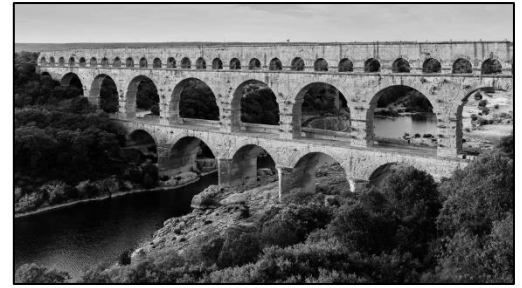




Engineering and Design in Ancient Roman Aqueducts

1.) Aqueducts were an ancient technology used for water transport. They made a big difference in the lives of ancient people. With aqueducts, people in areas without enough water to meet their basic needs could access water from elsewhere. Aqueducts took many forms. They included underground tunnels, surface channels and canals, covered clay pipes and enormous bridges.



2.) The earliest and simplest aqueducts were made out of clay tiles. They channeled water over short distances and followed the natural slopes and curves of the land. They were used by civilizations in Crete, an island in the Mediterranean, and Mesopotamia, an area that covers what is Iraq today. This was about four thousand years ago. Aqueducts were also an important feature of Mycenaean settlements in Greece, about five hundred years later.

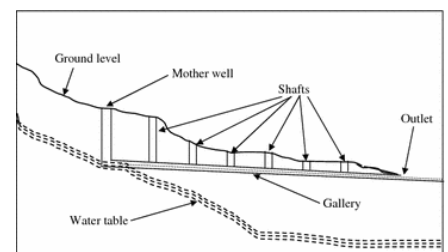


3.) The first sophisticated long-distance canal systems were constructed in the Assyrian empire about three thousand years ago. The Assyrians were a powerful civilization in Mesopotamia. Their canals included tunnels, which created a more direct line between the water source and the area where water was needed.



4.) A century later, the Babylonians built extensive and sophisticated canal systems. About 2,600 years ago, a wide canal crossed a 300-yard-long bridge to bring water to Nineveh, an ancient city in Mesopotamia. A tunnel also supplied water to Jerusalem, and was more than 550 yards long.

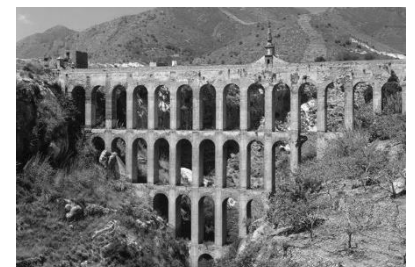
5.) Qanats were another important breakthrough. Qanats were a system of underground wells that collected groundwater and used gravity to channel it into reservoirs. They were probably first built in Persia, or perhaps Arabia. They were present throughout the ancient world from Egypt to China.



6.) The first Greek large-scale water management projects took place during the same era. Their early aqueducts were usually used to supply shared drinking fountains. Both Samos and Athens, two ancient city-states, were connected to long-distance aqueducts. The aqueduct leading to Samos was 1.5 miles long.

7.) A few hundred years later, the Greek city state called Priene had another impressive pipeline. It followed an artificial ditch covered in stone slabs. Meanwhile, the city-state Syracuse had three aqueducts, and the water system in Pergamon was even more impressive.

8.) It is the Romans, however, who are most well known as aqueduct builders. Rome undertook huge engineering projects. They successfully mastered all kinds of difficult and dangerous terrain and made magnificent arched aqueducts a common sight throughout their empire. Roman



