Bridge Building

STUDENT DESIGN WORKBOOK

Year 6

Name: ____________________________________________

Other group members: ____________________________________________

________________________________________________________________

________________________________________________________________

Group Number: __________________ Class: __________________
THINKING SPACE
… drawings, diagrams, observations, notes, reflections …
PART 1: DIFFERENT TYPES OF BRIDGES

1. Beam Bridges

Activity 1: Similarities and Differences of Bridges

a) **Describe** how the bridges you have seen in the pictures around the room are **similar**.

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b) **Describe** how the bridges are **different**.

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**Additional Notes**… drawings, diagrams, observations, notes, reflections …
THINKING SPACE
… drawings, diagrams, observations, notes, reflections …
Activity 2: Beam Bridges

Here is a picture of a simple beam bridge.

Make a beam bridge with your pencil, rubbers and rulers.

a) What supports the beam bridge across the bridge?

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b) What would make the beam of the bridge break?

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c) You have learnt about forces in Year 4. There are forces acting on the bridge to keep it stable. Label the compression forces and tension forces in the diagram below:
THINKING SPACE

… drawings, diagrams, observations, notes, reflections …
Activity 3: Truss Bridge

Here is a picture of a Truss Bridge, which has a beam bridge foundation but an extra part on the top.

a) What do you notice has been added to the beam bridge to support the bridge?
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___________________________________________________________________________

b) What shape/s are the structures that have been added?
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___________________________________________________________________________
___________________________________________________________________________

Additional Notes… drawings, diagrams, observations, notes, reflections …
THINKING SPACE
… drawings, diagrams, observations, notes, reflections …
Activity 4: Cantilever Bridge

Here is a picture of a Cantilever Bridge:

![Cantilever Bridge Image]

a) What do you notice is different about this bridge when compared to a beam bridge or truss bridge?

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b) What do you notice is similar about all three types of bridges (truss, beam, and cantilever)?

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Additional Notes… drawings, diagrams, observations, notes, reflections …
THINKING SPACE
… drawings, diagrams, observations, notes, reflections …
2. Arch Bridges

Here is a picture of an arch bridge:

![Arch Bridge Image]

a) **Why** is it called an “Arch Bridge?”

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b) **Draw** the **forces** that are acting on an arch bridge in this diagram:

![Arch Bridge Forces Image]

c) The picture below is of the Sydney harbour bridge.

![Sydney Harbour Bridge Image]

What **types of bridge structures** can you see in this picture?

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___________________________________________________________________________
THINKING SPACE

… drawings, diagrams, observations, notes, reflections …
3. Suspension Bridges

Here is a picture of a suspension bridge:

![Suspension Bridge Image]

a) **Why** do you think it is called a Suspension bridge?

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___________________________________________________________________________
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b) There are **many forces** operating on a suspension bridge to enable it to be stable and strong. **Draw** in some of these forces on the diagram below:
THINKING SPACE
… drawings, diagrams, observations, notes, reflections …
PART 3: BUILDING A BRIDGE

1. PROBLEM

Scenario: You have been asked by the DEEP Engineering Company (DEEPEC) to submit a design and model to the Brisbane City Council for another footbridge across the Brisbane River. The bridge will need to be wide enough to span the river and high enough for boats to pass under it. Council have asked for 1 in 100 scale models of the bridge (i.e., 1 cm in your model represents 1 m in real life) and have provided the specifications for the required models in Table 1.

<table>
<thead>
<tr>
<th>Table 1 Brisbane City Council Footbridge Model Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Minimum Span (pier to pier)</td>
</tr>
<tr>
<td>21 cm (A4 sheet width)</td>
</tr>
</tbody>
</table>

A diagram of A4 paper dimensions is below for reference.

Strength and safety are the most important aspects of bridge design. The bridge should be capable of supporting the specified minimum load capacity. Environmental impacts and construction costs are also of concern; bridge designs that provide the required span and load capacity with minimal material use in construction will be looked upon favourably.

Remember to follow the Engineering Design Model.

Council are happy to look at a range of bridge designs and will consider bridges of all types; including beam bridges, arch bridges, suspension bridges.
THINKING SPACE
… drawings, diagrams, observations, notes, reflections …
Council have advertised for bridge design submissions which must include:

2. MATERIALS AND EQUIPMENT

- You will be given 30 sheets of paper plus an additional 10 sheets of paper for experimentation
- 1 small roll of sticky tape per group.

