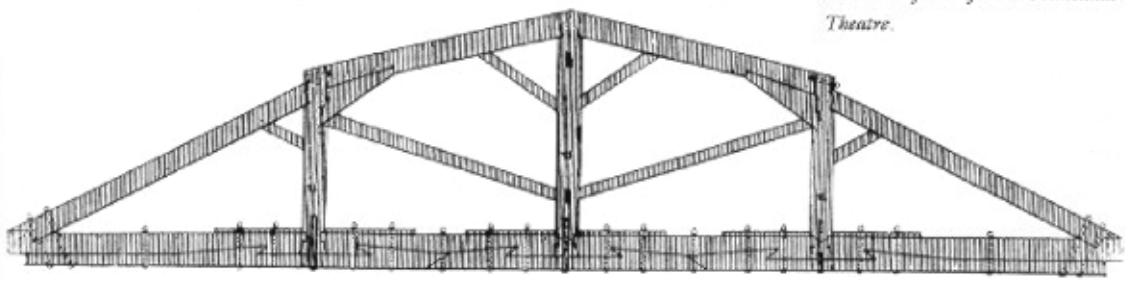
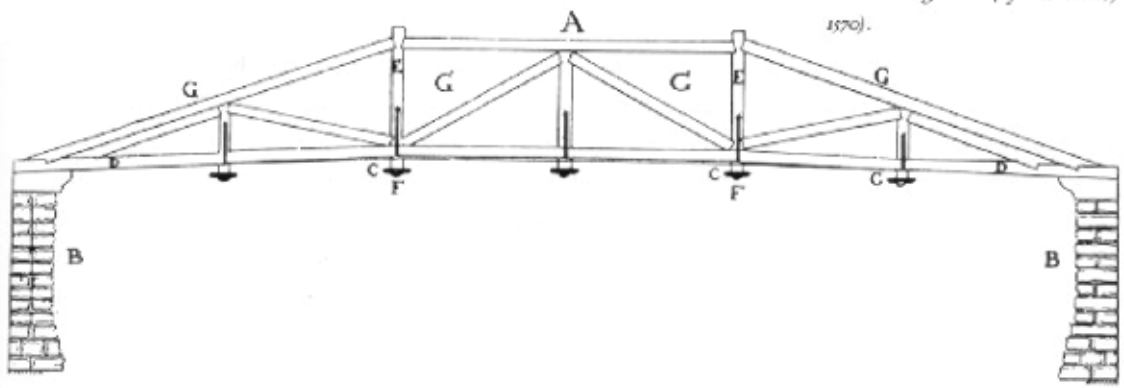
Historic Timber Structures

5.5
Wren's roof truss for the Sheldonian Theatre.

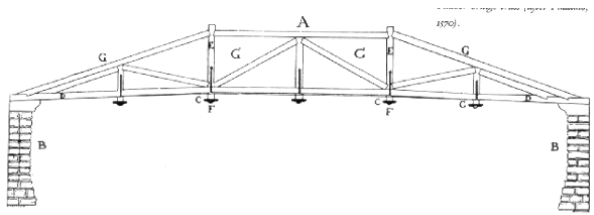


5.6
Timber bridge truss (after Palladio, 1570).



Today's Lecture

1. **History of Timber Structures**
2. **Potential Paper Topics**
3. **Properties of Timber**
4. **Case study**



Historical Development of Timber Structures

- Roman theatres
- Gothic roof systems
- 16th C bridges – Palladio
- 17th C roof trusses – Wren
- 18th C bridges – Grubenmann
- 19th C bridges – USA

Roman Timber Structures

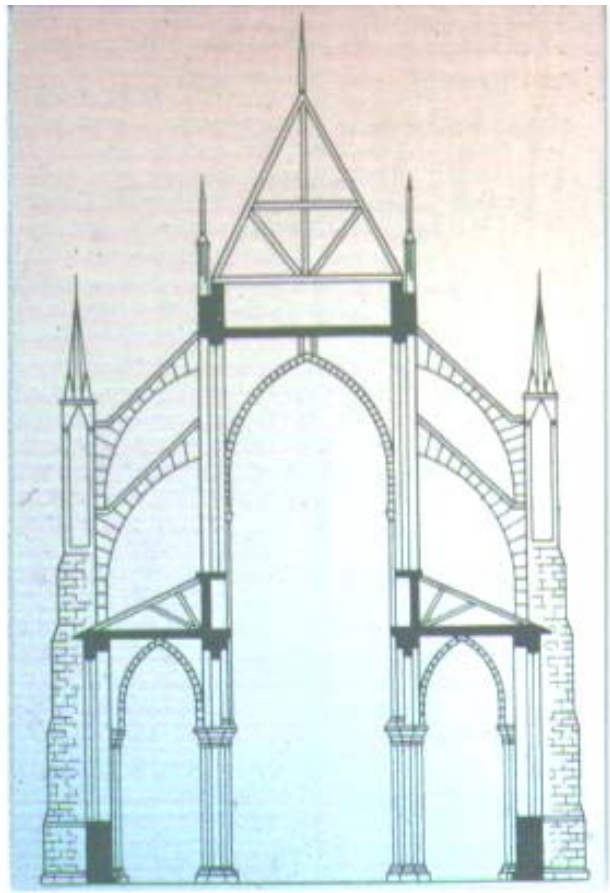
- **Trajan's column – details of a "trussed" arch bridge**

Roman Roof at Orange (France today)

- Timber cantilevers supported a lightweight roof
- Spanned greater than 60 feet (20m)
- Research questions?
  - Support conditions
  - Size of timbers
  - Geometry of timber trusses

