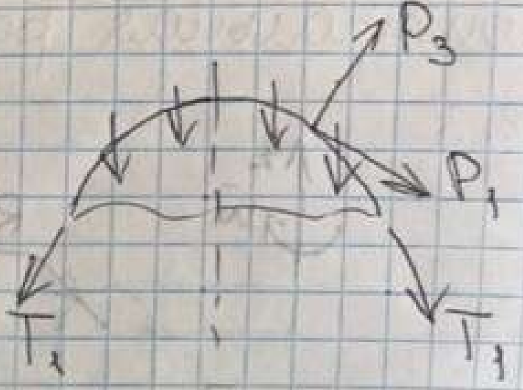
$$T_1 = \frac{C}{r\sin\alpha} + \frac{1}{r\sin\alpha}\int (P_3\cos\alpha - P_1\sin\alpha) r\,ds,$$

$$T_1 = 0$$

$$T_2 = P_3 R = \rho h w^2 r \sin\alpha \cdot R$$

N 12





$$T_1 \cdot 2\pi r \cdot \sin\alpha + G = 0$$

$$G = \rho g V \;;$$

$$V = 2\pi R^2 (1 - \cos\alpha) h$$

$$T_1 = -\frac{G}{2\pi r \sin\alpha}$$

$$r = R\sin\alpha$$

$$T_1 = -\frac{G}{2\pi R \sin^2\alpha} = -\frac{\rho g \cdot 2\pi R^2 (1-\cos\alpha) h}{2\pi R \sin^2\alpha} =$$

$$= -\frac{\rho g h (1-\cos\alpha)}{\sin^2\alpha}$$

$$\frac{T_1}{R_1} + \frac{T_2}{R_2} = P_3$$

$$T_2 = R_2 \left(P_3 - \frac{T_1}{R_1}\right)$$

$$P_3 = -\rho g h \cos\alpha$$

$$\frac{dz}{dr} = 2Ar$$

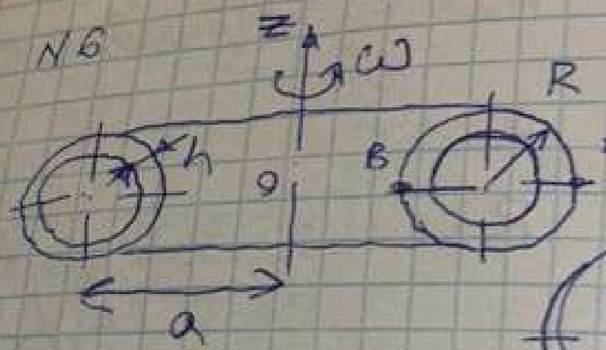
$$\operatorname{tg}\alpha = \frac{dz}{dr}$$

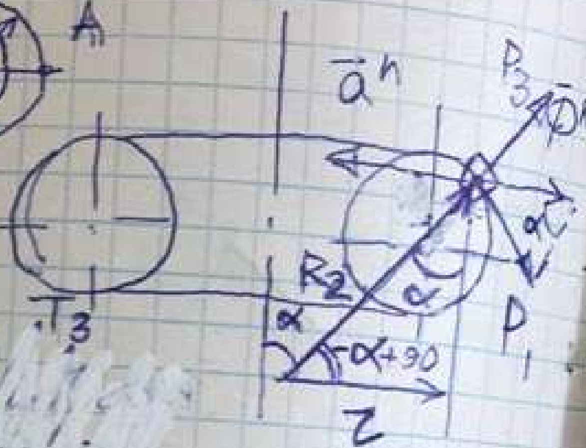
$$\operatorname{tg}\alpha = 2Ar \Rightarrow$$

$$\ldots = \frac{r}{\sin\alpha} = \frac{\operatorname{tg}\alpha}{2A\sin\alpha} = \frac{1}{2A\cos\alpha}$$

$$T_2 = R\rho\varphi_0 h\left(-\cos\alpha + \frac{1-\cos\alpha}{\sin^2\alpha}\right)$$

N6





$$R_2 = \frac{z}{\sin\alpha}$$

1) $a^n = \omega^2 z$

$\Phi^n = \rho h \omega^2 z$

$P_3 = \rho h \omega^2 z \sin\alpha$

$P_1 = \rho h \omega^2 z \cos\alpha$

2) $T_1 = 0$

3) $T_2 = R_2 P_3 = \rho h \omega^2 z \sin\alpha \frac{z}{\sin\alpha} = \rho h \omega^2 z^2$

точка A $r = a+R$ $T_{2A} = \rho h \omega^2 (a+R)^2$

точка B $r = a-R$ $T_{2B} = \rho h \omega^2 (a-R)^2$

3) $\frac{u_r}{r} = \frac{1}{Eh}(T_2 - \nu T_1)$

…нима формула для кр…
…стержня? Запишите выражение для преде…
…войства материала и предельное напряжение,
…ула для критических напряжений, известн…

…волн и критическое погонное усилие свободно
…тины сжатой по короткой стороне? Сколько
…ткой стороне пластины, сжатой вдоль длинной?

…рузка и для чего она вводится? Объясните на
…нного осевой силой.

…диаграмму потери устойчивости цилиндрической
… Сравните её с диаграммами потери

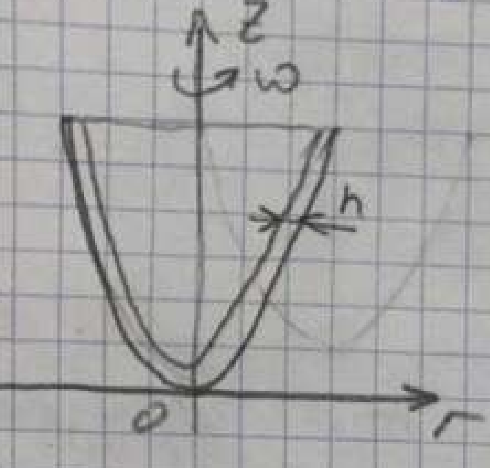
$$u_{ГA} = \frac{1}{Eh}\rho h\omega^2(a+R)^3$$

$$u_{ГB} = \frac{1}{Eh}\rho h\omega^2(a-R)^3$$

Рубежный контроль №2 - Папич А. 14.05.19

~~Вариант~~ СМ1-82

№9 лист 1.



Дано:

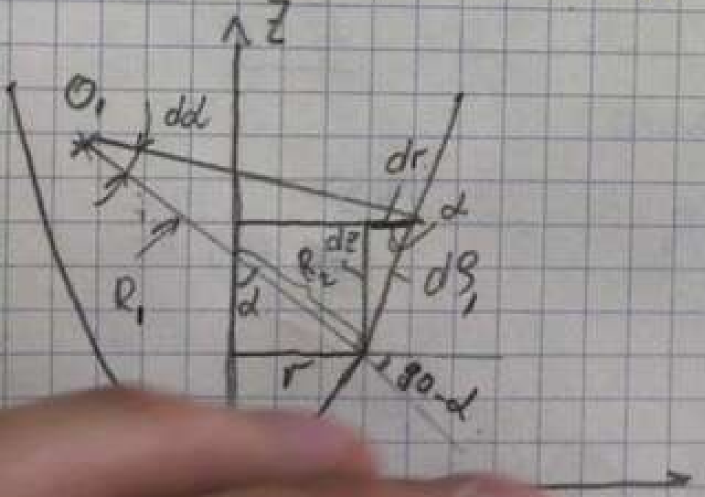
$z = Ar^2$

h, ω, ρ

$u_r - ?$

ешение:

определение главных радиусов кривизн.



$z = Ar^2 \Rightarrow$

$dz = 2Ar\,dr$

$\Rightarrow \frac{dz}{dr} = 2Ar.$

$tg\alpha = \frac{dz}{dr}$

$tg\alpha = 2Ar \Rightarrow$

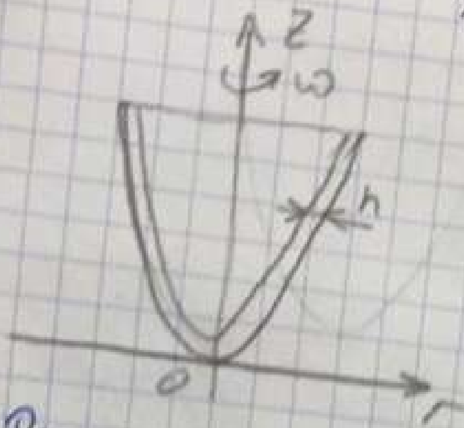
R ... $\sin\alpha = \frac{1}{2A\cos\alpha}$

Рубежный контроль №2 - Папич А. 14.05.19

Вариант №9

СМ1-82

лист 1.



Дано:

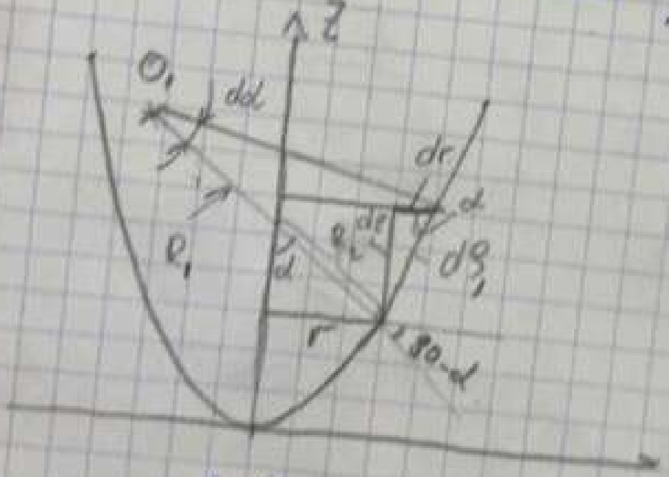
$z = Ar^2$

h, ω, ρ

u_r - ?

Решение:

1) определение главных радиусов кривизны.



$z = Ar^2 \Rightarrow$

$dz = 2Ar\,dr$

$\Rightarrow \frac{dz}{dr} = 2Ar.$

$tg\alpha = \frac{dz}{dr}$

$tg\alpha = 2Ar \Rightarrow$

$\Rightarrow \boxed{r = \frac{tg\alpha}{2A}}$

$\sin\alpha = \frac{r}{R_2} \Rightarrow R_2 = \frac{r}{\sin\alpha} = \frac{tg\alpha}{2A\cdot\sin\alpha} = \frac{1}{2A\cos\alpha}.$

$$dS_1 = R_1 d\alpha \Rightarrow R_1 = \frac{dS_1}{d\alpha} = \frac{dS_1}{dr}\cdot\frac{dr}{d\alpha} =$$

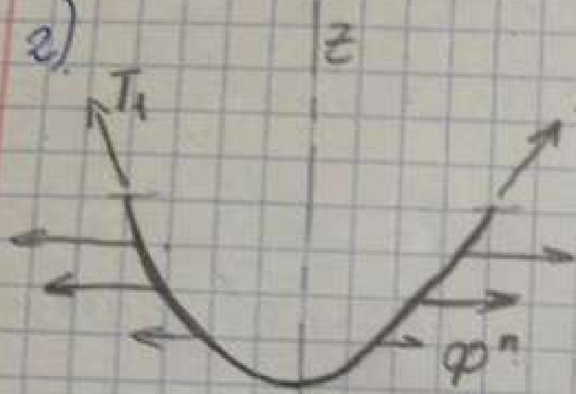
$$= \frac{1}{\cos\alpha}\cdot\frac{d}{d\alpha}\left(\frac{tg\alpha}{2A}\right) = \frac{1}{\cos\alpha}\cdot\frac{1}{2A}\cdot\frac{1}{\cos^2\alpha} = \frac{1}{2A\cdot\cos^3\alpha}$$

$$\Downarrow$$

$$R_1 = \frac{1}{2A\cdot\cos^3\alpha}$$

$$R_2 = \frac{1}{2A\cdot\cos\alpha}$$

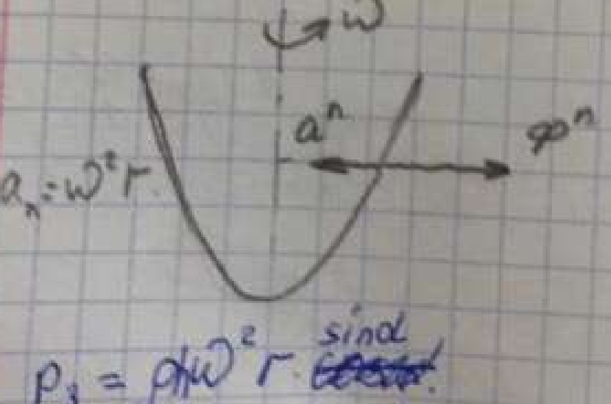
г)



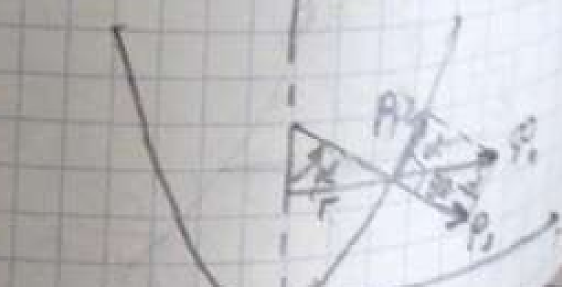
т.к. нагрузка уравновешивает сама себя, то $\underline{T_1 = 0}$

по ур-ю Лапласа:

$$\cancelto{0}{\frac{T_1}{R_1}} + \frac{T_2}{R_2} = p_3 \Rightarrow T_2 = p_3 \cdot R_2$$



$$\varphi^n = \rho h\omega^2 r$$



$$p_3 = \rho h\omega^2 r\cdot \frac{\sin\alpha}{\cancel{\cos\alpha}}$$

$$p_1 = \rho h\omega^2 r\cdot \frac{\cos\alpha}{\cancel{\sin\alpha}}$$

аров Магомед СМ1-82.

