ΕΘΝΙΚΟ ΜΕΤΣΟΒΙΟ ΠΟΛΥΤΕΧΝΕΙΟ
ΣΧΟΛΗ ΜΗΧΑΝΟΛΟΓΩΝ ΜΗΧΑΝΙΚΩΝ

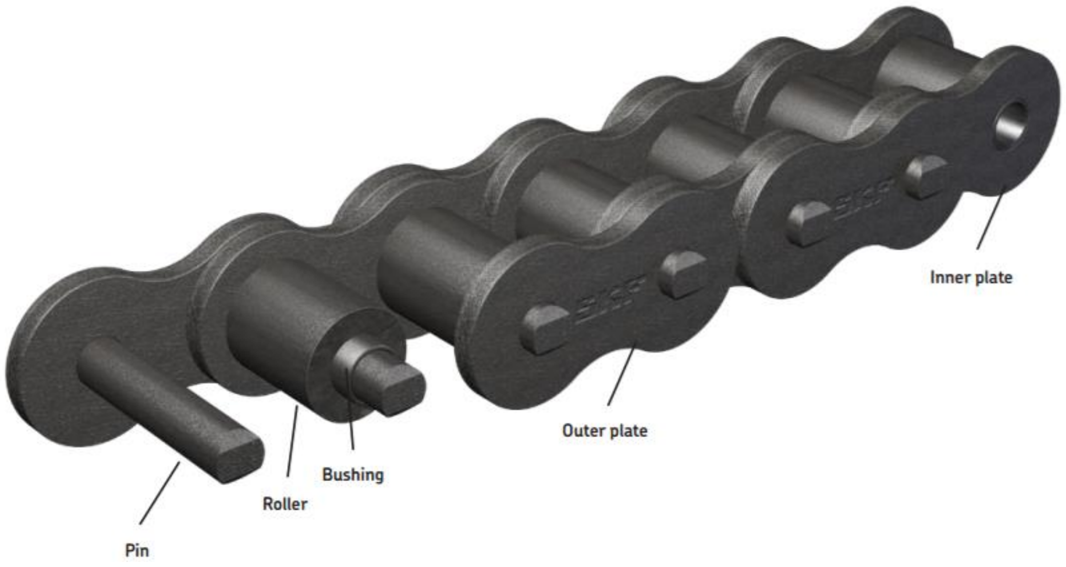
ΕΞΑΜΗΝΟ 4^{ο}
ΣΤΟΙΧΕΙΑ ΜΗΧΑΝΩΝ ΙΙ

ΑΛΥΣΟΚΙΝΗΣΕΙΣ

14/05/2020

ΓΕΩΡΓΙΟΣ ΒΑΣΙΛΕΙΟΥ, Διπλ. Μηχανολόγος Μηχανικός ΕΜΠ
ΚΩΝΣΤΑΝΤΙΝΟΣ ΤΣΙΟΥΜΑΝΗΣ ΜΑΝΟΣ, Διπλ. Μηχανολόγος Μηχανικός ΕΜΠ

ΣΤΟΙΧΕΙΑ ΜΗΧΑΝΩΝ ΑΛΥΣΟΚΙΝΗΣΕΩΝ

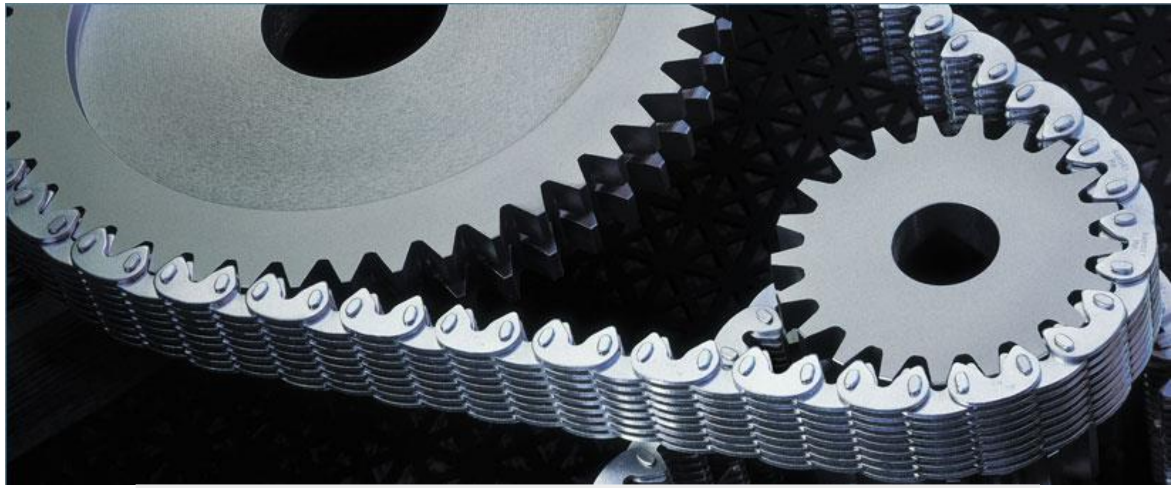


ΤΥΠΟΙ ΑΛΥΣΙΔΩΝ

Roller chains – most common use

Double pitch chains – conveyors

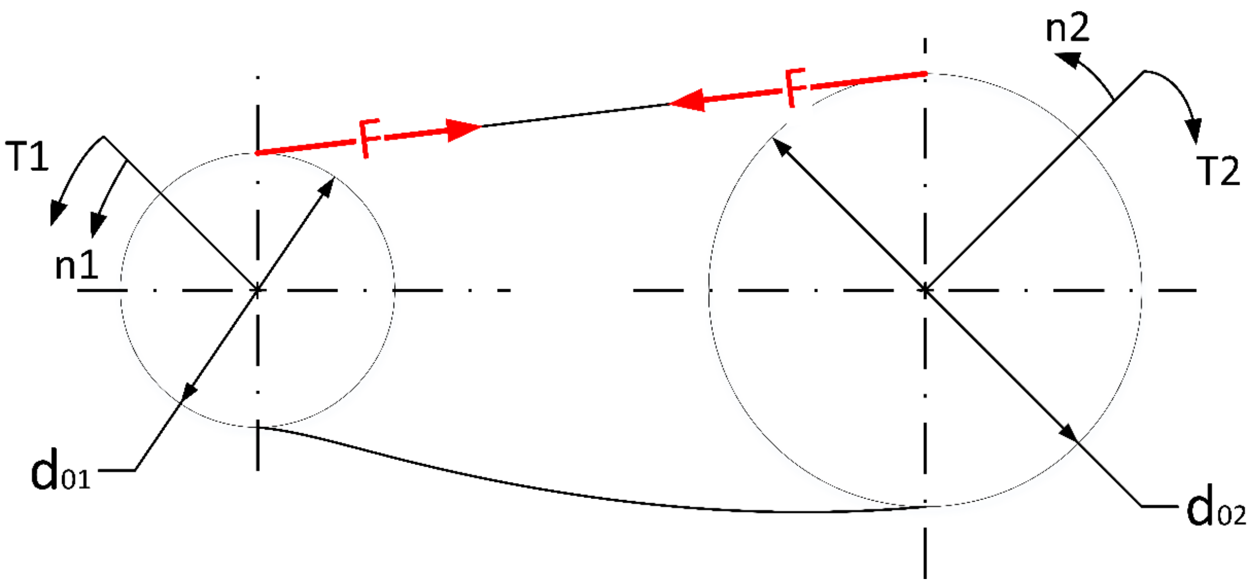
Engineered drive chains – high strength



Silent chains – low noise, tooth shaped links

ΠΡΟΣΘΕΤΑ ΣΤΟΙΧΕΙΑ ΜΗΧΑΝΩΝ

ΚΙΝΗΜΑΤΙΚΗ ΚΑΙ ΔΥΝΑΜΙΚΗ



- Δυνάμεις:

$$F = \frac{T_1}{d_{01}/2} = \frac{T_2}{d_{02}/2}$$

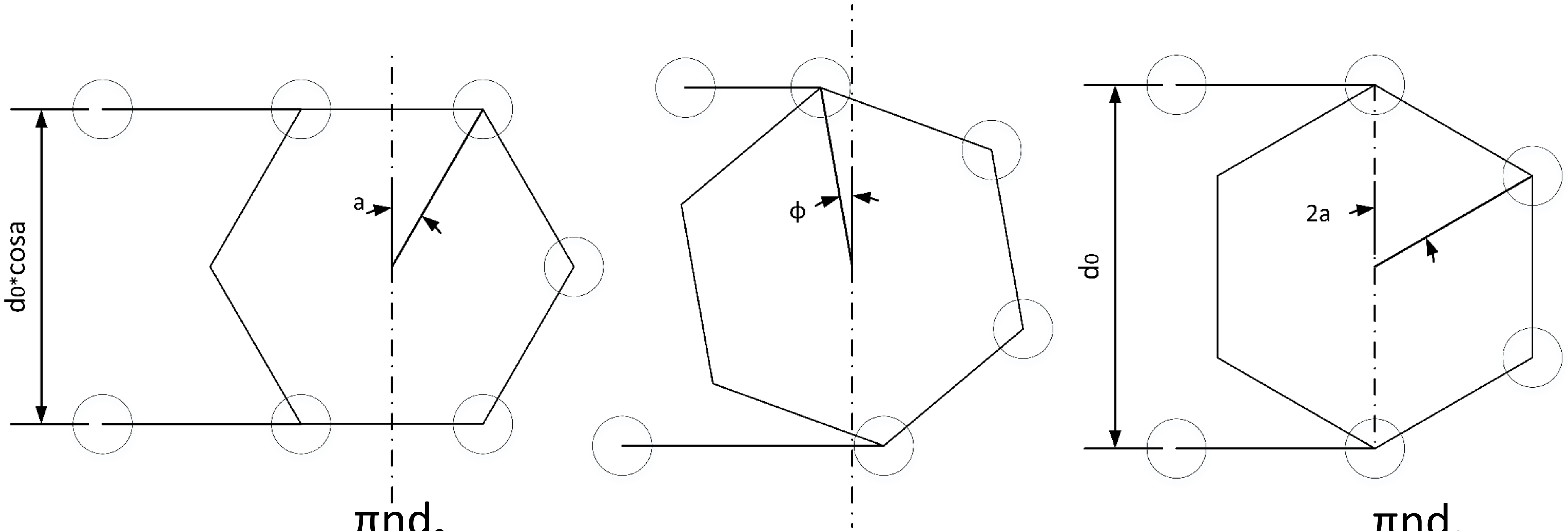
- Ταχύτητα περιστροφής:

$$v = w_1 \frac{d_{01}}{2} = w_2 \frac{d_{02}}{2} \Leftrightarrow \frac{n_1 \pi d_{01}}{60} = \frac{n_2 \pi d_{02}}{60}$$

