Bridges

In human history, few activities epitomize progress and ingenuity better than bridges. Franklin D. Roosevelt said in 1931 that the story of bridgebuilding is the story of civilization (Steinman and Watson 1957). Even before the days of the Roman engineers, bridges represented spectacular feats. In contrast to buildings, bridges are meant to facilitate transportation. For any modern government, the construction of infrastructure such as bridges is a primary tool for promoting economic growth. Cars, trucks, trains, and pedestrians need bridges to cross rivers, bays, inlets, fjords, highways, freeways, and even urban areas.

Structural engineers deal with many types of structures, with buildings and buildings being two main categories. Many aspects of the analysis of buildings and bridges are identical; structural members carry load by developing stresses and strains. However, bridge engineers and building engineers often work in different offices, with different design codes. In some countries, universities separate the education of building engineers from those addressing heavy structures, such as bridges, at an early stage. It also used to be a relevant joke that bridge engineers never needed to deal with architects, but that is no longer the case, if it ever was. The aesthetics of bridges is crucial and dependent upon the environment they reside in.

Codes

- Engineers who design bridges in **Canada** follow the CSA S6-14 Standard, labelled the Canadian Highway Bridge Code and published by the Canadian Standards Association.
- In the **United States** the American Association of State Highway and Transportation Officials, AASHTO, publishes codes that provide loads and bridge design specifications.
- In **Europe** there are several Eurocodes that may be relevant for bridge engineers: Eurocode 0: Basis of structural design; Eurocode 1: Actions on structures; Eurocode 2: Design of concrete structures; Eurocode 3: Design of steel structures; Eurocode 4: Design of composite steel and concrete structures; Eurocode 5: Design of timber structures; Eurocode 6: Design of masonry structures; Eurocode 7: Geotechnical design; Eurocode 8: Design of structures for earthquake resistance; and Eurocode 9: Design of aluminium structures.

Bridge Types and Terminology

- Several bridge types are sketched in the figures on the following pages: **Beam** bridge; **Suspension** bridge; **Arch** bridge; **Truss** bridge; **Cable stayed** bridge; **Cantilever** bridge; **Floating** bridge; and **Submerged** tunnels.
- The **abutments** of a bridge are the supports at the ends, usually where the bridge meets the landscape that the bridge is connected to. One may say that an abutment is a point at which the bridge “abuts” against firm ground.

- **Composite** bridges often consist of a reinforced concrete deck supported by steel girders. The steel girders have studs or “shear connectors” protruding from the top flange, transferring shear between the girders and the deck, ensuring the composite action.
- **Box girder** bridges have the deck carried by a hollow, i.e., “closed” beam cross-section.
- A **viaduct** is a bridge, with multiple small spans, often leading into a bridge. Not all bridges are viaducts, but all viaducts are bridges.

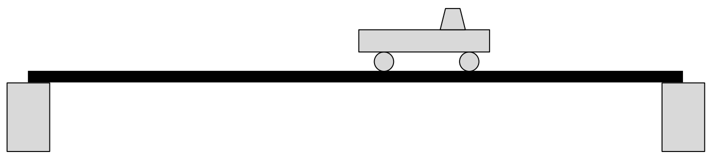

Figure 1: Beam bridge.

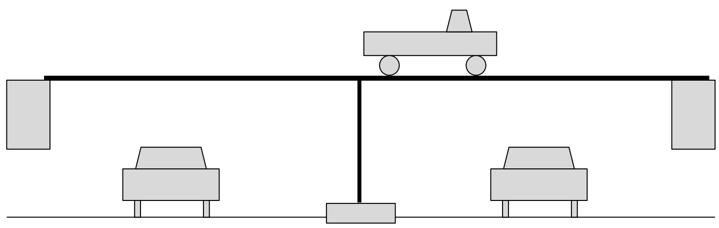

Figure 2: Two-span beam bridge.

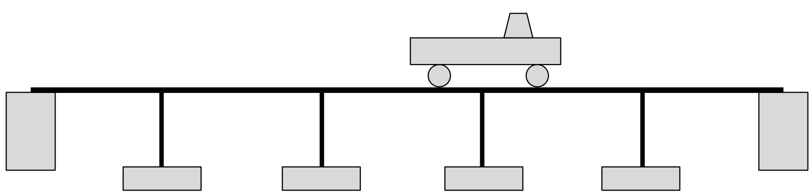

Figure 3: Continuous beam bridge.

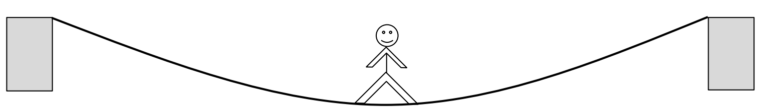

Figure 4: The concept of a suspension bridge.

