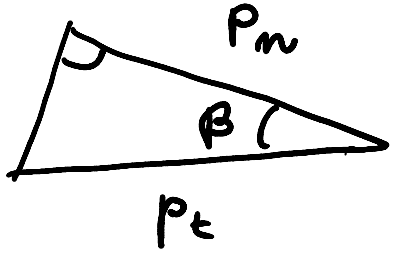
RADIALNI IN NORMALNI PROFIL OZOBJA



$p_n = p_t \cdot \cos\beta \Rightarrow p_t = \frac{p_n}{\cos\beta}$ – normalni razdelek

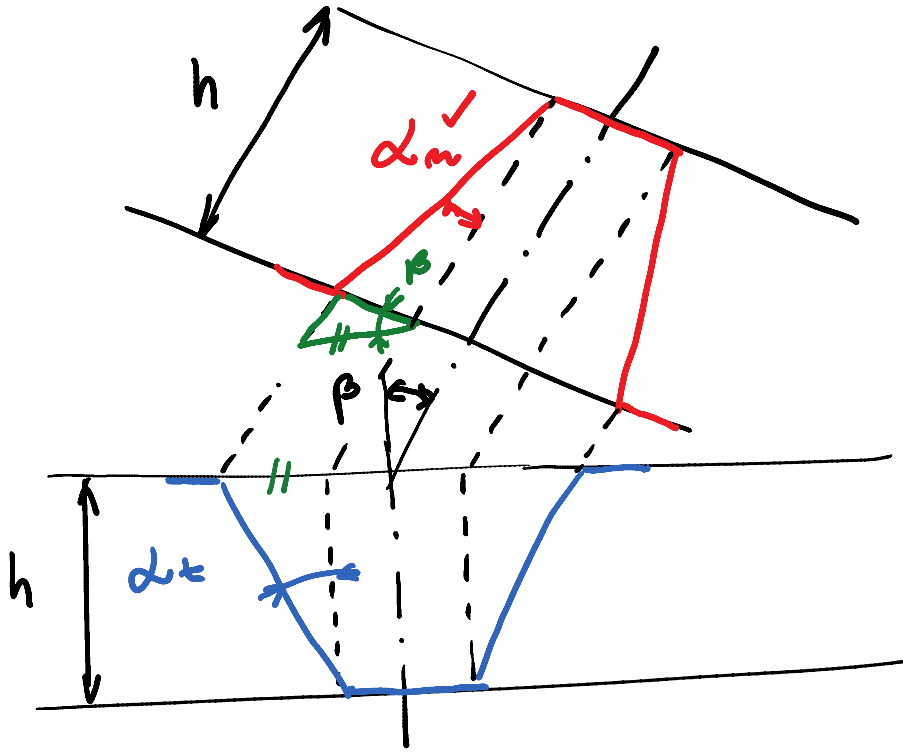
p_t – radialni razdelek

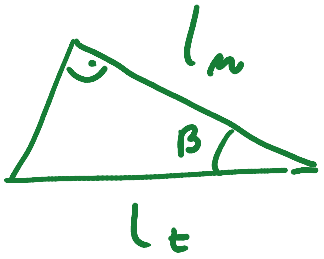
$p_t = s_t + e_t$; $p_n = s_n + e_n$

$s_t + e_t = \frac{s_n}{\cos\beta} + \frac{e_n}{\cos\beta} \Rightarrow s_t = \frac{s_n}{\cos\beta}$

$p_n = m_n \cdot \pi$; $p_t = m_t \cdot \pi$ $\qquad e_t = \frac{e_n}{\cos\beta}$

$m_t \cdot \pi = \frac{m_n \cdot \pi}{\cos\beta} \Rightarrow m_t = \frac{m_n}{\cos\beta}$





$$l_t = \frac{l_n}{\cos\beta}$$

$$\operatorname{tg}\alpha_n = \frac{l_n}{h}$$

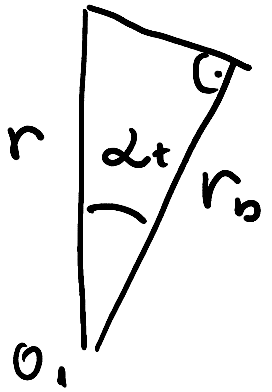
$$\operatorname{tg}\alpha_t = \frac{l_t}{h}$$

$$\operatorname{tg}\alpha_t = \frac{\operatorname{tg}\alpha_n}{\cos\beta} \qquad h\cdot\operatorname{tg}\alpha_t = \frac{h\operatorname{tg}\alpha_n}{\cos\beta}$$

$\alpha_n = 20°$ $\beta = \varphi \Rightarrow \alpha_n = \alpha_t = \alpha$

α_n, m_n, β → OSTALE VELIČINE RADIALNEGA PROFILA

$$d = m_t \cdot z = \frac{m_n}{\cos\beta} z$$



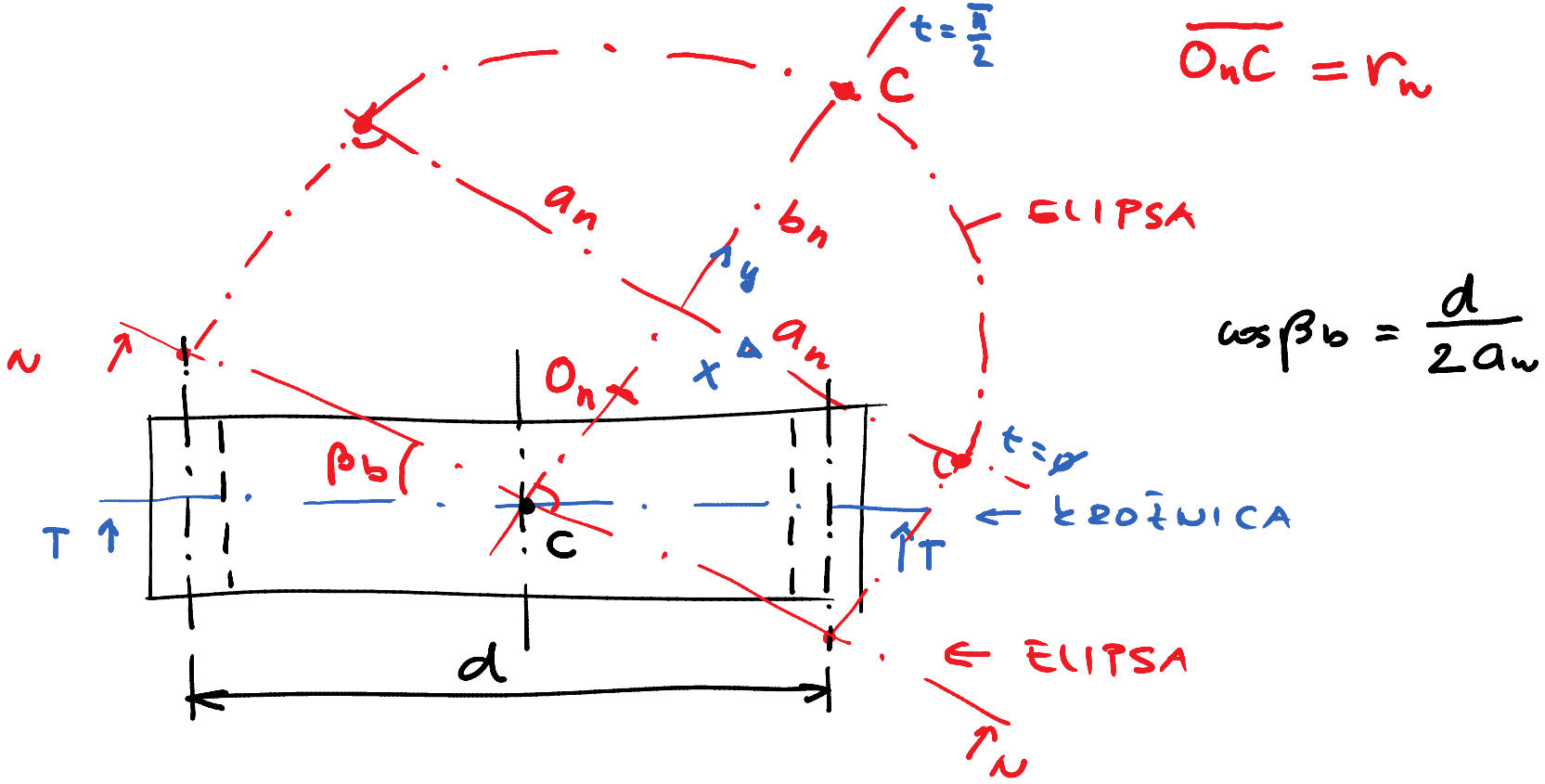
$$r_b = r \cdot \cos\alpha_t \quad | \cdot 2$$

$$d_b = d \cdot \cos\alpha_t$$

$$d_a = d + 2h_a$$

$$d_f = d - 2h_f$$

NADOMESTNO ŠTEVILO ZOB



$$\cos\beta_b = \frac{d}{2a_w}$$

IŠČEMO RADIJ UKRIVLJENOSTI V TOČKI C

$$a_n = \frac{d}{2\cos\beta_b} \qquad b_n = \frac{d}{2} \qquad m_n = \frac{m_t}{\cos\beta}$$

$$r = \frac{|x'^2 + y'^2|^{\frac{3}{2}}}{\begin{vmatrix} x' & y' \\ x'' & y'' \end{vmatrix}}$$

