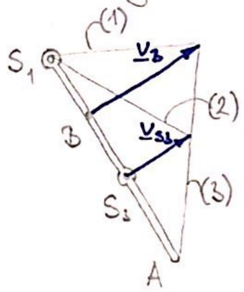
I./2) A (2) rúd szögsebessége:

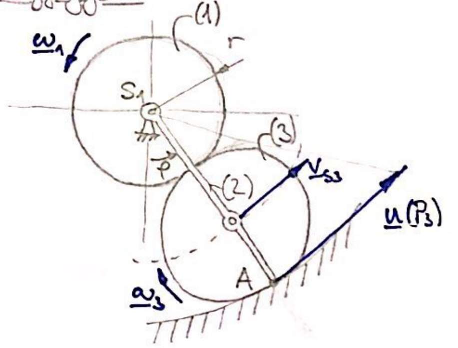
Az S_3 pont sebességének abszolút értéke az (2)-es és a (3)-as test felől is felírható:

$$\left.\begin{aligned} v_{S3} &= 2r\omega_2 \\ v_{S3} &= \frac{1}{2}r\omega_1 \end{aligned}\right\} \Rightarrow \omega_2 = \frac{1}{4}\omega_1 = \underline{\underline{2{,}5}}\ \frac{rad}{s}$$

3) Sebességeloszlás az $\overline{AB}$ szakaszon



Megjegyzés:



A pólusvándorlás egyszerűen számítható a (2)-es rúd kiterjesztésével

$$\omega_2 = \frac{v_{S3}}{2r} = \frac{u(P_3)}{3r} \quad \text{ahonnan} \quad u(P_3) = \frac{3}{2}v_{S3} = \underline{\underline{0{,}75}}\left[\frac{m}{s}\right]$$

Gyorsulásállapot (II)

A B_1 pont körpályán mozog, gyorsulása $\underline{a}_{B1} = \begin{bmatrix} r\varepsilon_1 \\ r\omega_1^2 \\ 0 \end{bmatrix} = \begin{bmatrix} 0{,}5 \\ 10 \\ 0 \end{bmatrix}\left[\frac{m}{s^2}\right]$

Az A póluspont gyorsulása y irányú: $\underline{a}_A = a_A\underline{j}$

Az S_3 pont körpályán mozog, normális gyorsulása: $a_{S3n} = \frac{v_{S3}^2}{2r}\underline{j}$

II.1) az S_3 pont gyorsulása

$$\underline{a}_{S3} = \underline{a}_A + \underline{\varepsilon}_3 \times \underline{r}_{AS3} - \omega_3^2\underline{r}_{AS3}$$

$$\begin{bmatrix} a_{S3x} \\ v_{S3}^2/2r \\ 0 \end{bmatrix} = \begin{bmatrix} 0 \\ a_A \\ 0 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ \varepsilon_3 \end{bmatrix} \times \begin{bmatrix} 0 \\ r \\ 0 \end{bmatrix} - \omega_3^2\begin{bmatrix} 0 \\ r \\ 0 \end{bmatrix} \equiv \begin{bmatrix} -\varepsilon_3 r \\ a_A - \omega_3^2 r \\ 0 \end{bmatrix} \Rightarrow a_A = \frac{v_{S3}^2}{2r} + \omega_3^2 r = \underline{\underline{3{,}75}}[m/s^2]$$

Az A és B pontokra, mint (3) merev test pontjaira:

$$\underline{a}_{B3} = \underline{a}_A + \underline{\varepsilon}_3 \times \underline{r}_{AB3} - \omega_3^2\underline{r}_{AB}$$

Figyelembe véve, hogy az egymáson gördülő (1) és (3) korongok B érintkezési pontjában a tangenciális gyorsuláskomponensek megegyeznek

$$a_{B3x} = a_{B1x} = r\varepsilon_1 \qquad \begin{bmatrix} r\varepsilon_1 \\ a_{B3y} \\ 0 \end{bmatrix} = \begin{bmatrix} 0 \\ a_A \\ 0 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ \varepsilon_1 \end{bmatrix} \times \begin{bmatrix} 0 \\ 2r \\ 0 \end{bmatrix} - \omega_3^2\begin{bmatrix} 0 \\ 2r \\ 0 \end{bmatrix} \equiv \begin{bmatrix} -\varepsilon_3 2r \\ a_A - \omega_3^2 \cdot 2r \\ 0 \end{bmatrix} \Rightarrow \varepsilon_3 = -\frac{1}{2}\varepsilon_1 = \underline{\underline{-2{,}5}}\left[\frac{rad}{s^2}\right]$$

f.