- Σχέση μετάδοσης:

$$i_{12} = \frac{z_2}{z_1}$$

ΦΑΙΝΟΜΕΝΟ ΠΟΛΥΓΩΝΟΥ

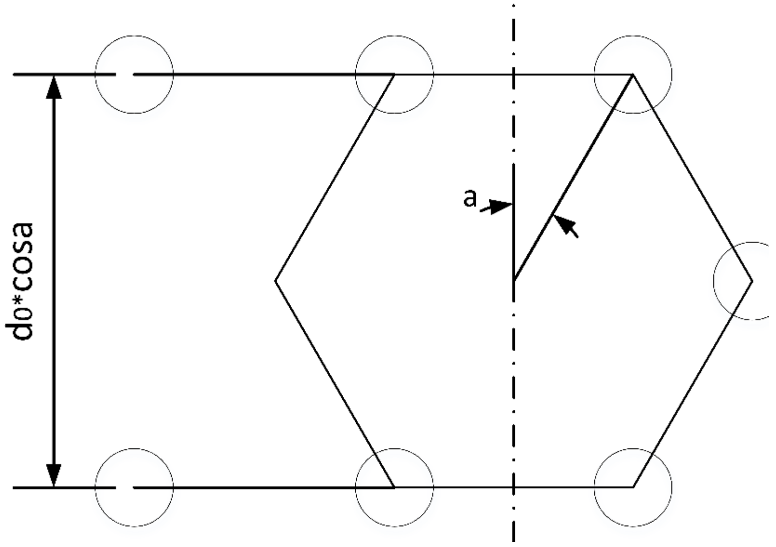


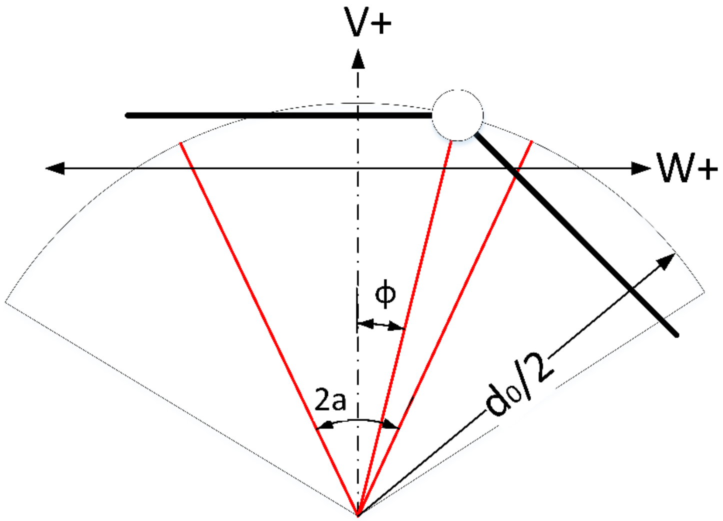
$$u_{min} = \frac{\pi n d_0}{60} \cos a$$

$$u_{max} = \frac{\pi n d_0}{60}$$

$$\left.\begin{aligned} n_{sprocket} &= constant \\ t_{chain} &= t_{sprocket} \end{aligned}\right\} i_{12} = constant?$$

ΦΑΙΝΟΜΕΝΟ ΠΟΛΥΓΩΝΟΥ



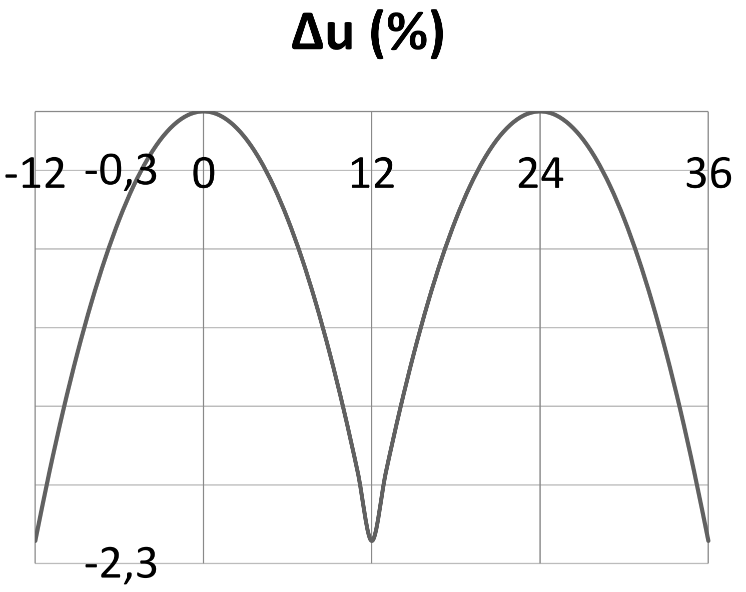


$$W_1 = \frac{d_{01}}{2}\sin\varphi_1, -a \le \varphi \le a$$

$$V_1 = \frac{dW_1}{dt} = \frac{d_{01}}{2}\cos\varphi_1 \frac{d\varphi_1}{dt}$$

$$t = d_{01}\sin a_1$$

$$i_{real} = \frac{\frac{d_{02}}{2}\cos\varphi_2}{\frac{d_{01}}{2}\cos\varphi_1} = \frac{\sin a_1 \cos\varphi_2}{\sin a_2 \cos\varphi_1}$$



ΦΑΙΝΟΜΕΝΟ ΠΟΛΥΓΩΝΟΥ

Διακύμανση σχέσης μετάδοσης

$$\Delta i_{min} = \frac{z_1}{z_2} \frac{\sin a_1}{\sin a_2} \left(\frac{\cos a_2}{\cos a_1} - 1 \right)$$

$$\Delta i_{max} = \frac{z_1}{z_2} \frac{\sin a_1}{\cos a_1 \sin a_2} (1 - \cos a_1 \cos a_2)$$

ΔΥΝΑΜΙΚΗ ΑΛΥΣΟΚΙΝΗΣΕΩΣ

ΕΓΚΑΡΣΙΕΣ ΤΑΛΑΝΤΩΣΕΙΣ

Βαθμοί Ελευθερίας: $m = 2\left(\frac{l_k}{t} - 1\right) + 2$

$$m_{tr}\,\ddot{y}_r = \frac{F}{t}\left(y_{r+1} - 2y + y_{r-1}\right)$$

$$m_t\left[kg\right] = m_{length}\left[\frac{kg}{m}\right] t\left[m\right]$$

$$f_E = \frac{1}{\pi}\sqrt{\frac{F}{m_t t}}\sin\left(\frac{\lambda}{\rho+1}\frac{\pi}{2}\right) \xrightarrow{?} f_E = \frac{1}{2}\frac{\lambda}{l_k}\sqrt{\frac{F}{m_{length}}}$$

Φαινόμενο πολυγώνου:

$$f_d = v\frac{z_1 n_1}{60} = v\frac{z_2 n_2}{60}$$

$$f_d = f_E \Rightarrow n_{critical} = 30\frac{\lambda}{l_k}\frac{1}{vz_1}\sqrt{\frac{F}{m_{length}}} = 30\frac{\lambda}{l_k}\frac{1}{vz_1}\sqrt{\frac{2T_1}{m_{length} d_{01}}}$$

