Department of

CIVIL AND ENVIRONMENTAL ENGINEERING

CEE212L Solid Mechanics Lab

STRUCTURAL ENGINEERING LABORATORY

NORTH SOUTH UNIVERSITY
Center of Excellence in Higher Education
The First Private University in Bangladesh

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Department of Civil and Environmental Engineering

CEE 212L
STRUCTURAL ENGINEERING LABORATORY

SL. No.	Name of the experiment
1	Tension test of mild steel specimen
2	Compression test of timber specimen
3	Impact test of metal specimen
4	Test of helical spring
5	Direct shear test of metal specimens
6	Static bending test of beam
7	Hardness test of metal specimen
8	Buckling Test of Slender Columns

North South University
Department of Civil and Environmental Engineering

CEE 212 SOLID MECHANICS LAB WORKBOOKS FOR LABORATORY PRACTICE

EXPERIMENT NO: 01
TENSION TEST OF MILD STEEL SPECIMEN

Name:

ID:

Group:

Section:

Performance Date:

Submission Date:

EXPERIMENT NO: 01
TENSION TEST OF MILD STEEL SPECIMEN

1. OBJECTIVE:
i. To test a mild steel specimen to failure under tensile load.
ii. To draw stress-strain diagram.
iii. To study the failure characteristics of mild steel.
iv. To determine different properties of mild steel specimen.

2. APPARATUS:
i. Extensometer ii. Balance
iii. Slide calipers iv. Measuring tape

3. MACHINE:
i. Universal Testing Machine (UTM).

4. SPECIMEN:
Standard round specimen (ASTM E8)

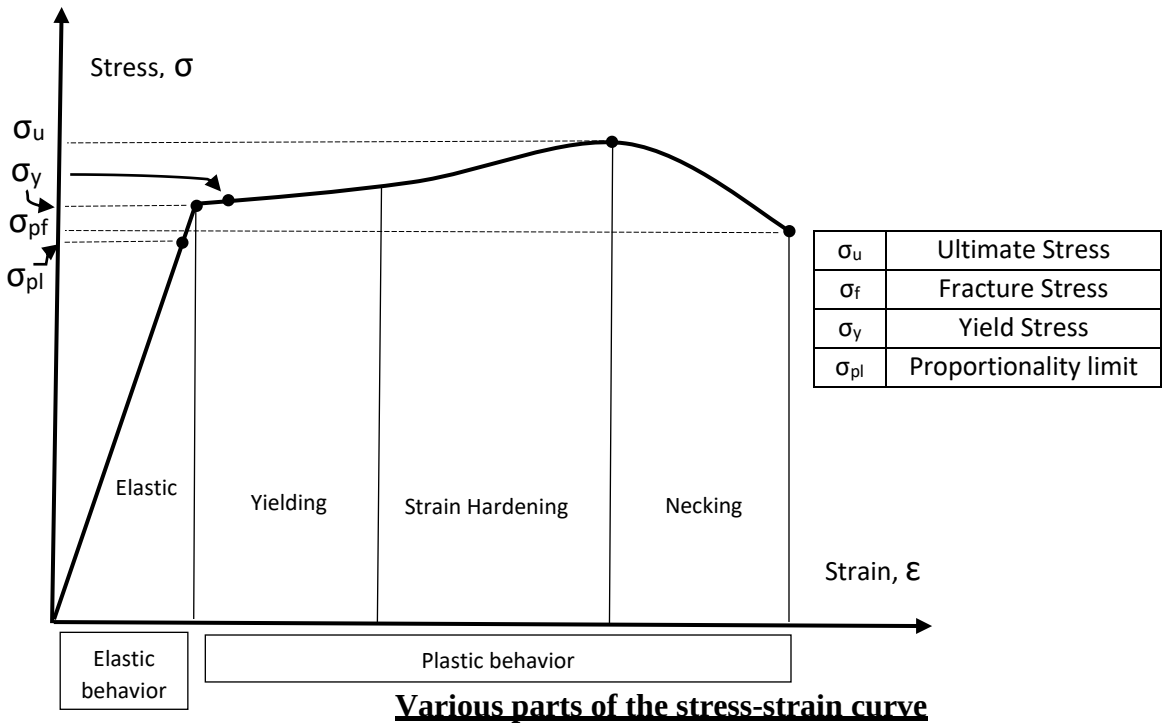
5. PROCEDURE:
Follow Class.