Scanned with CamScanner

$a_{B_{3y}} = a_A - \omega_3^2 \cdot 2r = \underline{\underline{-1{,}25}} \left[\frac{m}{s^2}\right]$

Ezzel

$$\underline{a}_{S3} = \begin{bmatrix} a_{S3x} \\ v_{S3}^2/2r \\ 0 \end{bmatrix} = \begin{bmatrix} -\varepsilon_3 r \\ v_{S3}^2/2r \\ 0 \end{bmatrix} = \begin{bmatrix} 0{,}25 \\ 1{,}25 \\ 0 \end{bmatrix} \left[\frac{m}{s^2}\right]$$

2) $\underline{a}_A, \underline{a}_{B1}, \underline{a}_{B3} = ?$

A keresett gyorsulások az előző feladatrész megoldása során kiadódtak:

$$\underline{a}_A = \begin{bmatrix} 0 \\ a_A \\ 0 \end{bmatrix} = \begin{bmatrix} 0 \\ 3{,}75 \\ 0 \end{bmatrix} \left[\frac{m}{s^2}\right] \qquad \underline{a}_{B1} = \begin{bmatrix} r\varepsilon_1 \\ r\omega_1^2 \\ 0 \end{bmatrix} = \begin{bmatrix} 0{,}5 \\ 10 \\ 0 \end{bmatrix} \left[\frac{m}{s^2}\right] \qquad \underline{a}_{B3} = \begin{bmatrix} r\varepsilon_1 \\ a_A - 2r\omega_3^2 \\ 0 \end{bmatrix} = \begin{bmatrix} 0{,}5 \\ -1{,}25 \\ 0 \end{bmatrix} \left[\frac{m}{s^2}\right]$$

3, Gyorsuláspólus helyének meghatározása

$$\underbrace{\underline{a}_G}_{=\underline{0}} = \underline{a}_A + \underline{\varepsilon}_3 \times \underline{r}_{AG} - \omega_3^2 \underline{r}_{AG} \quad \Rightarrow \quad \underline{0} = \begin{bmatrix} 0 \\ a_A \\ 0 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ \varepsilon_3 \end{bmatrix} \times \begin{bmatrix} x_{AG} \\ y_{AG} \\ 0 \end{bmatrix} - \omega_3^2 \begin{bmatrix} x_{AG} \\ y_{AG} \\ 0 \end{bmatrix} = \begin{bmatrix} -\varepsilon_3 y_{AG} - \omega_3^2 x_{AG} \\ a_A + \varepsilon_3 x_{AG} - \omega_3^2 y_{AG} \\ 0 \end{bmatrix}$$

$$\Rightarrow \quad x_{AG} = -\frac{\varepsilon_3}{\omega_3^2} y_{AG}$$

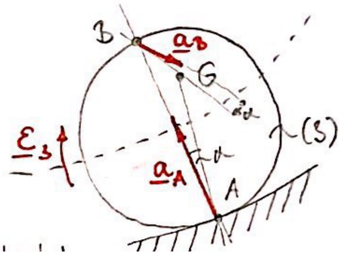
$$a_A - \frac{\varepsilon_3^2}{\omega_3^2} y_{AG} - \omega_3^2 y_{AG} = 0 \quad \Rightarrow \quad y_{AG} = \underline{\underline{0{,}1485}}\,[m]$$

$$x_{AG} = \underline{\underline{0{,}0149}}\,[m] \quad \Rightarrow \quad \underline{r}_{AG} = \begin{bmatrix} 0{,}1485 \\ 0{,}0149 \\ 0 \end{bmatrix} [m]$$

Gyorsulásábra:

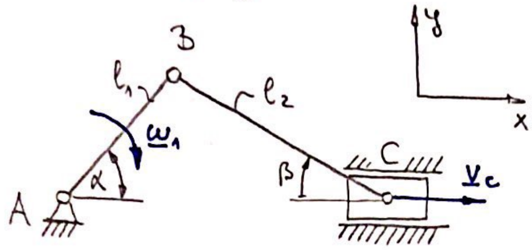
A gyorsuláspólus helye két gyorsulásvektor és a szöggyorsulás ismeretében szerkeszthető:

$$\alpha = \arctan \frac{\varepsilon_3}{\omega_3^2} = 5{,}7°$$



Scanned with CamScanner

1. Példa: Forgattyús mechanizmus



Adatok: l_1, l_2

$|\underline{v}_c| = \text{áll.}$

$\alpha = 60°$

$\beta = 30°$

Feladatok:

1. Az $\overline{AB}$ rúd szögsebessége, $\underline{\omega}_1 = ?$
2. A $\overline{BC}$ rúd szögsebessége, $\underline{\omega}_2 = ?$
3. Sebességábra?
4. Az $\overline{AB}$ rúd szöggyorsulása, $\underline{\varepsilon}_1 = ?$
5. A $\overline{BC}$ rúd szöggyorsulása, $\underline{\varepsilon}_2 = ?$
6. Gyorsulásábra?