РК №2 | Ягубян, СМ1-82

$$T_2 = \rho\omega^2 r \sin\alpha \cdot \frac{1}{2A\cos\alpha} = \frac{\rho\omega^2}{2A} \cdot$$

$$T_2 = \rho\omega^2 h r \cdot \sin\alpha \cdot R_2 = \rho\omega^2 h R_2 \sin\alpha \cdot R\sin\alpha \cdot R_2 =$$

$$= \rho\omega^2 h \sin^2\alpha \cdot R_2^2 = \rho\omega^2 h \sin^2\alpha \cdot \frac{1}{4A^2\cos^2\alpha} =$$

$$= \rho\omega^2 h \frac{1}{4A^2} \cdot tg^2\alpha.$$

Радиальное перемещение:

$$\frac{u_r}{r} = \frac{1}{Eh}\left(T_2 - \mu \underset{0}{T_1}\right) = \frac{1}{Eh} \cdot T_2$$

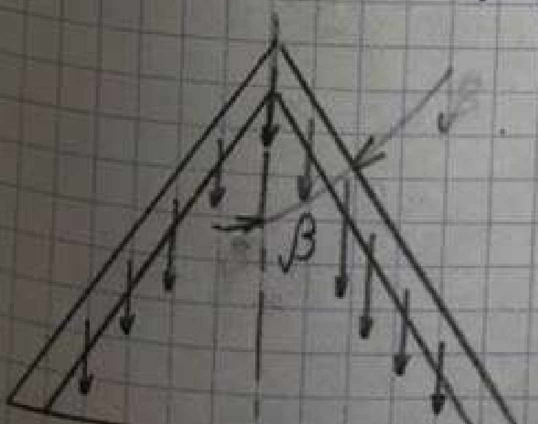
$$u_r = r \cdot \frac{1}{Eh} \cdot T_2 = R_2 \sin\alpha \cdot \frac{1}{Eh} \rho\omega^2 h \frac{1}{4A^2} \cdot tg^2\alpha =$$

$$= \frac{1}{2A\cos\alpha} \sin\alpha \cdot \frac{1}{Eh} \rho\omega^2 h \frac{1}{4A^2} \cdot tg^2\alpha =$$

$$= \frac{1}{8A^3} \cdot \frac{\rho\omega^2}{E\cancel{h}} \cdot tg^3\alpha.$$

$$\boxed{u_r = \frac{1}{8A^3} \cdot \frac{\rho\omega^2}{E\cancel{h}} tg^3\alpha.}$$

№ 8.



Дано: β, h, ρ, R

T_1, T_2 − ?

лист 2 Папич А.

№ 8 СМ1-82

(продолжение)

По ур-ю Лапласа:

$$\frac{T_1}{R_1} + \frac{T_2}{R_2} = p_з.$$

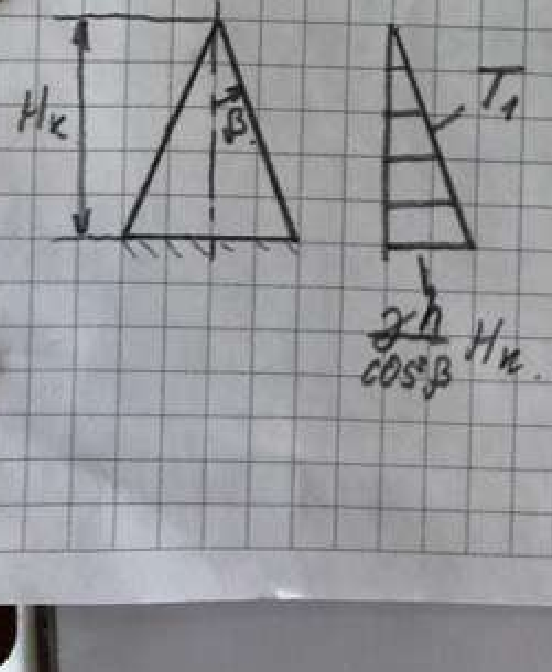
В данной задаче $p_з = 0$, $R_1 = \infty$

$\Rightarrow T_2 = 0 \cdot R_2 = 0 \qquad T_2 = 0$

Ранее: $T_1 = -\frac{\gamma h}{\cos^2\beta}(H_к - z)$

$z = 0$: $T_1 = -\frac{\gamma h}{\cos^2\beta} \cdot H_к$.

$z = H_к$: $T_1 = 0$.



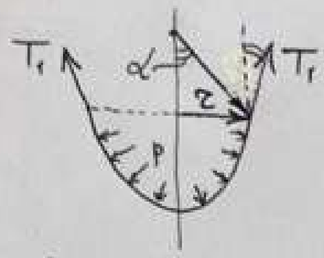
...тафаров Могаммед СМ1-82.

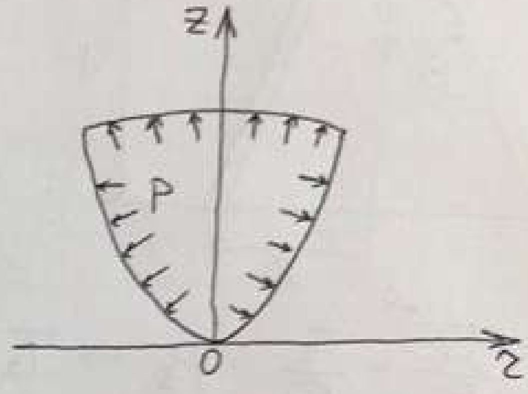
РК№2

Ягубян, СМ1-82

№3

Рассмотрим часть параболы:

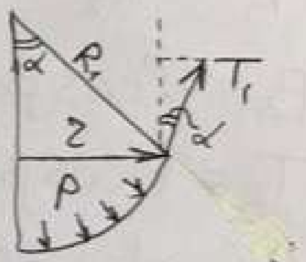




$$T_1 \cdot 2\pi r \cdot \sin\alpha = p \cdot \pi r^2$$

$$T_1 \cdot 2\sin\alpha = p r$$

$$T_1 = \frac{p r}{2\sin\alpha}$$



Уравнение Лапласа: $\frac{T_1}{R_1} + \frac{T_2}{R_2} = p_3 = p$

продифференцируем:

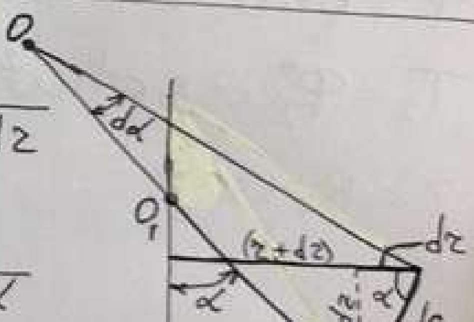
$$z = A r^2 \rightarrow \frac{dz}{dr} = 2Ar \Rightarrow r = \frac{dz}{2A\,dr}$$

$$\frac{dz}{dr} = tg\alpha \Rightarrow r = \frac{tg\alpha}{2A}$$

$$R_1 = \frac{r}{\sin\alpha} = \frac{tg}{2A\sin\alpha} = \frac{1}{2A\cos\alpha}$$

$$R_2 \cdot d\alpha = ds$$

$$R_2 = \frac{ds}{d\alpha}\frac{dr}{dr} = \frac{dr}{\cos\alpha\, d\alpha}$$



$OA = R_2$

$O_1A = R_1$

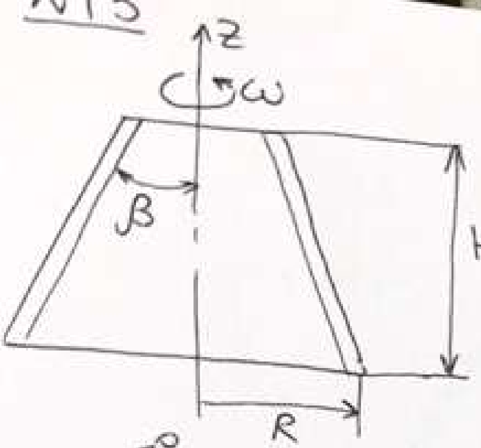
$$\frac{T_1}{R_1} = \frac{p r \cdot 2A\cos\alpha}{2\sin\alpha} = \frac{p r A}{tg\alpha} = p r A\, ctg\alpha$$

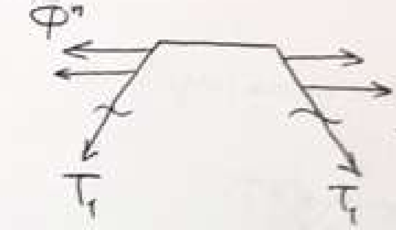
$$p r A\, ctg\alpha + \frac{T_2}{R_2} = p \Rightarrow T_2 = p(-rA\, ctg\alpha + 1)R_2$$

Джафаров Магамед СМ1-82.

N1. R; ρ. $T_1 - ?$; $T_2 - ?$

N13





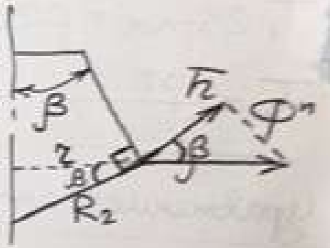
$\Rightarrow \underline{T_1 = 0}$

$$\cancel{\frac{T_1}{R_1}} + \frac{T_2}{R_2} = p_3 \Rightarrow T_2 = p_3 R_2$$

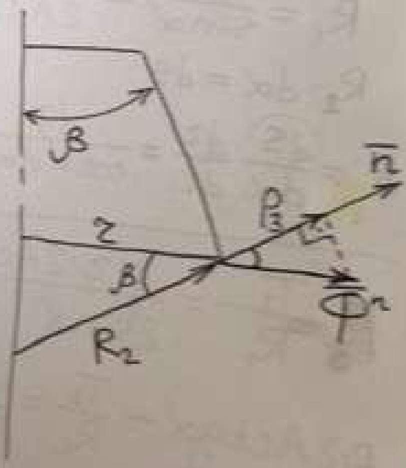
$$p_3 = \Phi^n \cos\beta$$

$$T_2 = \Phi^n \cos\beta\, R_2$$

$$\Phi^n = \rho h \omega^2 r$$

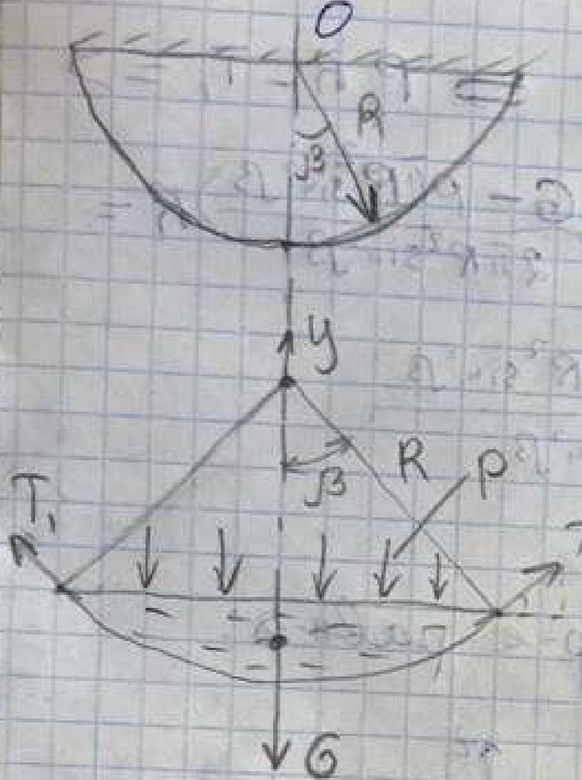


$$\left.\begin{aligned} T_2 &= R_2 \cos\beta\, \rho h \omega^2 r \\ r &= R_2 \cdot \cos\beta \end{aligned}\right\} \Rightarrow \underline{T_2 = R_2^2 \cos^2\beta \cdot \rho h \omega^2}$$



Джафаров Магомед СМ1-82.

№1.



$R;\ \rho.$

$T_1 - ?\ ;\ T_2 - ?$

$G = \rho g V.$

$V = \frac{\pi R^3}{3}(2 - 3\cos\beta + \cos^3\beta)$

$p = \rho g R \cos\beta.$

Напишем ур-е равн-я: $\Sigma F_y = 0$:

$T_1 \cdot 2\pi r \sin\beta - G + p\pi r^2 = 0.$

$r = R\sin\beta.$

Получим: $T_1 \cdot 2\pi R \sin^2\beta - G + p\pi r^2 = 0.$

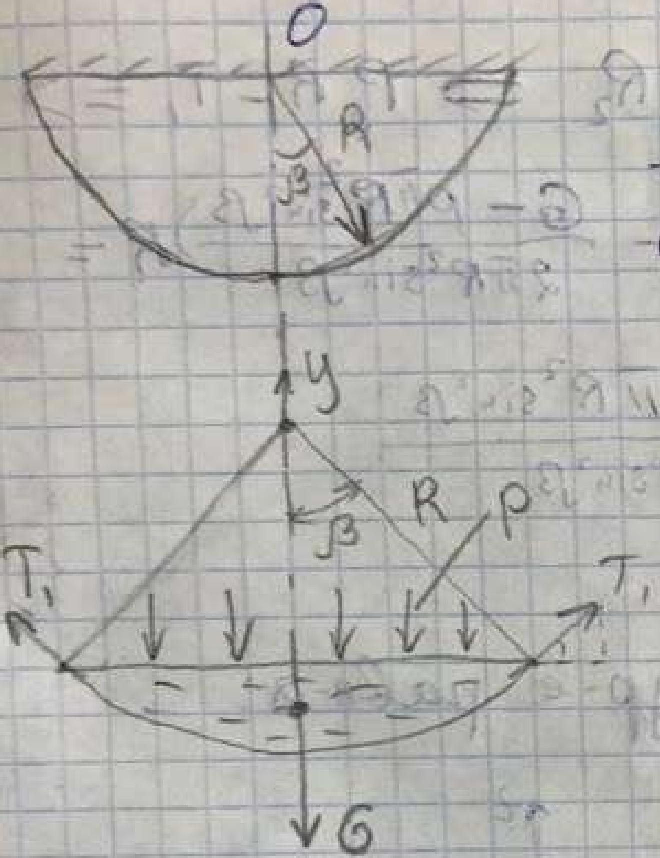
$T_1 = \frac{G - p\pi r^2}{2\pi R \sin^2\beta}.$

Для жидкости: $p_3 = p_{жид} = \rho g h = \rho g R\cos\beta$

Напишем ур-е Лапласа:

Джафаров Могаммед СМ1-82.

№1.



$R;\ \rho.$

$T_1-?\ ;\ T_2-?$

$G = \rho g V.$

$V = \frac{\pi R^3}{3}(2 - 3\cos\beta + \cos^3\beta).$

$P = \rho g R\cos\beta.$

Напишем ур-е равн-я: $\Sigma F_y = 0$:

$T_1 \cdot 2\pi r \sin\beta - G + p\pi r^2 = 0.$

$r = R\sin\beta.$

Получим: $T_1 \cdot 2\pi R\sin^2\beta - G + p\pi r^2 = 0.$

$$T_1 = \frac{G - p\pi r^2}{2\pi R\sin^2\beta}.$$

Для жидкости: $P_3 = P_{жид} = \rho g h = \rho g R\cos\beta$

Напишем ур-е Лапласа:

$$\frac{T_1}{R_1} + \frac{T_2}{R_2} = P_3 \Rightarrow \frac{T_2}{R_2} = P_3 - \frac{T_1}{R_1} \Rightarrow$$

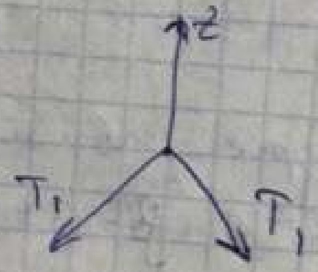
$$\Rightarrow T_2 = \left(P_3 - \frac{T_1}{R_1}\right) R_2 \Rightarrow P_3 R - T_1 \Rightarrow$$

$$\Rightarrow T_2 = \left(\rho g R\cos\beta - \frac{G - \rho\pi R^2 \sin^2\beta}{2\pi R^2 \sin^2\beta}\right) R =$$

$$= \rho g R^2 \cos\beta - \frac{G - \rho\pi R^2 \sin^2\beta}{2\pi R \sin^2\beta}.$$

№2.