$x = a_n \cdot \cos t$

$y = b_n \cdot \sin t$

$x' = -a_n \cdot \sin t$

$y' = b_n \cdot \cos t$

$x'' = -a_n \cos t$

$y'' = -b_n \sin t$

$t = \frac{\pi}{2}$

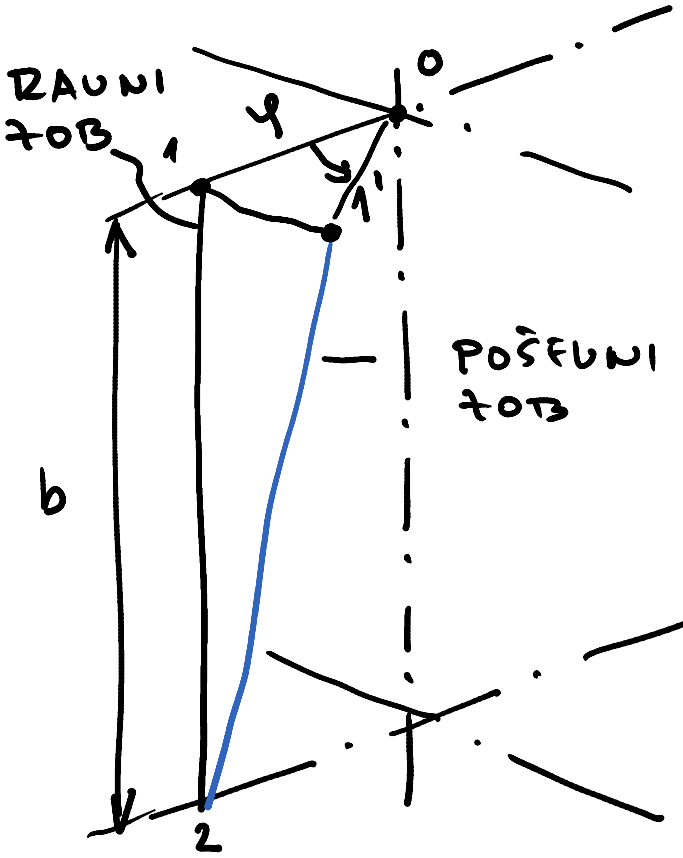
$x' = -a_n \; ; \; y' = 0 \; ; \; x'' = 0 \; ; \; y'' = -b_n$

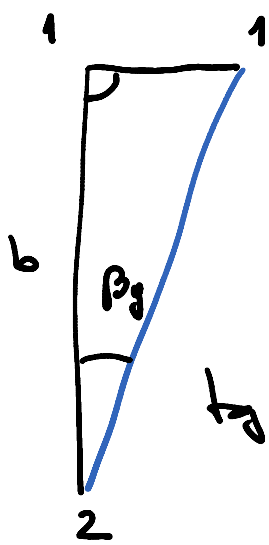
$$r_n = \frac{|a_n^2|^{\frac{3}{2}}}{a_n \cdot b_n} = \frac{a_n^3}{a_n \cdot b_n} = \frac{a_n^2}{b_n} = \frac{d^2}{4 \cos^2 \beta_b \, \alpha}$$

$$2r_n = \frac{d}{\cos^2 \beta_b} = d_n = m_n z_n = \frac{m_t z}{\cos^2 \beta_b} = \frac{m_n z}{\cos^2 \beta_b \cos \beta}$$

$$z_n = \frac{z}{\cos^2\beta_b \cos\beta}$$

NADOMESTNO ŠTEVILO ZOB





$\overline{10} = r_y \qquad \overline{11'} = r_y \cdot \varphi$

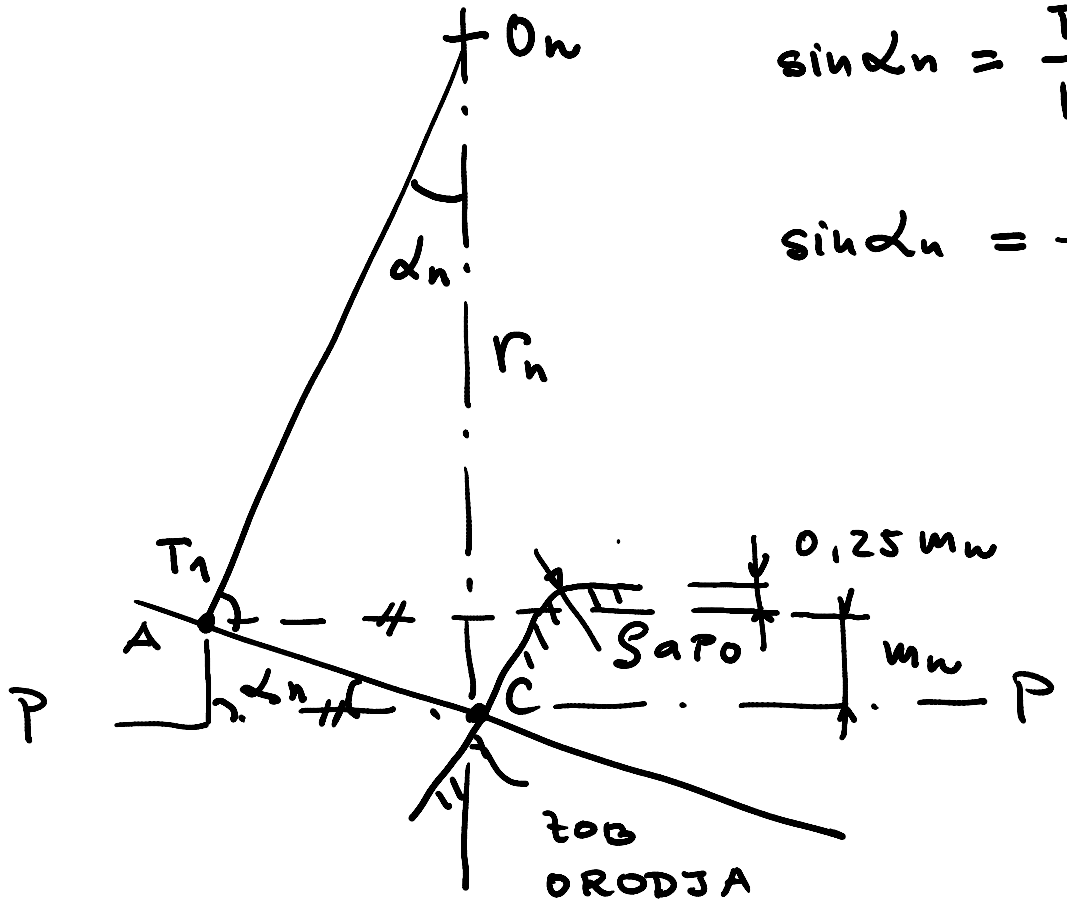
$$\operatorname{tg}\beta_y = \frac{r_y \varphi}{b}$$