6. REPORT OF TENSILE TEST FOR MILD STEEL SPECIMEN:
Total Length,Lt= Final length after test=

Diameter= Weight=

Area, A= Area at necking, Ao=

Length between grippers, Lo= Extensometer length, Le=



Various parts of the stress-strain curve

Data Table:

Obser-vation No.	Load (kN)	Stress (N/mm^2)	Elongation (mm)	Strain	Remarks

7. GRAPHS:

- Draw complete stress-strain diagram.
- Show all the points in the graphs.

Fill the following (with appropriate units)

Proportional limit = _____	Breaking stress =_____
Yield stress =_____	Modulus of elasticity =_____
Modulus of resilience =_____	Ductility: (a) % elongation =_____
Ultimate strength =_____	% reduction in area =_____

8. SAMPLE CALCULATIONS:

9. DISCUSSIONS:

(Discuss on the results found, graphs, and failure patterns and also compare the results found graphs and failure patterns.)

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EXPERIMENT NO: 02
COMPRESSION TEST ON TIMBER SPECIMEN

Name:

ID:

Group:

Section:

Performance Date:

Submission Date:

EXPERIMENT NO: 02
COMPRESSION TEST ON TIMBER SPECIMEN

1. OBJECTIVE:
i. To perform compression test of timber specimen on UTM.
ii. To study the effects of parallel and perpendicular loading.
iii. To study the failure characteristics of the timber specimen.

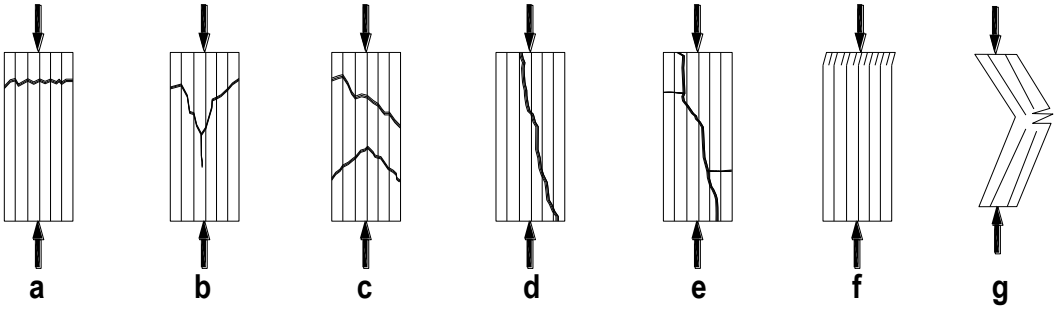
2. APPARATUS:
i. Balance ii. Slide calipers iii. Measuring tape

3. MACHINE:
i. Universal Testing Machine (UTM).

4. SPECIMEN:
i. 2”X2”X8” wooden block (ASTM D143)

5. PROCEDURE
Follow Class.

6. FAILURE PATTERNS:



Schematic diagram of failure pattern of wooden specimens

Parallel Loading:
a = crushing,
b = wedge split,
c = shearing,
d = splitting,
e = compression and shearing parallel to plane,
f = brooming or end rolling,
g = bending or buckling,

7. REPORT OF COMPRESSION TEST FOR TIMBER SPECIMEN:

Initial Height= Volume=

Width= Weight=

Area, A= Density=

DATA TABLE:

Specimen No.	Area (mm^2)	Load kN	Stress (N/mm^2)	Deformation (mm)	Strain	Failure Type

8. SAMPLE CALCULATIONS:

9. DISCUSSION:

(Discuss on the results found, graphs, and failure patterns and also compare the results found graphs and failure patterns.)

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EXPERIMENT NO: 03
DIRECT SHEAR TEST OF METAL SPECIMEN

Name:

ID:

Group:

Section:

Performance Date:

Submission Date:

EXPERIMENT NO: 03
DIRECT SHEAR TEST OF METAL SPECIMEN

1. OBJECTIVE:
i. To determine the shear strength of given material subjecting to fail under double shear.
ii. To determine the average strength in double shear.
iii. To observe the shape & texture of the fractured surface.

