

There are many different types of **concrete**, depending on the mixture used. Concretes are tested thoroughly to make sure that each mixture used will be suited to its task.

One of the most common tests used by civil engineers is used to test concrete's **destructive compression strength** (DCS). This is tested because concrete is often used to hold up large structures which will squeeze down on it. It is measured by compressing (squeezing) cylinders of concrete in a machine until they crumble or break. The compression machine measures the force needed to destroy the cylinder in **megapascals** (MPa).

Structural concrete used in construction can vary in strength from about 18 MPa for residential housing to above 30 MPa for larger structures like flats and bridges.

The results for the compression testing of a number of different concrete mixes are shown below. Each sample was tested three times.

The mix proportions are in the order *cement:sand:aggregate\** (c:s:a)

Mix proportions (c/s/a)	1/1/1	1/1/2	1/1/3	1/1/4	1/2/2	1/3/2	1/4/2	1/5/2
DCS (MPa) test 1	25	40	34	17	30	26	18	6
DCS (MPa) test 2	24	41	34	29	28	26	18	5
DCS (MPa) test 3	26	42	37	19	32	23	18	7

(\* aggregate is small pieces of crushed rocks)

- 1 Name three materials, apart from water, that are used to make concrete?
- 2 Why does the concrete used to make bridges need to have a higher DCS than the concrete used in normal house building?
- 3 Why do civil engineers need to test the strength of concrete mixes?
- 4 Which *one* of these mixes would be suitable for heavy bridge building? Explain your choice.
- 5 Which of these mixes would not be suitable for any building purposes? Explain your choice.
- 6 Describe how you might test concrete cylinders for their destructive compression strength.
- 7
  - a Identify the one anomalous result in the table and explain your choice.
  - b Suggest a possible reason for this anomalous result.
- 8
  - a Calculate the mean DCS value in MPa for these mixes: 1/1/2; 1/2/2; 1/3/2; 1/4/2 and 1/5/2.
  - b Describe what these results tell you about the effect of changing the proportion of sand on the strength of concrete.

**I can...**

- Explain the use of a composite material for a given application
- Explain why changes in the manufacture of a composite can change its properties.