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P4 6 Satellite Stomps- Harry's Power

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Abstract

We investigate the use of Kinetic Flooring during the "Satellite Stomps" in a performance of Harry Styles' "Love on Tour" as a way to produce the energy to power the entire show. We found that Harry alone would produce 2.63x10^{-4} kWh, while the entire show would use 15200 kWh, meaning a total of 57.8 million fans would be required to produce enough energy for the entire show.

Introduction

Over the course of 2 years, Harry Styles performed 169 shows as part of his tour "Love on Tour". In the song "Satellite", Harry performs a dance routine coined the "Satellite Stomps", which begs the question, would he be able to generate enough electrical energy while stomping to power his entire show?

Satellite Stomps

In order to calculate the energy generated from this dance, the force of one stomp by Harry was calculated. When running, a person is able to exert approximately 2 times their body weight on the ground [1], and hence the force of a single stomp was found using

$$F = 2mg \tag{1}$$

where m is the average mass of an adult in the UK, 71.8 kg [2], and g is gravitational field strength, 9.81 ms^2. From this, the force behind a single stomp was found to be 1410 N. We then converted this force into energy by calculating the work done.

$$W = Fd \tag{2}$$

where the distance d is the average height of a stomp. In this case it was taken to be the height of a pair of Adidas Gazelle trainers, 10 cm, from a video taken during a performance at Wembley [3]. From Equation 2 the energy from each stomp is calculated as 141 J.

In order to use the energy generated within a stomp "Kinetic Flooring" could be used, which when stepped or jumped on will generate electricity. This has previously been used successfully by Coldplay on their "Music of Spheres" tour [4]. The kinetic flooring has an efficiency of 70% of that of a regular solar panel [5], which have an efficiency of 20% [6], and so the overall efficiency of the kinetic flooring is calculated to be 14%. Hence the energy output of the flooring is found to be 19.7 J, or 5.47x10^{-6} kWh per step. In the video taken at Wembley, there are 48 steps during the "Satellite Stomps", and so the total energy generated by Harry is found to be 2.63x10^{-4} kWh.

Tour Staging

From the stage set up, it is assumed that most of the energy usage comes from the large LED screens. For the purpose of this paper, the

screens are assumed to be perfectly rectangular. Since the stage is approximately the width of the football pitch at Wembley stadium, 69 m [7], plus two 10 m screens on the side of the stage, a total width of 89m was used for all calculations. The height of the screens was calculated using a photo taken by the author at the aforementioned show, and it was found to be approximately 14 Harry's tall. Since he is 6 ft tall[8], a total height for the screens was found to be 25.6 m. Using 500 mm x 500 mm LED screen tiles, the total number of tiles used within the show is calculated to be 9080. The total power usage for all the LED tiles is calculated using Ohm's Law

$$P = VI \tag{3}$$

where V is the UK mains voltage, 230 V, and I is the current requirement of each tile, 2.25 A [9]. From this, a power usage of 4700 kW for the whole screen was calculated, which along with the average consumption of Wembley stadium, 4000 kW [10], gives the total power consumed during the show as 8700 kW, which for a 1 hour 45 min show, is equivalent to 15200 kWh.

Discussion

Comparing the energy generated by Harry during the stomps section, $2.36\text{x}10^{-4}$ kWh, to the total usage, 15200 kWh, we are able to see that Harry alone will not be able to generate enough energy using the kinetic flooring. Assuming each person generates the same energy as Harry, it will take 57.8 million fans consistently stomping to generate the power required for the event. However, since the standing capacity of Wembley Stadium is only 25000 [11], there will not be enough fans present at each night to make the show self sufficient through the exclusive use of kinetic flooring.

Conclusion

While the use of kinetic flooring would aid in making Love on Tour more environmentally friendly, unless Harry is able to find a way to get all his Spotify monthly listeners into one location for a show, he will sadly have to continue to use the electricity generated through the grid.

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