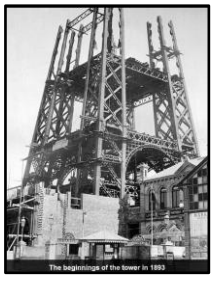
Year 6 Design and Technology: Structures – Block D
How strong is a piece of spaghetti?

- The outline and structure of the block is as follows:

Lesson 1	Lesson 2	Lesson 3
Identification of the problem Testing materials	Explicit teaching of skills relating to the brief	Application of skills Evaluation and adaptation




Blackpool Tower
by architects James Maxwell (1838 – 93)
and William Charles Tuke (1843 – 93)

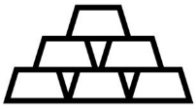
At the end of this block, pupils will …	
Know:	**Be able to:**
Structures can be supported with guy lines and flying buttresses The shorter the piece of spaghetti, the stronger it will be	Construct a flying buttress to support a tower Use appropriate lengths of spaghetti to increase strength and stability

In this block, pupils will test the strength of spaghetti and then apply what they have learned to construct a tower that is at least one metre tall.

CUSP Design & Technology Long term sequence	Block A	Block B	Block C	Block D	Block E	Block F
Year 1	Mechanisms	Structures	Food and Nutrition	Understanding Materials	Textiles	Food and Nutrition
Year 2	Textiles	Food and Nutrition	Mechanisms	Understanding Materials	Food and Nutrition	Structures
Year 3	Textiles	Food and Nutrition	Mechanisms	Food and Nutrition	Systems	Structures
Year 4	Food and Nutrition	Mechanisms	Textiles	Structures	Electrical Systems	Food and Nutrition
Year 5	Food and Nutrition	Systems	Textiles	Mechanisms	Structures	Food and Nutrition
Year 6	Food and Nutrition	Mechanisms	Food and Nutrition	Structures	Electrical Systems	Textiles

Point of reference:
Y6 Structures – Block D

Pupils will be able to:
- identify 2D shapes that have strength and stability, such as triangles



Prior Learning

- explain why cylinders are capable of bearing weight
- create a truss, using a series of triangles

Design or Technology History:

James Maxwell (1838 – 1893)
William Charles Tuke (1843 – 1893)
Blackpool Tower was designed by Lancashire architects James Maxwell and William Charles Tuke who oversaw the laying of its foundation stone on 29th September 1891. Built in the style of the Eiffel Tower, Blackpool Tower took three years to build and stands 518 feet tall. Weighing in at 2585 tons, it is made mainly from steel and cast iron and is one of the UK's most iconic buildings and one of Britain's best loved landmarks.

Links to Literature:

From Mud Huts to Skyscrapers by Christine Paxmann
13 Skyscrapers Children Should Know by Brad Finger
13 Buildings Children Should Know by Annette Roeder
13 Architects Children Should Know by Florian Heine

Materials:

Spaghetti (one packet between 3 pupils), marshmallows (both large and small), scissors, polystyrene sheets (1 A4 per 3 pupils), timer, paper, pencil, ruler, tape measure or metre stick, wooden blocks or books (for the load), paper cup, paper clip, string, masking tape

Health and Safety:

This block requires pupils to use: spaghetti which could pose a danger to eyes. Marshmallows are also used. Ensure these aren't a potential allergen to pupils. Teachers should follow their own school's risk assessments and policies for using the necessary materials and equipment. Pupils should be taught about how to use equipment and materials safely and responsibly as part of these lessons.

Working as a Designer

Design	Make	Evaluate	Apply
The art or process of deciding how something will look or work.	Create something by combining materials or putting parts together.	Form an opinion of the value or quality of something after careful thought.	Use something or make something work in a particular situation.

Point of explanation:
Y6 Structures – Block D

Core Knowledge	Explanation
guyed mast	A guyed mast or guyed tower is a tall, thin, vertical structure that depends on guy lines for stability.
flying buttress	A flying buttress is an architectural support that bears the load of roofs or vaulted ceilings.
load	Load refers to the amount of weight that is pressing down on something.

