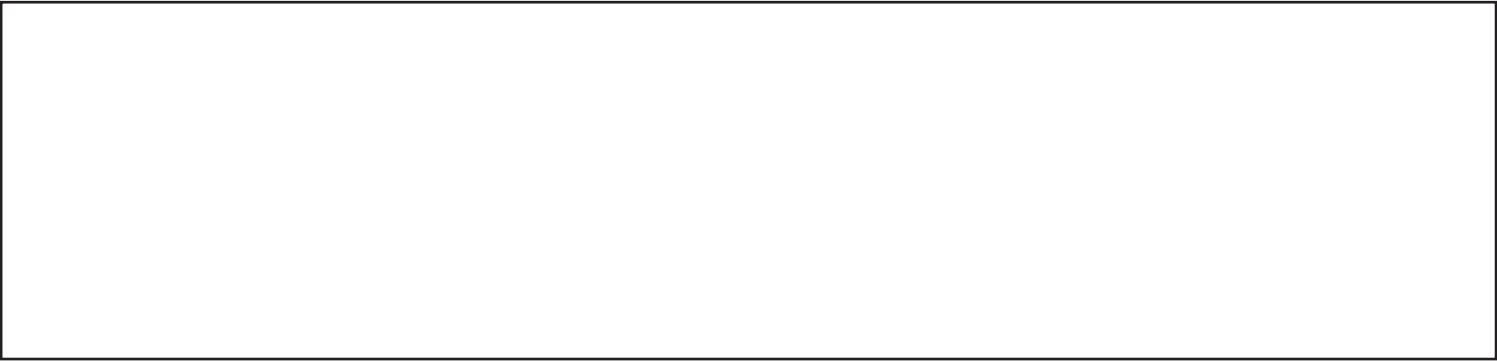


**How does the
arrangement
of the stones in
the arch support
the weight of the
earth above it?**

How does the arrangement of stone blocks in the arch support the weight of the roadway above it?

1. Look at the center arch in the stone bridge. Draw a picture of the bridge arch below. Use arrows to show what forces are acting on the arch to keep the stone blocks in place.

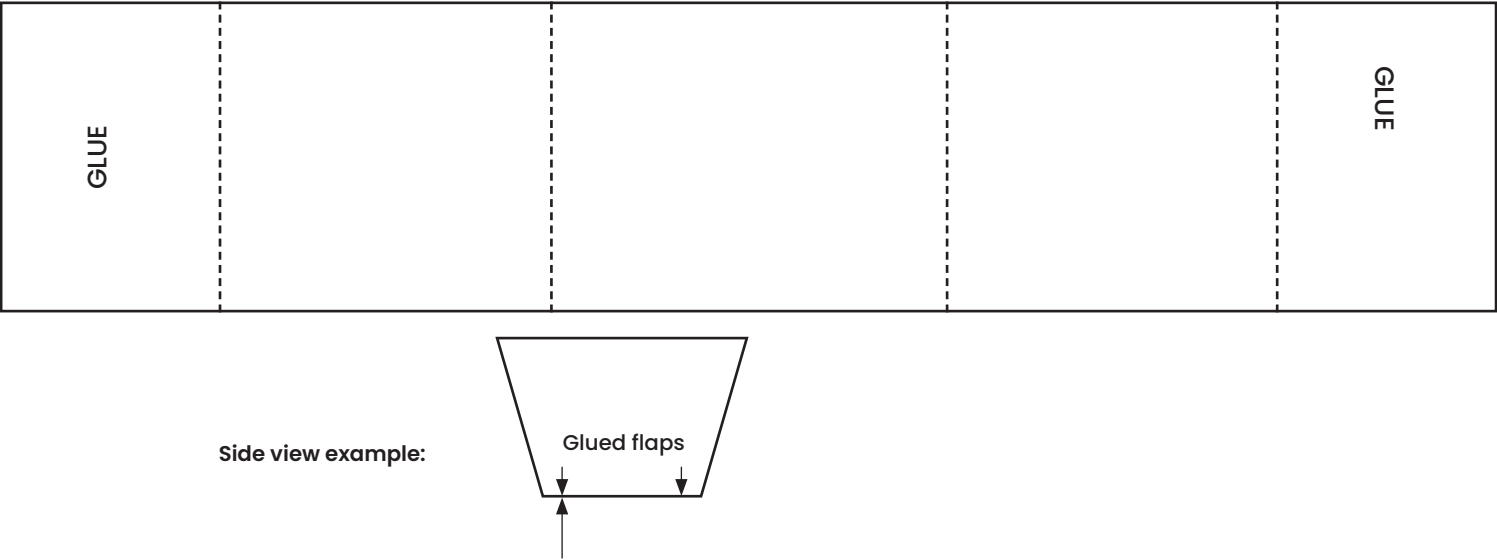


2. Research arch structures to answer the question: “How does the arrangement of the stone blocks in the arch support the roadway above it?” [Hint: Learn how arch structures are constructed. Find out what the term “keystone” means in building an arch structure. What advantage does the arch have over other types of bridge structures?]