1–2) $\underline{\omega}_1$ és $\underline{\omega}_2$ meghatározása:

$\underline{v}_B = \underline{v}_A + \underline{\omega}_1 \times \underline{r}_{AB}$, ahol $\underline{r}_{AB} = \begin{bmatrix} l_1\cos\alpha \\ l_1\sin\alpha \\ 0 \end{bmatrix}$ és $\underline{\omega}_1 = \begin{bmatrix} 0 \\ 0 \\ \omega_1 \end{bmatrix}$

$\underline{v}_B = \underline{v}_C + \underline{\omega}_2 \times \underline{r}_{CB}$, ahol $\underline{r}_{CB} = \begin{bmatrix} -l_2\cos\beta \\ l_2\sin\beta \\ 0 \end{bmatrix}$ és $\underline{\omega}_2 = \begin{bmatrix} 0 \\ 0 \\ \omega_2 \end{bmatrix}$

Ezek alapján:

$$\underline{v}_B = \underline{\omega}_1 \times \underline{r}_{AB} = \begin{bmatrix} 0 \\ 0 \\ \omega_1 \end{bmatrix} \times \begin{bmatrix} l_1\cos\alpha \\ l_1\sin\alpha \\ 0 \end{bmatrix} = \begin{bmatrix} -\omega_1 l_1\sin\alpha \\ \omega_1 l_1\cos\alpha \\ 0 \end{bmatrix}$$

$$\underline{v}_B = \begin{bmatrix} v_c \\ 0 \\ 0 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ \omega_2 \end{bmatrix} \times \begin{bmatrix} -l_2\cos\beta \\ l_2\sin\beta \\ 0 \end{bmatrix} = \begin{bmatrix} v_c - \omega_2 l_2\sin\beta \\ -\omega_2 l_2\cos\beta \\ 0 \end{bmatrix}$$

$$\left.\begin{aligned} x:&\ v_c - \omega_2 l_2\sin\beta = -\omega_1 l_1\sin\alpha \quad (1) \\ y:&\ -\omega_2 l_2\cos\beta = \omega_1 l_1\cos\alpha \quad (2) \end{aligned}\right.$$

$$(2)\quad \omega_1 = -\frac{\omega_2 l_2\cos\beta}{l_1\cos\alpha} = -\omega_2\frac{l_2}{l_1}\sqrt{3}$$

$$(2)\to(1)\quad v_c - \omega_2 l_2\frac{1}{2} = +\omega_2\frac{l_2}{\cancel{l_1}}\sqrt{3}\cdot\cancel{l_1}\frac{\sqrt{3}}{2}$$

$$v_c = \omega_2 l_2\frac{1}{2} + \omega_2 l_2\frac{3}{2}$$

$$v_c = 2\omega_2 l_2$$

$$\Downarrow$$

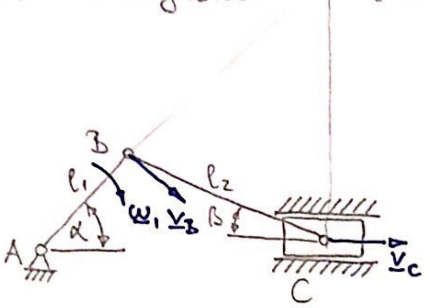
$$\boxed{\omega_2 = \frac{v_c}{2l_2}} \Rightarrow \boxed{\omega_1 = -\frac{v_c}{2l_1}\cdot\sqrt{3}}$$

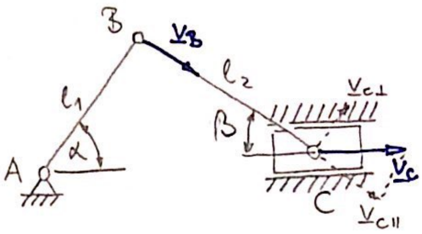
Ezzel a keresett szögsebességek:

$$\underline{\omega}_1 = \begin{bmatrix} 0 \\ 0 \\ -\frac{\sqrt{3}}{2}\frac{v_c}{l_1} \end{bmatrix} \qquad \underline{\omega}_2 = \begin{bmatrix} 0 \\ 0 \\ \frac{v_c}{2l_2} \end{bmatrix}$$

Scanned with CamScanner

3, Sebességábra:





