STR2
Bending Moment in a Beam
Student's Guide

TecQuipment has taken care to make the contents of this manual accurate and up to date. However, if you find any errors, please let us know so we can rectify the problem.

TecQuipment supply a Packing Contents List (PCL) with the equipment. Carefully check the contents of the package(s) against the list. If any items are missing or damaged, contact TecQuipment or the local agent.

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PE/AD/ajp/db/0210

SECTION 1 INTRODUCTION AND DESCRIPTION

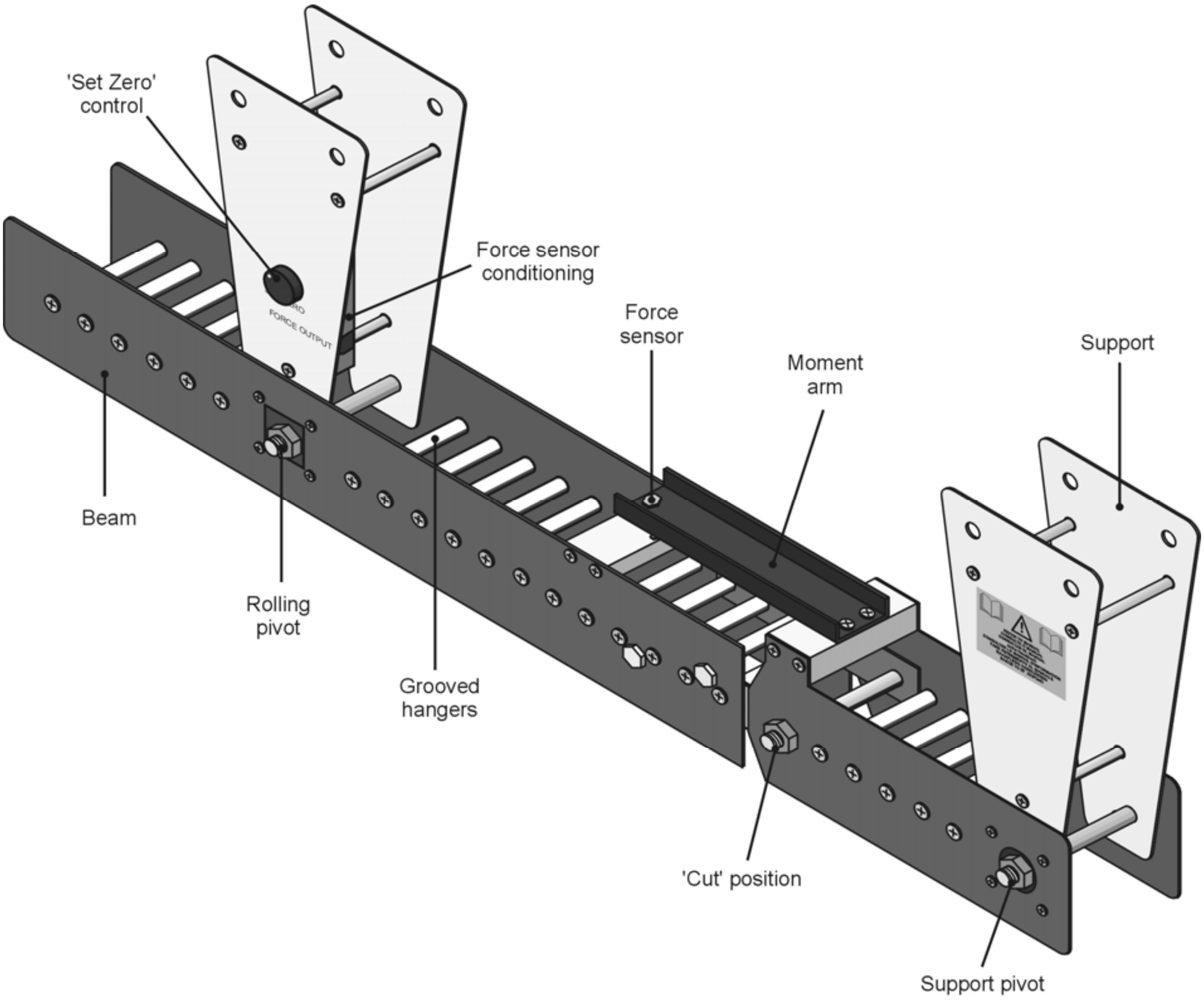

Figure 1 Bending moment in a beam experiment

Introduction

This guide describes how to set up and perform Bending Moment in a Beam experiments. It clearly demonstrates the principles involved and gives practical support to your studies.