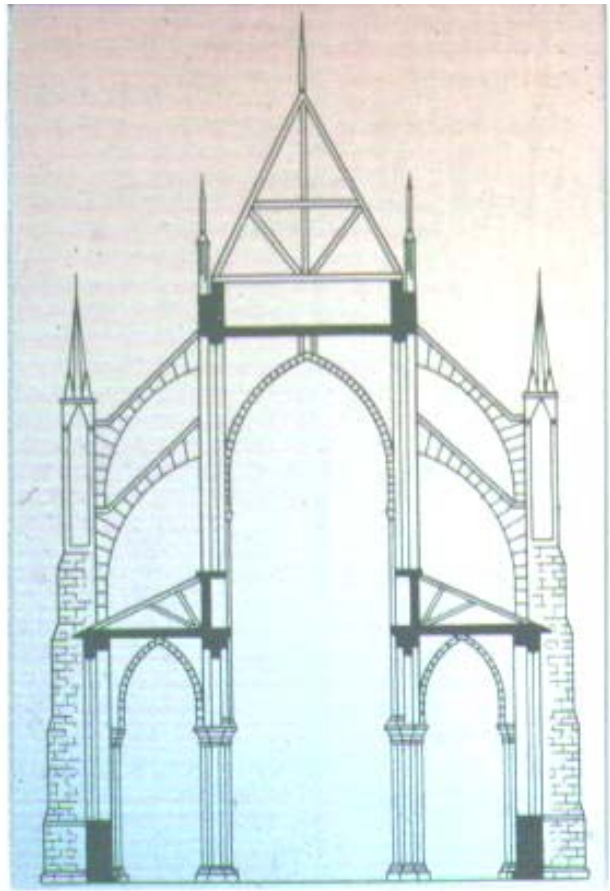
Gothic Roof systems

- Timber roof systems span above the vaults
- Typical spans of 30-60 ft (10-20 m)
- May have been built prior to the vaults to protect and aid the works



Gothic Roof systems

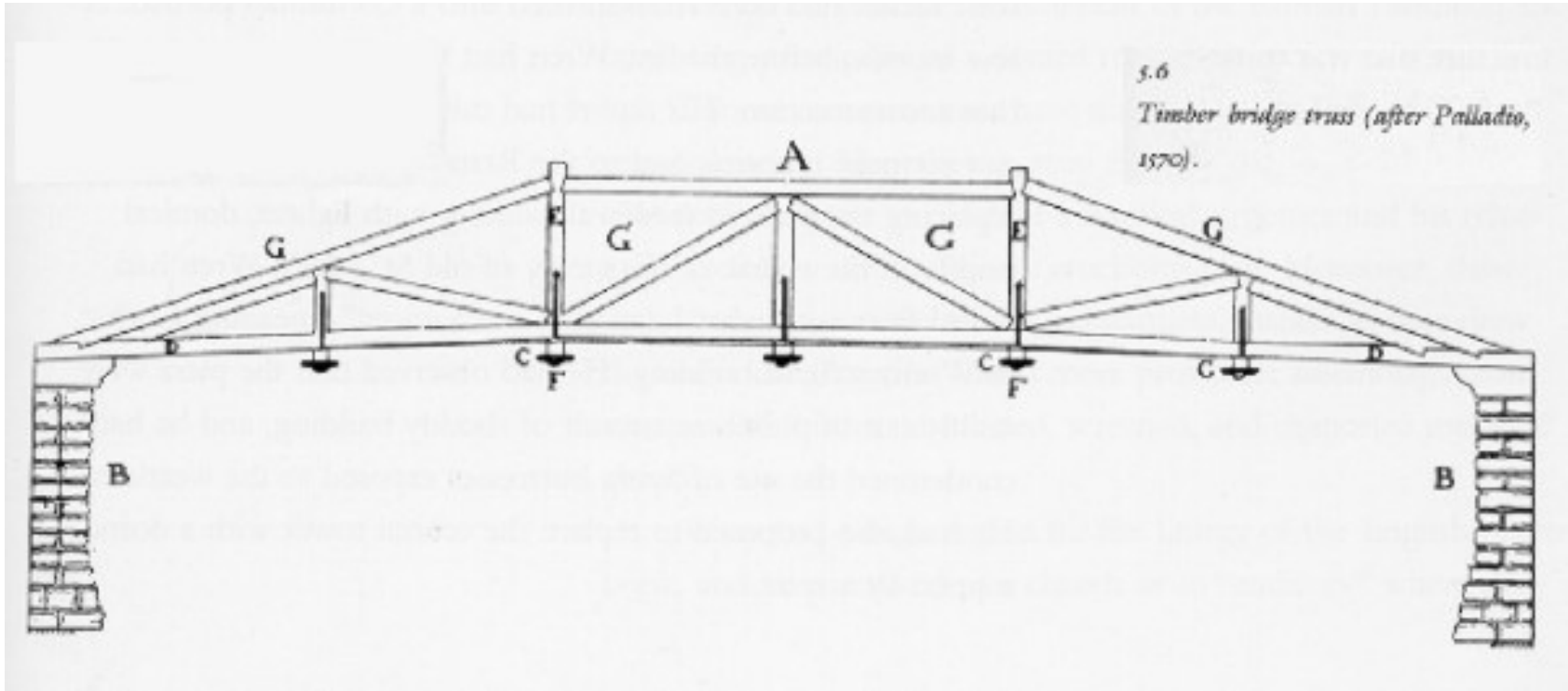
- **Paper topics**
  - **Comparison of timber roof systems for Gothic cathedrals**
  - **Analysis of various geometries for roofs**