ΔΥΝΑΜΙΚΗ ΑΛΥΣΟΚΙΝΗΣΕΩΣ

ΔΙΑΜΗΚΕΙΣ ΤΑΛΑΝΤΩΣΕΙΣ

Βαθμοί Ελευθερίας: $m = 2\left(\frac{l_k}{t} - 1\right) + 2$

$$m_{tr}\ddot{x}_r = k_t\left(x_{r+1} - 2x + x_{r-1}\right)$$

$$m_t\left[kg\right] = m_{length}\left[\frac{kg}{m}\right]t\left[m\right]$$

$$f_E = \frac{1}{\pi}\sqrt{\frac{k_t}{m_t}}\sin\left(\frac{\lambda}{\rho+1}\frac{\pi}{2}\right) \xrightarrow{?} f_E = \frac{1}{2}\frac{\lambda}{l_k}\sqrt{\frac{k_t t}{m_{length}}}$$

$$k^{'} = \frac{k_t t}{F_{Fail}}$$

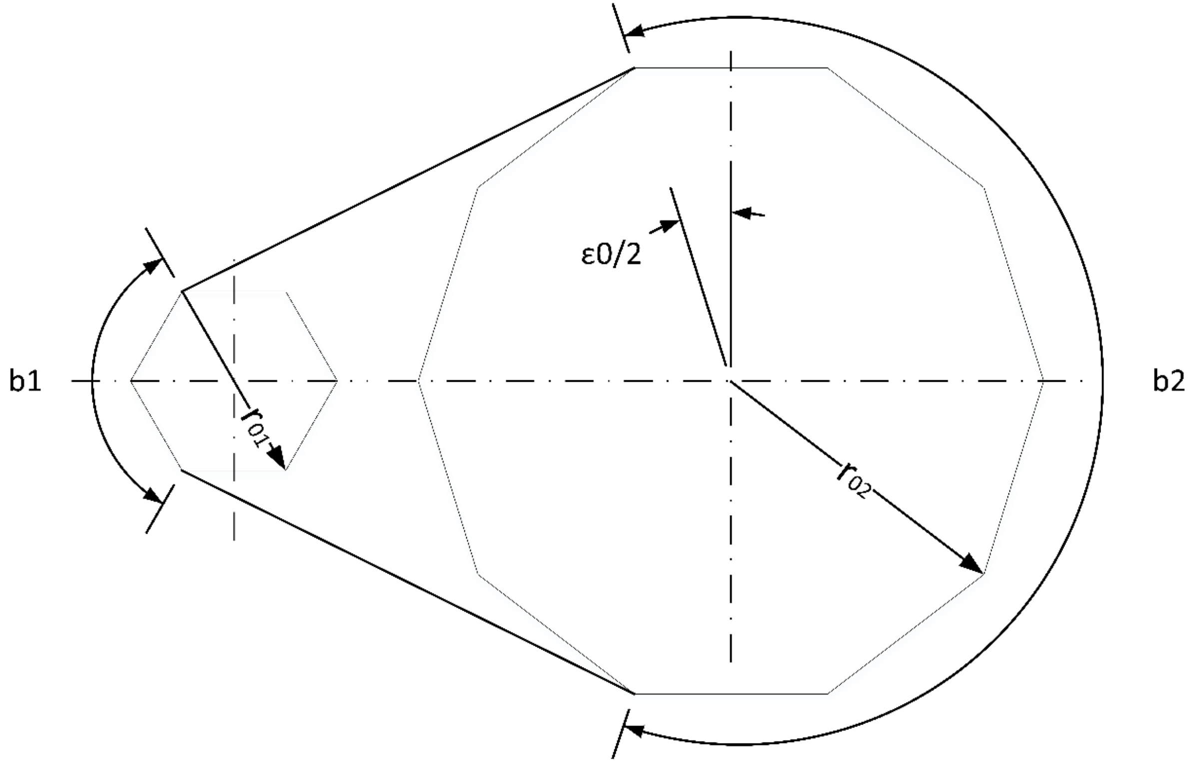
$$f_E = \frac{1}{2}\frac{\lambda}{l_k}\sqrt{\frac{k^{'}F_{Fail}}{m_{length}}}$$

Φαινόμενο πολυγώνου:

$$f_d = v\frac{z_1 n_1}{60} = v\frac{z_2 n_2}{60}$$

$$f_d = f_E \Rightarrow n_{critical} = 30\frac{\lambda}{l_k}\frac{1}{vz_1}\sqrt{\frac{k^{'}F_{Fail}}{m_{length}}}$$

ΓΕΩΜΕΤΡΙΑ ΑΛΥΣΟΚΙΝΗΣΕΩΣ



DIN 8195

$$X = 2\frac{a_0}{t} + \frac{z_1 + z_2}{2} + \left(\frac{z_2 - z_1}{2\pi}\right)^2 \frac{t}{a_0}$$

$$a_0 = \frac{t}{4}\left[\left(X - \frac{z_1 + z_2}{2}\right) + \sqrt{\left(X - \frac{z_1 + z_2}{2}\right)^2 - 2\left(\frac{z_2 - z_1}{\pi}\right)^2}\right]$$

Μέθοδος Worobjew

$$X = \frac{2a_0 \cos\varepsilon_0}{t} + \frac{z_1 + z_2}{2} + \frac{\varepsilon_0(z_2 - z_1)}{180}$$

$$a_0 = \frac{t}{2\cos\varepsilon_0}\left(X - \frac{z_1 + z_2}{2} + \frac{\varepsilon_0(z_2 - z_1)}{180}\right)$$

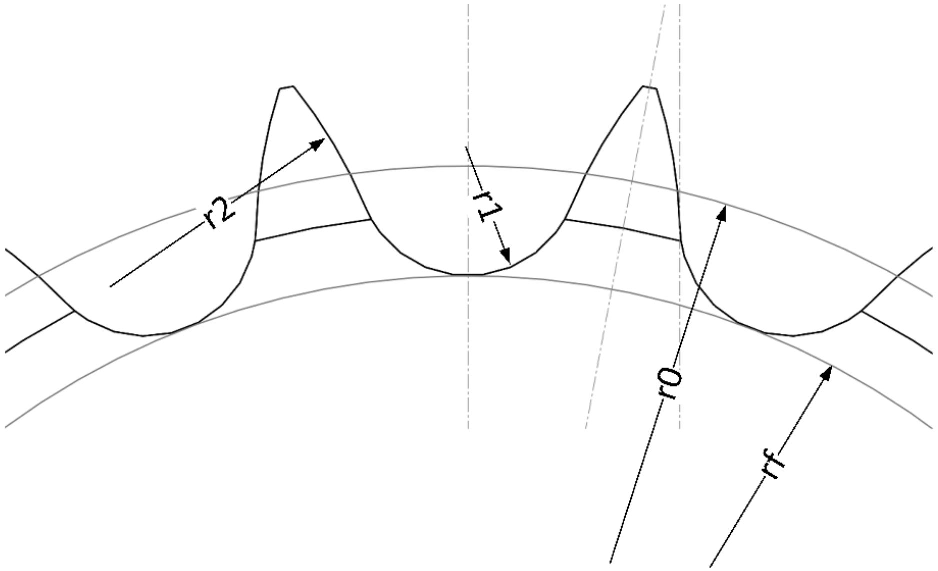
Βιομηχανία

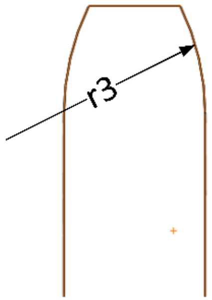
$$L = \frac{z_1 + z_2}{2} + 2C + \frac{K}{C}$$

$$C = 30 \div 80t$$

$$K : \text{tables} \propto z_2 - z_1$$

ΓΕΩΜΕΤΡΙΑ ΟΔΟΝΤΩΣΕΩΝ





$$d_0 = \frac{t}{\sin a}$$

$$a = \frac{180^o}{z}$$

$$d_f = d_0 - d_1$$

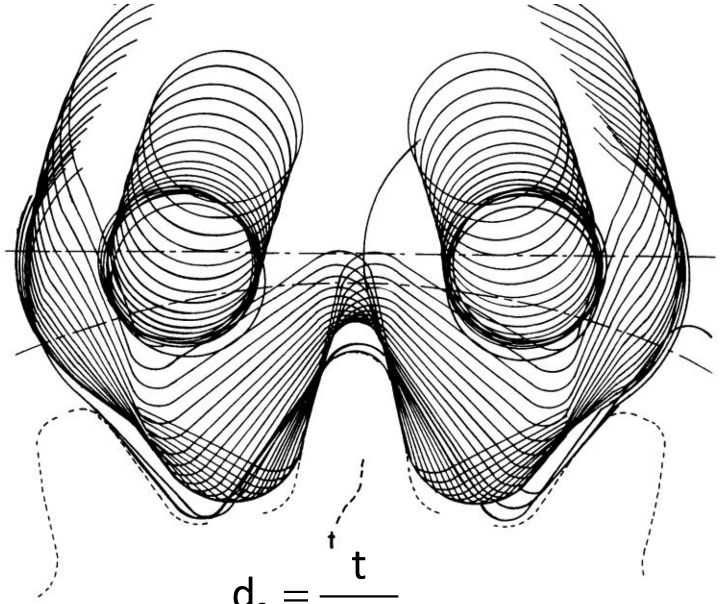
$$d_k = d_0 \cos a + 2k$$

$$r_1 = \left(0.51 \pm 0.005\right) d_1$$

$$r_2 = \begin{cases} 0.12 d_1 \left(z+2\right), \max \\ 0.008\left(z^2 + 180\right), \min \end{cases}$$

