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If the University of Leicester's Charles Wilson building were a transformer, how much fuel would it need to stand up?

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Abstract

In 1966, construction of the now infamous Charles Wilson building was completed. Unknown to its designer, Sir Denys Lasdun, it would later be affectionately known as the Optimus Prime building due to its uncanny resemblance to the transformer. A transformer being from the popular children's franchise in which cars have the ability to transform into sentient, humanoid robots. This paper aims to quantify the amount of fuel that would be needed for the building to stand, if it were a transformer. The energy needed for the Charles Wilson building to stand up, like a transformer, is approximately 281.02 MJ, requiring 7.34 L of kerosene and making the motion less fuel efficient than a Boeing 747.

Introduction

In the 1960s, Sir Denys Lasdun designed the Charles Wilson building (CW), see figure 1. The building is one of three which decorate the skyline of the University of Leicester. Nowadays CW is known for its likeness to notable transformer, Optimus Prime [1]. Thus, this paper seeks to quantify the amount of fuel that would be needed to allow the building, if it were a transformer, to stand up like a human would. This paper assumes that the building only makes up the head to hips of the transformer as if the legs were hidden underground, and so, they must be approximated.

How high would the building need to rise to be considered standing?

It is assumed that the building has approximately the same dimensions as a human-like transformer, so the 'legs' would be 35 % of the height of the building. CW is 52 m in height, hence this would equal the rest of the body and the 'legs' of the building would lift it by 28 m [3]. Resulting in the total standing height of 80 m.

Weight of the building

The specific dimensions of the building have been assumed in order to make these calculations. The weight of the building only takes into account the concrete of which the building is made and so the building is assumed to be mostly empty inside.

Figure 1 – Photo of the Charles Wilson building. In red are examples of the concrete blocks counted to carry out calculations [2].

CW is made of precast concrete units, 15.24 m long and weighing 9.5 tonnes each [3]. These units are shown in red in figure 1. Thus, to calculate the approximate weight of the building, these units are counted from photos. The total weight of the building is calculated to be approximately 665 tonnes, or 665,000 kg.

If this were to include the 'legs' of the building, again, the assumption is made that the weight of the building is 65 % of the total weight of the transformer. This assumes that the 'legs' would be made of the same materials. If this were the case, the total mass would be 1,023,076 kg.

How much energy and fuel would this require?
The force required for the building to rise would have to be greater than the force acting downward on it, weight. This is found as follows:

$$F = mg = 1{,}023{,}076 \times 9.81 = 10{,}036{,}385\ N$$

Where, F is force needed to lift the building, m is the mass of the building and g is the acceleration due to gravity.

To find the energy required to exert such a force the work done must be calculated as follows:

$$W = Fd = 10{,}036{,}385 \times 28 = 281{,}018{,}769\ J = 281.02\ MJ.$$

Where, W is the work done, F is force required to lift the transformer up and d is the distance the building travels up.

The energy density of gasoline is approximately 33.9 MJ L^{-1} and so this amount of energy would require at least 8.29 L of gasoline [4]. Whereas kerosene has the energy density of 38.3 MJ L^{-1} requiring at least 7.34 L of kerosene [4].

To put this into perspective, planes like a Boeing 747 can use around 4 L of fuel every second during a flight [5]. The Boeing can burn through 12 L km^{-1} during a flight whilst this motion of the building standing takes 262 L km^{-1} [5]. Thus, this motion is much less energy efficient.

Conclusion
The energy needed for the Charles Wilson building to stand up, like a transformer, is approximately 281.02 MJ. This amount can be carried out using 8.29 L of gasoline or 7.34 L of kerosene. However, the use of kerosene would use 262 L km^{-1}, much less efficient than the 12 L km^{-1} Boeing claims their 747 model burns through on average during flight.

References
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