Technical Vocabulary	Definition
aesthetic	connected with beauty and art and the understanding of beautiful things
edifice	a large, impressive building
constraints	restrictions or limitations

Link to Video: https://vimeo.com/638571959/e20013be4b

- Explanation and demonstration of taught content
- Lesson by lesson guidance
- Exemplification of techniques and outcomes

Point of delivery:
Y6 Structures – Block D

Revisiting prior learning	Taught content	Point of practice	Point of reflection
1. Identify forces that affect structures such as gravity, compression and tension	Devise and carry out an experiment to test the strength and stability of spaghetti Through testing, find ways to increase the weight that spaghetti can withstand Draw conclusions from observations and test results	Share the Knowledge Note and key vocabulary for this block. Introduce the design question: **How strong is a piece of spaghetti?** Discuss the properties of one strand of spaghetti and establish that it easily bends and breaks when pressure is applied. Working in groups of three, pupils conduct an investigation to find out if three strands of spaghetti, spanning a gap between two objects of equal height, can bear the load of a weighted cup. Challenge pupils to find ways to increase the load-bearing properties of the spaghetti, such as applying compression to either end. Refer pupils back to the forces they learned about in Year 4. Encourage pupils to explore the effects of binding the spaghetti in different ways. Challenge pupils to devise a way to test the strength of spaghetti that is positioned vertically, using polystyrene blocks. Prompt pupils to compare the strength of one piece of spaghetti with several pieces and to improve their strength by adding a further polystyrene block to distribute the weight of any load that is added. Take photographs at various stages to provide pupils with a record of their investigation for their portfolios. Prompt pupils to add notes about their findings.	Can use a systematic approach to test spaghetti for its strength and stability Can identify that methods of binding and the use of compression affect the amount of weight spaghetti will hold Can interpret results, draw conclusions and explain reasoning
2. Identify how positioning and the addition of compression affect the strength and stability of spaghetti	Investigate the stability and strength of 3D shapes Explore the effect of adding features such as flying buttresses to a structure Record observations and evaluate outcomes	Recap the findings from the previous lesson's investigations then set pupils a timed challenge to construct the tallest tower they can that will support the weight of a large marshmallow. Pupils will need to work within the constraints of limited time (18 minutes) and limited resources (20 pieces of spaghetti and tape). Allow pupils five minutes to brainstorm ideas and design their tower. Once the building is complete, pupils test, redesign, rebuild and compare their towers. Look at and discuss the design of the Blackpool Tower. Question pupils about what they notice about the shapes visible in the structure. Why do they think the tower is wider at the base? Demonstrate how to construct a square-based pyramid using spaghetti and marshmallows. Establish through discussion, and experimentation, that this shape is structurally more stable than a cube and that shorter pieces of spaghetti also create greater stability than longer lengths. Allow pupils the opportunity to build structures from these shapes. Model how to achieve greater rigidity and stability in their structures by adding flying buttresses which can be constructed from the same materials. Allow pupils time to share their constructions, record their observations in their portfolios and then complete Vocabulary Task 1.	Can identify shapes that provide strength and stability to a structure Can make adaptations to a structure to improve its stability Can use technical vocabulary when explaining structural features, outcomes and conclusions from investigations

Point of delivery:
Y6 Structures – Block D

Revisiting prior learning	Taught content	Point of practice	Point of reflection
3. Create additional support for structures Use triangles to provide strength and stability in a structure Construct flying buttresses to distribute the weight of a structure	Identify the features that make a tower more stable Explain how to use guy lines to provide support for a tower Combine techniques and features to construct a stable tower from limited materials Identify ways in which a structure can be made more stable and modify a design as necessary	Revisit the key question for this block: **How strong is a piece of spaghetti?** Recap on the methods pupils have used so far to improve the strength and stability of structures made from spaghetti. Discuss the work of engineers and what they have to consider in the design and construction of towers. Refer to the Blackpool Tower, the Eiffel Tower, church spires, the Shard and pylons. Establish, through questioning, that these structures are wide at the base and narrow as the height increases. Show examples of radio masts such as the Skelton mast in Cumbria, standing 365 metres tall, and explain the purpose of guy lines. Challenge pupils to use pieces of string as guy lines to make a pencil stand upright independently. Pose questions such as: How many guy lines are needed? Do the guy lines need to be the same length? Where on the pencil do they need to be attached to ensure stability? Explain that for their final challenge, pupils will need to apply the skills and knowledge they have acquired during this block by combining cubes and pyramids to build a structure that is at least one metre tall. Pupils must use only spaghetti and marshmallows for their construction. Prompt pupils to consider what features they could add to ensure their tower is strong and stable. Pupils must evaluate, modify, redesign and rebuild their towers if necessary. Once constructed, give pupils the opportunity to share their towers and judge whether they have been successful in strengthening and stabilising their spaghetti structures. Pupils should record their work in their portfolio and then complete Vocabulary Task 2.	Can explain how to use guy lines to achieve greater stability Can apply learned techniques and knowledge of structural features to construct a stable tower Can, during construction, identify how stability can be increased and make the necessary modifications

Questions for assessment

Does the way the spaghetti is arranged or bundled together determine the amount of weight it can bear?