$$\operatorname{tg}\beta = \frac{r \varphi}{b}$$

$$\operatorname{tg}\beta_y = \frac{r_y}{r} \operatorname{tg}\beta$$

$$\operatorname{tg}\beta_b = \frac{d_b}{d} \operatorname{tg}\beta$$

IZPODREZ ZOBNEGA KOLESA IN MEJNO ŠTEVILO ZOB



$$\sin\alpha_n = \frac{\overline{T_1C}}{r_n} = \frac{m_n}{\overline{T_1C}}$$

$$\sin\alpha_n = \frac{m_n}{\sin\alpha_n \, r_n}$$

$$\sin^2\alpha_n = \frac{2 m_n}{d_n}$$

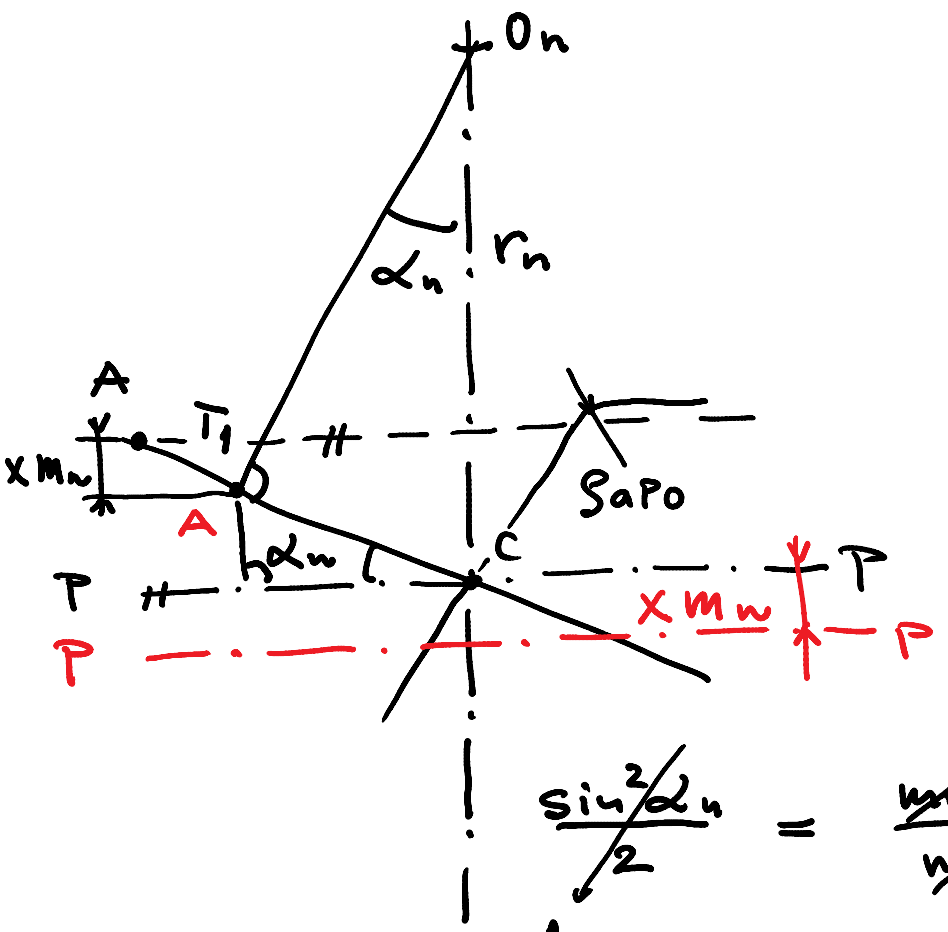
$$\frac{\sin^2\alpha_n}{2} = \frac{m_n}{m_n \cdot z_n}$$

$$z_n = \frac{2}{\sin^2\alpha_n} = \frac{z_g}{\cos^2\beta_b \cos\beta}$$

$$z_g = \frac{2\cos^2\beta_b \cdot \cos\beta}{\sin^2\alpha_n}$$

$\beta = 0 \Rightarrow \beta_b = 0 \Rightarrow z_g = 17$

PREMIK PROFILA OSNOVNE ZOBNICE



X STOPNJA PROFILEGA POMIKA

$X m_n$ PROFILNI POMIK

$$\sin\alpha_n = \frac{\overline{T_1C}}{r_n}$$

$$\sin\alpha_n = \frac{m_n - m_n X}{\overline{T_1C}}$$

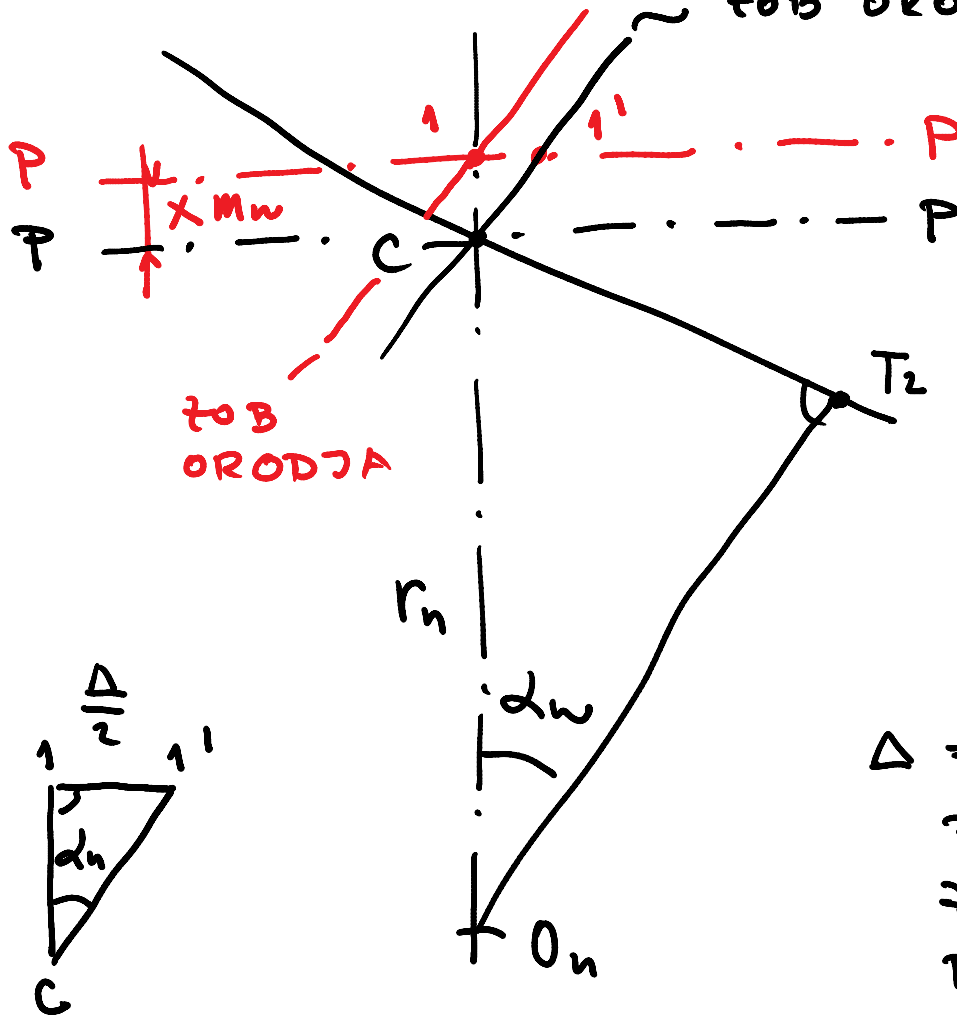
$$\sin\alpha_n = \frac{m_n(1-x)}{r_n \sin\alpha_w}$$

$$\sin^2\alpha_n = \frac{m_n (1-x)2}{\alpha_n}$$

$$\frac{\sin^2\alpha_n}{2} = \frac{m_n(1-x)}{m_n \cdot z_n}$$

$$\frac{1}{17} \qquad \frac{z_n}{17} = 1 - x \qquad x = 1 - \frac{z_n}{17} = x_{min}$$

