FRONTLINE

How high can you build with bricks?

To cite this article: Rick Marshall 2016 Phys. Educ. 51 013004

View the article online for updates and enhancements.

Related content

- Color coding for the brick tiling
  D Flom and S I Ben-Abraham

- Brick tiling
  S I Ben-Abraham and D Flom

- Angular dependence of the levitation force on a small magnet above a superconducting cylinder in the Meissner state
  F Y Alzoubi, H M Al-khateeb, M K Alqadi et al.
The book review in this issue of *Physics Education* (Why You Can Build It Like That: Modern Architecture Explained, page 2 of the reviews section) prompts the question how high is it possible to build using standard bricks? The tallest brick building in the world is the Chrysler building in New York. It was finished in 1930 and is 320 m high. However, all of the 3826000 bricks were used for non-load bearing walls infilling a steel frame. Surprisingly, modern bricks are a very good load bearing constructional material.

Consider a typical cuboid shaped brick, thickness $T$, width $W$, depth $D$. Thus the weight of one brick is $\rho WBTg$, and the pressure exerted by its lower face area $WB$ on whatever supports $\rho Tg$. So assuming that the dimensions $W$ and $D$ do not distort under load, the number of bricks stacked on top of each other for the pressure exerted on the bottom brick to equal its compressive strength $S$ is

$$\frac{S}{\rho Tg}$$

Ignoring the cumulative thickness of the mortar the height $H$ of the brick column is the number of bricks $x$ the thickness of one brick $T$

$$H = \frac{S}{\rho g}$$

As expected, this result does not depend on dimensions of the bricks (and it also reveals why mountains composed of the same rock are taller on Mars than on Earth).

Reasonable quality building bricks have a compressive strength $50 \times 10^6$ Pa, and density $1800\text{ kg m}^{-3}$, giving a height $H$ of

$$\frac{S}{\rho g} = \frac{50 \times 10^6}{1800 \times 10} = 2.8\text{ km}$$

The foundations for such a structure will need to be at least as strong as the bricks from which it is built, otherwise the building will sink into the ground.

For comparison, 2.8 km is over three times higher than the world’s tallest building, the Burj Khalifa in Dubai (828 m high) and over two and half times that of the Azerbaijan Tower under construction in Baku, which is intended to be 1050 m high.

However, brick walls are not simply made of bricks. They are a composite structure of mortar reinforced with bricks. Thus they are good in compression, but not in tension. For this reason, they are very poor at withstanding lateral stresses, which in the case of a skyscraper result from different wind speeds and directions at different heights above ground [1].

**Received 4 November 2015, in final form 5 November 2015 Accepted for publication 9 November 2015**

<http://doi.org/10.1088/0031-9120/51/1/013004>

© 2016 IOP Publishing Ltd
Rick Marshall worked for 21 years as a physicist in universities, ending up as the director of undergraduate studies, and then 12 years in school as head of physics and finally head of senior school. He has been a moderator for UK A-level investigation course work and has been involved in several curriculum development initiatives.

Reference