1) ур-е равн-я:



$$2\pi r T_1 \cos\beta = \pi r^2 p.$$

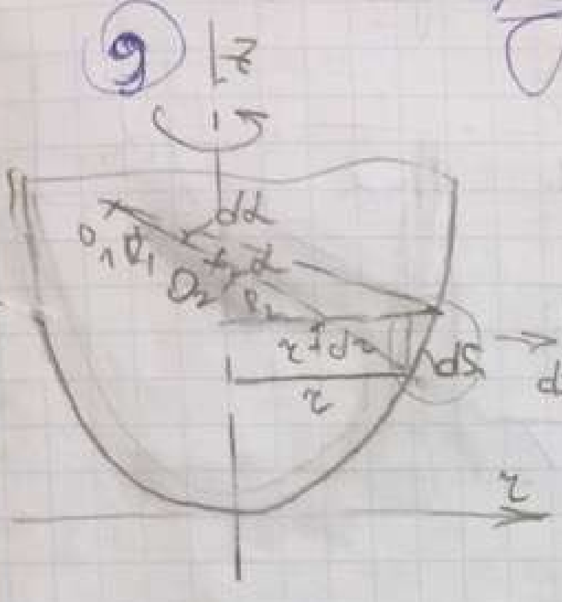
2) $T_1 = \frac{pr}{2\cos\beta}$; $T_2 = R_2\left(p - \frac{T_1}{R_1}\right) = R_2 p = \frac{pr}{\cos\beta}$

3) $\frac{u_r}{r} = \frac{1}{Eh}(T_2 - \mu T_1) = \frac{1}{Eh}\left(\frac{pr}{\cos\beta}\left(1 - \mu\frac{1}{2}\right)\right)$

$u_r = \frac{pr^2}{Eh\cos\beta}\left(1 - \frac{\mu}{2}\right).$

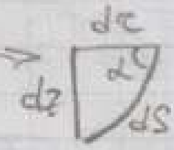
Тагшидов Т. СМ1-89

9



$z = Ar^2 \to dz = 2Ar\,dr \to$ 25 Тел

$\boxed{r = \frac{dz}{2A\,dr}}$



$dS \cdot \cos\alpha = dr$

$\frac{dz}{dr} = tg\alpha; \quad \frac{dS}{dr} = \frac{1}{\cos\alpha}$

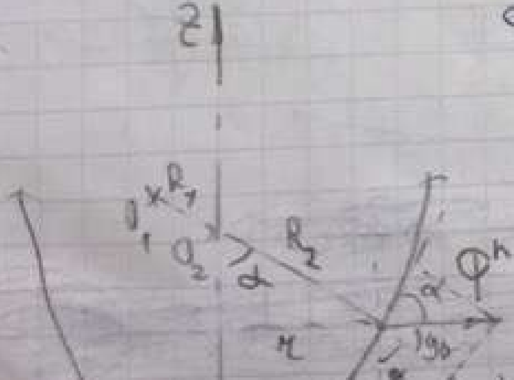
$R_2 = \frac{r}{\sin\alpha} = \frac{1}{\sin\alpha} \cdot \frac{dz}{2A\,dr} = \frac{1}{\sin A} \cdot \frac{1}{2A} \cdot tg\alpha = \frac{1}{2A}\frac{1}{\cancel{\sin\alpha}}\frac{\cancel{\sin\alpha}}{\cos\alpha}$

$dS = R_1\,d\alpha \to R_1 = \frac{dS}{d\alpha} \cdot \frac{dr}{dr} = \frac{1}{\cos\alpha} \cdot \frac{1}{2A} \cdot \frac{1}{\cos^2\alpha} =$

$\frac{1}{\cos\alpha} \qquad = \frac{1}{2A\cos^3\alpha}$

$\boxed{R_2 = \frac{1}{2A} \cdot \frac{1}{\sin\alpha} \cdot tg\alpha} = \frac{1}{2A\cos\alpha}$

$\boxed{R_1 = \frac{1}{2A \cdot \cos^3\alpha}}$



$\Phi^n = \rho\omega^2 r h$

$p_3 = \Phi^n \cdot \cos(90^\circ - \alpha) = \Phi^n \sin\alpha =$

$p_1 = \Phi^n \cdot \cos\alpha =$

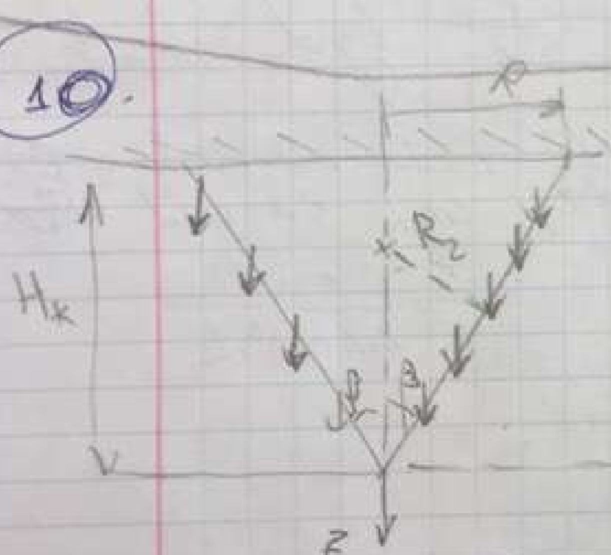
$T_1 = \frac{c}{r\sin\alpha} - \frac{1}{r\sin\alpha}\int(\Phi^n \cancel{\sin\alpha}\cos\alpha - \Phi^n \cancel{\cos\alpha}\sin\alpha)\, r\,dS_1 = 0.$

По ур. Лапласа: $\frac{\cancel{T_1}}{\cancel{R_1}} + \frac{T_2}{R_2} = p_3 \to$

$$\to \boxed{T_2 = p_3 R_2 = \Phi'' \sin\alpha \cdot \frac{1}{2A} \cdot \frac{1}{\sin\alpha} \cdot tg\alpha}$$

$$\boxed{u_r = \frac{r}{Eh}(T_2 - \cancel{\mu T_1}) = \frac{r}{Eh} T_2}$$

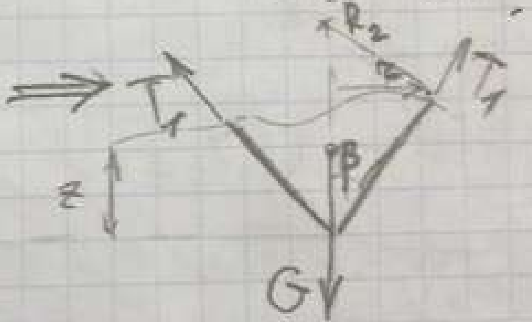
10.



$tg\beta = \frac{R}{H_k} \to H_k = \frac{R}{tg\beta}$

$\frac{r}{z} = tg\beta \to r = z\,tg\beta$

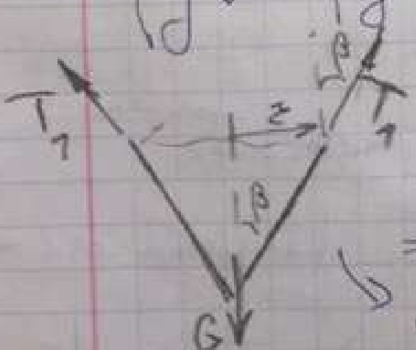
$\Rightarrow$



В этой фо

В этой формуле?

$$G = \rho g V = \rho g h (H_k - z)^2 \pi \frac{tg\beta}{\cos\beta}$$



$\Rightarrow$

$$G - T_1 \cdot \cos\beta \cdot 2\pi r = 0 \to$$

$$\to \boxed{T_1 = \frac{G}{2\pi r \cos\beta} = \frac{\rho g h (H_k - z)^2 \pi \frac{tg\beta}{\cos\beta}}{2\pi z\, tg\beta \cos\beta}}$$

$1 - \frac{ctg\alpha}{\ldots}) = T_3$

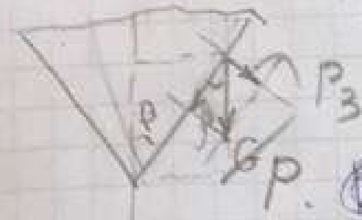
По ур. Лапласа: $\cancel{\frac{T_1}{R_1}} + \frac{T_2}{R_2} = p_3 \Rightarrow$

$0 \quad \infty$

$\Rightarrow T_2 = p_3 R_2$ $\qquad p_3 = \gamma \cdot h \cdot \sin\beta$

$$p_3 = \frac{G \cdot \sin\beta \cdot \frac{1}{2\pi r \cdot h}}{} = \frac{G \sin\beta}{2\pi \cdot z\, tg\beta \cdot h}$$

площадь



не путать вес G с распределённой нагрузкой

p. – $p = \gamma h = \rho g h$.

$$r = R_2 \cos\beta \rightarrow \boxed{R_2 = \frac{r}{\cos\beta} = \frac{z\, tg\beta}{\cos\beta}}$$

$$\boxed{T_2 = \frac{G\sin\beta}{2\pi \cancel{z\, tg}\beta\, h} \cdot \frac{\cancel{z\, tg}\beta}{\cos\beta} = \frac{G\sin\beta}{2\pi\cos\beta\, h} = \frac{G\, tg\beta}{2\pi h}}$$

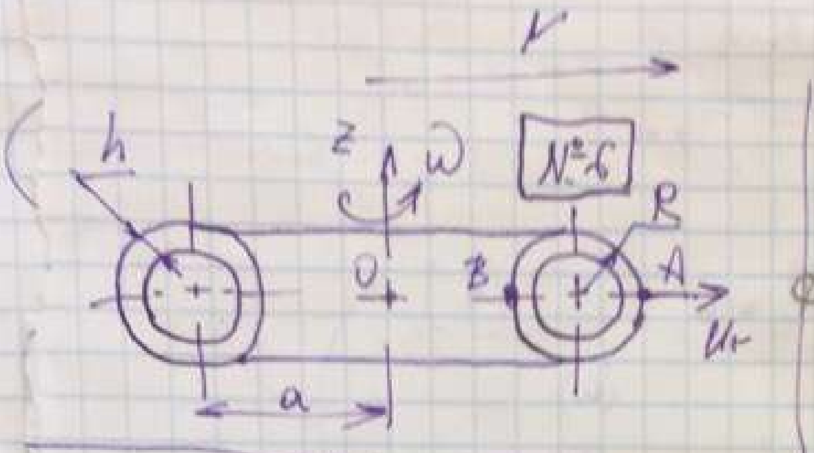
этой формуле z от вершины конуса?

формуле z от основания конуса

(28) Тел

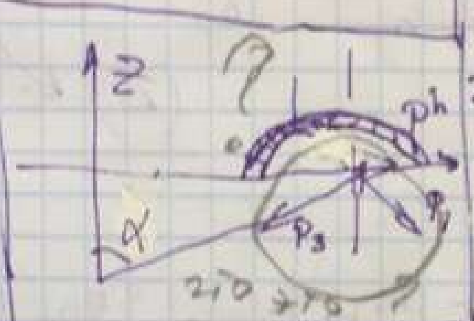
14.05.19г.

Марковский И.О.



Дано:
h, z, ω, ρ

u_r - ?



Реш-е.

1) $a^n = \omega^2 r$ где ? ? α ? R_2 - ?

$p^n = \rho h \omega^2 r$

$p_3 = -\rho h \omega^2 r \sin\alpha$ } где это видно

$p_1 = \rho h \omega^2 r \cos\alpha$

2) $T_1 = 0$ что такое T_1?

$T_2 = R_2 P - \rho h \omega^2 r \sin\alpha \cdot \frac{r}{\sin\alpha} = \rho h \omega^2 r^2$

Точка A: $r = a + R \Rightarrow T_2 A = \rho h \omega^2 (a+R)^2$

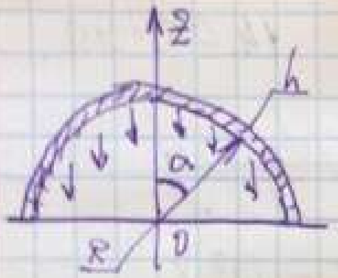
Точка B: $r = a - R \Rightarrow T_2 B = \rho h \omega^2 (a-R)^2$

3) $\frac{u_r}{r} = \frac{1}{Eh}(T_2 - \mu T_1)$

$$u_{rA} = \frac{r}{Eh} \rho h \omega^2 (a+R)^2 = \frac{1}{Eh} \rho h \omega^2 (a+R)^3$$

$$u_{rB} = \frac{1}{Eh} \rho h \omega^2 (a-R)^3$$

№ 12



Дано:
R, h, ρ
$T_1, T_2 - ?$

ур-о урівноваження. [illegible], це рисунок

1) $T_1 \cdot 2\pi r \cdot \sin\alpha + G = 0$ (1)

$G = \rho g V$ (а)

$V = 2\pi R^2 (1-\cos\alpha) h$ (б)

$T_1 = -\dfrac{G}{2\pi r \sin\alpha}$ (2)

$r = R\sin\alpha$ (в)

(а)(б)(в) → (2) $T_1 = -\dfrac{2\pi \rho g R^2 (1-\cos\alpha) h}{2\pi R \sin^2\alpha} = -\dfrac{\rho g h (1-\cos\alpha)}{\sin^2\alpha}$

2) $\dfrac{T_1}{R_1} + \dfrac{T_2}{R_2} = p_3$; $R_1 = R_2$.