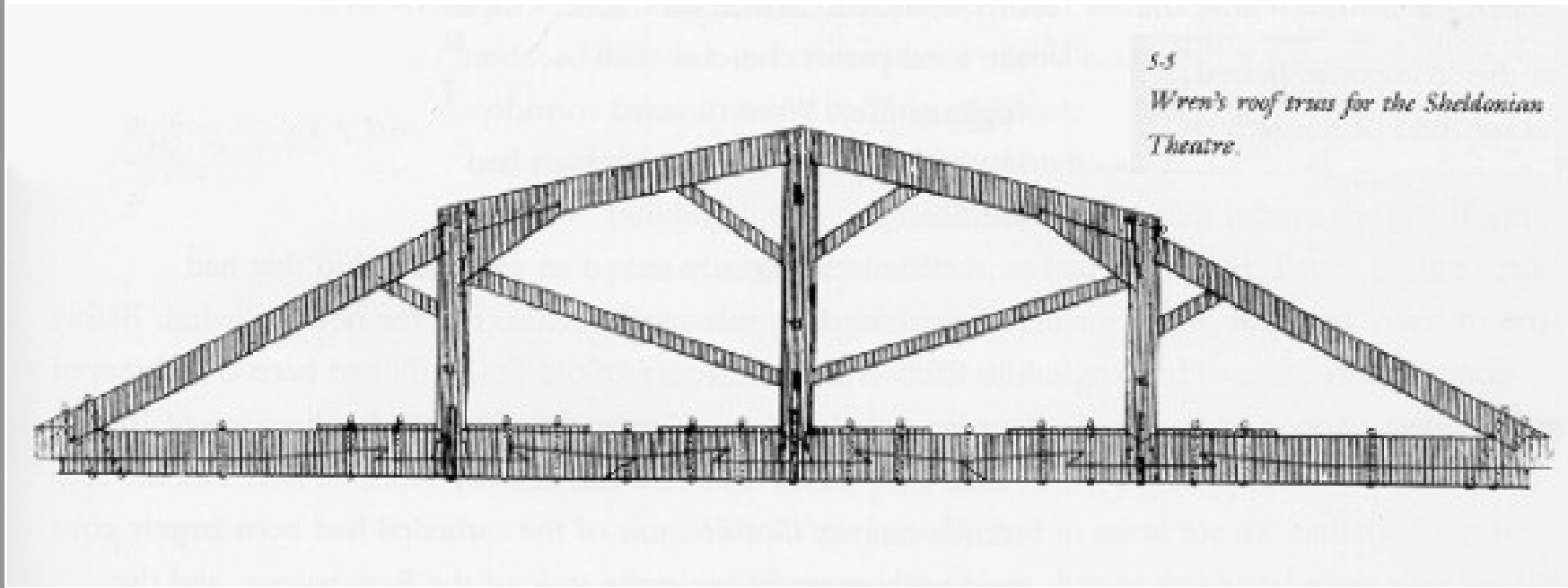
Hammer-Beam Roof systems

- **Typical in England**
  - **Case study next week**
  - **Used to help span longer distances**
- **Limit to span for a single beam**
  - **Diameter of trees**
  - **Length of elements**
  - **Consistency of materials**

