Journal of Physics Special Topics
An undergraduate physics journal

S3_5 Attack of the Aliens

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November 29, 2017

Abstract

Modelled after a very famous scene in the film "Alien" (1979), we calculated the force required by a "chestburster" alien to break through a human chest cavity in one blow. We found this force to be 155000 N. We also calculated that the speed at which the alien would need to leave the body would be 102 m/s.

Introduction

In the famous science-fiction horror "Alien" (1979) one of the most shocking scenes in the film involved an alien bursting out of a man's chest after having grown within the man. We measure the force required for the alien, known as a "chestburster", to fully escape through a human being's chest cavity from underneath the ribcage in one blow and the speed at which it must travel to do so. For this paper, the chestburster's shape is assumed to be a cylinder with an assumed radius of 0.03 m and length 0.305 m [1] and the alien has a mass of 9 kg [2].

Theory and Results

In order to calculate the force required for the chestburster to break through the chest cavity, we obtained the values of the average tensile strength for human skin and human flesh as 27.2 MPa [3] and 196 kPa [4] respectively. Initially, we calculated the cross sectional area of the alien using the following equation:

$$A = \pi r^2, \tag{1}$$

Where A is the cross sectional area of the alien, and r is the radius of the alien. In order to calculate the force that the alien would need to break through the chest cavity we used the following equation:

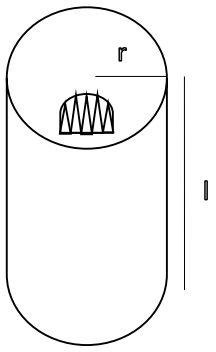

Figure 1: The schematic diagram above shows a basic approximation of the chestburster alien as a cylindrical shape. The radius r is 0.03 m and the length l is 0.305 m.

$$F = As, \tag{2}$$

We rearranged the original equation for stress (s) as $s = \frac{F}{A}$, for the force F by multiplying the values we found for the tensile strength of human flesh by A, the cross sectional area of the alien. In order to break through the flesh, the alien would need to have a force of 1110 N. This pro-

cess was then repeated to calculate the force that would be required for the alien to break through the skin, this value was found to be 154000 N. As there is a linear relationship between combined stresses, we added together the forces to find the total force required to break through the chest cavity, which we found to be 155000 N.

In addition to this, we also calculated the speed at which the alien would need to be travelling if it was to break through the chest cavity with the force that we calculated. We equated the equations for work done (W) which is $W = Fl$, where F is the calculated force and l is length of the alien, and kinetic energy (KE) which is $KE = \frac{1}{2}mv^2$, where v is the velocity of the alien, and m is the mass of the alien. Once we equated these two equations, we rearranged them to find the velocity:

$$v = \sqrt{\frac{2Fl}{m}}, \tag{3}$$

This gave us a value of 102 m/s for the velocity of the alien as it exited the chest cavity.

Discussion

In order to work out the forces needed to break through the chest cavity, we needed to address the maximum force that the chest cavity could undergo. We did this by finding the ultimate tensile strengths of both human flesh and human skin, as we assumed the alien would burst out in one go from the chest cavity beneath the ribcage. The value of the total force needed to do so is 155000 N, which is a huge value. This could very well be feasible though in the context of the film as it is an alien species. Furthermore, the alien would also need to have a speed of 102 m/s in order to exit the human being at the force we calculated, and again this is a very high value, and both the force and speed would prove fatal for any human infected with this parasitic alien.

Conclusion

In this paper, we calculated the force required for a chestburster alien to break through a human's chest cavity. We found this value to be 155000 N. The alien would have a speed of 102 m/s as it exited the human at the force we calculated. Both the force and speed that we have calculated would suggest that no human could survive being infected with the chestburster.

References

[1] `http://alienanthology.wikia.com/wiki/Chestburster/` [Accessed 15 November 2017]

[2] `http://avp.wikia.com/wiki/Chestburster/` [Accessed 15 November 2017]

[3] `http://www.ircobi.org/wordpress/downloads/irc12/pdf_files/59.pdf` [Accessed 15 November 2017]

[4] `http://www.ircobi.org/wordpress/downloads/irc12/pdf_files/59.pdf` [Accessed 15 November 2017]