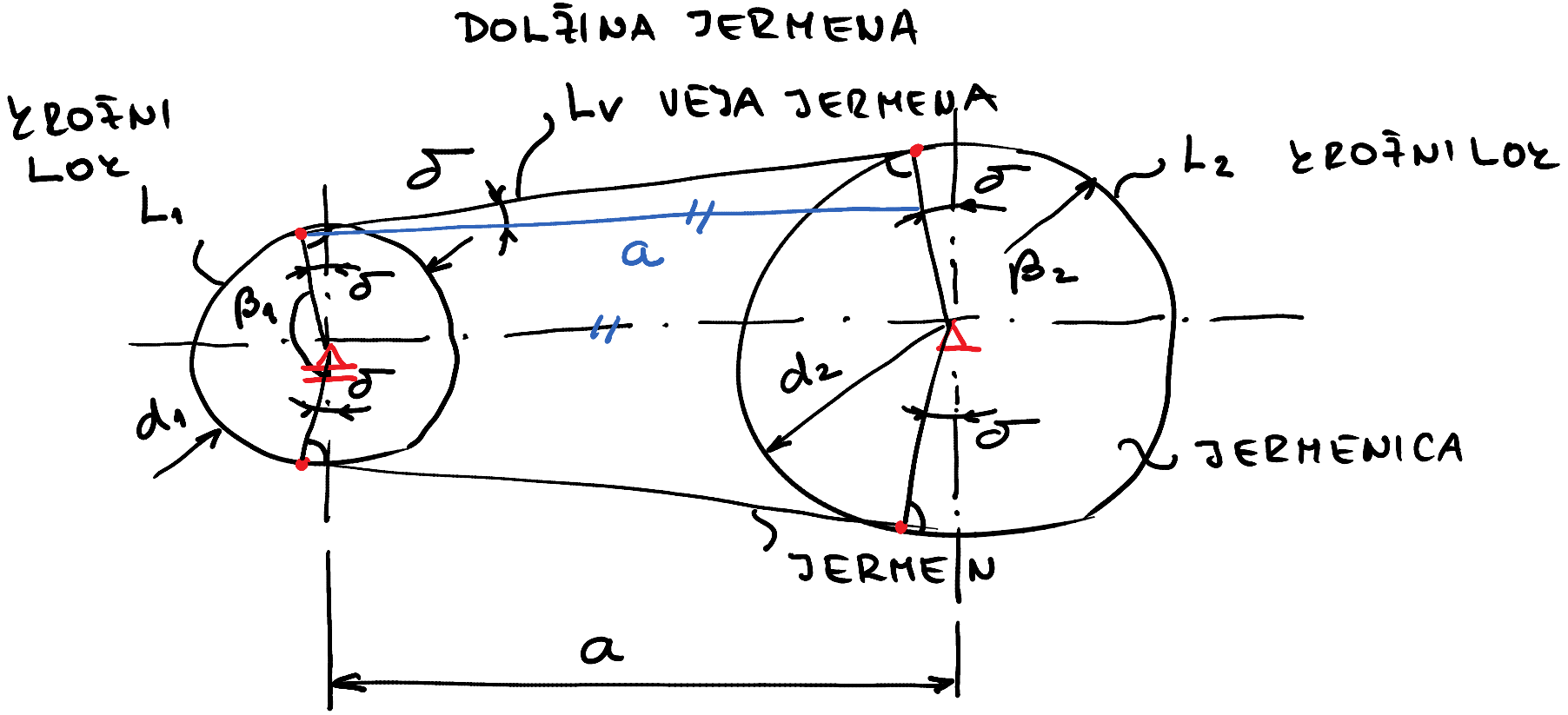
JERMENSKA GONILA

JERMENE DELIMO V : PLOŠČATE
KLINASTE
ZOBATI

NAČIN PRENOSA MOČI : S TRENJEM
Z OBLIZO

+ ENOSTAVNA KONSTRUKCIJA
+ PREPROSTO VZDRŽEVANJE
+ BLAŽENJE VIBRACIJ
+ VAROVANJE PRED PREOBREMENITVIJO
+ MOŽNE VELIKE MEDOSNE RAZDALJE
+ Z ENIM JERMENOM LAHKO POGANJAMO VEČ GREDI
- ZDRS V PRIMERU PRENOSA MOČI S TRENJEM
- HRUP V PRIMERU PRENOSA MOČI Z OBLIZO
- OBČUTLJIVOST NA VPLIVE IZ OKOLJA

– OBREMENITEV GREDI



a MEDOSNI RAZMIK β_1 IN β_2 OBJEMNI KOT

d_1 IN d_2 PREMERA JERMENIC NA NEUTRALNI OSI

$$L = L_1 + L_2 + 2L_v$$

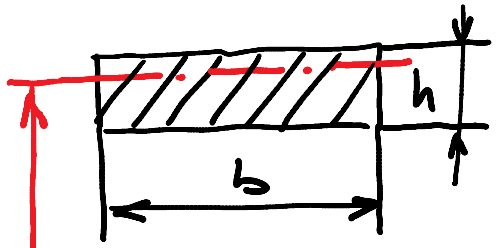
$$L_1 = \hat{\beta}_1 \frac{d_1}{2} \qquad L_2 = \hat{\beta}_2 \frac{d_2}{2}$$

$$\hat{\beta}_1 = \pi - 2\hat{\delta} \qquad \hat{\beta}_2 = \pi + 2\hat{\delta}$$

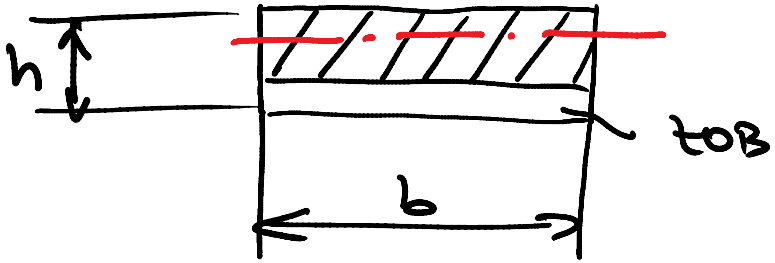
$$tg\,\delta = \frac{d_2 - d_1}{2L_v} \qquad L_v = \frac{d_2 - d_1}{2\,tg\,\delta}$$

