ANJUMAN
COLLEGE OF ENGINEERING & TECHNOLOGY
(MANAGED BY : ANJUMAN HAMI-E-ISLAM, NAGPUR)

Structural Analysis-I Lab Manual

CIVIL ENGINEERING
DEPARTMENT

Roll No:_____
Name:_____________________
Year:_____ Semester:____

ANJUMAN COLLEGE OF ENGINEERING & TECHNOLOGY

ESTD. 1999

Approved by A.I.C.T.E. New Delhi, Recognized by DTE, Mumbai, Affiliated to RTM Nagpur University, Nagpur.

CERTIFICATE

Certified that this file is submitted by

Shri/Ku.____

Roll No.__________ a student of __________ year of the course ____ as a part of PRACTICAL/ORAL as prescribed by the Rashtrasant Tukadoji Maharaj Nagpur University for the subject_______________________________________ in the laboratory of____during the academic year____________________________and that I have instructed him/her for the said work, from time to time and I found him/her to be satisfactory progressive.

And that I have accessed the said work and I am satisfied that the same is up to that standard envisaged for the course.

Date:-	Signature & Name of Subject Teacher	Signature & Name of HOD

Anjuman College of Engineering and Technology

Vision

- To be a centre of excellence for developing quality technocrats with moral and social ethics, to face the global challenges for the sustainable development of society.

Mission

- To create conducive academic culture for learning and identifying career goals.
- To provide quality technical education, research opportunities and imbibe entrepreneurship skills contributing to the socio-economic growth of the Nation.
- To inculcate values and skills, that will empower our students towards development through technology.

Vision and Mission of the Department

Vision:

- To be the centre of excellence for developing quality Civil Engineers with moral and social ethics to face global challenges for the sustainable development of society.

Mission:

- To create conductive academic culture for learning and identifying career goals.
- To impart quality technical education along with research opportunities.
- To impart knowledge and generate entrepreneurship skills contributing to socio-economic growth of the nation.
- To inculcate values and skills, that will empower our students, towards National development through technology, to preserve nature and its resources.

Program Educational Objectives (PEOs)

- Apply technical knowledge to find solution to the challenges in various areas and to develop independent thinking in the field of Civil Engineering.
- Have analyze, design, technical and soft skills, for solving problem Civil Engineering.
- Inculcate morality professionals and ethical sense and self confidence.
- Take higher education or lifelong learning and contribute in research and development throughout life.

Program Specific Outcomes (PSOs)

- An ability to plan, analyze, design and execute low cost housing and construction works.
- An ability to provide the basic facilities with optimal utilization of resources to meet the societal needs.

PROGRAM: CE	DEGREE: B.E
COURSE: Structural Analysis-I	SEMESTER: IV CREDITS:
COURSE CODE: BECVE401P	COURSE TYPE: REGULAR
COURSE AREA/DOMAIN:	CONTACT HOURS: 2 hours/Week.
CORRESPONDING LAB COURSE CODE :	LAB COURSE NAME : Structural Analysis -I

COURSE PRE-REQUISITES:

C.CODE	COURSE NAME	DESCRIPTION	SEM
BECVE401P			IV

LAB COURSE OBJECTIVES:

- This course explains the debate for each object oriented design principle.
- Draw a high level class diagram in UML for each pattern.
- Classify how the different components of the pattern collaborate with each other.
- List the consequences of each pattern to the overall software quality of a system.

COURSE OUTCOMES: Design Patterns

After completion of this course the students will be able -

SNO	DESCRIPTION	BLOOM'S TAXONOMY LEVEL
CO.1	***Compare*** the prototype & *analyze* different elements in the structure	LEVEL 4
CO.2	***Apply*** the concept of slope and deflection to solve the beam	LEVEL 3
CO.3	***Relate*** the behavior of column in different end conditions & *solve* for critical load	LEVEL 1
CO.4	***Apply*** concept of horizontal thrust in maintaining parabola of two hinged parabolic arch for external loading & *analyze* the horizontal thrust	LEVEL 4
CO.5	***Compare*** the experimental and theoretical results	LEVEL 2

Lab Instructions:

- Students should come to the lab on time unless prior permission is obtained from the supervisor. As per department policy, a grace period of 10 minutes will be given to late

  students. Student arriving after 10 minutes of the starting time will be considered absent.

  Hence, he/she will automatically receive "zero" mark for the lab report.
- Students will be divided in to groups (preferably 2/3 students in a group). Each group will be given a handout. This will serve as a guide for them throughout the experiment.
- All students must have to submit the lab report just after the entrance and before the class

  start.
- Lab reports have to be submitted serially.
- Students have to complete the sample calculations and graphs in class and take sign from

  the course teacher. (In some experiment which require more times, should be completed

  as possible in class time.)
- Students should be very careful about any test. They should conduct the tests by taking

  maximum care of the equipment during test.
- Thoroughly clean your laboratory work space at the end of the laboratory session.
- Keep work area neat and free of any unnecessary objects.

- Never block access to exits or emergency equipment.
- Food and drink, open or closed, should never be brought into the laboratory.
- Know the location of all the exits in the laboratory and building at the time of emergency.