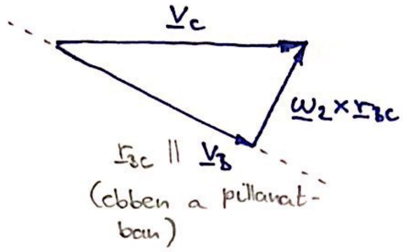
$\underline{v}_{C\parallel} = \underline{v}_B$

$\underline{v}_C = \underline{v}_B + \underline{\omega}_2 \times \underline{r}_{BC}$

$\underline{r}_{BC} \perp (\underline{\omega}_2 \times \underline{r}_{BC})$

$\underline{v}_B = \underline{v}_A + \underline{\omega}_1 \times \underline{r}_{AB}$

$\underline{v}_B \perp (\underline{\omega}_1 \times \underline{r}_{AB})$



4-5) $\underline{\varepsilon}_1$ és $\underline{\varepsilon}_2$ meghatározása:

$$\underline{a}_B = \underbrace{\underline{a}_A}_{=\underline{0}} + \underline{\varepsilon}_1 \times \underline{r}_{AB} - \underline{\omega}_1^2 \underline{r}_{AB} \quad (1)$$

$$\underline{a}_B = \underbrace{\underline{a}_C}_{=\underline{0}} + \underline{\varepsilon}_2 \times \underline{r}_{CB} - \omega_2^2 \underline{r}_{CB} \quad (2)$$

$$(1) \quad \underline{a}_B = \begin{bmatrix} 0 \\ 0 \\ \varepsilon_1 \end{bmatrix} \times \begin{bmatrix} l_1 \cos\alpha \\ l_1 \sin\alpha \\ 0 \end{bmatrix} - \omega_1^2 \begin{bmatrix} l_1 \cos\alpha \\ l_1 \sin\alpha \\ 0 \end{bmatrix} = \begin{bmatrix} -\varepsilon_1 l_1 \sin\alpha - \omega_1^2 l_1 \cos\alpha \\ \varepsilon_1 l_1 \cos\alpha - \omega_1^2 l_1 \sin\alpha \\ 0 \end{bmatrix}$$

$$(2) \quad \underline{a}_B = \begin{bmatrix} 0 \\ 0 \\ \varepsilon_2 \end{bmatrix} \times \begin{bmatrix} -l_2 \cos\beta \\ l_2 \sin\beta \\ 0 \end{bmatrix} - \omega_2^2 \begin{bmatrix} -l_2 \cos\beta \\ l_2 \sin\beta \\ 0 \end{bmatrix} = \begin{bmatrix} -\varepsilon_2 l_2 \sin\beta - \omega_2^2 l_2 \cos\beta \\ -l_2 \varepsilon_2 \cos\beta - \omega_2^2 l_2 \sin\beta \\ 0 \end{bmatrix}$$

$x: -\varepsilon_1 l_1 \sin\alpha - \omega_1^2 l_1 \cos\alpha = -\varepsilon_2 l_2 \sin\beta - \omega_2^2 l_2 \cos\beta$

$y: \varepsilon_1 l_1 \cos\alpha - \omega_1^2 l_1 \sin\alpha = -l_2 \varepsilon_2 \cos\beta - \omega_2^2 l_2 \sin\beta$

$\Downarrow$

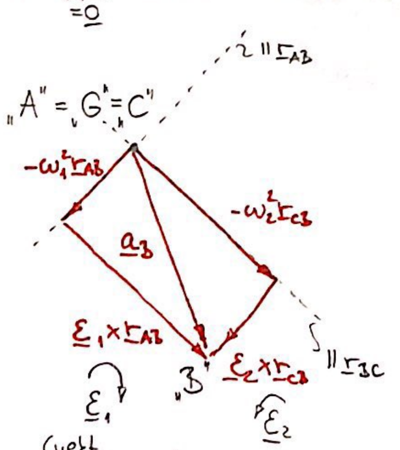
$\varepsilon_1, \varepsilon_2 = \ldots$

6) Gyorsulásábra:

$$\left.\begin{aligned} \underline{a}_B &= \underbrace{\underline{a}_A}_{=\underline{0}} + \underline{\varepsilon}_1 \times \underline{r}_{AB} - \omega_1^2 \underline{r}_{AB} = \underline{\varepsilon}_1 \times \underline{r}_{AB} - \omega_1^2 \underline{r}_{AB} \\ \underline{a}_B &= \underbrace{\underline{a}_C}_{=\underline{0}} + \underline{\varepsilon}_2 \times \underline{r}_{CB} - \omega_2^2 \underline{r}_{CB} = \underline{\varepsilon}_2 \times \underline{r}_{CB} - \omega_2^2 \underline{r}_{CB} \end{aligned}\right\} \Rightarrow \underline{\varepsilon}_1 \times \underline{r}_{AB} - \omega_1^2 \underline{r}_{AB} = \underline{\varepsilon}_2 \times \underline{r}_{CB} - \omega_2^2 \underline{r}_{CB}$$

