Truss bridge under static loading

A dataset containing the reaction of a laboratory-scale truss bridge to static loading

# Introduction

This dataset is designed to identify the loads transmitted through the struts of a truss bridge when the bridge is loaded. Various loading scenarios are included, and the effect of damage to the bridge is also tested.

# Bridge geometry

The structure of interest is a laboratory-scale truss bridge, shown in Figure 6, which was constructed at the Laboratory for Verification and Validation (LVV) in Sheffield. The bridge is a truss bridge of standard design, and it can be compared to many real-life structures around the world. The main load-bearing components of bridges of this type are the trusses, or struts.

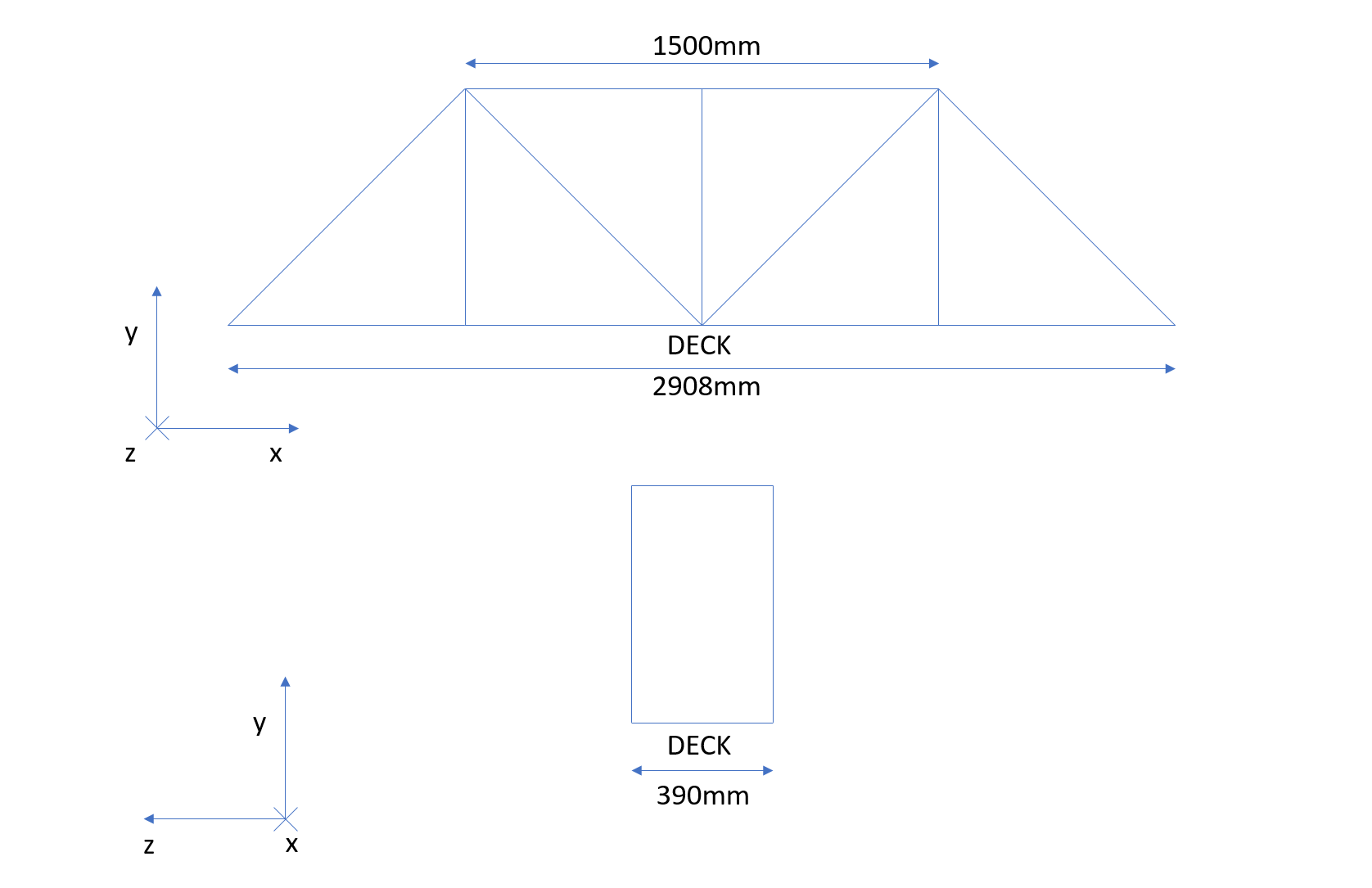


Figure : A schematic of the bridge structure with key dimensions marked

The bridge is 700mm in height, 390mm in width and 2908mm in length; see FIGURE The struts and deck are cut from aluminium plate of 4mm and 3mm depth respectively. The longer, diagonal, struts are 1006.52mm in length and the shorter, vertical, struts are 700mm in length; both are 20mm in height. The deck border and upper frame are constructed from aluminium Rexroth, which is of 20mm in depth and height; the upper frame is of 1500mm in length. The deck is of 390mm width and 2908mm length, which are the same as the bridge as a whole.

# Strain gauge calibration

Before the tests were carried out, the strain gauges on the struts were calibrated to ensure accurate measurement. This process was carried out by applying a series of known loads to the struts. The struts were pinned at one end, while dead weights were attached at the other to apply the load. Ten-kilogram weights were used, up to a maximum load of 40 kg. The setup used is shown in Figure 1.

A picture containing indoor, building, orange, table

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Figure : The test rig used for calibration of the strain gauges

The results of the calibration process were highly satisfactory. As can be seen in Figure 2, the strain response to load was highly linear over the range tested, making the following numerical calibration tasks trivial. The correlation coefficient for each test was 1 (accurate to five decimal places).

It should be noted that the gradient of Strut 4 under loading was different to the others, but given that it is still linear, this can be easily accounted for in calibration.



Figure : The results of the strain gauge calibration tests for each strut

