KWAME NKRUMAH UNIVERSITY OF SCIENCE AND TECHNOLOGY

COLLEGE OF ENGINEERING

DEPARTMENT OF MECHANICAL ENGINEERING

MECHANICAL ENGINEERING LAB IV (ME 396)

GROUP N

TITLE OF EXPERIMENT: CIRCULAR BENDING

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INTRODUCTION

The axis of the beam deflects from its initial position under action of applied forces. Accurate values for these beams deflections are sought in many practical case: elements of machines must be sufficiently rigid to prevent misalignment and to maintain dimensional accuracy under load; in buildings ,floor beams cannot deflect excessively to avoid the undesirable psychological effect of flexible floors on occupants and to minimize or prevent distress in brittle-finish materials; likewise, information on deformation characteristics of members is essential in the study of vibrations of machines as well as of stationary and flight structures.

THEORY

The formula that will be used is

$$\frac{M}{I} = \frac{E}{R}$$

Where

M = Applied moment

R = radius of curvature

E = Young's modulus for cantilever material (Nm^{-2}) I

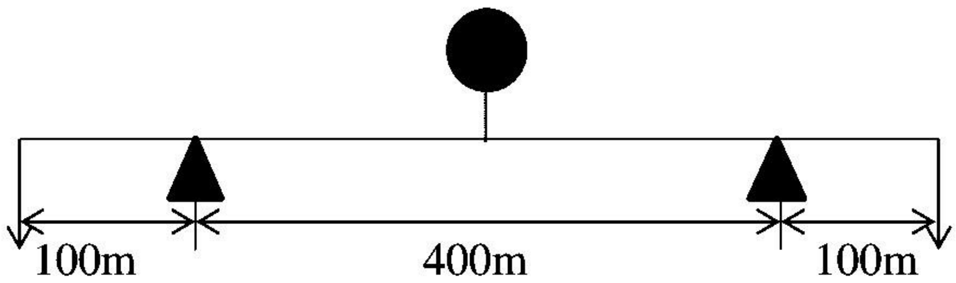
= Second moment of area of the cantilever.

$$R = \frac{c^2+4h^2}{8h}$$

APPARATUS

1. Beam apparatus with movable knife frame (bending fixture)
2. Vernier calipers, dial gauge, and a Tape measure. Calipers should be used to measure the width and thickness of the beam. Dial gauge will be used to measure the deflection of the beam. The tape measure is used to measure the length of the test region.
3. Metal beam (aluminum, brass and steel)

EXPERIMENTAL SETUP



PROCEDURE

Using a Vernier, measure the width and depth of the aluminum, brass and steel test beams. For each material, record the values next to the results tables and use them to calculate the second moment of area, I

Remove any clamps from the backboard and set up the beam. Slide the digital dial test indicator into position on the beam and lock it using the thumbnut at the rear. Slide a knife edge hanger onto each end of the beam.

Tap the frame lightly and zero the digital dial test gauge or indicator using the origin button. Tapping the frame lightly each time apply masses to the knife-edge hangers in increments. Record the digital dial test indicator reading for each increment of mass. Repeat the procedure for the other two specimens.