Continuous Assessment Practical

Exp No	NAME OF EXPERIMENT	Date	Sign	Remark
1	To verify the Maxwell's reciprocal theorem for beam.			
2	To find the value of Flexural rigidity (EI) for a given beams and compare with theoretical value.			
3	To find the slope and deflection of continuous beam			
4	Determination of deflection of trusses			
5	To find horizontal thrust for two hinge arch.			
6	To calculate horizontal deflection at roller end in two hinged arch			
7	To determine horizontal thrust for indeterminate portal frame			
8	To study the behaviour of different types of struts and to calculate the Euler's Buckling load for each case.			
9	To determine the moment required to produce a given rotation at one end of a beam when the other end is i) Pinned ii) Fixed			
10	Study of various types of strain gauges			

CONTENTS

EXPERIMENT NO. – 1

CLERK'S MAXWELL RECIPROCAL THEOREM

AIM:

To verify the Maxwell's reciprocal theorem for beam**.**

APPARATUS :

Mild steel overhand beam, (Fig. 1) dial gauges, weights**.**

Fig.1

THEORY :

Clark Maxwell's theorem in its simplest form states that the deflections of any pint a of any elastic structure due to a load P at any other point B is the same as the deflection of B due to the same load P applied at point A, deflection being measured in the direction of P.

It is , therefore easily derived that the deflection curve of a beam under unit load at any point is the same as the influence line of deflection for that point when a unit load moves along the beam. Thus application of the theorems to a beam can be verified by this experiment by plotting both the curves fro any point.

PROCEDURE :

1. A load of 1 kg is placed either at the centre of the simply supported span or at the free end of the cantilever so that the deflection may be appreciable.
2. Measure the heights of the upper edge of beam at the interval of 10 cms. By means of a dial gauge before and after loading and determine the deflection at 10 cms. Interval before and after loading at each pint separately. This shall be measured by moving the dial gage form one point to another and taking the heights before and after loading at each point.
3. Now move a 1 kg. load along the beam at 10 cms. interval and for each position of the load, find the deflection of the point where the load was applied in step 1, above, This deflection should be measured at each such point before and after the loading. Separately,
4. Plot the graph between deflection as ordinate and position of point on abscissa and compare the plot for graph drawn in step 2 and step 4, These are the influence line ordinates for deflection of the beam :
5. The steps 1 to 4 should be repeated for central load on simply supported beam or load at free end of the cantilever.

OBSERVATION AND CALCULATIONS :

Sr. No.	Distance for Load (mm)		Distance For Deflection (mm)		Load Applied (Kg)	Deflection (mm)
	From A	From B	From A	From B		

RESULTS :

Comparison of the deflection for the beam.

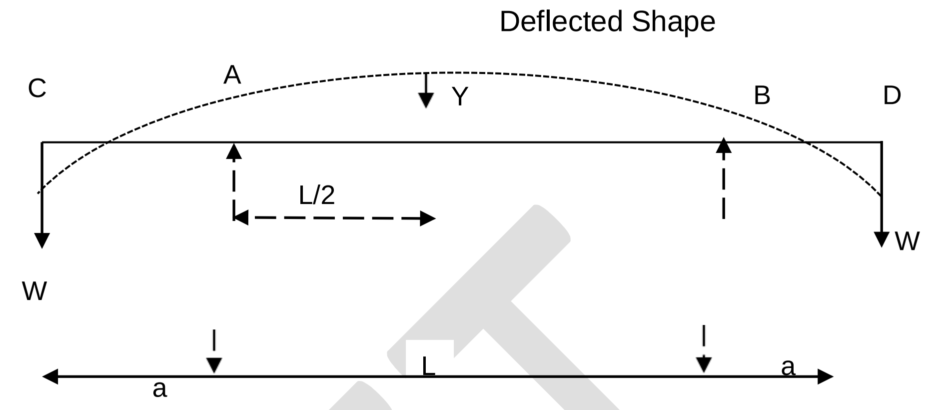
EXPERIMENT NO. – 2

ELASTIC PROPERTIES OF DEFLECTED BEAM

AIM :

To find the value of flexural stiffness (EI) for a given beam and compare it with theoretical value.

THEORY :



For the beam with two equal overhangs and subjected to two concentrated loads W each at the free ends, the maximum deflection y at the centre is given by

Central upward deflection, $y = \dfrac{w.a.L^2}{8EI}$ (1)

Where,

a=length of overhang on each side

W=load applied at the free ends

L=main span

E=modulus of elasticity of the material of the beam

I=moment of inertia of cross section of the beam.

$\therefore\ EI = \dfrac{w.a.L^2}{8y}$ (2)

Also it is known that EI for beam $= \dfrac{E \times b^3 d}{12}$ (3)

Where, b = width of beam

d = depth of beam

PROCEDURE :

Step 1 : Find b and d of the beam and calculate the theoretical value of by Eq. (3)

Step 2 : Measure the main span and overhang span of the beam with a scale.

Step 3 : By applying equal loads at the free end of the overhang beam, find the central deflection y.

Step 4 : Repeat the above steps for different loads.

