Rally's wheel – \( V \) & \( a \) diagrams

Vel diagram for \( V_B \)

\[
V_B = V_0 + V_{B/0}
\]

\[
V_{B/0} = \omega_{BO} \times \hat{r}_{B_0}
\]

\[
V_{B/0} = \omega_{BO} \times (-\hat{e}_x)
\]

\[
V_0 = \omega_{BO} \times \hat{r}_y
\]

This shows that at B, cycloid curve’s tangent is 45°.

Acceleration – \( \omega_{BO} \) constant

\[
\ddot{a}_B = \ddot{a}_0 + \ddot{a}_{B/0} - n + \ddot{a}_{B/0} - t
\]

\[
\ddot{a}_{B/0} - n = \omega_{BO}^2 \times \hat{e}_x
\]

But tangent to curve is 45°.
So we got the normal acceleration from the relative acceleration equation, which is $B_0$'s total acceleration, since $V_0$ is constant, and then we broke it up into path-referenced normal & tangential accelerations. We got the path's $\varepsilon$ from the direction of $V_B$.

Let's look at pt F, @ 45° from B CW

\[
\vec{a}_F = \vec{a}_0 + \vec{a}_F/10
\]

\[
\vec{a}_F = \vec{a}_F/10 - \vec{a}_0
\]

\[
\vec{a}_F = \vec{a}_F/10 - \vec{a}_0 = \omega_{B0}^2 \vec{r} (-\vec{e}_{F10})
\]

But we know the direction of $V_F$ at this point: $V_F = V_0 + V_{F/10}$, $F/10 = \omega_{B0} \times \vec{r}_{F/10}$

Both have length $\omega_{B0} \vec{r}$
So @ F, tangent is 22.5°
(What's it @ E?)

Path-referenced acceleration @ F

Obviously, as you go around the wheel toward the top, \( V_{\star.t} \) gets less & less & \( V_{\star.n} \) gets more & more. The overall \( a_{\star} \) is always the same, \( W_{Bo} \). But how it's distributed along the path between path-\( t \) & path-\( n \) changes. At the top it's all path-\( n \). At A, it's all path-\( t \).