DEBELINA ZOBA IN ŠIRINA MEDZOBNE UDREL



X-TA ZOBNIŠKA DUOJICA

X - NIČTA ZOBNIŠKA DUOJICA

$\overline{11'} = \frac{\Delta}{2}$

$tg\alpha_n = \frac{\Delta}{2 \cdot x \cdot m_n}$

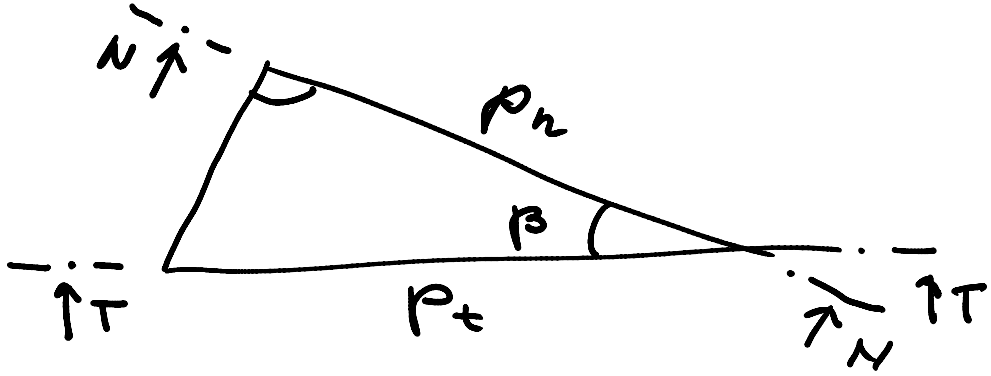
$\overline{C1} = x \cdot m_n$

$\Delta = 2 \cdot x \cdot m_n \cdot tg\alpha_n$

POVEČANJE DEBELINE ZOBA ZARADI PROFILNEGA POMIKA

$$s_n = \frac{p_n}{2} + 2x\, m_n \operatorname{tg}\alpha_n$$

$$e_n = \frac{p_n}{2} - 2x\, m_n \operatorname{tg}\alpha_n$$



$$s_n = m_n\left(\frac{\pi}{2} + 2x \operatorname{tg}\alpha_n\right)$$

$$e_n = m_n\left(\frac{\pi}{2} - 2x \operatorname{tg}\alpha_n\right)$$

$$s_t = m_t\left(\frac{\pi}{2} + 2x \operatorname{tg}\alpha_n\right)$$

$$e_t = m_t\left(\frac{\pi}{2} - 2x \operatorname{tg}\alpha_n\right)$$

$$m_t = \frac{m_n}{\cos\beta}$$

$$p_n = m_n \cdot \pi$$

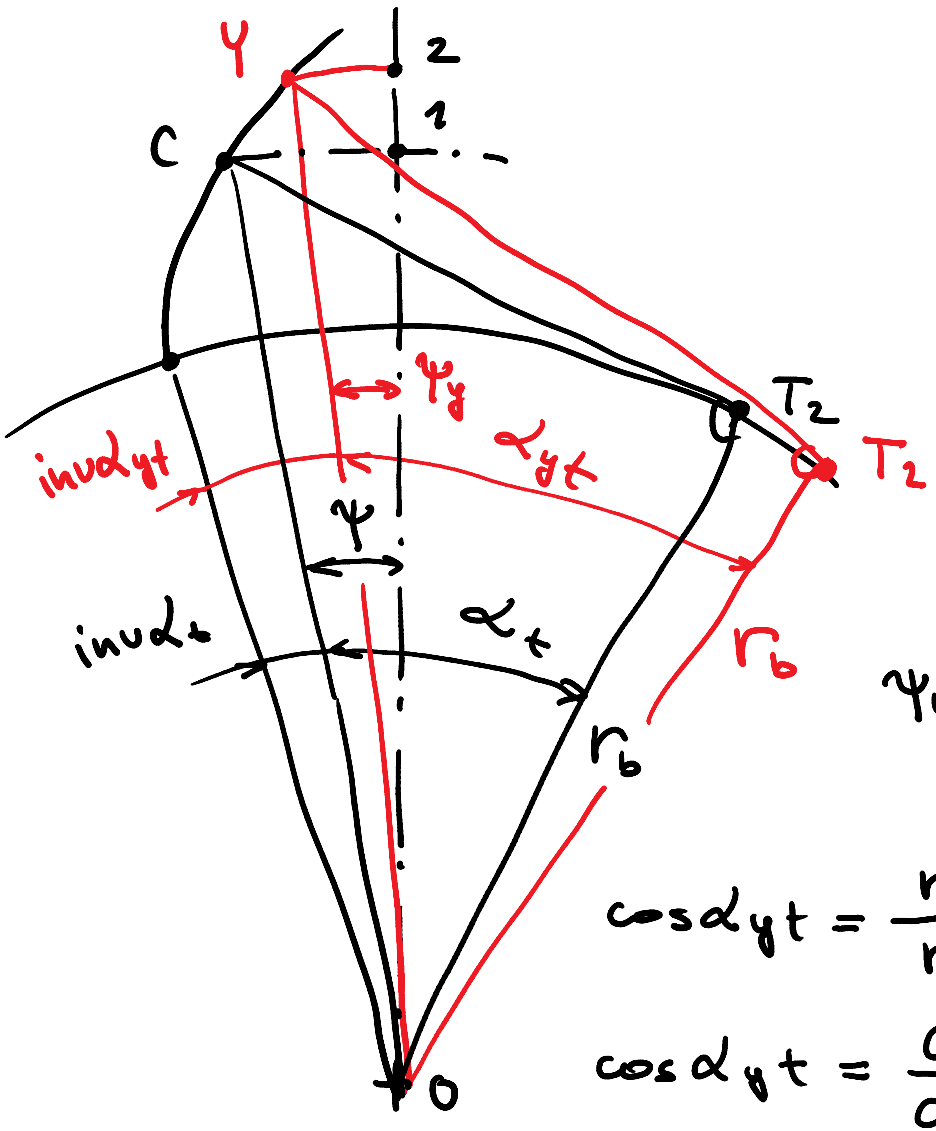
$$\cos\beta = \frac{p_n}{p_t}$$

$$p_t = m_t \cdot \pi$$

$$p_t = \frac{p_n}{\cos\beta}$$

$$s_t = \frac{s_n}{\cos\beta}$$

$$e_t = \frac{e_n}{\cos\beta}$$



$$\overline{OC} = r \; ; \; \widehat{C1} = \frac{s_t}{2}$$

$$\frac{s_t}{2} = \psi \frac{d}{2}$$

$$\psi = \frac{s_t}{d}$$

$$\overline{OY} = r_y \; ; \; \widehat{Y2} = \frac{s_{yt}}{2}$$

$$\frac{s_{yt}}{2} = \psi_y \cdot \frac{d_y}{2}$$

$$\psi_y = \psi - (inv\alpha_{yt} - inv\alpha_t)$$

$$= \psi + inv\alpha_t - inv\alpha_{yt}$$

$$\cos\alpha_{yt} = \frac{r_b}{r_y} \; ; \; \cos\alpha_t = \frac{r_b}{r}$$

$$\cos\alpha_{yt} = \frac{d}{d_y} \cos\alpha_t$$

$$s_{yt} = d_y \cdot \psi_y = d_y(\psi + inv\alpha_t - inv\alpha_{yt})$$

$$s_{yt} = d_y\left(\frac{s_t}{d} + inv\alpha_t - inv\alpha_{yt}\right)$$

$$p_{yt} = s_{yt} + e_{yt}$$

$$p_t \frac{d_y}{d} = s_{yt} + e_{yt}$$

$$e_{yt} = p_t \frac{d_y}{d} - s_{yt}$$

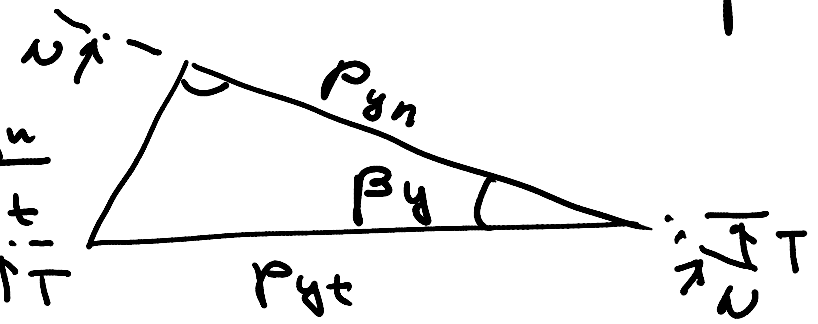
$$p_t \, z = \pi d$$

$$p_{yt} \, z = \pi d_y$$

$$\frac{p_{yt}}{p_t} = \frac{d_y}{d}$$

$$p_t = m_t \cdot \pi = \frac{m_n \cdot \pi}{\cos\beta}$$

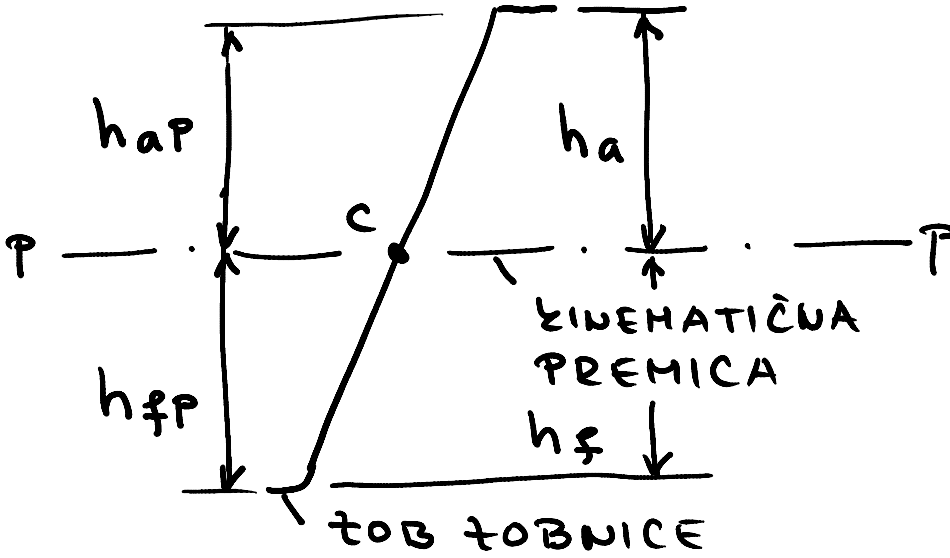
$$\cos\beta_y = \frac{p_{yn}}{p_{yt}} = \frac{e_{yn}}{e_{yt}} = \frac{s_{yn}}{s_{yt}}$$

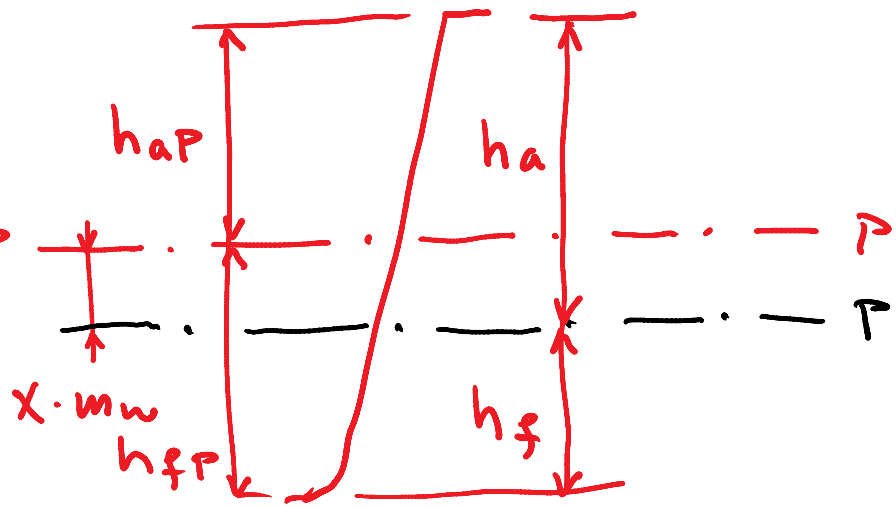


$$S_{yn} = S_{yt} \cdot \cos \beta_y$$

$$e_{yn} = e_{yt} \cdot \cos \beta_y$$

VIŠINA ZOBNEGA ZAREZA IN ZOBNEGA VRHA





X - NIČTA ZOBNIŠKA DUOJICA

$h_a = h_{aP} = m_n$

$h_f = h_{fP} = m_n + c_P^* m_n$

$c_P = c_P^* m_n = 0{,}25\, m_n$ TEMENSKI RAZTOP

X-TA ZOBNIŠKA DUOJICA

$h_a = h_{aP} + x m_n + k$?