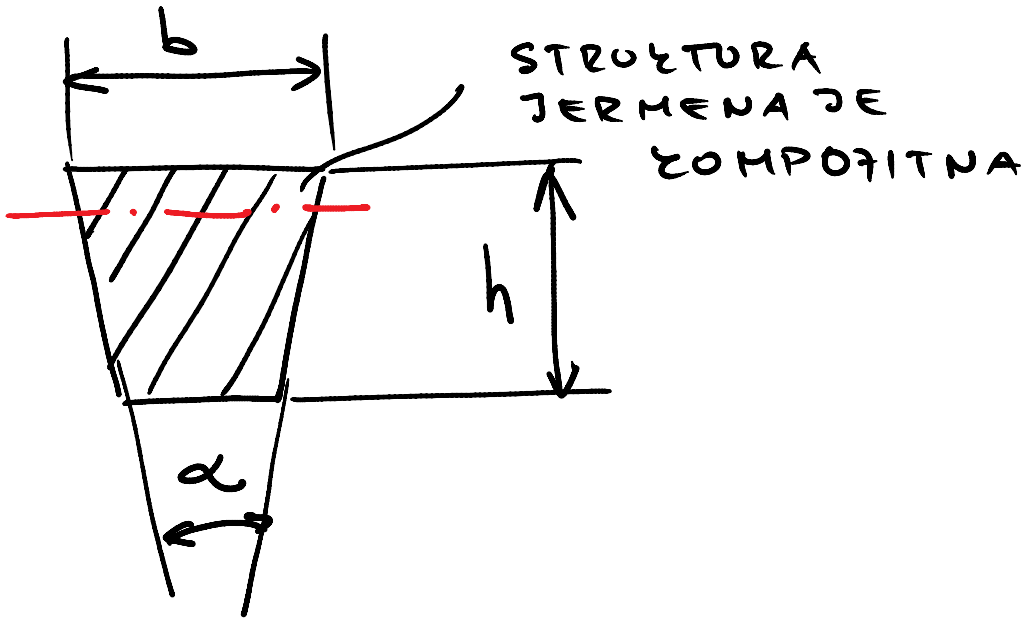
$$L = \frac{\hat{\beta}_1 d_1}{2} + \frac{\hat{\beta}_2 d_2}{2} + \frac{d_2 - d_1}{tg\,\delta}$$

$$\check{d}_1, \check{d}_2, \check{\alpha} \qquad \sin\delta = \frac{d_2 - d_1}{2a}$$

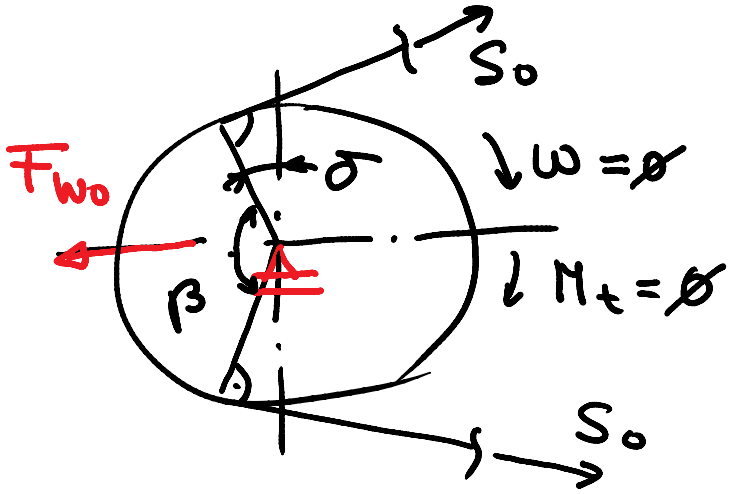


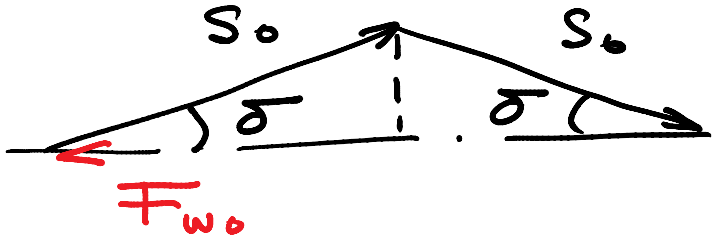
a_1, a_2 SE MERITA OD NEUTRALNE OSI JERMENA





