3.3 Building Quadrilaterals

Quadrilaterals, especially rectangles, appear throughout buildings in which we live, work, and go to school. You see rectangles as the mortar around bricks, the frames of windows, and the outlines of large buildings.

Most buildings stand up because of a rectangular frame of studs and beams. Rectangles have very different physical properties from triangles.

- Do quadrilaterals have the same relationship among their sides as triangles?
- What properties do quadrilaterals have that make them useful?

Problem 3.3

Your study of triangle properties will help you understand quadrilaterals. You will use polystrips to build and test some sample quadrilaterals.

A Build polystrip quadrilaterals with each of the following sets of numbers as side lengths. If you are able to build one quadrilateral with a set of side lengths, try to build two or more different figures using those side lengths. Sketch and label your results.

1. 6, 10, 15, 15
2. 3, 5, 10, 20
3. 8, 8, 10, 10
4. 12, 20, 6, 9

B Choose your own set of four numbers. Use them as side lengths to try to build quadrilaterals. Record your results. Combine your results with your observations from Question A.

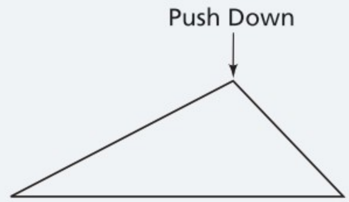
1. Is it possible to make a quadrilateral using any set of four side lengths? If not, how can you tell when you can make a quadrilateral from four side lengths?
2. Can you make two or more different quadrilaterals from the same four side lengths?
3. What combinations of side lengths are needed to build rectangles? Squares? Parallelograms?

Problem 3.3 continued

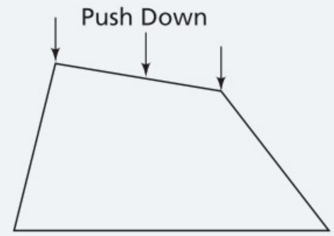
C Use several of your polystrip figures to study the reaction of triangles and quadrilaterals to stress.

1. Hold one of your triangles and push down on a vertex. What happens?

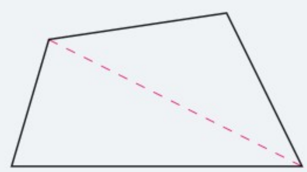
   This stress test is similar to the way a bridge would act under the weight of a car or a train.



2. What happens when you push down on a side or vertex of a quadrilateral?
3. How do the results from your stress tests in parts (1) and (2) explain the frequent use of triangles in building structures ike bridges and towers?



D Use a polystrip to add a diagonal to a test quadrilateral from Question C, part (2).



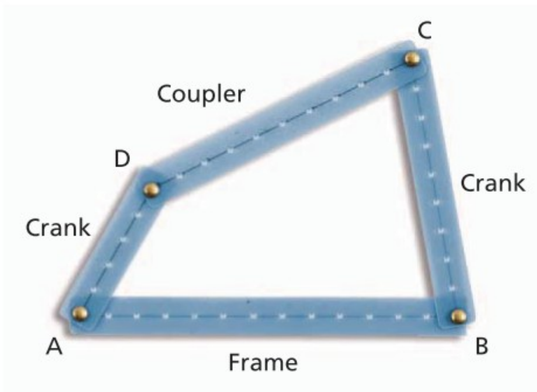
Repeat the same stress test from Question C, part (2). Does your quadrilateral respond differently? If so, why do you think there is a different response with an additional diagonal brace?

E Describe what you learned from experiments in building triangles and quadrilaterals. How are the two kinds of polygons similar and different? How do the differences explain the frequent use of triangles when building structures?

ACE Homework starts on page 76.

Did You Know?

Mechanical engineers use the fact that quadrilaterals are not rigid figures to design *linkages*. Here is an example of a quadrilateral linkage made from polystrips.



One of the sides is fixed. It is the *frame*. The two sides attached to the frame are the *cranks*. One of the cranks is the driver and the other the follower. The fourth side is called the *coupler*. Quadrilateral linkages are used for windshield wipers, automobile jacks, and reclining lawn chairs.

In 1883, the German mathematician Franz Grashof suggested an interesting principle for quadrilateral linkages. Sum the lengths of the shortest and longest sides. If that sum is less than or equal to the sum of the other two sides, then the shortest side can rotate 360°.