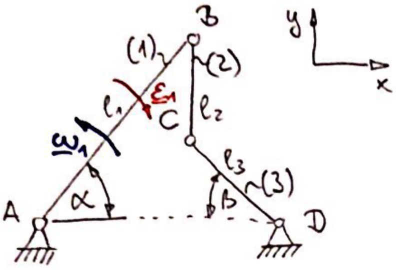
$\Downarrow$ $\underline{r}_{AB} \perp (\underline{\varepsilon}_1 \times \underline{r}_{AB})$

$\Downarrow$ $\underline{r}_{CB} \perp (\underline{\varepsilon}_2 \times \underline{r}_{CB})$



Scanned with CamScanner

2. Példa: Négycsuklós mechanizmus



Adatok: $l_1 = 0{,}6\ m$

$l_2 = 0{,}3\ m$

$l_3 = 0{,}3\ m$

$\omega_1 = 3{,}5\ rad/s$

$\varepsilon_1 = 20\ rad/s$

$\alpha = 60°$

$\beta = 45°$

Feladatok:

I, Sebességállapot:

- $\underline{v}_B = ?$, $\underline{\omega}_2 = ?$
- $\underline{v}_C = ?$, $\underline{\omega}_3 = ?$
- $P_2 = ?$

II, Gyorsulásállapot:

- $\underline{a}_B = ?$, $\underline{\varepsilon}_2 = ?$
- $\underline{a}_C = ?$, $\underline{\varepsilon}_3 = ?$
- $G_2 = ?$

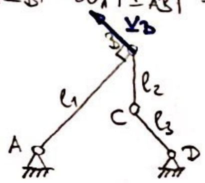
I,

1) $\underline{v}_B = ?$ (A B pont körpályán mozog $\underline{v}_B \perp \underline{r}_{AB}$)

$$\underline{v}_B = \underbrace{\underline{v}_A}_{=\underline{0}} + \underline{\omega}_1 \times \underline{r}_{AB} = \begin{bmatrix} 0 \\ 0 \\ \omega_1 \end{bmatrix} \times \begin{bmatrix} l_1 \cos\alpha \\ l_1 \sin\alpha \\ 0 \end{bmatrix} = \begin{bmatrix} -\omega_1 l_1 \sin\alpha \\ \omega_1 l_1 \cos\alpha \\ 0 \end{bmatrix} = \begin{bmatrix} -1{,}819 \\ 1{,}05 \\ 0 \end{bmatrix} \frac{m}{s}$$

Szemlélet alapján: körpályán mozog a B pont

$$|\underline{v}_B| = \omega_1 |\underline{r}_{AB}| = \omega_1 l_1 = 2{,}1\ \frac{m}{s}$$



$\underline{v}_C = ?$

$$\underline{v}_C = \underbrace{\underline{v}_D}_{=\underline{0}} + \underline{\omega}_3 \times \underline{r}_{DC} = \begin{bmatrix} 0 \\ 0 \\ \omega_3 \end{bmatrix} \times \begin{bmatrix} -l_3 \cos\beta \\ l_3 \sin\beta \\ 0 \end{bmatrix} = \begin{bmatrix} -\omega_3 l_3 \sin\beta \\ -l_3 \omega_3 \cos\beta \\ 0 \end{bmatrix}$$

$$\underline{v}_C = \underline{v}_B + \underline{\omega}_2 \times \underline{r}_{BC} = \begin{bmatrix} v_{Bx} \\ v_{By} \\ 0 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ \omega_2 \end{bmatrix} \times \begin{bmatrix} 0 \\ -l_2 \\ 0 \end{bmatrix} = \begin{bmatrix} v_{Bx} + \omega_2 l_2 \\ v_{By} \\ 0 \end{bmatrix}$$

$$x: \quad v_{Bx} + \omega_2 l_2 = -\omega_3 l_3 \sin\beta \quad (1)$$

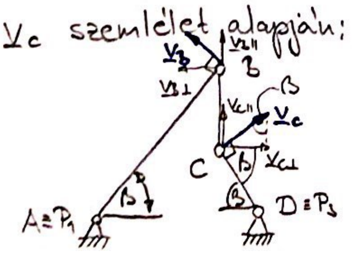
$$y: \quad v_{By} = -l_3 \omega_3 \cos\beta \quad (2)$$

$$(2) \quad \omega_3 = -\frac{v_{By}}{l_3 \cos\beta} = \underline{\underline{-4{,}95}}\ \frac{rad}{s}$$

$$(2) \to (1) \quad \omega_2 = \frac{-v_{Bx} - \omega_3 l_3 \sin\beta}{l_2} = \underline{\underline{9{,}56}}\ \frac{rad}{s}$$

