Bridge Project Main Submission

Team 309

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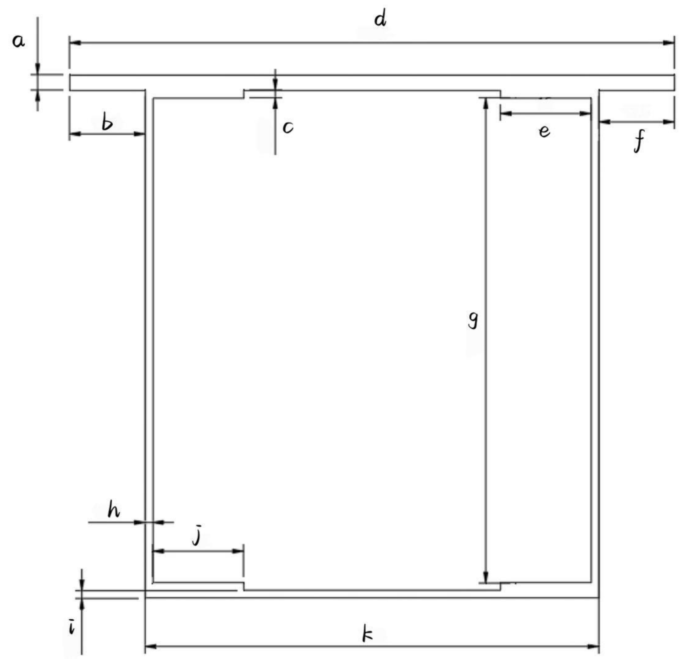
1. Introduction

The bridge our team built has two 100 mm wide layers on top of two 80 mm tall sections and a 75 mm wide bottom. They are held together by four 15 mm glue tabs, two on the top and two on the bottom. In addition, there are 13 diaphragms holding up the structure. The distance between sides is 75 mm in accordance with the distance between cartwheels, we deliberately left side flanges on top in order to minimize Case 2 buckling, and the height of 80 mm was based on material considerations, there was not enough mat board otherwise.

2. Iterations on the cross-section of the bridge



a. The first iteration:

Dimensions:

a = 2.54; b = 10; c = 1.27; d = 100; e = 5; g = 80; h = 1.27; i = 1.27; j = 5; k = 80

This dimension is mainly based on the design zero, with an additional part at the bottom as glue tab.

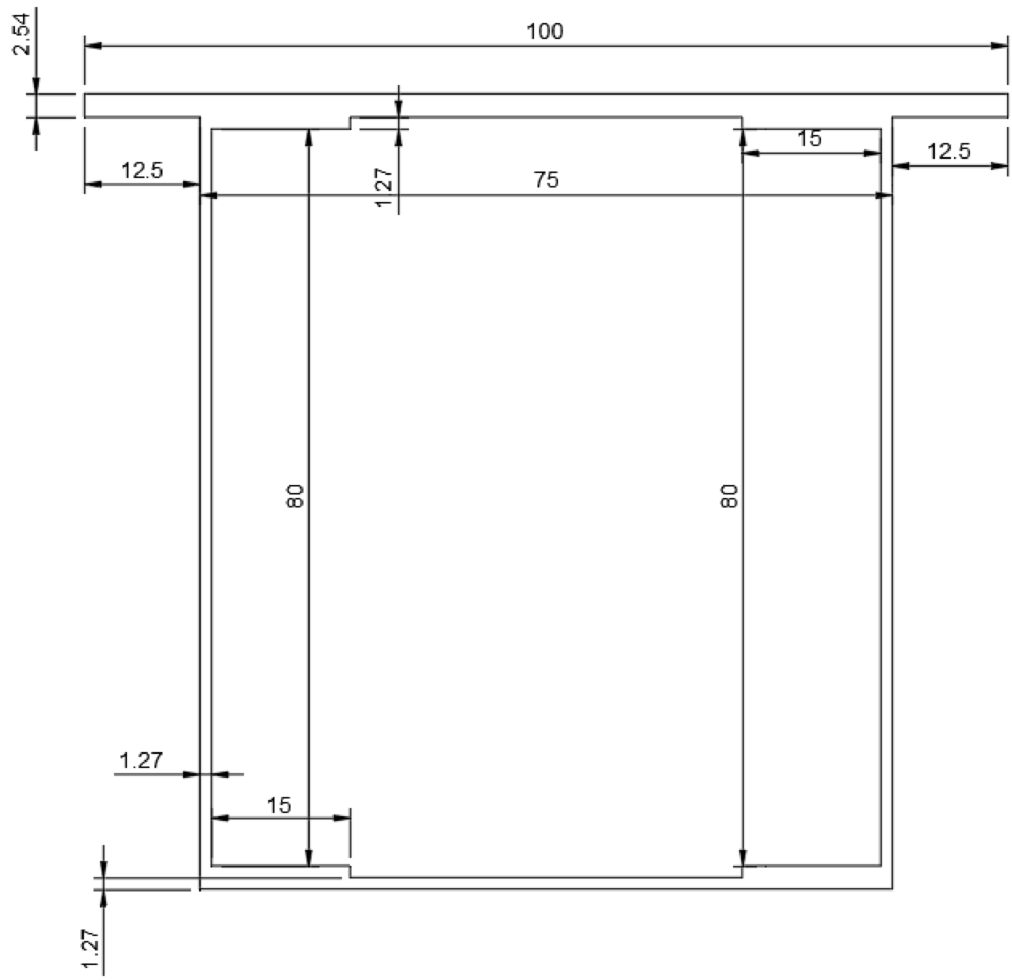
Based on the results of deliverable 1, the compression stress dominates the structure failure, therefore the thickness of the top flange(a) is increased to 2.54, instead of 1.27 at first.