How does adding more spaghetti affect the weight it can hold?

Can spaghetti strands carry a heavier load when the weight applied is distributed over a wider area?

How tall and strong can a tower be made in 18 minutes?

How is the strength and stability of a 3D shape affected by the length of the spaghetti used?

Why are guy lines effective in supporting tall, upright structures?

How does a flying buttress improve the stability of a structure?

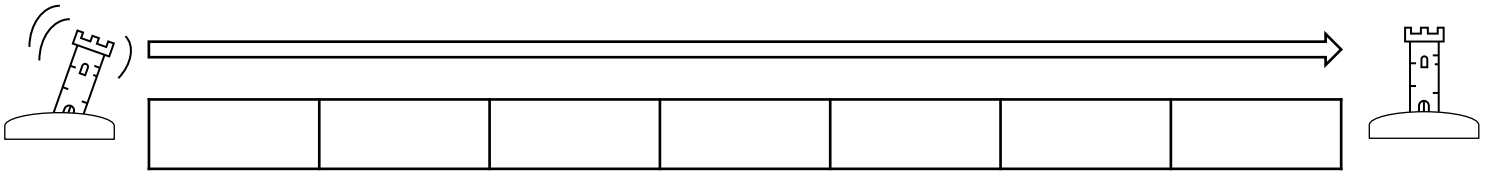
How does the number of guy lines used affect the stability of a tower?

Oracy and Vocabulary:
Y6 Structures – Block D

Task 1:

Order these synonyms of the word *unstable*, according to their strength of meaning.

wobbly teetering wavering unsteady shaky precarious insecure



List five antonyms for the word *unstable*.

Exploration:

Are square-based pyramids more stable than triangular-based pyramids?

Does making a material more rigid, make it stronger?

Task 2:

Work with a partner to evaluate your spaghetti structure.
Use these questions to guide your discussion.

Describe the methods you have used to make spaghetti a strong and stable material for use in building structures.
Explain the changes or modifications you made to your tower. Explain why you made these changes.
Were your modifications successful?
List three ways you can make spaghetti stronger.
Which part of your work are you most proud of and why?

If you made another tower, what would you do differently next time and why?

Vocabulary: Y6 Structures – Block D

OWN-it — Analyse

Underline the part of this word that means *build*.

structural

Write the root of the word *compression*.

Change the noun *buttress* into an adjective.

KNOW-it — Define

Explain what a *guy line* is.

Tick the most accurate definition of *compression*.

press objects together	
press objects into a surface	

Write two different definitions of the word *load*.

LINK-it — Connect

Tick the word that is not a synonym of *constraints*.

- restrictions
- limits
- structures

Write two synonyms of the word *aesthetic*.

Write two words associated with the word *edifice*.

USE-it — Use in context

Use the following words in one sentence.

load stability triangles

Write a brief description of a *flying buttress*.

Tick the sentence if the word *aesthetic* has been used correctly.

Their furniture was more *aesthetic* than functional.

Knowledge Note:
Y6 Structures – Block D

Year 6: Structures

How strong is a piece of spaghetti?

Core content:

Test the strength of spaghetti.
Construct a tower that is at least three levels tall.

Technical vocabulary:

Guyed mast – a tall, thin, vertical structure that depends on guy lines for stability.

Flying buttress – an architectural support that bears the load of roofs or vaulted ceilings.

Load – the amount of weight that is pressing down on something.

Aesthetic – connected with beauty and art and the understanding of beautiful things.

Edifice – a large, impressive building.

Constraints – restrictions or limitations.

Connections:

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Exemplification: Y6 Structures – Block D
How strong is a piece of spaghetti?

Hang a paper cup on strands of spaghetti spanning the gap between two objects of equal height

Add weights to the cup

Investigate how the strength and stability of spaghetti can be increased when individual pieces are placed close together

Pose the question to pupils:

Can spaghetti strands carry a heavier load when the weight applied is distributed over a wider area?