Description

Figure 1 shows the Bending Moment in a Beam experiment. It consists of a beam, which is 'cut' by a pivot. To stop the beam collapsing a moment arm bridges the cut onto a load cell thus reacting (and measuring) the bending moment force. A digital display shows the force from the load cell.

A diagram on the left-hand support of the beam shows the beam geometry and hanger positions. Hanger supports are 20 mm apart, and have a centre slot, which positions the hangers. The moment arm is 125 mm long.

How to Set up the Equipment

The Bending Moment in a Beam experiment fits into a Test Frame. Figure 2 shows the Bending Moment of a Beam experiment assembled in the Frame.

Before setting up and using the equipment, **always:**

- Visually inspect all parts, including electrical leads, for damage or wear.
- Check electrical connections are correct and secure.
- Check all components are secured correctly and fastenings are sufficiently tight.
- Position the Test Frame safely. Make sure it is mounted on a solid, level surface, is steady, and easily accessible.

Never apply excessive loads to any part of the equipment.

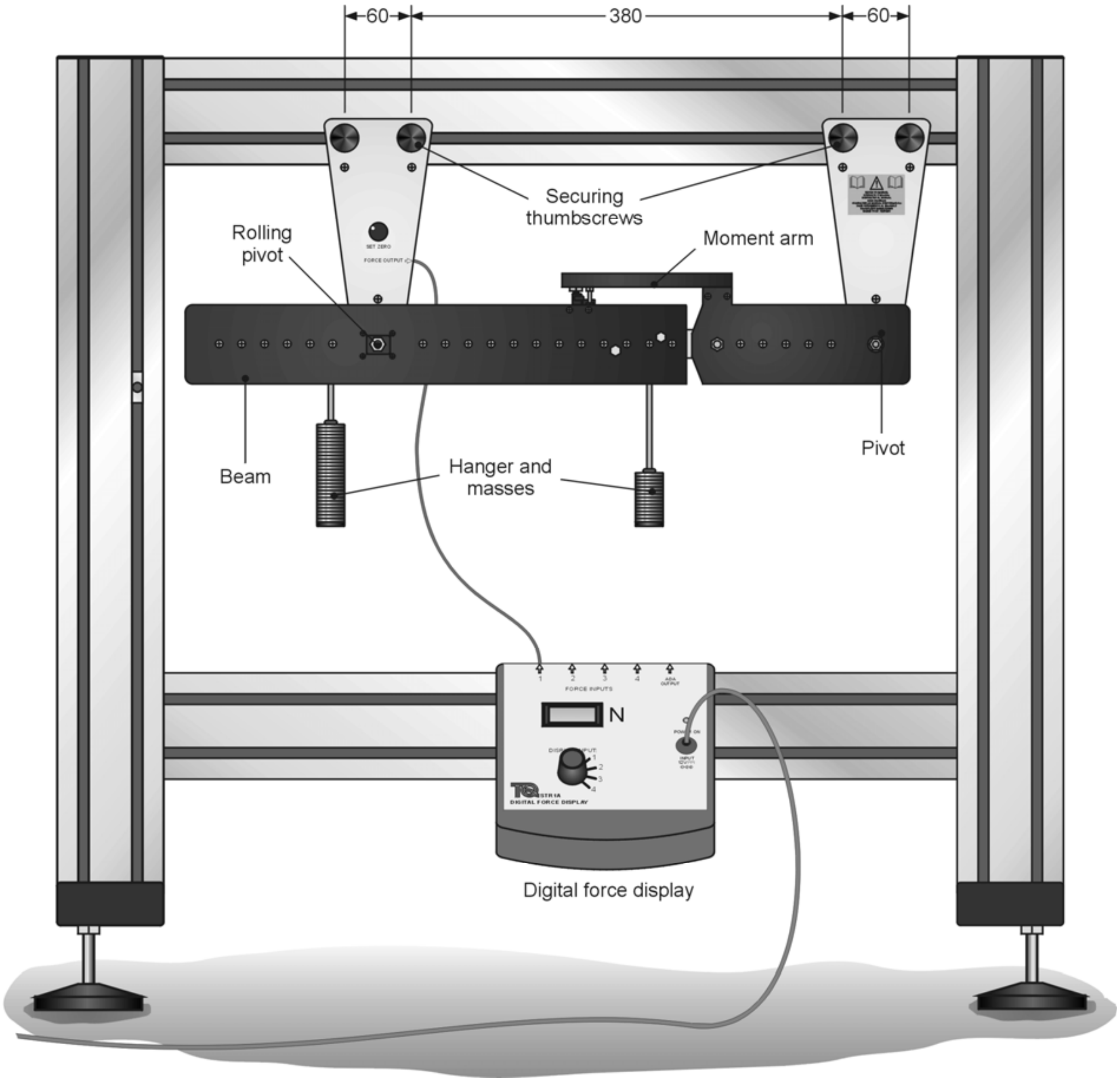

Figure 2 Bending moment of a beam experiment in the structures frame

Steps 1 to 4 of the following instructions may already have been completed for you.

1. Place an assembled Test Frame (refer to the separate instructions supplied with the Test Frame if necessary) on a workbench. Make sure the ‘window’ of the Test Frame is easily accessible.
2. There are four securing nuts in the top member of the frame. Slide them to approximately the positions shown in Figure 3.
3. With the right-hand end of the experiment resting on the bottom member of the Test Frame, fit the left-hand support to the top member of the frame. Push the support on to the frame to ensure that the internal bars are sitting on the frame squarely. Tighten the support in position by screwing two of the thumbscrews provided into the securing nuts (on the front of the support only).
4. Lift the right-hand support into position and locate the two remaining thumbscrews into the securing nuts. Push the support on to the frame to ensure the internal bars are sitting on the frame squarely. Position the support horizontally so the rolling pivot is in the middle of its travel. Tighten the thumbscrews.