RESULTS AND DISCUSSIONS:

1. Calculate the experimental value of EI by Eq. (2)
2. Compare the experimental value of EI with theoretical values.

CALCULATION :

Length of main span, L (cm)	=	
Length of overhang on each side, a (cm)	=	
Width of beam, b (cm)	=	
Depth of beam, d (cm)	=	
Modulus of elasticity, E (kg/cm^2)	=	$2x10^6$
Average value of EI from observation	=	cm^4
Average value of EI from calculation	=	cm^4

PRECAUTION :

- Measure the centre deflection y very accurately.
- Ensure that the beam is devoid of initial curvature
- Loading should be within the elastic limit of the materials.

EXPERIMENT NO. – 3

TO FIND THE SLOPE AND DEFLECTION OF CONTINUOUS BEAM

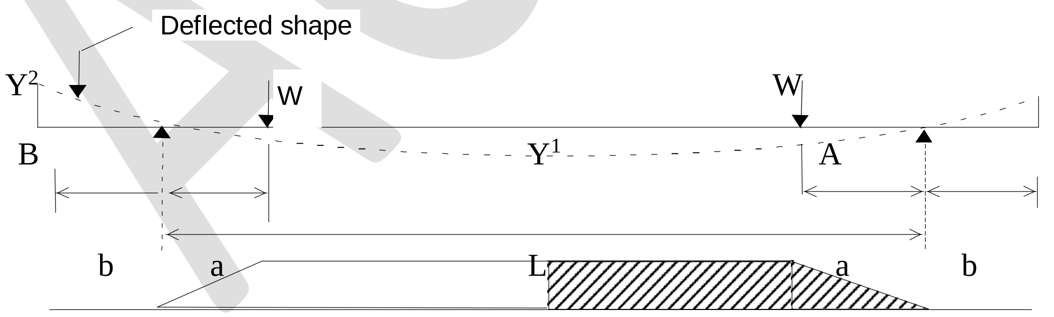
AIM : To find the slope and deflection of continuous beam.

THEORY : According to moment area theorem.

1. The change of slope of the tangents of the elastic curve between any two points of the deflected beam is equal to the area of $\frac{M}{EI}$ diagram between these two points.

2. The deflection of any point relative to tangent at any other point is equal to the moment of the area of the $\frac{M}{EI}$ diagram between the two points about the point at which the deflection is required.

B



From Fig.

Slope at $B = \frac{Y_2}{b}$

SUGGESTED EXPERIMENTAL WORK :

Step 1 : Measure a, b and L of the beam.

Step 2 : Place the hangers at equal distance form the sports A and load them with equal loads.

Step 3 : Measure the deflection by dial gauges at the end B (y_2) and at the centre C (y_1).

Step 4 : Repeat the above steps foe different loads.

RESLUTS AND DISCUSSIONS :

1. Calculate the slope at B as $\frac{Y_2}{b}$ (measured value).

2. Compute slope and deflection at B theoretically form B.M.D and compare with experimental values

3. Deflection at C = Y_1

4. Deflection at C = Average calculated value.

SAMPLE DATA SHEET :

Length of main span, L (cm.) =

Length of overhang on each side, a (cm.) =

Modulus of elasticity, E (kg/cm^2) = 2×10^6

COMMENTS :

The moment area theorems may often be used more conveniently in the computation of slopes and Deflection of beams and frames, practically when the deformation is caused by concentrated rather than distributed loads. These theorems are based on a consideration of the geometry of the elastic curve of the beam and the relation between the rate of a change of slope and the bending moment at a point on the elastic curve.

PRECAUTIONS:

- Apply the concentration loads without jerks.
- Measures the deflection only when the beam attains equilibrium.
- Measure deflection very carefully and accurately.

EXPERIMENT NO. – 4

DEFLECTION OF A TRUSS

AIM:

Determination of deflection of trusses by Willot-Mohrs diagram.

THEORY :

The deflection of a node of truss under a given loading given by

$$= \frac{TUL}{AE}$$

Where

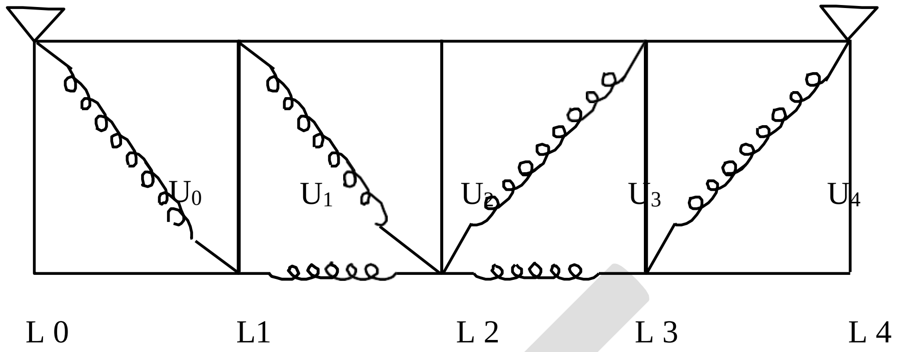
T = force in any number under the given loading.
U = force in any number under a unit load at the point at which the deflection is required. The unit loads acts when the load on the truss has been removed and in the direction in which the deflection is required.
L = length of any member.
A = cross sectional area of any member.
E = modulus of elasticity.