$h_f = h_{fP} - x \cdot m_n$

k KOREKCIJA ZOBNEGA VRHA

PREMER VTNOŽNEGA IN TEMENSKEGA KROGA

$$d_f = d - 2h_f$$

$$d_a = d + 2h_a$$

MEJNE VREDNOSTI KOEFICIENTA PROFILNEGA POMIKA

$$S_{am} \geq 0.2 \text{ mm}$$

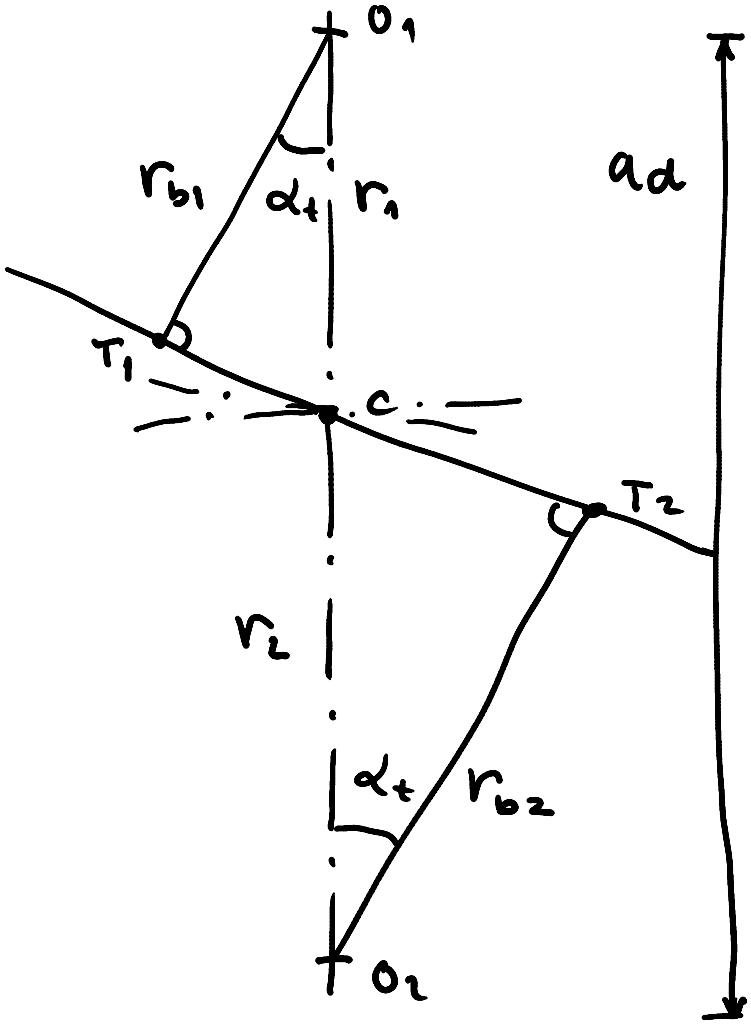
X - NIČTE IN X-TE KOBNIŠKE DVOJICE

X - NIČTA $\Rightarrow$ $X_1 = \phi \wedge X_2 = \phi$

X - TA $\Rightarrow$ $X_1 \neq \phi \vee X_2 \neq \phi$

$X_1 = -X_2$ POSEBEN PRIMER

MEDOSNI RAZMIK X-NIČTE ZOBNIŠKE DVOJICE



$$a_d = \frac{d_1 + d_2}{2} = \frac{m_t (z_1 + z_2)}{2}$$

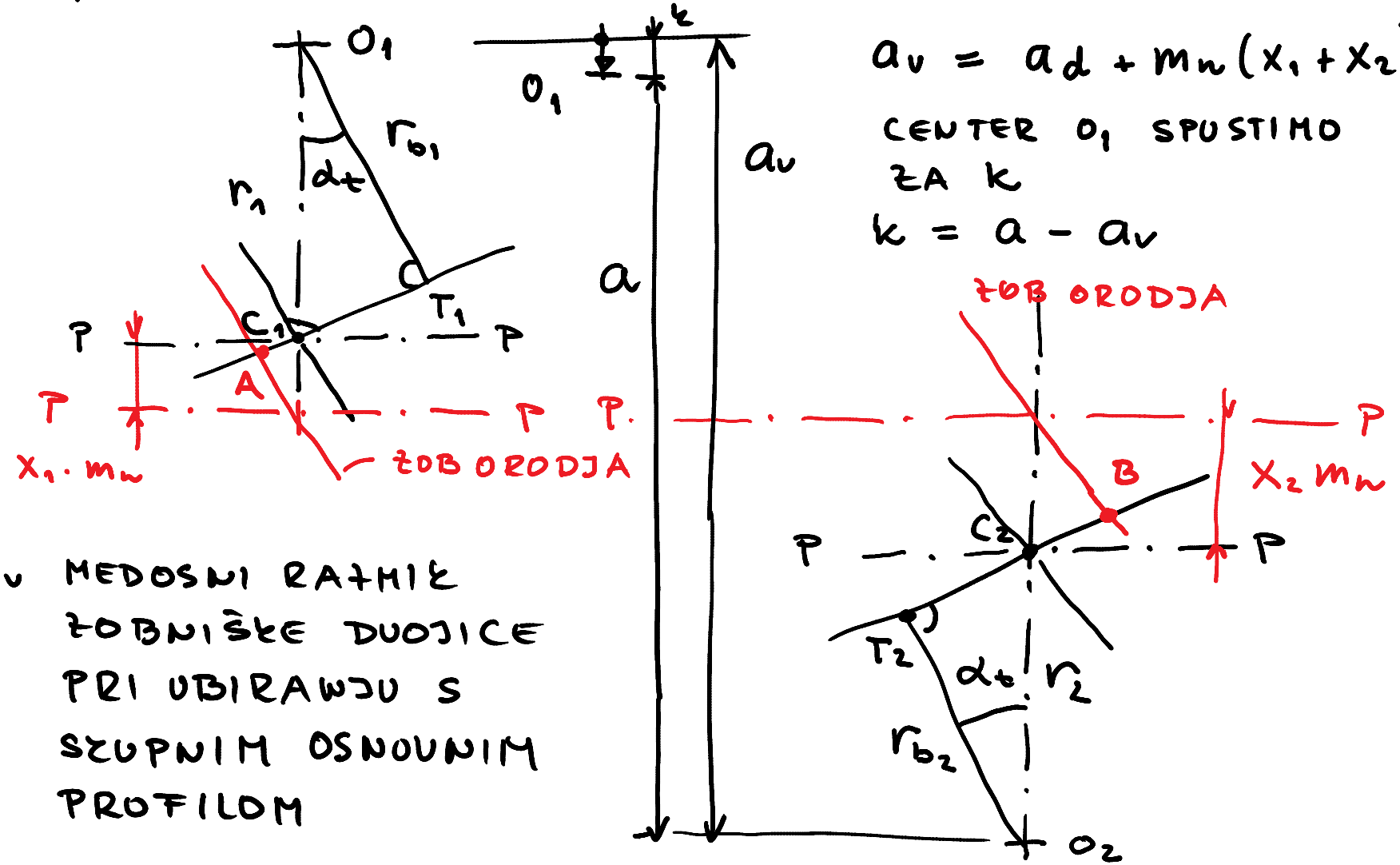
$$a_d = \frac{m_n (z_1 + z_2)}{2 \cos\beta}$$