$T_2 = R_2 \left(p_3 - \dfrac{T_1}{R_1} \right)$

$p_3 = -\rho g h \cos\alpha$

$T_2 = R \rho g h \left(-\cos\alpha + \dfrac{1-\cos\alpha}{\sin^2\alpha} \right)$ ✓

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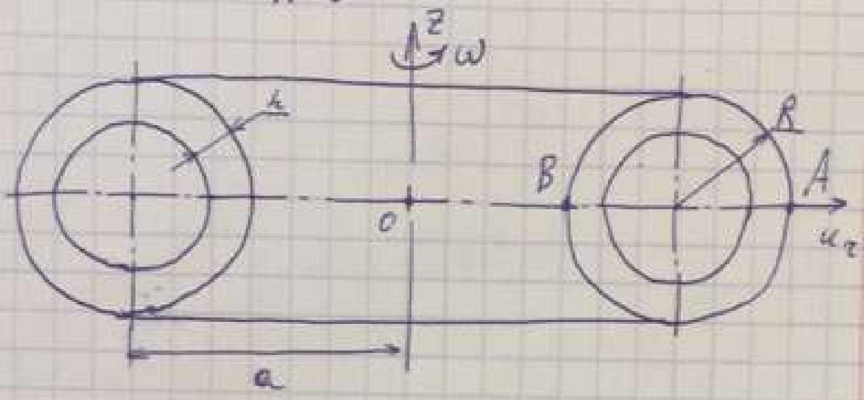
СМ1-89

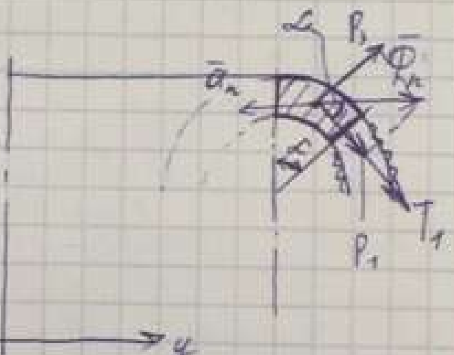
35

№ 6

ρ - плотность



$\Phi_n = \rho h \ \omega^2 r = \rho h \, a_n$



$P_3 = \rho h \omega^2 r \sin\alpha$

$P_1 = \rho h \omega^2 r \cos\alpha$

$\Sigma F_z = 0$: $\Sigma F_z = 0$

$T_1 = 0$

ур. Лапласа: $\frac{T_1}{R_1} + \frac{T_2}{R_2} = P$.

$T_2 = R_2 P = \rho h \omega^2 r^2$; $u_r = \frac{r}{Eh}(T_2 - \mu T_1)$

т. A: $r = a + R \Rightarrow T_2 = \rho h \omega^2 (a+R)^2 \Rightarrow u_r^A = \frac{\rho \omega^2}{E}(a+R)^3$

т. B: $r = a - R \Rightarrow T_2 = \rho h \omega^2 (a-R)^2 \Rightarrow u_r^B = \frac{\rho \omega^2}{E}(a-R)^3$

Ответ: $u_r^A = \frac{\rho \omega^2}{E}(a+R)^3$ $u_r^B = \frac{\rho \omega^2}{E}(a-R)^3$

$e^{-k\ell}(\cos k\ell + \sin k\ell) = 0{,}05$

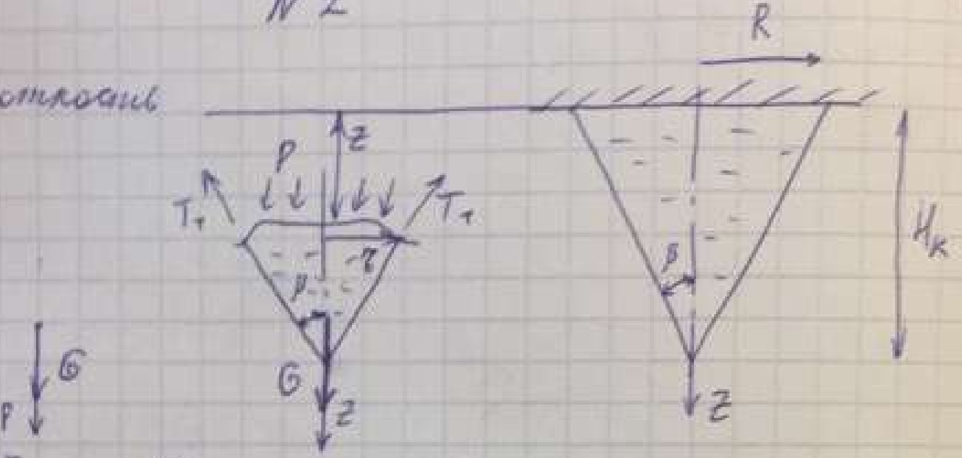
$kl = \ln 28$ $\quad l = \frac{\ln 28}{k} = 3{,}35$

Найти: T_1;

Решение:

N 2

ρ - плотность



$$H_к = \frac{R}{tg\beta} \qquad V = \frac{1}{3}\pi (H_к - z)^2 tg^2\beta$$

$$tg\beta = \frac{R}{H_к}$$

$$G = \rho g V$$

$$p = \rho g z$$

$$\sum F_{z} = 0: \; T_1 \cdot 2\pi r\cos\beta - \rho g \frac{1}{3}\pi (H_к - z)^2 tg^2\beta - \rho g z \, tg^2\beta\, \pi (H_к - z)^2 = 0$$

$$r = (H_к - z)\, tg\beta$$

$$\boxed{T_1 = \frac{(H_к - z)\rho g\, tg\beta}{2\cos\beta}\left[(H_к - z)\frac{1}{3} + z\right] = \frac{(R - z\,tg\beta)\rho g}{6\cos\beta}\left(\frac{R}{\cancel{3}tg\beta} + \frac{2}{\cancel{3}}z\right)}$$

ур. Лапласа

$$\left.\begin{aligned} &\frac{T_1}{R_1} + \frac{T_2}{R_2} = p_3 \\ &R_1 \to \infty \Rightarrow \frac{T_1}{R_1} \to 0 \end{aligned}\right\} \qquad \left.\begin{aligned} &T_2 = p_3 R_2 \\ &p_3 = p_{жидк} = \rho g z \\ &R_2 = \frac{r}{\cos\beta} \end{aligned}\right\} \Rightarrow$$

$$\Rightarrow \boxed{T_2 = \rho g z \frac{R - z\,tg\beta}{\cos\beta}}$$

$z = 0 \Rightarrow$

$z = H_к \Rightarrow$

Ответ:

Дано: ρ, ...

Найти: $T_1; T_2$

Решение:

$$z = 0 \Rightarrow T_1 = \frac{R\rho g}{6\cos\beta}\,\frac{R}{tg\beta} = \frac{\rho g R^2}{6\sin\beta};\quad T_2 = 0$$

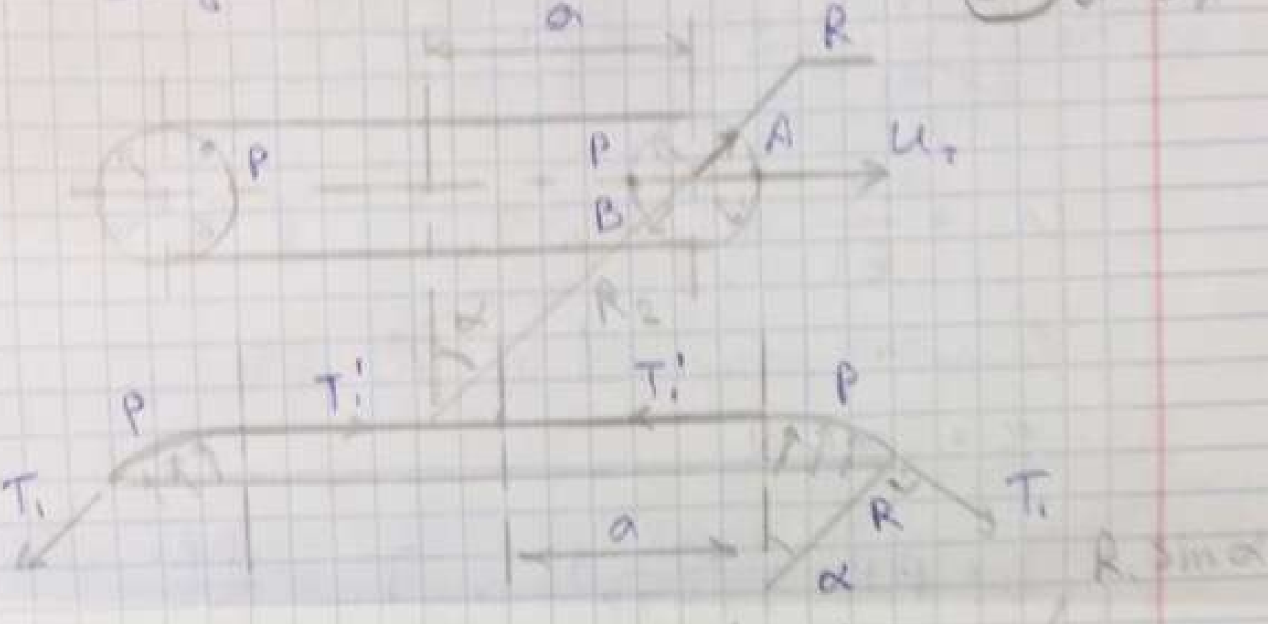
$$z = H_k = \frac{R}{tg\beta} \Rightarrow T_1 = 0;\quad T_2 = 0$$

Ответ: $z = 0$: $T_1 = \frac{\rho g R^2}{6\sin\beta}$; $T_2 = 0$;

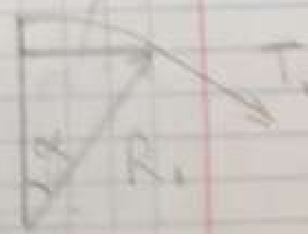
$z = H_k$: $T_1 = 0$; $T_2 = 0$.

Стариков Т.Р. 14.05.19г

Задача №17 35 Тел



$$T_1 \cdot \sin\alpha \cdot 2\pi r = \pi p (r^2 - a^2)$$



$$\Rightarrow T_1 = \frac{p(r^2 - a^2)}{2r\sin\alpha}$$

$$r = a + R_1 \sin\alpha \quad , \quad \frac{r-a}{R_1} = \sin\alpha$$

$$T_1 = \frac{p(r^2 - a^2)}{2r\frac{(r-a)}{R_1}} \Rightarrow T_1 = \frac{p(r+a)R_1}{2r} \checkmark$$

Ур-ние Лапласа:

$$\frac{T_1}{R_1} + \frac{T_2}{R_2} = p \Rightarrow T_2 = \left(p - \frac{T_1}{R_1}\right) R_2$$

$$R_2 = \frac{r}{\sin\alpha} = \frac{rR_1}{r-a}$$

$$\Rightarrow \quad T_2 = \frac{r R_1}{r-a}\left(p - \frac{p(r+a)}{2r}\right) =$$

$$= \frac{p R_1 r}{r-a}\,\frac{(r-a)}{2r} = \frac{p R_1}{2} \quad \checkmark$$

$$u_r = \frac{r}{Eh}\left(T_2 - \mu T_1\right)$$

Смотрим в т. A:

$$r = a + R$$

$$T_1 = pR\left(\frac{2a+R}{2a+2R}\right), \quad T_2 = \frac{pR}{2}$$

$$u_r = \frac{a+R}{Eh}\left(\frac{pR}{2} + \mu pR\,\frac{2a+R}{2a+2R}\right) =$$

$$= \underbrace{\frac{pR}{2Eh}\left(a(1+2\mu) + R(1+\mu)\right)}\ \checkmark$$

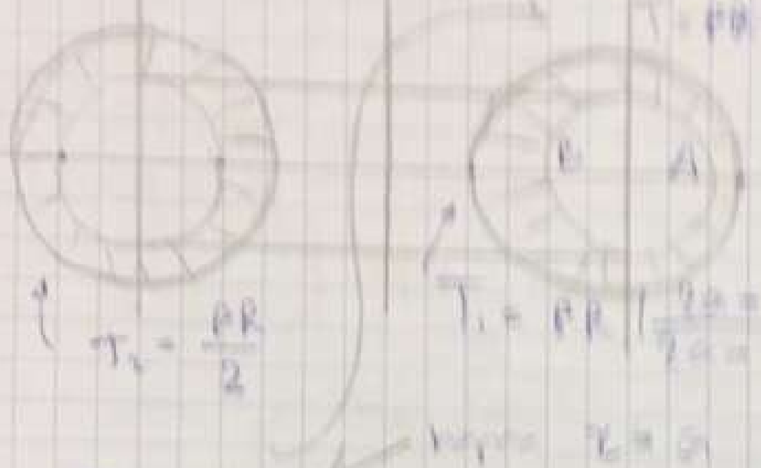
В т. B:

$$r = a - R$$

$$T_1 = pR\left(\frac{2a-R}{2a-2R}\right), \quad T_2 = \frac{pR}{2}$$

$$u_r = \frac{a-R}{Eh}\left(\frac{pR}{2} + \mu pR\,\frac{2a-R}{2a-2R}\right) =$$

$$= \underbrace{\frac{pR}{2Eh}\left(a(1+2\mu) - R(1+\mu)\right)}\ \checkmark$$



$T = PR$

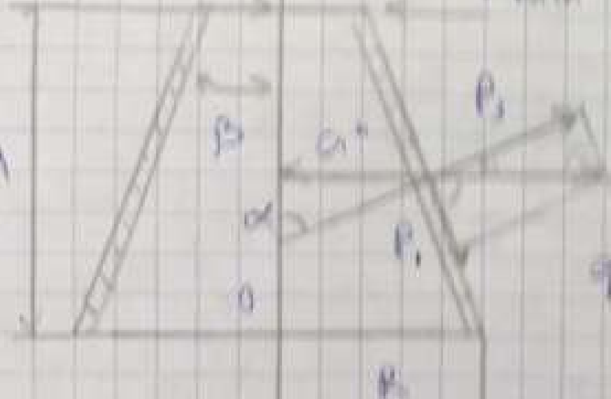
$T_1 = \frac{PR(2a+R)}{(2a+2R)}$

$T_2 = \frac{PR}{2}$

$T_1 = PR\left(\frac{2a+R}{2a+2R}\right)$

$T_1 = PR$

~ 2 (13)



$P_2 = \varphi_n \sin\alpha$

$P_1 = \varphi_n \cos\alpha$

$r\omega^2 = a^2$

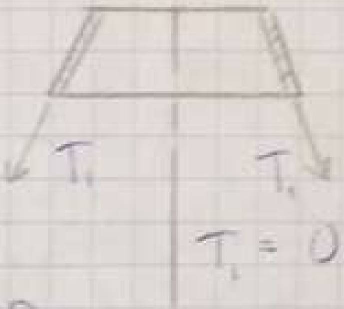
$\varphi_n = gh\,\omega^2 r = gh\,a^2$

$$T_1 = \frac{C}{r\frac{\cos\alpha}{\sin\alpha}} + \frac{1}{r\frac{\cos\alpha}{\sin\alpha}}\int (P_2\cos\alpha - P_1\sin\alpha)\, r\, ds_1$$

$$= \frac{C}{r\frac{\cos\alpha}{\sin\alpha}} + \frac{1}{r\sin\alpha}\varphi_n \int \underbrace{(\sin\alpha\cos\alpha - \cos\alpha\sin\alpha)}_{0}\, r\, ds_1$$

