CONFIDENTIAL

UNIVERSITI KUALA LUMPUR
Malaysian Institute of Marine Engineering Technology

FINAL EXAMINATION
FEBRUARY 2025 SEMESTER SESSION

SUBJECT CODE	:	**LMB22902**
SUBJECT TITLE	:	**MECHANICS OF MATERIALS**
PROGRAMME NAME (FOR MPU: PROGRAMME LEVEL)	:	**BACHELOR OF MARINE ENGINEERING TECHNOLOGY WITH HONOURS**
TIME / DURATION	:	**09.00 AM – 12.00 PM (3 HOURS)**
DATE	:	**25 JUNE 2025**

INSTRUCTIONS TO CANDIDATES

1. Please CAREFULLY read the instructions given in the question paper.
2. This question paper has information printed on both sides of the paper.
3. This question paper consists of ONE (1) section ONLY; Section A.
4. Answer FOUR (4) questions ONLY in Section A.
5. Please write your answers on the answer booklet provided.
6. Answer should be written in blue or black ink except for sketching, graphics and illustration.
7. Answer all questions in English language ONLY.
8. Appendixes have been appended for your references.

THERE ARE 6 PAGES OF QUESTIONS, INCLUDING THIS PAGE.

SECTION A (Total: 100 marks)

INSTRUCTION: Answer FOUR (4) questions only.
Please use the answer booklet provided.

Question 1

With reference to the mechanical properties of materials;

(a) Figure 1 shows an acrylic rod 200 mm long and 15 mm in diameter. An axial load of 300 N is applied to I and E_p is given by 2.70 GPA and v_p = 0.4. By referring to Appendix B, determine the change in its length and diameter.

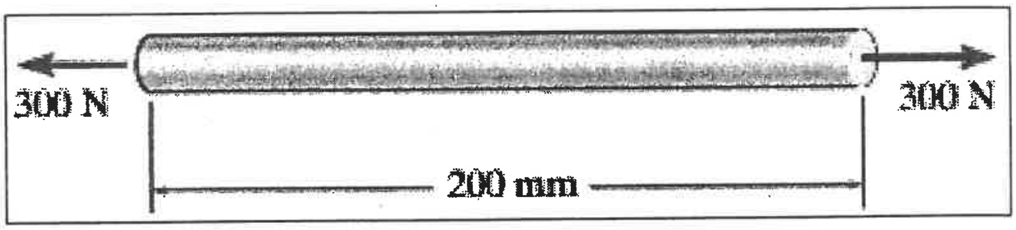


Figure1

(10 marks)

(b) An aluminum block as shown in Figure 2, has a rectangular cross-section and is subjected to an axial compressive force of 36 kN. If the 37-mm side changed its length to 37.5033 mm and E_{al} = 70 GPa, determine;

i. the Poisson's ratio
ii. the new length of the 50-mm.

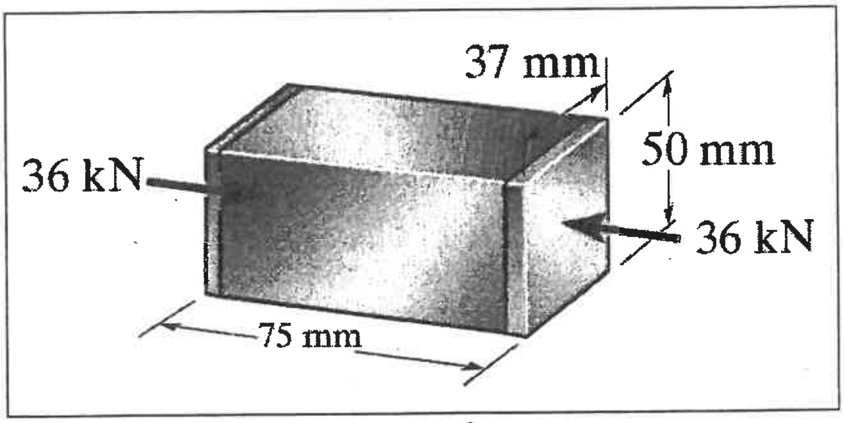


Figure 2

(15 marks)

Question 2

With reference to the mechanical properties of materials;

(a) A tension test was performed on a steel specimen having an original diameter of 12.5mm and a gauge length of 50mm. The data is listed in Table 1.