Devise a range of ways to test the strength of a single piece of spaghetti

Notice where the pasta bends and lifts

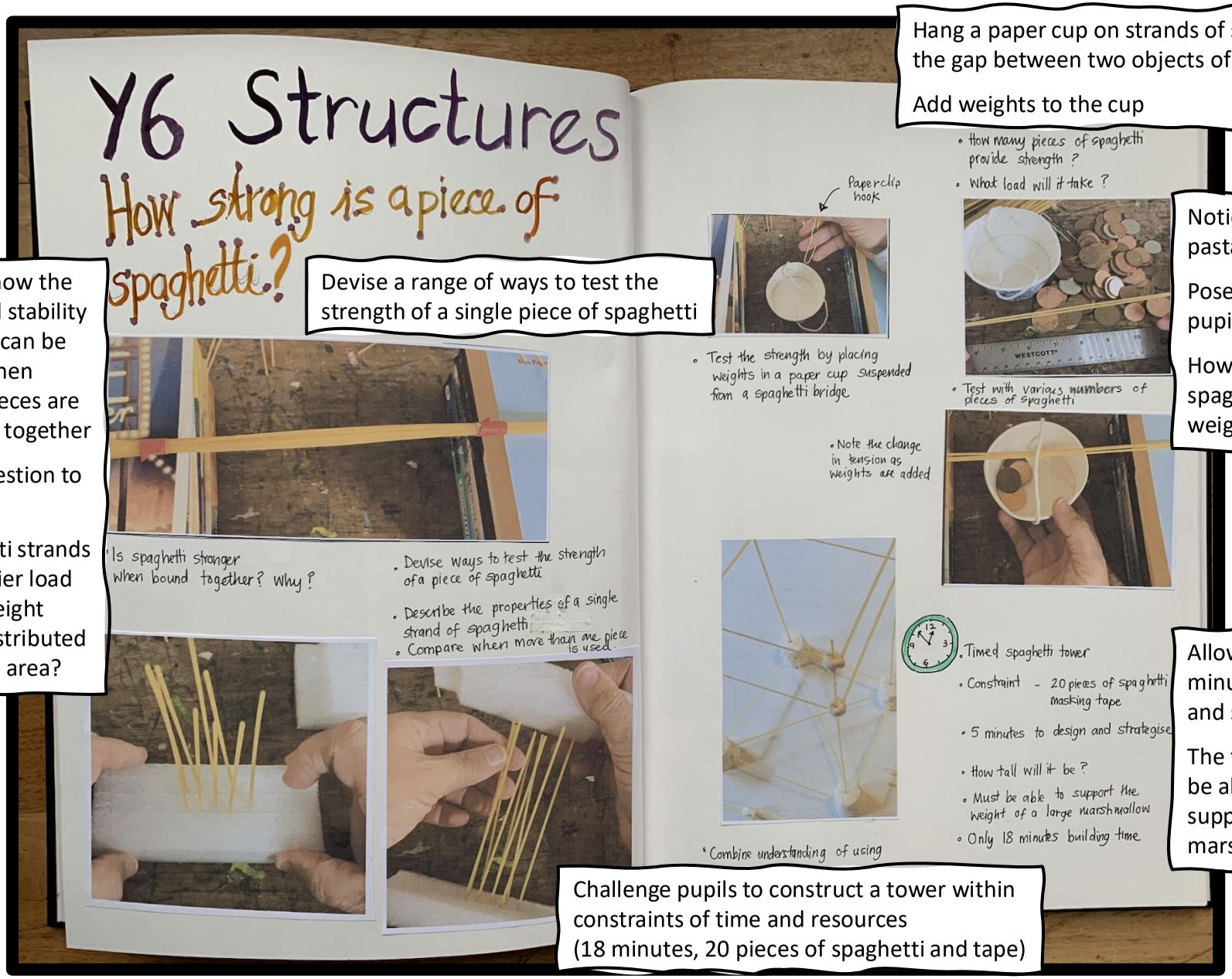
Pose the question to pupils:

How does adding more spaghetti affect the weight it can hold?

Allow pupils five minutes to plan and strategise

The tower must be able to support a large marshmallow

Challenge pupils to construct a tower within constraints of time and resources
(18 minutes, 20 pieces of spaghetti and tape)



Exemplification: Y6 Structures – Block D
How strong is a piece of spaghetti?