Ezzel: $\underline{\omega}_2 = \begin{bmatrix} 0 \\ 0 \\ 9{,}56 \end{bmatrix} \frac{rad}{s}$, $\underline{v}_C = \begin{bmatrix} 1{,}05 \\ 1{,}05 \\ 0 \end{bmatrix} \frac{m}{s}$, $\underline{\omega}_3 = \begin{bmatrix} 0 \\ 0 \\ -4{,}95 \end{bmatrix} \frac{rad}{s}$

$\underline{v}_C$ szemlélet alapján:



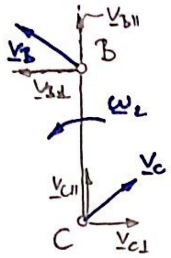
$$v_{C\parallel} = v_{Cy} = v_{B\parallel} = v_{By}$$

$$v_{C\perp} = v_{Cx} = v_{C\parallel} \tan\beta = v_{C\parallel} = v_{B\parallel} = v_{By}$$

$$\Rightarrow \underline{v}_C = \begin{bmatrix} v_{By} \\ v_{By} \\ 0 \end{bmatrix} = \begin{bmatrix} 1{,}05 \\ 1{,}05 \\ 0 \end{bmatrix} \frac{m}{s}$$

Scanned with CamScanner

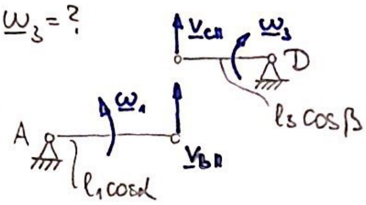
$\underline{\omega}_2$ és $\underline{\omega}_3$ szemlélet alapján:



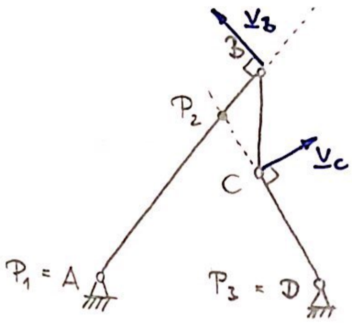
Merőleges sebességek a pillanatnyi forgásnak felelnek meg

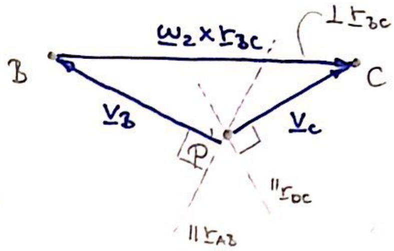
$$\omega_2 = \frac{|\underline{v}_{C\perp}|+|\underline{v}_{B\perp}|}{l_2} = \underline{\underline{9{,}56}}\ \frac{rad}{s}$$

$\underline{\omega}_3 = ?$



$$|\underline{v}_{B\parallel}| = |\underline{v}_{C\parallel}| = \omega_1 l_1 \underbrace{\cos\alpha}_{=1/2} = \omega_3 l_3 \underbrace{\cos\beta}_{=\sqrt{2}/2} \Rightarrow \omega_3 = \omega_1 \frac{l_1}{l_3}\cdot\frac{1}{\sqrt{2}} = \underline{\underline{4{,}95}}\ \frac{rad}{s}$$





Sebességábra:

$$\underline{v}_C = \underline{v}_B + \underline{\omega}_2 \times \underline{r}_{BC}$$

$$\Downarrow$$

$$\underline{r}_{BC} \perp (\underline{\omega}_2 \times \underline{r}_{BC})$$

$$\underline{v}_C = \underline{v}_D + \underline{\omega}_3 \times \underline{r}_{DC} = \underline{\omega}_3 \times \underline{r}_{DC}$$