3. CHALLENGE

Using the materials listed you will design a bridge with the specifications above. You will include:

1. A design drawing of the bridge including your group name.
2. A 1 in 100 scale model of the bridge (1 cm represents 1m).
3. A list of the amount of material (paper and sticky tape) actually used in construction of the model bridge. These should be listed on the drawing. An approximate measurement (in centimetres) of the amount of sticky tape used is required.
4. Certified load testing performance of the model. Tests will be witnessed by supervising engineers and teachers and results recorded on the drawings.
5. You will work in groups of 3.
6. You will apply the modified engineering design model as you work.
7. You will be given 30 sheets of paper and 1 small roll of sticky tape per group.
8. Additional paper (10 sheets) will provided to do some preliminary testing of designs prior to starting work on their full scale bridge.

The group whose final design withstands certified load testing and provides the required span is the winner of the Challenge. If more than one group achieves this, the bridge with the least materials used in construction will win.
THINKING SPACE
… drawings, diagrams, observations, notes, reflections …
4. BRAINSTORM

Discuss the questions below with your group. Record your answers in the box.

- What type of bridge do you want to build? Why?
- What shapes will you use for your bridge?
- How tall will the bridge be?
- How wide will the bridge be?
- How will you make it strong?
- Draw and label some draft designs in the ‘Thinking Space’ on page 18.

5. EXPERIMENT

- Your group will be given 30 sheets of paper and 1 small role of sticky tape. Additional paper (10 sheets) will be provided to do some preliminary testing of designs prior to starting work on a full scale bridge.
- If you wish, you can work with the materials and experiment with different construction methods. You are allowed to modify your paper as desired i.e. cut, tear etc.
- Discuss possible designs with your group, taking into account the quantity of materials you use.
THINKING SPACE
… drawings, diagrams, observations, notes, reflections …
6. DESIGN

- **Draw** and **label** your first design.
- Make sure you **label the shapes** you used with the correct names.
- **Remember** to put **measurements** on the design.
- **Note** the **amount of materials** you use.
THINKING SPACE
… drawings, diagrams, observations, notes, reflections …
7. **BUILD**

**Build** your structure using the materials supplied.

**Calculate** the amount of materials used in your bridge. **Record** the quantity of materials in the table below.

<table>
<thead>
<tr>
<th>Materials</th>
<th>Number used</th>
</tr>
</thead>
<tbody>
<tr>
<td>A4 paper</td>
<td>(Number of sheets used)</td>
</tr>
<tr>
<td>Sticky tape</td>
<td>(Approximate number of cm used)</td>
</tr>
</tbody>
</table>
THINKING SPACE

… drawings, diagrams, observations, notes, reflections …
8. TEST

Write answers to the following questions.

a) Place your bridge flat on a table. **Place one 500g weight** on top of the bridge. This will test the minimum load capacity. **Observe, describe and record** what happens when the first weight is placed on the bridge.

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________________________________________________________________________________

b) **Continue to place extra 500g weights on top of the bridge, one at a time**, to see how many it will hold. The bridge will reach its maximum load capacity when the structure starts to buckle under the weight. **Observe, describe and record** what happens when the final weight is placed on the bridge.

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c) **How many** weights did the bridge hold?

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d) What **total weight** did the bridge hold?

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e) **What did you learn** about your bridge from the test (including any **maths and science** that you used)?

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THINKING SPACE
… drawings, diagrams, observations, notes, reflections …
9. EXPERIMENT AND REDESIGN

Write answers to the following questions.

a. **What** can you **change** to improve your design?

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b. **How** will these changes make your bridge **better**?

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THINKING SPACE
… drawings, diagrams, observations, notes, reflections …
• **Draw** and **label** your improved design below.
THINKING SPACE

… drawings, diagrams, observations, notes, reflections …
10. REBUILD

**Rebuild** your new and improved bridge.

**Calculate** the amount of materials used in your new bridge. **Record** the quantity of materials in the table below.

<table>
<thead>
<tr>
<th>Materials</th>
<th>Number used</th>
</tr>
</thead>
<tbody>
<tr>
<td>A4 paper</td>
<td></td>
</tr>
<tr>
<td>(Number of sheets used)</td>
<td></td>
</tr>
<tr>
<td>Sticky tape</td>
<td>cm</td>
</tr>
<tr>
<td>(Approximate number of cm used)</td>
<td></td>
</tr>
</tbody>
</table>
THINKING SPACE

… drawings, diagrams, observations, notes, reflections …
11. **RETEST**

Write answers to the following questions.

a) Place your bridge flat on a table. **Place one 500g weight** on top of the bridge. This will test the minimum load capacity. **Observe, describe and record** what happens when the first weight is placed on the bridge.

__________________________________________________________________________________
__________________________________________________________________________________
__________________________________________________________________________________
__________________________________________________________________________________

b) **Continue to place extra 500g weights on top of the bridge, one at a time**, to see how many it will hold. The bridge will reach its maximum load capacity when the structure starts to buckle under the weight. **Observe, describe and record** what happens when the final weight is placed on the bridge.

