ASCE NATIONAL CAPITAL SECTION
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National Capital Section
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OCTOBER 2016

DR. Z's CORNER

Conquering the FE & PE exams
Problems & Applications

This Month's Problem Topics

- FE CIVIL Exam & Topics - Number of Questions
- Types of Calculators / For FE and PE Exams
- Technology Usage / Imaginary Numbers
- Mathematics / Derivatives
- Statics / Plane Truss Analysis
- Dynamics / Rectilinear Motion
- Strength of Material / Deflections
- Strength of Material / Torsion
- Strength of Material / Determinate Frames
- Centroids & Moments of Inertia
- Structures / Shear and Moment Diagrams
- Transportation / Stopping Sight Distance (SSD)
- Geotechnical / Soil Classification (USCS)
- Geotechnical / Soil Classification (AASHTO)

FUNDAMENTALS OF ENGINEERING

CIVIL EXAM TOPICS

Computer-Based Test (CBT)

Total Number of Questions: 110
Time: 6 hours

The new Civil FE Computer-Based Test (CBT) consists of 110 multiple-choice questions (Each problem only one question) the examinee will have 6 hours to complete the test.

- **Mathematics (Approx. 9 questions*)**
- **Probability and Statistics (5 questions)**
- **Computational Tools (5 questions)**
- **Ethics and Professional Practice (5 questions)**
- **Engineering Economics (5 questions)**
- **Statics (9 questions)**
- **Dynamics (5 questions)**
- **Mechanics of Materials (9 questions)**
- **Civil Engineering Materials (5 questions)**
- **Fluid Mechanics (5 questions)**
- **Hydraulics and Hydrologic Systems (10 questions)**
- **Structural Analysis (8 questions)**
- **Structural Design (8 questions)**
- **Geotechnical Engineering (12 questions)**
- **Transportation Engineering (10 questions)**
- **Environmental Engineering (8 questions)**

* Here the number of questions are the average values taken from the NCEES Reference Handbook (Version 9.3 / Computer-Based Test)

ASCE-111
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OCT. 2016

TYPES OF CALCULATORS

ACCEPTABLE FOR USE IN FE / PE EXAMS

To protect the integrity of FE/PE exams, NCEES limits the types of calculators you may bring to exam sites. The only calculator models acceptable for use during the 2016 exams are as follows:

Casio: All fx-115 models. Any Casio calculator must contain fx-115 in its model name. Examples of acceptable Casio fx-115 models include (but are not limited to):

- fx-115 MS
- fx-115 MS Plus
- fx-115 MS SR
- fx-115 ES
- fx-115 ES Plus

Texas Instruments: All TI-30X and TI-36X models. Any Texas Instruments calculator must contain either TI-30X or TI-36X in its model name. Examples of acceptable TI-30X and TI-36X models include (but are not limited to):

- TI-30Xa
- TI-30Xa SOLAR
- TI-30Xa SE
- TI-30XS Multiview
- TI-30X IIB
- TI-30X IIS
- TI-36X II
- TI-36X SOLAR
- TI-36X Pro

Hewlett Packard: The HP 33s and HP 35s models, but no others.

FUNDAMENTALS OF ENGINEERING

MATHEMATICS

EXPRESSIONS W/ IMAGINARY NUMBERS

Problem-1

$$F = \frac{(1-i)^2}{(1+i)^2} \qquad i = \sqrt{-1}$$

For the expression given above the value of *F* is most nearly:

(A) - 1
(B) 0
(C) 1 - i
(D) 1 + i

F = ?

Problem-2

$$F = \frac{(1-i)^3}{(1+i)} \qquad i = \sqrt{-1}$$

For the expression given above the value of *F* is most nearly:

(A) 0
(B) -1
(C) -2
(D) 1 + i

F = ?

Problem-3

$$F = \frac{2i}{1+i} \qquad i = \sqrt{-1}$$

For the expression given above the value of *F* is most nearly:

(A) 1
(B) 2
(C) 1 + i
(D) 2 $-3i$

F = ?

MATH-130-A
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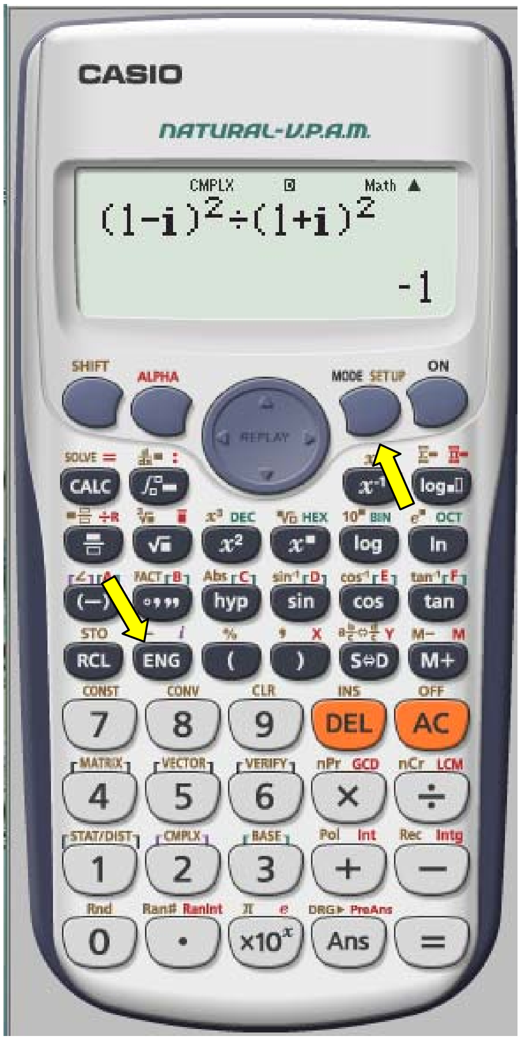
FUNDAMENTALS OF ENGINEERING

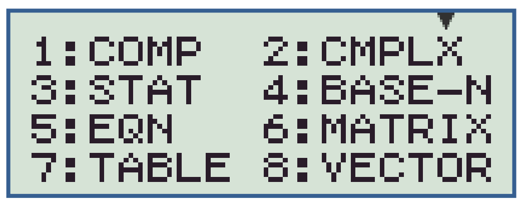
MATHEMATICS / IMAGINARY NUMBERS

TECHNOLOGY USAGE



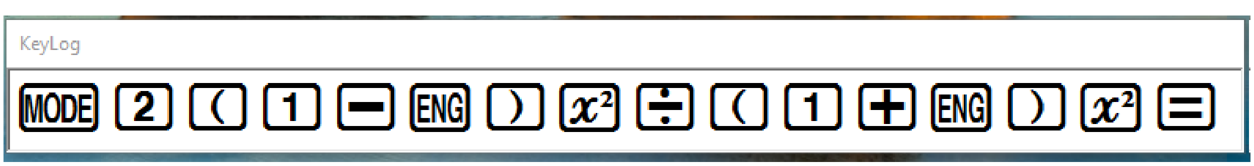
$$F = \frac{(1-i)^2}{(1+i)^2}$$

$$F = ?$$



Make sure calculator is in the COMPLEX mode. How do you do that? Just hit MODE key as shown and then select 2.

The answer as shown: -1



The answer is: (A)

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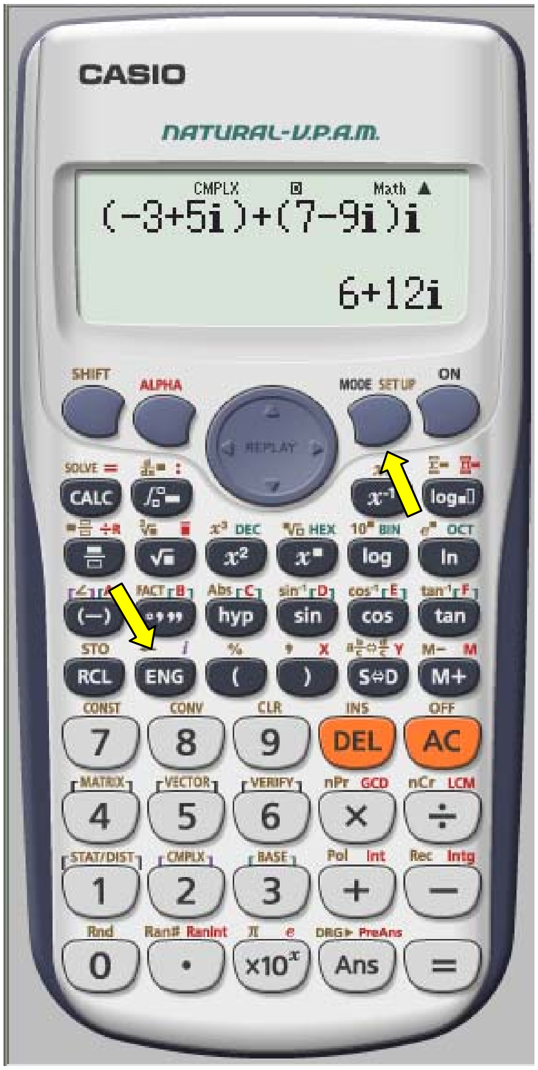
FUNDAMENTALS OF ENGINEERING
MATHEMATICS / IMAGINARY NUMBERS
TECHNOLOGY USAGE



$$F=(-3+5i)+(7-9i)i$$

$$F=?$$

1:COMP	2:CMPLX
3:STAT	4:BASE-N
5:EQN	6:MATRIX
7:TABLE	8:VECTOR

Make sure calculator is in the COMPLEX mode. How do you do that? Just hit MODE key as shown and then select 2.