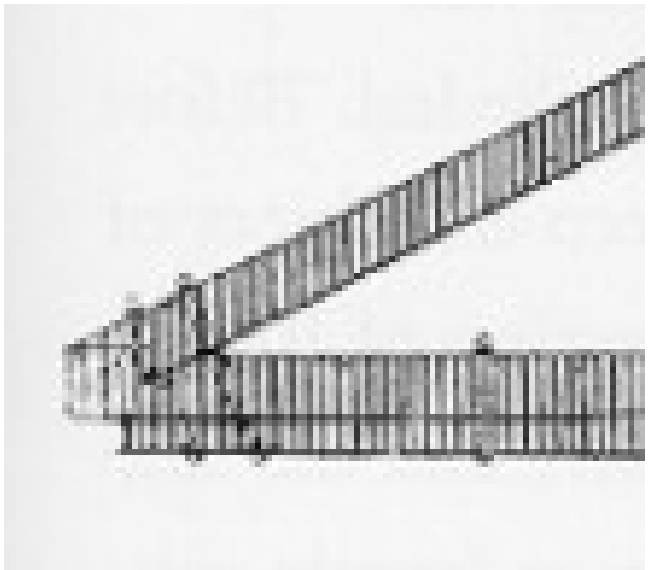
Palladio
Timber Truss Bridge, 1570

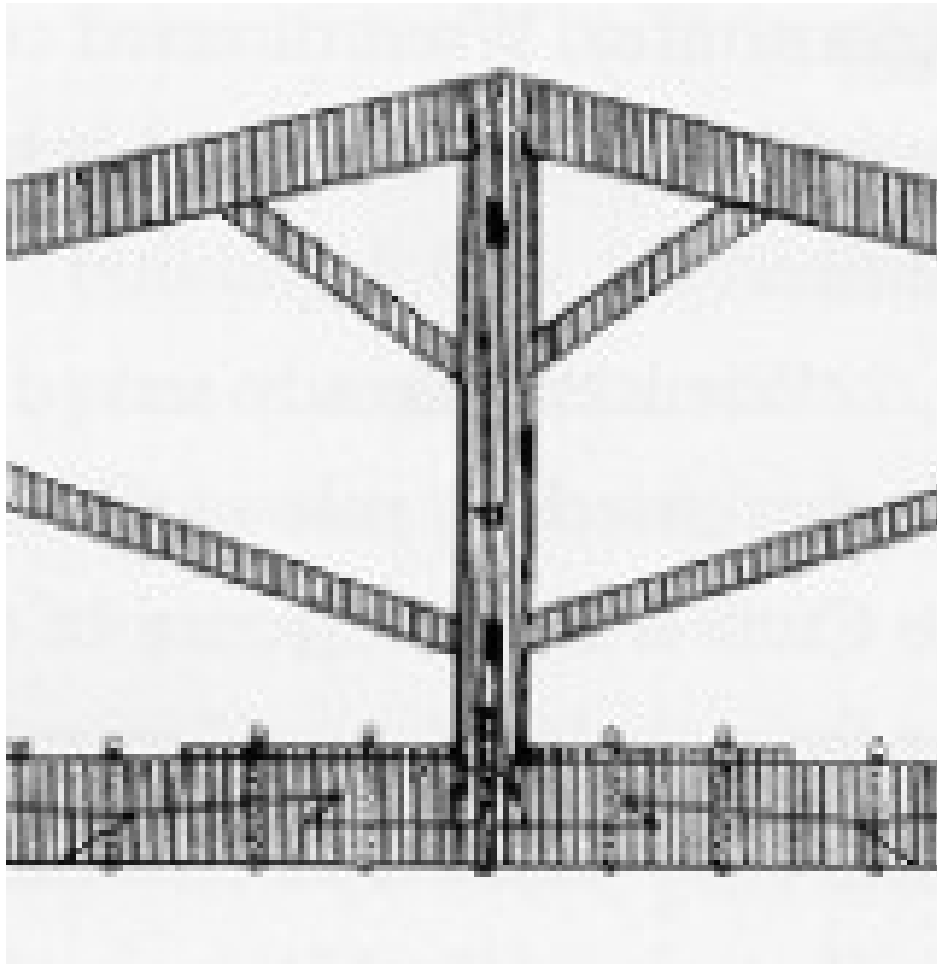


Sheldonian Theatre, Oxford
Christopher Wren, 1669



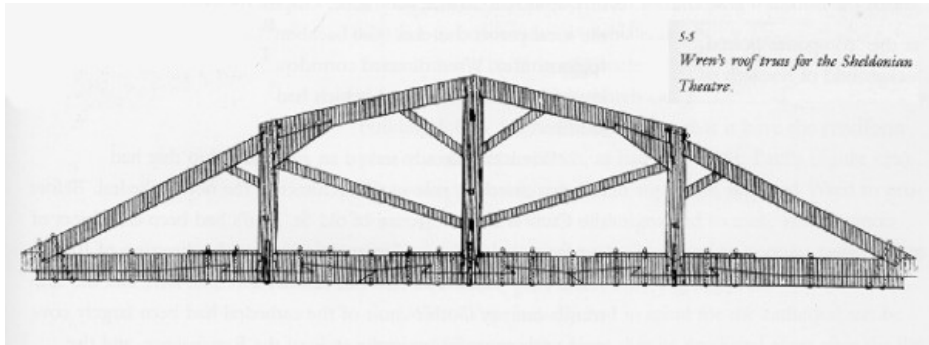
Connection Details