SILA PREDNAPETJA PRI MONTAŽI

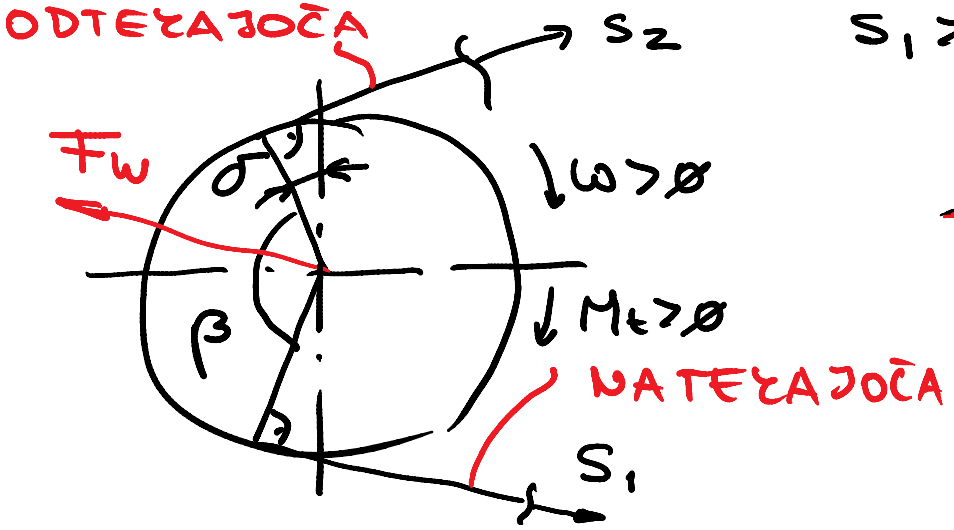




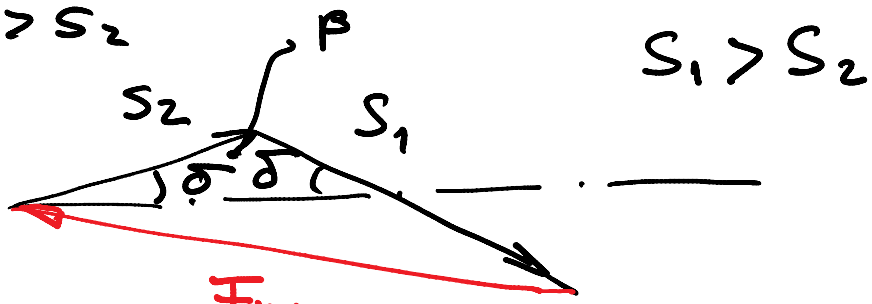
$$F_{W0} = 2 S_0 \cos\delta$$

SILA PREDNAPETJA PRI OBRATOVANJU

ODTEŽAJOČA



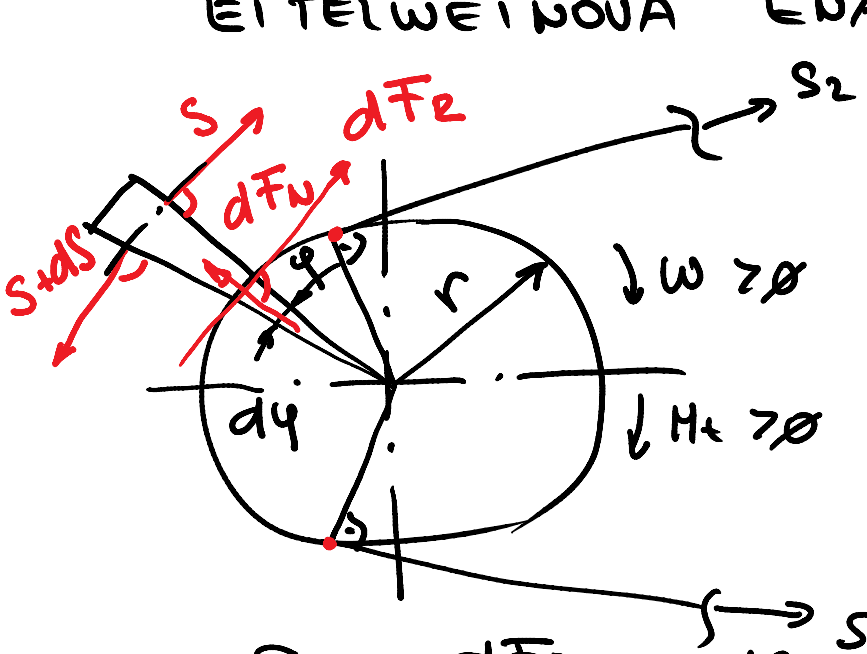
$S_1 > S_2$

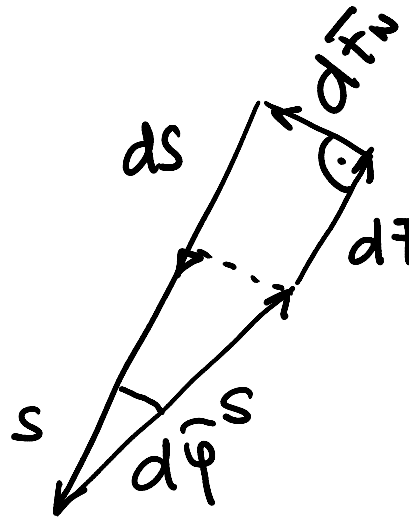


$S_1 > S_2$

$$F_W = \sqrt{S_1^2 + S_2^2 - 2 S_1 S_2 \cos\beta}$$

EITELWEINOVA ENAČBA





$$dF_R = \mu\, dF_N$$

$$S\, d\varphi \cong dF_N$$

$$dS \cong dF_R$$

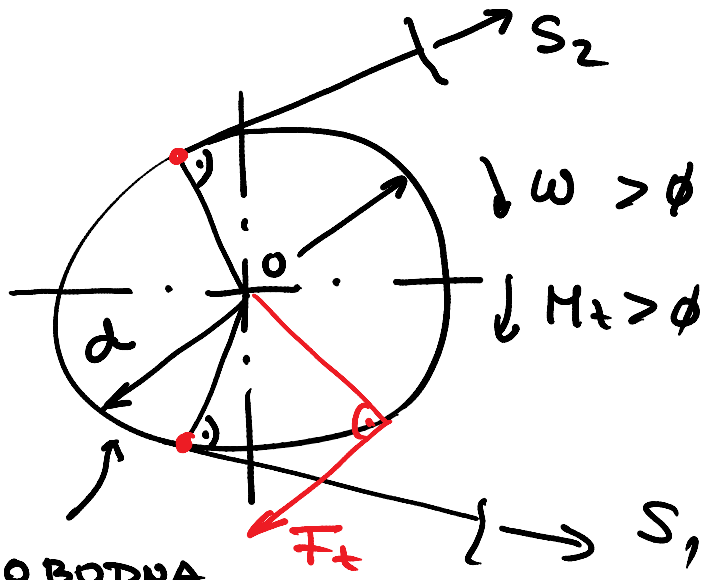
$$S\, d\varphi = \frac{dF_R}{\mu} = \frac{dS}{\mu}$$

$$\int_0^{\hat{\beta}} \mu\, d\varphi = \int_{S_2}^{S_1} \frac{dS}{S}$$

$$\mu\hat{\beta} = \ln S \Big|_{S_2}^{S_1} = \ln \frac{S_1}{S_2}$$

$$S_1 = S_2 \cdot e^{\mu\hat{\beta}} = S_2 \cdot m$$

m: RAZMERJE SIL



OBODNA SILA SE PRENAŠA ZOT „INTEGRAL" PREZO ZONTAKTA JERMENA IN JERMENICE

$$\sum M_i^{\circ} = \phi = S_2 \cdot r - S_1 r + F_t r \mid :r$$

$$F_t = S_1 - S_2$$

$M_t \vee$

$$F_t = \frac{M_t}{r} \vee$$

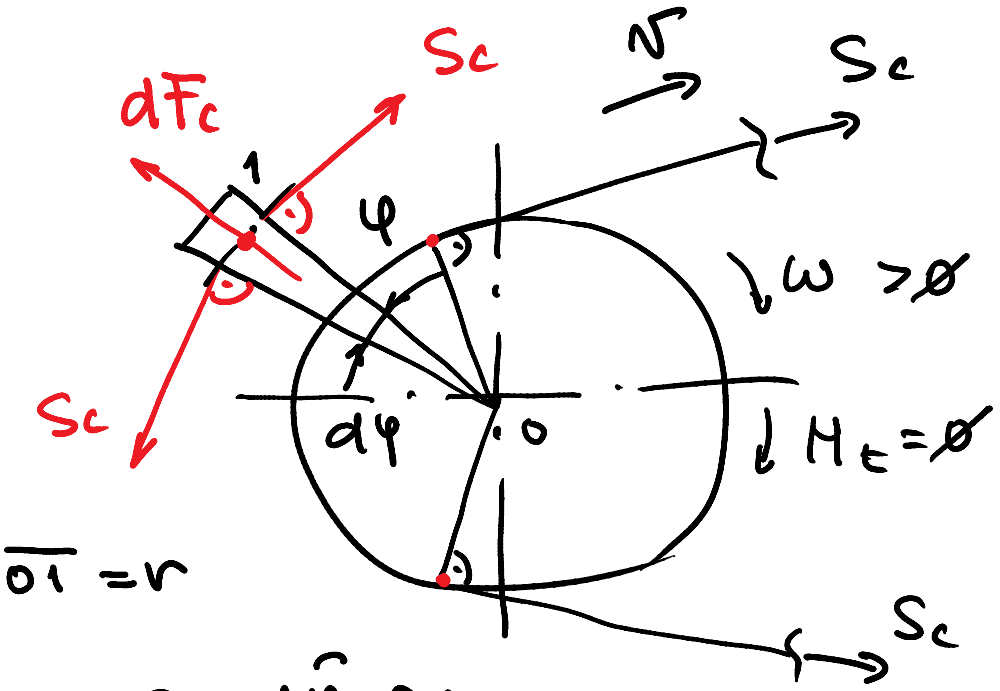
EITELWEINOVA ENAČBA OBRAUNAVA RAZMERE NA MEJI ZDRSA

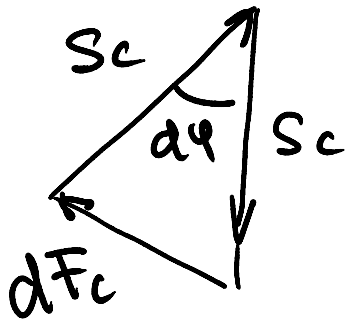
$F_R = F_t$.