3. Can you design an arch structure that can hold the weight of 100 pennies? Use the template below to create wedge-shaped building blocks to construct your own arch structure. Draw your design first before building your arch structure. How could you modify your design to hold even more weight?

Wedge-shaped block template

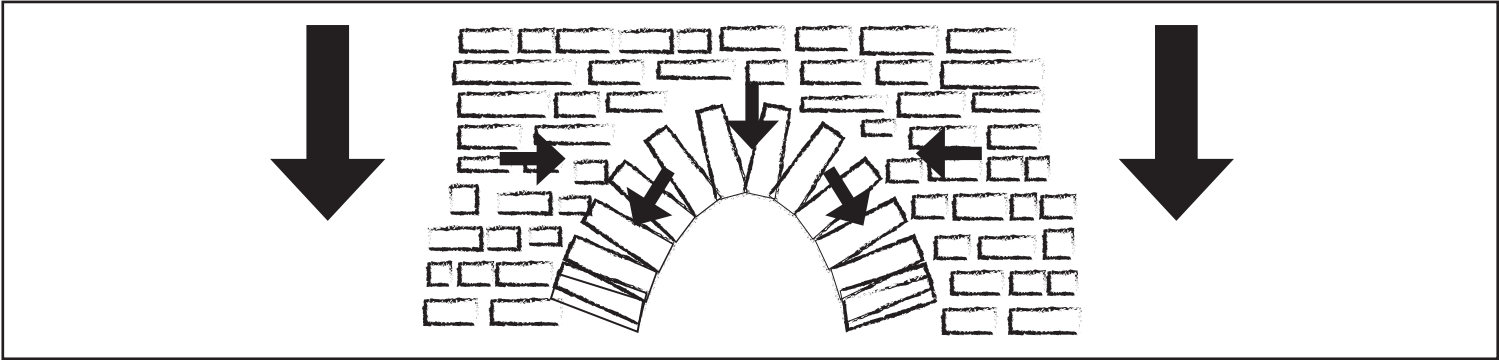
(Cut along the outer solid line. Fold along the dotted lines and glue the end flaps together to create a trapezoidal prism)



Stone Arch Bridge, Sharon Woods, Hamilton County, Ohio

Image Information: The stone arch bridge built in 1935–1936, spans part of the waterway that flows through Sharon Woods, a 730-acre recreational area north of Cincinnati, OH. Sharon Woods is the oldest park in the Great Parks of Hamilton County system, opening to the public in 1932. It became a very popular destination for outdoor recreation with picnic areas, fresh-water bathing, and wooded trails.

Possible student answers:



Gravity is pulling down on all the blocks [large arrows on the sides]. The blocks in the arch are pushing against each other as gravity pulls them down [arrows in the arch blocks]. The blocks to the outside of the arch are keeping the arch blocks from moving outward [arrows pointing in towards the arch]. The larger center block at the top of the arch is called the “keystone”. As gravity pulls this stone downward, it acts as a wedge pushing against the blocks to its sides and keeps them from moving. It is the ‘key [or essential] stone’ that keeps the arch in place.

Support the Phenomenon: How does the shape of the arch support the roadway above it? What advantages does the arch shaped structure have over a rectangular or circular opening?

NGSS Science and Engineering Practice #6 – Constructing Explanations and Designing Solutions: In K-2, students use tools/ materials to **build a device that solves a specific problem**. In 3-5, students **generate and compare multiple solutions to the design problem**. In 6-8, students **engage in the design cycle to construct and evaluate a specific design criterion**. In 9-12, students **design, evaluate, and refine their solution using student generated sources of evidence, prioritized criteria and trade-off considerations**.

Engineering Activity Suggestions:

- In K-2, have students design an arch structure using the paper block template that can support the weight of 100 pennies.
- In 3-5, have students create different arch structures, measure how much weight each one can hold, and have them propose explanations on why one design worked better than another.
- In 9-12, students should determine design criteria for an arch bridge structure of their own choosing (Example:. height, length, weight support) and then build and test their structure to evaluate the effectiveness of their design by collecting data that supports their stated goal.
- In 9-12, have students determine design criteria an arch structure (ex. has a height of at least 15 cm; a span of 25 cm.; must support a minimum weight of 1500 gm; subjected to cost limitations or building time) and evaluate their design effectiveness against others in meeting the predetermined design criteria and constraints.

Copy the template on cardstock or manila file folders for the wedge blocks. Either use glue or tape to secure the end flaps together to form the trapezoidal prisms. Students will need at least 7-10 blocks each to create their arch tunnel structure. Encourage students to explore using different size trapezoidal prisms.

More information: Learn more about the different recreational places in Ohio, visit **Ohio State Parks** or the **National Parks Service**. Visit **Sharon Woods: The Start of Great Parks** to learn more about its interesting history.