Journal of Interdisciplinary Science Topics

Are the Hometrees in James Cameron's *Avatar* Structurally Possible?

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25/03/2016

Abstract

In James Cameron's *Avatar*, the Hometree is a sacred home for the Na'vi clans. These "trees" are said to be made of several thinner trees which have grown together to form a larger structure, suitable for its inhabitants. On Earth, the largest trees are significantly smaller (by almost a third). This paper concludes that factors such as reduced gravity result in only 22,100 N m^{-2} of compression, low enough to allow the tree to stand.

Introduction

The fictional planet Pandora is home to many diverse flora and fauna, with the largest and most impressive being the 'Hometrees' as dubbed by the indigenous humanoid Na'vi. This paper investigates whether the Home Tree depicted in the film *Avatar* [1] would be strong enough to hold its own weight.

Approximations

In order to determine whether or not the tree could support itself, some basic assumptions will be made. Firstly, that the trunk is not too dissimilar in strength to that of tree trunks on Earth. Secondly, it is the compressive force which is presumed to break the tree; no contributions from wind or other external forces are included. Finally, the weakest point is taken to be where the trunk is thinnest.

The height of the tree is given as approximately 150 m [2]. The width is not given, however it can be estimated by comparison to the relative height on screen. 56 minutes into the film, the Hometree is shown in full as a hologram (figure 2). Using Photoshop, the relative ratio of height to width was measured to be 95 to 13 which gives a width of 8.2 m using the 150 m height. This is where the trunk is thinnest, and therefore presumed weakest.

Using existing data for the mass of trees with respect to their diameters, it is possible to extrapolate to the much larger Hometree. Figure 1 shows a plot of data for common hardwoods [3]. The equation of the trend line was used to calculate the approximate tree mass. When converted to SI unit, this came to 614,000 kg.

The mass of the tree above the weakest point in the trunk is presumed to be a quarter of the total tree mass.

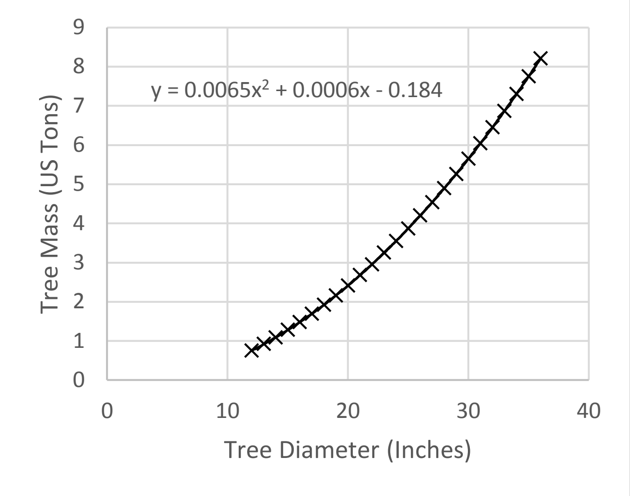

Figure 1) Tree mass as a function of diameter [3].

The gravity on Pandora is 20 % lower than Earth's, or 0.8 g [4]. This will reduce the force exerted by the canopy on the tree and must be taken into consideration. The gravity will be used as the acceleration term when calculating the force.

The tree is also on an angle, shown in figure 2 which is an edited still image from the film. This angle will alter the magnitude of the lateral force acting on the trunk. The length ratio from the image can be used with some basic trigonometry to calculate an approximate angle, which can in turn be used in the final calculation. Photoshop was used to add markers and measure the relative lengths of the sides of the triangle produced by the tilted trunk.

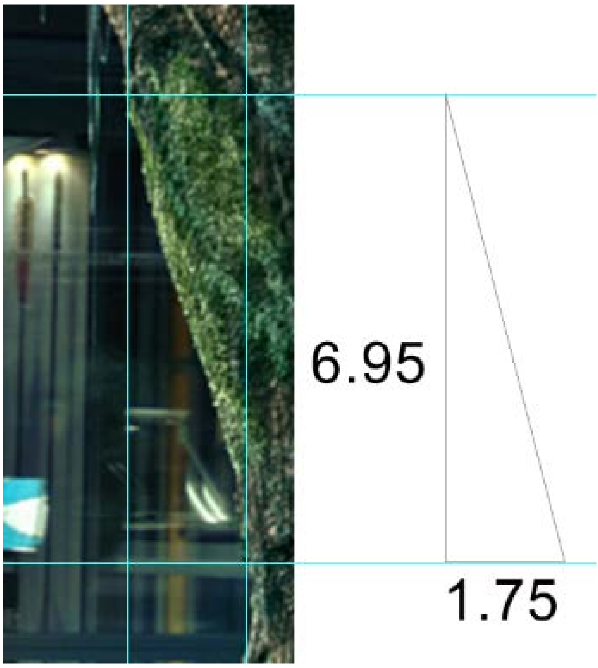

Figure 2) Diagram showing the angle of the Hometree. Numerical values are an arbitrary, relative scale from Photoshop [2].

This allows the force due to the canopy mass to be calculated using equation 1.

$$F = \frac{m_{tree}}{4} \times 0.8g \times \cos\left(\tan^{-1}\left(\frac{opp}{adj}\right)\right)$$

$$F = \frac{614{,}000}{4} \times 0.8 \times 9.81 \times \cos\left(\tan^{-1}\left(\frac{1.75}{6.95}\right)\right)$$

$$F = 1.17 \times 10^6\ N$$

This value can be compared to typical compressive strengths of trees on Earth. Assuming the compressive strength of dead wood is not too dissimilar to that of living wood, a value of 920 psi can be used [5]. Converted to SI units, this gives 9.34×10^6 N m^{-2}.

The diameter of the tree at its thinnest was already found to be 8.2 m, giving a cross-sectional area of 52.8 m^2. This means the tree only experiences 2.22×10^4 N m^{-2} of compression.

Conclusion

The pressure the tree experiences from its own weight on Pandora would not be sufficient to induce collapse. Even accounting for some fairly large inaccuracies in the calculation, the tree would still need to be almost two orders of magnitude weaker to be crushed.

References

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