This increases the value of ybar, so the value of ytop decreases, with the increase of I(second moment of area), the compression stress decreases. This change brings the Safety Factor of compression from 0.98 to 1.98, which will not cause failure when the load case 2 is applied.

b. The second iteration:
   Unfortunately, from our first iteration, while this did balance the compression and tension strengths, the Factor of Safety for buckling(Buckl 1- the middle part of the top flange) was deemed too low due to the position of the loads. Therefore, we decided to decrease the distance between the two side flanges from 80mm to 75mm, since 75 is the same as the distance between two cartwheels.
   This caused the value of “b” in the formula of thin wall buckling to decrease, which in turn decreased the stress of case 1 buckling from 4.3(MPa) to 15.72MPa, therefore the safety factor increased to 2.99.

c. The third iteration:
   We decided to increase the width of the glue tabs from 5mm to 15(mm) since the matboard is hard to shape, and the 5mm width may not be enough to connect the top flange and side wed.
   This only changes the shear stress from 3.47 to 4.55.

d. The fourth and final iteration took into account the flaws of the third iteration and added side flanges to the top while also adding glue tabs between the sides and bottom. In addition, after calculating the dimensions necessary, taking into account the lack of material, the height was reduced to 80 mm.



3. Construction Process

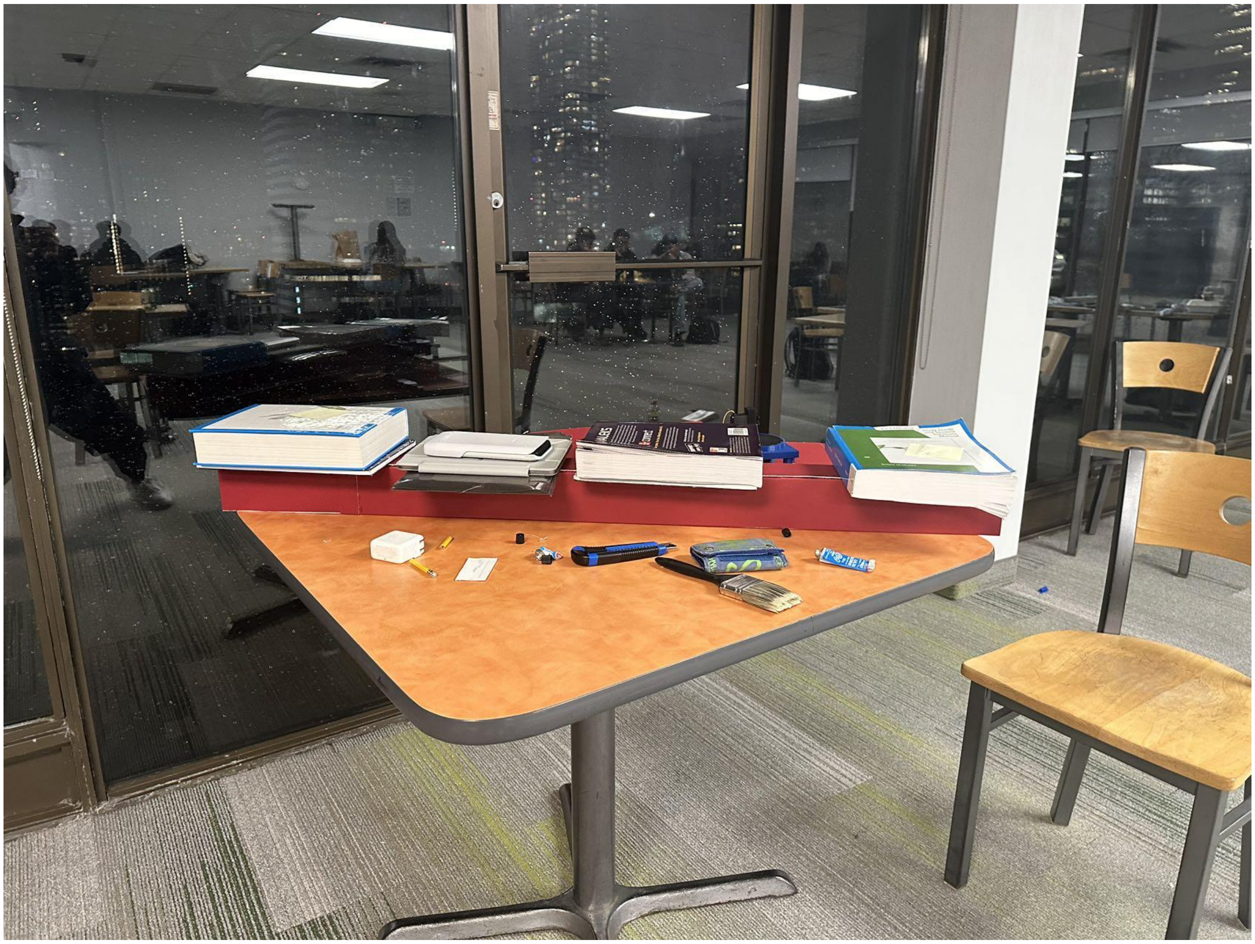
Picture of the Upper Deck (Laminated with 2 pieces of matboard)

Picture of the sides of the bridge in construction (We used different types of mass to hold the diaphragms in place until the glue dries.)

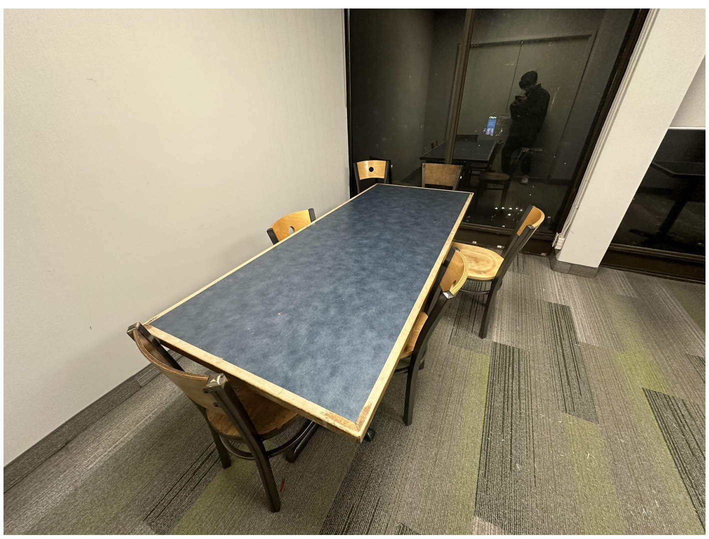
Picture of team members trying to glue the upper side of the bridge to the diaphragms.

The final assembly of the bridge with upper side and lower side glued together.

Pictures of Team members working on Matlab and Fusion 360



Picture of the main body with masses on it when we were trying to glue the bottom piece of the bridge with the sides.



Picture of the design space after building.

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