2. APPARATUS:
i. Johnson's shear tool ii. Slide Callipers

3. MACHINE:
i. Universal Testing Machine (UTM).

4. SPECIMEN:
i) High carbon steel (H.C.S) rod ii) Mild steel rod (Various dia.)

5. PROCEDURE
Follow Class.

6. REPORT OF DIRECT SHEAR TEST FOR METEL SPECIMENS:

Specimen	Diameter	Area	Shear force	Shear Stress (Two Face)	Average Shear Stress

7. SAMPLE CALCULATION:

8. DISCUSSION:

(Discuss on the results found, graphs, and failure patterns and also compare the results found graphs and failure patterns.)

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EXPERIMENT NO: 04
TEST OF HELICAL SPRING

Name:

ID:

Group:

Section:

Performance Date:

Submission Date:

EXPERIMENT NO: 04
TEST OF HELICAL SPRING

1. OBJECTIVE:
i. To find the stiffness of the spring.
ii. To draw a curve by plotting load against deflection.
iii. To determine different properties of helical spring.

2. APPARATUS:
i. Slide calipers ii. Measuring tape

3. MACHINE:
i. Universal Testing Machine (UTM).

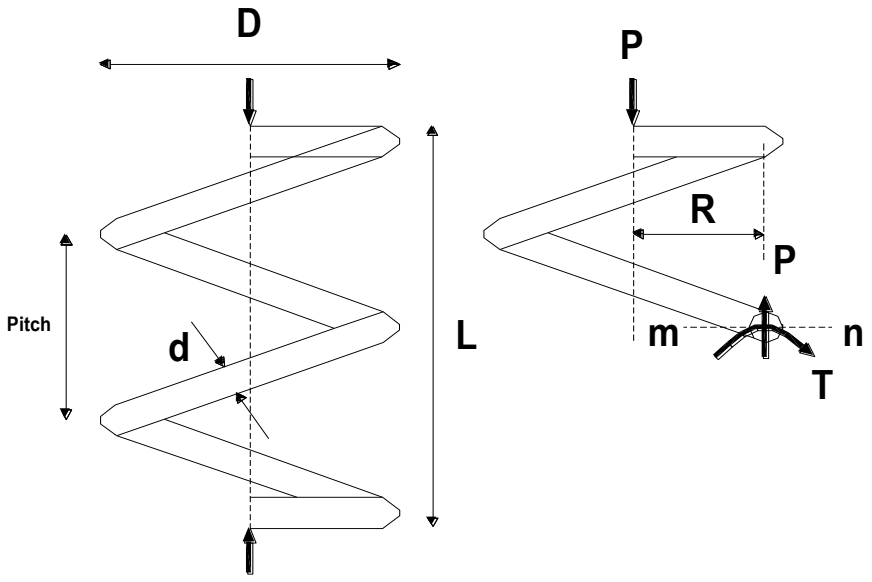
4. SPECIMEN:
Closely-coiled helical spring.

5. PROCEDURE:
Follow Class.

6. REPORT OF HELICAL SPRING TEST:
Height of the spring = Mean radius of the helix (R) =

No. of turns (N) = Dia. of the wire (d) =

Radius of spring's wire or rod (r) = Area of the spring's rod (A) =



Closely-coiled helical spring

Data Table:

Applied load, (P)	Load Increasing Deflection, δ_1	Load Decreasing Deflection, δ_2	Average Deflection, $\Delta\delta=(\delta_1+\delta_2)/2$	Actual Stiffness, k = $\Delta P/\Delta\delta$

7. GRAPHS:

- Draw a graph by plotting load against deflection.

Fill the following (with appropriate units):

Stiffness of the spring =

Modulus of rigidity, $G = 64KR^3N/d^4$ =

Maximum torsional shear stress, $\frac{PRr}{\pi r^4/2}$ = ε

Maximum total shear stress, $\tau_{max} = \frac{P}{\pi r^2} + \frac{PRr}{\pi r^4/2} = \frac{P}{A}(1 + \frac{2R}{r})$ =

Ratio of max. torsional shear stress to the max. total shear stress (%),=

8. SAMPLE CALCULATIONS:

9. DISCUSSIONS: (Discuss on the results found, graphs)

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EXPERIMENT NO: 05
HARDNESS TEST OF METAL SPECIMEN

Name:

ID:

Group:

Section:

Performance Date:

Submission Date:

EXPERIMENT NO: 05
HARDNESS TEST OF METAL SPECIMEN

1. OBJECTIVE:

i. To determine the Rockwell Hardness Number of metal specimen.
ii. To calculate Brinell's Hardness Number from that of Rockwell's.
iii. To find the tensile strength of the metal from Rockwell Hardness Number by using empirical relationships.