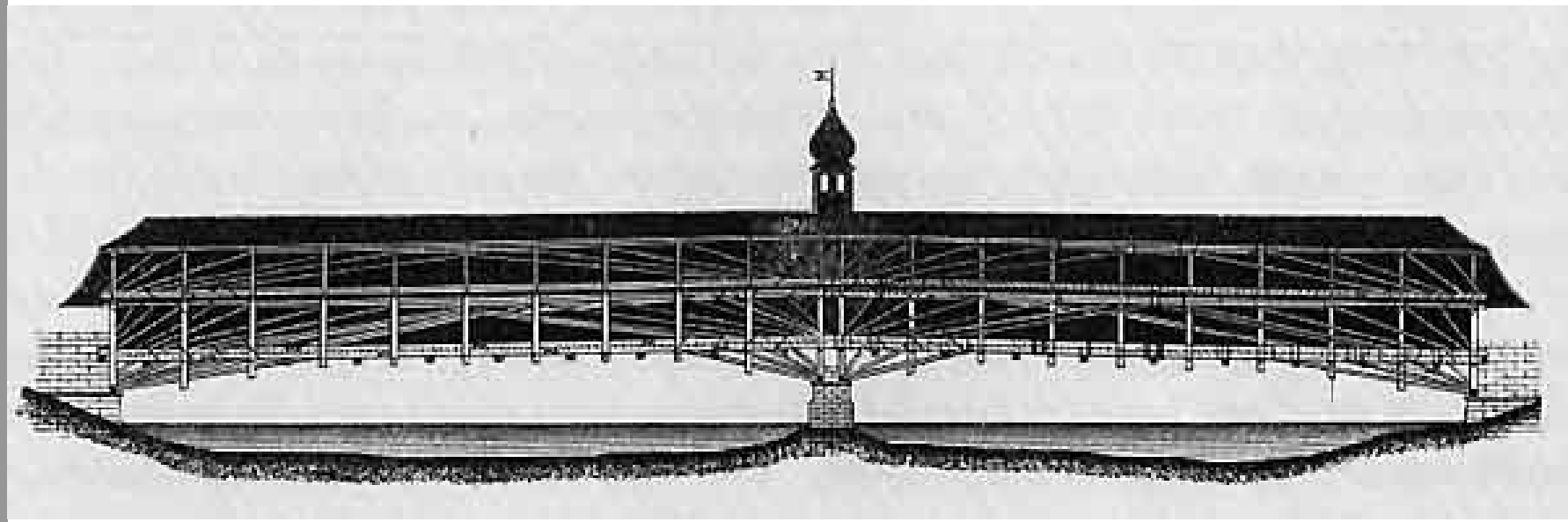


Sheldonian Theatre, Oxford Christopher Wren, 1669

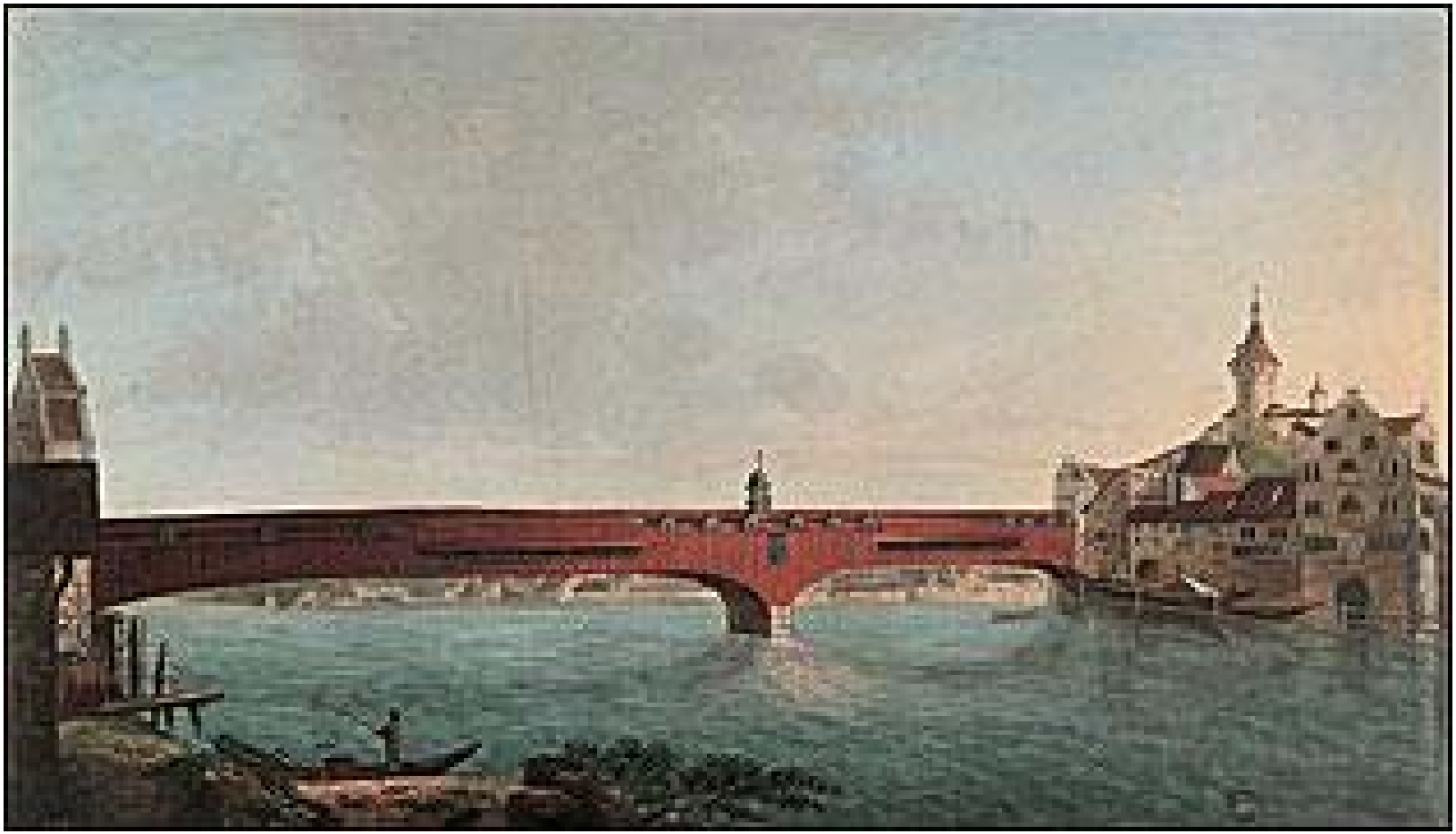
- **Paper topic:**
  - **Comparison of Wren trusses**
    - **How much did he understand?**
    - **How efficient are the truss designs?**



