1 Introduction

1.1 Motivation

Max speed @ $1g$ lateral acceleration:

$$\frac{v^2}{r} = g \Rightarrow v_{max} = \sqrt{rg}$$

Therefore, we have:
Inside: $v_{max} = \sqrt{Rg} = 31.3m/s$
Outside: $v_{max} = \sqrt{(R+w)g} = 35.7m/s$
Racing: $v_{max} = \sqrt{(R+w)g} = 35.7m/s$

1.2 Derivation

We know distance travelled is $d = r\theta$. For the inside and outside tracks, $\theta = \pi$. We can calculate θ for the racing track by examining the illustrated curve. We can draw a right triangle with hypotenuse $R + w$ and vertical side w, with θ between them. Therefore, $cos\theta = \frac{w}{R+w}$, or:

$$\theta_{racing} = 2 \arccos \frac{w}{R+w}$$

So we have:
Inside: $d = \pi R = 314m$
Outside: $d = \pi(R+w) = 408m$
Racing: $d = (2 \arccos \frac{w}{R+w})(R+w) = 348m$

1.3 Time through the curve

We know $t = \frac{d}{v_{max}}$, so:
Inside: $t = \pi\sqrt{\frac{R}{g}} = 10.0s$
Outside: $t = \pi\sqrt{\frac{R+w}{g}} = 11.4s$
Racing: $t = 2 \arccos \frac{w}{R+w}\sqrt{\frac{R+w}{g}} = 9.74s$

1.4 Which line to choose

The racing line has the fastest time. The racing line and outside line have the fastest exit speed. So I would choose the racing line.

1.5 Limitations

The transition from a straight section to a constant radius curve requires an instantaneous step change in steering angle, which is impossible to accomplish in reality.

2 Results

3 Conclusion