$d_1 = d_{w1}$

$d_2 = d_{w2}$

d_w PREMER VIRTUALNEGA KROGA

MEDOSNI RAZMIK X-TE ZOBNIŠKE DUOJICE

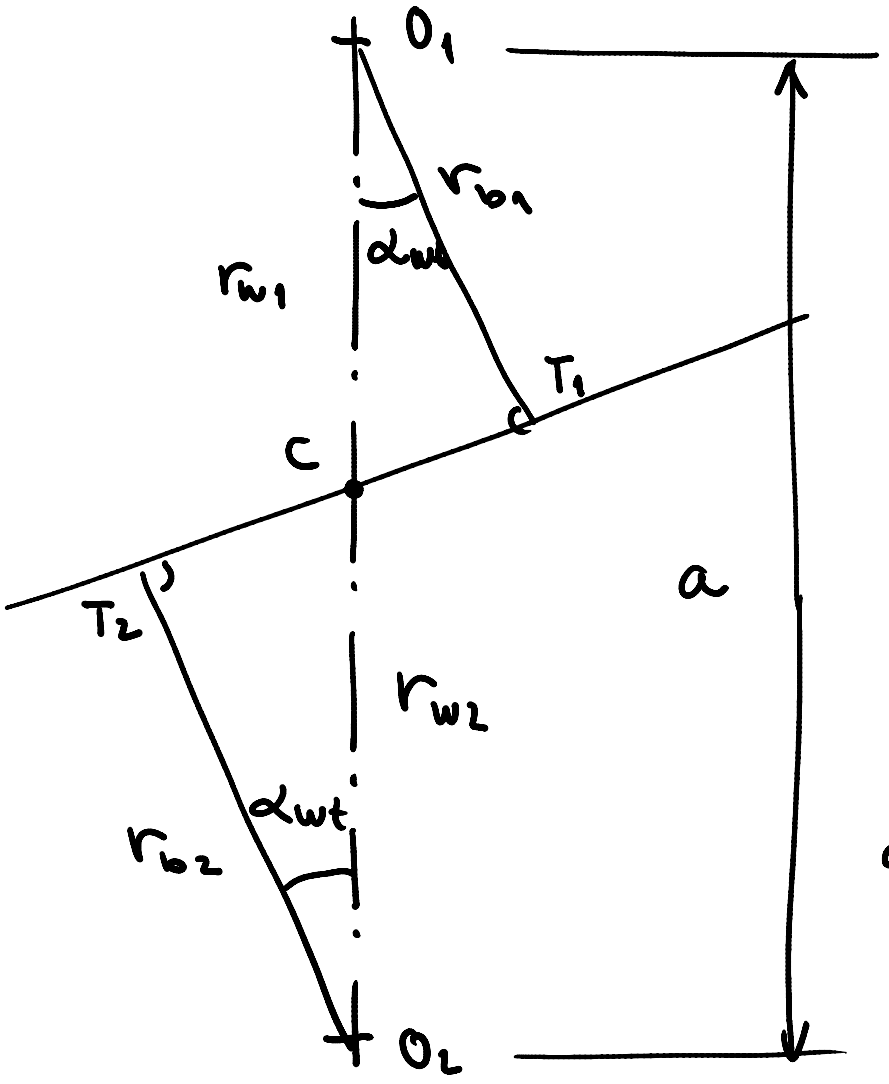


$$a_v = a_d + m_n(x_1 + x_2)$$

CENTER O_1 SPUSTIMO ZA k

$$k = a - a_v$$

a_v MEDOSNI RAZMIK ZOBNIŠKE DUOJICE PRI UBIRANJU S STOPNIM OSNOVNIM PROFILOM



$$a = \frac{d_{w1} + d_{w2}}{2}$$

$$\cos\alpha_{wt} = \frac{r_{b1}}{r_{w1}}$$

$$\cos\alpha_t = \frac{r_{b1}}{r_1}$$

$$r_{w1} = \frac{r_{b1}}{\cos\alpha_{wt}} = r_1 \cdot \frac{\cos\alpha_t}{\cos\alpha_{wt}}$$

$$d_{w1} = d_1 \cdot \frac{\cos\alpha_t}{\cos\alpha_{wt}}$$

$$d_{w2} = d_2 \cdot \frac{\cos\alpha_t}{\cos\alpha_{wt}}$$

$$a = \frac{d_{w1} + d_{w2}}{2} = \frac{d_1 + d_2}{2} \cdot \frac{\cos\alpha_t}{\cos\alpha_{wt}} = a_d \frac{\cos\alpha_t}{\cos\alpha_{wt}}$$

α_{wt} VPADNI KOT RADIALNEGA PROFILA NA KINEMATIČNEM KROGU

VPADNI KOT RADIALNEGA PROFILA NA KINEMATIČNEM KROGU

$$a_d = \frac{m_n (z_1 + z_2)}{2 \cos\beta}$$

$$a = \frac{m_n (z_1 + z_2)}{2 \cos\beta} \frac{\cos\alpha_t}{\cos\alpha_{wt}}$$

a JE ZNAN

$$\cos\alpha_{wt} = \frac{m_n (z_1 + z_2) \cos\alpha_t}{2 a \cos\beta}$$

a w1 τwAN

$$s_{w1} = e_{w2} \; ; \; s_{w2} = e_{w1}$$

$$p_{w1} = s_{w1} + e_{w1} = s_{w1} + s_{w2} = p_{w2}$$

$$s_{yt} = d_y \left(\frac{s_t}{d} + inv\alpha_t - inv\alpha_{yt} \right)$$

$$s_t = m_t \left(\frac{\pi}{2} + 2x\, tg\alpha_w \right)$$

$$p_{w1} \cdot z_1 = \pi d_{w1} \rightarrow p_{w1} = \frac{\pi d_{w1}}{z_1} \; ; \; \frac{z_2}{z_1} = \frac{d_{w2}}{d_{w1}}$$

$$p_{w2} \cdot z_2 = \pi d_{w2} \rightarrow \frac{p_{w1} \cdot z_1}{p_{w2} z_2} = \frac{\pi d_{w1}}{\pi d_{w2}}$$

$$\frac{\pi\, d_{w1}}{z_1} = d_{w1}\left(\frac{s_{t1}}{d_1} + inv\alpha_t - inv\alpha_{wt}\right) + d_{w2}\left(\frac{s_{t2}}{d_2} + inv\alpha_t - inv\alpha_{wt}\right)$$

$$\frac{\pi}{z_1} = \frac{s_{t1}}{d_1} + inv\alpha_t - inv\alpha_{wt} + \frac{z_2}{z_1}\left(\frac{s_{t2}}{d_2} + inv\alpha_t - inv\alpha_{wt}\right)$$

$$T = \cancel{z_1}\,\frac{s_{t1}}{m_t \cdot \cancel{z_1}} + z_1\left(inv\alpha_t - inv\alpha_{wt}\right) + \cancel{z_2}\,\frac{s_{t2}}{m_t \cancel{z_2}} + z_2\left(inv\alpha_t - inv\alpha_{wt}\right)$$

$$\cancel{\pi} = (z_1 + z_2)\left(inv\alpha_t - inv\alpha_{wt}\right) + \frac{\cancel{\pi}}{\cancel{2}} + 2x_1 tg\alpha_n + \frac{\cancel{\pi}}{\cancel{2}} + 2x_2 tg\alpha_n$$

$$2(x_1 + x_2)\, tg\alpha_n = (z_1 + z_2)\left(inv\alpha_{wt} - inv\alpha_t\right)$$

$$inv\alpha_{wt} = \frac{2(x_1 + x_2)\, tg\alpha_n}{z_1 + z_2} + inv\alpha_t$$

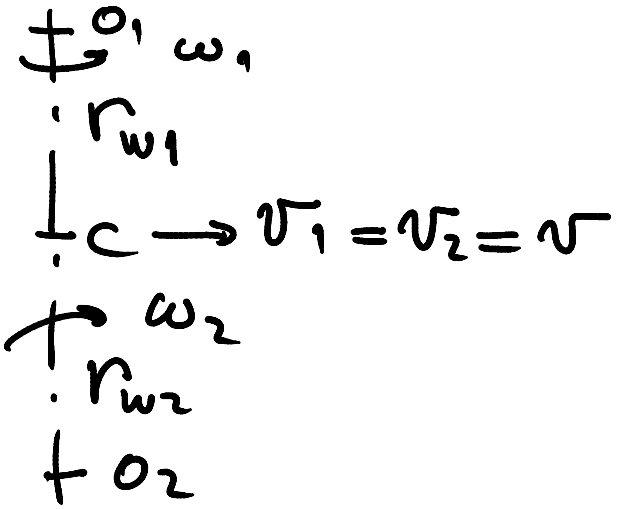
VSOTA KOEFICIENTOU PROFILNIH POMIKOU

$$X_1 + X_2 = \frac{(z_1 + z_2)(\text{inv}\,\alpha_{wt} - \text{inv}\,\alpha_t)}{2\ \text{tg}\,\alpha_w}$$