Here L/AE is a property of member, which is equal to the extension per unit load. It may be determined for each member separately by suspending a load from it and notice the extension

APPARAUTS :
Apparatus consists of a 4 panels of a PRATT truss, each panel being 40 cm. in horizontal direction and 30 cm. in vertical direction. Load can be applied on each panel point. All tension members are providing with detachable spring so as to obtain appreciable deformation of the member. Direction of the diagonal members may be changed. Apparatus can be used to illustrate visually the nature of forces set up in various members of the truss.

PROCEDURE:

1. Take out each member with a spring. Plot extension against loads suspended from it and obtain the extension per unit load from the graph in mm/kg.
2. Load the truss with 200 gm. load at each node and assume this as the initial position. Not the reading in the dial gauge under each node in this position.
3. Add loads of 2 kg. at central node and 1& 2 kg. at either of other nodes. Measure the deflection through dial gauge of again. The added deflections due to applied loads are found by difference between two readings of dial gauge.
4. Calculate deflection according to the formula given above under three nodes and compare with the experimental values obtained.
5. Discuss the discrepancies.



OBSERVATION AND TABLE

1. Values of L/AE

U_0L_1	U_1L_2	U_3L_2	U_4L_2	U_1L_2	U_2L_3
Load Extension Kg. mm.	Load Extension Kg. mm.	Load Extension Kg. mm.	Load Extension Kg. mm.	Load Extension Kg. mm.	Load Extension Kg. mm.

2. Deflection by calculation.

Node	L_1	L_2	L_3
1. Initial Loads (kg.)			
2. Initial dial gauge reading			
3. Additional Loads (kg.)			
4. Final dial gauge (kg.)			
5. Deflection (4)-(2)			

3. Deflection by calculation.

Member L/AE (kg.)	Node L_1	Node L_2	Node L_3
	U F.UL/AE	U F.UL/AE	U F.UL/AE
U_0U_1			
U_1U_2			
U_2U_3			
U_3U_4			
U_0U_1			
U_1U_2			
U_2U_3			
U_0U_0			
U_1U_1			
U_2U_2			
U_3U_3			
U_4U_4			
U_0U_1			
U_1U_2			

4. Comparison of Deflections

		Node L_1	Node L_2	Node$_3$
1.	Experimental			
2.	Calculated			

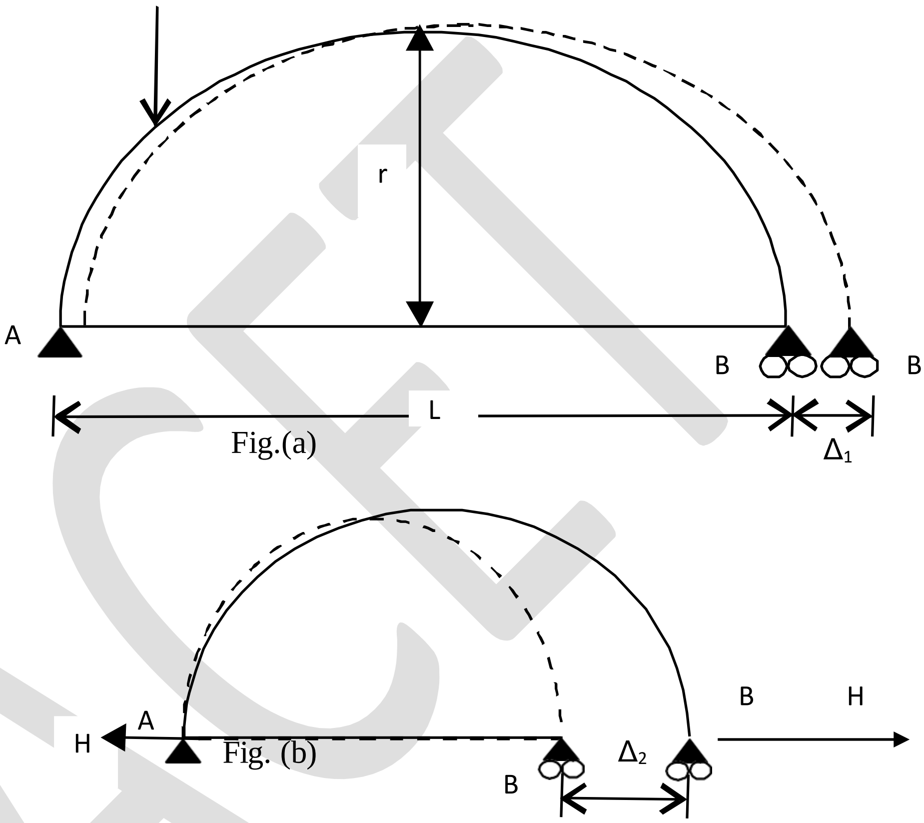
EXPERIMENT NO. – 5

TWO HINGED ARCH APPARATUS

AIM:
To find horizontal thrust and to draw the influence line for horizontal thrust for two hinge arch.

THEORY :-

The two hinged arch is a statically indeterminate structure of the first degree. The horizontal thrust is the redundant reaction and is obtained by the use of strain energy methods.



