

**Structural Analysis III**  
***Lab Session 3:***  
***Christmas Bridge Build & Break***  
***Competition***

**2008/9**

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# 1. Introduction

## 1.1 Background

This lab aims to unify many of the classroom topics that can seem unconnected. By designing, building, and testing a model structure, it is hoped that the fundamentals of structural design and failure can be easily seen, more so than from a set of equations.

## 1.2 Dates

There are two important dates for this lab:

- **The laboratory report:**

This will be collected before class at 10am Friday 12 December 2008;

- **The model and presentation:**

All models and presentations are to be submitted at 13:30 Thursday 18 December 2008, prior to the testing of the bridges.

Late submissions will not be accepted.

The testing of the bridges will take place at:

**14:00-17:00 on Thursday 18 December in Rm 236**

All students are to attend the full event.

## 1.3 Prizes

Since this is the last lab before Christmas, the elves in the Department of Civil/Structural Engineering have put together a little enhancement package for the lab. The 1st and 2nd placed groups will receive a ridiculously generous gift (TBC). The bridges will be ranked according to their strength-to-weight ratio.

### 1.4 Groups

The class is split into random groups of 5 students as follows:

No.					
1	Sean Bradley	Robert McAuliffe	Gavin Murphy	David McGuire	Maria Leonard
2	Sarah Cooray	Tom Nolan	James Whelan	Joseph Muller	Aine McBride
3	Kevin Doody	Liam Corscadden	Cillian Courtney-Finn	Jane Hennaghan	Tommy O'Brien
4	Killian Mason	Killian Gallagher	Peter Brady	David Roche	James Ashmore
5	Adam Craig	James Sutton	Evan Farrell	Erica Perris	David Gibbons
6	John Breen	Kevin Freyne	Peter Coleman	Aidan Tighe	Joseph Mears
7	Kataryne Skalka	Kevin O'Brien	Adam Carpenter	Neal Renehan	Craig McDonnell
8	Fergal Kellett	Ian Crowley	William Noonan	Colin Mulvihill	Sean Harpur
9	Domhnall Keane	Anne McKay	Oisin Doyle	Kevin Higgins	David Sreenan
10	Thomas Vaughan	Kieran Convery	Anthony Morris	Enda Murphy	Keith Chapman
11	Oona Finn	Fiach McDaid	Padraig Mullen	Matthew Fagan	Miriam Ryan

## **2. The Submission**

### **2.1 Report**

Each group is to prepare a report on their bridge design. It must include:

- Engineering drawings of the bridge;
- Calculations that lead to a prediction of collapse load;
- Concise summary of computer analysis output where relevant;
- Predictions of collapse load and failure mechanism;
- Failure loads for non-critical mechanisms;
- Results of any materials testing carried out.

Your report is to be professionally presented. Poorly presented reports will be returned and no marks awarded. Your report must be typed and bound.

### **2.2 Presentation**

For the day of the competition, you will have a PowerPoint presentation of less than 5 slides which summarizes your bridge and predictions on the model behaviour. You will make this presentation immediately before your model is tested and answer any questions the judges may have.

### **2.3 Bridge**

You will construct a bridge made of pasta and thread that will be tested to destruction. The bridge is to be constructed according to the rules outlined further on.

The success of the bridge will be assessed according to its strength to weight ratio, where its strength is the load it carries just prior to failure.

## 2.4 Marking

The marks for this lab will be award as follows:

- Report and presentation: 40% of the marks;
- Bridge Efficiency: 30% of the marks;
- Calculation Accuracy: 30% of the marks.

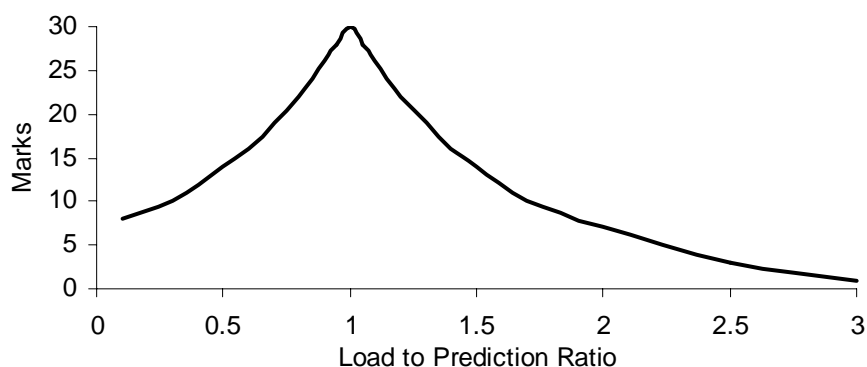
In this way careful design of the bridge will be rewarded, whereas inefficient use of materials will not. Also, accuracy in prediction/calculations is rewarded.