$\Rightarrow C = 0$, $\alpha = 0$, $r = 0$

$\Rightarrow T_1 = 0$



T_2 из равенства:

$$T_2 = R_2 \left(P_3 - \frac{T_1}{R_1} \right) = R_2 P_3$$

$$T_2 = \rho h \omega^2 r \sin\alpha = \rho h \omega^2 r \cos\beta$$

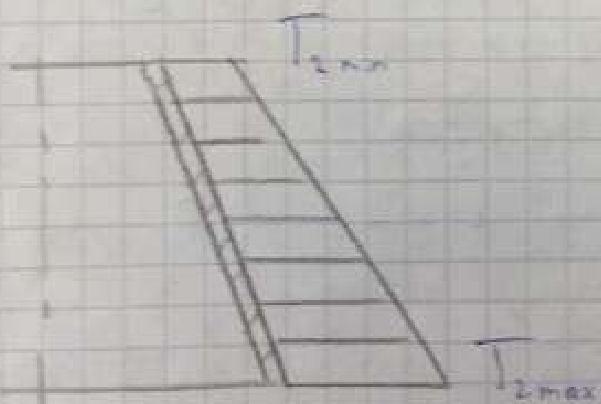
Т при $r = R$:

$$T_2 = \rho h \omega^2 R \sin\alpha = \rho h \omega^2 R \cos\beta = \underbrace{}_{= T_{2max}}$$

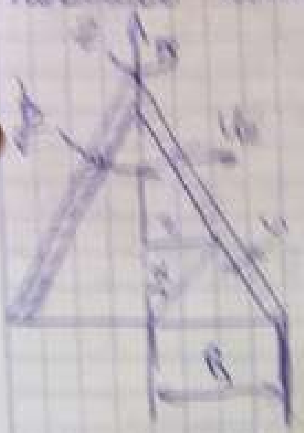
$$R - r_{min} = H \sin\beta$$

$$r_{min} = R - H \sin\beta$$

$$T_2 = \rho h \omega^2 (R - H \sin\beta) \cos\beta = T_{2min}$$



Новицький Климик СМ-41



$\Phi = \rho h d s \omega^2 z$

[illegible]

Φ_0 [illegible]

[illegible]

$T_1 = 0$

$\Sigma F = 0 \Rightarrow T_1 = 0$

$T_2 = P_z R_2$ $\Phi = ?$

где $P_z = \frac{\Phi_0}{ds} \cos\beta$ где P_z?, $R = \frac{r}{\cos\beta}$?

$u_z = \frac{1}{Eh}(T_2 - \mu T_1) = \frac{1}{Eh} \cdot P_z R_2 = \frac{R^2 \cos\beta \, \Phi}{Eh \, ds}$?

$= \frac{R^2 \cos^2\beta \, \Phi_0}{Eh\,ds} = \frac{R^2 \cos^2\beta \, \rho h d s \omega^2 z}{Eh\,ds} =$

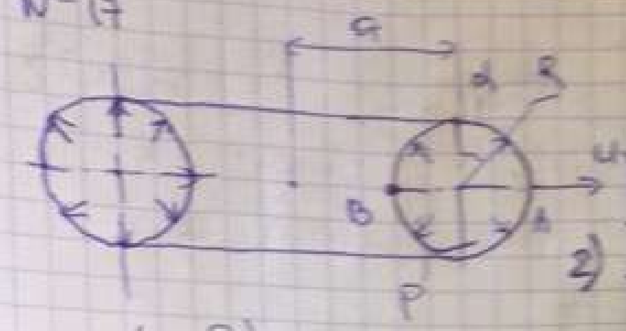
$= \frac{R^2 \cos^2\beta \, \rho \omega^2}{E}$

Написать [illegible]

$A = \Phi^4$ [illegible]

[illegible] $\frac{\Phi}{ds}$ [illegible]

№ 17

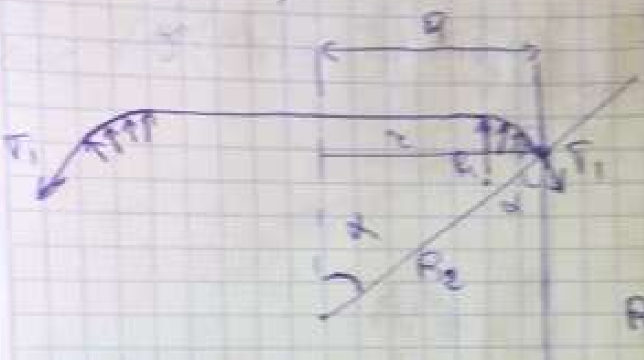


1) $p\pi(r^2-a^2) = T_1 2\pi r\sin\alpha$

$T_1 = p\frac{(r^2-a^2)}{2\sin\alpha \cdot r}$

2) $\frac{T_1}{R_1}+\frac{T_2}{R_2}=p$ $r=a+R_1\sin\alpha$ $R_1=\frac{r-a}{\sin\alpha}$

$T_2=\left(p-\frac{T_1}{R_1}\right)R_2$



$\frac{T_1}{R_1} = \frac{p(r^2-a^2)\sin\alpha}{2\sin\alpha \, r\,(r-a)} = \frac{p(r+a)}{2r}$; $R_2 = \frac{r}{\sin\alpha}$

$R_2=\frac{rR_1}{r-a}$

3) $T_2 = \left(p-\frac{p(r+a)}{2r}\right)\cdot\frac{rR_1}{r-a} = \frac{prR_1}{r-a}\left(\frac{r-a}{2r}\right) = \frac{pR_1}{2}$ ✓

при $r=a$: $T_1 = pR$

$r=a+R$: $T_1 = pR\frac{(2a+R)}{(2a+2R)}$

в (·)A: $T_1=pR\left(\frac{2a+R}{2a+2R}\right)$, $T_2=\frac{pR}{2}$, $r=a+R$

$u_z=\frac{r}{Eh}(T_2-\mu T_1)=\left(\frac{pR}{2}-\mu pR\frac{2a+R}{2a+2R}\right)\frac{r}{Eh}$ $(a+R)$

в (·)B: $T_1=pR\left(\frac{2a-R}{2a-2R}\right)$, $T_2=\frac{pR}{2}$, $r=a-R$

$u_z=\frac{r}{Eh}(T_2-\mu T_1)=\left(\frac{pR}{2}-\mu pR\frac{2a-R}{2a-2R}\right)\frac{r}{Eh}$ $(a-R)$

РК№2

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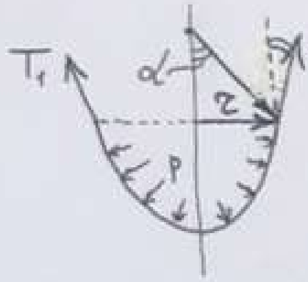
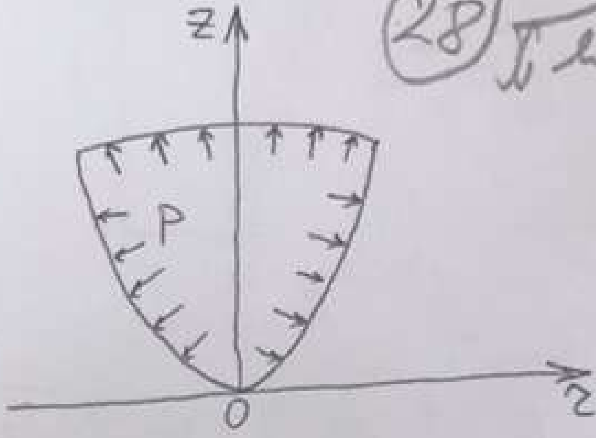
№3

Рассмотрим часть параболы:

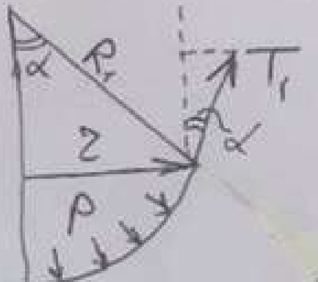




$T_1 \cdot 2\pi r \cdot \sin\alpha = p \cdot \pi r^2$

$T_1 \cdot 2\sin\alpha = pr$

$T_1 = \frac{pr}{2\sin\alpha}$ ✓



уравнение Лапласа: $\frac{T_1}{R_1} + \frac{T_2}{R_2} = p_3 = p$

продифференцируем:

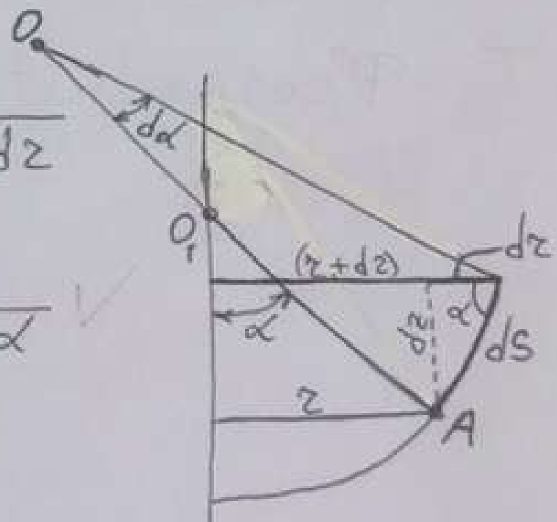
$z = Ar^2 \to \frac{dz}{dr} = 2Ar \Rightarrow r = \frac{dz}{2A\,dr}$

$\frac{dz}{dr} = tg\alpha \Rightarrow r = \frac{tg\alpha}{2A}$

$R_{\cancel{1}2} = \frac{r}{\sin\alpha} = \frac{tg}{2A\sin\alpha} = \frac{1}{2A\cos\alpha}$

$R_{\cancel{2}1}\, d\alpha = ds$

$R_{\cancel{2}1} = \frac{ds}{d\alpha}\frac{dr}{dr} = \frac{dr}{\cos\alpha\, d\alpha}$ $\quad R_1 = ?$



$OA = R_2$

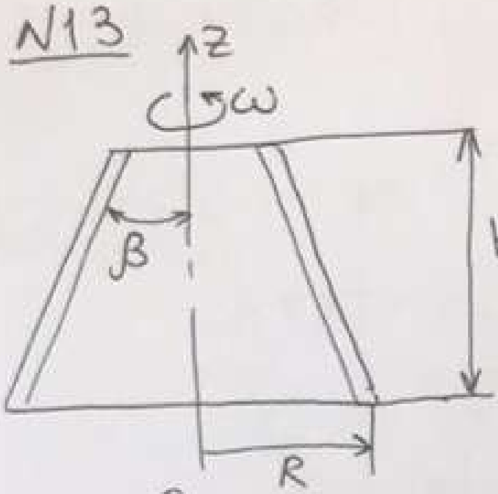
$O_1A = R_1$

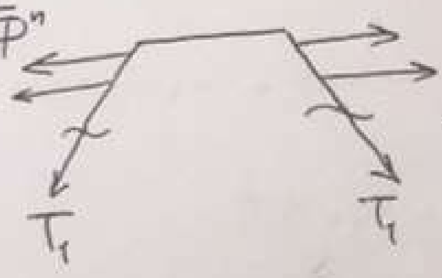
$\frac{T_1}{R_1} = \frac{pr \cdot \cancel{2A\cos\alpha}}{2\sin\alpha} = \frac{prA}{tg\alpha} = prA\,ctg\alpha$

$prA\,ctg\alpha + \frac{T_2}{R_2} = p \Rightarrow \underline{T_2 = p(-rA\,ctg\alpha + 1)R_2}$

Перепутали R_1 и R_2. R_1 — не найден.

N13





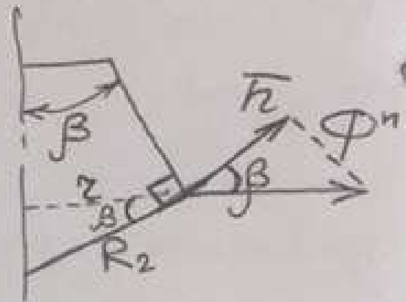
$\Rightarrow \underline{T_1 = 0}$

$$\cancel{\frac{T_1}{R_1}} + \frac{T_2}{R_2} = p_3 \Rightarrow T_2 = p_3 R_2$$

$p_3 = \Phi^n \cos\beta$

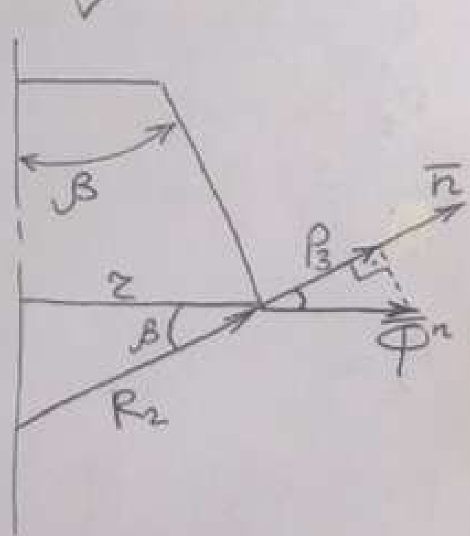
$T_2 = \Phi^n \cos\beta\, R_2$

$\Phi^n = \rho h \omega^2 r$



$$\left.\begin{aligned} T_2 &= R_2 \cos\beta\, \rho h \omega^2 r \\ r &= R_2 \cdot \cos\beta \end{aligned}\right\} \Rightarrow \underline{T_2 = R_2^2 \cos^2\beta \cdot \rho h \omega^2}$$

✓



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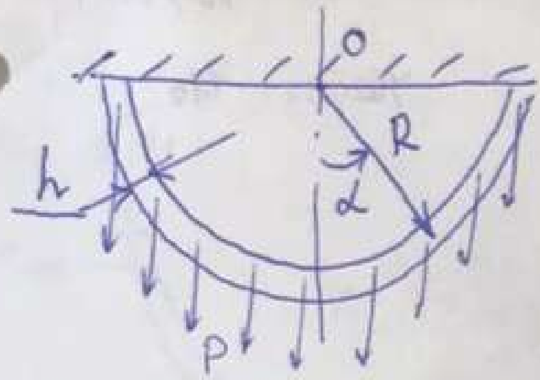
№7.