Look at and discuss structures such as Blackpool Tower, pylons and radio masts

Note how the base is wide and the structures narrow as they get taller

Construct square-based pyramids using spaghetti and marshmallows

Pose the question to pupils:

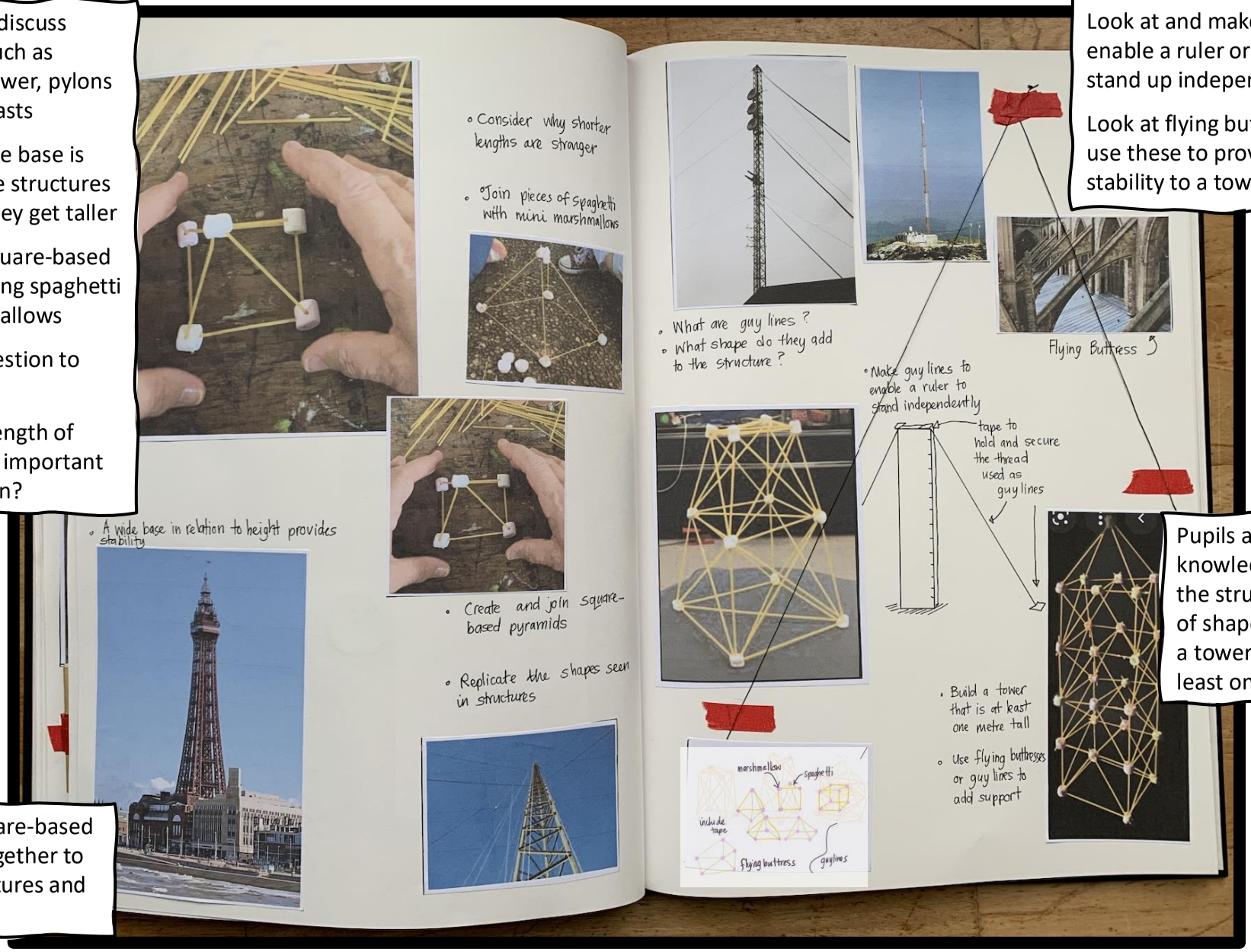
Why is the length of spaghetti an important consideration?

Pose the question to pupils:

How can towers be supported to ensure they remain upright?

Look at and make guy lines to enable a ruler or pencil to stand up independently

Look at flying buttresses and use these to provide more stability to a tower



Join the square-based pyramids together to create structures and towers

Pupils apply their knowledge of the structural stability of shapes to construct a tower that is at least one metre tall