i. Plot the stress-strain diagram with a scale of 25 mm = 0.05 mm/mm.

ii. Determine the ultimate stress and stress rupture

iii. Redraw the elastic region using the same stress scale but a strain scale of 25mm = 0.001 mm/mm.

iv. Determine approximately the yield stress and the modulus elasticity.

v. Determine the modulus of resilience

vi. Determine the modulus of toughness

Table 1

σ(MPa)	ε (mm/mm)
0	0
57.07	0.00025
171.21	0.00075
293.51	0.00125
407.66	0.00175
432.12	0.0025
432.12	0.0040
440.27	0.010
611.49	0.020
733.79	0.050
790.86	0.140
715.85	0.200
679.16	0.230

(25 marks)

Question 3

With reference to the concept oF axial load;

(a) Figure 3 shows a bar with dimensions in mm subjected to a tension force of P = 8 kN. Calculate the maximum normal stress developed in the bar. (Refer to *Appendix A*).

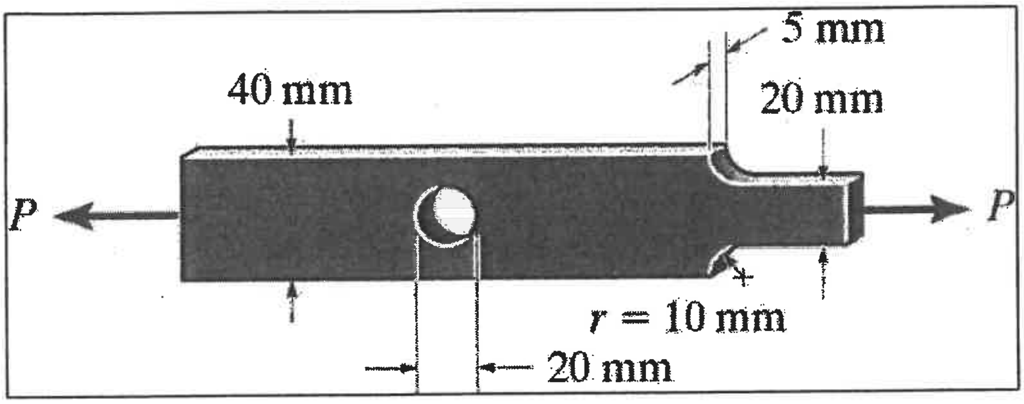


Figure 3

(10 marks)

(b) A composite shaft, consisting of aluminum, copper and steel sections is subjected to the loadings, with the cross-sectional area and modulus of elasticity for each section shown in Figure 4. Neglect the size of the collars at B and C. Determine,

i. the displacement of end A with respect to end D

ii. the normal stress in each section.

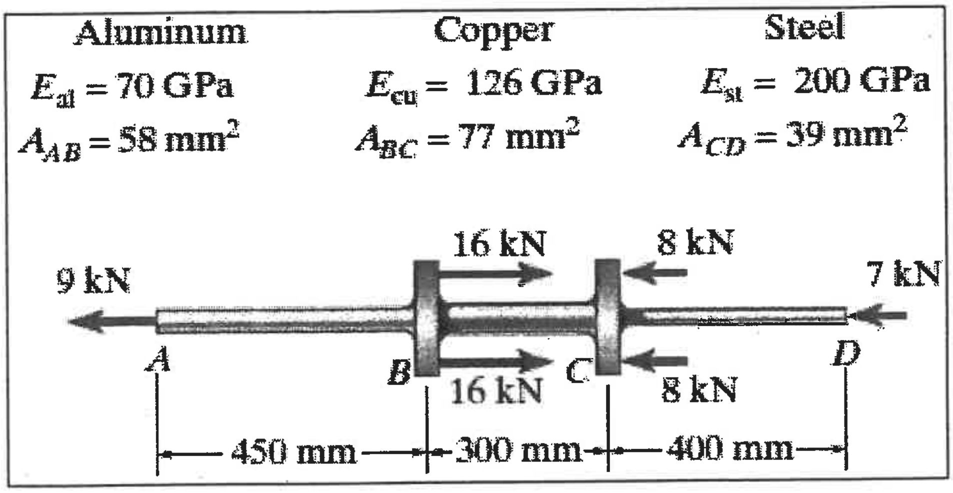


Figure 4

(15 marks)

Question 4

With reference to the concept of stress, strain, axial load, bending and torsion;

(a) Figure 5 shows an A-36 hollow steel shaft that is 2 m long and has an outer diameter of 40 mm as shown in Figure 7. The shaft rotates at 80 rad/s and transmits 32 kW of power from engine *E* to the generator *G*. If the allowable shear stress is τ_{allow} = 140 MPa and the shaft is restricted not to twist more than 0.05 rad, determine the smallest thickness of the shaft.