Дано: $R;\ h;\ \rho$

Найти: T_1 и T_2 - ?

$$G = \rho g V = \gamma V$$

$$p = \rho g h$$

$$\gamma = \rho g$$

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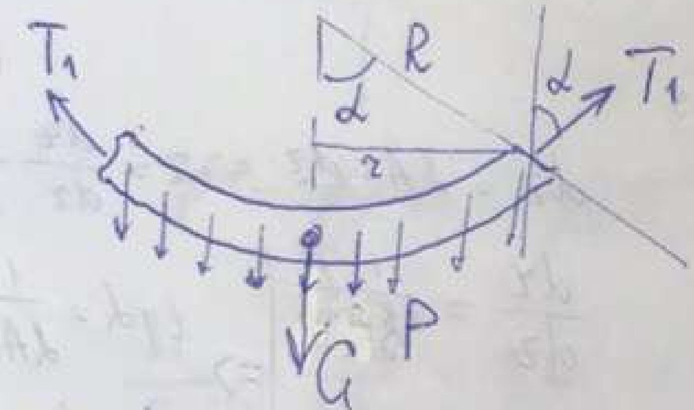


$$T_1 \cdot 2\pi r = \gamma \cdot 2\pi R^2 (1-\cos\alpha) h$$

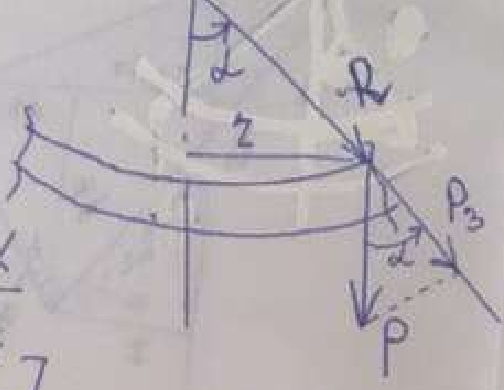
$$r = R \sin\alpha$$

$$T_1 = \frac{\gamma R^{\cancel{2}} (1-\cos\alpha) h}{\cancel{R} \sin\alpha} = \gamma R h \frac{1-\cos\alpha}{\sin\alpha}$$

$$\frac{T_1}{R_1} + \frac{T_2}{R_2} = p_3 \quad ; \quad R_1 = R_2 = R$$

$$T_2 = p_3 \cdot R - T_1$$

$$p_3 = p\cos\alpha$$



$$T_2 = \rho g h R\cos\alpha - \rho g h R \frac{1-\cos\alpha}{\sin\alpha}$$

$$T_2 = \rho g h R \left[\cos\alpha - \frac{1-\cos\alpha}{\sin\alpha} \right]$$

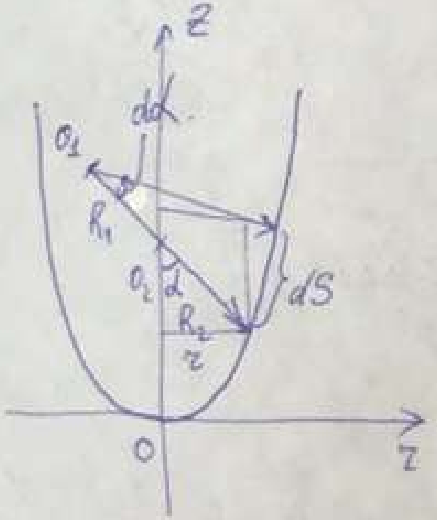
№9

$z = Ar^2$

Дано: $z = Ar^2$

h, ω, ρ

Найти: u_r



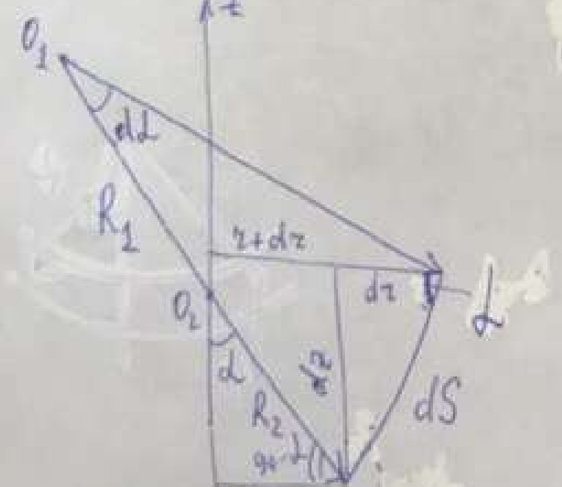
$$dz = 2Ar\,dr \Rightarrow r = \frac{dz}{dr}\cdot\frac{1}{2A}$$

$$\frac{dz}{dr} = tg\alpha$$

$$r = \frac{tg\alpha}{2A}$$

$$R_2 = \frac{r}{\sin\alpha} = \frac{1}{2A}\,\frac{tg\alpha}{\sin\alpha}$$

$$R_2 = \frac{1}{2A\cos\alpha}$$



$$dS = R_1 \cdot d\alpha$$

$$R_1 = \frac{dS}{d\alpha}\cdot\frac{dr}{dr} =$$

$$= \frac{1}{\cos\alpha}\cdot\frac{1}{2A}\cdot\frac{1}{\cos^2\alpha}$$

$$R_1 = \frac{1}{2A\cos^3\alpha}$$

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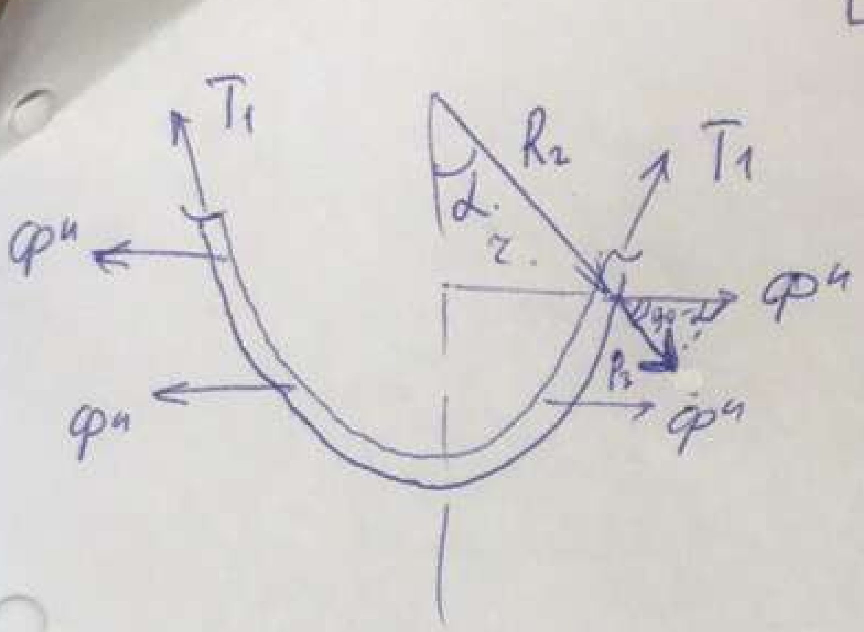
№9



$\underbrace{T_1 = 0}$

p_3

$\Phi^и = \rho g a_n = \rho g \omega^2 r$;

$$\frac{T_1}{R_1} + \frac{T_2}{R_2} = p_3 \Rightarrow T_2 = p_3 \cdot R_2.$$

$p_3 = \Phi^и \cdot \sin\alpha.$

$T_2 = \rho g \omega^2 r \sin\alpha \cdot R_2$

$r = R_2 \sin\alpha \Rightarrow T_2 = \rho g \omega^2 R_2^2 \sin^2\alpha =$

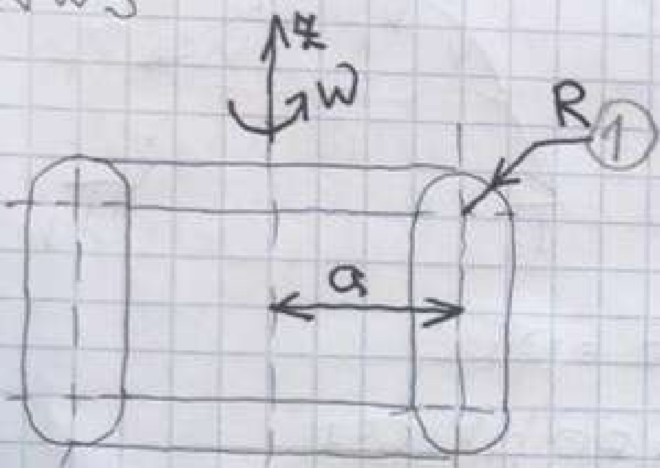
$$= \rho g \omega^2 \underbrace{\frac{\sin^2\alpha}{\cos^2\alpha}}_{tg^2\alpha} \frac{1}{2A}$$

Ясенкова Анна СМ1-82

Контрольная работа №2

№23

(30) Тел



$$a^n = w^2 r$$

$$\Phi^n = \rho h w^2 r$$

$$P_1 = \Phi^n \cos\alpha = \rho h w^2 r \cos\alpha$$

$$P_3 = \Phi^n \sin\alpha = \rho h w^2 r \sin\alpha$$

$$T_1 = \frac{C}{r\sin\alpha} + \frac{1}{r\sin\alpha}\int (P_3\cos\alpha - P_1\sin\alpha) r\,ds,$$

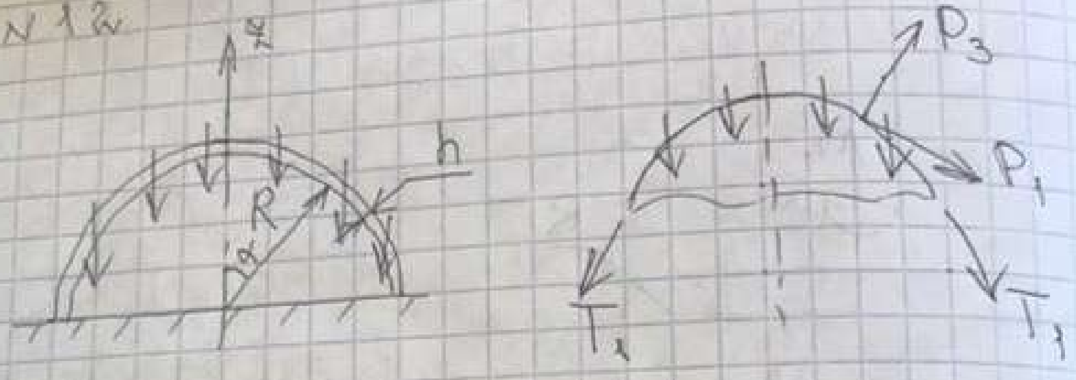
$$T_1 = 0$$

$$T_2 = P_3 R_2 = \rho h w^2 r \sin\alpha \cdot R_2$$

$$\frac{T_1}{R_1} + \frac{T_2}{R_2} = P_3$$

а цилиндрическая оболочка?

№ 12



$$T_1 \cdot 2\pi r \cdot \sin\alpha + G = 0$$

$$G = \rho g V \;;$$

$$V = 2\pi R^2 (1-\cos\alpha) h$$

$$T_1 = -\frac{G}{2\pi r \sin\alpha}$$

$$r = R\sin\alpha$$

$$T_1 = -\frac{G}{2\pi R \sin^2\alpha} = -\frac{\rho g \cdot 2\pi R^2 (1-\cos\alpha) h}{2\pi R \sin^2\alpha} =$$

$$= -\frac{\rho g h (1-\cos\alpha)}{\sin^2\alpha}$$

$$\frac{T_1}{R_1} + \frac{T_2}{R_2} = P_3$$

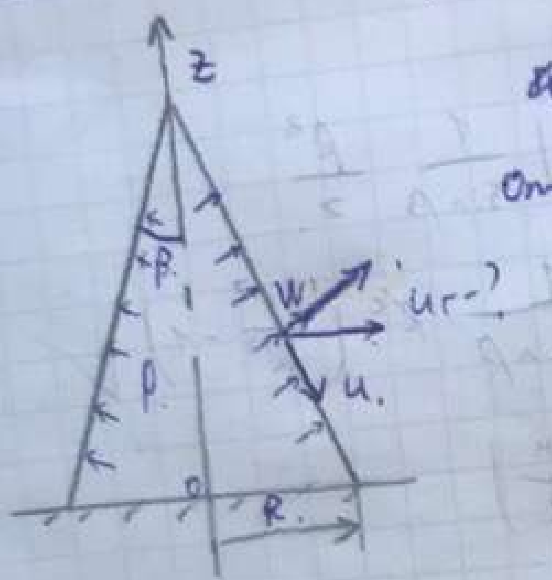
$$T_2 = R_2\left(P_3 - \frac{T_1}{R_1}\right)$$

$$P_3 = -\rho g h \cos\alpha$$

$$T_2 = R\rho g_0 h\left(-\cos\alpha + \frac{1-\cos\alpha}{\sin^2\alpha}\right)$$

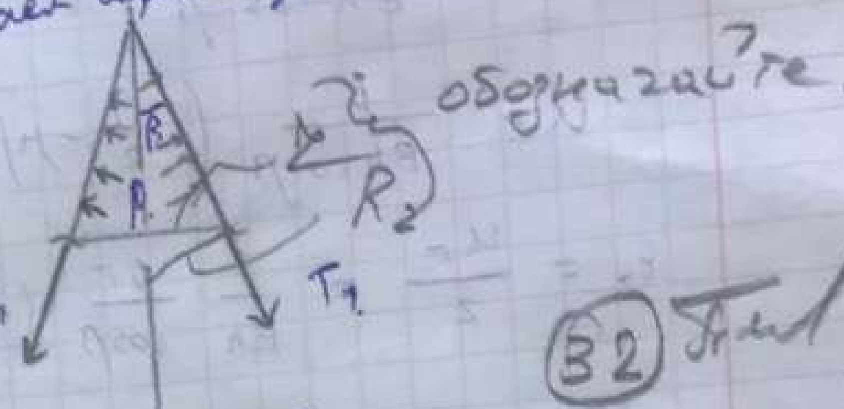
Казаринов К. СМ1-81.