Two hinged arch is made determinate by treating it as a simply supported curved beam and horizontal thrust as a redundant reaction the arch spreads out under external load as shown in fig. (a). this results in a horizontal displacement of support B by Δ_1. here, deflection due to flexure only has been considered. Since the support conditions dictate that the final displacement at support B should be zero, horizontal reaction H should be such that displacement Δ_2 caused by H must satisfy the condition.

$$\therefore \Delta_1 + \Delta_2 = 0$$

$$\Delta_1 + f \; x \, H = 0$$

Where, f is the displacement caused by a unit force applied in the direction of H.

$$H = -\frac{\Delta_1}{f} \qquad (1)$$

Therefore, it is required to calculate the horizontal displacement on arch caused by external load as well as unit horizontal force.

The horizontal displacement in a curved member can be found by either castiglano's second theorem or the unit load method.

$$H = \int_A^B M \frac{\partial M}{\partial H} \frac{ds}{EI}$$

$$= \int_A^B Mm \frac{\partial M}{\partial H} \frac{ds}{EI}$$

Similarly $f = \int_A^B m^2 \frac{ds}{EI}$

Therefore, $H = \dfrac{\int \frac{Mm\, ds}{EI}}{\int \frac{m^2 ds}{EI}}$ (2)

Where, M= Bending moment on any point on the arch due to given loading.

m= moment on any point on the arch due to a unit horizontal force applied at B in the direction of H.

the expression given by Eq. (20 will become simpler provided the curve of the arch axis is parabolic and moment of inertial of curve at any section varies as $I=I_o \sec\theta$ where θ is angle between the horizontal and tangent to the arch axis at that particular point.

I_o = moment of inertia at the crown

I = moment of inertia at any other section

m = y, ds= sec θdx

it may be noted that the integration is to be carried out form 0 to L then Eq. (2) will become.

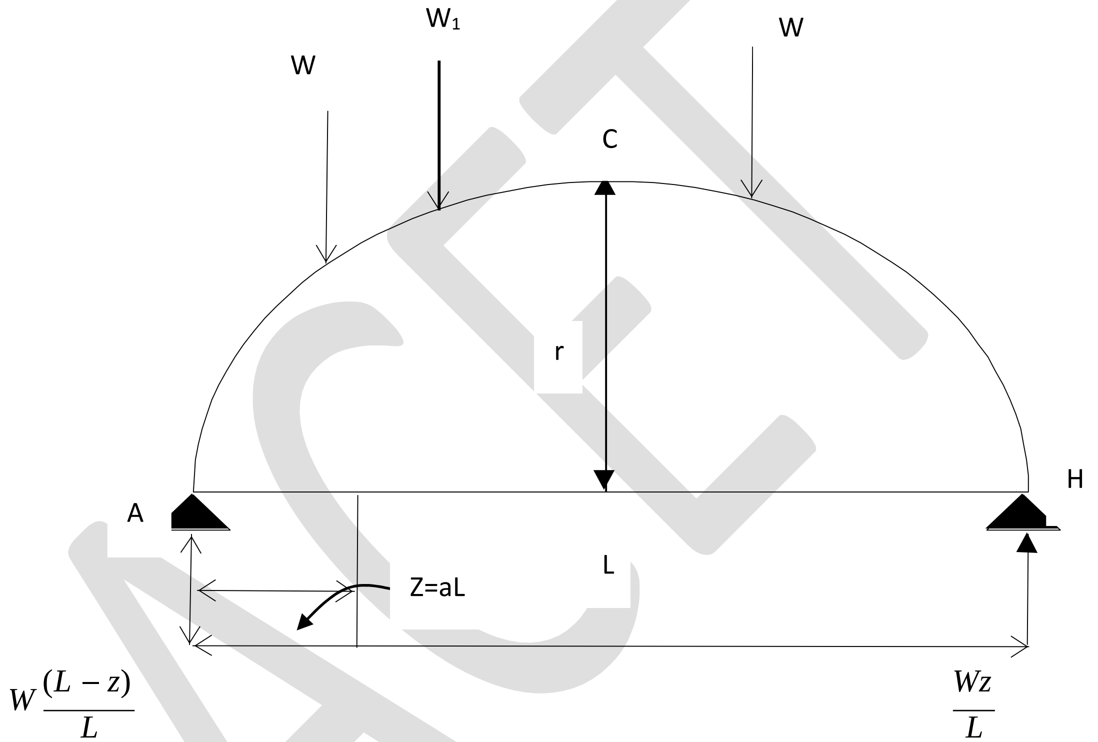
$$H = \frac{\int_0^L \frac{Mydx}{EI}}{\int_O^L y^2 dx} \quad (3)$$

And Δ_1=horizontal displacement $= \dfrac{\int_0^L \frac{Mydx}{EI}}{\int_O^L \quad 0}$ for a concentrated load W at the crown it is found that

Horizontal displacement $\Delta_1 = \dfrac{5}{48} \dfrac{WL^2 r}{EI_0}$ (4)

Where, L is the span of the arch and r is the rise.

The horizontal movement of arch roller end can be found by this method for any position of the load on the arch.



