CIV102 Report

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INTRODUCTION

This project is the CIV102 Bridge Design Project, where teams are working to design and construct a small bridge that is capable of spanning 1,200 mm using only one sheet of matboard and two tubes of contact cement. The design process relies on concepts like beam principle, thin-plate buckling principle, and the material properties. By iteratively analyzing multiple designs, the team aims to develop a bridge that is both structurally efficient and able to safely carry the moving train load in the testing.

The project's objective is to understand how failure mechanisms constrain the behavior of thin-plate structures. The tensile strength (30 MPa), compressive strength (6 MPa), and shear strength (4 MPa) of Martboard impose clear performance limitations, and compression and buckling are important factors in the design process.

During each design iteration, the team diverged into the design space to consider better possible solutions. After converging, we investigated optimizing web height, flange width, diaphragm spacing, and splice reinforcement to improve stiffness, reduce applied stresses, and delay buckling while staying within the material and constructability constraints. Shear force diagrams (SFDs), bending moment diagrams (BMDs), and their respective envelopes were computed for various train positions to predict applied stresses along the span. These stresses were then compared with material and buckling capacities to determine the factor of safety for each failure situation. This report provides an overview of the design process during building a bridge, and the engineering skills with CIV102 concept was collaborative to build a safe and effective bridge.

DESIGN ITERATION

Initially, we considered a few options. In our first concept diverging stage, we thought of different cross-sections that may be available to us to start from. Choosing between triangular, trapezoidal, and rectangular, we ultimately decided on using a rectangular cross-section.

Firstly, triangular cross-sections proved hard to find in literature (and we trusted it was likely for good reason). Secondly, choosing between trapezoidal and rectangular, noting that modelling is an important part of this project, we chose rectangular for the simplified geometry and load profiles.

BIBLIOGRAPHY

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USE THIS FOR CITATIONS

[1] C. P. Heins, "Box Girder Bridge Design; State of the Art," Engineering Journal, vol. 15, no. 4, pp. 126–142, Dec. 1978, doi: https://doi.org/10.62913/engj.v15i4.322.

[2] Juan Camilo Molina-Villegas, J. Eliecer, and Giovanni Martínez Martínez, "Closed-form solution for non-uniform Euler–Bernoulli beams and frames," Engineering structures/Engineering structures (Online), vol. 292, pp. 116381–116381, Oct. 2023, doi: https://doi.org/10.1016/j.engstruct.2023.116381.

APPENDIX

AI Statement

No form of AI was used in planning the lab, writing the lab, or writing the processing code.

AI was used to spell-check the report after finishing with the prompt "Note any typing errors". 6 minor suggestions regarding spelling mistakes were accepted. I decided to use it because there is no spell checker available in my IDE for LaTeX.