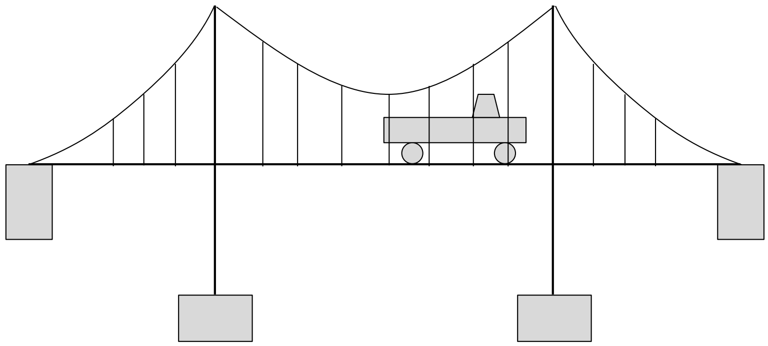

Figure 5: Suspension bridge.

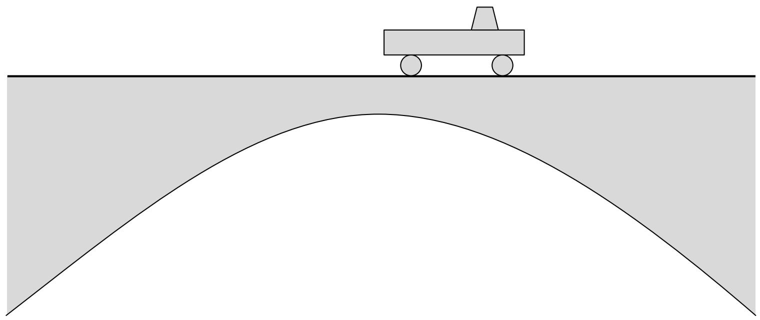

Figure 6: Arch bridge.

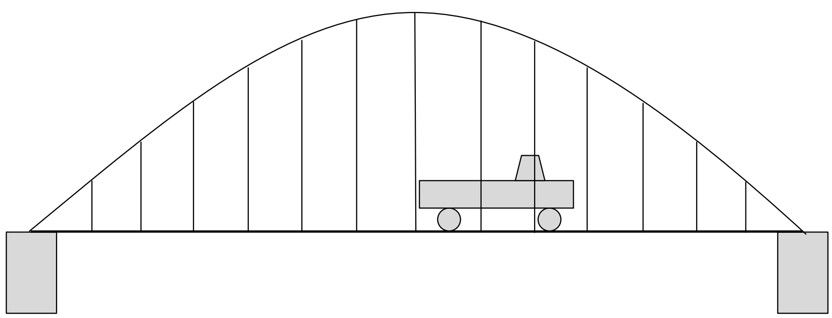

Figure 7: Arch bridge.

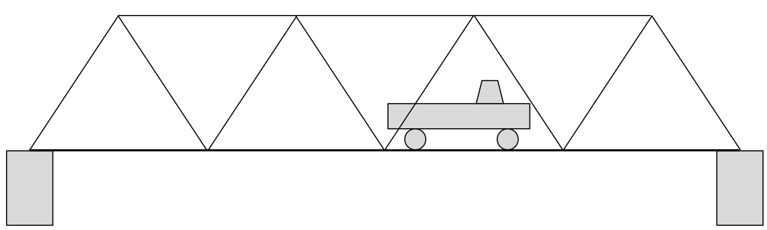

Figure 8: Truss bridge.

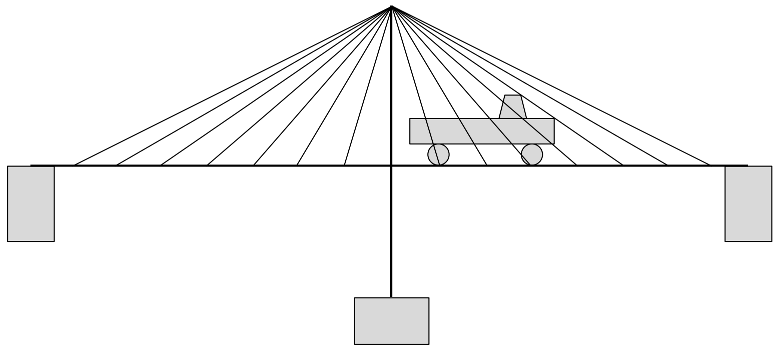

Figure 9: Cable stayed bridge.

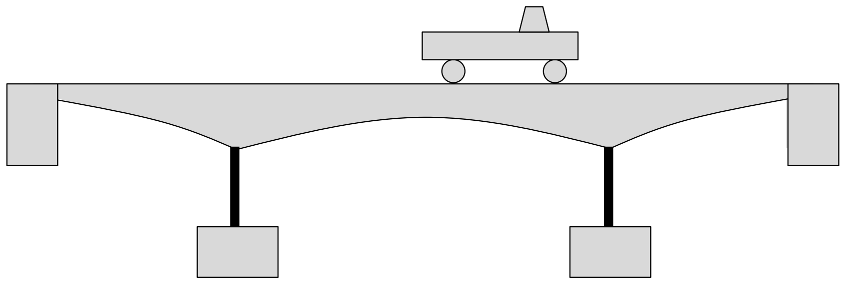

Figure 10: Cantilever bridge.