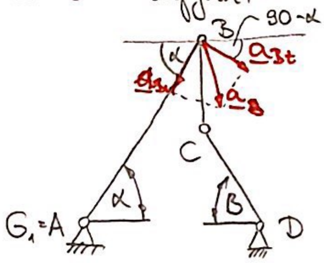
$$\Downarrow$$

$$\underline{r}_{DC} \perp (\omega_3 \times \underline{r}_{DC})$$

II. $\underline{a}_B = ?$

$$\underline{a}_B = \underbrace{\underline{a}_A}_{=\underline{0}} + \underline{\varepsilon}_1 \times \underline{r}_{AB} - \omega_1^2 \underline{r}_{AB} = \begin{bmatrix} 0 \\ 0 \\ -\varepsilon_1 \end{bmatrix} \times \begin{bmatrix} l_1\cos\alpha \\ l_1 \sin\alpha \\ 0 \end{bmatrix} - \omega_1^2 \begin{bmatrix} l_1\cos\alpha \\ l_1\sin\alpha \\ 0 \end{bmatrix} = \begin{bmatrix} +\varepsilon_1 l_1 \sin\alpha - \omega_1^2 l_1 \cos\alpha \\ -\varepsilon_1 l_1 \cos\alpha - \omega_1^2 l_1 \sin\alpha \\ 0 \end{bmatrix} = \begin{bmatrix} 6{,}717 \\ -12{,}365 \\ 0 \end{bmatrix} \frac{m}{s^2}$$

Szemlélet alapján:



$$\underline{a}_B = \underline{a}_{Bn} + \underline{a}_{Bt}$$

$$|\underline{a}_{Bt}| = \varepsilon l_1 = 12\ \frac{m}{s^2}$$

$$|\underline{a}_{Bn}| = l_1 \omega_1^2 \left(= \frac{(l_1\omega_1)^2}{l_1} \right) = 7{,}35\ \frac{m}{s^2}$$

$$\underline{a}_B = \begin{bmatrix} a_{Bt}\cos(90-\alpha) - a_{Bn}\cos\alpha \\ a_{Bt}\sin(90-\alpha) - a_{Bn}\sin\alpha \\ 0 \end{bmatrix} = \begin{bmatrix} 6{,}717 \\ -12{,}365 \\ 0 \end{bmatrix} \frac{m}{s^2}$$

$\underline{a}_C = ?$

$$\left.\begin{aligned} \underline{a}_C &= \underline{a}_B + \underline{\varepsilon}_2 \times \underline{r}_{BC} - \omega_2^2 \underline{r}_{BC} \\ \underline{a}_C &= \underbrace{\underline{a}_D}_{=\underline{0}} + \underline{\varepsilon}_3 \times \underline{r}_{DC} - \omega_3^2 \underline{r}_{DC} \end{aligned}\right\} \begin{aligned} &(1) \\ &(2) \end{aligned}$$

(1)

$$\underline{a}_C = \begin{bmatrix} a_{Bx} \\ a_{By} \\ 0 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ \varepsilon_2 \end{bmatrix} \times \begin{bmatrix} 0 \\ -l_2 \\ 0 \end{bmatrix} - \omega_2^2 \begin{bmatrix} 0 \\ -l_2 \\ 0 \end{bmatrix} = \begin{bmatrix} a_{Bx} + \varepsilon_2 l_2 + 0 \\ a_{By} + 0 + \omega_2^2 l_2 \\ 0 \end{bmatrix} = \begin{bmatrix} a_{Bx} + \varepsilon_2 l_2 \\ a_{By} + \omega_2^2 l_2 \\ 0 \end{bmatrix}$$

Scanned with CamScanner

(2)

$$\underline{a}_C = \begin{bmatrix} 0 \\ 0 \\ \varepsilon_3 \end{bmatrix} \times \begin{bmatrix} -l_3 \cos\beta \\ l_3 \sin\beta \\ 0 \end{bmatrix} - \omega_3^2 \begin{bmatrix} -l_3 \cos\beta \\ l_3 \sin\beta \\ 0 \end{bmatrix} = \begin{bmatrix} -\varepsilon_3 l_3 \sin\beta + \omega_3^2 l_3 \cos\beta \\ -\varepsilon_3 l_3 \cos\beta - \omega_3^2 l_3 \sin\beta \\ 0 \end{bmatrix}$$

(1) és (2) alapján:

$$\left.\begin{aligned} x:&\quad a_{Bx} + \varepsilon_2 l_2 = -\varepsilon_3 l_3 \sin\beta + \omega_3^2 l_3 \cos\beta \\ y:&\quad a_{By} + \omega_2^2 l_2 = -\varepsilon_3 l_3 \cos\beta - \omega_3^2 l_3 \sin\beta \end{aligned}\right\} \begin{aligned} &\Rightarrow \varepsilon_2 = -\frac{1}{l_2}\left(a_{Bx} + \varepsilon_3 l_3 \sin\beta - \omega_3^2 l_3 \cos\beta\right) \\ &\Rightarrow \varepsilon_3 = -\frac{\omega_3^2 l_3 \sin\beta + a_{By} + \omega_2^2 l_2}{l_3 \cos\beta} = \underline{\underline{-95{,}46 \ \frac{rad}{s^2}}} \end{aligned}$$