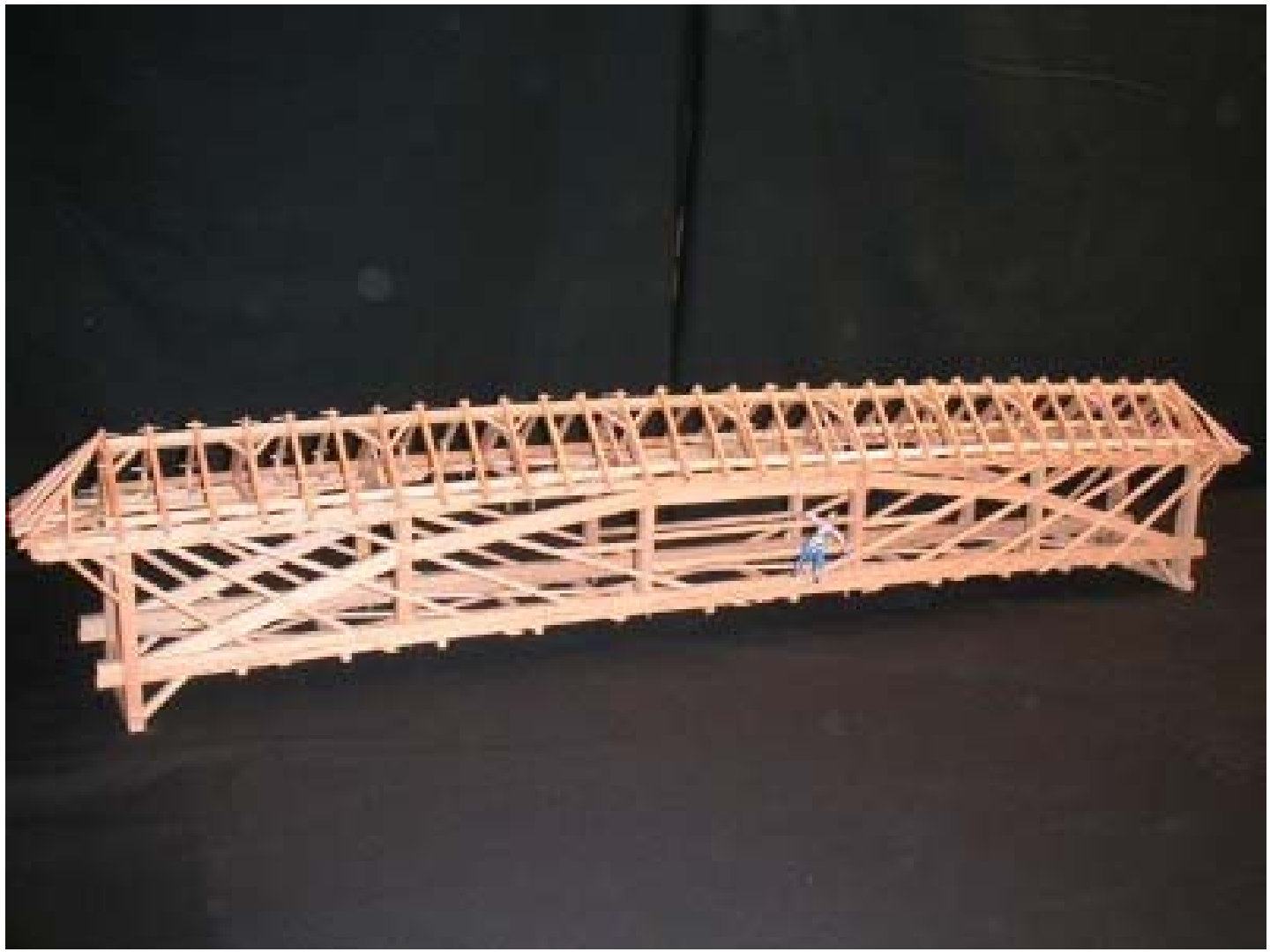
18th C covered bridges in Switzerland



Schaffhausen Bridge, 1755

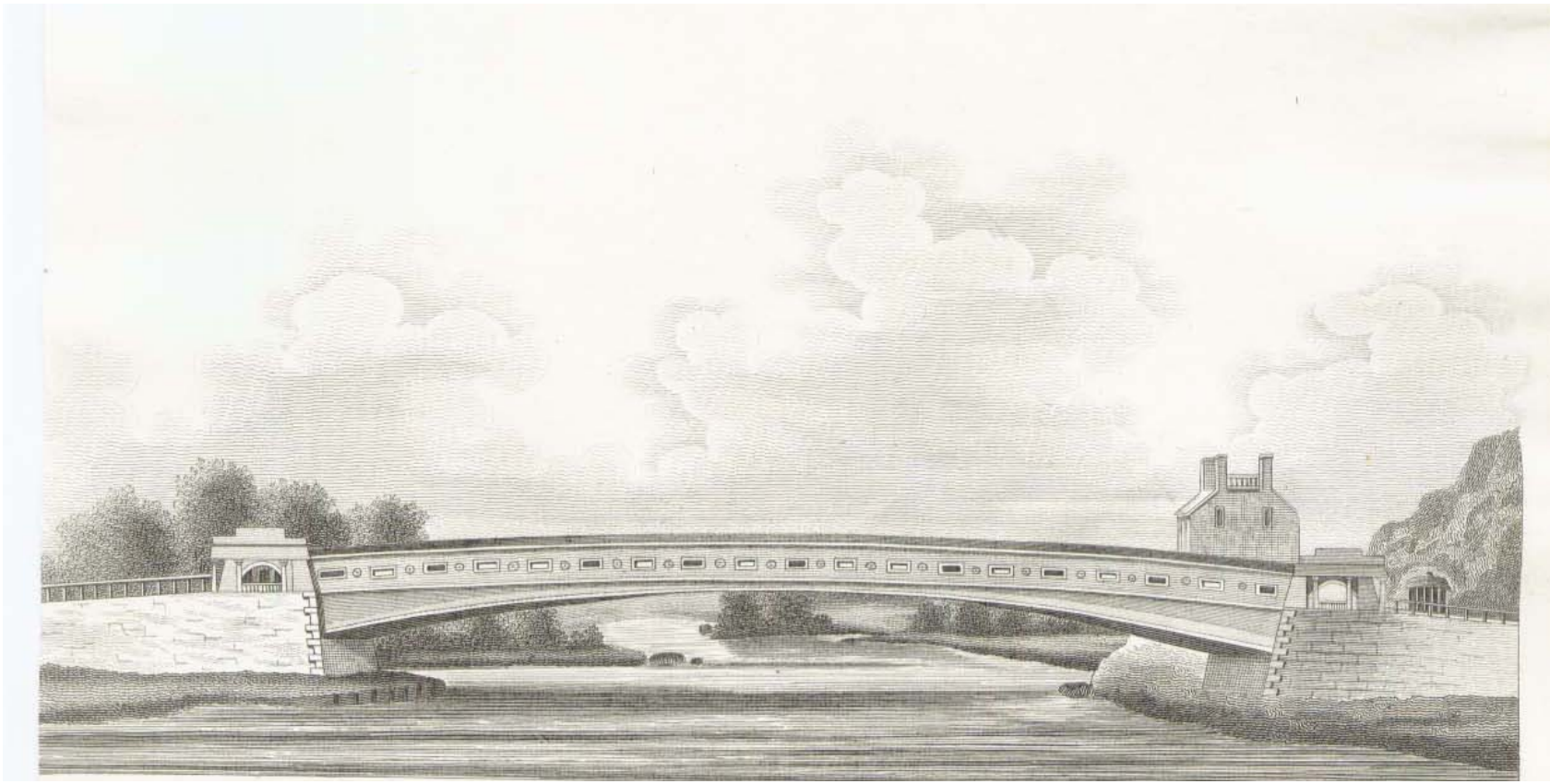


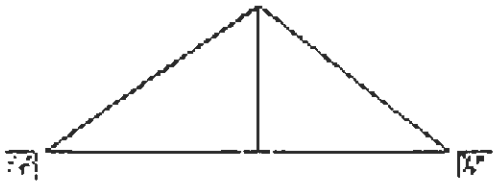
Schaffhausen Bridge, 1755



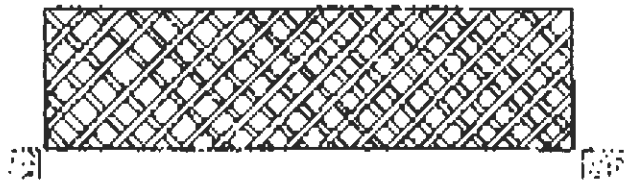
Craft traditions of timber bridges

“Colossus” over Schuylkill River in Philadelphia, 1812, 340 ft span

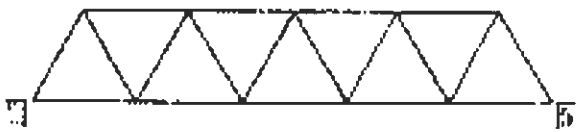




King Post Truss

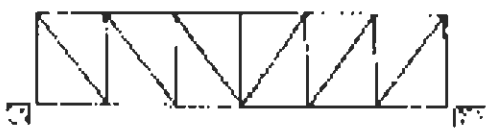


Lattice Truss

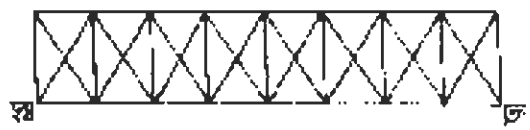


James Warren Truss