Ordinate for the influence line diagram for H at any distance z = aL form L.H.S can be obtained as follows :

$$M = \frac{Wx}{L}(L-z) \quad for 0 < x < z$$

$$M = \frac{Wz}{L}(L-x) \; for \; z < x < L$$

Now H can be evaluated using Eq.(3).

$$\int_0^L My \; dx = \int_0^z \frac{Wx}{L}(L-z)4r\left(\frac{x}{L}-\frac{x^2}{L^2}\right)dx + \int_z^L \frac{W_z(L-x)}{L}\,4r\left(\frac{x}{L}-\frac{x^2}{L^2}\right)dx = \frac{W_z(L-z)(L^2+Lz-Z^2)}{3L^2}$$

$$\int_0^L y^2\,dx = \int_0^L \left[4x\left(\frac{x}{L} - \frac{x^2}{L^2}\right)\right]^2 dx = \frac{18}{15} Lr^2$$

$$\therefore\ H = -\frac{5}{8}\frac{Wz}{rL^3}(L-z)(L^2 + Lz - z^2)$$

Now substituting z=aL

We have $H = -\dfrac{5}{8}\dfrac{WL}{r}(a - 2a^3 + a^4)$

Taking W=1kg.

∴Influence line ordinate are given by

$$ILO = \frac{5}{8}\frac{WL}{r}(a - 2a^3 + a^4)$$

APPARATUS :

The model has a span of 100cm and rise 25cm. both end are hinged but one of the ends is also free to move longitudinally. A lever arrangement is fitted at this end for the application of known horizontal inward force for measuring the horizontal thrust. Along the horizontal span of the arch various pints are marked at equidistant for the application of load. This being a statically indeterminate structure of the first degree. A dial gauge with magnetic base is supplied with the apparatus.

PROCEDURE :

Step 1 : Fix the dial gauge to measure the movement of the roller end of the model and keep the lever out of contact.

Step2 : Place a load of 0.5kg on the central hanger of the arch at remove any slackness and taking this as the initial position, set the reading on the dial gauge to zero.

Step3 : Now add 1kg weights to the hanger and tabulated the horizontal movement of the roller end with increase in the load in steps of 1gk. Take the reading up to 5kg load. Dial gauge reading should be noted at the time of unloading also.

step4 : Plot a graph between the load end displacement (theoretical and experimental) compare. Theoretical values should be computed by Eq.(4)

Step5 : Now move the lever in contact with 200gm hanger on ratio 4/1 position with a 1kg load on the first hanger. Set the initial reading of the dial gage to zero.

Step6 : Place additional 5kg.load on the first hanger without shock and observe the dial gauge reading.

Step7 : Restore the dial gauge reading to zero by adding loads to the lever hanger, say the load is w kg.

Step8 : The experimental value of the influence line ordinate at the first hanger position shall be $\frac{4w}{5}$.

Step9 : Repeat the steps 5 to 8 for all other hanger loading positions and tabulate. Plot the influence line ordinates.

Step10 : Compare the experimental values with those obtained theoretically by using Eq. (5)

RESULTS AND DISCUSSIONS :

Compare the two results obtained theoretically and analytically.

CALCULATION :

TABLE-1

Horizontal thrust

Sr.No.	Central load (kg.)	0.0	1.0	2.0	3.0	4.0	5.0	6.0
1	Observed horizontal thrust							
2	Calculated horizontal thrust							

EXPERIMENT NO. – 6

HORIZONTAL DEFLECTION AT ROLLER END IN TWO HINGED ARCH

AIM:

To calculate horizontal deflection at roller end in two hinged arch

Procedure and steps same as above.

Horizontal displacement

Sr.No.	Central load (kg.)	0.0	1.0	2.0	3.0	4.0	5.0	6.0
1	Observed horizontal displacement							

EXPERIMENT NO. – 8

BEHAVIOUR OF STRUTS

AIM :

To study the behaviour of different types of struts and to calculate the Euler's buckling load for each case.

APPARATUS :

Steel strip struts with different end conditions , graph paper, weights, lead shots with container.

PROCEDURE :

The column members fail not only by crushing but also due to buckling. This is particularly true if the members are considerably long in comparison with their lateral dimensions. Once a member shows signs of buckling, it will lead to a failure of the member. The load at which the member just buckles is called the buckling load or critical load which is less than the crushing load. Following four cases of struts with different end conditions arise for which the corresponding buckling lead P is given in general by $P = \frac{\pi^2 EI}{l^2_{eff}}$

i. When both ends of the member are pinned, $P = \frac{\pi^2 EI}{l^2}, l_{eff} = l$ (i)

ii. When one end is fixed and other end is pinned, $P = \frac{\pi^2 EI}{l^2}, l_{eff} = \frac{l}{\sqrt{2}}$

iii. When both ends of the member are fixed, $P = \frac{4\pi^2 EI}{l^2}, l_{eff} = \frac{l}{2}$

iv. When one end is fixed and other end is free, $P = \frac{\pi^2 EI}{4l^2}, l_{eff} = 2l$

Where E= modules of elasticity of steel=$2x10^6 kg/cm^2$

I = moment of inertia for the steel strip

l_{eff} = effective length of strut for each case or Euler's equivalent length.

l = distance between the points of fixity at top and bottom of the strut.

PROCEDURE :

1. Calculate the Euler's buckling load for each case separately by the expression given in theory above.

2. Place the loads on the struts and note down the loads at which the strut buckles. When the loading platform goes down by about half its height, it shall be assumed that the strut has buckled.

