Free report on the objectives of this experiment are listed as follows

Literature

Introduction

Beams are very crucial elements in engineering structures. They carry the loads and the weight of the structure and then transmit them to the supports . There are various types of beams configuration that engineers must select depending on the application. These include simply supported beams, cantilever beams and curved beam amongst others. Curved beams are very common in complex structures such as bridges, forklift hooks, crane hooks and in many other applications. Analysis of curved beams is complex compared to that of cantilever and simply supported beams. Thus, in order to enhance the structural integrity of the structure, engineers must ensure that the design of the curved beam is done well. Deflection of beams is dependent on a number of parameters such as loading position, loading condition, type of the beam, magnitude of the load and material of the beam amongst many other factors. Engineers carry out various experiments to determine the various parameters when designing using curved beams. Determination of end displacement in a curved beam. Hence this, report is concerned with determination of end displacement of curved beam using both experimental and theoretical investigations. This report will also compare theoretical and experimental values and account for their deviation.

Objective

Theory

A curved beam loaded at one end will deform in addition to being strained. The resulting deflection is quantified by two components; δv (vertical) and δv (Horizontal). By using Castigliano's theorem , the deflections are expressed by equations that involve load (W), Dimension of the beam (R), the material(E) and the cross-section properties (I) of the beam .

The mild steel curved beams that have been tested in this experiment as well as their corresponding vertical and horizontal displacement are shown below:

Figure 1: Beam 1

The horizontal and vertical displacement of beam 1 are shown below.

Figure 2: Beam 2

The horizontal and vertical displacement of beam 2 are shown below.

Figure 3: Beam 3

The horizontal and vertical displacement of beam 3 are shown below.

Methodology

Apparatus

The apparatus used in this experiment are listed as follows:

- Norwood curved bar apparatus

- Weights

- Dial gauges

- Bridge

- Curved beam (Dimensions, radii: 150mm, B*D: 20 mm* 50 mm, E: 200 Gpa)

Procedure

The Norwood curved bar apparatus was set-up and the first curved beam (Beam 1) was attached . Loading was done up to the safe weight (80 N for beam 1) for beam 1. This was done in steps of 10 N. The vertical deflection δv and horizontal deflection δh. Extreme care was ensured for accurate results to be obtained. The above procedure was repeated for the beam 2 and beam 3. The results obtained for the three beam are tabulated in the following section. Extreme care was ensured when lifting the weigh on and off the machine. After the experiment, all the weights were put back in proper place. The analysis of data obtained in this experiment is described in the following section.

Results and data analysis

The results obtained in this experiment are tabulated as follows:

Graphs and calculation

Beam 1

Beam 2

Beam 3

Theoretical values

sample calculation-beam 1

For W= 10 N

I= bh312= 20*5312= 208. 33 mm4

E= 200 Gpa= 200000 N/mm2

% error= Theoretical value-measured valueTheoretical value*100 %

vertical deflection

δv= 2 W R3EIπ8-1π

δv= 2 *10* 1503200000*208. 33 π8-1π= 12. 05 mm

% error= 12. 05-13. 512. 05*100= 12. 03 %

Horizontal deflection

δh= W R3EI= 2*10* 1503200000*208. 33= 2. 8 mm

% error= 2. 8-32. 8*100= 7. 142 %

sample calculation-beam 2

For W= 10 N

Horizontal deflection

δh= 2 W R3EI= 2*10* 1503200000*208. 33= 49. 5 mm

% error= 49. 5-55*10049. 5= 11. 11 %

vertical deflection

δv= π W R32EI

δv= π *10* 15032*200000*208. 33 = 148. 3 mm

% error= 148. 3-155148. 3*100= 4. 51 %

Sample calculation-beam 3

For W= 10 N

Horizontal deflection

δh= W R32EI= 2*10* 15032*200000*208. 33= 61. 8 mm

% error= 61. 8 -66. 561. 8 *100= 7. 6 %

vertical deflection

δv= Wπ R34EI=

δv= 10*π* 15034*200000*208. 33 = 61. 8 mm

% error= 61. 8 -71. 561. 8 *100= 15. 7 %

The remaining theoretical deflections were calculated using the same methodology and tabulated as shown in table 2.

Discussion

The deflection of the three beams has been determined experimentally and theoretically. The investigation involved has shown that both vertical deflections are small in beam 1 followed by beam followed by beam 3 and finally beam 2 had the largest deflection. On the other hand, horizontal deflection were small in beam 1 and largest in beam 2. This was consistent with our expectations. Beam 1 is more rigid and hence small deflections were expected. The investigations has shown that due to the difference in deflection, the applications of the three types of beams in must differ. beam 1 is much suited in situations where small deflections are expected, on the other hand beam 2 configuration is more suited where large deflections are allowed. The graphs of vertical and horizontal deflections versus load for the three beams has shown linear relationship between deflection and load. This was expected for all the configurations since the equations governing vertical and horizontal deflections for the three beams were linear. Comparison of experimental and theoretical values for vertical and horizontal deflection have shows a very small deviation between the two values. This shows that the methodology adopted herein was very successful in predicting the deflection of the beam. We can attribute the small deviation between the experimental values and theoretical values to experimental errors. We can attribute this small deviation to a number of experimental errors.

- Composition of material of the specimens provided was only labeled as mild steel . Further details on the alloy composition were not provided. Therefore, the experimental value obtained from this work may be different from that theoretical value because of the assumed value of E used in the calculation.

- The specimens provided in the lab had been tested earlier. This could have interfered with the homogenous and isotropic structure of the material. In addition, the manufacturing process adopted may differ in terms of quality of the inter-granular structure.
- Finally, we can attribute this deviation to manufacturing errors and material deformation during preparation of the specimen.

Conclusion

The main objective of this experiment was to measure the deflection of the three curved beams and compare the results obtained with theoretical values. From this experiment, it can be deduced that beam 2 had the largest deflection followed by beam 3 and finally beam 1 with the smallest deflections. Despite the various experimental errors explained in the previous section, the results obtained were acceptable and compared well with theoretical values stated in values.

Works cited

Beer, Ferdinand P, et al. Mechanics of Materials. McGraw Hill, 2009.

Chawla, M. A. Mechanical Behavior of Materials. Cambridge: Cambridge University Press, 2000.