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P4_4 Snorlax used Body Slam

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Abstract

In this paper we consider the maximum strength of Ash's Snorlax, from the Pokémon original TV series, this will occur when the Snorlax jumps as high as it can. The maximum height of the jump was calculated to be 41.8 m, the velocity it impacts the ground with is 28.1 ms^{-1} and the momentum of the Snorlax when it hits the ground is $12,900$ kgms^{-1}.

In Pokémon, the move Body Slam is an attack used frequently in the TV show and across most of the video game series. Body Slam is very often associated with the Pokémon Snorlax as it is a very large and heavy Pokémon. The attack requires the Pokémon using the move to drop onto the foe with its full body weight. The aim of this paper is to calculate the maximum strength of a Snorlax's Body Slam, to do this we will focus on Ash's Snorlax from the TV show [1]. In the show Ash's Snorlax often jumps into the air when using Body Slam to increase the effect of the attack. In episode 254 of the original series Ash's Snorlax is standing under water at the bottom of a pool and is instructed to jump as hard as it can to get out of the pool. During this jump it stands at the bottom of a pool 3 m deep and jumps 9 m clear of the surface of the water, the depth of the pool and height of the jump were calculated using images from the show. This jump from under water will be used to calculate the maximum height Ash's Snorlax can jump when on the ground and then the momentum that Snorlax will subsequently hit the ground with.

Figure 1: A Snorlax

Snorlax is 2.1 m tall and has a mass of 460 kg [2]. To model how Snorlax moves through the water we need to calculate the volume and density of Snorlax, we used Figure (1) and its height to find the lengths and width of its arms giving 0.58 m and 0.19 m respectively and the length and width of its legs were extrapolated to be 0.19 m and 0.38 m respectively. Using the same method the height of its head and body were found to be 0.48 m and 1.43 m respectively. By modelling the arms and the legs to be cylinders and the head and the body to be spheres the total volume of Snorlax was calculated to be 1.7 m^3.

$$\rho = \frac{m}{V} \tag{1}$$

Where ρ is density, m is mass and V is volume. Using equation (1) the density of Snorlax was then calculated to be 271 kgm^{-3}. For simplicity we shall now model Snorlax as a single sphere with the same volume and density as previously calculated. We then split the jump into five phases; phase one starts with Snorlax pushing off from the bottom of the pool, phase 2 starts when Snorlax finishes pushing and includes its movement to the surface of the water, phase 3 starts when Snorlax breaks the surface of the water and continues until it is only half submerged, phase 4 starts when Snorlax is only half submerged, ending when it is no longer submerged in water and phase 5 models its path through the air to reach the height of 9 m above the water surface. To calculate the force with which Snorlax jumps we need to work backwards from phase 5 to phase 1.

$$v^2 = u^2 - 2as \tag{2}$$

Where v is final velocity, u is initial velocity, a is acceleration and s is the distance over which the acceleration is applied.

$$F_d = \frac{1}{2} C_d A \rho_m v^2 \tag{3}$$

Where F_d is drag force, C_d is the coefficient of drag and A is the surface area of the object, ρ_m is the density of the medium and v is the velocity of the object.

$$F_b = m_d g \tag{4}$$

Where F_b is the buoyancy force, m_d is the mass of displaced water and g is the acceleration due to gravity at the Earth's surface.

In phase 5 the initial velocity, u_5, that Snorlax leaves the surface of the water with is calculated, using equation (2), $s = 9$ m, $a = -9.81$ ms^{-2} and setting $v = 0$ ms^{-1}, to be 13.3 ms^{-1}. This calculation assumed that air resistance is negligible. An iterative method, a while loop, was set up in R and used to calculate the initial velocities at the start of phases 2, 3, 4 and the push force exerted by Snorlax in phase 1, using equations (3), (4) with the values of $C_d = 0.47$ [3] and $\rho = 1000$ kgm^{-3}. This iterative method took into consideration the change in buoyancy force due to change in volume submerged as Snorlax left the water, the change in drag force due to change in velocity and change in surface area as Snorlax left the pool. The initial velocities calculated for phases 4, 3, 2 and the push force, F_p, were calculated to be $u_4 = 13.4$ ms^{-1}, $u_3 = 15.4$ ms^{-1}, $u_2 = 29.3$ ms^{-1} and $F_p = 1.98\text{x}10^7$ N respectively.

Using the push force calculated, the trajectory of Snorlax jumping through air was calculated using an iterative process to model air resistance by using equation (3) and $\rho = 1.225$ kgm^{-3}. The maximum height of its jump was calculated to be 41.8 m, the velocity it impacts its opponent with, assuming the opponent is on the ground, is 28.1 ms^{-1} and the momentum the Snorlax is $12,900$ kgms^{-1}.

Conclusion

In conclusion, using iterative processes the maximum height of Ash's Snorlax's jump was calculated to be 41.8 m. If Snorlax were to Body Slam a target from this height it would hit the target with a velocity of 28.1 ms^{-1} and momentum of $12,900$ kgms^{-1}. The momentum Snorlax hits the target with is roughly that of an average car travelling 30 mph. That said there would be a lot of time to dodge such an attack and with Snorlax being largely made of fat, the time over which the impact force would be acting would be greatly increased compared to that of a car which would decrease the average force of impact.

References

[1] Pokémon, Episode 252-254 (2003). `http://www.imdb.com/title/tt0176385/` accessed on 25/11/2016

[2] `http://www.serebii.net/pokedex-xy/143.shtml` accessed on 10/11/2016

[3] `https://en.wikipedia.org/wiki/Drag_coefficient` accessed on 23/11/2016