3. For the strut where one end is fixed and other completely free on roller, it shall be ensured that rollers are well greased and before noting the load the base is lightly tapped.

4. Pin a graph paper on the wooden board and slide it behind the strut. With a sharp pencil carefully mark the deflected shape of the struts. Mark the pints of inflection on the curves and measure the effective or equivalent length.

OBSERVATIONS AND CALCULATIONS

L=………….., b=…………….., d=……………….

Sr.No.	**End conditions**	**Critical load (kgs)**		**Effective length (cm.)**	
		Theoretical	**Observed**	**Theoretical**	**Observed**
1	Both ends pinned				
2.	Both ends fixed				
3.	One end pinned and other end fixed				
4.	One end fixed and other end free				

EXPERIMENT NO. – 9

EXPERIMENT NO. – 9

AIM:
To determine the moment required to produce a given rotation at one end of a beam when the other end is i) Pinned ii) Fixed

THEORY :

According to moment area theorem
For a beam AB which is simply supported at A and fixed at B, a clock-wise rotation of ϕ_A can be effected by applying a clockwise moment of $M_A = \left(\frac{4EI}{L}\right) X \phi_A$ at A, (Fig a) = stiffness X Rotation which in turn induces a clockwise moment of $= MB = \frac{1}{2} MA$ on the member at B. The expression $M_A = \left(\frac{4EI}{L}\right)$ is called the stiffness factor, which is defined as the moment required to be applied at A to cause a rotation of 1 radian at A of a span AB simply supported at A and fixed at B. the number $\frac{M_A}{M_B} = +\frac{1}{2}$ is the carry over factor, which iis the rotation of the moment induced at B due to the moment at A.
If the far end is hinged instead of being fixed, the moment required to rotation the tangent at the near end through 1 radian will be $\frac{3EI}{L}$ instead of $\left(\frac{4EI}{L}\right)$ Fig . B.

$$M_A = \left(\frac{4EI}{L}\right) Ø_A \qquad M_A = \left(\frac{3EI}{L}\right) Ø_A$$

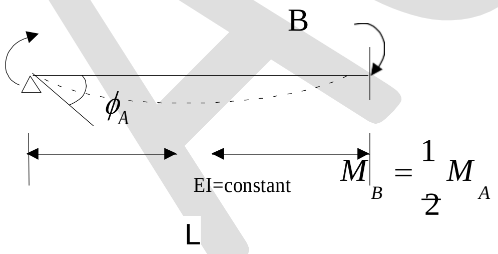


Fig. A

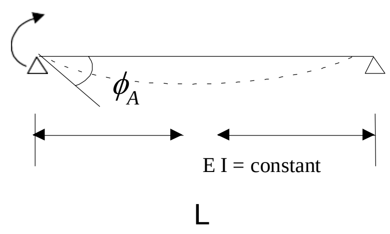
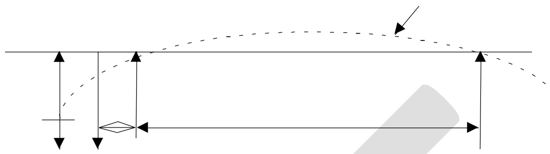


Fig. B

Moment required to produce a given rotation at one end of the beam when the other end is pinned is ¾ of the moment required to produce the same rotation when the other end is fixed.

Suggested Experimental Work :

(A) Beam with overhang having far end pinned.

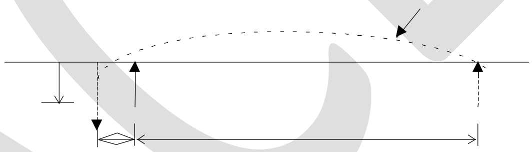


Step 1 : Measure the height of free end C of the beam form the top of the table.

Step 2 : Load W is applied at the free end C. the beam will get deflected as shown in fig. Measure the height of the deflected end c form the table to. The difference will give the deflection y.

Step 3 : Measure deflection Y at C and find the slope ($\frac{Y}{a}$) at A.

(B) Beam with overhang having far end fixed.



Step 1 : Repeat all the steps a in beam with far end connected.

RESULT & DISCUSSIONS:

1. A graph is plotted between moment as ordinate and sloes for pinned end and slopes for fixed end as abscissa.

2. Find the ration of moments in the two cases for the same slope.

CALCULATION:

a =   cm.

Sr. No	Load W (kg.)	Far end pinned		Far end fixed	
		Deflection y (cm)	Slope y/a rad	Deflection y (cm)	Slope y/a rad

COMMENTS:

PRECAUTION:

- Measure the deflection of each free end of the beam very accurately.
- Apply the load at the end without any jerk.
- Perform this experiment away from any external disturbances.