The marks for the bridge efficiency will be based upon the strength-to-weight (SW) ratio of your bridge as follows:

$$\text{Bridge Marks} = (30\%) \times \left( \frac{\text{SW ratio of bridge}}{\text{Best SW ratio}} \right)$$

The marks for calculation accuracy decay as your accuracy reduces:

$$\text{Calculation Marks} = (30\%) \left\{ \exp \left( -1.5 \left| 1 - \frac{\text{Load}}{\text{Prediction}} \right| \right) \right\}$$



Since all members of the group achieve the same marks it is vital that all members of the group contribute equally to this lab. Please report any problems to the lecturer.

## 3. Requirements

### 3.1 Introduction

This section outlines the requirements for the bridge. Since things are likely to get a little competitive, these rules must be adhered to. In all cases:

*The decisions of the judges are final!*

Disqualified bridges may still be load tested, but will not be eligible for a prize. The judges have the right to disqualify any bridge that in their opinion is in violation of the intent or letter of the rules. The judges have the right to accept any bridge that in their opinion is consistent with the rules.

### 3.2 Materials

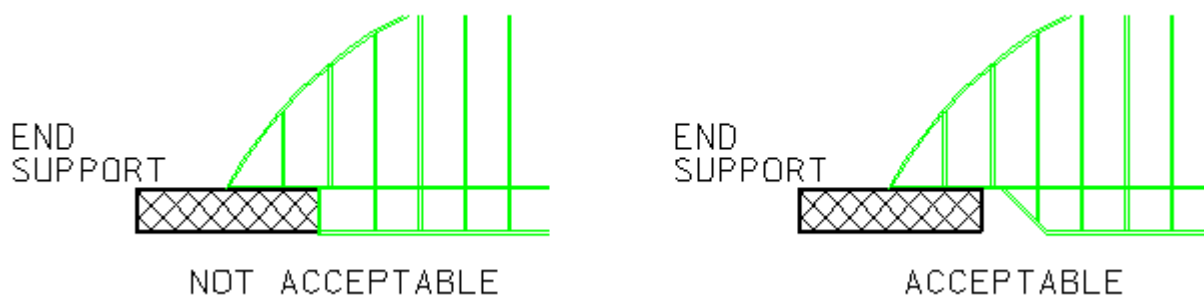
The allowable materials for this project are as follows:

- **Pasta:**  
Spaghetti pasta is to be used. Lasagna pasta may be used in the horizontal plane, to represent the bridge deck. The pasta may be boiled.
- **Thread:**  
Ordinary weight, not heavy duty, may be used.
- **Glue:**  
Super glue or hot-melt glue gun are both acceptable. Any sticky-backed tape (e.g. duct tape) is not acceptable.

### 3.3 Measurements

Restrictions on various measurements are:

- **Clear span:**  
The bridge is to span 900 mm between two tables.
- **Length:**  
The bridge cannot be longer than 1500 mm, since it must fit on the tables.
- **Height:**  
The top of the bridge must be less than 500 mm from the surface of the table.
- **Depth:**  
The bottom of the bridge must not be lower than 100 mm below the surface of the table.
- **Weight:**  
The bridge must not weigh more than 1 kg.
- **Clearances:**  
A 50 × 50 mm clear passageway must be provided at all bridge cross-sections. This is to model the allowance for vehicles to traverse the structure.
- **Minimum load:**  
The bridge must be able to sustain a minimum load of 1 kg.
- **Edge of tables:**  
Bridges cannot use the edge of tables for support:





- **Loading apparatus:**

Load will be applied to the middle of the bridge span via an S-hook. The bridge must have an element at this location to which the load will be applied. Please ensure that adequate reinforcement is provided to take this point load.

- **Supports:**

A 1 kg mass will be available to resist uplift at each support. Bridges cannot be glued or stuck down to the table surface by any means.

### 3.4 Judging

The following apply:

- **Before the test:**

The bridge will be examined by the judges for consistency with the rules. The bridge will be weighed.

- **During the test:**

You may not touch the bridge during the load test.

- **Failure:**

Failure is defined as:

- **Ultimate:** When the bridge can no longer sustain the load for a duration of under 10 seconds;
- **Serviceability:** When the bottom point of the bridge has deflected 100 mm below its starting position, the bridge is deemed to have failed.

- **After the test:**

The load the bridge carried will be assessed by the judging panel. The strength to weight ratio will then be determined.

## 4. Further Information

There are many resources on the web relating to pasta bridge competitions. Some useful sites are:

- [www.garrettsbridges.com](http://www.garrettsbridges.com)
- [www.fka.utm.my/bridge/](http://www.fka.utm.my/bridge/)
- [www.jhu.edu/virtlab/spaghetti-bridge/](http://www.jhu.edu/virtlab/spaghetti-bridge/)
- [www.okanagan.bc.ca/departments/engineeringtechnologies/spaghetti-bridge.html](http://www.okanagan.bc.ca/departments/engineeringtechnologies/spaghetti-bridge.html)