



Aim

Test and compare hardness, density, porosity and strength of different rocks to determine their suitability for engineering uses.

Materials

- Rock samples: granite, basalt, limestone, sandstone
- Hand lens/magnifying glass/microscope
- Nail, steel file or screwdriver
- Scale
- Graduated cylinder or beaker with water

Method

1. Observe rock samples with hand lenses (figure 1), magnifying glasses or digital microscopes. Write observations in the table below.
2. Hardness test: Scratch each rock with a nail, steel file or screwdriver (figure 2). Record which resist scratching.
3. Density Test: Measure mass and volume (water displacement; figure 3). Calculate density:

$$Density (g/ml) = \frac{Mass}{Volume}$$

4. Porosity test: Weigh dry rock (figure 4), submerge for 10 min (figure 5), re-weigh, calculate water absorbed and porosity:

Calculate water absorbed:

$$Water\ Absorbed\ (g) = Wet\ Mass\ (g) - Dry\ Mass(g)$$

Estimate porosity:

$$Porosity\ (\%) = \frac{Water\ Absorbed\ (g)}{Dry\ Mass\ (g)} \times 100$$

5. Strength demo (Teacher only): Wearing PPE, lightly tap each rock with a hammer in a tray or outside on a hard surface (figure 6). Observe if it fractures or crumbles.

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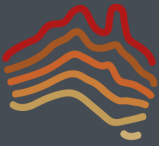


Figure 1: Observing with a hand lens



Figure 2: Scratch test



Figure 3: Measuring water displacement



Figure 4: Measuring the dry mass



Figure 5: Submerging for 10 mins



Figure 6: Strength test

Guidance: Ideal properties by engineering use

- 1) Road base: a compacted, multi-sized crushed rock material used as a stable foundation for driveways, paths, and under slabs, providing strength and support before a final surface is applied



Figure 7: Road base (source: <https://www.bracingystems.com/what-is-road-base-and-why-does-it-matter>)

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Ideal properties:

- **Hardness:** Moderate to high (to resist wear)
- **Density:** High (for stability and load bearing)
- **Porosity:** Low (to prevent water infiltration and weakening)
- **Strength:** High compressive strength (to withstand traffic loads)

2) Concrete aggregate: granular materials (like sand, gravel, crushed stone, or recycled concrete) that form the bulk of concrete, providing strength and volume, with cement acting as the binder



Figure 8: Concrete aggregate

Ideal properties:

- **Hardness:** High (to ensure durability of concrete)
- **Density:** High (for strong concrete mix)
- **Porosity:** Low (to avoid water absorption and weakening)
- **Strength:** High (to maintain structural integrity)

3) Landscaping (pavers, decorative stone, facing): rock materials selected for outdoor surfaces and aesthetic features, including pavers, stepping stones, wall facing, and garden rock.

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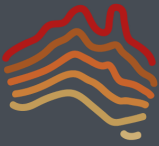


Figure 9: Landscaping

Ideal properties:

- **Hardness:** Can be moderate (ease of shaping)
- **Density:** Moderate (lighter rocks easier to handle)
- **Porosity:** Can be higher (for aesthetic and drainage purposes)
- **Strength:** Not as critical as structural uses, but should resist weathering

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Results

Rock Sample	Observations	Hardness	Density (g/ml)	Porosity (%)	Strength Notes	Suitability
Granite						
Basalt						
Limestone						
Sandstone						

Discussion

1. How do these properties relate to their formation?

2. Which rock would be best for a tunnel lining? Why?

3. Why might sandstone be less suitable for road base?



4. For density and porosity measurements, what sources of uncertainty or error might there be

Extension: Research how engineers modify or treat rocks (e.g., crushing, chemical treatments) to improve suitability for construction.

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