Teaching Steel Beam Design with RUBBER!

Development of a Novel Teaching Tool for Steel Beams and Connections

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What Do We Know ?

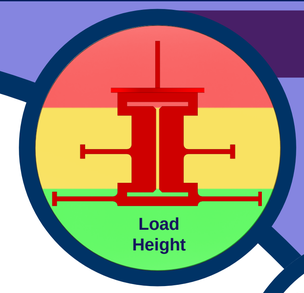
When designing steel I beam structures, their loads and dimensions are often governed by lateral torsional buckling (LTB). LTB is a mode of failure which is mathematically complicated and difficult to physically visualize.

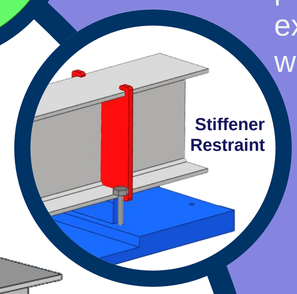
More than 20% of current university students and many practicing engineers really struggle [1] to understand the visual link between LTB math and physical behaviour making it one of the **most difficult topics in civil engineering.**

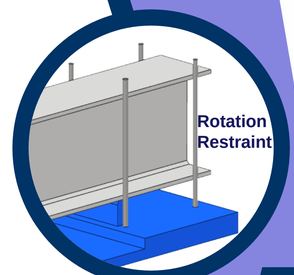
Why Does it Matters?

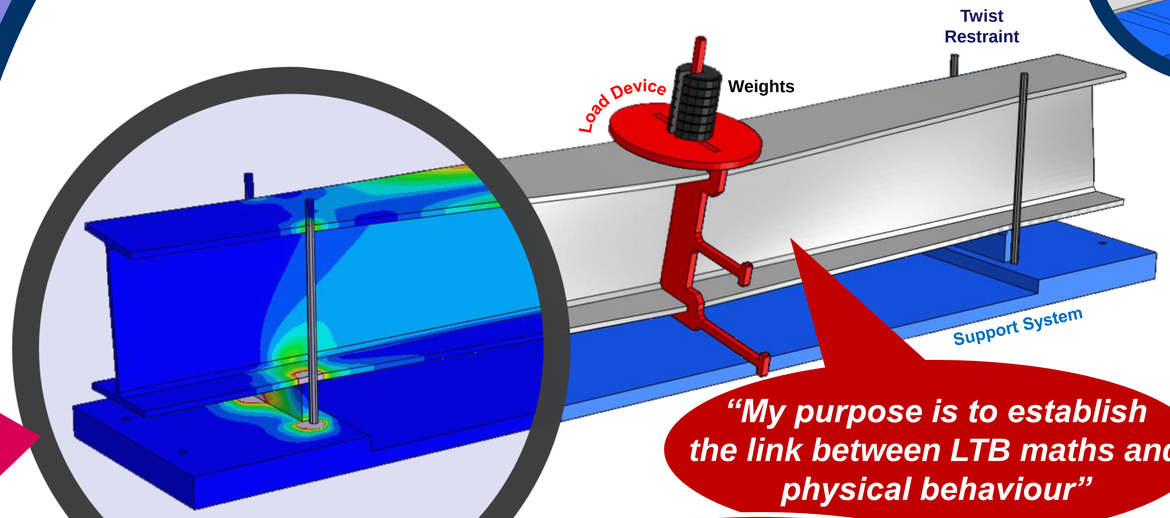
To date, there is no existing research on improving teaching for LTB [2]. Current methods involve dated texts or diagrams. It is critical today's civil engineers have a thorough understanding of LTB. Poorly designed steel I beam structures can be dangerous and, in severe cases, **result in the loss of life.**

WHAT IS LATERAL TORSIONAL BUCKLING?









"My purpose is to establish the link between LTB maths and physical behaviour"

"I am also made of rubber! I am reusable by bending back after deformation!"

"the behaviour generated by loading a steel beam so one flange laterally bends out of plane limiting the strength"

To provide enrichment and clarity on learning steel I beam design

What Has Been The Impact?

The teaching tool's additional features include the ability to display the effects of load height, bolted stiffener restraints and rotation restraints to name a few. All these comprehensive features and many more were exercised through a third year civil course where students completed an assignment with a **hands on lab!** This was possible inside a generic classroom due to the compact design of the teaching tool.

WE DEVELOPED A TEACHING TOOL!

1) Material and Math

The first stage involved selecting a reusable material with an elastic nature unlike steel. This was a rubber called polyurethane. Using NZS3404 [3], the steel standard used in the industry, we back calculated a suitably sized I beam for the teaching tool.

2) Design and Fabricate

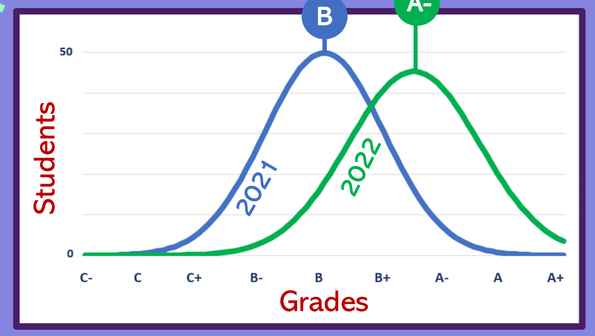
This stage involved designing namely a **support system** for the I beam, a **load device** to hold **weights** and the rest of the components. These were then all fabricated.

3) Finite Element Analysis

The last stage involved developing numerical models in Abaqus to be used as further material in aiding the teaching of more difficult concepts.

Results and Future

When comparing student grades for LTB in the course before and after the teaching tool was exposed. There is an expected increase between averages.



Alongside the grade increase, students gave feedback with great positivity after each lab. The successful design of the teaching tool itself has been very rewarding. As **a world's first** in education of steel I beam design, this enables many new opportunities for students, teachers and even practising engineers due to the complex features while serving as an influence to younger generations.

References

[1] G.C. Clifton. University of Auckland Associate Professor and Senior Civil Engineering Lecturer. (2021)
[2] K. Cheng, G.C. Clifton, L. Hogan. Development of a Demonstration Teaching Tool for I section Flexural Buckling. (2021)
[3] G.C. Clifton, B.J. Brown, J.W. Butterworth, T.W. Robertson. NZS3404 Steel Structures Standard. (1997)