The answer shown: 6+12i

MODE 2 (− 3 + 5 ENG) + (7 − 9 ENG) ENG =

Final answer is : 6+12i

SUPPLEMENTAL PROBLEMS

	Function $y = f(x)$	Derivative $y' = f'(x)$
1	$x^3 e^x$	$x^2 e^x (x + 3)$
2	$x^4 Ln(x)$	$x^3 [1 + 4 Ln(x)]$
3	$2x^2 Ln(x) - x^2$	$4x Ln(x)$
4	$Ln(x^5)$	$\frac{5}{x}$
5	$[Ln(x)]^2$	$2 Ln(x) / x$
6	$(4 - 5e^x)^3$	$-15e^x (4 - 5e^x)^2$
7	$\frac{Ln(x)}{x^4}$	$\frac{1 - 4Ln(x)}{x^5}$

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FUNDAMENTALS OF ENGINEERING

DYNAMICS

PROJECTILE & PARTICLE MOTION

Problem-1

Suppose that a projectile is fired vertically from ground level with an initial velocity of 88 ft/s. Knowing that the air resistance is neglected, the time (seconds) when the projectile is 96 ft. above the ground is most nearly:

(A) 4.5 and 6
(B) 3.5 and 6
(C) 2.5 and 5
(D) 1.5 and 4

Problem-2

Suppose that a projectile is fired vertically from 50 ft above ground level with an initial velocity of 88 ft/s. Knowing that the air resistance is neglected, the time (seconds) when the projectile is 162 ft. above the ground is most nearly:

(A) 4.0 and 6.6
(B) 3.5 and 5.0
(C) 2.0 and 3.5
(D) 1.5 and 3.0

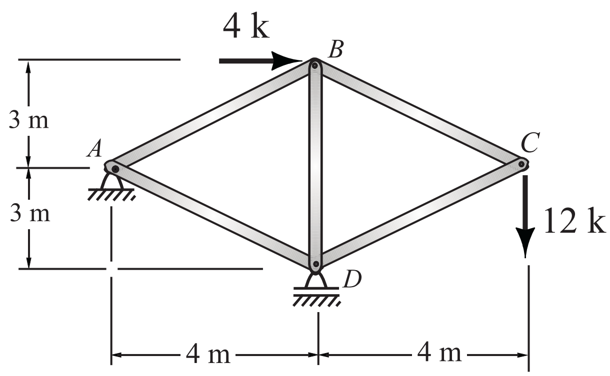
Problem-3

Suppose the velocity (ft/s) of a moving particle after t seconds have elapsed is given by the equation $v\,(\mathrm{t}) = 3t^{2} + 2t$. The distance traveled (ft.) by the particle over the interval $3 \le t \le 6$ is most nearly:

(A) 65.6
(B) 85.5
(C) 113
(D) 216

FUNDAMENTALS OF ENGINEERING

STATICS / PLANE TRUSSES



Support A : Pin
Support D : Roller

A plane truss system is loaded as shown. Using the listed data and the loads, determine:

(1) the magnitude of the member force (kN) in member *BD* is most nearly:

(A) 15.00 (C)
(B) 25.25 (T)
(C) 30.00 (C)
(D) 20.00 (T)

$F_{BD} = ?$

(2) the magnitude of the member force (kN) in member *BC* is most nearly:

(A) 35.00 (C)
(B) 25.25 (T)
(C) 22.00 (C)
(D) 10.00 (T)

$F_{BC} = ?$

(3) the magnitude of the member force (kN) in member *AD* is most nearly:

(A) 35.00 (T)
(B) 25.25 (T)
(C) 22.00 (C)
(D) 10.00 (C)

$F_{AD} = ?$

TRSS-322
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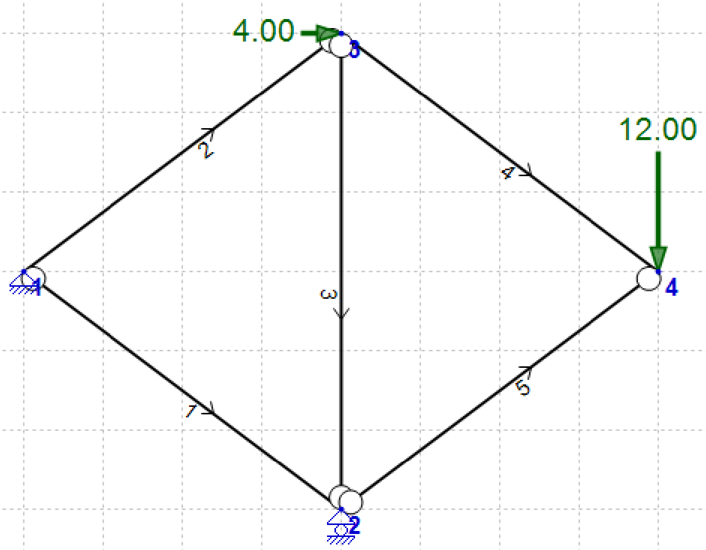
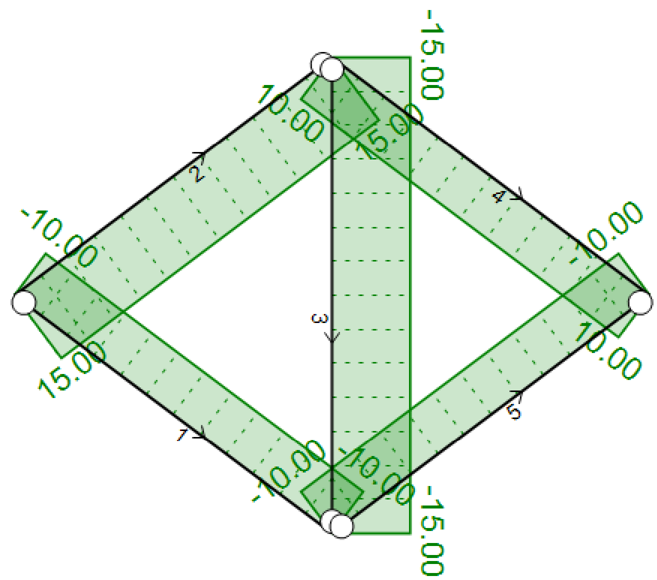
OCT. 2016

Solution by Dr. Vagelis Plevris

Model



Axial Force Diagram



Answers:

(1) A (F_{BD}=15.0 [C])

(2) D (F_{BC}=10.0 [T])

(3) D (F_{AD}=10.0 [C])

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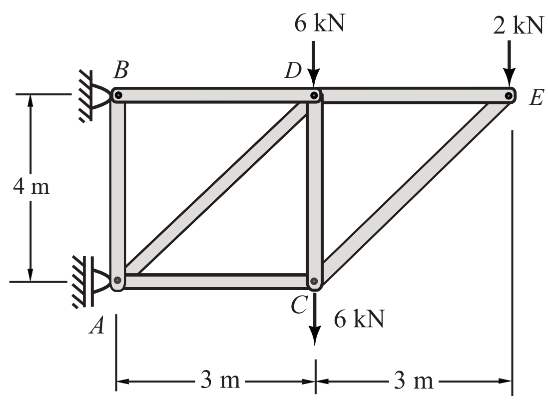
Software BEAM.2D by ENGILAB
www.engilab.com

FUNDAMENTALS OF ENGINEERING

STATICS / PLANE TRUSSES



FE EXAM

Support B : Hinge
Support A : Roller

The plane truss is subjected to the loads as shown in the figure. Assuming the support *A* is a roller, answer the following questions:

(1) the magnitude of the member force (kN) in BD is most nearly

(A) 12.0
(B) 14.5
(C) 16.0
(D) 18.5

$F_{AB} = ?$

(2) the magnitude of the member force (kN) in AD is most nearly

(A) 25.0
(B) 21.5
(C) 19.0
(D) 17.5

$F_{AD} = ?$

(3) the magnitude of the member force (kN) in AC is most nearly

(A) 3.5
(B) 2.0
(C) 1.5
(D) 0.5

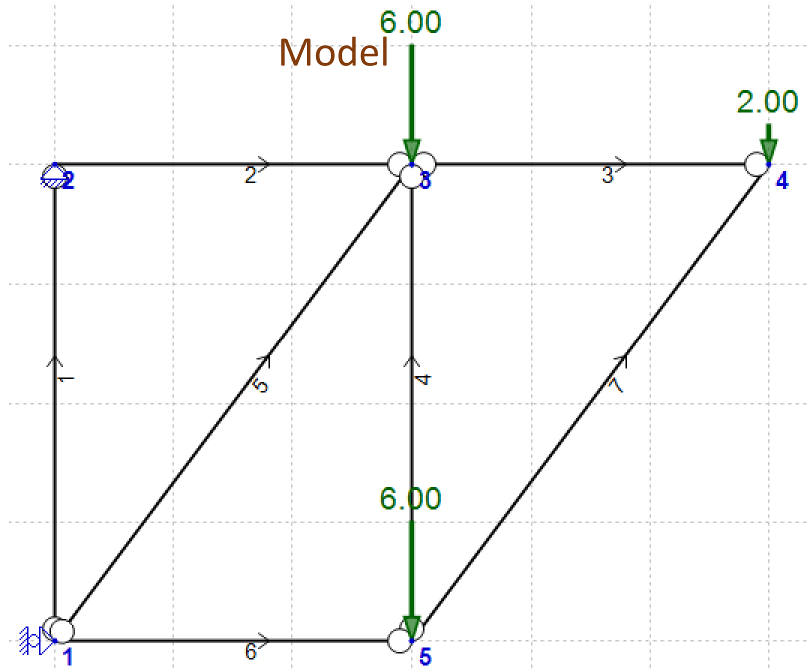
$F_{AC} = ?$

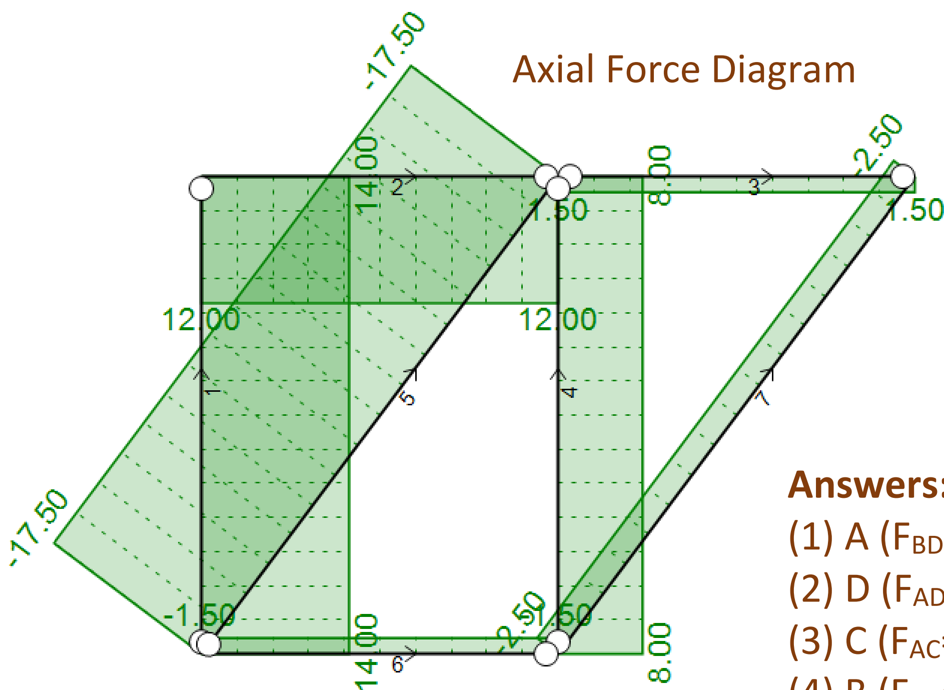
(4) the magnitude of the member force (kN) in CD is most nearly

(A) 10.5
(B) 8.0
(C) 6.0
(D) 4.5

$F_{CD} = ?$

Solution by Dr. Vagelis Plevris





Answers:

(1) A (F_{BD}=12.0)

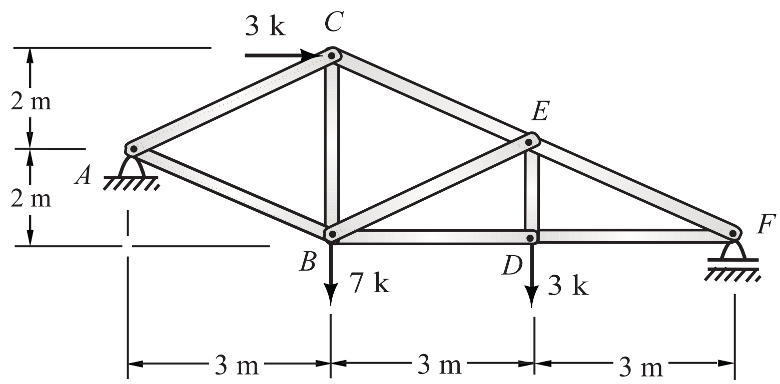
(2) D (F_{AD}=17.5)

(3) C (F_{AC}=1.5)

(4) B (F_{CD}=8.0)

FUNDAMENTALS OF ENGINEERING

STATICS / PLANE TRUSSES



Support A : Pin
Support F : Roller

A plane truss system is loaded as shown. Using the listed data and the loads, determine:

(1) the magnitude of the member force (kN) in member *CE* is most nearly:

(A) 5.00 (C)
(B) 6.31 (C)
(C) 8.35 (C)
(D) 9.16 (T)

$F_{CE} = ?$

(2) the magnitude of the member force (kN) in member *BD* is most nearly:

(A) 9.00 (T)
(B) 8.25 (T)
(C) 7.50 (T)
(D) 6.00 (C)

$F_{BD} = ?$

(3) the magnitude of the member force (kN) in member *ED* is most nearly:

(A) 3.00 (T)
(B) 4.25 (T)
(C) 5.35 (T)
(D) 6.00 (T)

$F_{ED} = ?$

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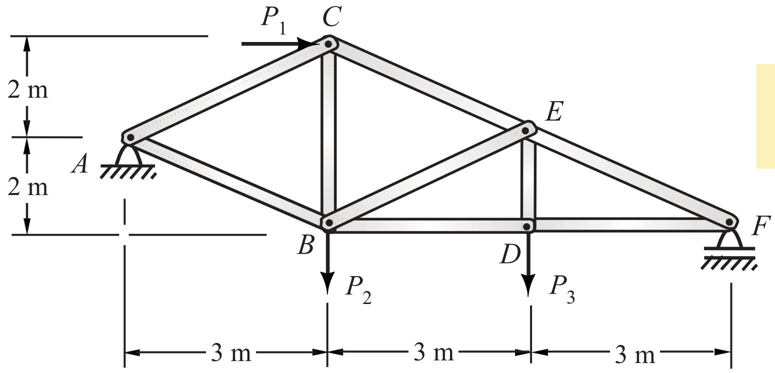
DETERMINATE TRUSS ANALYSIS

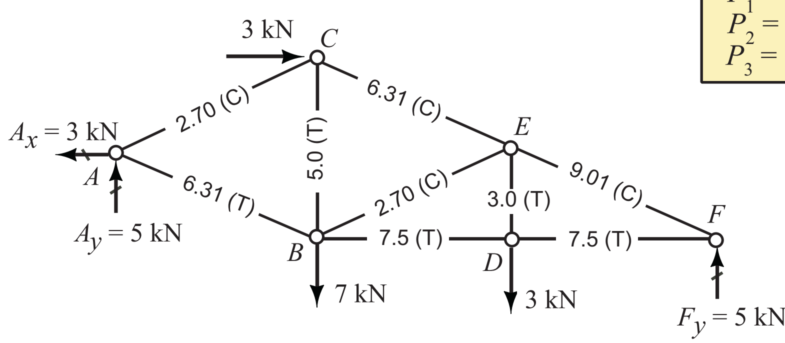


Support A : Hinge
Support F : Roller

Support Reactions and Member Forces

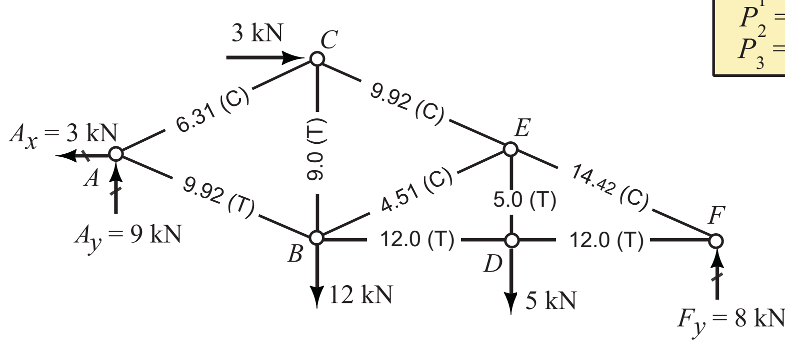
A

P_1 = 3 kN
P_2 = 7 kN
P_3 = 3 kN

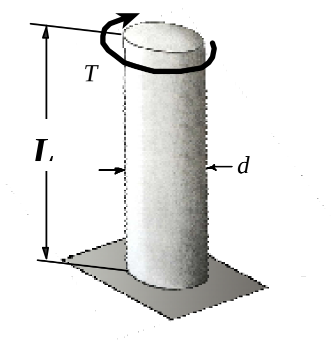


B

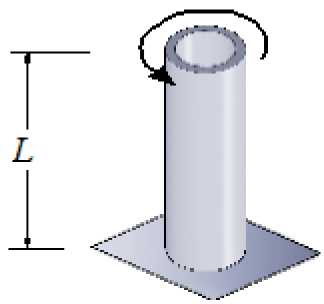
P_1 = 3 kN
P_2 = 12 kN
P_3 = 5 kN



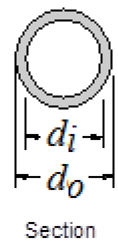
STRENGTH OF MATERIALS
TORSION
BASIC FORMULAS



Solid Shaft



Hollow Shaft



d_o: outside diameter
d_i: inside diameter

(1)

$$J = \frac{\pi d^4}{32}$$

$$J = \frac{\pi\left(d_o^4 - d_i^4\right)}{32}$$

(2)

$$\tau_{max} = \frac{T \cdot r}{J}$$

$$T = \frac{\tau \cdot J}{r}$$

NCEES-Reference Handbook
Version 9.3
Page-81

T = torque, torsional moment
J = polar moment of inertia
L = length of shaft
d= diameter
r = radius

