3M Science. Applied to Life.™

2018 3M Young Innovators Challenge

Tower Tech Challenge

Tower specifications and design brief

The aim of the Challenge is to design and construct a free-standing Tower, consisting of three parts (Foundation, Superstructure and Loading Container – see Figure 1) maximising its slenderness and load capacity while minimising its total mass.

The three parts of the Tower should be clearly identifiable, e.g. by using different materials, different manufacturing techniques or distinctly different dimensions.

The Superstructure can only be built from materials on the Materials List. The Foundation and Loading Container can be made from different materials of the students' choice, taking into account their mass, cost and sustainability.

The height h_2 of the Superstructure must be between h_{min} = 50 and h_{max} 100 cm; any of its transverse dimensions must be between 2 and 20 cm.

The height h_1 of the Foundation must not exceed 10% of h_2; any of its transverse dimensions must not exceed 30 cm.

The Loading Container should have a minimum volume of 6,000 cm^3, with a minimum height h_3 of 15 cm.

The slenderness ratio λ of the Superstructure is defined as:

$$\lambda = \frac{B + b}{h_2}$$

where B and b are the maximum dimensions at the bottom and at the top of the Superstructure, e.g. the outer diameter for a tube, the diagonal for a solid square, etc. (see Figure 2).

The maximum transverse dimension d shall not increase along the height of the Superstructure. See Figure 3 – where a) and b) are acceptable but c) is not.

CREST AWARDS

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Figure 1: Design requirements for the Tower Tech Challenge

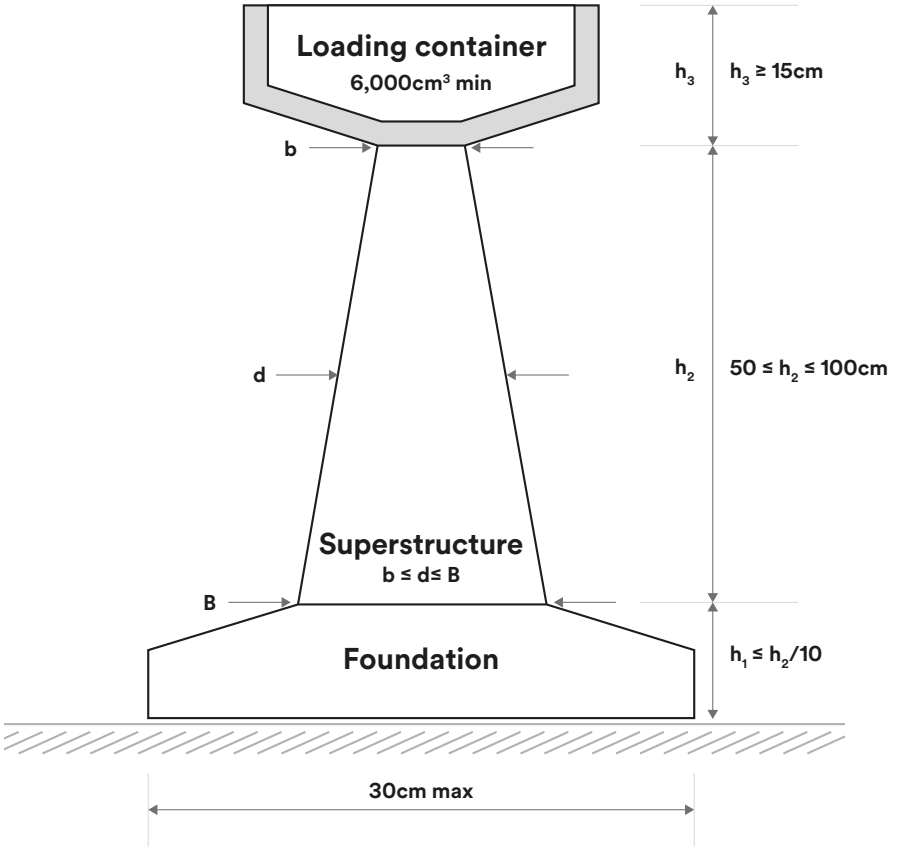


Figure 2: Examples of maximum dimensions for a tube **A**, a solid square **B** and a star **C**

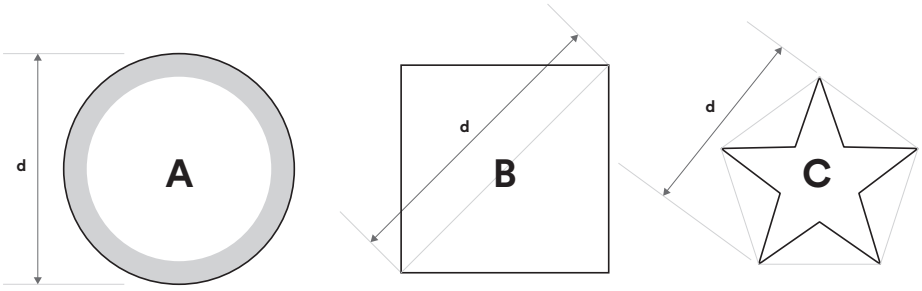
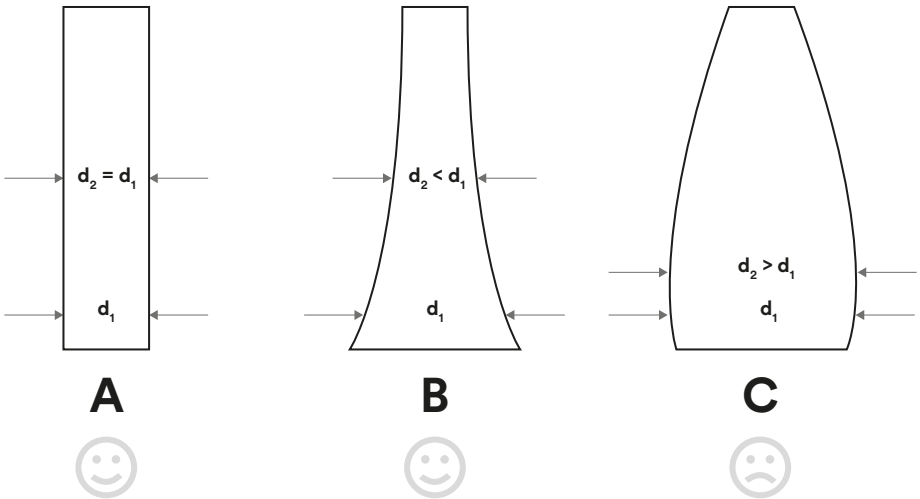


Figure 3: Acceptable (**A** and **B**) and unacceptable (**C**) examples of variations of **d** along the height of the superstructure



Mark scheme

- Up to 10 marks for the total mass (M) of the Tower using the formula:

$$p_1 = 10 \bullet \exp\left(-\frac{M}{2}\right)$$

where M is expressed in kg

- Up to 10 marks for the height h_2 of the Superstructure using the formula:

$$p_2 = \frac{h_2 - h_{min}}{5} \leq 10$$

- Up to 15 marks for the slenderness λ of the Superstructure using the formula:

$$p_3 = \frac{3}{(5 \bullet \lambda)}$$

- Up to 15 marks for the maximum load capacity (Q) using the formula:

$$p_4 = 15 \bullet \frac{Q}{Q_{max}} \leq 15$$

- Up to 10 marks for the aesthetics and visual appeal of the Tower.
- Up to 20 marks for the quality of the presentation and evidence of STEM learning.
- Up to 20 marks for the report content. Reports which consider the cost and sustainability implications of the chosen materials and design will score more highly.