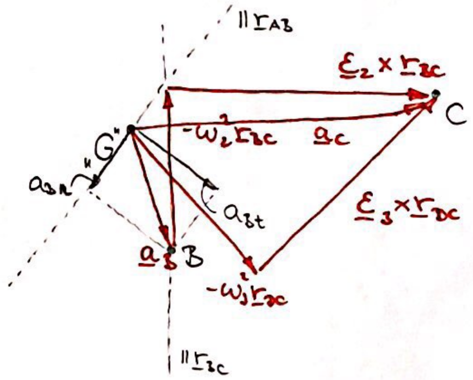
$$\varepsilon_2 = \underline{\underline{62{,}43 \ \frac{rad}{s^2}}}$$

Ezzel:

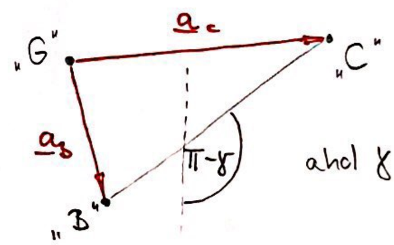
$$\underline{\varepsilon}_2 = \begin{bmatrix} 0 \\ 0 \\ 62{,}43 \end{bmatrix} \frac{rad}{s^2} \ ; \quad \underline{a}_C = \begin{bmatrix} 25{,}45 \\ 15{,}05 \\ 0 \end{bmatrix} \frac{m}{s^2} \ ; \quad \underline{\varepsilon}_3 = \begin{bmatrix} 0 \\ 0 \\ -95{,}46 \end{bmatrix} \frac{rad}{s^2}$$

Gyorsulásábra:

$$\left.\begin{aligned} \underline{a}_C &= \underline{a}_B + \underline{\varepsilon}_2 \times \underline{r}_{BC} - \omega_2^2 \underline{r}_{BC} \\ \underline{a}_C &= \underbrace{\underline{a}_D}_{=\underline{0}} + \underline{\varepsilon}_3 \times \underline{r}_{DC} - \omega_3^2 \underline{r}_{DC} \end{aligned}\right\} \Rightarrow \underline{a}_B + \underbrace{\underline{\varepsilon}_2 \times \underline{r}_{BC}}_{\underline{r}_{BC} \perp (\underline{\varepsilon}_2 \times \underline{r}_{BC})} - \omega_2^2 \underline{r}_{BC} = \underbrace{\underline{\varepsilon}_3 \times \underline{r}_{DC}}_{\underline{r}_{DC} \perp (\underline{\varepsilon}_3 \times \underline{r}_{DC})} - \omega_3^2 \underline{r}_{DC}$$



Egyszerűsítve:

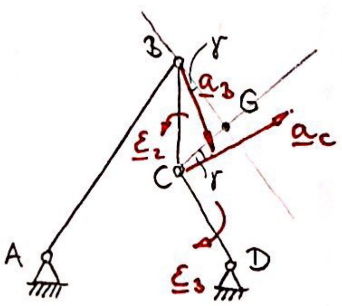


ahol $\gamma = \arctan \dfrac{\varepsilon_2}{\omega_2^2}$

Gyorsuláspólus helye:

$$\underline{a}_G = \underline{a}_B + \underline{\varepsilon}_2 \times \underline{r}_{BG} - \omega_2^2 \underline{r}_{BG} = \begin{bmatrix} a_{Bx} \\ a_{By} \\ 0 \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \\ \varepsilon_2 \end{bmatrix} \times \begin{bmatrix} x_{BG} \\ y_{BG} \\ 0 \end{bmatrix} - \omega_2^2 \begin{bmatrix} x_{BG} \\ y_{BG} \\ 0 \end{bmatrix} \equiv \underline{0} \equiv \begin{bmatrix} a_{Bx} - \varepsilon_2 y_{BG} - \omega_2^2 x_{BG} \\ a_{By} + \varepsilon_2 x_{BG} - \omega_2^2 y_{BG} \\ 0 \end{bmatrix}$$

$$\left.\begin{aligned} x:&\quad a_{Bx} = \varepsilon_2 y_{BG} + \omega_2^2 x_{BG} \\ y:&\quad a_{By} = -\varepsilon_2 x_{BG} + \omega_2^2 y_{BG} \end{aligned}\right\} \Rightarrow \begin{aligned} x_{BG} &= 0{,}1131 \text{ m} \\ y_{BG} &= -0{,}058 \text{ m} \end{aligned}$$



Scanned with CamScanner