$\frac{S_1}{S_2} > m$ ELASTIČNI IN PRAVI ZDRS

$\frac{S_1}{S_2} \leq m$ ELASTIČNI ZDRS

UPLIV CENTRIFUGALNE SILE NA SILE U JERMENU





$$dm = \rho\, dV = \rho A r\, d\varphi$$

$$S_c\, d\varphi \cong dF_c = r\,\omega^2\, dm$$

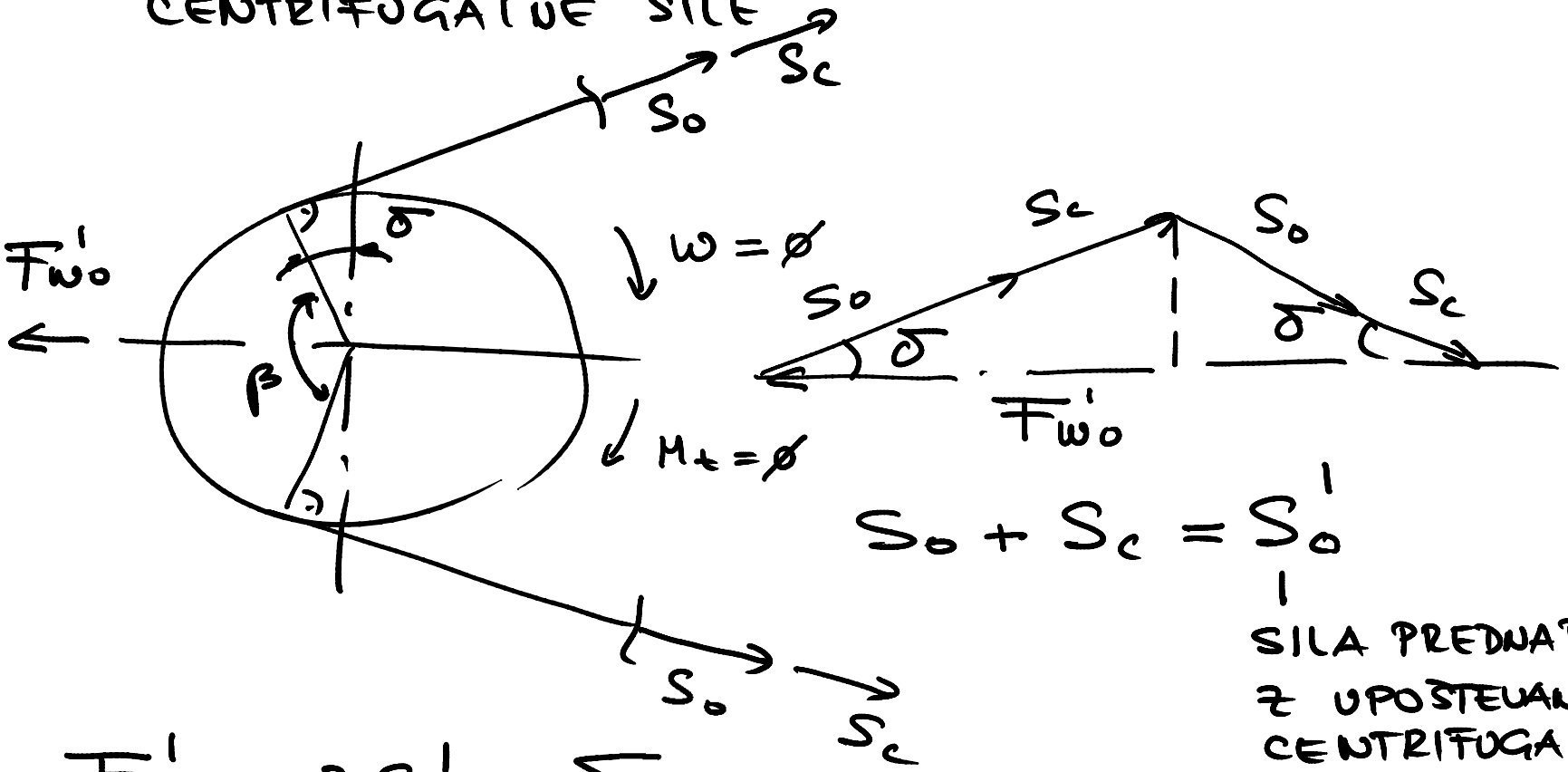
$$S_c\, d\varphi = r\,\omega^2\, \rho A r\, d\varphi$$

v: OBODNA HITROST JERMENA

$$S_c = \rho A v^2$$

SILA U JERMENU ZBOG CENTRIFUGALNE SILE

SILA PREDNAPETJA PRI MONTAŽI Z UPOŠTEVANJEM CENTRIFUGALNE SILE



$$S_0 + S_c = S_0'$$

S_0' – SILA PREDNAPETJA Z UPOŠTEVANJEM CENTRIFUGALNE SILE

$$F'_{w0} = 2 S_0' \cos\delta$$

$\omega = \emptyset$: $S_0 + S_c$

$\omega > \emptyset$: S_0

$\omega > \emptyset$: $S_0' + S_c$

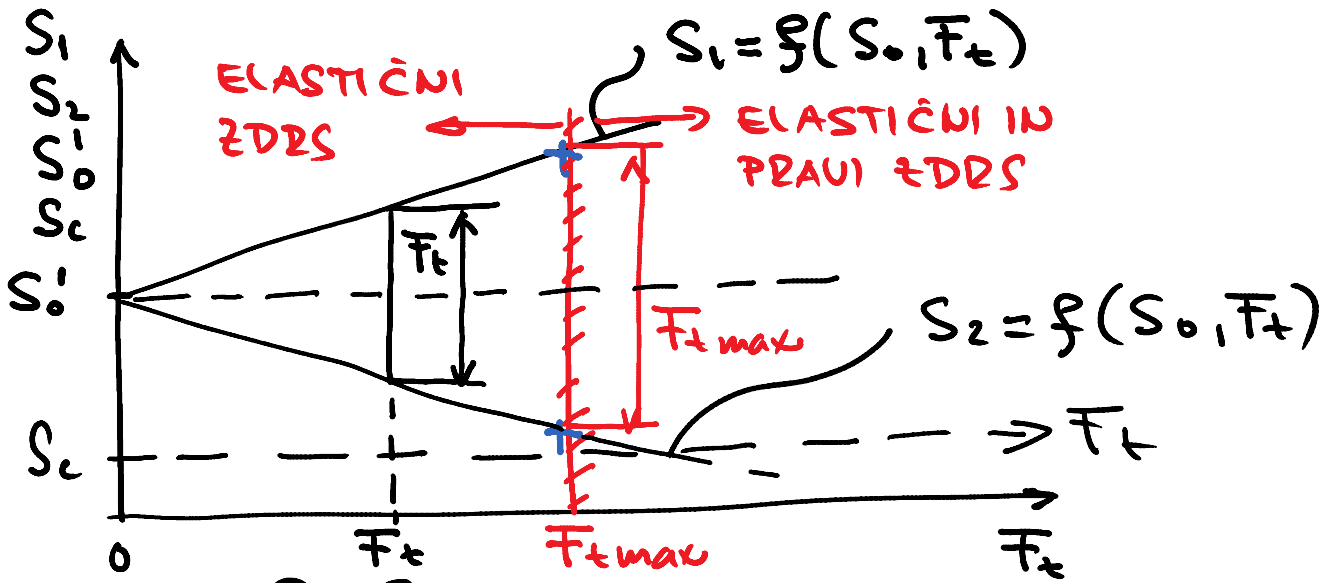
$\omega = \emptyset$: S_0'

SE WA NASA NA GRED

SE WANASA NA JERMEN

ZGORAJ NAVEDENO VELJA ZA $M_t = \emptyset$

VPLIV OBODNE SILE NA SILE V JERMENU



$m = 1{,}5$

$S_c = 300\,N$

$F_{t\,max} = 1500\,N$

D. N.

$$S_0 = \frac{S_1 + S_2}{2} \qquad F_t = S_1 - S_2$$

$$S_1 = S_1(S_0, F_t) = ?^2$$

$$S_1 = S_0 + \frac{F_t}{2}$$

$$S_0 = \frac{S_1 + S_2}{2} = \frac{S_1 + S_1 - F_t}{2} = S_1 - \frac{F_t}{2}$$

DIAGRAM VELJA, ČE JERMEN NAPENJAMO S TOMILANJEM JERMENICE.

$$S_2 = S_2(S_0, F_t) = ?$$

$$S_0 = \frac{S_1 + S_2}{2} = \frac{S_2 + F_t + S_2}{2} = S_2 + \frac{F_t}{2}$$

$$S_2 = S_0 - \frac{F_t}{2}$$

NAJVEČJA OBODNA SILA, KI JO ŽELIMO PRENAŠATI! TO SILO POIŠČEMO.

$$S_1 = S_2 \cdot m \qquad F_{t\,max} = S_1 - S_2$$

$$S_1 = S_1(F_{t\,max}) = ?$$

$$S_1 = (S_1 - F_{t\,max}) \cdot m$$

$$S_1(1 - m) = -F_{t\,max}\, m$$

$$S_1 = F_{t\,max} \frac{m}{m-1}$$

$$S_2 = S_2(F_{t\,max}) = ?$$

$$S_2 = \frac{S_1}{m} = \frac{F_{t\,max} + S_2}{m}$$

$$S_2\left(1 - \frac{1}{m}\right) = \frac{F_{t\,max}}{m}$$

$$S_2 = \frac{F_{t\,max}}{m-1}$$

$$S_0' = \frac{S_1+S_2}{2} + S_c = \frac{1}{2} F_{t\,max}\left(\frac{m}{m-1} + \frac{1}{m-1}\right) + S_c$$

$$S_0' = \frac{F_{t\,max}}{2}\,\frac{m+1}{m-1} + \rho A v^2$$

S_0

MINIMALNA POTREBNA SILA PREDNAPETJA, ČE JE $F_{t\,max}$ MAKSIMALNA PRIČAKOVANA OBODNA SILA.

POTEK IZRAČUNA

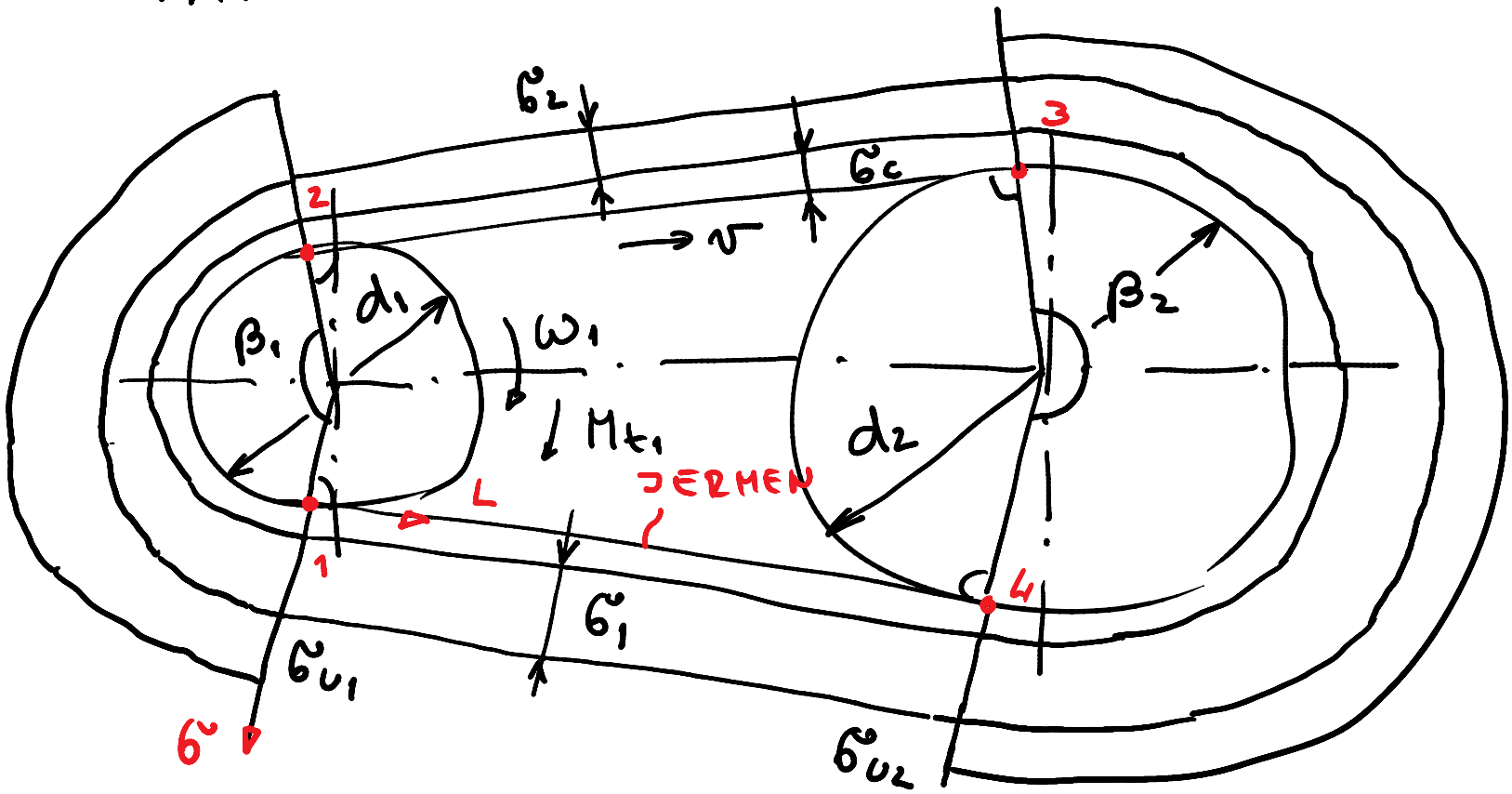
$F_{t\,max}$ ✓ → S_1, S_2 → F_w

ρ, A, v ✓ → S_c → F_{w0} in F_{w0}'

$F_{t\,max}$ ✓ → S_0

S_c
S_0 → S_0'

NAPETOSTI U ZUBU



$$\sigma_{max} = \sigma_1 + \sigma_c + \sigma_{u1}$$

NAPETOST ZARADI CENTRIFUGALNE SILE

$$\sigma_c = \frac{S_c}{A} = \rho v^2$$

NAPETOST V NATEGAJOČI VEJI JERMENA

$$\sigma_1 = \frac{S_1}{A}$$

NAPETOST V ODTEGAJOČI VEJI JERMENA

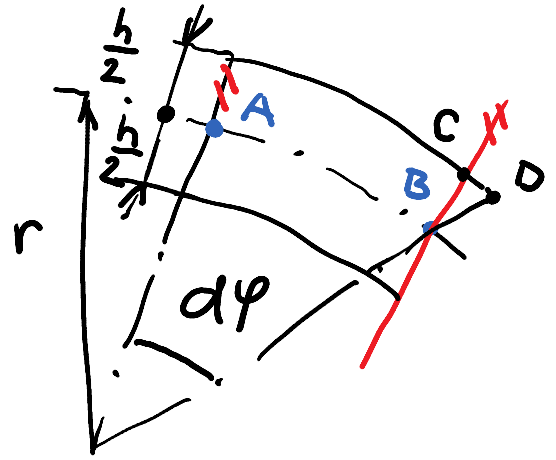
$$\sigma_2 = \frac{S_2}{A}$$

UPOGIBNA NAPETOST

$$\widehat{AB} = dL = r\,d\varphi$$

$$\widehat{CD} = ddL = \frac{h}{2}\,d\varphi$$

$$\varepsilon = \frac{ddL}{dL} = \frac{h\,d\varphi}{2r\,d\varphi}$$



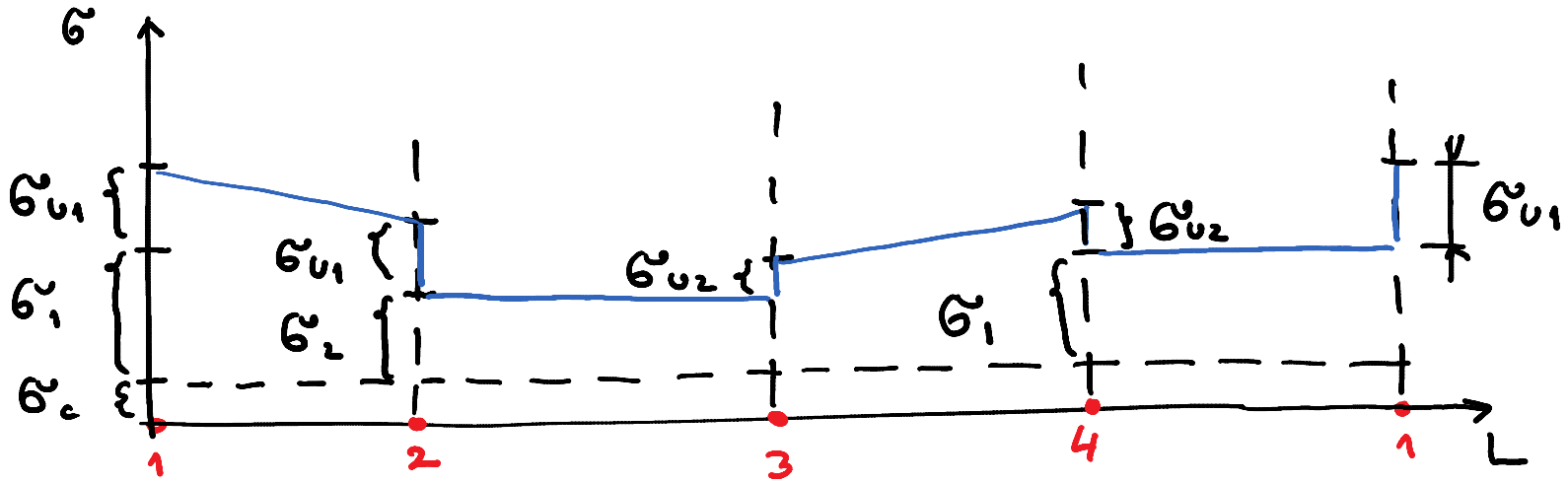
$$\varepsilon = \frac{h}{d} = \frac{\sigma_u}{E} \rightarrow \sigma_u = \frac{Eh}{d}$$

$$\sigma_{u1} = \frac{Eh}{d_1} \quad ; \quad \sigma_{u2} = \frac{Eh}{d_2}$$

MAKSIMALNA NAPETOST V JERMENU

$$\sigma_{max} = \sigma_1 + \sigma_c + \sigma_{u1} \leq \sigma_{dop}$$

NAPETOSTI V JERMENU PO DOLŽINI JERMENA



NATEŽNA NAPETOST V JERMENU ZARADI OBODNE SILE

$$\sigma_{max} = \sigma_1 + \sigma_c + \sigma_{v1} \leq \sigma_{dop}$$

$$\sigma_{tmax} = \frac{F_{tmax}}{A}$$ NATEŽNA NAPETOST ZARADI OBODNE SILE

$$S_1 = F_{tmax} \frac{m}{m-1} \; ; \; \sigma_1 = \frac{S_1}{A}$$

$$\sigma_1 + \sigma_c + \sigma_{v1} = \sigma_{dop}$$

$$\frac{F_{tmax}}{A} \frac{m}{m-1} + \rho v^2 + \sigma_{v1} = \sigma_{dop}$$

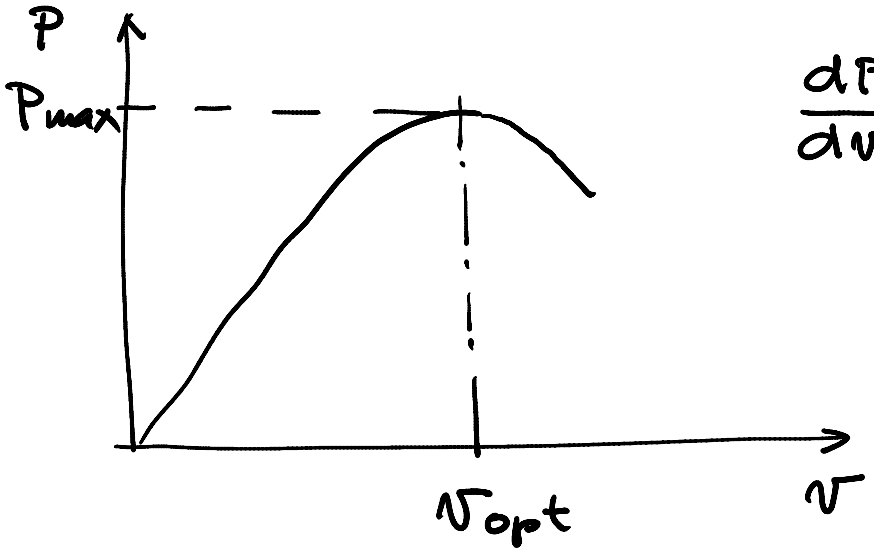
σ_{tmax}

$$\sigma_{tmax} = (\sigma_{dop} - \rho v^2 - \sigma_{v1}) \frac{m-1}{m}$$

MOČ IN OPTIMALNA OBODNA HITROST JERMENA

$$P = F_{tmax} \cdot v = \sigma_{tmax} \cdot A \cdot v = \left(\sigma_{dop} - \rho v^2 - \sigma_{v1} \right) \frac{m-1}{m} A \cdot v$$

$$= \underbrace{\left(\sigma_{dop} - \sigma_{v1} \right) \frac{m-1}{m} A}_{const = A_1} \cdot v - \underbrace{\rho \frac{m-1}{m} A}_{const = A_2} v^3$$