__________________________________________________________________________________
__________________________________________________________________________________
__________________________________________________________________________________
__________________________________________________________________________________


c) **How many** weights did the bridge hold?

__________________________________________________________________________________

d) What **total weight** did the bridge hold?

__________________________________________________________________________________

e) **What did you learn** about your bridge from the test (including any maths and science that you used)?

__________________________________________________________________________________
__________________________________________________________________________________
__________________________________________________________________________________
THINKING SPACE

… drawings, diagrams, observations, notes, reflections …
12. **PRESENTATION**

Present your best bridge design to the class.

- Use the ‘Thinking Space’ on page 34 to **plan your presentation**.
- **Include the following points** in your presentation.

- ✓ A description of their bridge (e.g. shapes used, dimensions) and what bridge design you have used (e.g. arch, beam).
- ✓ How the bridge withstood capacity testing (e.g. how many weights and total weight the bridge held).
- ✓ The amount of materials used.
- ✓ Why this was your best design.
THINKING SPACE
… drawings, diagrams, observations, notes, reflections …
13. REFLECTING

Write answers to the following questions.

a. Which was your best design and why?

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b. What would you do to further improve your design?

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c. In what ways were you working like a civil engineer today?

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d. Write down everything about how you were using mathematics and science ideas today for the design of your bridge. You can use diagrams in your explanation.
THINKING SPACE

… drawings, diagrams, observations, notes, reflections …
**BRIDGE BUILDING CHALLENGE FEEDBACK**

Please **colour in the face** to show how you felt about the different parts of the *Bridge Building Challenge*.

<table>
<thead>
<tr>
<th>Did you like:</th>
<th>Did not like it</th>
<th>Not sure</th>
<th>Liked it</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. ... the activities about bridges?</td>
<td>☹</td>
<td>☹</td>
<td>☺</td>
</tr>
<tr>
<td>2. ... having a real problem to solve?</td>
<td>☹</td>
<td>☹</td>
<td>☺</td>
</tr>
<tr>
<td>3. ... designing a model of a bridge?</td>
<td>☹</td>
<td>☹</td>
<td>☺</td>
</tr>
<tr>
<td>4. ... making a model of a bridge?</td>
<td>☹</td>
<td>☹</td>
<td>☺</td>
</tr>
<tr>
<td>5. ... testing your model of a bridge?</td>
<td>☹</td>
<td>☹</td>
<td>☺</td>
</tr>
<tr>
<td>6. ... recording the results of the test of your model of a bridge?</td>
<td>☹</td>
<td>☹</td>
<td>☺</td>
</tr>
<tr>
<td>7. ... doing a presentation about your model of a bridge?</td>
<td>☹</td>
<td>☹</td>
<td>☺</td>
</tr>
<tr>
<td>8. ... thinking about how to make your model of a bridge better?</td>
<td>☹</td>
<td>☹</td>
<td>☺</td>
</tr>
</tbody>
</table>

**Next time I would like to:**

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THINKING SPACE
… drawings, diagrams, observations, notes, reflections …
PART 4: HOW THE WEATHER CAN AFFECT THE STABILITY OF THE BRIDGE

Activity 1: External changes to a bridge

a) How do external changes caused by weather affect the stability of a bridge over time?
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b) What are some possible changes that could affect a bridge? For example natural disasters, problem in the design, boat accident.
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Additional Notes… drawings, diagrams, observations, notes, reflections …
THINKING SPACE

… drawings, diagrams, observations, notes, reflections …
Activity 2: Chemical Changes to a Bridge

a) What is rusting? What does it look like?

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b) What can be done to prevent bridges rusting away?

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Additional Notes… drawings, diagrams, observations, notes, reflections …
THINKING SPACE

… drawings, diagrams, observations, notes, reflections …
Activity 3: Physical Changes to a Bridge

a) Can you think of any **physical** changes that may affect the **stability** of the bridge?
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___________________________________________________________________________
___________________________________________________________________________
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___________________________________________________________________________

b) Are there any physical changes that may impact on a pedestrian’s **safety** when walking on the bridge?
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**Additional Notes**… drawings, diagrams, observations, notes, reflections …
THINKING SPACE
… drawings, diagrams, observations, notes, reflections …
**Activity 3: Physical Changes to a Bridge**

c) Have you ever *seen* something that has sunk into the ground over time? *What* was it and *where* did you see it?

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___________________________________________________________________________

d) *What* do you think could happen if there was a lot of water washing over the soil on which the *foundations* of the bridge had been laid?

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e) Is this a *physical* or *chemical* change?

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Additional Notes... drawings, diagrams, observations, notes, reflections ...
THINKING SPACE
… drawings, diagrams, observations, notes, reflections …