**Roman Engineering (Part I)**

**The Republic (509 – 27 BCE)**

* Rome is located in the middle of the Italian peninsula
* Rome’s climate is temperate; soil is volcanic and more fertile than Greece
* Rome is surrounded by seven hills, which provided defense
* Rome was first settled by 1000 B.C.E.
* Myth that Romulus founded the city in 753 B.C.E

**Roman Society Under the Republic**

* Wealthy patrician families could take in dependents called clients
* Roman families were ruled by the paterfamilias
* Romans had many slaves, as many as one slave for every three free citizens

**Roman Engineering**

* The Romans were great engineers
* Focused on practical knowledge and engineering rather than science.
* Sophisticated Infrastructure
  + Roads, aqueducts, bridges, etc.
* Secret: Roman cement
  + Called *pozzalana*
  + Used volcanic ash
  + Could set in water

**Roman Arch**

* Could hold significant weight (directs weight to the ground)
* Less material
* Less expensive
* Opens spaces (for post and lintel the space is filled with sea of columns)

**1. Road Construction**

**Watch**: “Engineering an Empire: Rome” (11 – 18 minutes, at FOD)

<https://www.youtube.com/watch?v=C5obOUDyQ5s>

**Roads**:

* Primary purpose: military but good for trade as well
* Cambered
* Layers:
  + Sand (bottom)
  + Small stones
  + Gravel
  + Paving stones (top)
* Groma: Instrument to make straight roads

**The Appian Way** (~ 300 B.C.)

* From Rome to Capua
* Built by Appius Claudius Caecsus

**2. Roman Aqueducts**

**Watch**: “Engineering an Empire: Rome” (18 – 28 minutes, at FOD)

<https://www.youtube.com/watch?v=C5obOUDyQ5s>

* **Cement:** volcanic sand (pozzolana) mixed with lime and water
* vital to urban communities
* Operate by force of gravity
* Descend gradually
  + Gradients ~ .004%.
* Difficulty:
  + Need to keep consistent gradient
* Solution:
  + Tunnel through mountains
  + In valleys put on arches (~ 6.5 ft.)
  + In between: *substructio*
  + Limited height ~ 70 ft, go to second tier

**Examples**

* 1 Tier (Aqua Claudia)
* 2 Tiers (Segovia, 167 ft)
* 3 Tiers (Pont du Gard, France, 180 ft.)

**One Tier: Aqua Claudia at Rome**

* Began under Caligula ~ 38CE and completed by Claudius
* ~ 35 mile
* Last 1/7 on arches

**Sluices**

* One went to public drinking water
* One to public baths
* One to homes of wealthy citizens
* The system was set up to adjust to water availability

**3. Caesar’s Bridge Over the Rhine**

**Watch:** “Engineering an Empire: Rome” (0 – 10 minutes, at FOD)

<https://www.youtube.com/watch?v=C5obOUDyQ5s>

**Julius Caesar (c. 100-44BC)**

* From a noble family
* An outstanding orator
* 59B.C. became consul
* 58B.C. became governor of Cisalpine Gual
* By 50B.C. conquered all of Gual

**4. Ballista:** Ancient Roman catapult

**Read**: *Science and Technology* (87-88) and *Engineering in the Ancient World* (106 – 124)

**Watch**: “Roman Catapult” (youtube below)

<https://www.youtube.com/watch?v=CgNlPOMOps0>

* A large stone-throwing torsion catapult
* Some threw bolts rather than stones.

**Study Guide for Quiz # 4 and Exam # 1:**

Pozzalana key stone

Via Appia (Appian Way) groma

Cambered aqueducts

*Substructio*  sluices

Ballista torsion springs

What was Rome’s relationship with science?

Was Rome an open or a closed society?

What are the benefits of arches over post and lintel?

Why was Rome’s cement unique?

Why did the Romans have to build arched walls in valleys to carry water to the cities?

Why were aqueducts so important to the Roman way of life?

Why did Caesar build a bridge over the Rhine?

How was Caesar able to build his bridge in such a short time?

How did Caesar’s engineers make the bridge stable?

What material did the Greeks and Romans use in their torsion springs?

What were the problems the Greeks and Romans encountered in creating torsion catapults?

How did they solve these problems?