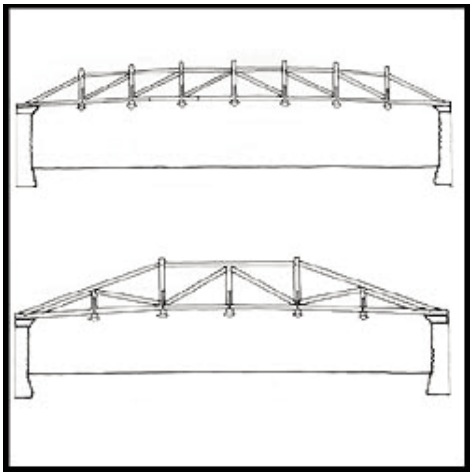
82. Plane Truss

Classroom Activity: Design and build a plane truss and load test it to failure. With the experience gained, design, build and test to failure a through truss bridge constructed of two plane trusses tied together with floor and roof beams.

Appropriate Grade Level:

This project was conducted with a Grade 7 class but the project could be used at the higher levels. One would attempt to develop a more complete understanding of the relative efficiencies of different truss designs and of the modes of failure



Grade: 7

Strand(s): Understanding Structures and Mechanisms

This task addresses the following overall expectations:

- analyse personal, social, economic, and environmental factors that need to be considered in designing and building structures and devices;
- design and construct a variety of structures, and investigate the relationship between the design and function of these structures and the forces that act on them;
- demonstrate an understanding of the relationship between structural forms and the forces that act on and within them.

and the following specific expectations:

- evaluate the importance for individuals, society, the economy, and the environment of factors that should be considered in designing and building structures and devices to meet specific needs;
- follow established safety procedures for using tools and handling materials;
- design, construct, and use physical models to investigate the effects of various forces on structures;
- investigate the factors that determine the ability of a structure to support a load;
- use technological problem-solving skills to determine the most efficient way for a structure to support a given load;
- investigate methods used by engineers to ensure structural safety;
- use appropriate science and technology vocabulary, including truss, beam, ergonomics, shear, and torsion, in oral and written communication;
- use a variety of forms (e.g., oral, written, graphic, multimedia) to communicate with different audiences and for a variety of purposes;
- describe ways in which the centre of gravity of a structure affects the structure's stability;
- identify the magnitude, direction, point of application, and plane of application of the forces applied to a structure;
- distinguish between external forces and internal forces (tension, compression, shear, and torsion) actingon a structure;
- identify and describe factors that can cause a structure to fail.

Assessment Categories:

- Knowledge and Understanding
- Thinking and Investigation
- Communication
- Application
- Teambuilding skills

Project Category:

Classroom/science lab.

Preparation before introducing the activity:

The teams are required to produce orthogonal drawings of the truss and later of the bridge. Time to teach elementary drafting must be provided.

Time to complete the activity:

This is a major project taking several periods. Depending upon the extent to which the class was expected to prepare a drawing and to the extent that they were already experienced in doing so, the truss and the bridge might each require five hours of class time.

Task: Teams were expected to work together effectively and collaborate in the design, construction and testing. The projects were scored on the ratio of applied load weight at failure to truss or bridge weight. A tolerable score was 200 times and 300 times was very good but we did see a few much higher scores.

Materials/Resources for teachers:

- Wood about 1/4" by 1/4" or 5 or 6 mm square.
- Carpenters glue.
- Newspapers to protect tables and/or desks.
- Saws.
- A disk sander was most useful.
- Clamps for hold the trusses while the glue set. Elastic bands were very useful and often the only clamps needed.
- A scale to determine the mass of the completed truss or bridge.
- A mechanism for applying load - this was a plastic pail into which sand was poured to increase the load. Shot puts and other hardware were used for the stronger units.
- A platform or bathroom scale to measure the load.
- Safety goggles, particularly during the testing procedure.

Materials/Resources for students:

None other than wearing clothing appropriate for working with wood and carpenter's glue.

Detailed Activity Description:

Specifically, the assignments were, first, to produce from 1/4 inch by 1/4 inch wood members a glue-joint plane truss made to support a concentrated load at the midpoint of a 60 cm. span, and, second, to produce a bridge of the same construction and for the same span. For the bridge, the loading plate could rest on two or three or even four cross-members. Power tools can be used if available, but saws and mitre boxes could be used.

There was only one class per week or there was adequate time for the glue to set properly between classes. Some organization by the students is necessary so that most of the construction periods end with a freshly glued and clamped component.

Before the test, the truss or bridge was weighed.

The load pail was suspended from the lower chord of the truss as close to the mid-span as possible.The load pail was suspended from a steel plate about 20 cm long resting on the floor cross-members. The plate was centered on the span.

After a test, the team was assisted to examine the pieces of the failed truss or bridge and determine where and/or how it had initially failed. The attached photos illustrate some of the process.

Tips for Teachers/EIRs:

Make certain that the students know the dimensions of the loading plate for the bridge in advance of joining their trusses together with cross-members. One of our bridges was too narrow and a special plate was required.

My (EIR Bill) own time in this class was divided between assisting Teacher Keith Kelsey with the more challenged members in the class complete their projects and assisting the highest achievers reach a more complete understanding of the nature and modes of failure and the contribution of each of design and of construction quality to final strength.

This process can help students identify their own potential for a career in engineering. That identification, when it happened, usually occurred when examining the debris from a test and trying to visualize how the truss or bridge had began to fail.

Grade Extensions:

None were contemplated. As indicated earlier, the analysis element of the project could be enhanced to challenge a more senior class.

Follow-up Activities:

Internal only - the bridge sub-project is a direct follow-up of the truss sub-project.