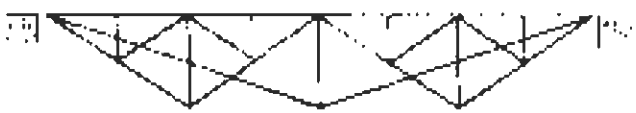
Squire Whipple Truss



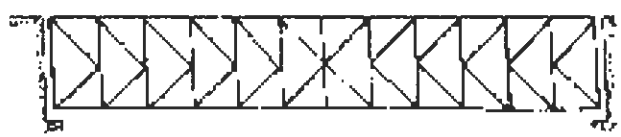
Pratt Truss



William Howe Truss



Albert Fink Truss



K-Truss

US Covered Bridges

US Covered Bridges

Taftsville Bridge in NH, 1836

US Covered Bridges

Bamboo Suspension Bridges

From Himalaya and China

Spans of 600 feet (200 m)

Longest spans in the world

Barely studied at all

→ great paper topic!

Inca Woven Bridge Construction: An Annual Festival

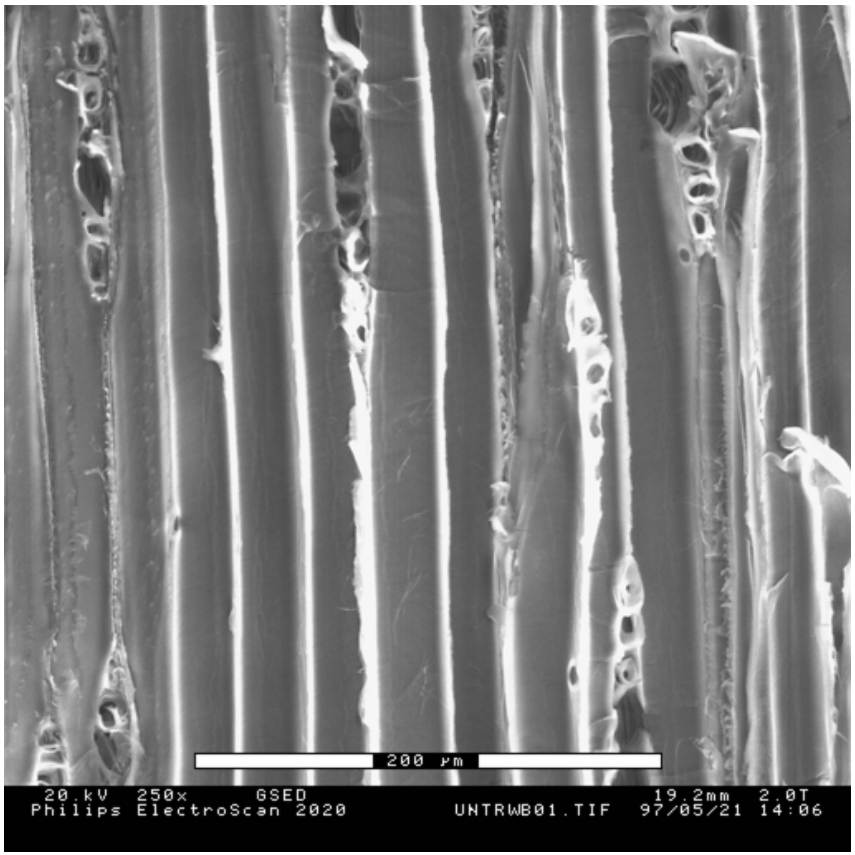
Day 1: Ropes made from local grass or plant fibers