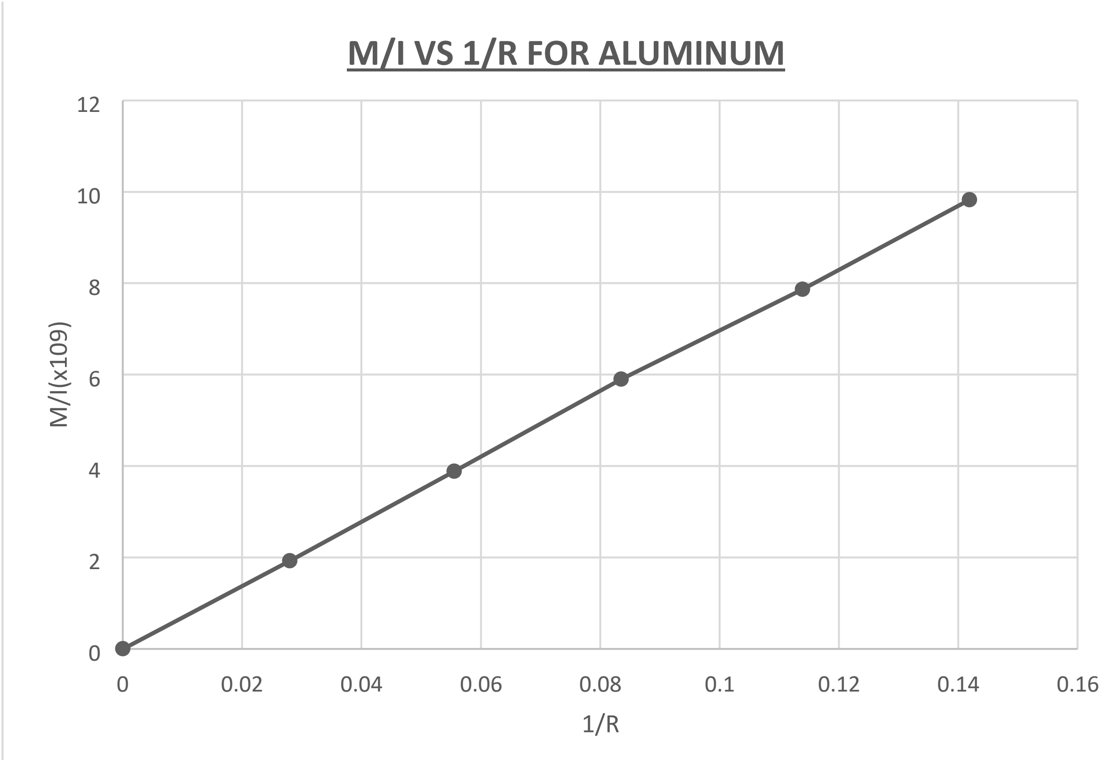
RESULTS TABLE OF VALUES

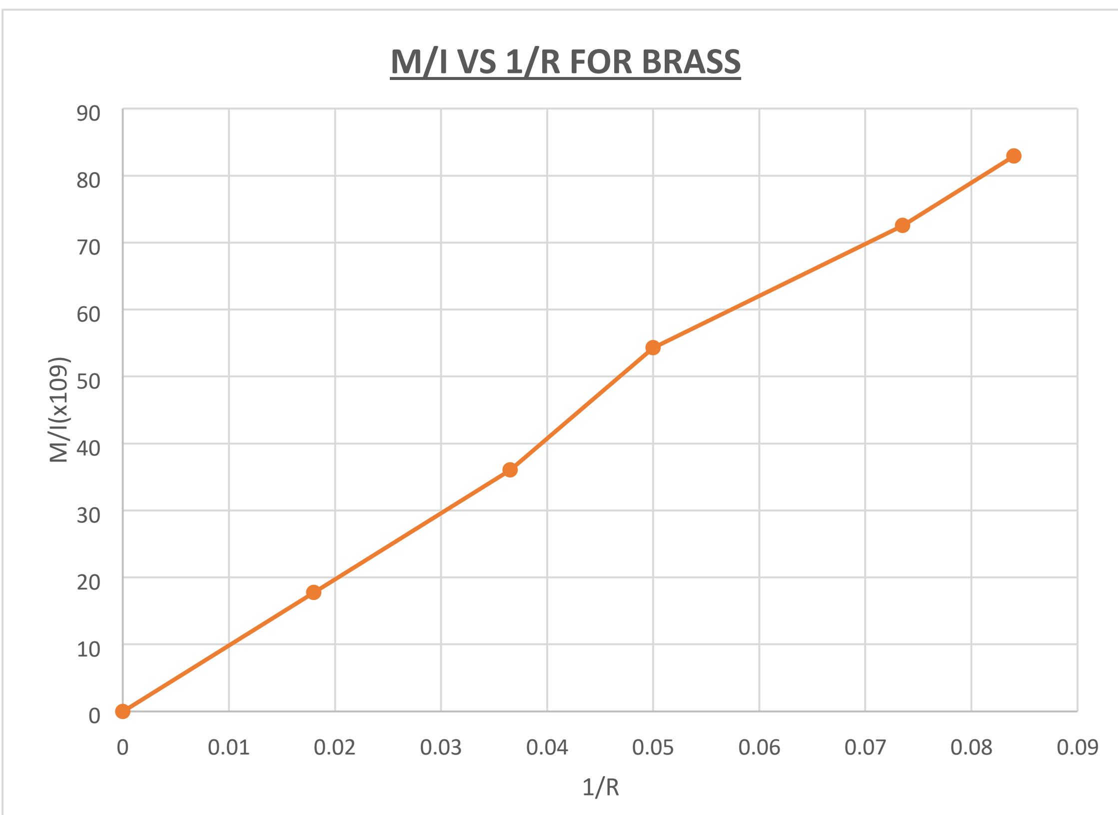
Aluminum		**E value =** 69×10^{9} Nm^{-2}	**Width,** b=9mm	**Depth,** d=3mm	**I=**$2.025\times10^{-11}m^{4}$
Mass of each end (g)	**Deflection (mm)**	**Applied moment (Nm)**	**Radius of curvature(m)**	**1/R**	**M/I(**$\times10^{9}$**)**
0	0	0	∞	0	0
100	0.56	0.0391	35.7145	0.02799	1.93
200	1.13	0.0785	18.019	0.0555	3.89
300	1.71	0.1181	11.977	0.0835	5.90
400	2.28	0.1611	8.7730	0.1139	7.87
500	2.85	0.2007	7.0436	0.1419	9.83

