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# Can The Mercenary from James Bond Shoot Through A Train Coupling?

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**Abstract**
This paper discusses the possibility of the mercenary from Skyfall, Patrice, being able to shoot through the link between two train carriages to attempt to get away from the secret agent, James Bond. During an altercation atop a train in Istanbul, Patrice shoots through the coupling with ease, separating the two carriages. This paper shows that the required force to shoot through a steel alloy coupling would be 148285N, as the bullet would only exert around a third of the force required, 52099.2N, and this paper proves that this cannot be done with such ease as portrayed in the film.

## Introduction

Skyfall is the twenty-third James Bond 007 story in the longest-running film franchise of all time (Skyfall Movie, 2012). It features Daniel Craig starring in his third performance as James Bond. This paper questions the possibility of one of the action scenes, set in Istanbul when Bond is in pursuit of a mercenary, Patrice, who has stolen a hard-drive containing top secret information about the identities of undercover agents placed in terrorist organisations. The confrontation between Bond and Patrice occurs atop a train. This paper looks at the possibility of shooting through a train coupling as a way of escape during scenes such as these.


Figure 1 Altercation atop the train [1]

## Energy of Bullet

The gun that this model uses is a Beretta M 195

Figure 2 Daniel Craig as James Bond [2]

Bullet diameter = 9mm = $9\times10^{-3}$m [3]
Bullet length = 10mm = $10\times10^{-3}$m [3]
Velocity = $360ms^{-1}$ [3]
Mass = $8.04\times10^{-3}$kg [3]

To calculate the kinetic energy of the bullet we use the equation:

$$KE = \frac{1}{2}mv^2$$

Equation 1[4]

Where *KE* is the kinetic energy, *m* is the mass and *v* is the velocity.

$$KE = 0.5 \times (8.04 \times 10^{-3}) \times (360)^2 = 520.992J \approx 521J$$

To find the force that this bullet would exert onto the object it hits, the acceleration first needs to be calculated, using the rearranged form of the suvat equation:

$$v^2 = u^2 + 2as$$

Equation 2[4]

Where *v* is the final velocity, in this case 0ms$^{-1}$ as the bullet has come to rest, *u* is the initial velocity of 360ms$^{-1}$, and *s* is the displacement of the bullet coming to rest, which has been modelled as the length of the bullet, 10x10$^{-3}$m.

$$a = -\frac{(360)^2}{2 \times 10^{-2}} = -6480 \times 10^3 ms^{-2}$$

The negative sign simply indicates direction, showing that the bullet is decelerating. Now that the deceleration is known, the force can now be calculated using the equation:

$$F = ma$$

Equation 3[4]

Where *F* is the force exerted, *m* is the mass of the bullet and *a* is the deceleration:

$$F = 8.04 \times 6480 \times 10^3 = 52099.2\ N$$

The work can also be calculated using:

$$W = Fd$$

Equation 4[4]

Where *W* is the work done, *F* is the force and *d* is the perpendicular distance.

$$W = 52099.2\ \times 10 \times 10^{-3} = 520.992J \approx 521J$$

**Modelling the Train Coupling**

Assuming that the link between the two train carriages is made from Steel Alloy (4340) it fracture toughness ($K_{lc}$)would be $50MPa\sqrt{m}$. Assuming that this is a fairly old train that exhibits some rust and a crack of 5mm depth, the stress intensity factor can be calculated.

$$K = \frac{4P}{B}\sqrt{\frac{\pi}{w}}\left[1.6\left(\frac{a}{w}\right)^{\frac{1}{2}} - 2.6\left(\frac{a}{w}\right)^{\frac{3}{2}} + 12.3\left(\frac{a}{w}\right)^{\frac{5}{2}} - 21.2\left(\frac{a}{w}\right)^{\frac{7}{2}} + 21.8\left(\frac{a}{w}\right)^{\frac{9}{2}}\right]$$

Equation 5 [5]

Where *w* is the depth of the specimen, which is 0.15m, *a* is the crack depth which is 0.005m, *B* is the width of the block, 0.15m, and *P* is the applied load, and K is the fracture toughness, $50MPa\sqrt{m}$.

As $\left(\frac{a}{w}\right)$ is very small, the higher orders of magnitude can be neglected. Rearranging the equation to give the applied load (P), it can be determined how much force would be required to break the steel.

$$P = \frac{KB}{4}\sqrt{\frac{w}{\pi}}\left[1.6\left(\frac{a}{w}\right)^{\frac{1}{2}} - 2.6\left(\frac{a}{w}\right)^{\frac{3}{2}}\right]^{-1} = 148285N$$

**Conclusion**

The force required to break the steel coupling that links the trains together is 148285N. This under the assumption that there is no plastic deformation, and that there is already a crack due to the train being old and rusty, therefore the calculations are very generous with their values. The force exerted by the bullet is 52099.2N, which is not quite even a third of the force that would be required to break the steel. The film consequently portrays an inaccurate representation of this scenario, therefore if you ever find yourself in a similar altercation, do not waste bullets trying to separate the carriages.

**References**

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[4] Tipler, P.A., & Mosca, G., (2008). *Physics for Scientists and Engineers.* W.H. Freeman.
[5] Bower, A. F., (2009). *Applied Mechanics of Solids.* CRC Press.