Teacher notes

Building for the future : Rigid Structures

Description

This topic looks at the exciting mathematics connected with the regeneration going on in our cities. The three activities are based around the construction of rigid structures and provide opportunities for practical work and mathematical problem solving.

Activity 1: Finding rigidity

Activity 2: Testing rigidity

Activity 3: Bracing squares

Dramatic photographs of complex rigid structures, for example, the York observation wheel, large cranes which are currently a major feature of many of our cityscapes, and much else feature in **Finding rigidity**. These act as stimulus material for further activities on rigid structures. There will be many more examples of rigid structures in the young peoples' local environments and in your school environment.

Pupils can be encouraged to find similar rigid structures within their school buildings or may even have opportunity to look at new buildings in their local environment. If these are recorded using a digital camera they will provide a rich source of additional stimulus material. Your pupils will then engage in two practical activities to construct simple structures and test their rigidity, analysing and refining their structures to improve this.

In **Testing rigidity**, the pupils are initially encouraged to explore rigid structures in an open way, experimenting, conjecturing and testing their hypotheses. You will need to direct the pupils to work in 2D with the geostrips and support the pupils in finding an effective way to organise and record their results. This can involve drawing round their geostrip constructions on large sheets of paper or, for higher attainers, using geometric tools.

After they have had time to experiment, draw their attention to the language of braces by encouraging them to work on the bracing of a square as shown on the activity sheet. Invite the pupils to explore further the structures they have made, looking for minimum bracings and make conjectures about what effect different bracings have on rigidity.

Resources

Geostrips (Geometric Strips) are available from Taskmaster Ltd. http://www.taskmasteronline.co.uk

Geostrips are coloured plastic strips assembled with clips to build a large variety of plane geometric figures.

Groups of pupils can share their theories, and the arguments in support of these theories, with the rest of the class. Towards the end of the activity the pupils are given some specific examples to test out their ideas and to revisit their earlier conjectures in the light of this. A final plenary or some individual writing will usefully round off the activity.

In **Bracing squares** the pupils explore frameworks of squares. The starting activity is to make a 3X3 framework of squares and to recognise that it is not rigid. At this stage pupils should not have any bracing geostrips. They are then presented with three possible bracings and asked to predict whether these are rigid. It's important that the pupils discuss this in groups or pairs and commit themselves to a conjecture. A useful way of getting this commitment is to ask for a show of hands (or technological equivalent).

At least one bracing should be a surprising result and you can demonstrate this for them. This counter-intuitive result really motivates the ensuing pupil enquiry. Groups of pupils will come up with many plausible conjectures which turn out to be wrong. You will need to have a ready store of counterexamples to prompt and support their thinking. For example, many pupils will initially suppose that all bracings where the central square is braced must be a rigid framework.

The activity presents an opportunity for emphasising to pupils the need to organise and record all of their experiments and any of their findings. You may decide to leave this very open or to adopt a more structured approach.

Posters can be a good way for pupils to present their work.

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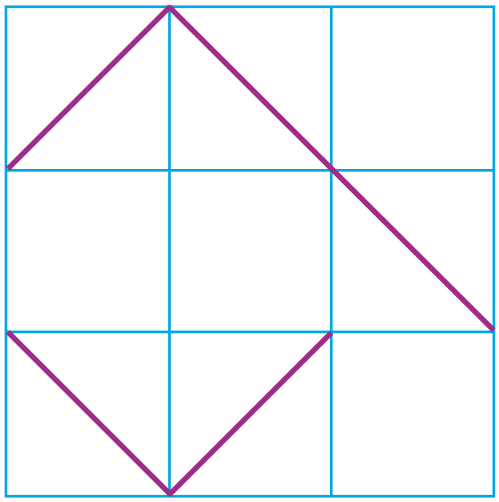
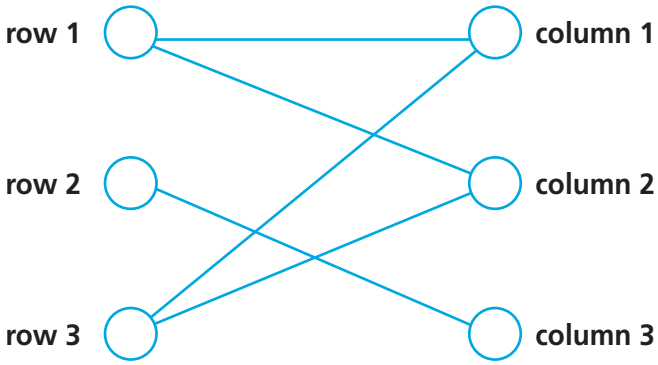
This work links to further study of the properties of quadrilaterals and types of triangles; measurement of length and angle; construction of triangles and quadrilaterals using geometric tools; congruency.

For example, this bracing can be represented by a graph.





The graph lines are not all connected and so the attempted bracing fails.

The mathematics

One focus of these activities is to develop a wide range of mathematical process skills in the problem solving arena; describing, recording, organising, experimenting, conjecturing and justifying.

In addition, **Testing rigidity** will involve the use of the mathematical vocabulary particularly that associated with polygons and the properties of quadrilaterals and triangles. Pupils will discover that many rigid structures are made up of triangles. You will see opportunities to discuss with the pupils the fact that three given lengths completely define a triangle. They will also see that braces at right angles to pairs of parallel lines make structures rigid. *A full understanding of this would involve invariant lines and shear transformations.*

Bracing squares creates a conjecturing atmosphere and motivates the need for analysis through challenging yet accessible mathematical thinking. The pupils will develop an effective language for mathematical communication of their ideas. A more structured recording draws on ideas leading to decision mathematics.