Brass		**E value =** 105×10^{9} Nm^{-2}	**Width,** b=9mm	**Depth,** d=3mm	**I=**$2.025 \times 10^{-11} m^4$
Mass of each end (g)	**Deflection (mm)**	**Applied moment**	**Radius of curvature(m)**	**1/R**	**M/I(**$\times 10^{9}$**)**
0	0		∞	0	0
100	0.31		0.0383	0.0180	17.778
200	0.64	**(Nm)** 0 0.36 0.73 1.10 1.47 1.68	0.0776	0.0365	36.049
300	0.97		0.1063	0.0500	54.321
400	1.50		0.1562	0.0735	72.593
500	1.66		0.1786	0.0840	82.963

Steel		**E value =** 207×10^{9} Nm^{-2}	**Width,** b=9mm	**Depth,** d=3mm	**I=**$2.025 \times 10^{-11} m^4$
Mass of each end (g)	**Deflection (mm)**	**Applied moment**	**Radius of curvature(m)**	**1/R**	**M/I(**$\times 10^{9}$**)**
0	0		∞	0	0
100	0.19		105.263	0.0095	1.966
200	0.38	**(Nm)** 0 0.03982 0.07964 0.1174 0.1572 0.1970	52.632	0.019	3.933
300	0.56		35.715	0.028	5.798
400	0.75		26.667	0.0375	7.763
500	0.94		21.277	0.047	9.728

GRAPHS


M/I VS 1/R FOR ALUMINUM
M/I(x109)
1/R
0
2
4
6
8
10
12
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16


M/I VS 1/R FOR BRASS
M/I(x109)
1/R
0
10
20
30
40
50
60
70
80
90
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08
0.09

GRADIENT CALCULATIONS

Aluminum specimen

Slope = 68.75 GNm^{-2}

Brass specimen

Slope = 987.62 GNm^{-2}

Steel specimen

Slope= 105.00 GNm^{-2}

PRECAUTIONS

1. Parallax errors were avoided when setting the dial test indicator.
2. The beam was properly placed on the supports before the weight hangers.
3. The experimental setup was not disturbed during the experiment which could have affected the deflection.

CONCLUSION

1. The graphs of M/I against 1/R for all three specimens are straight lines and are directly proportional to each other.
2. From the graphs, the slopes (gradients) of the graphs denote the corresponding E values thus the Young's modulus of the specimens.
3. Every specimen has its maximum deflection.

REFERENCES

1. E P Popov; Sammurthy Nagarajan; Z A Lu. "Mechanics of Material".
2. Englewood Cliffs, N.J.: Prentice-Hall, ©1976, p. 119, "Pure bending of Beams"