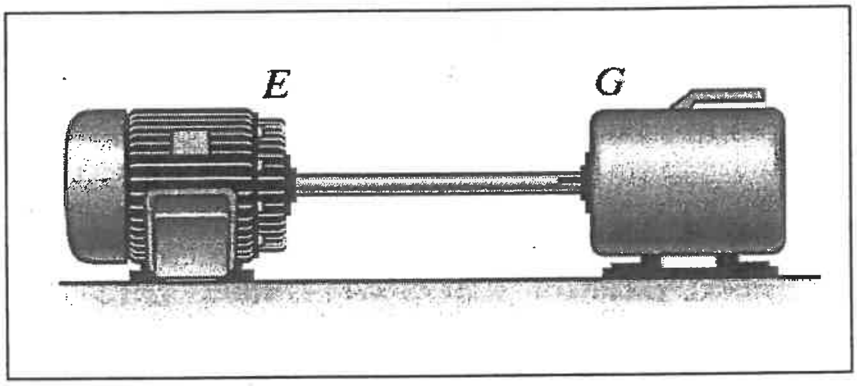


Figure 5

(10 marks)

(a) Figure 6 shows a shaft supported by a smooth thrust bearing at *A* and a smooth journal bearing at *B*.

i. Sketch free body diagram and shear diagram for the shaft

ii. Draw the moment diagrams for the shaft

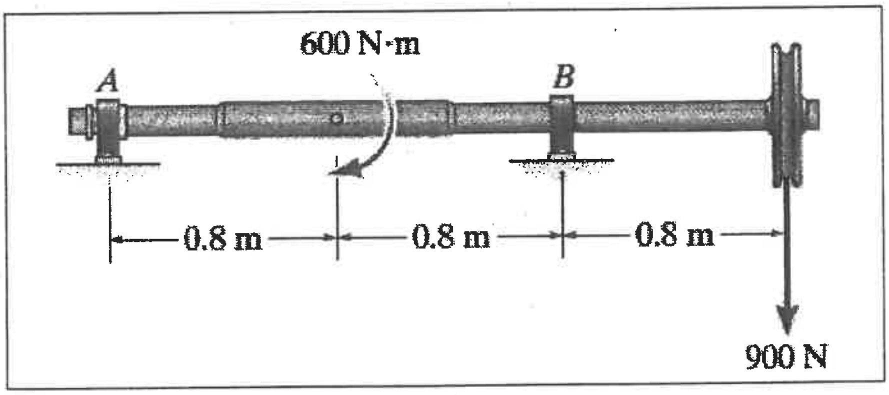


Figure 6

(15 marks)

Question 5

With reference to the concept of stress, strain, axial load, bending and torsion.

(a) Figure 7 shows the propeller of a ship connected to an A-36 steel shaft that is 60 m long and has an outer diameter of 340 mm and an inner diameter of 260 mm. If the power output is 4.5 MW when the shaft rotates at 20 rad/s, determine

i. the maximum torsional stress in the shaft

ii. angle of twist.

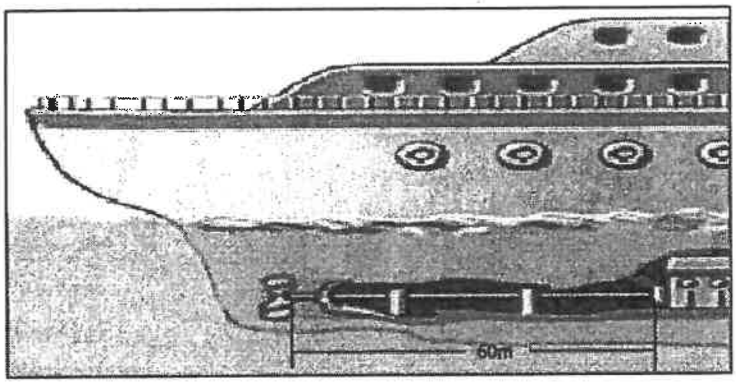


Figure 7

(10 marks)

(a) Figure 8 shows bearings at *A* and *D* exert only vertical reaction on the shaft. Loading is applied to the pulleys at *B* (360 N) and *C* (500 N) and *E* (160 N). Sketch.

i. the shear diagrams of the shaft.

ii. the moment diagrams of the shaft.

