Historical development of road construction
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Highlights:

- Wheel invention – necessity of hard surface
- Mortar usage – Romans
- Macadam’s scientific approach – economical construction
Historical development of road construction

- Early development
  - Roman roads
  - Tresaguet construction
  - Metcalf construction
  - Telford construction
  - Macadam construction
- Further developments
Early Man

- Walked
- Dragged, rolled, or pushed what he or she needed to transport
- Alone or as a group
- Early “roads” were worn paths
First Vehicle

• Most likely a sled / sledge
Man Becomes Mobile

The development of the wheel led to the development of wheeled vehicles.
First Roads

• Mesopotamia
• Hard surfaces for travel purposes
• Most likely packed material, soil, etc.

3500 BC
Early Transport

Domesticated Animals

6000 BC

3000 BC

2000 BC

0

2000 AD

Sails

Wheeled Vehicles
Road “Upgrade”

- Crete - Mediterranean

- First stone surfaced roads constructed

Timeline:
- 6000 BC
- 4000 BC
- 2000 BC
- 0 AD
- 2000 AD

Event:
- 1500 BC

Symbol:
- First stone surfaced roads constructed
... and in the West...

- Mayans, Aztecs, Incas are building roads away from the coast
- Why?
  - Move armies to conquer others or defend themselves
  - Move food and trade goods

Timeline:
- 1500 BC
- 6000 BC
- 4000 BC
- 2000 BC
- 0
- 2000 AD
Early development

- The oldest mode of travel obviously was on the foot-paths.
- Animals were also used to transport men and materials.
- Later simple animal drawn vehicles were developed and this became a common and popular mode of transportation for very long period after the invention of *wheel*.
- This brought up the necessity of providing a *hard surface* for these wheeled vehicles to move on.
- Such a hard surface is believed to have existed in the period of about 3500 B.C.
- Only during the period of *roman* empire, roads were constructed in large scale.
Early Pavement Technology

- Roman Empire
- Used broken stones in mortar for roadway surfaces
Roman roads

- During this period of roman civilization many roads were built of stone blocks of considerable thickness.
- The *appian way* was built in 312 B.C. extending over 580 km which illustrate the road building technique used by Romans.
- The main features of Roman roads are:
  - They were built *straight* regardless of *gradients*.
  - They were built after the *soft soil was removed* and a *hard stratum was reached*.
  - The *total thickness* of the construction was *as high as 0.75 to 1.2 m* at some places, even though the *magnitude of wheel loads* of animal drawn vehicles was very low.
Roman roads

Ref: Roman Roads of Europe, NHH Sitwell, Cassell-London, 1981
Roman Roads

The Roads of the Romans
Roman Road Construction

Basic cross section

1) At the bottom of the trench, the Romans put a big layer of stones.

2) Broken stones, pebbles, cement and sand to make a firm base.

3) Cement mixed with broken tiles

4) Paving stones formed the surface of the road. These were cut so they fitted together tightly.

5) Kerb stones at the sides held in the paving stones and made a channel for the water to run away.
Roman roads

Although the above construction was strong but economic cost of construction cannot be justified at all, if this technique is compared with the modern trend of pavement design based on more scientific approaches.
Ancient Greek Roads –
grooves and large stone blocks
After fall of roman empires, their technique of road construction did not gain popularity in other countries.

Until the 18th century there is no evidence of any new construction method, except the older concept of using thick construction of road beds as the roman did.

The main feature of Tresaguet proposal (1775) was that the thickness of construction need to be only in the order of 30 cm.

Further due consideration was given by him to subgrade moisture condition and drainage of surface water.
Metcalf construction

- He was engaged on road construction works in England during the period Tresaguet was working in France.
- He apparently followed the recommendations of Robert Phillips.
- He was responsible for the construction of about 290 km of road in the northern region of England.
- Much of his work was not recorded.
Telford construction

- He began work in early 19th century.
- He also believed in using heavy foundation stones above the soil subgrade in order to keep the road foundation firm.
- He insisted on providing a definite cross slope for top surface of the pavement by varying the thickness of foundation stones.
- Subgrade is kept horizontal and hence subgrade drainage was not proper.
Telford construction

- 2 layers (100 mm & 50 mm) of stones (60 mm max. size)
- 40 mm gravel
- Broken stones and gravel
- Min. crossfall 100 mm on a 10 m road
- Flat subgrade
- Stones 100 mm wide and 175 to 75 mm in depth
- 365 mm
Macadam construction

- The importance of subgrade draining and compaction was recognized and cross slope of 1 in 36 was proposed from subgrade level itself.

- The first method based on scientific thinking.

- It was realized that the stresses due to wheel loads of traffic gets decreased to the lower layers of the pavement and therefore it is not required to provide large boulders and stones or soling course at the lower layer of the pavement.
Macadam construction

- 2 layers (each 100 mm thick) of broken stones (75 mm max.)
- 50 mm layer of broken stones (25 mm)
- 0.75% Slope
- Sloped subgrade
- 250 mm
Macadam Road

[Diagram of a cross-section of a road with labels for ditch, smaller stones, gravel, large stones, and MacAdam's Roads]

[Road image with a horse-drawn carriage]
India Grand Trunk Road

2,500 kilometres (1,600 mi).
Plank roads were typically constructed of wood planks two inches thick and eight feet long, which were nailed to four-inch-square stringers at a 90-degree angle.
Comparison

**Trésaguet**
- gravel or broken stone (1-inch layer)
- broken stone (2-inch layer)
- foundation layer (8 inches)

**Telford**
- gravel or broken stone (1-inch layer)
- broken stone (7-inch layer)
- foundation layer (7 inches)

**McAdam**
- gravel or broken stone (1-inch layer)
- broken stone (8-inch layer)

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Further developments

- Macadam’s method of construction gained recognition as a scientific method of construction and hence was adopted by various countries with slight modifications.

- One of the most popular methods which is even now prevalent in many countries is the water bound macadam (WBM) construction, known after Macadam’s technique.

- The next development was the penetration and bituminous macadam roads etc, cement concrete roads, soil stabilization techniques.