Dyson Bursary Outreach Activity

Long Span Bridges

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Introduction

The inspiration for this activity came from two aspects of my project - the use of cables as a structural element, and the very large size of the structure.

Presentation

My dyson day session began with a five minute presentation on long span bridges. I introduced the idea that different bridge types tended to be used depending on the length being spanned, with long spans typically either suspension bridges or cable-stayed. The terms tension and compression were explained, with buckling introduced as a compression problem - using material in tension can be more efficient, hence long span bridges tend to be supported by cables. The presentation then looked at what makes up a suspension bridge, and how the loads are carried (through a combination of tension and compression), and likewise for a cable stayed bridge. Some examples of the varieties of cable stayed bridges were shown to show the real creativity possible with structural engineering.

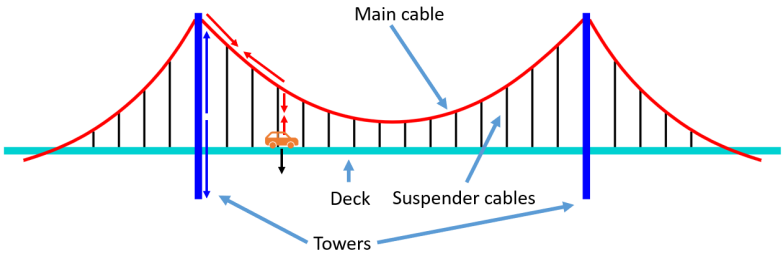

Figure 1: Explaning the load paths in a suspension bridge

The group activity was then introduced, and some tips on how to build the bridge provided.

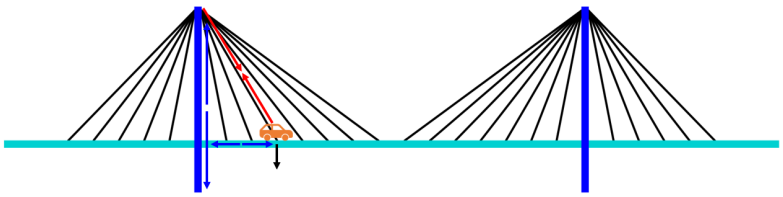

Figure 2: Explaning the load paths in a cable-stayed bridge

Planned group activity

The group activity of bridge building was as follows:

- Students in groups of 4 or 5
- 40 minutes to build a suspension bridge from paper, string and sellotape across a 2 metre gap between desks
- Allowed 1 support in between (with a chair and a 1 metre ruler for the tower)
- Will be tested to failure with 50 g weights – bridge which holds the most weight wins

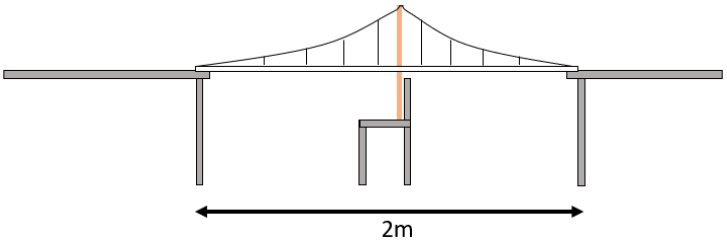

Figure 3: An example of what the students were to aim for.

The activity on the day

Alterations to plan

On the day the time for building the bridges had to be cut from 40 to 30 minutes as we were running slightly behind time. Masking tape was used instead of sellotape to allow tearing the tape without requiring scissors. The students had already been in groups of 4/5 for a previous activity so the same groups were used for this activity.

Figure 4: How I suggested building the deck

Figure 5: An example of the bridge I build to test the concept

Building

The groups were quick to re-arrange the decks and begin building the decks. Constructing the tower posed slightly more challenging as the chairs were not the best suited to attaching a metre stick, but most groups managed by wrapping a large quantity of masking tape round the ruler and the chair.

The main difficulty appeared to come with stringing up the main cables, and then attaching the deck. With 10 minutes to go, most groups had not even put the main cables in place, and with 5 minutes to go only a few had even begun attaching the deck. A last minute push meant most groups were able to attach the decks, but many were poorly attached with only a few suspender cables, which meant the resulting structure was not overly strong.

Testing

Lots of 50 g masses were available, which were distributed among the groups to allow testing to occur in parallel. Groups were told to place them spread out along the bridge deck until the structure failed (failure was judged to have occurred, if not immediately obvious, by the teacher, Maria and myself). By counting how many were on the structure when it failed, the total load it carried could be calculated. All bridges carried at least some load; the strongest bridge had a failure load 89 masses, a total mass of 4.45 kg, which is a very impressive amount.

Clearing up

As soon as the bridges had failed in testing the groups were instructed to begin clearing up, which consisted of putting the string, paper and tape in the bin and putting the desks back in the correct position. This was performed quickly and efficiently (impressively so for a school class) which left time for a Q&A with the students and all the Dyson bursary recipients at the end.

Overall conclusions

I think the activity was a success - the large amount of noise during the bridge building suggested they were having a lot of fun. Despite the time pressure, all the groups got some sort of bridge built, which will have been rewarding. They will have appreciated the difficulty in structural engineering comes as much from figuring out how to actually construct the structure as it does from designing the structure, and will hopefully have taken away an understanding of how the loads are carried in suspension bridges. I myself had good fun delivering the presentation and watching the bridges being built.