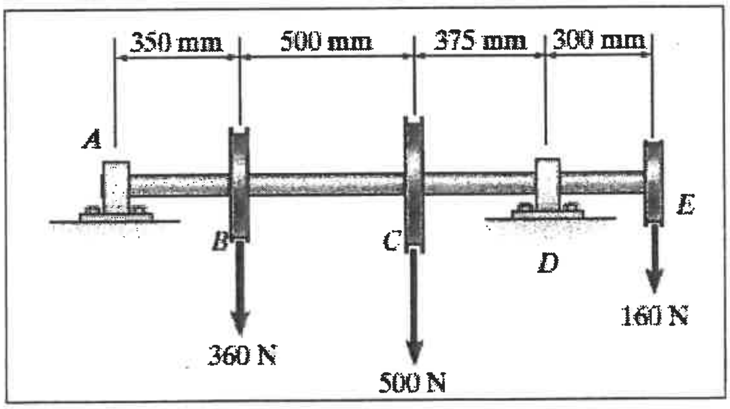
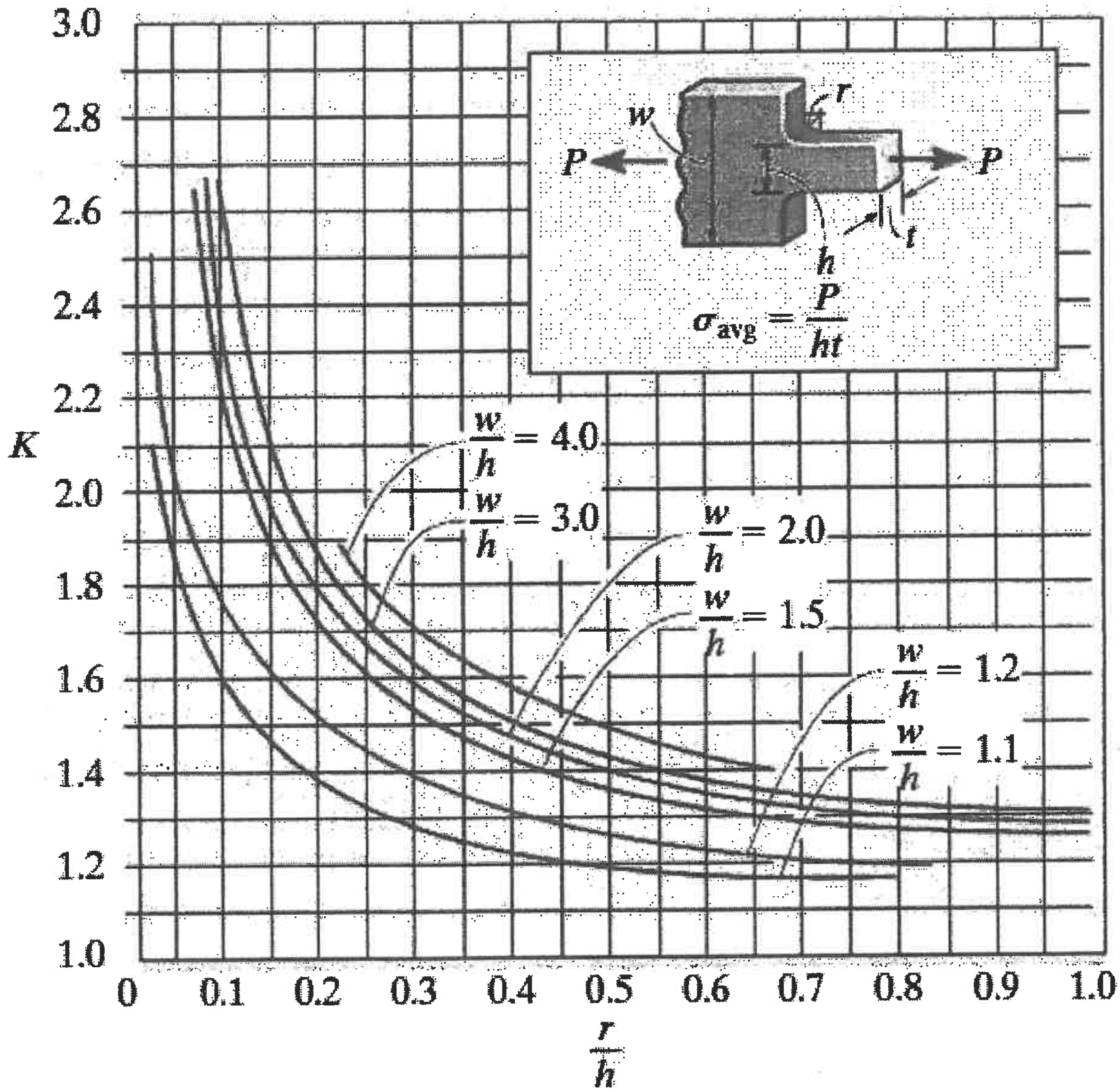


