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A3_10 "Hang on a Minute Lads, I've Got a Great Idea…"

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Abstract

This paper analyses one of the stunts completed in the 1969 film *The Italian Job* and discusses the effect of the mass of the stolen gold on the ability to complete this stunt. It was found that only $2,290,000 (out of $4 million) worth of gold could be stolen in order for an unmodified Mini Cooper to complete the getaway.

Introduction

In the classic 1969 crime/comedy film *The Italian Job* a British criminal, Charlie Croker (played by Sir Michael Caine), and his team steal $4,000,000 worth of gold from Italy. The getaway is made in three Mini Coopers during which a series of stunts are performed. Although the film company completed these stunts with the real vehicles (i.e. not CGI), obviously, real gold was not used. This paper therefore will evaluate one of the stunts and investigate what effect the mass of the stolen gold would have had.

Analysis

During the getaway the three Mini Coopers jump from one rooftop to another, see Figure 1a, and although the mass of the gold would not affect the rate at which the Minis would fall (and therefore the velocity needed to complete the jump) it would affect the ability of the Minis to reach the required velocity.

During the film $4,000,000 worth of gold was stolen from a security van. The average price of gold in 1969 was $41.10 per troy ounce [1], where a troy ounce is the equivalent of 31.1g. This means that the mass of the gold can be worked out simply to give a value of 3027 kg

This means that each mini would therefore need to carry an extra 1009kg on top of its own mass of 584kg [2], thus giving a total mass of 1593kg.

Figure 1a: Screenshot of the jump from the film [3]

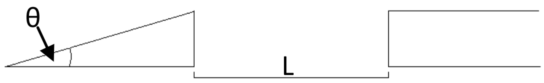

Figure 1b: Simplified diagram of the jump

A simplified version of the jump is indicated in Figure 1b and values for θ and L and the time taken to complete the jump, t, were all estimated from the film, [3]. L was estimated by repeatedly pausing the film whilst the jump was performed and counting the number of Mini lengths. t was the time taken between the Minis leaving the ramp (Fig. 1) and being directly above the start of the landing ramp, as in the film the Minis land a considerable distance from the edge.

Using Eq. 1, and substituting in the expression for deceleration due to air resistance (Eq. 2), a value for the takeoff velocity can be calculated.

$$s = ut + \frac{1}{2}at^2, \qquad (1)$$

also

$$F_D = \frac{C_D \rho A u^2}{2} = ma$$
$$\Rightarrow a = \frac{C_D \rho A u^2}{2m}, \qquad (2)$$

where s = L = 12m [3] and is the horizontal distance travelled by the Minis, t is the time taken for the Minis to traverse the jump (0.7s [3]), C_D is the coefficient of drag of an average car (0.525 [4]), ρ is the density of air (1.205kgm^{-3} at 20°C [5]), A is the cross-sectional area of the Mini (1.397x1.346m [2]), u is the takeoff velocity and m is the total mass of the car as previously calculated. The combination of Eq. 1 and Eq. 2 can be written as shown below.

$$u^2\left(\frac{C_D \rho A t^2}{4m}\right) - ut + L = 0,$$

where the air resistance term is negative as it is acting in the negative x direction. This is a quadratic in u and can therefore be solved using the quadratic formula to give a value for the takeoff velocity. Two values of the velocity were calculated at 17.18 ms^{-1} and 7633 ms^{-1}, the former of which is the more sensible and therefore will be used from now on. However this is only the component of velocity in the x direction (u_x). Eq. 3 can be used to get the resultant velocity of the car (**u**).

$$u_x = \mathbf{u} \cos\theta, \qquad (3)$$

where θ is the angle which the car takes off at and has been estimated at 25 degrees [3]. This gives a value of the resulting velocity of 18.96 ms^{-1}, which corresponds to 42.7 mph in order for the Mini to just make the jump. This value should, therefore, be rounded up to 45 mph (=20 ms^{-1}) to make sure the Mini clears the gap with room to spare. Eq. 4 shows the relationship between the maximum velocity of the car and the power developed by the engine.

$$P = Fv_{\max} = mav_{\max}. \qquad (4)$$

The top speed of a Mini Cooper is 85 mph (=37.8 ms^{-1}) with an engine power of 55 bhp (=41 kW, where 1 bhp = 745.7 W) and a mass of 584 kg [2]. Assuming the acceleration is constant a value of 1.86ms^{-2} can be calculated.

Discussion

Using this value for the acceleration of the car a top speed when the gold is loaded (m=1593kg) can be calculated to be 13.8 ms^{-1} using Eq. 4. This is slower than the velocity needed for the Mini to make the jump. This therefore puts a limit on the amount of gold that can be put into each car. By setting the maximum velocity as 18.96 ms^{-1} so the Mini just makes the jump a maximum mass of the car can be calculated by rearranging Eq. 4. This gives a value for the maximum mass of the car as 1162kg (rounding down to make sure the car clears the jump). This is an equivalent mass of gold per Mini of 578kg.

Conclusion

Therefore, without modification, three Mini Coopers would only have been able to steal a total mass of 1734kg which corresponds to a value of $2,290,000 (in 1969). In order for the full $4 million to be stolen either 6 unmodified Mini Coopers would need to be used or (using the values for the max speed and acceleration above) the engine power would need to be increased to 56.2 kW or 76 bhp.

References

[1]http://www.lbma.org.uk/pages/?page_id=53&show=1969&type=monthly, 11/03/11
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