$$r_3 = 1.5 d_1$$

$$\gamma = 15 \div 19^o$$



$$d_0 = \frac{t}{\sin a}$$

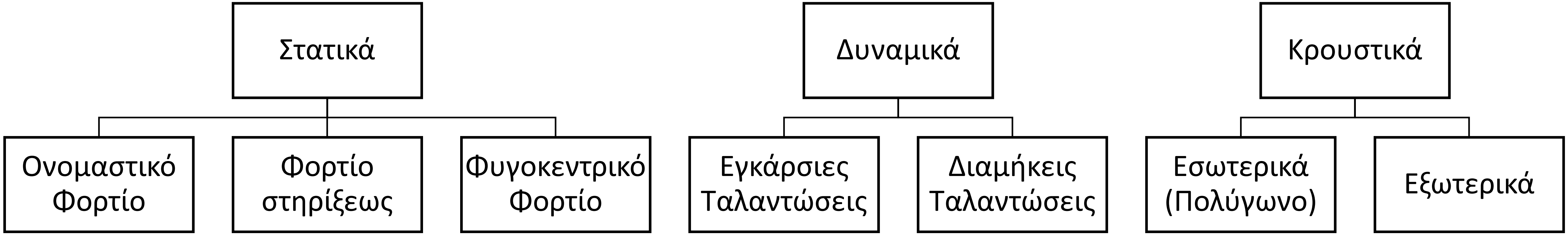
$$a = \frac{180^o}{z}$$

$$d_f = d_0 - h_1 = d_k - h_2$$

$$d_k = d_0 \cos a$$

$$\gamma = 30^o - 2a$$

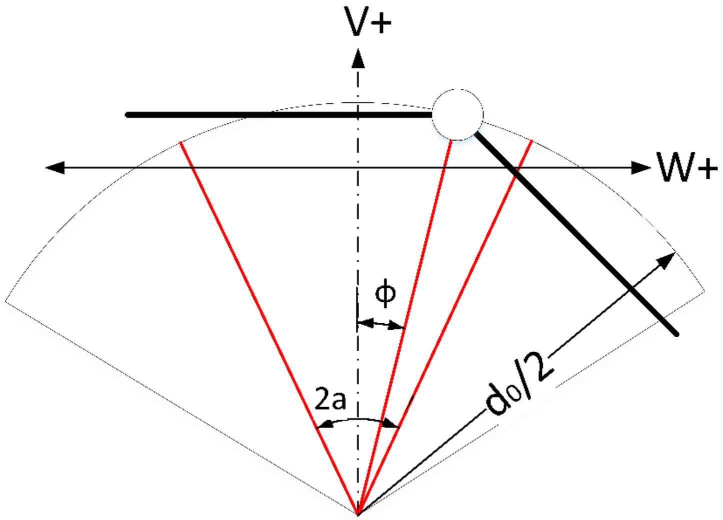
ΦΟΡΤΙΑ ΑΛΥΣΟΚΙΝΗΣΕΩΣ



ΣΤΑΤΙΚΑ ΦΟΡΤΙΑ

- Ονομαστικό φορτίο $F = \frac{T_1}{d_{01}/2} = \frac{T_2}{d_{02}/2}$

$$F = \frac{T_1}{d_{01}/2} = \frac{2T_1}{d_{01}\cos\varphi}$$



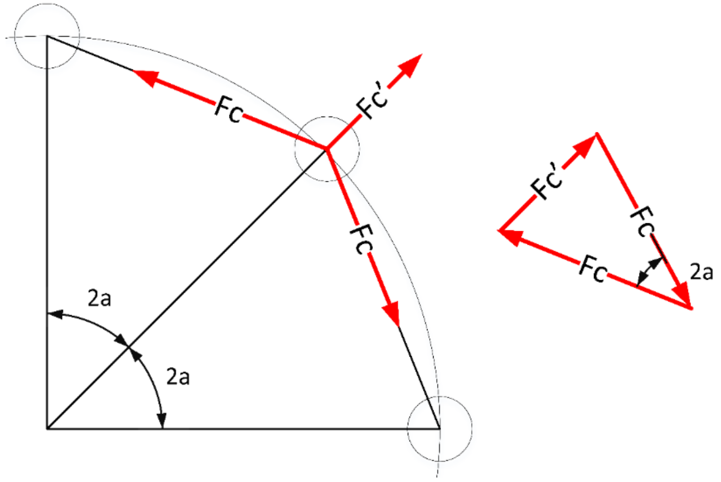
- Φυγοκεντρικό φορτίο

$$F_C' = m_{length}\, t \frac{v^2}{r}$$

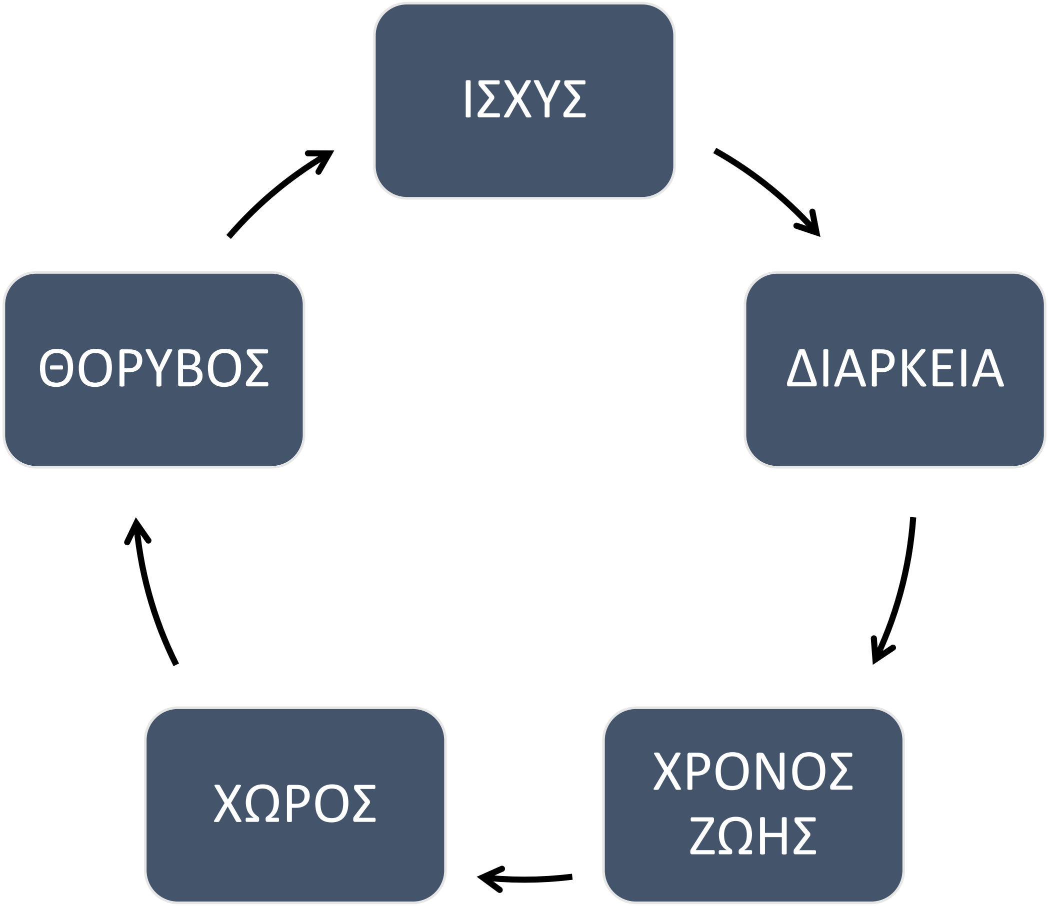
$$r = \frac{d_0}{2} = \frac{t}{\sin a}$$