2. MACHINE:

i. Rockwell Hardness Tester

3. SPECIMEN:

i) Mild Steel. ii) Cast Iron. iii) Stainless steel.

4. PROCEDURE:

Follow Class.

5. REPORT OF HARDNESS TEST FOR METAL SPECIMENS:

For RB 35 to RB 100

$$BHN = \frac{7300}{130 - RB}$$

For RC 20 to RC 40

$$BHN = \frac{20000}{100 - RC}$$

For RC 41 or greater

$$BHN = \frac{25000}{100 - RC}$$

Data Table:

No. of Obs.	Specimen	Applied Load	Used Scale	Rockwell Hardness Number	Mean RHN	Brinell Hardness Number, BHN	Tensile Strength

6. SAMPLE CALCULATIONS:

7. DISCUSSIONS:

Approximate relationships of hardness values and approximate tensile strength of steels.

HRC	Appx. Tensile Strength (ksi)	HRB	Appx. Tensile Strength (ksi)
68	-	100	116
67	-	99	114
66	-	98	109
65	-	97	104
64	-	96	102
63	-	95	100
62	-	94	98
61	-	93	94
60	-	92	92
59	351	91	90
58	338	90	89
57	325	89	88
56	313	88	86
55	301	87	84
54	292	86	83
53	283	85	82
52	273	84	81
51	264	83	80
50	255	82	77
49	246	81	73
48	238	80	72
47	229	79	70
46	221	78	69
45	215	77	68
44	208	76	67
43	201	75	66
42	194	74	65
41	188	73	64
40	182	72	63
39	177	71	62
38	171	70	61
37	166	69	60
36	161	68	59
35	156	67	58
34	152	66	57
33	149	65	56
32	146	64	-
31	141	63	-
30	138	62	-
29	135	61	-
28	131	60	-
27	128	59	-
26	125	58	-
25	123	57	-
24	119	56	-
23	117	55	-
22	115		
21	112		
20	110		

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EXPERIMENT NO: 06
IMPACT TEST OF METAL SPECIMENS

Name:

ID:

Group:

Section:

Performance Date:

Submission Date:

EXPERIMENT NO: 06
IMPACT TEST OF METAL SPECIMENS

1. OBJECTIVE:
i. To find energy absorbed in fracturing mild steel and cast iron specimens under impact load.

2. APPARATUS:
i) Slide Calipers

3. MACHINE:
i. Pendulam Impact Tester.

3. SPECIMEN:
Mild steel and cast iron specimen of the following types:
i) Charpy simple beam. ii) Izod cantilever beam. iii) Charpy tension rod.

4. PROCEDURE:
Follow Class.

5. REPORT OF IMPACT TEST FOR METAL SPECIMENS:
- Izod Test: Angle of hammer before striking = 90°
- Charpy Test: Angle of hammer before striking = 135°

Data Table:

Type of Specimen	Material of the specimen	Cross sectional area, A_{Notch}	Initial error (i)	Energy absorbed (E)	Corrected energy (E-i)	Impact toughness, U= (E-i)/A_{Notch} (J/mm^2)
Izod cantilever beam	Mild Steel					
	Cast Iron					
Charpy simple beam	Mild Steel					
	Cast Iron					
Charpy tension rod.	Mild Steel					
	Cast Iron					

6. SAMPLE CALCULATIONS:

7. DISCUSSIONS:

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EXPERIMENT NO: 07
SLENDER COLUMN TEST FOR DIFFERENT END CONDITIONS

Name:

ID:

Group:

Section:

Performance Date:

Submission Date:

EXPERIMENT NO: 07
SLENDER COLUMN TEST FOR DIFFERENT END CONDITIONS

1. OBJECTIVE:
i. To determine the critical load or buckling load of slender columns.
ii. To compare the experimental and theoretical critical loads.
iii. To draw the column strength curves.