Figure 8

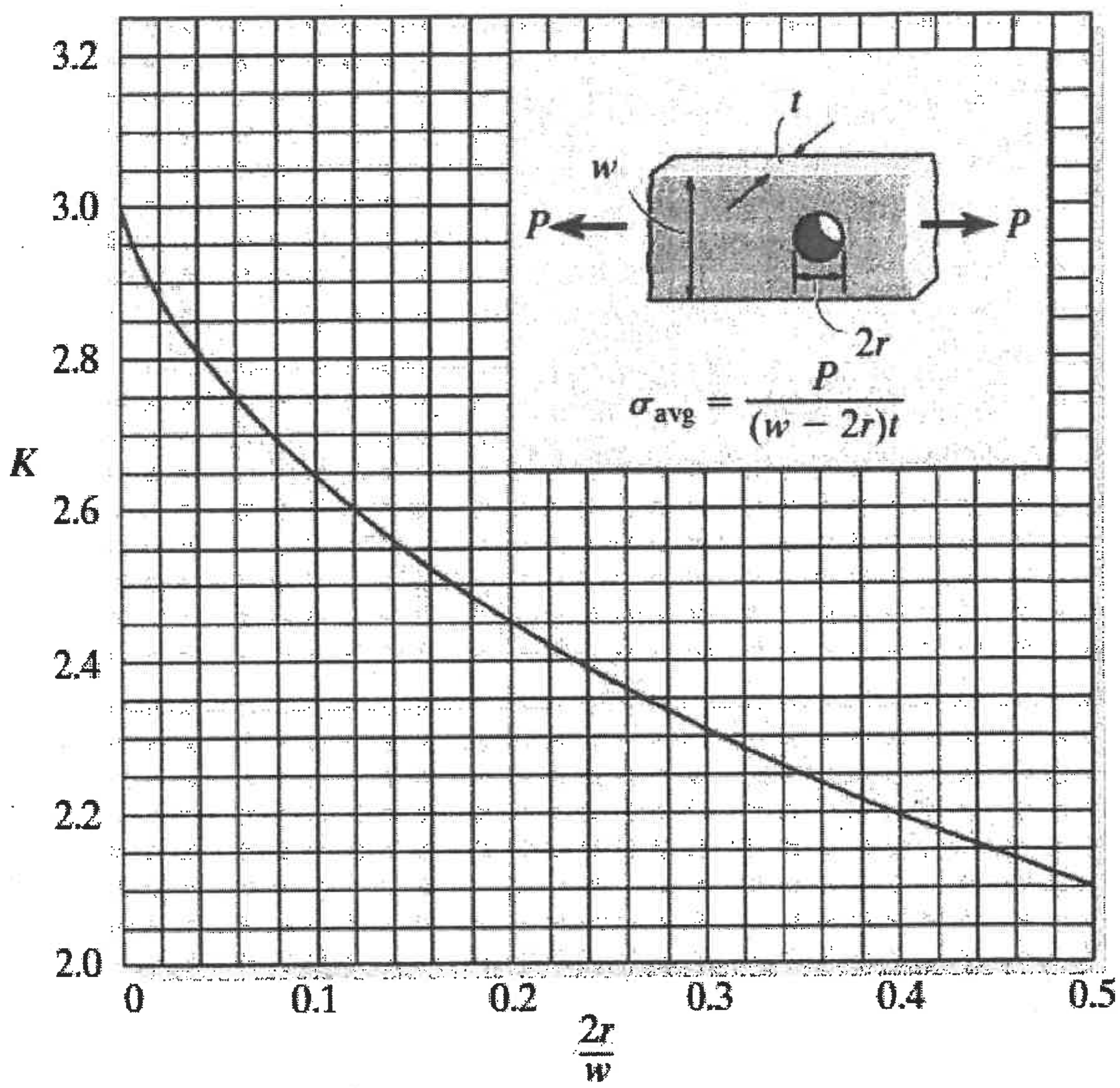
(15 marks)

