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Nobody tosses a Dwarf! – Modelling Gimli being tossed by Aragorn

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Abstract

Gimli the Dwarf, a character from *The Lord of the Rings*, is at one point in the film series tossed by Aragorn into enemies to help buy time for a frantic gate repair at Helm's Deep. In this paper, the amount of force that Aragorn produces to perform this feat is calculated. By using a number of assumptions and simple physical models, the force with which Gimli was thrown by Aragorn was calculated to be 2767 N, a significant exertion.

Introduction

In the popular film trilogy *The Lord of the Rings*, Gimli the Dwarf is one of the members of the Fellowship of the Ring. There are two points in the film trilogy where humour is made around Gimli not being able to make a large jump, the first of which happens in the mines of Moria. In this instance he exclaims "Nobody tosses a Dwarf!" and subsequently makes the leap (with the help of a tug on the beard from Legolas) [1].

In the second instance, during the Battle of the Hornburg at Helm's Deep, he admits "I cannot jump the distance you'll have to toss me!" to Aragorn and is subsequently thrown onto the bridge in front of the main gate to the fortress [2]. In this paper, the force with which Aragorn tosses Gimli is calculated.

Assumptions

The Lord of the Rings is set in the fictional land known as Middle-Earth. Within it there are many different creatures and races. The Dwarves are one of the most iconic humanoid races within Middle-Earth and Gimli is perhaps the most important in the *Lord of the Rings* series.

There is no given height or weight for Gimli in the film series, however discussion on internet forums tend to agree that Dwarves are between 4 and 5 foot tall and that their weight is somewhere between 190-250 pounds (depending on their height) [3]. For the purposes of this paper, it is

assumed that Gimli is 1.37m (4 ft 6 inches tall) and weighs 99.8 kg (220 lbs).

In addition to his weight, Gimli is heavily laden with armour and his weapon. Using medieval weapons and armour as a guide, his heavy chain mail is taken to weigh 25 kg [4], his helmet taken to weigh 3 kg [5] and his large battle-axe is taken to weigh 3 kg [6]. It is assumed that Gimli, although being shorter than the average human, would be wearing armour of equivalent weight to humans armour due to their stocky strong build [7]. This brings his total weight to approximately 131 kg.

In order to model Gimli, he will be treated as a point mass so that his motion can be calculated using standard projectile motion methods. The gravity in Middle-Earth shall be assumed to be the same as that on Earth, 9.81 ms^{-2} .

It is assumed that Gimli does not provide any assistance to Aragorn for the toss and that all the force required for the toss comes from Aragorn himself.

Modelling the Toss

By using a video clip of the scene in question from 'The Lord of the Rings: The Two Towers' [8], a basic model for the journey of Gimli throughout his flight was able to be made. By observing the clip, the duration for which Gimli was being thrown by Aragorn and for Gimli's flight were found to be

approximately 0.4 and 1.5 seconds respectively. Additionally, the angle of release of Gimli was found to be approximately 45° by the same method.

Figure 1 shows a model of Gimli's flight, extrapolated from screenshots of the video clip. Aragorn's height is known to be 1.98 m tall [9]. Using this, the various distances required for the calculation could be found by scaling the image to Aragorn's height.



Figure 1) Estimation of parameters using the height of Aragorn as a scale. The path of travel was found using a series of screenshots from a video clip. Original video from [8].

A more simplified schematic diagram of the model is shown in Figure 2, including all the distances that were calculated from Figure 1.

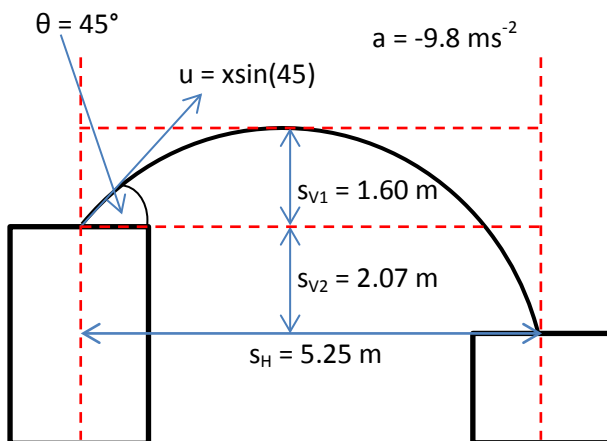


Figure 2) Simple schematic drawing of Gimli's flight path when modelled as a projectile.

Calculations

The start point of the calculation is from the point of release from Aragorn so Gimli will have non-zero initial velocity. In order to calculate the velocity at which Gimli is tossed, the standard equations of motion shall be used; in particular [9]:

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

where s is the displacement, t is time, u is initial velocity and a is acceleration. Re-arranging this equation gives:

$$u = \frac{(s - \frac{1}{2}at^2)}{t} \quad (2)$$

Only the vertical portion of the motion needs to be considered to find u and hence x in this case. As the end point of motion is 2.07 m lower than the start, $s = -2.07$ m. Resolving vertically (upwards +ve):

$$x \sin 45 = \frac{-2.07 - \frac{1}{2} \times -9.81 \times (1.5)^2}{1.5}$$

$$x = \frac{-2.07 + \frac{1}{2} \times 9.81 \times (1.5)^2}{1.5 \times \sin 45} = 8.45 \text{ ms}^{-1}$$

This value is the initial velocity at which Gimli is thrown. Using a modified form of Newton's second law [9]:

$$F = ma = \frac{mv}{t} \quad (3)$$

with the values of mass, velocity and the time that Gimli is being thrown by Aragorn gives:

$$F = \frac{131 \times 8.45}{0.4} = 2767 \text{ N}$$

This is the force with which Gimli is thrown by Aragorn. To put this into perspective, the average force of a human bite at the molars is 720 N and the maximum force achieved by a weightlifter during a 'clean and jerk' is around 8000 N [10]. The amount of force produced therefore is not a minor amount but also does not make Aragorn inhumanly strong. Even though Aragorn has been expending effort in a battle before this point, the amount of force produced does not seem impossible when you consider his training and experience.

Conclusion

In conclusion, by using simple models, footage from the film and various assumptions the amount of force that it took Aragorn to toss Gimli was 2767 N. This is a significant amount of force; however it would be possible for a human to produce it. We can assume therefore, that Gimli's weight is not the reason why nobody tosses a dwarf.

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