Task 13: Planning calculations and simulation results

Track layout

1. Starting ramp: length 3.5 m, drops elevation by 2.5 m
2. Straight track section: length 18 m, drops elevation by 12.7 m
3. Circular curve: length 32 m, radius 20.4 m, angle 90°
4. Parabolic curve: approximated by length 58 m, radius 37 m, angle 45°, +10.8 m
5. Straight track section: length 5 m, no change in elevation
6. Circular curve: length 44 m, radius 14 m, angle 180°
7. Straight track section: length 5 m, no change in elevation

Speed rough calculations

From conservation of energy (μ = 0.015)

$$\frac{1}{2}mv^2 + mg\Delta y = \frac{1}{2}mu^2 - \mu Lmg\cos\theta \rightarrow v = \sqrt{u^2 - 2\mu Lg\cos\theta - 2g\Delta y}$$

After stage 2: v = 17.1 ms^{-1}

At stage 3 bottom: v = 20.0 ms^{-1}

→ Maximum speed is within 20 ms^{-1} range

Accelerations rough calculations

Curve at stage 3: a = $20^2/32$ - 9.8 = 2.7 ms^{-2}

Curve at stage 4: a = $17^2/20.1$ cos 45 = 3.5 ms^{-2}

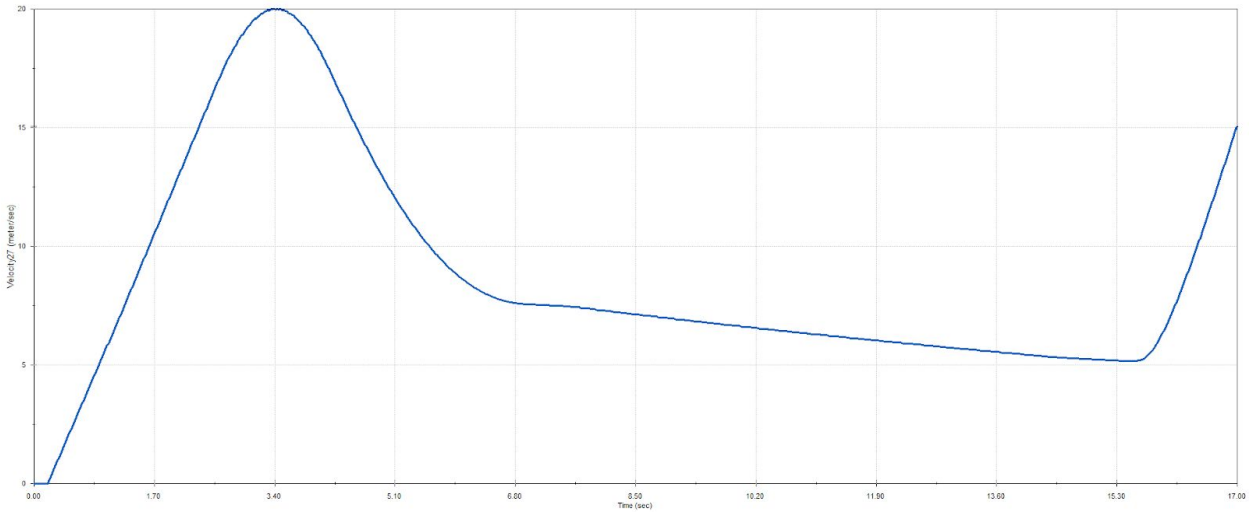
→ Maximum vertical acceleration is within 0.75g = 7.4 ms^{-2} range

Curve at stage 6: a = $7.5^2/14$ = 4.0 ms^{-2}

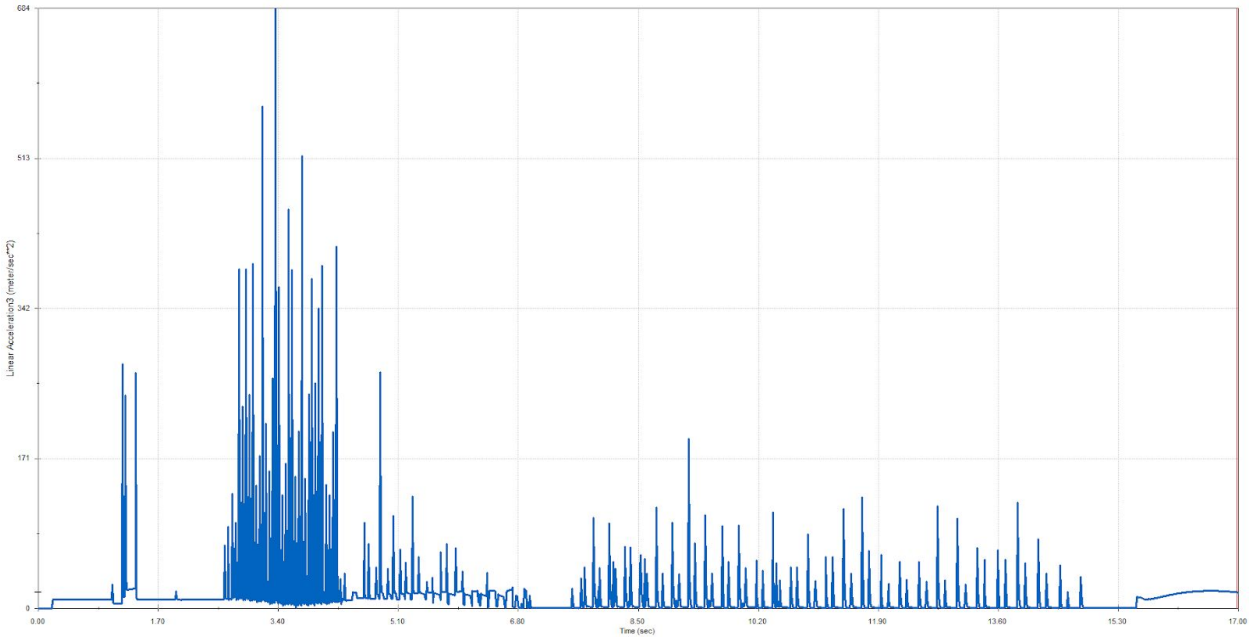
→ Maximum lateral acceleration is within 0.45g = 4.4 ms^{-2} range.

Simulation results

Velocity - *y*-axis from 0 to 20



Linear acceleration - spikes due to straightening of curves into sudden lines



Centripetal acceleration - spikes due car crashing into edge of circular section