END OF EXAMINATION PAPER

Appendix A



3.0
2.8
2.6
2.4
2.2
2.0
1.8
1.6
1.4
1.2
1.0
K
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
0.9
1.0
r/h
w
r
P
P
h
t
σ_avg = P/ht
w/h = 4.0
w/h = 3.0
w/h = 2.0
w/h = 1.5
w/h = 1.2
w/h = 1.1


3.2
3.0
2.8
2.6
2.4
2.2
2.0
K
0
0.1
0.2
0.3
0.4
0.5
2r/w
t
w
P
P
2r
σ_avg = P / ((w − 2r)t)

Appendix B

Average Mechanical Properties of Typical Engineering Materials[a]

(SI Units)

Materials		Density ρ (Mg/m³)	Modulus of Elasticity *E* (GPa)	Modulus of Rigidity *G* (GPa)	Yield Strength (MPa) σ_Y Tens.	Yield Strength (MPa) σ_Y Comp.[b]	Yield Strength (MPa) σ_Y Shear	Ultimate Strength (MPa) σ_u Tens.	Ultimate Strength (MPa) σ_u Comp.[b]	Ultimate Strength (MPa) σ_u Shear	% Elongation in 50 mm specimen	Poisson's Ratio ν	Coef. of Therm. Expansion α (10^{-6})/°C
Metallic													
Aluminum Wrought Alloys	2014-T6	2.79	73.1	27	414	414	172	469	469	290	10	0.35	23
	6061-T6	2.71	68.9	26	255	255	131	290	290	186	12	0.35	24
Cast Iron Alloys	Gray ASTM 20	7.19	67.0	27	[illegible]	–	–	179	669	–	0.6	0.28	12
	Malleable ASTM A-197	7.28	172	68	[illegible]	–	–	276	572	–	5	0.28	12
Copper Alloys	Red Brass C83400	8.74	101	37	70.0	70.0	–	241	241	–	35	0.35	18
	Bronze C86100	8.83	103	38	345	345	–	655	655	–	20	0.34	17
Magnesium Alloy	[Am 1004-T61]	1.83	44.7	18	152	152	–	276	276	152	1	0.30	26
Steel Alloys	Structural A-36	7.85	200	75	250	250	–	400	400	–	30	0.32	12
	Structural A992	7.85	200	75	345	345	–	450	450	–	30	0.32	12
	Stainless 304	7.86	193	75	207	207	–	517	517	–	40	0.27	17
	Tool L2	8.16	200	75	703	703	–	800	800	–	22	0.32	12
Titanium Alloy	[Ti-6Al-4V]	4.43	120	44	924	924	–	1,000	1,000	–	16	0.36	9.4
Nonmetallic													
Concrete	Low Strength	2.38	22.1	–	–	–	12	–	–	–	–	0.15	11
	High Strength	2.37	29.0	–	–	–	38	–	–	–	–	0.15	11
Plastic Reinforced	Kevlar 49	1.45	131	–	–	–	–	717	483	20.3	2.8	0.34	–
	30% Glass	1.45	72.4	–	–	–	–	90	131	–	–	0.34	–
Wood Select Structural Grade	Douglas Fir	0.47	13.1	–	–	–	–	2.1[c]	26[d]	6.2[d]	–	0.29[e]	–
	White Spruce	3.60	9.65	–	–	–	–	2.5[c]	36[d]	6.7[d]	–	0.31[e]	–

[a] Specific values may vary for a particular material due to alloy or mineral composition,mechanical working of the specimen,or heat treatment. For a more exact value reference books for the material should be consulted.

[b] The yield and ultimate strengths for ductile materials can be assumed equal for both tension and compression.

[c] Measured perpendicular to the grain.

[d] Measured parallel to the grain.

[e] Deformation measured perpendicular to the grain when the load is applied along the grain.