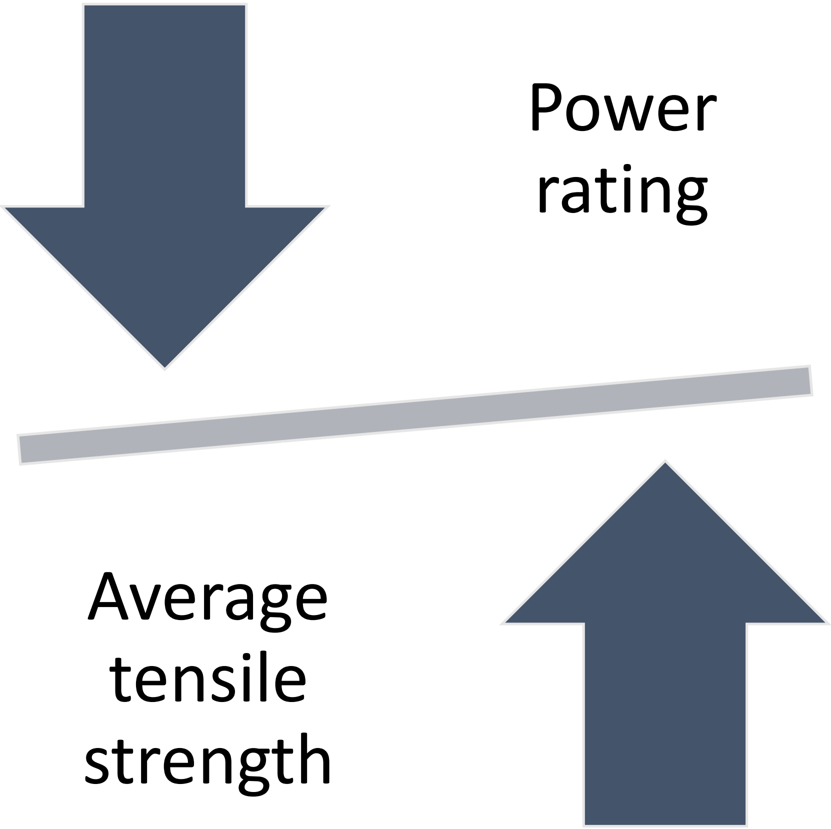
$$F_c' = m_{length} v^2 \sin a$$

$$F_C = \frac{F_c'}{\sin a} = m_{length} v^2$$

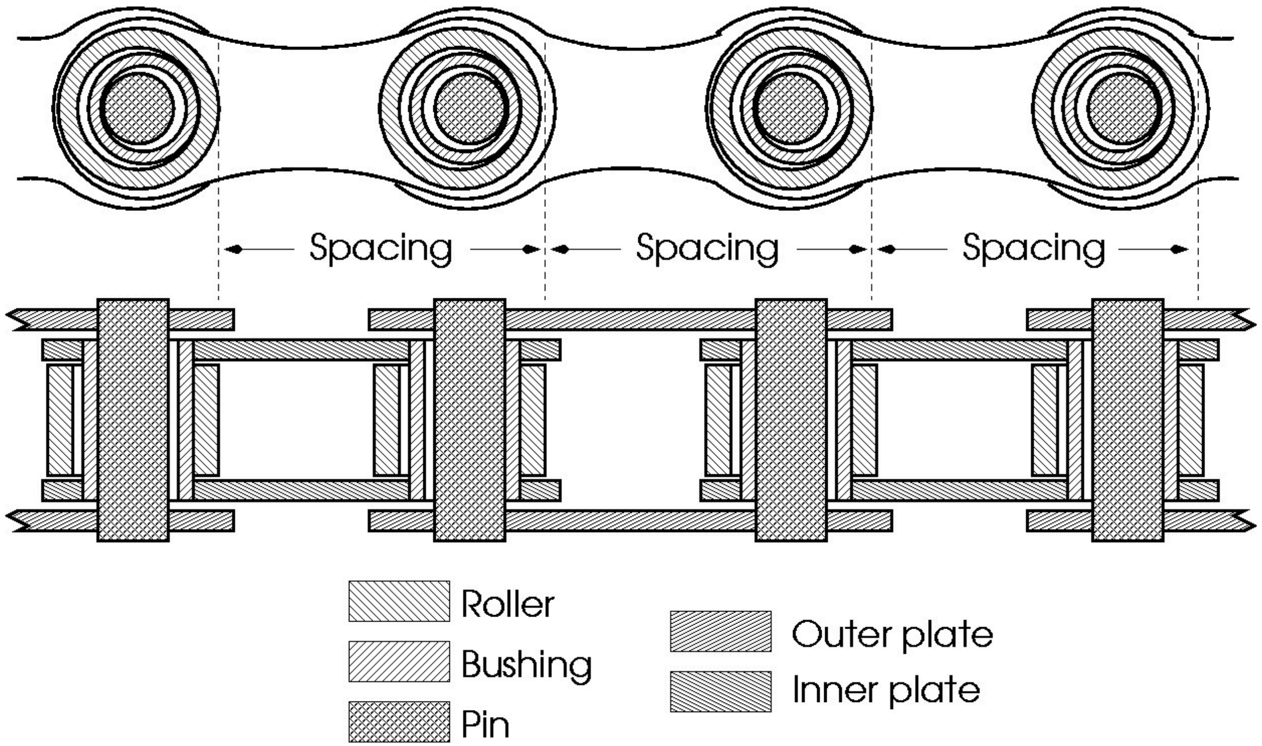


ΕΠΙΛΟΓΗ ΑΛΥΣΙΔΑΣ

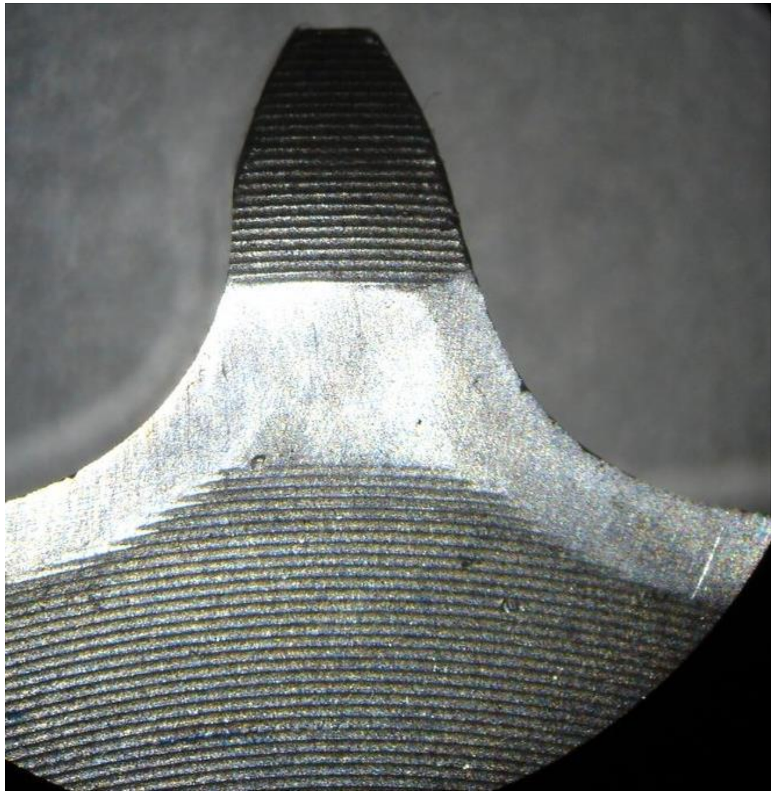




ΦΘΟΡΑ ΚΑΙ ΔΙΑΡΚΕΙΑ ΖΩΗΣ



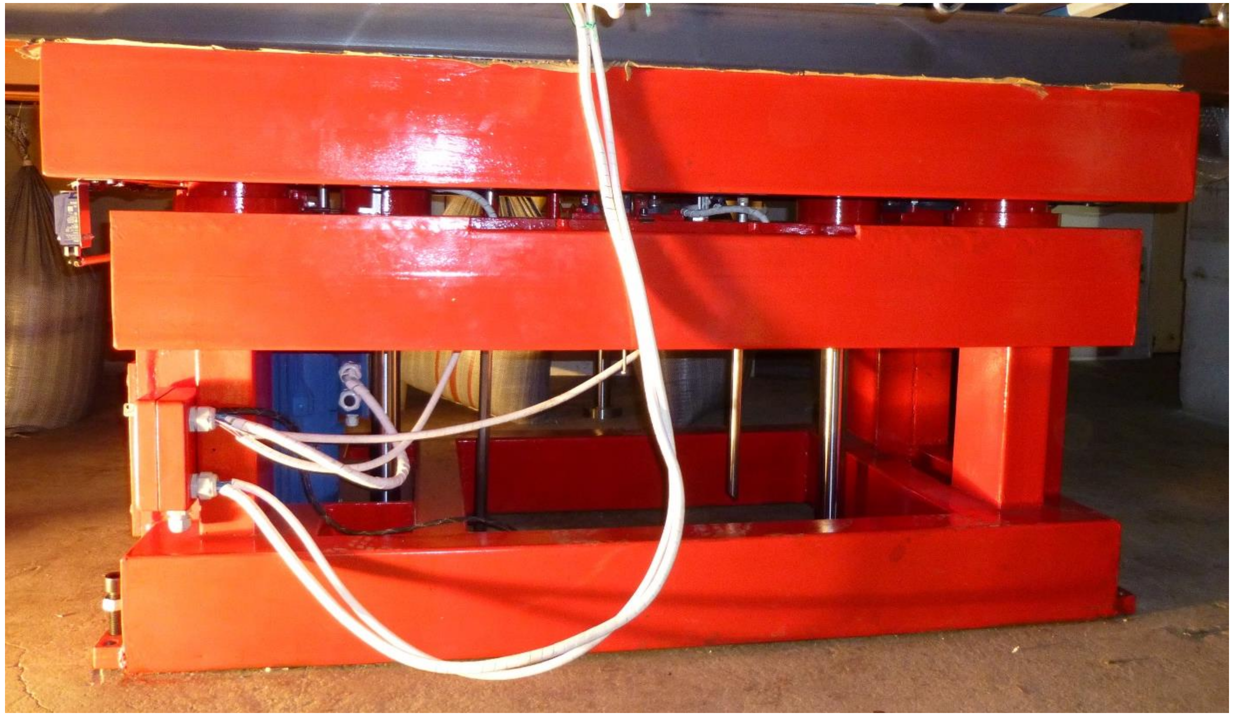
Νόμος φθοράς πίεσης επιφανείας – ταχύτητας ολίσθησης (p-v wear rule)