The least squares fit was then calculated for each strut on the assumption of linear correlation. The projected error using this approximation is shown in Figure 3. It should be noted that the error remains very low (less than 1%) at all values, particularly when higher loads are used. These errors are due to measurement noise on the strain gauges and random errors associated with measurement of the weights used in loading.



Figure : The error associated with the linear fit for each strut

# Methodology and nomenclature

This section outlines the procedures followed in the static tests carried out, as well as defining the nomenclature of the test conditions.

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Figure : The labels for each bridge strut

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Figure : The labels for each experimental load point

Strain gauges were placed on strut 1 to 4, which represent each structurally unique section in the bridge. A variable deadweight mass of up to 50kg was placed at each load point (for example see Figure 6). The attachment also shown was rigid in an effort to reduce any pinching effect applied to the deck by the load. The load transmitted was recorded using the calibrated strain gauges as load cells.

A picture containing indoor, table, sitting, blue

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Figure : The rig used for the full bridge test (attachment shown in red box)

## Undamaged condition load tests

The first run of tests designed were carried out with the bridge in its undamaged, healthy condition. The loads at struts 1 to 4 were recorded for a range of loads at each load point (shown in Figure 5).

## Damaged condition load tests

In order to investigate a worst-case damage scenario, tests were carried out as before with single struts removed entirely. This situation effectively replicates the fully damaged scenario.

Tests were carried out in which the diagonal struts were removed, as these contributed far more to load-bearing than the vertical.

# Format of dataset

The dataset is a structure containing:

1. healthy\_state, containing the data from the undamaged condition load tests, is organised by load point (rows)
   1. rows of cell represent load point A to U
   2. each cell entry contains a row of loads applied (kg), followed by rows containing the response (kg) at struts 1 to 4 at each load
2. damage\_state, containing the data from the damaged condition load tests, is organised by load point (rows) and strut removed (columns)
   1. rows of cell represent load point H to N (along centreline of bridge deck)
   2. columns of cell represent strut removed (5, 7, 8, 10, 12, 14)
   3. each cell entry contains a row of loads applied (kg), followed by rows containing the response (kg) at struts 1 to 4 at each load