EXPERIMENT NO. – 10

EXPERIMENT NO. – 10

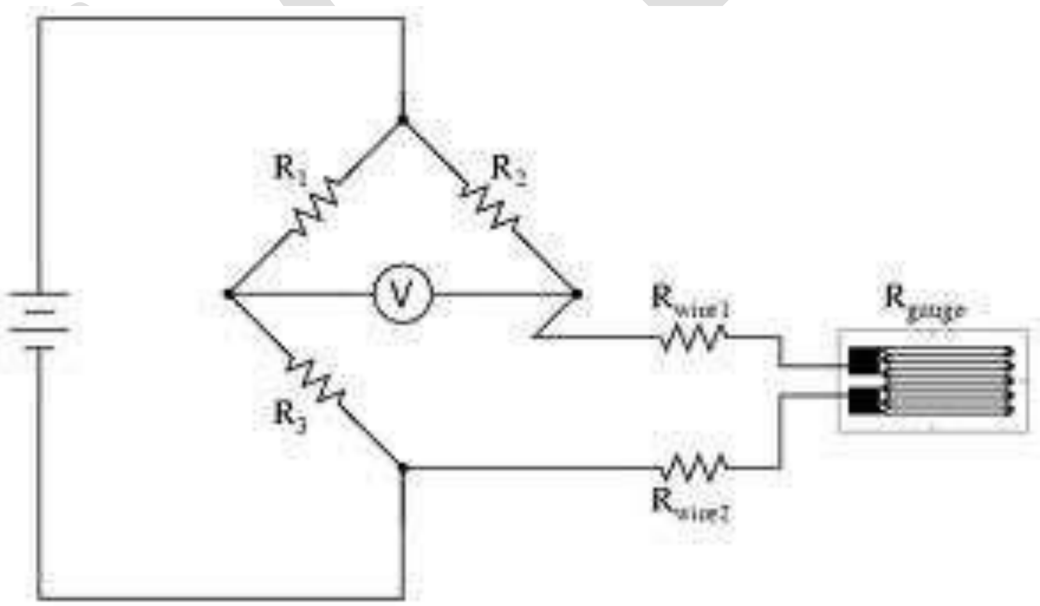
AIM: Study of Strain Gauges.

Definition: A strain gauge is defined as a passive transducer that converts a mechanical displacement into a change of resistance.

A strain gauge is a thin, wafer-like device that can be attached to a variety of materials to measure applied strain.

Structure: The majority of strain gauges are foil types, available in a wide choice of shapes and sizes to suit a variety of applications. They consist of a pattern of resistive foil which is mounted on a backing material. They operate on the principle that as the foil is subjected to stress, the resistance of the foil changes in a defined way.

Working: The strain gauge is connected into a Wheatstone Bridge circuit. The change in resistance is proportional to applied strain and is measured with Wheatstone bridge.



The sensitivity of a strain gauge is described in terms of a characteristic called the gauge factor, defined as unit change in resistance per unit change in length, or

$$K = \frac{\Delta R/R}{\Delta l/l}$$

Gauge factor is related to Poisson's ratio μ by,

$$K=1+2\mu$$

Types:

Based on principle of working :

- Mechanical
- Electrical
- Piezoelectric

Based on mounting :

- Bonded strain gauge
- Unbonded strain gauge

Based on construction :

- Foil strain gauge
- Semiconductor strain gauge
- Photoelectric Strain gauge

MECHANICAL STRAIN GAUGE

It is made up of two separate plastic layers. The bottom layer has a ruled scale on it and the top layer has a red arrow or pointer. One layer is glued to one side of the crack and one layer to the other. As the crack opens, the layers slide very slowly past one another and the pointer moves over the scale. The red crosshairs move on the scale as the crack widens.

ELECTRICAL STRAIN GAUGE

When an electrical wire is stretched within the limits of its elasticity such that it does not break or permanently deform, it will become narrower and longer, changes that increase its electrical resistance end to-end.

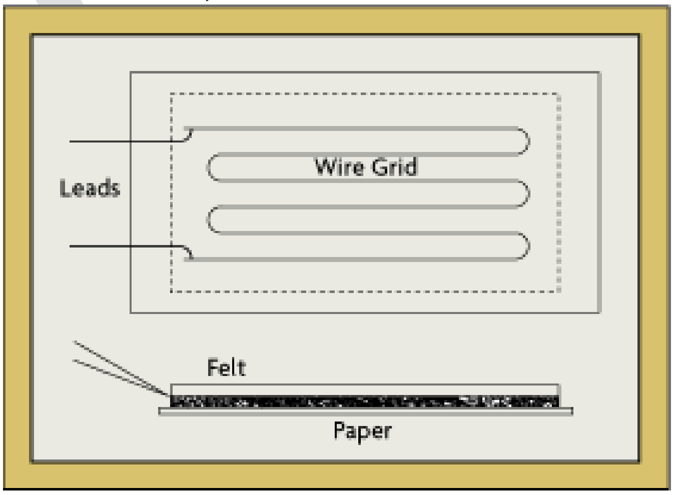
Strain can be inferred by measuring change in resistance.

PIEZOELECTRIC STRAIN GAUGE

Piezoelectric generate electric voltage when strain is applied over it. Strain can be calculated from voltage. Piezoelectric strain gauges are the most sensitive and reliable devices.

BONDED STRAIN GAUGE

A bonded strain-gage element, consisting of a metallic wire, etched foil, vacuum-deposited film, or semiconductor bar, is cemented to the strained surface.



UNBONDED STRAIN GAUGE

The unbonded strain gage consists of a wire stretched between two points in an insulating medium such as air. One end of the wire is fixed and the other end is attached to a movable element.

Unbonded Strain Gauge