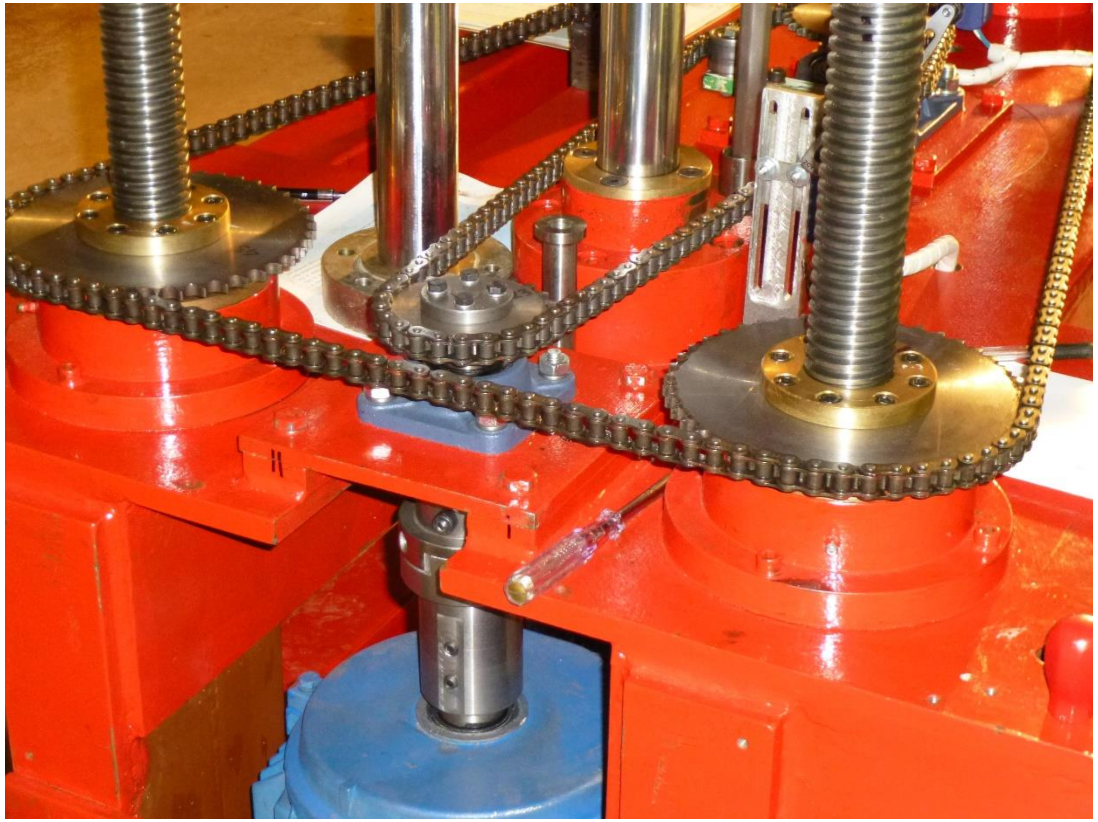


ΕΦΑΡΜΟΓΗ

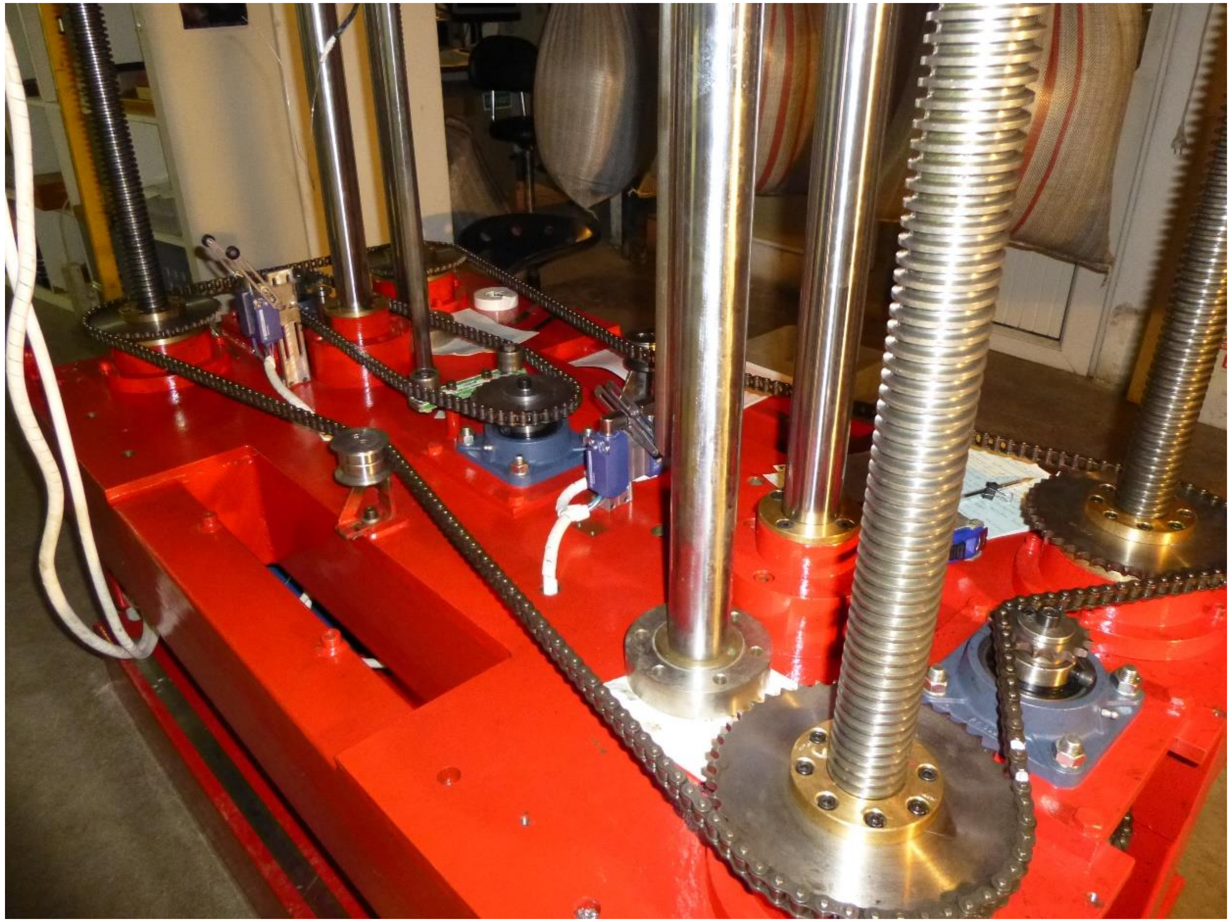
- Four remotely controlled vertical lifting platforms (10MT) for the XTDV - CERN
- Chain Drive
- 3 speed reduction stages