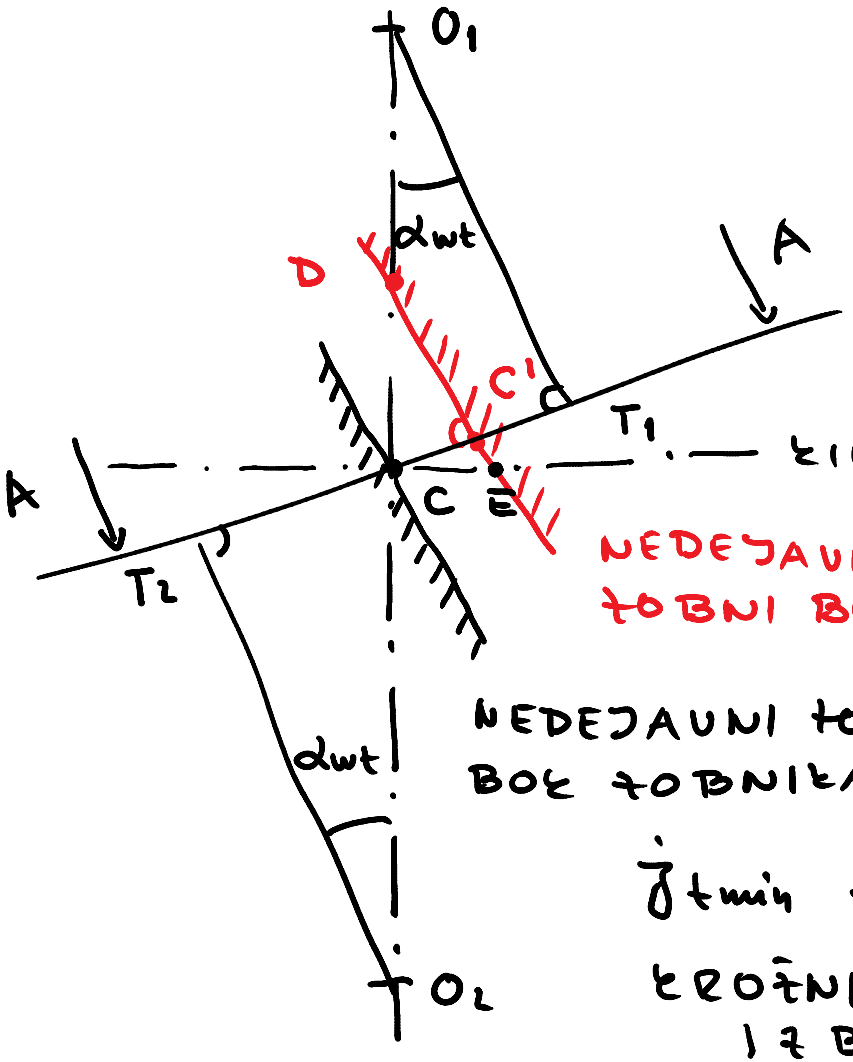
NEOBČUTLJIVOST EVOLVENTNEGA OZOBJA NA SPREMEMBO PROFILNEGA POMIKA

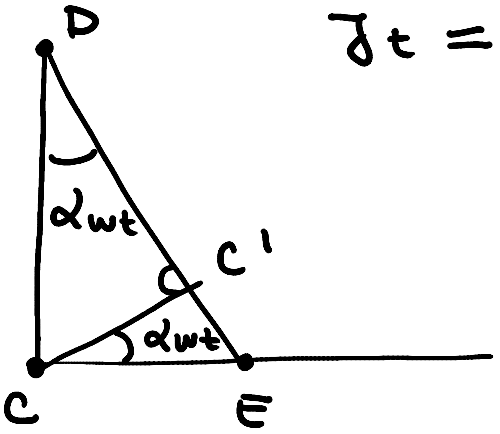
$$i = \frac{\omega_1}{\omega_2} = \frac{r_{w2}}{r_{w1}} = \frac{r_{b2}}{\cancel{\cos\alpha_{wt}}} \frac{\cancel{\cos\alpha_{wt}}}{r_{b1}} = \frac{r_{b2}}{r_{b1}} = \text{const}$$

$$v_1 = \omega_1 \cdot r_{w1} = \omega_2 \cdot r_{w2} = v_2 = v$$



BOČNI RAZSTOP





$\dot{j}_t = \overline{CE}$

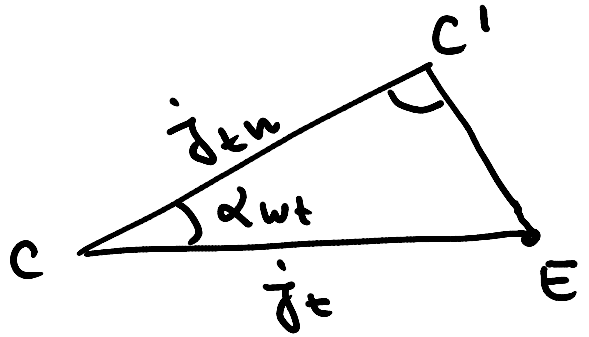
KINEMATIČNA PREMICA

NEDEJAVNI ZOBNI BOK PASTORKA

NEDEJAVNI ZOBNI BOK ZOBNIKA

$\dot{j}_{tmin} \leq \dot{j}_t \leq \dot{j}_{tmax}$

KROŽNI BOČNI RAZSTOP IZ BEREMO



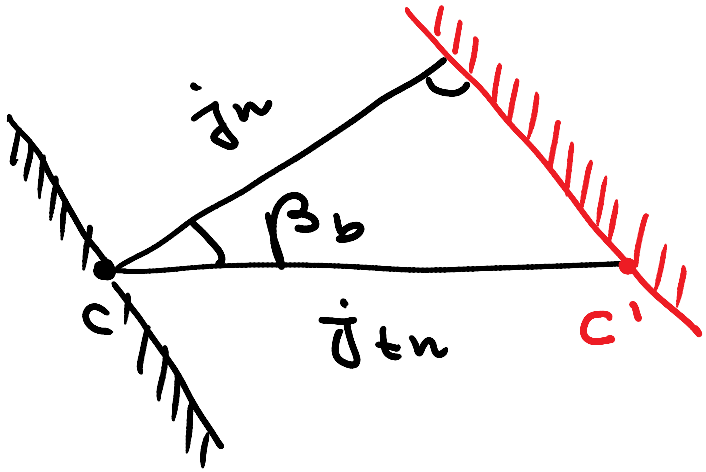
$$\cos\alpha_{wt} = \frac{j_{tn}}{j_t}$$

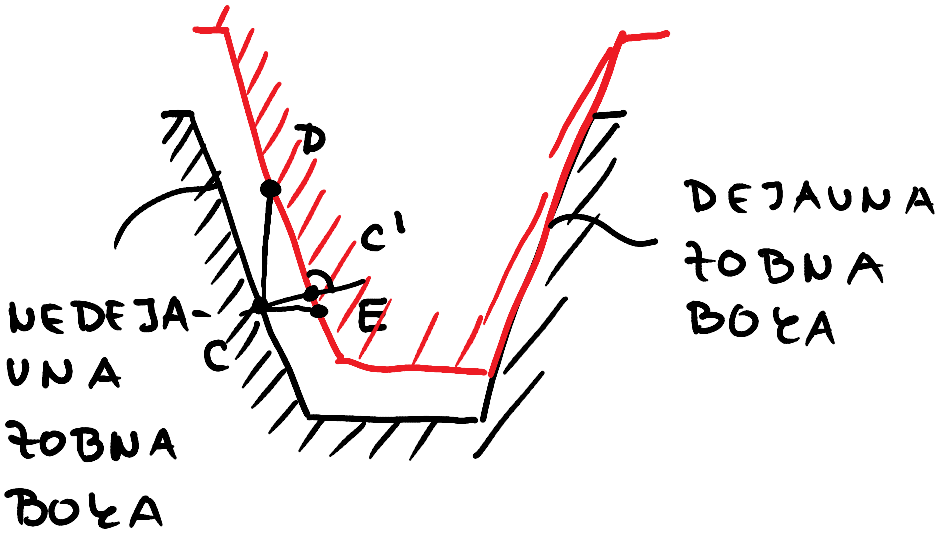
$$j_{tn} = j_t \cdot \cos\alpha_{wt}$$

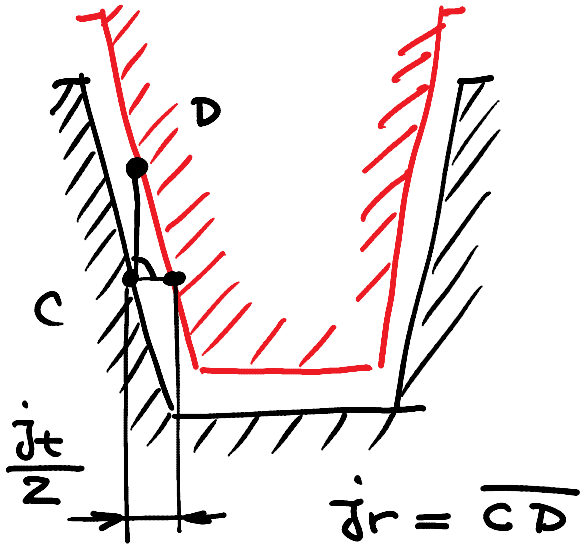
$$j_n = j_{tn} \cdot \cos\beta_b = j_t \cdot \cos\alpha_{wt} \cos\beta_b$$