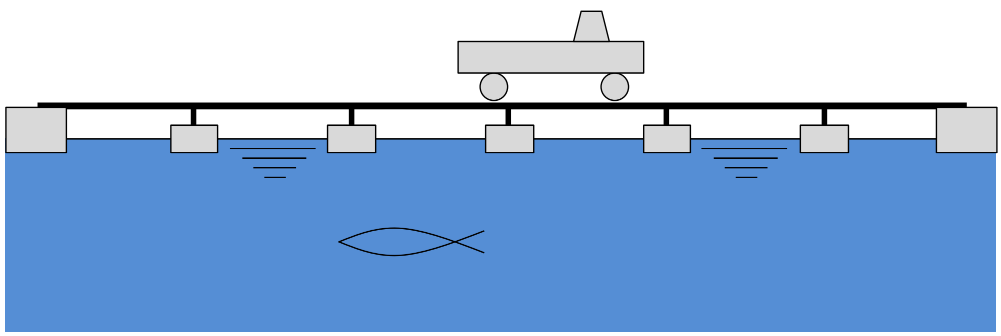

Figure 11: Floating bridge.

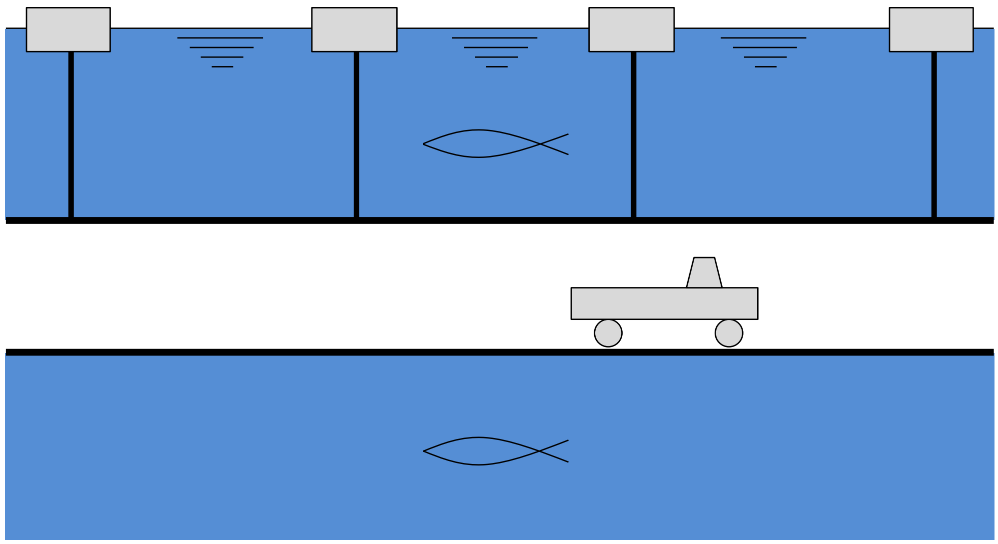

Figure 12: Submerged tunnel with pontoons.

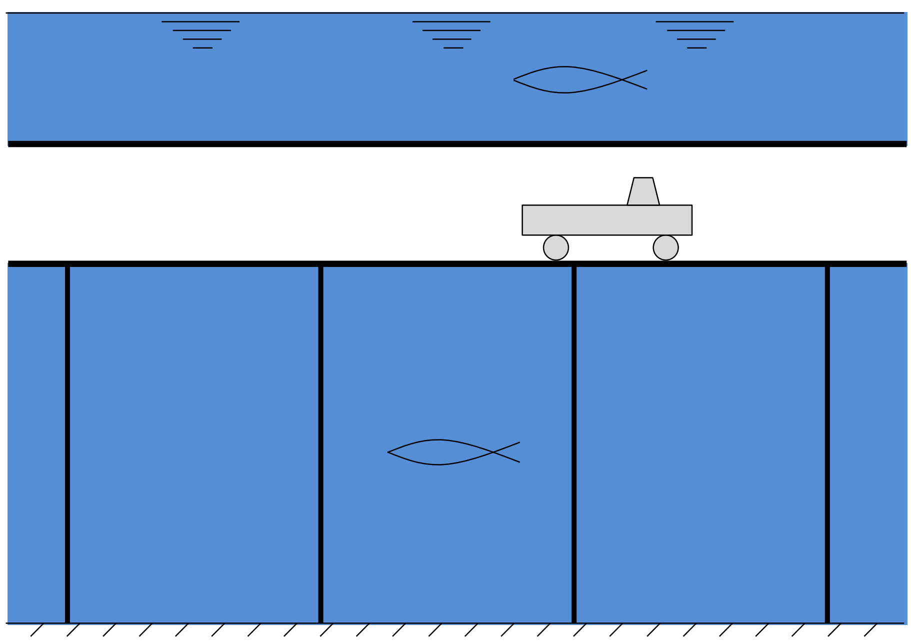

Figure 13: Submerged tunnel with tension legs.

Famous Bridges and Failures

Yet to be written.

References

Steinman, D. B., and Watson, S. R. (1957). *Bridges and Their Builders*. Dover.