№5



~~……~~

Отсекаем вершину:



32 Бил

$$\pi r^2 p = T_1 \cdot 2\pi r \cdot \cos\beta \qquad T_1 = \frac{p r}{2\cos\beta}$$

$$\frac{T_2}{R_2} + \frac{T_1}{\cancel{R_1}}^{\to 0} = p$$

$$T_2 = p \cdot R_2 = p \cdot \frac{r}{\cos\beta}$$

$$\varepsilon_1 = \frac{1}{Eh}(T_1 - \mu T_2) = \frac{1}{Eh}\frac{pr}{\cos\beta}\left(\frac{1}{2} - \mu\right)$$

$$\varepsilon_2 = \frac{1}{Eh}(T_1 - \mu T_2) = \frac{1}{Eh}\frac{pr}{\cos\beta}\left(1 - \frac{\mu}{2}\right)$$

$$\frac{u}{\sin\alpha} = \int \frac{\varepsilon_1 R_1 - \varepsilon_2 R_2}{\sin\alpha}\, d\alpha + C$$

$$u = \sin\alpha \cdot \frac{1}{\sin\alpha} \int \left(\varepsilon_1 - \varepsilon_2 \frac{R_2}{R_1}\right) \overbrace{R_1\, d\alpha}^{ds_1} + C\sin\alpha$$

$$u = \frac{p}{Eh\cos\beta}\left(\frac{1}{2} - \mu\right)\int r\, ds_1 + \underbrace{C\cos\beta}_{=\sin\alpha}$$

$$u = \frac{p}{Eh\cos\beta}\left(\frac{1}{2} - \mu\right)\int \frac{1}{\sin\beta}\, r\, dr + C\cos\beta$$

$$u = \frac{p}{Eh\cos\beta}\left(\frac{1}{2} - \mu\right)\frac{1}{\sin\beta}\frac{r^2}{2} + C\cos\beta$$

$r = R \qquad u = 0.$

$$t = -\frac{p}{Eh\cos^2\beta}\left(\frac{1}{2} - \mu\right)\frac{1}{\sin\beta}\frac{R^2}{2}.$$

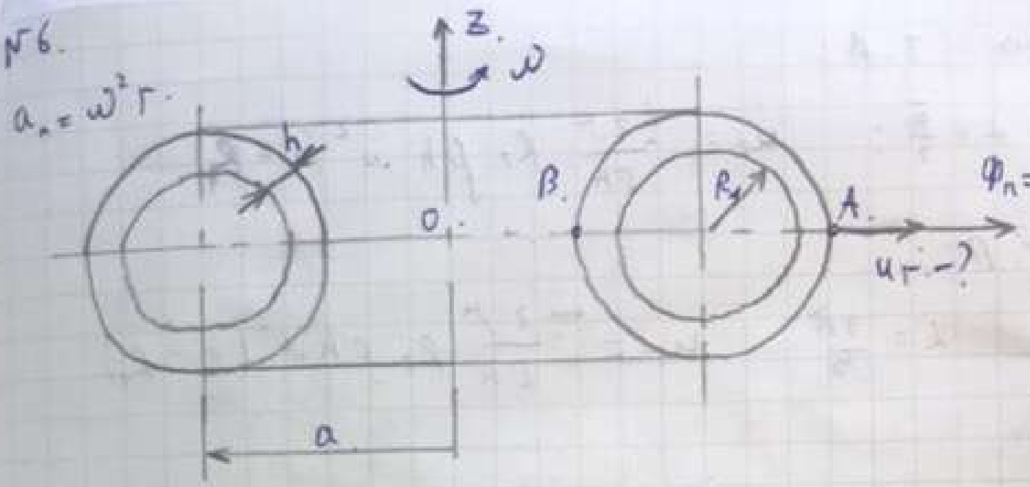
$$u = \frac{p}{Eh\cos\beta}\left(\frac{1}{2} - \mu\right)\frac{1}{2\sin\beta} R^2\left(\frac{r^2}{R^2} - 1\right) \quad V$$

$$\varepsilon_2 = \frac{u_r}{2} = \frac{1}{Eh}\frac{pr}{\cos\beta}\left(1 - \frac{\mu}{2}\right)$$

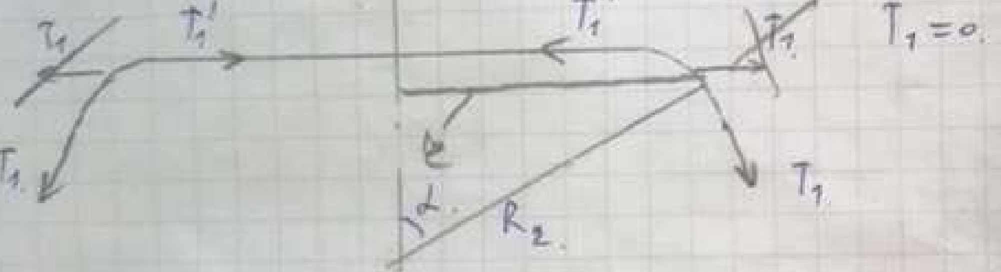
$$u_r = \frac{2}{Eh}\frac{pr}{\cos\beta}\left(1 - \frac{\mu}{2}\right). \quad V$$

№6.

$a_n = \omega^2 r.$



Отсечём верхнюю часть:



$T_1 = 0.$

Ур-е Лапласа:

$$\frac{T_1}{R_1} + \frac{T_2}{R_2} = p \Rightarrow \quad T_2 = R_2 \cdot p = R_2 \cdot \rho h \omega^2 r$$

$$r = a + R_1 \sin\alpha \Rightarrow \cancel{R_2 = (a+R_1)^2 \rho h \omega^2}$$

$$\sin\alpha = \frac{r-a}{R_1} \qquad R_2 = \frac{r}{\sin\alpha} = \frac{a + R_1 \sin\alpha}{\sin\alpha}$$

$$T_2 = R_2 \rho h \omega^2 (a + R_1 \sin\alpha) = \rho h \omega^2 \frac{(a + R_1 \sin\alpha)^2}{\sin\alpha}$$

$$\varepsilon_2 = \frac{1}{Eh}(\cancel{T_1}^{0} - \mu T_2) = \frac{u_r}{r}$$

$$u_r = -\frac{r\mu}{Eh} R_2 \rho h \omega^2 (a + R_1 \sin\alpha)$$

Для т. A:

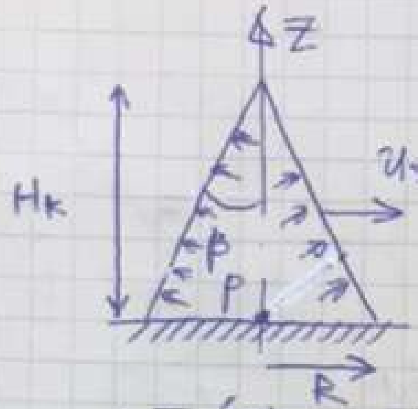
$\alpha = \frac{\pi}{2}$: $\quad u_r = \frac{\pm 2\mu}{Eh} R_2 \rho h \omega^2 (a + R_1)$

т. B:

$\alpha = \frac{3\pi}{2}$ $\quad u_r = \frac{-2\mu}{Eh} R_2 \rho h \omega^2 (a - R_1)$

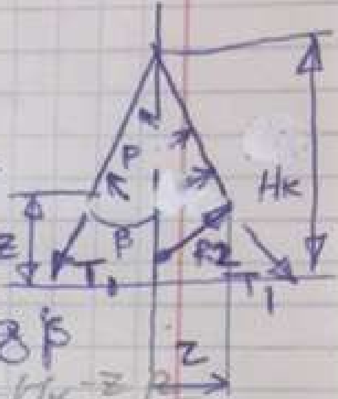
N5

$H_k = \frac{R}{tg\beta}$ Пицдев В.В СМ1-82



$R_1 = \infty$

$R_2 = \frac{(H_k - z)R}{H_k \cos\beta}$



$r = (H_k - z)\, tg\beta$

$R_2 = \frac{r}{\cos\beta} = \frac{H_k - z}{\cos\beta}\frac{R}{H_k}$

$$p\pi (H_k - z)^2 \frac{tg\beta}{\cos\beta}\sin\beta - T_1 \cdot 2\pi r \cos\beta = 0$$

$$T_1 = \frac{p(H_k - z) H_k \sin^2\beta}{2R\cos^2\beta} \;?$$

$T_1 \cdot 2\pi (H_k - z) \cancel{tg\beta} \cos\beta$ ← написать подробнее вывод

$p_3 = p$

$$T_2 = R_2\left(p_3 - \cancel{\frac{T_1}{R_1}}\right) = \frac{(H_k - z)Rp}{H_k \cos\beta}$$

30

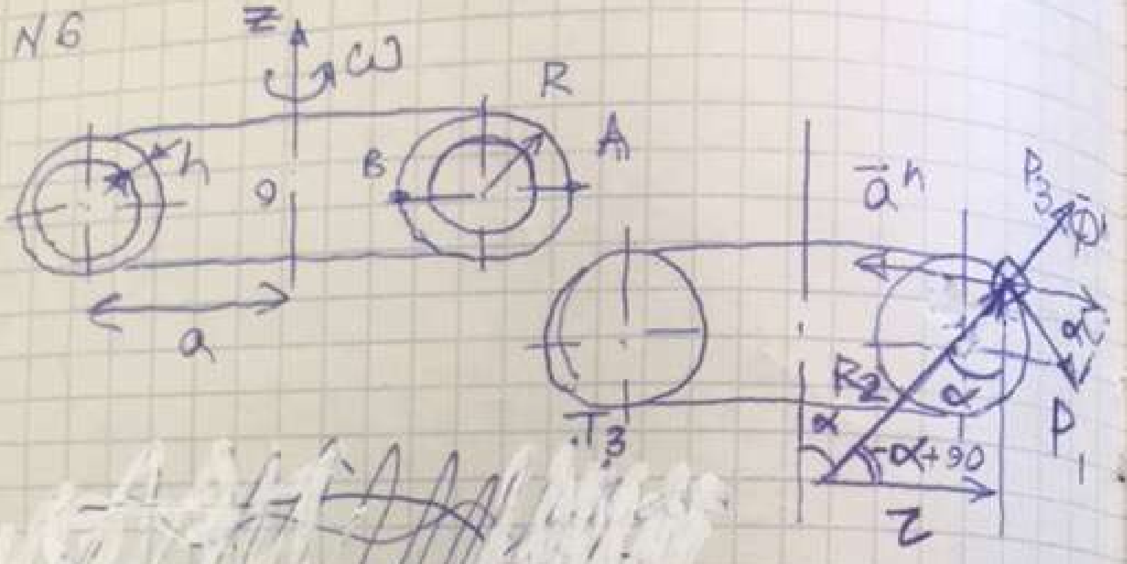
$$\frac{u_z}{z} = \frac{1}{Eh}(T_2 - \mu T_1)$$

$$u_z = \frac{z}{Eh}\left(\frac{(H_k - z)Rp}{H_k\cos\beta} - \mu\frac{p(H_k - z)H_k\sin^2\beta}{2R\cos^2\beta}\right)$$

$$u_z = \frac{(H_k - z)^2 tg\beta\, p}{Eh}\left(\frac{R}{H_k\cos\beta} - \frac{\mu H_k}{2R} tg^2\beta\right)$$

$$u_z = \frac{(R - z\,tg\beta)^2}{Eh\,tg\beta} p\left(\frac{tg\beta}{\cos\beta} - \frac{\mu}{2} tg\beta\right)$$

N6



$$R_2 = \frac{z}{\sin\alpha}$$

1) $a^n = \omega^2 z$

$\Phi^n = \rho h \omega^2 z$

$P_3 = \rho h \omega^2 z \sin\alpha$

$P_1 = \rho h \omega^2 z \cos\alpha$

2) $T_1 = 0$

3) $T_2 = R_2 P_3 = \rho h \omega^2 z \sin\alpha \frac{z}{\sin\alpha} = \rho h \omega^2 z^2$

точка A $r = a+R$ $T_{2A} = \rho h \omega^2 (a+R)^2$

точка B $r = a-R$ $T_{2B} = \rho h \omega^2 (a-R)^2$

3) $\frac{u_r}{r} = \frac{1}{Eh}(T_2 - \nu T_1)$

Кафедра: Косми...

Домашнее задание №2 по ди...

«Строительная механика»

Вариант 15

$= \rho h \omega^2 r^2$

$(a+R)^2$

$(a-R)^2$

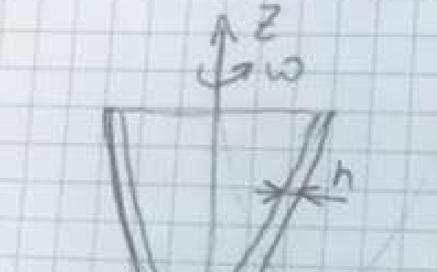
$$u_{rA} = \frac{1}{Eh}\rho h \omega^2 (a+R)^3$$

$$u_{rB} = \frac{-1}{Eh}\rho h \omega^2 (a-R)^3$$

Рубежный контроль №2. Папич А. 14.05.19

~~Вариант~~ СМ1-82

№9 лист 1.



Дано:

$z = Ar^2$

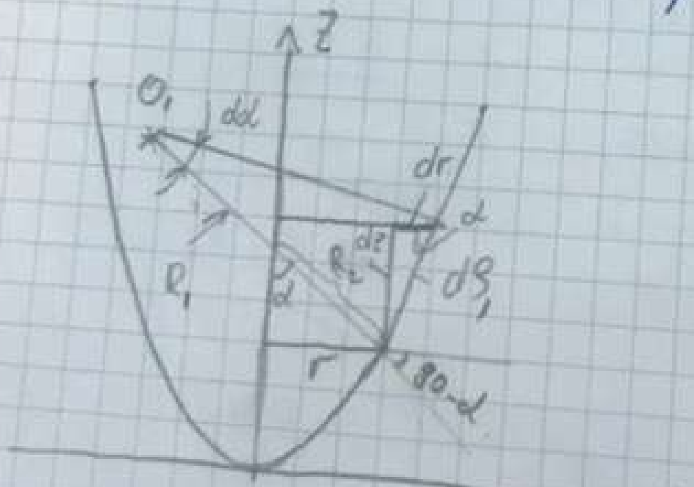
h, ω, ρ

$u_r - ?$

30

Решение:

1) определение главных радиусов кривизны.