FTOR-155
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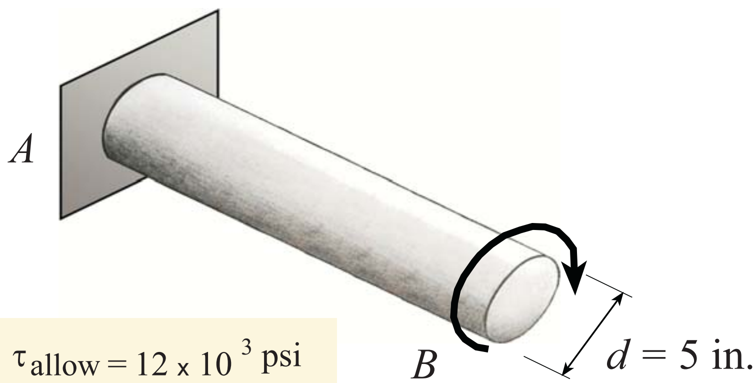
OCT. 2016

MECHANICS OF SOLIDS
TORSION
STRENGTH REDUCTION

Problem: (Torsion)



$\tau_{allow} = 12 \times 10^{3}$ psi

(1) A 5-in diameter solid steel shaft is given as shown. Using the listed max. allowable shearing stress, the loss of strength (%) by boring a 2.5-in. axial hole would be most nearly:

(A) 3.45 %
(B) 4.50 %
(C) 5.12 %
(D) 6.25 %

$\Delta T = ?$

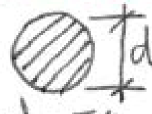
(2) After 2.5-in. diameter hole is bored axially in the shaft, the percentage of reduction (%) in weight would be most nearly:

(A) 15 %
(B) 18 %
(C) 25 %
(D) 32 %

$\Delta W = ?$

SOLUTION (TOR-65)

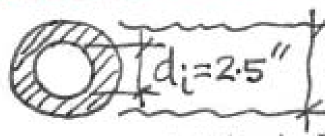
SOLID SHAFT



$$J_s = \frac{\pi d^4}{32} = \frac{\pi(5^4)}{32} = 61.36 \text{ in}^4$$

$$A_s = \frac{\pi d^2}{4} = \frac{\pi(5^2)}{4} = 19.63 \text{ in}^2$$

HOLLOW SHAFT



$J_h = ?$
$A_h = ?$

$$J_h = \frac{\pi(d_o^4 - d_i^4)}{32} = \frac{\pi(5^4 - 2.5^4)}{32} = 57.52 \text{ in}^4$$

$$A_h = \frac{\pi}{4}(d_o^2 - d_i^2) = \frac{\pi}{4}(5^2 - 2.5^2) = 14.73 \text{ in}^2$$

SOLID SHAFT: Max. allowable torque

$$T_s = \frac{\tau_{max} \cdot J_s}{r} = \frac{(12 \text{ ksi})(61.36 \text{ in}^4)}{2.5 \text{ in}} = 294.52 \text{ in-kips}$$

HOLLOW SHAFT: Max. allowable torque

$$T_h = \frac{\tau_{max} J_h}{r} = \frac{(12 \text{ ksi})(57.52 \text{ in}^4)}{2.5 \text{ in}} = 276.12 \text{ in-kips}$$

Percentage of reduction in strength: (ΔT)

$$\Delta T = \frac{T_s - T_h}{T_s} \times 100 = \frac{294.52 - 276.12}{294.52} \times 100 = 6.25\%$$

Percentage of reduction in weight: (ΔW)

$$\Delta W = \frac{A_s - A_h}{A_s} \times 100 = \frac{19.63 - 14.73}{19.63} \times 100 = 25\%$$

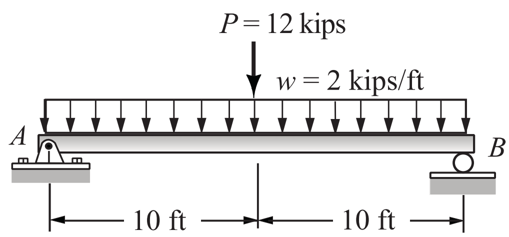
AZ

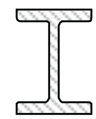
Answers: (1) The correct answer is (D)
(2) The correct answer is (C)

MECHANICS OF SOLIDS

DESIGN OF STEEL STRUCTURES

BEAM DEFLECTIONS





section
W18 x 50

NCEES-RH
PAGE-158
W-SHAPES

$E = 29{,}000$ ksi

A determinate beam is loaded as shown. Knowing that the beam weight is included in the uniform load, answer the following questions:

(1) The maximum moment (ft.kips) in the beam is most nearly:

(A) 160
(B) 180
(C) 200
(D) 150

$M_{max} = ?$

(2) The maximum deflection (inches) is most nearly:

(A) 0.38
(B) 0.46
(C) 0.62
(D) 1.02

$\delta_{max} = ?$

NCEES-RH
PAGE-84
DEFLECTIONS

(3) The slope (degrees) at the left support is most nearly

(A) 0.344
(B) 0.241
(C) 0.512
(D) 0.112

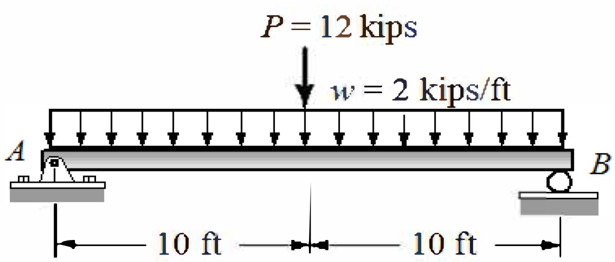
$\theta_A = ?$

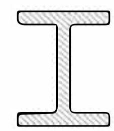
ANSWERS

DEF-380
VPLEVRIS
OCT. 2016

MECHANICS OF SOLIDS
DESIGN OF STEEL STRUCTURES
BEAM DEFLECTIONS

Problem: ***DEF-380*** ***Solution in MS Excel***





section
W18 x 50

SECTION:	**W18X50**	
E =	29000	ksi
P =	12	kips
w =	2	kips/ft
L =	20	ft

ID	Quantity	Symbol	Value	Unit
37	x - Moment of Inertia	I_x	800.00	in^4

w =	0.166666667	kips/in
L =	240	in
M_P =	60	ft·kips
M_w =	100	ft·kips
$\mathbf{M_{max}}$ =	**160**	ft·kips
δ_P =	0.149	in
δ_w =	0.310	in
$\boldsymbol{\delta_{max}}$ =	**0.46**	**in**
θ_P =	0.00186	rad
θ_w =	0.00414	rad
θ_A =	*0.0060*	rad
$\boldsymbol{\theta_A}$ =	***0.344***	**deg**

$$M_P = \frac{PL}{4} \qquad M_w = \frac{wL^2}{8}$$

$$\delta_P = \frac{1}{48}\frac{PL^3}{EI} \qquad \delta_w = \frac{5}{384}\frac{wL^4}{EI}$$

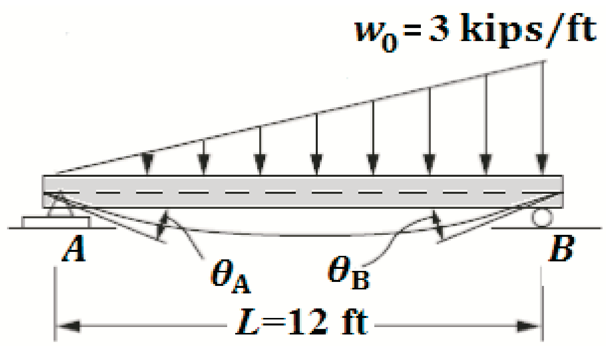
$$\theta_P = \frac{1}{16}\frac{PL^2}{EI} \qquad \theta_w = \frac{1}{24}\frac{wL^3}{EI}$$

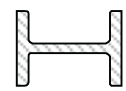
DEF-380
VPLEVRIS
OCT. 2016

MECHANICS OF SOLIDS

DESIGN OF STEEL STRUCTURES

BEAM DEFLECTIONS





section
W18 x 55

NCEES-RH
PAGE-158
W-SHAPES

$E = 29{,}000$ ksi

A determinate beam is loaded as shown. Knowing that the beam weight is included in the uniform load, answer the following questions:

(1) The maximum deflection (inches) is most nearly:

(A) 0.81
(B) 0.54
(C) 0.69
(D) 0.99

$\delta_{max} = ?$

(2) The slope (degrees) at the left support (A) is most nearly:

(A) -0.705
(B) -0.639
(C) -0.525
(D) -0.312

$\theta_A = ?$

NCEES-RH
PAGE-84
DEFLECTIONS

(3) The slope (degrees) at the right support (B) is most nearly:

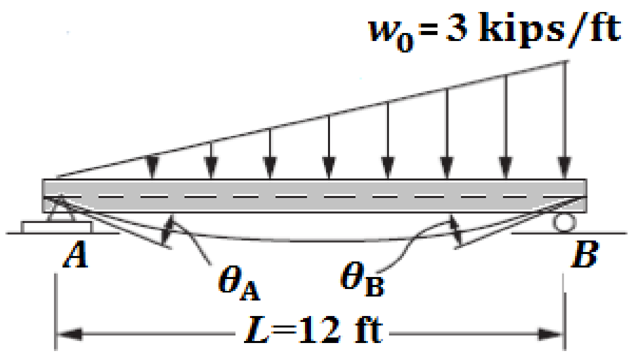
(A) 0.730
(B) 0.632
(C) 0.916
(D) 0.881

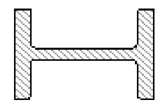
$\theta_B = ?$

ANSWERS

MECHANICS OF SOLIDS
DESIGN OF STEEL STRUCTURES
BEAM DEFLECTIONS

Problem: ***DEF-382*** ***Solution in MS Excel***





SECTION: **W18X55**

E = 29000 ksi
w_0 = 3 kips/ft
L = 12 ft

ID	Quantity	Symbol	Value	Unit
41	y - Moment of Inertia	I_y	44.90	in^4

w_0 = 0.25 kips/in
L = 144 in

δ_{max} = 0.54 in

$$\delta_{\max} = 0.00652 \frac{w_0 L^4}{EI}$$

at x = 6.23 ft

$$\text{at } x = 0.5193L$$

θ_A = -0.01115 rad
θ_A = -0.639 deg

$$\theta_A = \frac{-7 w_0 L^3}{360 EI}$$

θ_B = 0.01274 rad
θ_B = 0.730 rad

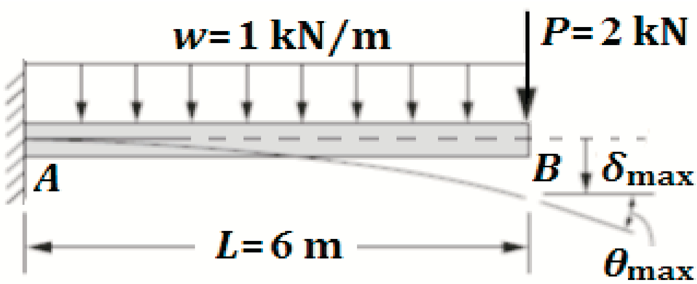
$$\theta_B = \frac{w_0 L^3}{45 EI}$$

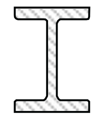
DEF-382
VPLEVRIS
OCT. 2016

MECHANICS OF SOLIDS

DESIGN OF STEEL STRUCTURES

BEAM DEFLECTIONS





section
W530x109

AISC DATABASE
(METRIC UNITS)

$E = 200$ GPa

A determinate beam is loaded as shown. Knowing that the beam weight is included in the uniform load, answer the following questions:

(1) The maximum moment (kN.m) in the beam is most nearly:

(A) 22
(B) 40
(C) 30
(D) 62

$M_{max} = ?$

(2) The maximum deflection (mm) is most nearly:

(A) 2.3
(B) 1.8
(C) 2.8
(D) 1.5

$\delta_{max} = ?$

NCEES-RH
PAGE-84
DEFLECTIONS

(3) The slope (degrees) at the right edge is most nearly

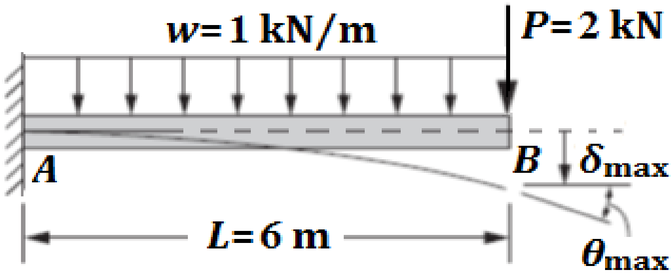
(A) 0.031
(B) 0.026
(C) 0.021
(D) 0.042

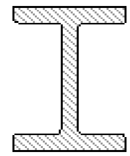
$\theta_{max} = ?$

ANSWERS

MECHANICS OF SOLIDS
DESIGN OF STEEL STRUCTURES
BEAM DEFLECTIONS

Problem: ***DEF-384*** ***Solution in MS Excel***





SECTION: W530X109

E = 200 GPa
P = 2 kN
w = 1 kN/m
L = 6 m

ID	Quantity	Symbol	Value	Unit
36	x - Moment of Inertia	I_x	66600.00	cm^4

E = 200000000 kPa
I_x = 0.000666 m^4

M_P = 12 kN·m
M_w = 18 kN·m
M_{max} = 30 kN·m

$$M_P = PL$$

$$M_w = \frac{wL^2}{2}$$

δ_P = 0.00108 m
δ_w = 0.00122 m
δ_{max} = 0.00230 m
δ_{max} = 2.3 mm

$$\delta_P = \frac{PL^3}{3EI}$$

$$\delta_w = \frac{wL^4}{8EI}$$

θ_P = 0.00027 rad
θ_w = 0.00027 rad
θ_{max} = 0.00054 rad
θ_{max} = 0.031 deg

$$\theta_P = \frac{PL^2}{2EI}$$

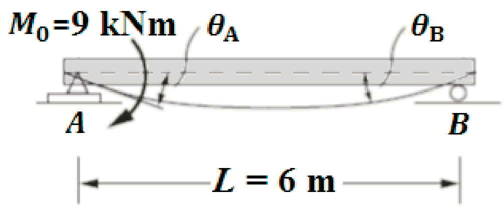
$$\theta_w = \frac{wL^3}{6EI}$$

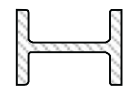
DEF-384
VPLEVRIS
OCT. 2016

MECHANICS OF SOLIDS

DESIGN OF STEEL STRUCTURES

BEAM DEFLECTIONS





section
W610x153

AISC DATABASE
(METRIC UNITS)

$E = 200$ GPa

A determinate beam is loaded as shown. Without taking into account the beam weight, answer the following questions:

(1) The maximum deflection (mm) is most nearly:

(A) 2.1
(B) 2.5
(C) 2.7
(D) 1.7

$\delta_{max} = ?$

(2) The slope (degrees) at the left support (A) is most nearly:

(A) -0.092
(B) -0.130
(C) -0.122
(D) -0.104

$\theta_A = ?$

NCEES-RH
PAGE-84
DEFLECTIONS

(3) The slope (degrees) at the right support (B) is most nearly:

(A) 0.032
(B) 0.043
(C) 0.052
(D) 0.065

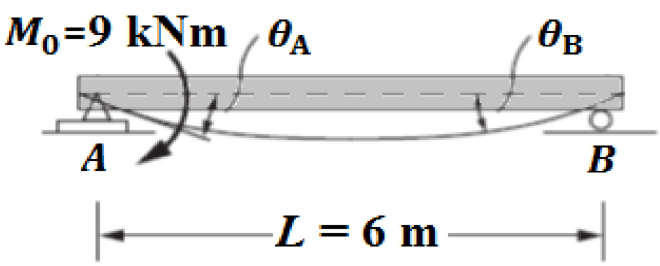
$\theta_B = ?$

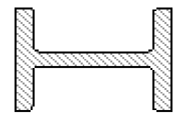
ANSWERS

DEF-386
VPLEVRIS
OCT. 2016

MECHANICS OF SOLIDS
DESIGN OF STEEL STRUCTURES
BEAM DEFLECTIONS

Problem: ***DEF-386*** ***Solution in MS Excel***





SECTION: **W610X153**

E = 200 GPa
M_0 = 9 kNm (clockwise)
L = 6 m

ID	Quantity	Symbol	Value	Unit
40	y - Moment of Inertia	I_y	4950.00	cm^4

E = 200000000 kPa
I_y = 0.0000495 m^4

δ_{max} = 0.00210 m
δ_{max} = 2.1 mm

$$\delta_{max} = \frac{M_0 L^2}{\sqrt{243} EI}$$

θ_A = -0.00182 rad
θ_A = -0.104 deg

θ_B = 0.00091 rad
θ_B = 0.052 deg

$$\theta_A = \frac{-M_0 L}{3EI}$$

$$\theta_B = \frac{M_0 L}{6EI}$$

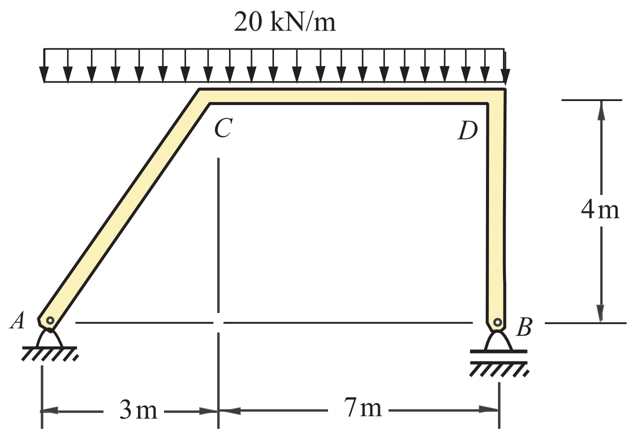
DEF-386
VPLEVRIS
OCT. 2016

FUNDAMENTALS OF ENGINEERING

STRENGTH OF MATERIALS

Internal Forces in Determinate Frames

Problem:



Support A : Pin
Support B : Roller

The dimensions, loading and support conditions of a determinate frame are given as shown in the figure:

(1) the axial load diagram in *AC* is most nearly

- (A) Parabola
- (B) Rectangle
- (C) Triangle
- (D) Trapezoid

(2) the magnitude of the *axial force* (kips) at *A is most nearly*

- (A) 30
- (B) 40
- (C) 60
- (D) 80

$N_A = ?$

(3) the magnitude of the *shear force* (kips) *at A* is most nearly

- (A) 60
- (B) 50
- (C) 40
- (D) 30

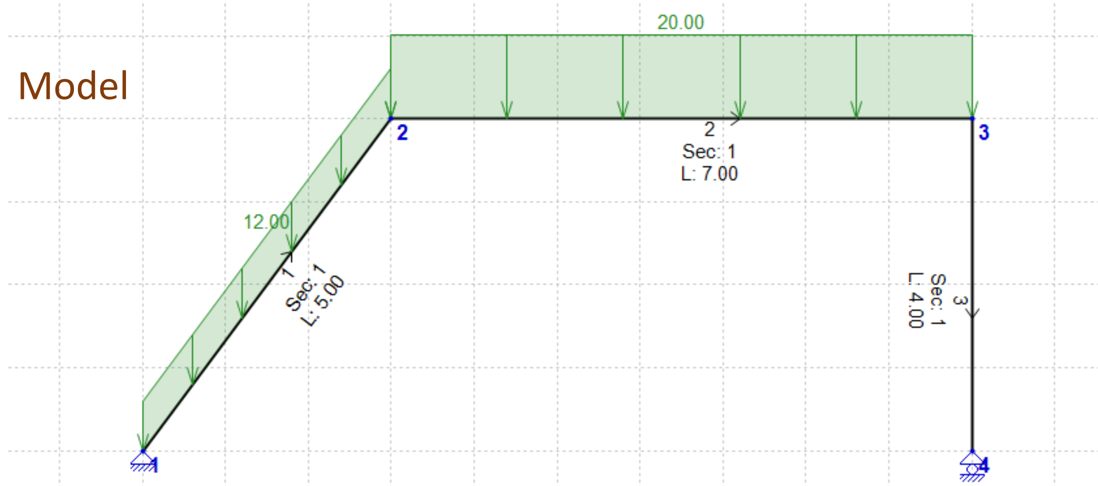
$V_A = ?$

ANSWERS

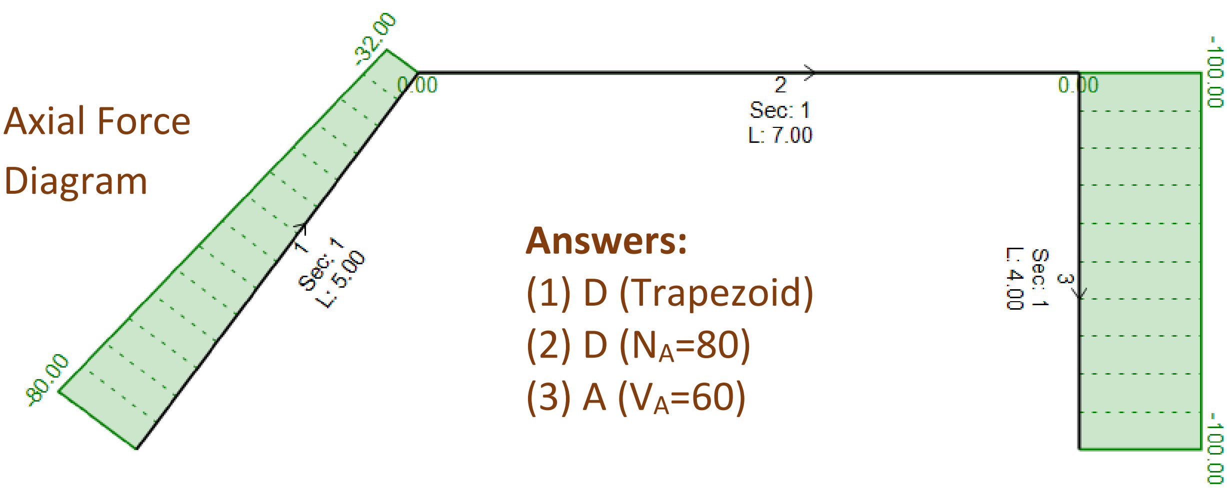
FR-712
VPLEVRIS
OCT. 2016

Solution by Dr. Vagelis Plevris

Model



Axial Force Diagram



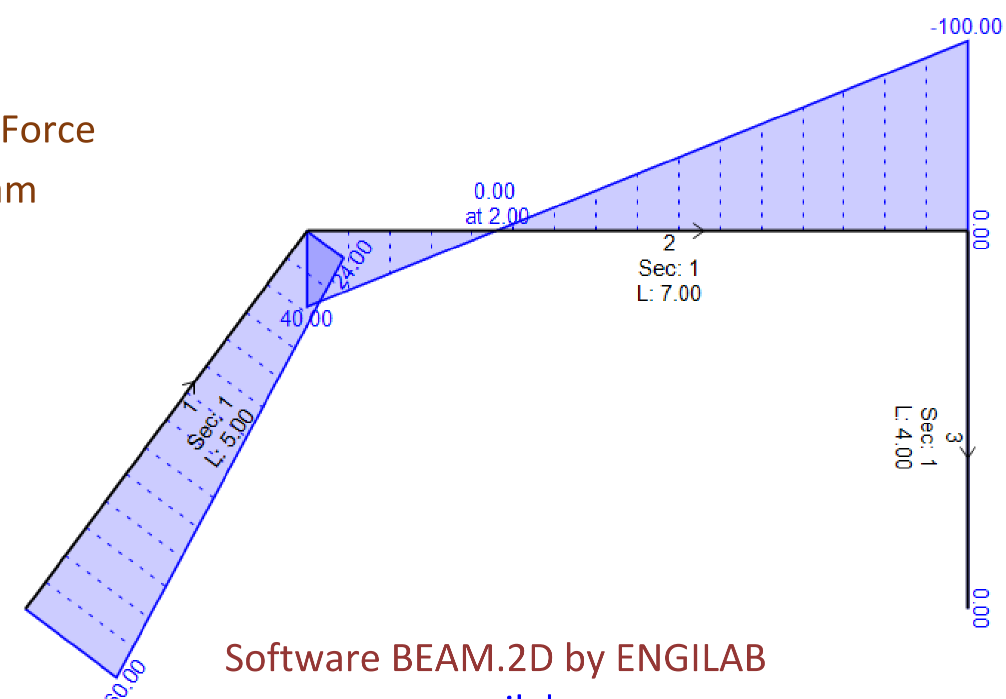
Answers:

(1) D (Trapezoid)

(2) D (N_A=80)

(3) A (V_A=60)

Shear Force Diagram



FR-712
VPLEVRIS
OCT. 2016

Software BEAM.2D by ENGILAB

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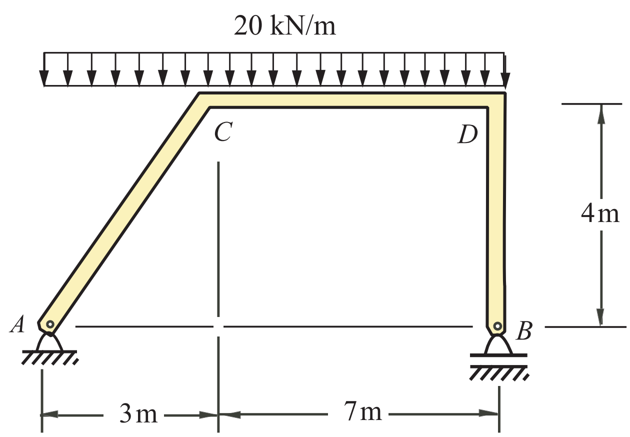
FUNDAMENTALS OF ENGINEERING

STRENGTH OF MATERIALS

Internal Forces in Determinate Frames

Problem:



Support A : Pin
Support B : Roller

The dimensions, loading and support conditions of a determinate frame are given as shown in the figure:

(1) the support reaction (kN) at support *B* is most nearly

(A) 80
(B) 90
(C) 100
(D) 110

$B_y = ?$

(2) the magnitude of the *axial force* (kips) in *DB is most nearly*

(A) 130
(B) 125
(C) 115
(D) 100

$N_{DB} = ?$

(3) the magnitude of the *max. moment* (ft-kips) in CD is most nearly

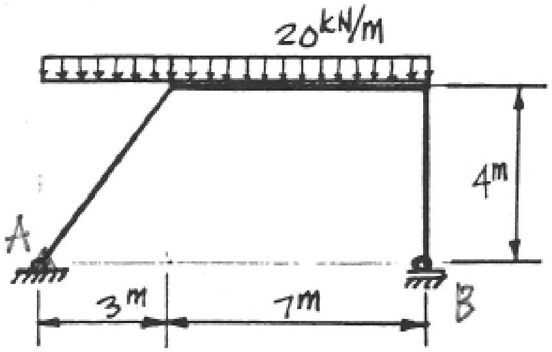
(A) 360
(B) 250
(C) 140
(D) 130

$M_{\max} = ?$

SOLUTION

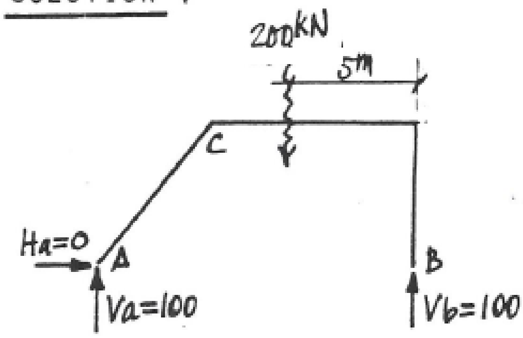
FR-710
VPLEVRIS
OCT. 2016

PROBLEM :



Draw V,N,M diagrams.