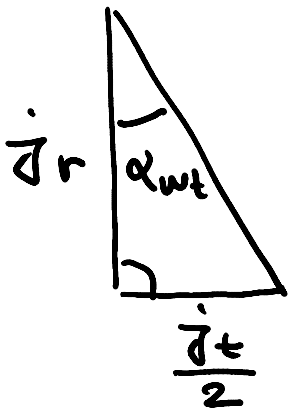
NORMALNI BOČNI RAZTOP

A - A







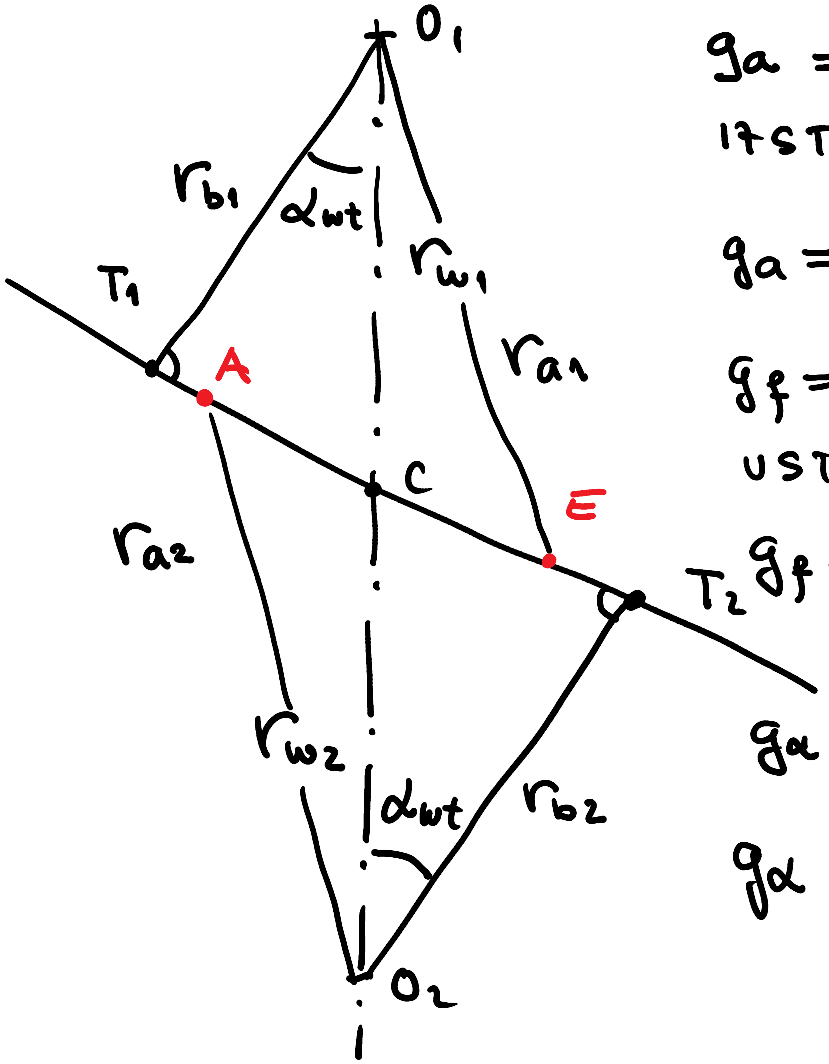


$$\operatorname{tg}\alpha_{wt} = \frac{j_t}{2\, j_r}$$

$$j_r = \frac{j_t}{2\, \operatorname{tg}\alpha_{wt}}$$

RADIALNI BOČNI
RAZSTOP

PROFILNA STOPNJA PREKRIVANJA



$$g_a = \overline{CE} = \overline{T_1E} - \overline{T_1C}$$

1. STOPNA UBIRNICA

$$g_a = \sqrt{r_{a1}^2 - r_{b1}^2} - r_{w1}\sin\alpha_{wt}$$

$$g_f = \overline{CA} = \overline{T_2A} - \overline{T_2C}$$

2. STOPNA UBIRNICA

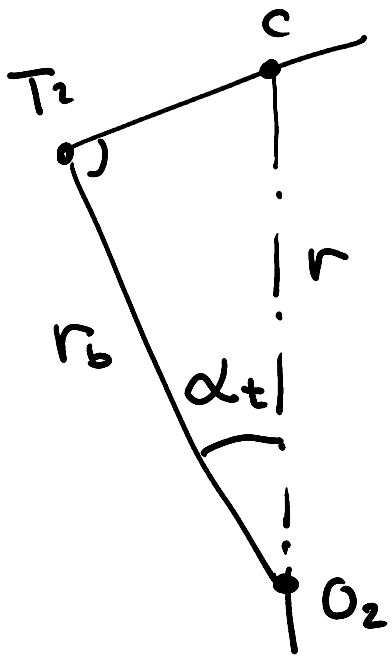
$$g_f = \sqrt{r_{a2}^2 - r_{b2}^2} - r_{w2}\sin\alpha_{wt}$$

$$g_\alpha = g_a + g_f$$

$$g_\alpha = \frac{1}{2}\left(\sqrt{d_{a1}^2 - d_{b1}^2} + \sqrt{d_{a2}^2 - d_{b2}^2} - 2a\sin\alpha_{wt}\right)$$

$$\varepsilon_\alpha = \frac{g_\alpha}{p_{bt}}$$ - RAZDELEK NA OSNOVNEM KROGU

$$p_{bt} \cdot \cancel{z} = \pi d_b = \pi d \cdot \cos\alpha_t = \pi m_t \cdot \cancel{z} \cos\alpha_t$$



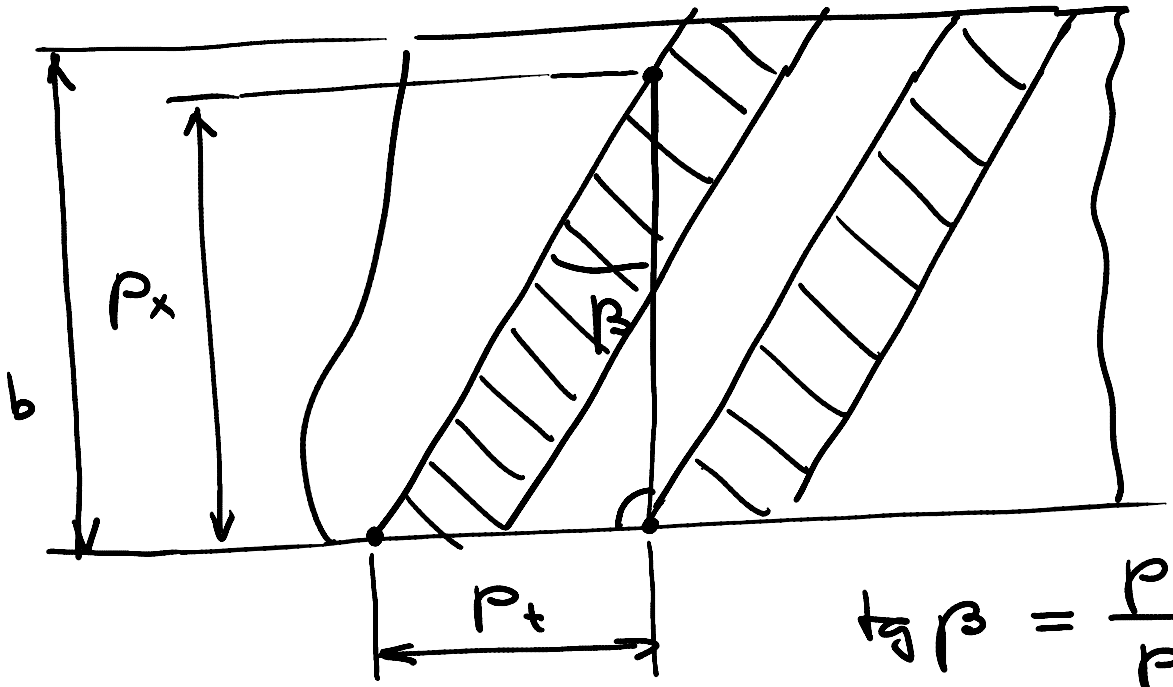
$$\cos\alpha_t = \frac{r_b}{r} \rightarrow r_b = r \cdot \cos\alpha_t$$

$$d_b = d \cos\alpha_t$$

$$p_{bt} = \pi m_t \cos\alpha_t$$

$$1{,}1 \leq \varepsilon_\alpha \leq 2$$

BOČNA STOPNJA PREKRIVANJA



RAZDELNI VALJ RAZUIT V RAVNINO

$$\varepsilon_\beta = \frac{b}{p_x}$$

$\varepsilon_\beta = 1, 2, 3, \ldots$

STOPNA DOLŽINA DOTIKALNIH LINIJ

$$tg\,\beta = \frac{p_t}{p_x}$$ KONSTANTNA

$$p_x = \frac{p_t}{tg\,\beta}$$

CELOTNA STOPNJA PREZRIVANJA

$$\varepsilon_g = \varepsilon_\alpha + \varepsilon_\beta$$

POŠKODBE VALJASTIH ZOBNIŠKIH DVOJIC

LOM ZOBA – TRENUTNI
– UTRUJENOSTNI

JAMIČENJE – ZAČETNO
– NAPREDUJOČE

RAZJEDANJE – HLADNO
– TOPLOTNO

OBRABA – NORMALNA
– BRUSILNA

IZDELAVA VALJASTIH TOBNIKOV

BREZ ODREZAVANJA
- ULIVANJE
- KOVANJE
- VLEČENJE
- SINTRANJE

Z ODREZAVANJEM
- PROFILNO
  - REZKANJE
  - PEHANJE
  - ŠTANCANJE
- KOTALNO
  - ŠKOBLJANJE
  - REZKANJE
  - PEHANJE