5. Make sure the Digital Force Display is ‘on’. Connect the mini DIN lead from ‘Force Input 1’ on the Digital Force Display to the socket marked ‘Force Output’ on the left-hand support of the experiment. Ensure the lead does not touch the beam.
6. Carefully zero the force meter using the dial on the left-hand beam of the experiment. Gently apply a small load with a finger to the centre of the beam and release. Zero the meter again if necessary. Repeat to ensure the meter returns to zero.

Note: If the meter is only ±0.1 N, lightly tap the frame (there may be a little stiction and this should overcome it).

SECTION 2 EXPERIMENTS

Experiment 1: Bending Moment Variation at the Point of Loading

This experiment examines how bending moment varies at the point of loading. Figure 3 shows the force diagram for the beam.

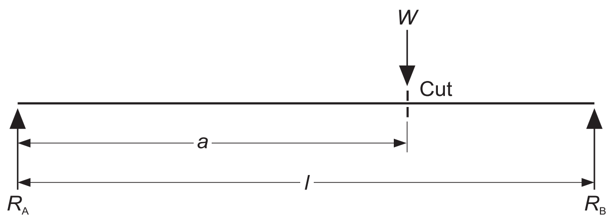

Figure 3 Force diagram

The equation we will use in this experiment is:

$$\text{BM (at cut)} = Wa\frac{(l-a)}{l}$$

You may find the following table useful in converting the masses used in the experiments to loads.

Mass (Grams)	Load (Newtons)
100	0.98
200	1.96
300	2.94
400	3.92
500	4.90

Table 1 Grams to Newtons conversion table

Check the Digital Force Display meter reads zero with no load.

Place a hanger with a 100 g mass at the 'cut'. Record the Digital Force Display reading in a table as in Table 1. Repeat using masses of 200 g, 300 g, 400 g and 500 g.

Convert the mass into a load (in N) and the force reading into a bending moment (Nm). Remember;

$$\text{Bending moment at the cut (in Nm)} = \text{Displayed force} \times 0.125$$

Calculate the theoretical bending moment at the cut and complete Table 2.

Mass (g)	Load (N)	Force (N)	Experimental bending moment (Nm)	Theoretical bending moment (Nm)
0				
100				
200				
300				
400				
500				

Table 2 Results for Experiment 1

Plot a graph which compares your experimental results to those you calculated using the theory.

Comment on the shape of the graph. What does it tell us about how bending moment varies at the point of loading? Does the equation we used accurately predict the behaviour of the beam?

Experiment 2: Bending Moment Variation away from the Point of Loading

This experiment examines how bending moment varies at the cut position of the beam for various loading conditions. Figure 4, Figure 5 and Figure 6 show the force diagrams.