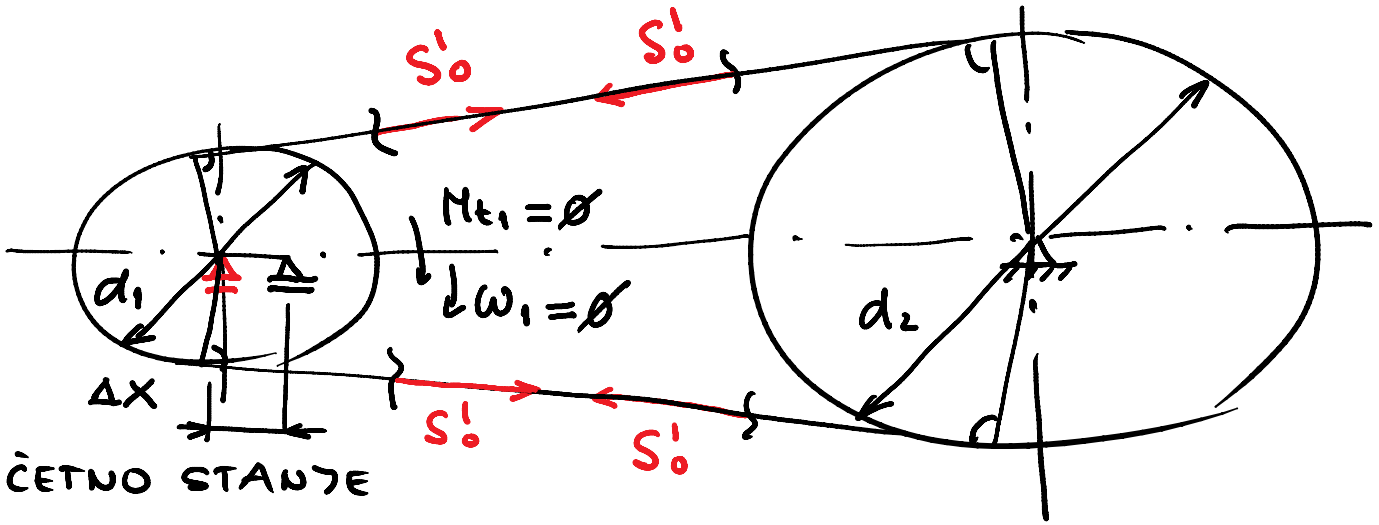


$$\frac{dP}{dv} = \phi = A_1 - 3A_2 v_{opt}^2$$

$$v_{opt}^2 = \frac{A_1}{3A_2} = \frac{\sigma_{dop} - \sigma_{v1}}{3\rho}$$

$$v_{opt} = \sqrt{\frac{\sigma_{dop} - \sigma_{v1}}{3\rho}}$$

PREDNAPENJANJE JERMENA

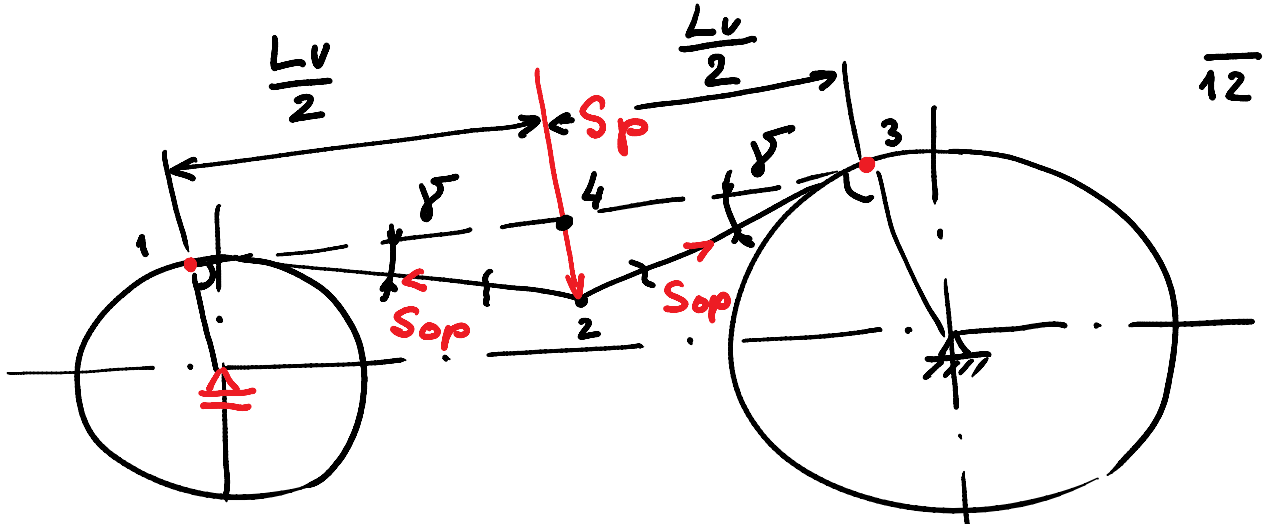


$\underline{\underline{\Delta}}$ ZAČETNO STANJE

$\underline{\underline{\Delta}}$ PO PREDNAPENJANJU

$$\sigma = E\,\varepsilon \qquad \sigma = \frac{S_0'}{A}\ ;\quad \varepsilon = \frac{\Delta L}{L}$$

$$S_0' = \frac{AE}{L}\Delta L \rightarrow \frac{\Delta L}{L} = \frac{S_0'}{AE} \quad (4)$$



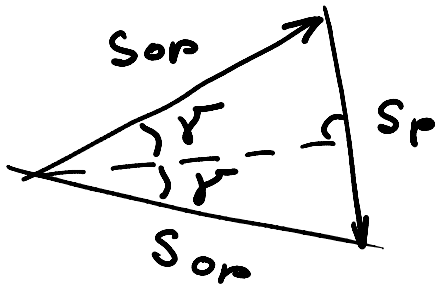
$$\overline{12} = \frac{Lv}{2} + \frac{\Delta Lv}{2} = \overline{23}$$

S_{op} SILA PREDNAPETJA U JERMENU PO PRITISKU NA UEJO JERMENA S_p. $S_{op} > S_0'$

$$\cos\gamma = \frac{\overline{14}}{\overline{12}} = \frac{Lv\ x}{x\,(Lv + \Delta Lv)} = \frac{Lv}{Lv + \Delta Lv} \quad (1)$$

$$\sin\gamma = \frac{S_p}{2\,S_{op}}$$

$$S_{op} = \frac{S_p}{2\sin\gamma} \quad (3)$$



$$\sigma_{op} = E\,\varepsilon_{op} \quad ; \quad \sigma_{op} = \frac{S_{op}}{A} \; ; \quad \varepsilon_{op} = \frac{\Delta L + \Delta L_v}{L}$$

③ $\dfrac{S_{op}}{A} = E\,\dfrac{\Delta L + \Delta L_v}{L}$ ← ④ ← ② $\quad | \cdot A$

IZ ① SLEDI

$$\cos\gamma = \frac{L_v}{L_v + \Delta L_v} \rightarrow L_v + \Delta L_v = \frac{L_v}{\cos\gamma}$$

$$\Delta L_v = L_v\left(\frac{1}{\cos\gamma} - 1\right) \quad ②$$

$$\frac{S_p}{2\sin\gamma} = AE\left(\frac{S_0'}{AE} + \frac{L_v}{L}\left(\frac{1}{\cos\gamma} - 1\right)\right)$$

$$= S_0' + \frac{L_v}{L} AE\left(\frac{1}{\cos\gamma} - 1\right)$$

K KONSTANTA JERMENA

$$S_0' = \frac{S_p}{2\sin\gamma} - K\frac{L_v}{L}$$

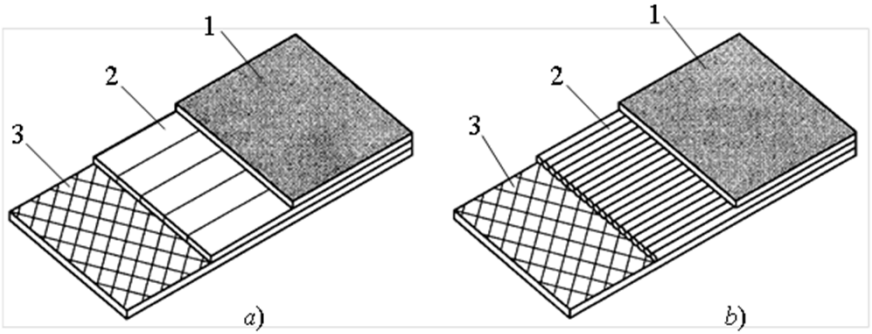
PROTIVNÁLEC JEDNOU PŘEDPÍŠE ÚHEL γ

$$\operatorname{tg}\gamma = \frac{\overline{24}}{Lv}\,2 = 2\,\frac{q}{Lv} \rightarrow q = \frac{\operatorname{tg}\gamma \cdot Lv}{2}$$

$$\overline{24} = q$$

ZGRADBA JERMENOV

PLOŠČATI JERMENI



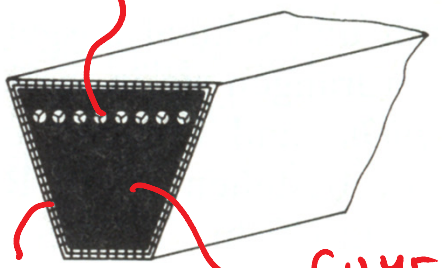
1- krovna plast, 2- vlečna plast, 3- toma plast