SOLUTION :

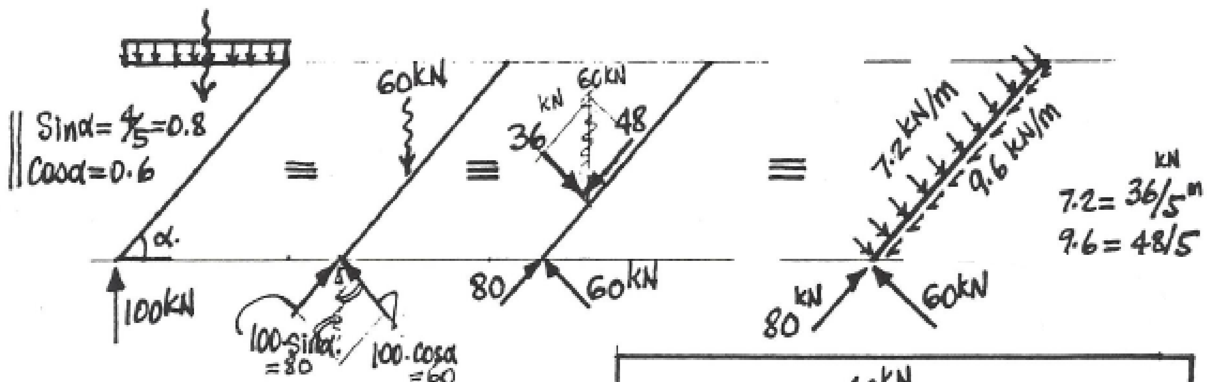


REACTIONS :

$\Sigma Fx = 0 \rightarrow Ha = 0$

$\Sigma Ma = 0 \rightarrow (200)(5^m) = 10\,Vb \rightarrow \boxed{Vb = 100^{kN}}$

$\Sigma Mb = 0 \rightarrow (200)(5^m) = 10\,Va \rightarrow \boxed{Va = 100^{kN}}$



$7.2 = 36/5^m$ kN

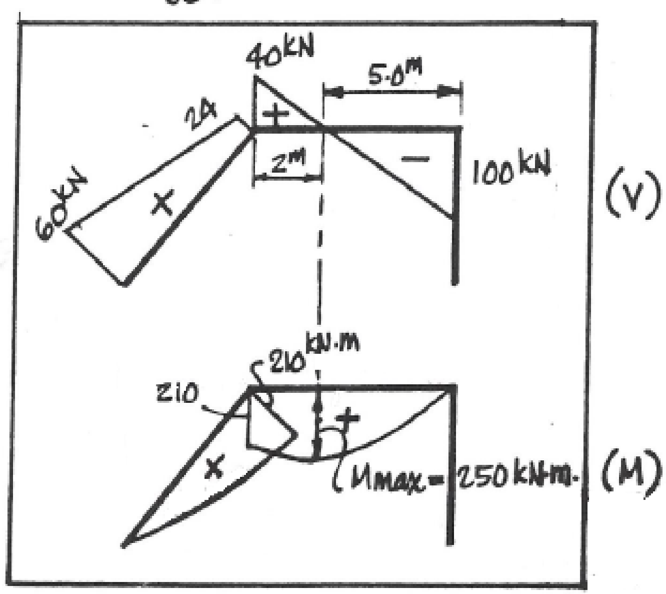
$9.6 = 48/5$

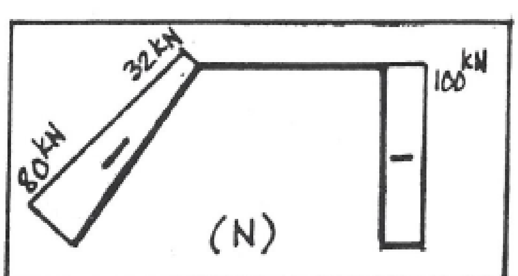
$M_C = 60 \times 5^m - (7.2)(5^2)/2 = 210^{kN \cdot m}$ (or)

$M_C = (100)(7^m) - (20)(7^2)/2 = 210$ kN.m.

$M_{max} = \frac{1}{2}(5)(100) = 250$ kN.m (or)

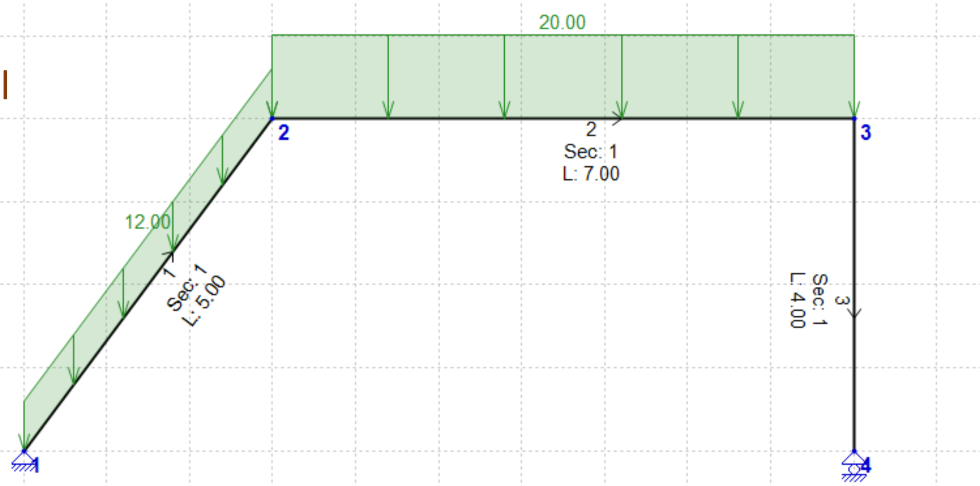
$M_{max} = M + T^2/2w = 210 + (40)^2/2 \times 20 = 250$ kN.m.





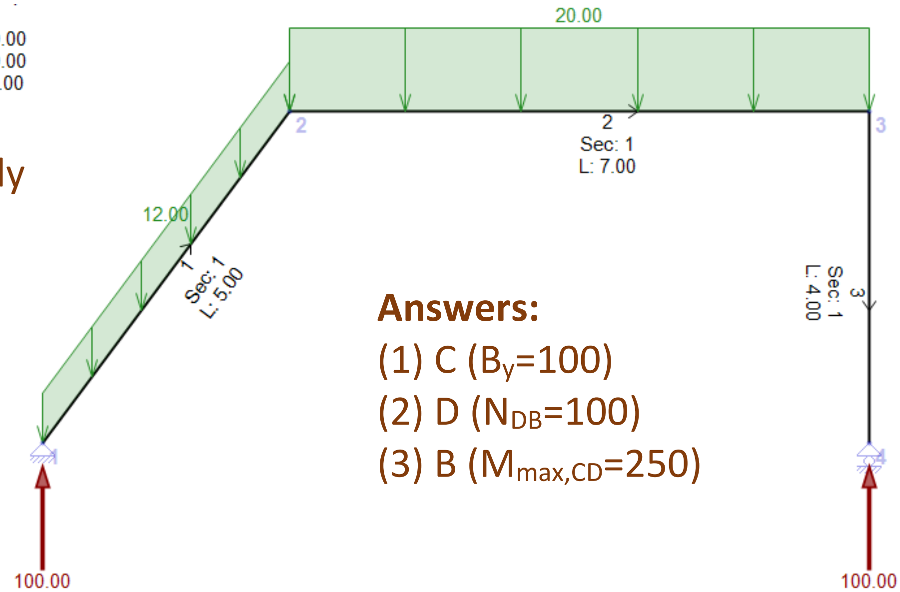
Solution by Dr. Vagelis Plevris

Model



ΣFX= 0.00
ΣFY= 0.00
ΣM = 0.00

Free Body Diagram



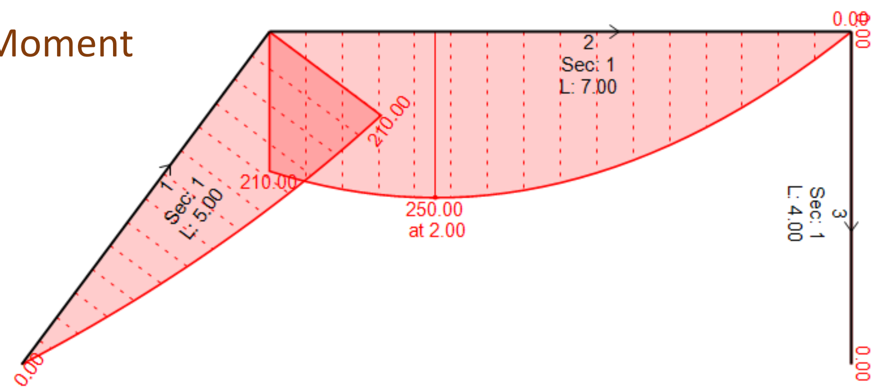
Answers:

(1) C (B_y=100)

(2) D (N_{DB}=100)

(3) B ($M_{max,CD}$=250)

Bending Moment Diagram



FR-710
VPLEVRIS
OCT. 2016

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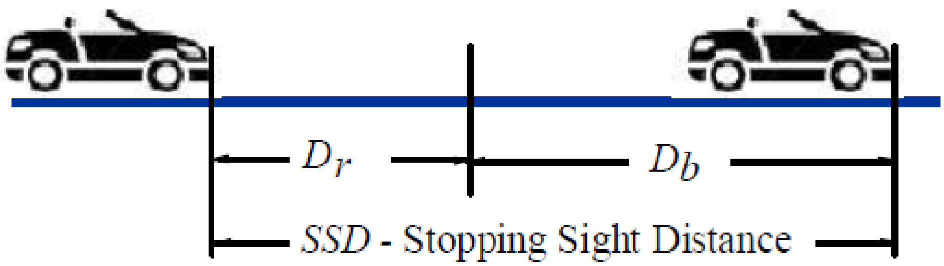
(FE/PE) AFTERNOON SESSION
TRANSPORTATION

PERCEPTION-REACTION DISTANCE (D_r)

BREAKING DISTANCE (D_b)

STOPPING SIGHT DISTANCE (SSD)



Perception-Reaction Distance (D_r)

$$D_r = 1.47\,Vt$$

Braking Distance (D_b)

$$D_b = \frac{V^2}{30\{(\frac{a}{g}) \pm G\}}$$

NCEES Ref. Handbook 9.4 Page-169

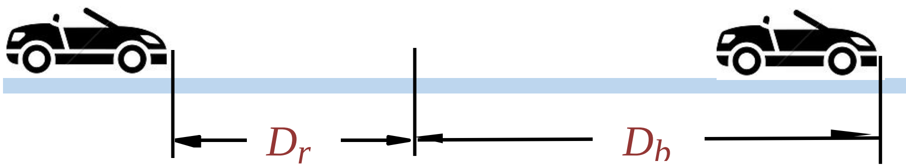
Perception-Reaction Distance (D_r)

$$SSD = 1.47\,Vt + \frac{V^2}{30\{(\frac{a}{g}) \pm G\}}$$

(FE) AFTERNOON SESSION

TRANSPORTATION

STOPPING SIGHT DISTANCE (SSD)



NCEES Reference Handbook, Page 169

$$SSD = 1.47\,V t + \frac{V^2}{30\left\{\left(\frac{a}{g}\right) \pm G\right\}}$$

SSD = Total stopping sight distance (ft)
V = Design speed (mph)
t = Perception- reaction time (seconds)
f = friction coefficient (f = a/g)
a = Deceleration rate (ft/s^2)
g = Acceleration due to gravity (32.2 ft/s^2)
G = The grade of the road

Problem-1 (Perception-Reaction Distance, d_r)

A driver traveling at 50 mph sees a blocked road ahead. Assuming the reaction time is 2.0 seconds, determine the perception-reaction distance (ft) that the vehicle travels between the time the driver notices the sign and the time brakes are applied:

(A) 275
(B) 240
(C) 195
(D) 147

$D_r = ?$
(D_{reaction})

Problem-2 (Braking Distance-D_b)

Consider a highway with a straight alignment sloping down -1.8% to a stop sign. Using the data from the problem given above and knowing that the driver is traveling at 50 mph with a deceleration rate of 11.2 ft/s^2 and reaction time of 2 seconds, the braking distance (ft) that the vehicle travels between the time the driver notices the sign and the time brakes are applied is most nearly:

(A) 253
(B) 380
(C) 420
(D) 540

$D_b = ?$
$(D_{breaking})$

Problem-3 (Stopping Sight Distance-SSD)

While descending a -2.5% grade at a speed of 65 mph, George notices a large object in the roadway ahead of him. Without thinking about any alternatives, he stabs his brakes and begins to slow down. Knowing that his reaction time is 2.5 seconds and the deceleration rate is 11.2 ft/s^2 the stopping sight distance (ft) is most nearly:

(A) 375
(B) 400
(C) 525
(D) 675

$SSD = ?$

PROFESSIONAL ENGINEERING

GEOTECHNICAL ENGINEERING

SIEVE ANALYSIS / ATTERBERG LIMITS

(1) For a soil sampleThe following laboratory results were obtained for a soil sample:

Sieve analysis:

Sieve size	Percentage passing
No. 4	100
No. 10	92
No. 40	68
No. 100	40
No. 200	13

Atterberg Limits:

Liquid Limit	NP
Plastic Limit	NP

Note: NP denotes non-plastic.

Classify this soil according to the AASHTO system:

(A) A-1-b
(B) A-2-4
(C) A-2-6
(D) A-4

(2) Based on the laboratory results obtained from Problem 1, please classify the soil according to the Unified Soil Classification System (USCS):

(A) SW-SM
(B) SC
(C) SM
(D) ML

(3) Using the data presented for the given inorganic soil sample, determine the soil classification according to the AASHTO system:

Sieve analysis:

Sieve size	Percentage passing
No. 4	100
No. 10	100
No. 40	92
No. 100	77
No. 200	55

Atterberg Limits:

Liquid Limit	41
Plastic Limit	29

Note: Liquid limit and plastic limit are determined based on the minus No. 40 fraction.

(A) A-2-7
(B) A-6
(C) A-7-5
(D) A-7-6

(4) Based on the laboratory results obtained from Problem 3, classify the soil according to the Unified Soil Classification System (USCS):

(A) ML
(B) CL
(C) CL-ML
(D) MH

(5) The sieve analysis and Atterberg Limit tests on a soil sample were performed. Using the data presented below, determine the soil classification according to the AASHTO system:

Sieve analysis:

Sieve size	Percentage passing
No. 4	100
No. 10	98
No. 40	82
No. 100	28
No. 200	5

Note: The coefficient of uniformity and coefficient of gradation determined from the particle size distribution curve are C_u = 4, C_c =0.9, respectively.

Atterberg Limits:

Liquid Limit	NP
Plastic Limit	NP

Note: NP denotes non-plastic.

(A) A-2-4
(B) A-2-6
(C) A-3
(D) A-5

(6) Based on the laboratory results obtained from Problem 5, please classify the soil according to the Unified Soil Classification System (USCS):

(A) SP
(B) SW
(C) SP-SM
(D) SM

SOLUTIONS:

Solution: #1

The percentage passing No. 200 sieve is 13%, less than 35%, so it is a granular material. Based on the percentage passing for No. 10, No. 40 and No. 200 sieves, it is an A-2 soil. It is a non-plastic soil based on Atterberg Limits, so the symbol can only be A-2-4.

The answer is (B)

Solution: #2

The percentage passing No. 200 sieve is 13%, less than 50%, so it is a coarse grained soil. The percentage of sand (87%, percentage passing No. 4 minus No. 200) is greater than gravel (0%, 100%-percentage passing No. 4), so it is a sandy soil. The fines content (13%, percentage passing No. 200) is greater than 12%, so it is sand with fines. Based on PI=0 (non-plastic), it is a silty sand, SM.

The answer is (C)

Solution: #3

The percentage passing No. 200 sieve is 55%, greater than 35%, so it is a silt-clay material, can only be A-4 to A-7. Based on the LL=41, PI=LL-PL=41-29=12, it is an A-7 soil. PI>LL-30, so it is A-7-6.

The answer is (D)

Solution: #4

The percentage passing No. 200 sieve is 55%, greater than 50%, so it is a fined grained soil. LL<50 and inorganic, it can either be CL or ML. Because LL = 41 and PI = 12 are plotted below A line in Plasticity Chart, it is a ML, sandy silt.

The answer is (A)

Solution: #5

The percentage passing No. 200 sieve is 5%, less than 35%, so it is a granular material. Based on the percentage passing for No. 10, No. 40 and No. 200 sieves, it is an A-3 soil.

The answer is (C)

Solution: #6

The percentage passing No. 200 sieve is 5%, less than 50%, so it is a coarse grained soil. The percentage of sand (95%, percentage passing No. 4 minus No. 200) is greater than gravel (0%, 100%-percentage passing No. 4), so it is a sandy soil. The fines content (5%, percentage passing No. 200) is less than 52%, so it is clean sand, can either be SW or SP. Based on C_u = 4<6 and C_c=0.9<1, it can only be SP, poorly graded sand.

The answer is (A)

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FOR ENGINEERING STUDENTS & PRACTICING ENGINEERS

November 19, 2016 / 11:00 am -3:45 pm