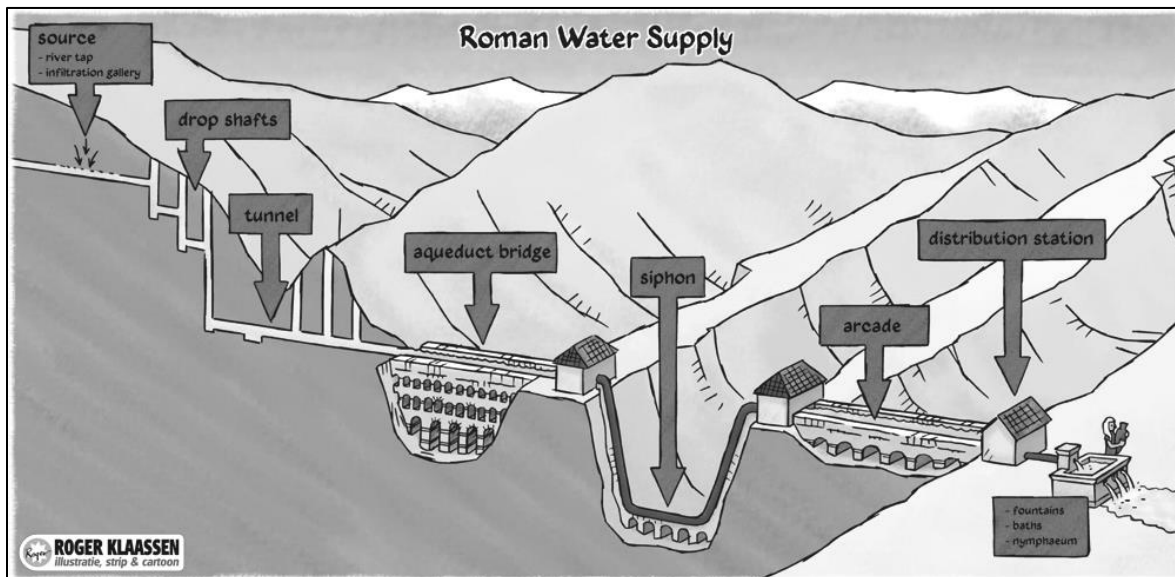
aqueducts supplied towns with water to meet not only basic needs but also to fill large public baths, decorative fountains and private villas.

9.) Most aqueducts continued to run along the ground and follow the slope of the land wherever possible. However, thanks to the invention of the arch, the Romans could build elevated aqueducts that gently sloped downward, using gravity to transport water across huge distances. They used new materials such as concrete and water-proof cement, letting them work around unfavorable land features. Similarly, improved engineering allowed for large-scale and deep tunneling projects.



10.) The Romans also mastered siphons, early devices that used water pressure to push water uphill. This made it easier for aqueducts to cross valleys. Siphons were made of clay or multiple lead pipes reinforced with stone blocks.

11.) The Romans also had systems to manage water pressure and regulate water flow, store water in reservoirs and filter out dirt. Sometimes water was also 'freshened' by aerating it through a system of small waterfalls.



12.) The first aqueducts to serve Rome were the Aqua Appia, the Anio Vetus and the 56-mile-long Aqua Marcia. Soon, the Romans started creating connections between aqueducts, creating a huge water network.

13.) As time went on, more aqueducts were built across Italy and beyond. Julius Caesar was a powerful general, politician and then leader of the Roman Republic. He built an aqueduct at Antioch, the first outside Italy. After Caesar, Rome became an empire led by a single person. The person who became emperor, Augustus, oversaw the construction of aqueducts at Carthage, Ephesus and Naples. Indeed, about 2000 years ago there was an explosion of aqueduct construction, perhaps connected to the spread of Roman culture and their love of bathing and fountains. More aqueducts were also needed to meet the water needs of a larger population and more crowded cities.

14.) Some of the largest Roman aqueducts were constructed in the years that followed. They started reaching new heights: the aqueduct of Segovia was more than 90 feet high and the Pont du Gard in southern France was 160 feet. Both aqueducts still survive today as spectacular monuments to the skill and boldness of Roman engineers



Engineering and Design in Ancient Roman Aqueducts

1. What human need did the Romans meet by designing, engineering and building aqueducts?

2. Describe 2 different design problems that the Romans needed to overcome.

3. Describe the design solutions the Romans used to overcome the design problems you listed in #2.

4. Cite evidence from the text that shows how the complexity of the engineering of aqueducts went from simpler designs to more complex designs

5. Observe paragraphs 8 and 9. How did the arch contribute to overcoming design problems.

6. Your Opinion – What role do you think the Roman aqueduct system played in the success of the Roman culture?