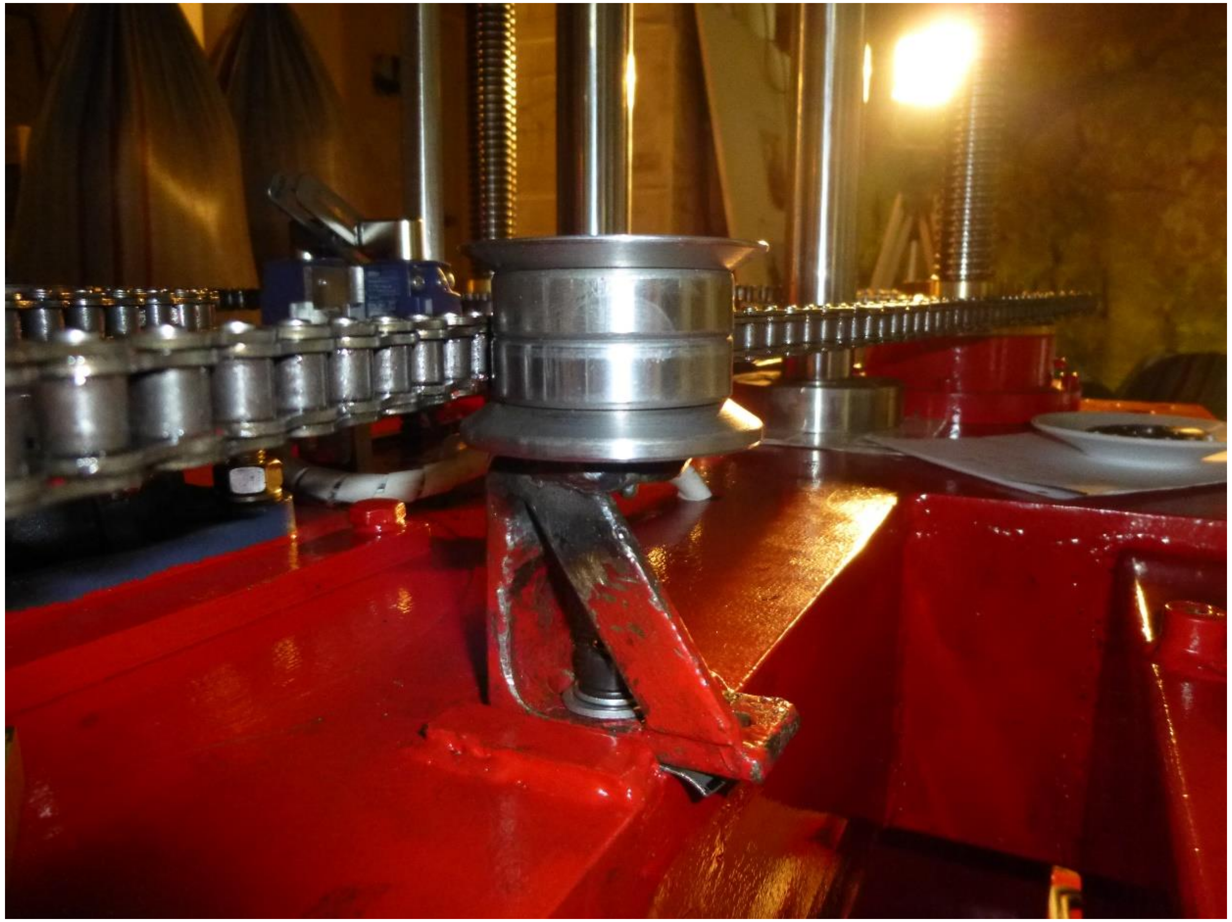
ΕΦΑΡΜΟΓΗ



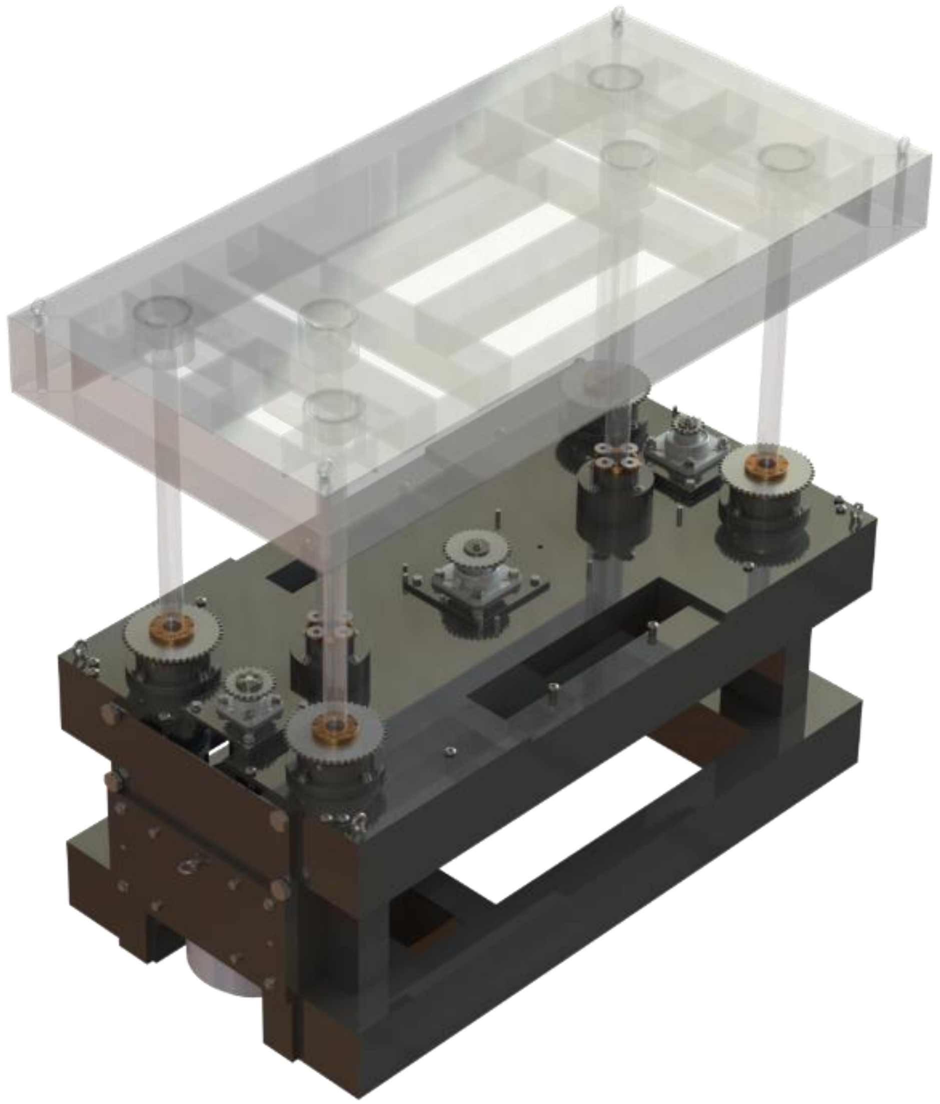


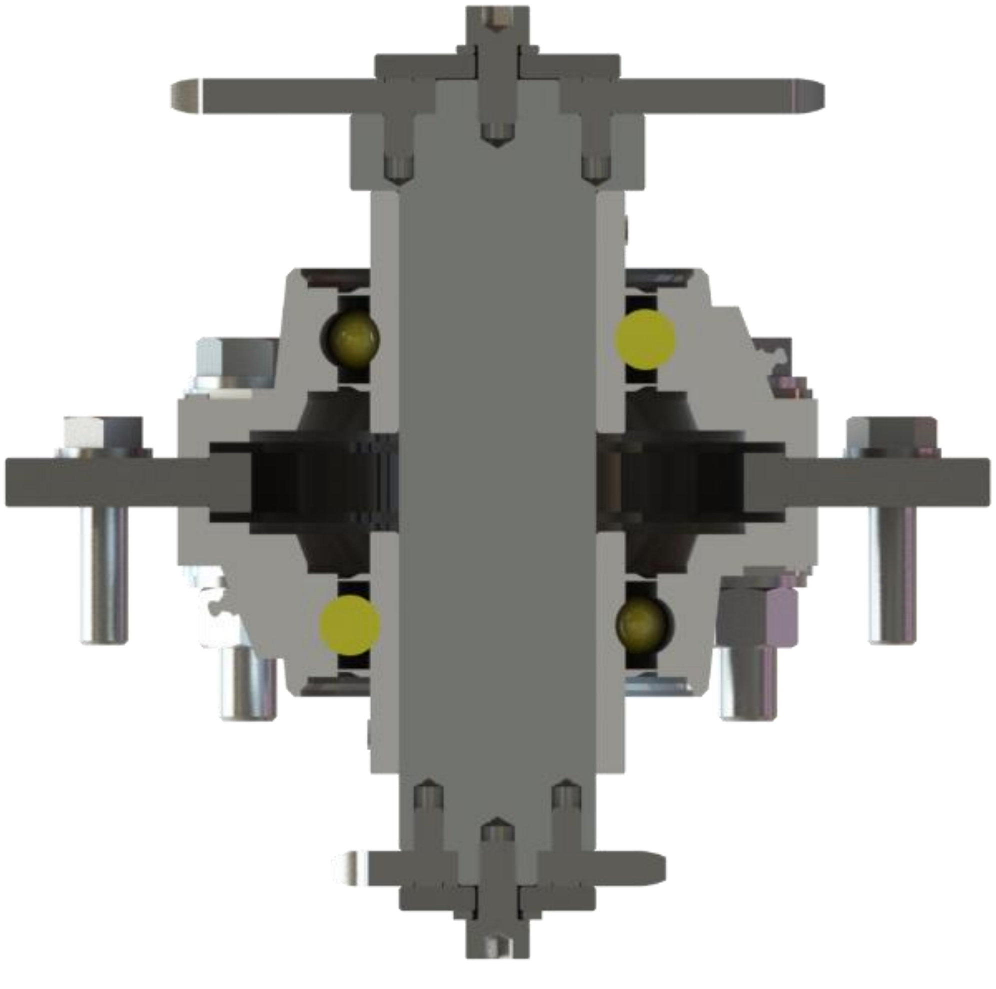
ΕΦΑΡΜΟΓΗ



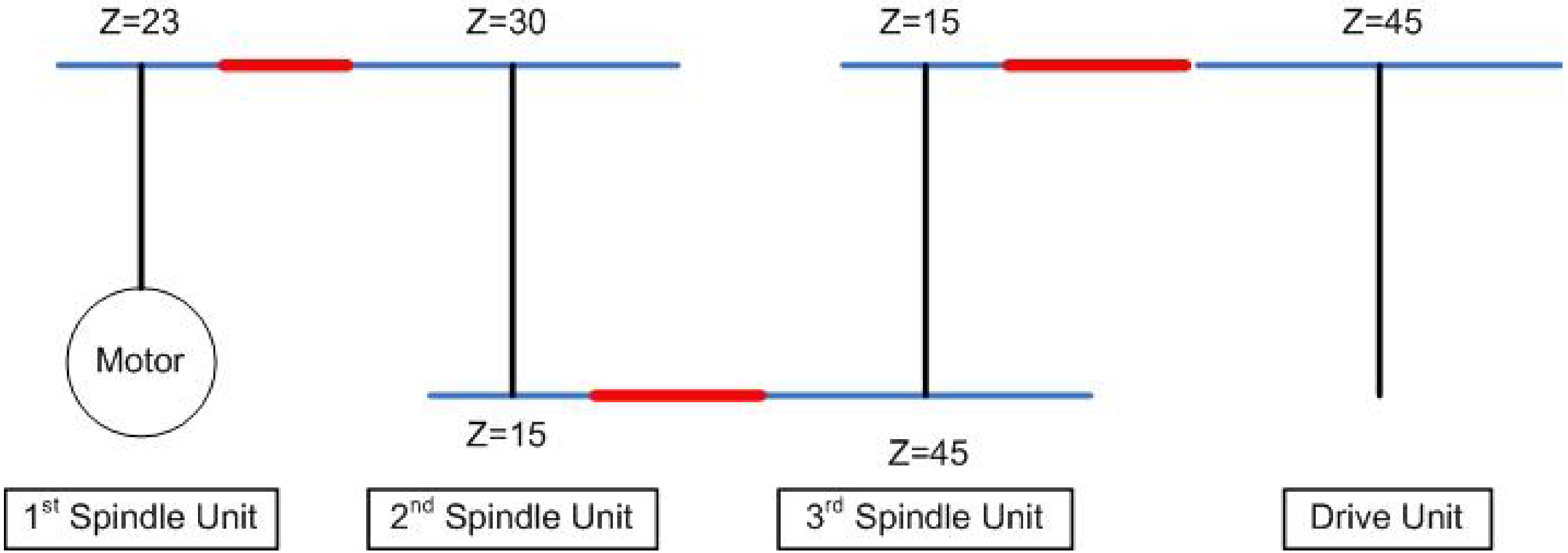


ΕΦΑΡΜΟΓΗ





Chain Drive

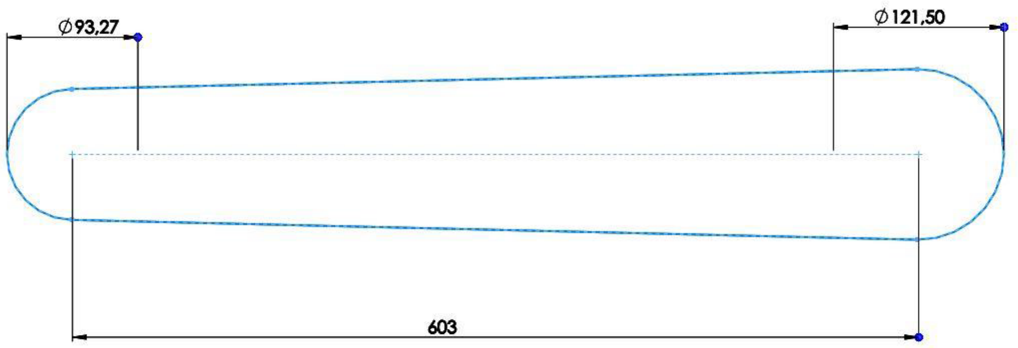


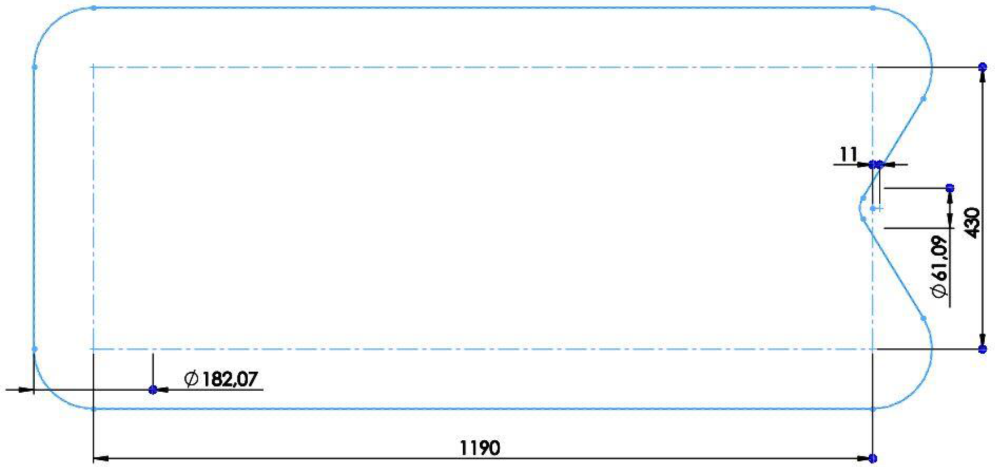
- 3 stage speed reduction
- Speed reduction ratio i=11,74
- Chain 08B-1 (1/2")
- Tensile Strength 21,1kN

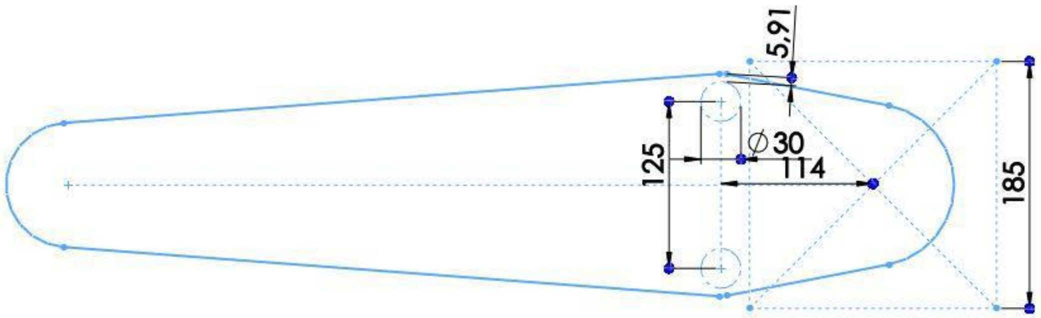
Chain Drive

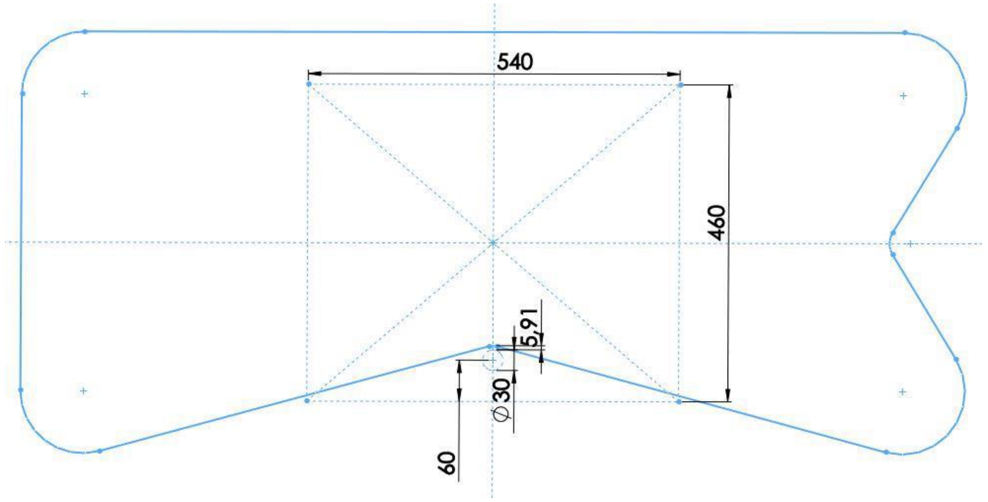
- 3 stage speed reduction
- Speed reduction ratio i=11,74
- Chain 08B-1 (1/2”)
- Tensile Strength 21,1kN

Chain Drive - Tensioners





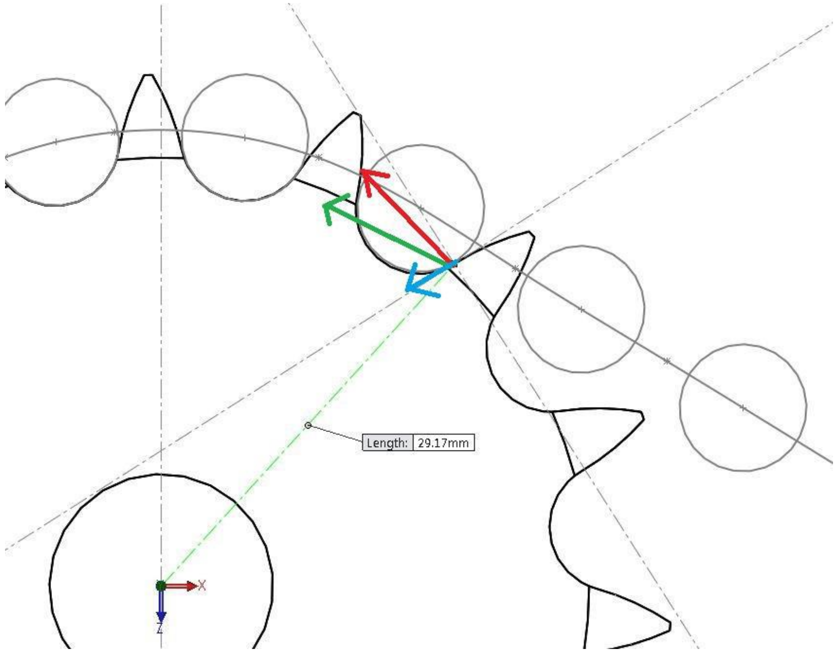




ΥΠΟΛΟΓΙΣΜΟΣ ΑΛΥΣΙΔΑΣ

- ΑΝΤΟΧΗ

