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P5_10 The battle against the Titans

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Abstract

This paper investigates the use of omnidirectional manoeuvre gear in the animated series Attack on Titan and the possibility for human beings to use the gear and remain unharmed when considering the physical affects on the body. In the scene examined the user experienced a G force of $7.18 m^3/kg/s^2$, an impact force of 119,000 N and utilised a reaction time of 0.0139 s.

Introduction

Attack on Titan is a Japanese animated show in which an apocalyptic scenario has taken place leaving humanity at the expense of man eating giants, known as Titans [1]. In order to combat the Titans the use of omnidirectional gear (OMD) was designed allowing pilots to travel at high velocities using a combination of pressurised gas and grappling hooks. This paper looks at a specific scene in the show, [2] in which a pilot travels at such velocities and discusses the credibility of a human performing such movements.

Method

The pilot in the scene was taken to have a velocity of 44.4 m/s [2] traveling a distance of approximately 14.0 m across a 2.00 s interval. With the assumption that the pilots flight path was linear, acceleration could be calculated with the following equation.

$$v^2 = u^2 + 2ax \tag{1}$$

Kinematic equation relating final velocity v in m/s, initial velocity u, assumed to be 0.00 m/s, acceleration a in m/s^2 and distance x in m.

The acceleration was then used to calculate the G force experienced by dividing by the gravitational constant $9.81 m/s^2$. As the pilot goes through constant phases of abruptly landing on surfaces, the impact force the pilot experiences must also be considered as a potential risk. It was assumed the pilot had no further assistance and the full impact would be felt, with an assumption of impact duration of a second (although this time could be faster it becomes difficult to analyse a video with the human eye so a second was taken as a standard). The total mass of the pilot was deduced using the combination of the weight of the pilot 65.0 kg [3] and the proposed weight of the ODM gear 56.6 kg [4]. Although unreasonable it was assumed the pilot could carry the gear without affecting performance. These values were then used to calculate impact force using the equation below.

$$F = 0.5 m v^2/d \tag{2}$$

Where F is the impact force in N, m is the total mass of the pilot in Kg, v is the velocity at impact in m/s and d is the impact duration in s [5].

The force was then compared to a threshold that human femurs are able to withstand.

The final component to consider regarding the

functionality of the equipment was the pilots reaction time. By further analysing the scene the character can be seen to make 7 precise incisions across a time frame of approximately 0.097 s [2]. These values were then used to derive the pilots reaction time by simply dividing the time frame by the number of actions, 7 , which was then compared to the average human reaction time.

Results

Acceleration of pilot (m/s)	70.4
G force experienced ($m^3/kg/s^2$)	7.18
Impact Force (N)	119,000
Reaction time (s)	0.0139

Table 1 shows values obtained throughout the experiment.

Discussion

Using Table 1 a G force of approximately 7.18 G was found to be experienced by the pilot during this maneuver. The average human being cannot withstand G forces of above 5.00 G [6] due to the relativistic effects experienced by blood during this acceleration, this restriction of blood flow causes many individuals to pass out as seen on roller coasters and would therefore be an impractical state to fight in. However, it is known with the correct training, that it is possible to withstand up to 9.00 G [6]. Assuming that the pilots would undergo this training it is possible certain humans could fight in these conditions however this is ignoring the muscle strength required to perform such maneuvers with the additional weight of OMD.

The impact force experienced by the user poses a lethal threat with an instantaneous value of 119,000 N experienced. The standard force a human femur can withstand before damage is approximately 4,000 N[7]. This means regardless of other factors the gear has no practical application, this value could theoretically be reduced by travelling at slower speeds however it would come at the offset of combat ability. The addition of crumple zones to increase impact duration in items of clothing, specifically shoes could reduce this number to a lower level however it is unlikely the force would ever be non lethal.

The reaction time calculated further disproves the functionality of the gear in the scene with a value of 0.0139 s observed by the user, the average human reaction time is approximately 0.250 s with the fastest reaction times residing around 0.150 s [8] meaning that the skill needed to use the gear in such situations is an ability human beings cannot posses. Although possible to perform slower movements this may come at a cost to combat ability making the gear unsuitable for typical human use.

Conclusion

Overall in the scene the pilot theoretically could survive the 7.18 G imposed apon them however realistically it would be impossible as the human body simply cannot handle the 119,000 N of force required to operate the OMD. Even when not considering human eyesight limitation and accuracy it is impossible to react at the speeds of around 0.0139 seconds in the scene and assuming pilots will have to react at similar speeds this discredits the use of OMD gear to actually combat Titans.

References

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