$z = Ar^2 \Rightarrow$

$dz = 2Ar\,dr$

$\Rightarrow \dfrac{dz}{dr} = 2Ar,$

$tg\alpha = \dfrac{dz}{dr}$

$tg\alpha = 2Ar \Rightarrow$

$\Rightarrow \boxed{r = \dfrac{tg\alpha}{2A}}$

$\sin\alpha = \dfrac{r}{R_2} \Rightarrow R_2 = \dfrac{r}{\sin\alpha} = \dfrac{tg\alpha}{2A\cdot\sin\alpha} = \dfrac{1}{2A\cos\alpha}$ ✓

$$dS_1 = R_1\, d\alpha \Rightarrow R_1 = \frac{dS_1}{d\alpha} = \frac{dS_1}{dr}\cdot\frac{dr}{d\alpha} =$$

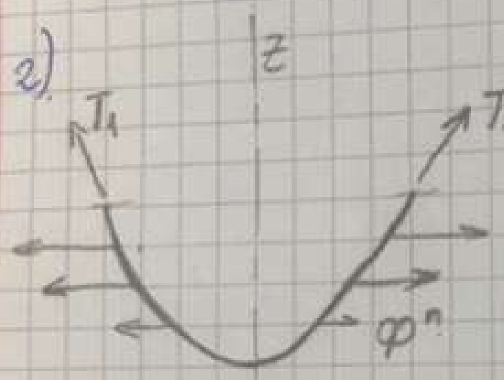
$$= \frac{1}{\cos\alpha}\cdot\frac{d}{d\alpha}\left(\frac{tg\,\alpha}{2A}\right) = \frac{1}{\cos\alpha}\cdot\frac{1}{2A}\cdot\frac{1}{\cos^2\alpha} = \frac{1}{2A\cdot\cos^3\alpha}$$

$$\Downarrow$$

$$R_1 = \frac{1}{2A\cdot\cos^3\alpha}$$

$$R_2 = \frac{1}{2A\cdot\cos\alpha}$$

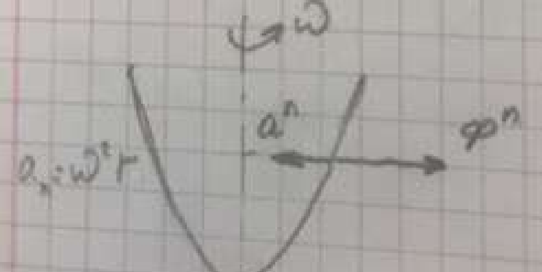
г)



т.к. нагрузка уравновешивает сама себя, то $\underline{T_1 = 0}$

по ур-ю Лапласа:

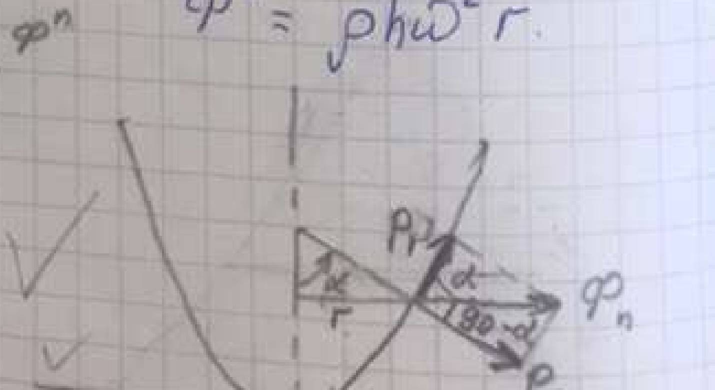
$$\cancel{\frac{T_1}{R_1}}^{\,0} + \frac{T_2}{R_2} = p_3 \Rightarrow T_2 = p_3\cdot R_2$$



$$\Phi^n = \rho h \omega^2 r$$

$$p_3 = \rho h\omega^2 r\cdot \sin\alpha$$

$$p_1 = \rho h\omega^2 r\cdot \cos\alpha$$



$$T_2 = \rho\omega^2 r \sin\alpha \cdot \frac{1}{2A\cdot\cos\alpha} = \frac{\rho\omega^2}{2A}.$$

$$T_2 = \rho\omega^2 h r \cdot \sin\alpha \cdot R_2 = \rho\omega^2 h R_2 \sin\alpha \cdot R \sin\alpha \cdot R_2 =$$

$$= \rho\omega^2 h \sin^2\alpha \cdot R_2^2 = \rho\omega^2 h \sin^2\alpha \cdot \frac{1}{4A^2\cos^2\alpha} =$$

$$= \rho\omega^2 h \frac{1}{4A^2} \cdot tg^2\alpha.$$

Радиальное перемещение:

$$\frac{U_r}{r} = \frac{1}{Eh}\left(T_2 - \mu \underset{0}{T_1}\right) = \frac{1}{Eh} T_2$$

$$U_r = r \cdot \frac{1}{Eh} \cdot T_2 = R_2 \sin\alpha \cdot \frac{1}{Eh} \rho\omega^2 h \frac{1}{4A^2} \cdot tg^2\alpha =$$

$$= \frac{1}{2A\cos\alpha} \sin\alpha \cdot \frac{1}{Eh} \rho\omega^2 h \frac{1}{4A^2} \cdot tg^2\alpha =$$

$$= \frac{1}{8A^3} \cdot \frac{\rho\omega^2}{E\cancel{h}} \cdot tg^3\alpha.$$

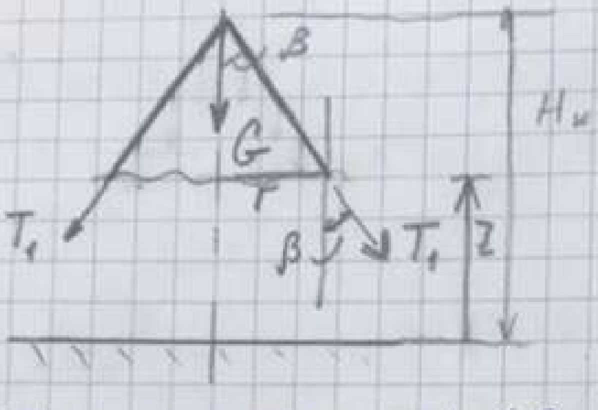
$$\boxed{U_r = \frac{1}{8A^3} \cdot \frac{\rho\omega^2}{E\cancel{h}} tg^3\alpha.}$$

№ 8.

Дано: β, h, ρ, R

T_1, T_2 — ?

Решение.



$$G = \cancel{\rho}\,\gamma V,$$

где $\gamma = \rho g$.

$$V = h(H_к - z)^2 \pi \frac{tg\beta}{\cos\beta}$$

$$H_к = \frac{R}{tg\beta}$$

$$T_1 \cdot \cos\beta \cdot 2\pi r = -\gamma h \left(\frac{R}{tg\beta} - z\right)^2 \pi \frac{tg\beta}{\cos\beta}$$

$$tg\beta = \frac{r}{H_к - z} \Rightarrow r = tg\beta(H_к - z) =$$

$$= tg\beta\left(\frac{R}{tg\beta} - z\right)$$

$$T_1 = -\frac{\gamma h \left(\frac{R}{tg\beta} - z\right)^2 \frac{tg\beta}{\cos\beta}}{2\cancel{\pi}\cos\beta\; tg\beta\left(\frac{R}{tg\beta} - z\right)} = -\frac{\gamma h}{\cos^2\beta}\left(\overbrace{\frac{R}{tg\beta}}^{H_к} - z\right)$$

По уравнению Лапласа

$$\frac{T_1}{R_1} + \frac{T_2}{R_2} = p_з$$

Главные радиусы кривизны для конуса:

$$R_1 = \infty$$

$$\cos\beta = \frac{r}{R_2} \Rightarrow$$

$$\Rightarrow R_2 = \frac{r}{\cos\beta}$$

далее см. лист 2.

лист 2 Папич А.

№8 СМ1-82

(продолжение)

По ур-ю Лапласа: ?

$$\frac{T_1}{R_1}^{\nearrow 0} + \frac{T_2}{R_2} = p_3.$$

??

В данной задаче $p_3 = 0$; $R_1 = \infty$

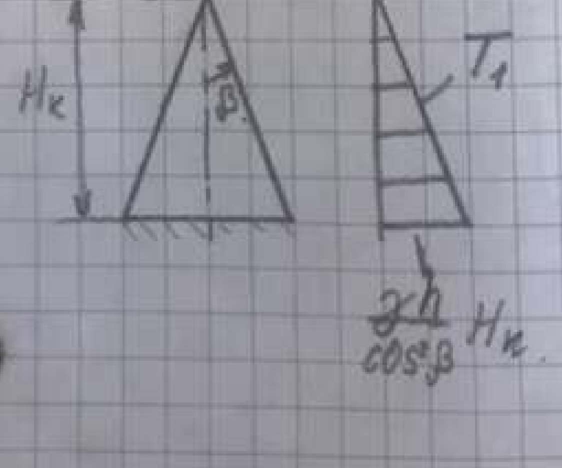
=> $T_2 = 0 \cdot R_2 = 0$ $T_2 = 0$

Ранее: $T_1 = -\frac{\gamma h}{\cos^2\beta}\left(H_к - z\right)$

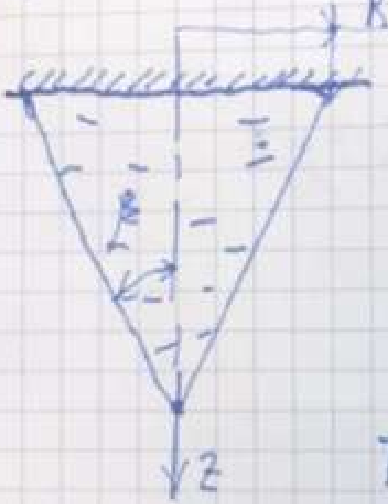
?

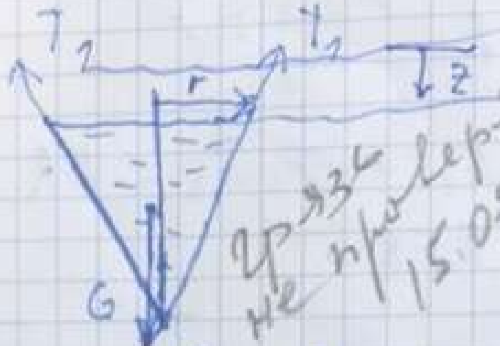
$z = 0$: $T_1 = -\frac{\gamma h}{\cos^2\beta} \cdot H_к$

$z = H_к$: $T_1 = 0$



Стройнеев ДЗ 2 №2. Студеникин Д.А.
СМ1-82
14.05.19.





Грязно
не проверяю
15.05.19

ур. равновесия:

$T_1 \cdot 2\pi r = G$

$tg\beta = \frac{R}{H}$

$H = R\,ctg\beta$

$\cancel{G = \rho g V = \rho g \frac{1}{3}\pi R^3 ctg\beta}$

$\cancel{T_1 = \frac{\rho g \frac{1}{3}\pi R^3 ctg\beta}{2\pi R} = \frac{\rho g R^2 ctg\beta}{6}}$

$r = \frac{H-z}{H}R = (R\,ctg\beta - z)\,tg\beta$

~~ур. Л.:~~ $\cancel{\frac{T_1}{R_1} + \frac{T_2}{R_2} = p}$

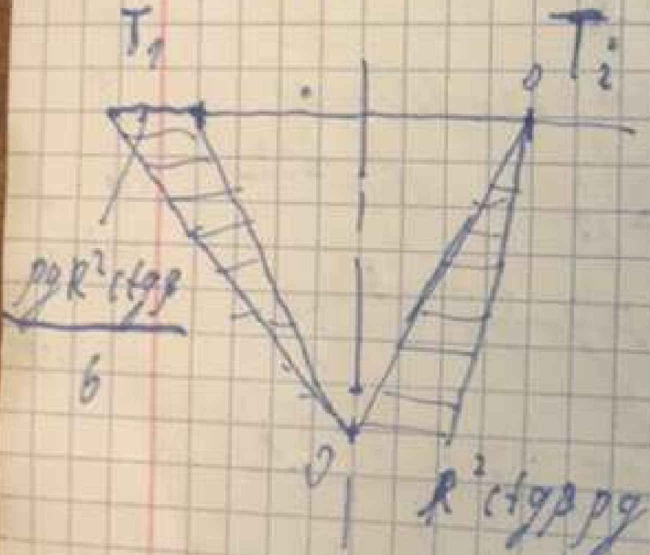
$\cancel{p = \rho g z}$ $G = \rho g V = \rho g \frac{1}{3}\pi (R\,ctg\beta - z)^3\, tg^2\beta$

$T_1 = \frac{\rho g (R\,ctg\beta - z)^3\, tg^2\beta}{6 (R\,ctg\beta - z)\, tg\beta} = \frac{1}{6}\rho g (R\,ctg\beta - z)^2 \times$

$\times\, tg\beta$

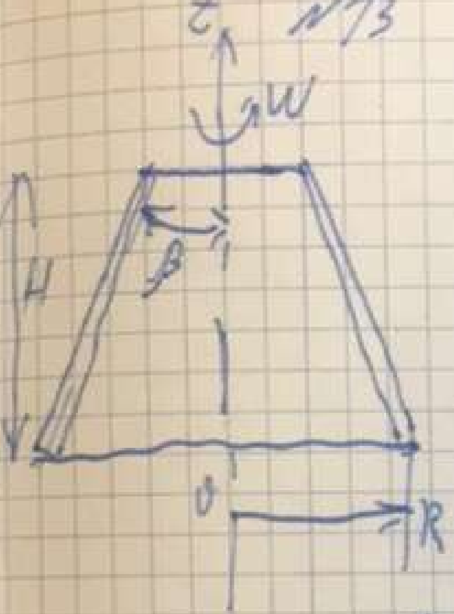
$$\frac{T_1}{R_1} + \frac{T_2}{R_2} = p$$

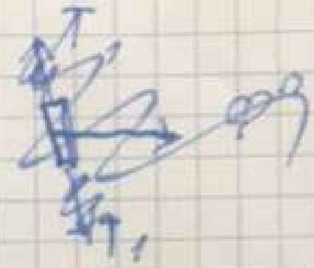
$$\left.\begin{array}{l} R_1 = \infty \\ R_2 = R \end{array}\right\} \Rightarrow T_2 = pR = R\rho g z$$

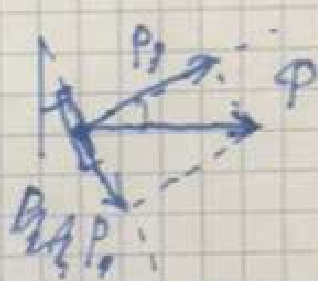


$$T_1 = \frac{\rho g}{6}\left(R\,ctg\,\beta - z\right)^2 tg\,\beta$$

$$T_2 = R\rho g z$$







$$P_3 = \Phi^и \cos\beta \qquad P_1 = \Phi^и \sin\beta$$

$$\Phi^и = \rho h w^2 r$$

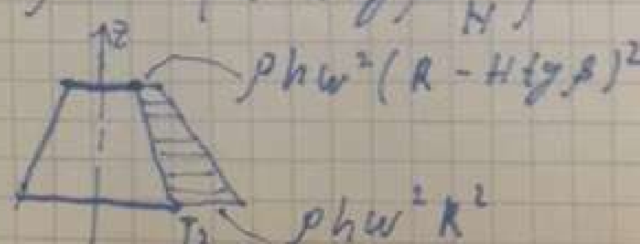
$\cancel{T_1 = 0}$ [illegible]

$$T_1 = 0$$

$$\frac{T_2}{R_2} = P_3$$

$$r = R_2 = R - H\,tg\beta\,\frac{z}{H}$$

$$T_2 = \rho h w^2 \left(R - H\,tg\beta\,\frac{z}{H}\right)^2$$



$x = H\,tg\beta$

$tg\beta = \frac{x}{H}$

$H - R = H\,tg\beta$