TORNA PLAST : ELASTOMER , ZOBOVJU USNJE

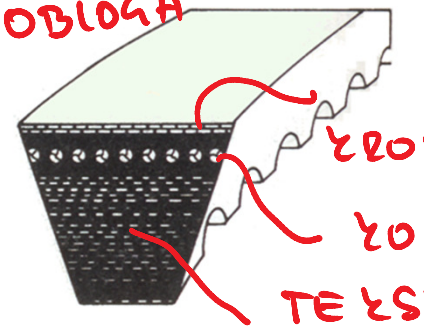
VLEČNA PLAST : POLIAMIDNI TRAK, ZORDNE VRVICE

ZROVNA PLAST : TEKSTILNA TKANINA

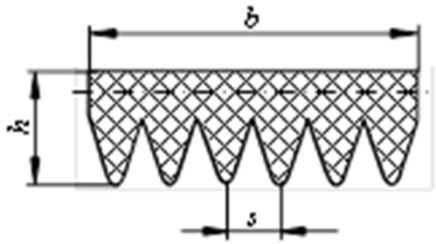
KLINASTI JERMENI



OPLAŠČENI KLINASTI JERMEN
NORMALNA ALI OZKA IZVEDBA



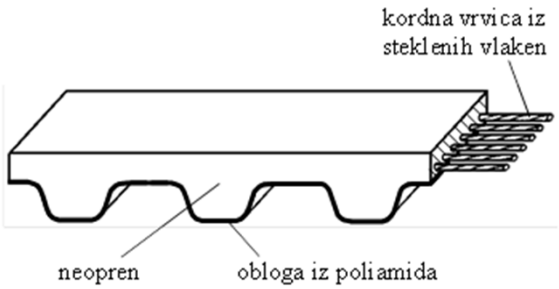
REZANI KLINASTI JERMEN
NORMALNA ALI OZKA IZVEDBA



h višina jermena
s razmak med rebri
b širina jermena
Z število reber

REBRASTI KLINASTI JERMEN

ZOBATI JERMENI



a)

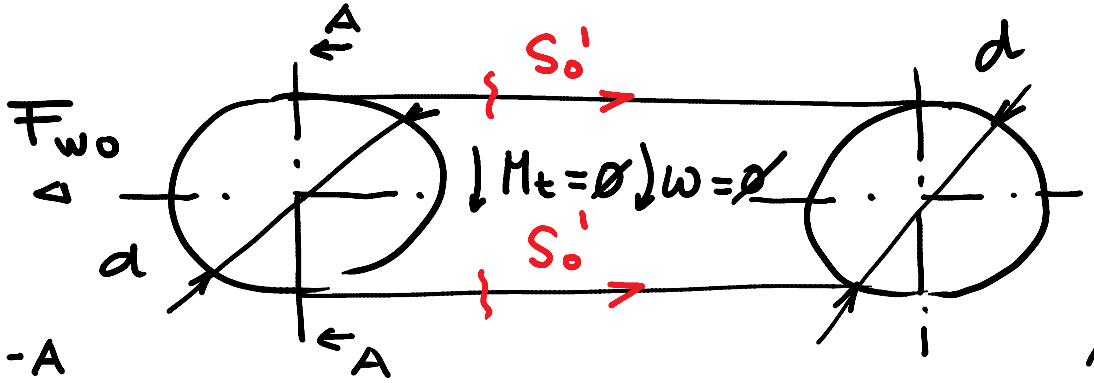
VLEČNA PLAST : KORDNE VRVICE IZ JEKLA, STEKLENIH VLAKEN, KEVLARJA

ZAŠČITNA PLAST : NEOPREN

ZOBJE : NEOPREN

OBLOGA : POLIAMID

PRIMERJAVA PLOŠČATEGA IN KLINASTEGA JERMENA GLEDE NA RADIALNO SILO



$F_{t1} \leq F_{R1}$ $\quad M_{tmax1} \cong F_{R1} \frac{d}{2}$ $\quad F_{t2} \leq F_{R2}$

PRI ENAKI SILI PREDNAPETJA S_0' LAHKO PREKO KLINASTEGA JERMENA PRENAŠAMO VEČJE MOMENTE M_t KOT PREKO PLOŠČATEGA JERMENA!

VREDNOTENJE JERMENSKIH GONIL

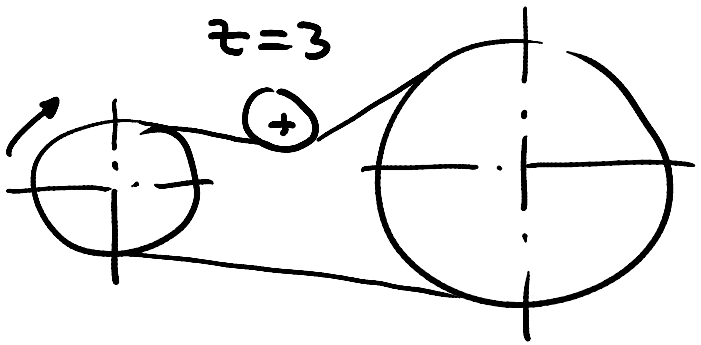
- OBODNA HITROST JERMENA

$v \leq v_{dop}$ PRI VISOKIH v OBSTAJA NEVARNOST TRENUTNEGA LOMA (EKSPLOZIJE) JERMENICE ZARADI CENTRIFUGALNE SILE

- UPOGIBNA FREKVENCA JERMENA

$$f = \frac{v\,z}{L} \leq f_{dop}$$ NEVARNOST UTRUJENOSTNEGA LOMA

z: ŠTEVILO JERMENIC



- MAKSIMALNA NAPETOST V JERMENU

$\sigma_{max} \leq \sigma_{dop}$ NEVARNOST TRENUTNEGA LOMA

- ŠIRINA JERMENA OZIROMA ŠTEVILO JERMENOV

$b \geq \frac{P}{P_i}$ [mm] PLOŠČATI IN ZOBATI JERMENI

P: MOČ, ZI JO PRETO GONILA PRENAŠAMO [kW]

P_i: IMENSKA MOČ JERMENA [kW/mm]

$i \geq \frac{P}{P_i}$ [-] KLINASTI JERMEN

P_i: IMENSKA MOČ JERMENA [kW/JERMEN]

i : ŠTEVILO JERMENOV