Engineering

1 **Look at the photos below and discuss the question. Why do you think engineers sometimes decide to build tunnels rather than bridges and other overground structures?**

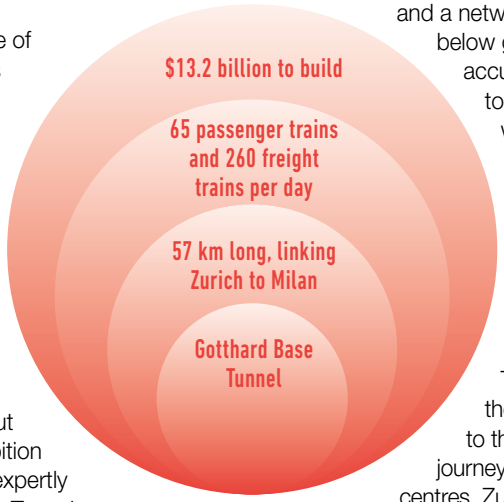
2 **Read the text quickly. Which sentence below best describes what it is about?**

1 New technology in constructing tunnels.
2 Important factors when building a tunnel.
3 Environmentally-friendly engineering

Gotthard Pass, Switzerland

An engineering feat: building the world's longest tunnel

Engineers are faced with solving some of our most difficult travel problems. As the world's population grows, our demand for more products increases. As a result, the roads are getting overcrowded and pollution is increasing. The geography of the landscape also forces engineers to think creatively. Mountainous areas of high peaks and deep valleys often mean it is slow and difficult to connect communities. One way to overcome these issues is to put the traffic on trains and go underground. Initially this idea might seem impossible, but engineers have the creativity, skill and ambition to make it a reality. These strengths were expertly shown in the building of the Gotthard Base Tunnel (GBT), which is currently the world's longest tunnel. Stretching 57 km between central Switzerland and northern Italy, it lies 2500m deep below the snowy Alpine peaks above. It is a truly remarkable piece of engineering.



Construction considerations

Before construction can begin, you have to study the geology carefully and plan your route according to the type of rock. During the building of the GBT, it was crucial to avoid pockets of water-filled rock, where the liquid would have destroyed the entire project if hit. There are also design considerations. Some projects, such as the Channel Tunnel, have three parallel shafts, whilst others decide on one tunnel with two tracks. The GBT has two shafts but, unusually, the twin tunnels go straight and flat through the Alps, saving energy, compared to older tunnels and roads which had to climb the mountains.

Building conditions

The working conditions underground are very demanding. Temperatures can reach over 45ºC, making it impossible to work, so refrigerated units and fans are brought in to cool the engineers. In such dangerous situations, safety is also a major consideration. Emergency exits were built between the GBT tunnels every 325 metres. Even the doors to these exits had to be designed to withstand the ten-tonne force of passing trains.

Tunnelling methods

Another crucial factor is the precision of the digging. During the GBT project, skilled surveyors used a combination of GPS and a network of reference points both above and below ground to ensure the route was perfectly accurate. The tunnel was built in five sections to speed up the work and engineers waited nervously at the 'breakthrough' – the moment when two tunnel sections are supposed to meet. If they had miscalculated, it would have cost the project billions, but incredibly this never happened. It took ten years and 700 people to dig the huge tunnels, at a cost of over $13.2 billion.

The construction of the GBT will transform the landscape and make a huge difference to the local communities. It has shortened the journey between two major social and economic centres, Zurich and Milan, to under three hours. So next time you travel through a tunnel, take a moment to consider the amazing engineering feat it took to construct it.

Gotthard Base Tunnel

3 Read the text again and answer the questions.

1 Why are some roads becoming so overcrowded?

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2 What geological problems can occur in tunnel construction?

.....

3 How do tunnel workers cope with challenging conditions underground?

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4 How do engineers ensure the tunnel digging is accurate?

.....

4 What do these numbers in the text refer to?

1 45

.....

2 325

.....

3 ten

.....

4 2500

.....

5 700

.....

5 Work with a partner and discuss the questions.

1 Engineers are highly trained workers. What kind of personality characteristics does an engineer need? Would you like to be an engineer?

2 Think of the journeys you take every year. Could any of them be improved by building a tunnel or other infrastructures?

?? DID YOU KNOW?

The GBT is the first tunnel project in the world to recycle its waste rock. 8000 tonnes of rock were excavated each day during its construction, making a total of 25 million tonnes over the ten-year project. Half of this went into building the railway through the tunnel. The innovative engineers decided to turn the other half into sand and gravel to make concrete. This concrete is then used to line the inside of the tunnel. Engineering really can be environmentally-friendly too.

PROJECT

1 Work with a partner. Choose an innovative engineering project in your country or another country.

2 Find out information about the following:

- main features (include interesting statistics)
- the design considerations
- the technology and equipment used in construction
- the challenges faced by the engineers
- the impact it has had on the local environment

3 Present your research to the class. If possible, try to find photos to show the project.

VOCABULARY FOCUS

overcrowded [adj]: *containing too many people or things*
demanding [adj]: *difficult, challenging*
feat [n]: *achievement, accomplishment*
overcrowded [adj]: *when somewhere has too many people or things*
overcome [v]: *solve*
precision [n]: *accuracy*
surveyor [n]: *a skilled person who assesses land and buildings using specialist equipment*
withstand [v]: *survive, tolerate*