Εφελκυσμός: $F = \frac{M}{d_p / 2}$



- ΦΘΟΡΑ

Νόμος πίεσης-ταχύτητας ολίσθησης (p-v wear rule)

$$p_{pin} = \frac{M}{d_{p,sprocket}/2} \frac{1}{A_{pin}}$$

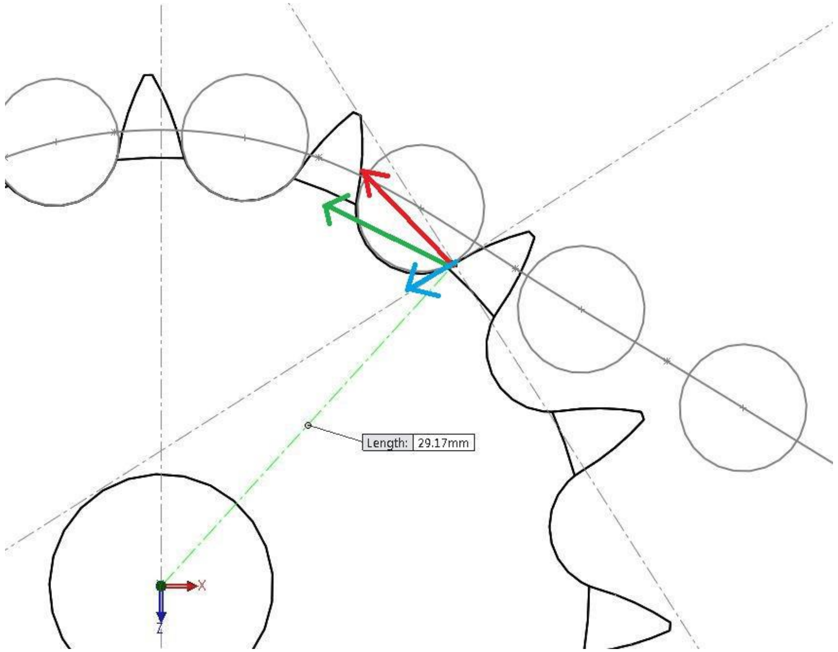
$$\frac{dh}{dt} = kpv_{contact}$$

ΥΠΟΛΟΓΙΣΜΟΣ ΑΛΥΣΙΔΑΣ

ΦΘΟΡΑ

Νόμος πίεσης-ταχύτητας ολίσθησης (p-v wear rule)

$$p_{pin} = \frac{M}{d_{p,sprocket}/2}\frac{1}{A_{pin}} \qquad \frac{dh}{dt} = kpv_{contact}$$



$$z = 15$$

$$d_0 = 61.09mm$$

$$\omega = 36.13\,rad/s$$

$$r_{pin} = 8.51mm$$

$$b = 7.2mm$$

$$T = 130Nm$$

$$r_{wheel} = 29.17mm$$

$$r_{pin} = 30.545$$

$$\theta_{wheel} = 74.79^o$$

$$\theta_{pin} = 65.84^o$$

$$k = 1.23*10^{-15}\frac{m^3}{Nm}$$

$$\theta_{slip} = 0.33^o$$

$$t_{stroke} = 40s$$

CERN 10MT LIFTING PLATFORMS