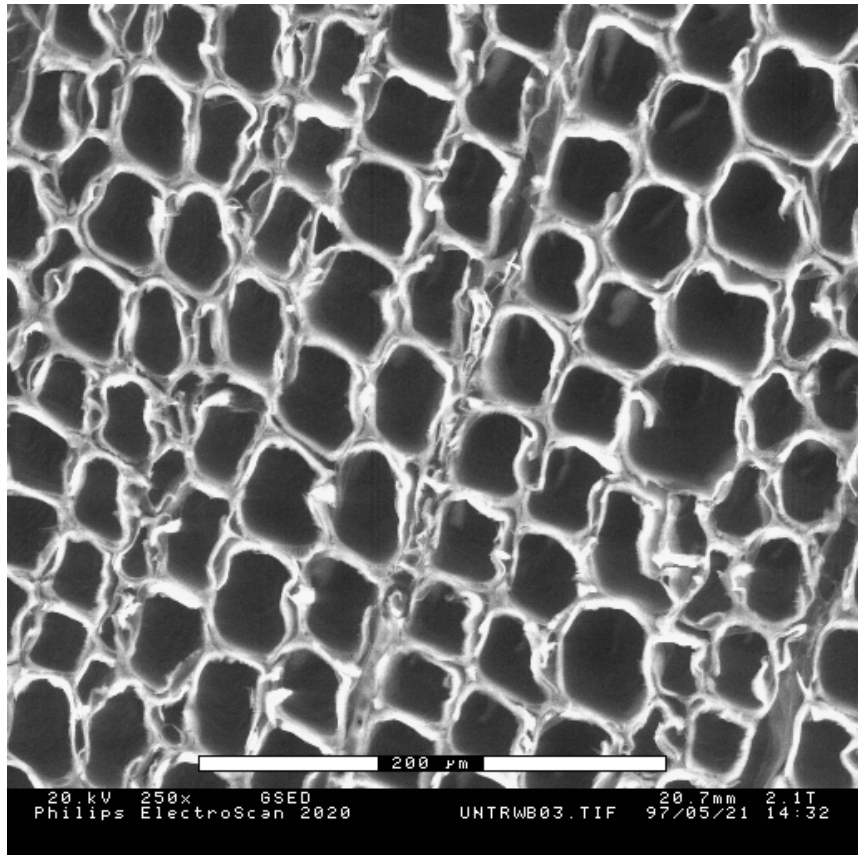
Day 2: Old bridge is cut and new ropes are installed

Day 3: Roadway and handrails are added and bridge is complete

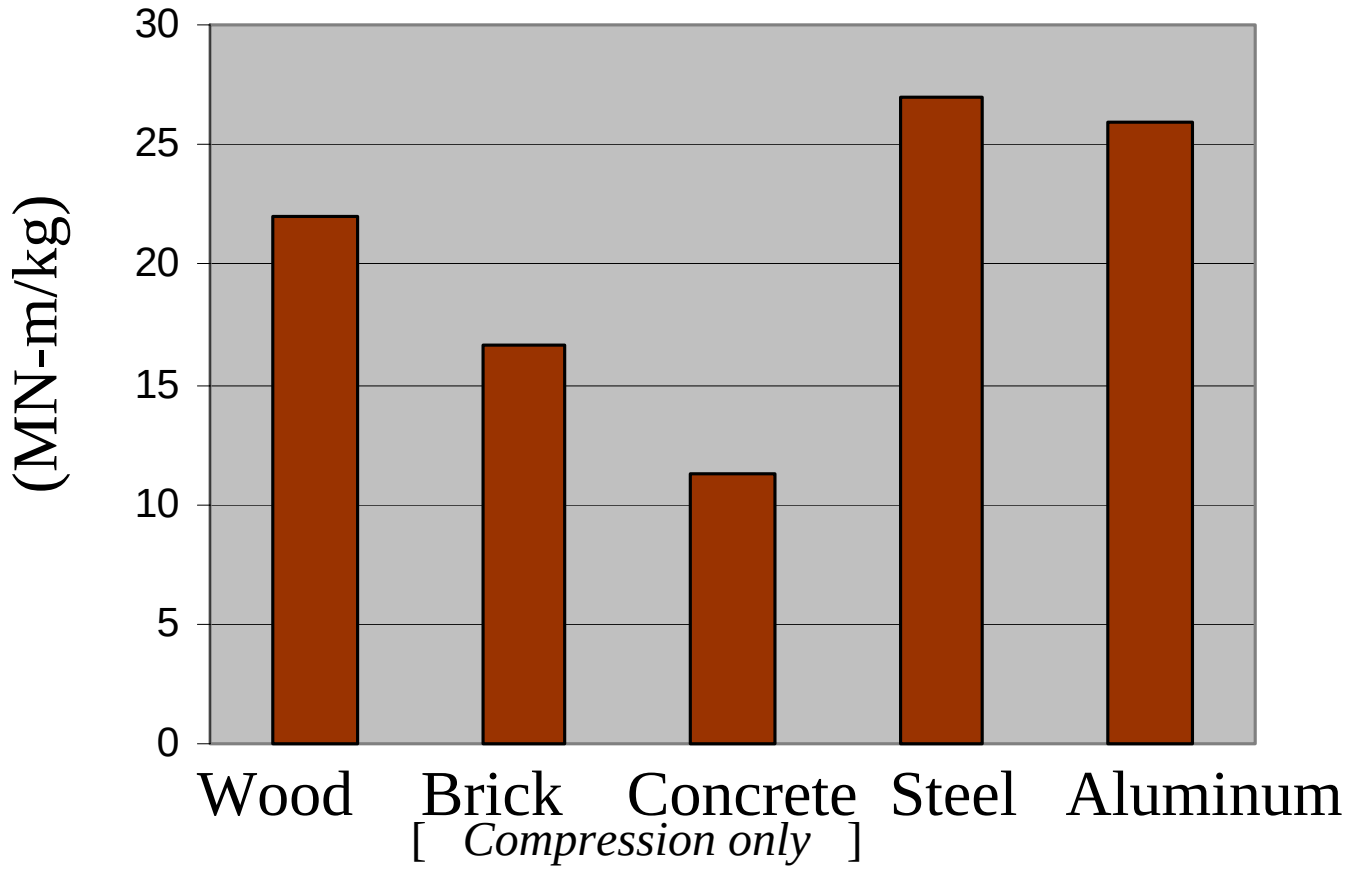
Rebuilt ever year for 500 years

Microstructure of Wood





Stiffness (E) per unit weight



Source: Biggs (1991)

Properties of Timber

- Cellular structure is very efficient
- Handles both compression and tension well
- Different strengths with and against the grain
- Inhomogeneous material with imperfections

Enemies of Timber

- Fire
- Water
- Insects

Conclusions

- **The distanced spanned by wood is limited by the size of trees**
- **Trusses allow for longer spans**
- **Many subjects of historic timber construction have not been studied**
- **Apply simple truss analysis in most cases**