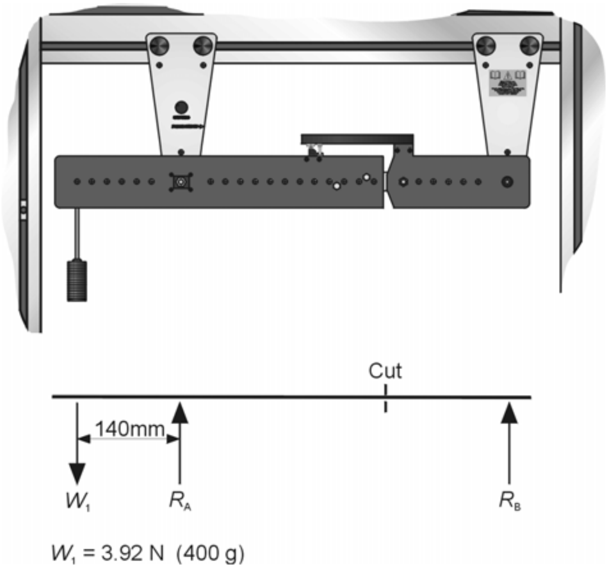

Figure 4 Force diagram

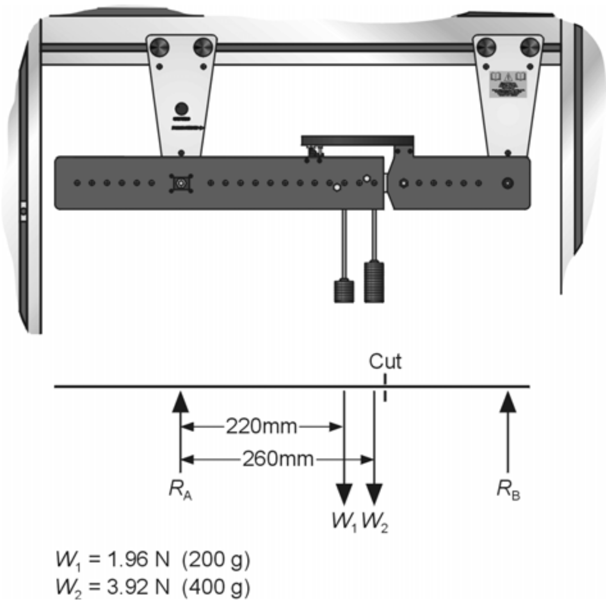

Figure 5 Force diagram

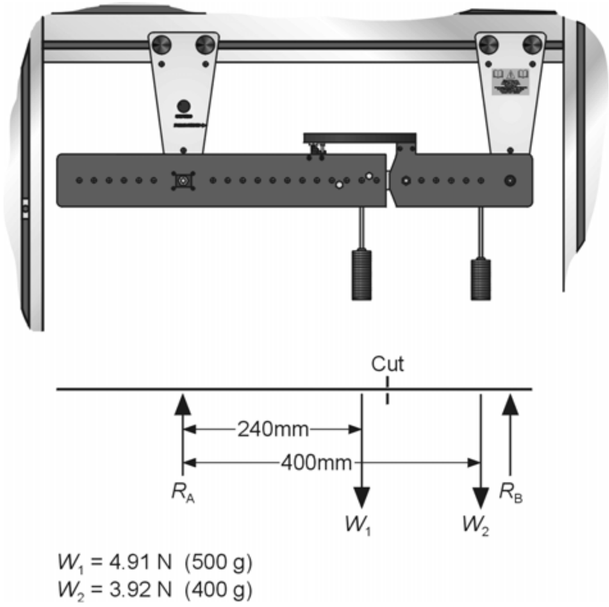

Figure 6 Force diagram

We will use the statement:

"The Bending Moment at the 'cut' is equal to the algebraic sum of the moments caused by the forces acting to the left or right of the cut."

Check the Digital Force Display meter reads zero with no load.

Carefully load the beam with the hangers in the positions shown in Figure 4, using the loads indicated in Table 3. Record the Digital Force Display reading in a table as in Table 2.

Convert the force reading into a bending moment (in Nm). Remember;

$$\text{Bending moment at the cut (in Nm)} = \text{Displayed force} \times 0.125$$

Calculate the support reactions (R_A and R_B) and calculate the theoretical bending moment at the cut.

Repeat the procedure with the beam loaded as in Figure 5 and Figure 6.

Comment on how the results of the experiments compare with those calculated using the theory.

Figure	W_1 (N)	W_2 (N)	Force (N)	Experimental bending moment (Nm)	R_A (N)	R_B (N)	Theoretical bending moment (Nm)
4	3.92						
5	1.96	3.92					
6	4.91	3.92					

Table 3 Results for Experiment 2