2. APPARATUS:
i. Slide calipers ii. Column testing apparatus. iii. Weights

3. SPECIMEN:
i. Columns of different length.

4. PROCEDURE:
Follow Class.

5. REPORT OF SLENDER COLUMN TEST:
Effective length of various condition-

End Condition of the Column	Effective Length
Both end hinged	1.0 l
One end hinged and one end fixed	0.707 l
Both end fixed	0.5 l
One end fixed and one end free (Cantilever)	2.0 l

DATE TABLE:

No. of Obs.	End Condi-tion	Dia of the Column (d)	X-sec. Area (A)	Radius of Gyration (r)	Length of the Column (L)	Eff. Length (Le)	Le/r	Critical Load in lbs (P)	Critical Stress in psi P/A	Theo. Critical Stress $\sigma_{cr} = \frac{\pi^2 E}{\left(\frac{Le}{r}\right)^2}$
1	Both end hinged									
2										
3										
4										
1	One fixed one hinged									
2										
3										
4										
1	Both end fixed									
2										
3										
4										

6. SAMPLE CALCULATIONS:

7. GRAPHS:

i. Critical Stress Vs Slenderness Ratio.

8. DISCUSSIONS:

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EXPERIMENT NO: 08
STATIC BENDING TEST OF TIMBER BEAM

Name:

ID:

Group:

Section:

Performance Date:

Submission Date:

EXPERIMENT NO: 08
STATIC BENDING TEST OF TIMBER BEAM

1. OBJECTIVE:

i. To study the behavior of a timber beam under load.

ii. To verify Navier's theorem, $f = \frac{My}{I}$

iii. To find different results of a wooden beam by conducting bending test.

2. APPARATUS:

i. Slide calipers ii. Beam bending apparatus.

3. MACHINE:

i. Universal Testing Machine (UTM).

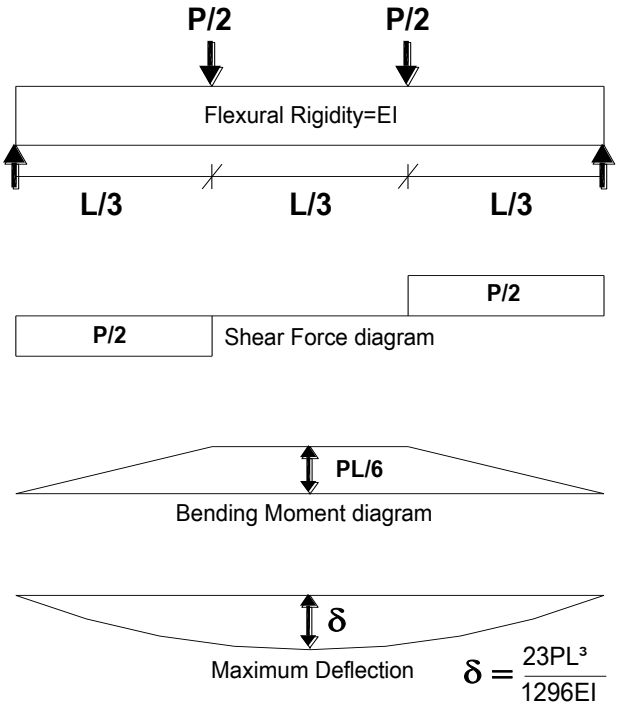
4. SPECIMEN:

i. Timber beam.

5. PROCEDURE:

Follow Class.

6. REPORT OF FLEXURE TEST FOR TIMBER BEAM:



Two point loading: pure moment in the central portion of the beam

Gauge length:_____ Span of the beam:_____

Depth of the beam:_____ Width of the beam:_____

Date Table:

Load	Top Hole		Bot. Hole		Deflection	Stress *f*	Moment *M*	Rotation θ
	S.G.R	Unit Strain	S.G.R	Unit Strain				

Results:

Maximum Stress =

Flexural rigidity of the section (EI) =

7. SAMPLE CALCULATIONS:

8. GRAPHS:

a) Load vs Deflection.

9. DISCUSSIONS: