CIVIL ENGINEERING

PE EXAM

CONSTRUCTION

STUDY GUIDE

**"If one advances confidently
in the direction of one's dreams,
and endeavors to live the life
which one has imagined,
one will meet with a success
unexpected in common hours."
~ *Henry David Thoreau***

**"Incidentally, one can get beaten up in school
simply by referring to oneself as one."
~ *Dr. Sheldon Cooper, The Big Bang Theory***

CIVIL ENGINEERING

PRINCIPLES & PRACTICES of ENGINEERING

PE EXAM STUDY GUIDE

CONSTRUCTION

Copyright© 2015 Jeff Setzer

All rights reserved. No part of this book may be used or reproduced by any means, graphic, electronic, or mechanical, including photocopying, recording, taping or by any information storage retrieval system without the written permission of the publisher except in the case of brief quotations embodied in critical articles and reviews.

Because of the dynamic nature of the Internet, any Web addresses or links contained in this book may have changed since publication and may no longer be valid.

Any resemblance in the images in this book to actual people or locations is merely coincidental. Images in this book may not be reprinted, copied, modified, reproduced, published, uploaded, posted, transmitted, or utilized in any other manner without the permission of:

SETZER MEDIA GROUP

Version 2.0 (May 1, 2015)

“Your work is going to fill a large part of your life,
and the only way to be truly satisfied
is to do what you believe is great work.
And the only way to do great work
is to love what you do.
If you haven’t found it yet, keep looking.
Don’t settle.
As with all matters of the heart,
You’ll know when you find it.
And, like any great relationship,
it just gets better and better as the year roll on.
So keep looking until you find it.
Don’t settle.”
~ *Steve Jobs*

* The exam-specific topics were extracted from **www.ncees.org**. Refer to this site for an up-to-date listing of topics.

UPCOMING TEST SCHEDULE

STATE BOARD OF ENGINEERING DEADLINE	NCEES REGISTRATION DEADLINE	TEST DATE
Typically early June prior to the October Exam*	Thursday, September 10, 2015**	Friday, October 30, 2015
Typically early December prior to the April Exam*	Thursday, February 25, 2016**	Friday, April 15, 2016
Typically early June prior to the October Exam*	Thursday, September 8, 2016**	Friday, October 28, 2016
Typically early December prior to the April Exam*	Thursday, March 2, 2017**	Friday, April 21, 2017
Typically early June prior to the October Exam*	Thursday, September 7, 2017**	Friday, October 27, 2017
Typically early December prior to the April Exam*	Thursday, February 22, 2018**	Friday, April 13, 2018
Typically early June prior to the October Exam*	Thursday, September 6, 2018**	Friday, October 26, 2018
Typically early December prior to the April Exam*	Thursday, February 14, 2019**	Friday, April 5, 2019
Typically early June prior to the October Exam*	Thursday, September 5, 2019**	Friday, October 25, 2019
Typically early December prior to the April Exam*	Thursday, February 27, 2020**	Friday, April 17, 2020
Typically early June prior to the October Exam*	Thursday, September 3, 2020**	Friday, October 23, 2020

*Check with your state's Board of Engineering for exact deadline information

**tentative date, verify actual date with NCEES

"Your time is limited,
so don't waste it living someone else's life.
Don't be trapped by dogma
– which is living with the results
of other people's thinking.
Don't let the noise of other's opinions
drown out your own inner voice.
And most important,
have the courage to follow your heart and intuition.
They somehow already know
what you truly want to become.
Everything else is secondary."
~ *Steve Jobs*

INTRODUCTION

The Civil Engineering – Construction PE Exam is administered twice annually in April and in October. By following the advice in this manual and preparing your test day materials in a systematic manner (i.e. not taking every resource you can find into the test) you will be in a good position to perform well on the exam. Remember, you only have approximately 6 minutes per question. This is not enough time to read the question, determine what information you need to solve the problem, find the information, solve the problem, mark your answer and move on. Some questions will be automatic and will be answered in a minute or less. Some will require much more time than 6 minutes. You do not have time to locate, search, read and evaluate an exhaustive "library" of information so take the time to put together a succinct reference system … it will serve you well.

I wish you the best in your career and hope that you find this study guide invaluable in preparing for your licensure examination. But additionally, that you find yourself referring to the information contained herein throughout your career.

Sincerely,

Jeff Setzer, PE
Kansas State University
1988

NOTE

Reading and studying one manual prior to taking the Civil Engineering – Construction PE Exam (or any other test) is not a substitute for actual, in-depth preparation and study.

It is assumed that the Engineer-in-Training preparing to take the Civil Engineering – Construction PE Exam has attained an adequate level of competence in his or her area of practice and a general knowledge of the remaining specialties. The intent of this manual is to give the reader a base of understanding and knowledge upon which a solid study strategy can be built and a useable resource "library" can be assembled.

The author of this study manual makes no guarantees and does not promise you success in passing the test. The intent of this manual is to get you information you need to make yourself successful.

RECOMMENDED LIST OF TEST DAY RESOURCES

Test day will most likely look something like this …

- You arrive at the testing facility an hour early (because you didn't want to be late and that's what engineers do.)
- You wait in line with what seems like thousands of other from all engineering disciplines.
- You get herded into the enormous testing room where you find a seat and get set up (more on this to follow.)
- You fill out the confirmation sheet(s) to tell someone, somewhere that you are who you are.
- And you wait (again and more anxiously) for the command to begin.

On the day of my Principles & Practice exam, I sat in amazement and witnessed hundreds of people transporting what appeared to be their entire educational history into the testing room. Literally, I saw people with hand-trucks wheeling in bookshelves – actual bookshelves – loaded with textbooks, three-ring binders, and other assorted reference materials. They then proceeded to "set up shop" around their table; attempting to organize their stuff into an accessible library.

Wow!

If nothing else, it was an amusing sight to see and it eased my test-day anxiety

As you know, there are 40 questions in the morning and 40 questions in the afternoon. Once the direction to begin is given, you have +/- 6 minutes per question to:

(1) read the question
(2) decide what resource(s) to use (unless you already know the answer)
(3) find that resource
(4) find the information in that resource
(5) solve the problem
(6) choose the correct answer (remember, it's multiple choice and a good deal of the questions are structured to "find the answer closest to the following answers")
(7) mark the answer sheet.

I worked at a comfortable, steady pace and finished with enough time to back-check some of my answers and make sure I had all the answer bubbles filled in on the test sheet. I did not have time to search through a multitude of textbooks, notebooks, etc. to find an answer.

I recommend (2) two three-ring binders with the following:

Binder 1 – Building Systems Integration

- The International Building Code

  As a minimum, have a copy of the following chapters:

  Chapter 3 – Use and Occupancy Classification
  Chapter 4 – Special Detailed Requirements Based on Use and Occupancy
  Chapter 5 – General Building Heights and Areas
  Chapter 6 – Types of Construction
  Chapter 16 – Structural Design
  Chapter 18 – Soils and Foundations

Binder 2 – Structural Systems

- SEI/ASCE 7-05 (ASCE Standard No. 7-05) – Minimum Design Loads for Buildings and Other Structures
- As a minimum obtain a copy of Chapter 13 – Seismic Design Requirements for Nonstructural Components
- ARCOM ➔ MasterSpec® (www.arcomnet.com)

  As a minimum obtain a copy of the following Division 01 specification sections:

  10000 General Requirements
  11000 Summary
  11200 Multiple Contract Summary
  12500 Substitution Procedures
  13100 Project Management and Coordination
  13300 Submittal Procedures

  Additionally, depending on your level of expertise with the topics and your familiarity with standard requirements, you may want to add sections from the following specification divisions:

  Division 03 – Concrete
  Division 04 – Masonry
  Division 05 – Metals
  Division 06 – Wood, Plastics and Composites

And most importantly, a copy of this study guide with each section tabbed for easy retrieval of information.

The Civil Engineering – Construction PE Exam deals with types of construction including structural steel, timber, concrete, and masonry. This section also involves design questions involving, foundations, retaining walls, structural design, beams, columns, and connections. Knowledge of information related to code issues, design and theory will be required to successfully answer questions in this section.

Additionally, resources related to:

- Seismic
- Fasteners
- Welds
- Live and Dead Loads

These resources will be extremely beneficial to your success.

Applicable Standards, Codes, and Regulations (e.g. NFPA, ASHRAE, ICC, ADA Requirements)

A municipal civic center auditorium designed to accommodate a maximum of 450 people in an emergency situation (i.e. earthquake, hurricane, etc.) is assigned which Occupancy Category (OC), Seismic Design Category (SDC) and Component Importance Factor (I_p)? (assume a mapped spectral response acceleration parameter at 1-second period is less than 0.75)

a. OC = II, SDC = B, I_p = 1.0

b. OC = III, SDC = E, I_p = 1.5

c. OC = IV, SDC = D, I_p = 1.5

d. OC = IV, SDC = F, I_p = 1.5

Solution:

1. Refer to either Table 1604.5 of the International Building Code or Chapter 13, Table 1-1 of ASCE 7-05, Minimum Design Loads for Buildings and Other Structures: Occupancy Category IV includes “Buildings and other structures designated as essential facilities, including, but not limited to … designated earthquake, hurricane, or other emergency shelters.”
2. International Building Code, Section 1613.5.6 – Determination of seismic design category indicates that “all other structures shall be assigned a seismic design category based on their occupancy category …” i.e. Occupancy Category IV ➔ Seismic Design Category D.
3. Chapter 13, ASCE 7-05, Minimum Design Loads for Buildings and Other Structures, section 13.1.3 – Component Importance Factor indicates that the Importance Factor (I_p) shall be taken as 1.5.

Solution is “c”

Specifications

The following MasterSpec® sections should be reviewed and studied to become familiar with ductwork, piping materials and insulation. If possible, a copy of these sections could be included in the Resources for Test Day.

DIVISION 03 - CONCRETE

03 3000 **Cast-In-Place Concrete**
General building and structural applications; concrete mixtures, formwork, reinforcing, finishing, and curing.

03 4100 **Precast Structural Concrete**
Conventional precast structural concrete units.

03 4713 **Tilt-Up Concrete**
Wall panels and insulated sandwich panels.

03 4900 **Glass-Fiber-Reinforced Concrete (GFRC)**
GFRC cladding panels; panel framing.

03 5216 **Lightweight Insulating Concrete**
Mineral-aggregate and foam types.

03 5300 **Concrete Topping**
High-strength special-aggregate concrete slab toppings.

03 5413 **Gypsum Cement Underlayment**
Self-leveling, gypsum-cement-based underlayment.

DIVISION 04 - MASONRY

04 2000 **Unit Masonry**
CMU, brick, structural-clay facing tile, and stone trim units.

04 2200 **Concrete Unit Masonry**
Single-wythe CMU including decorative units.

04 2613 **Masonry Veneer**
Brick veneer over wood- or metal-stud backup.

04 4200 **Exterior Stone Cladding**
Exterior stone panels.

DIVISION 05 - METALS

05 1200 Structural Steel Framing
Structural steel framing for buildings.

05 2100 Steel Joist Framing
Standard manufactured open-web units, including steel joists, long-span steel joists, and joist girders.

05 3100 Steel Decking
Roof, floor, and form steel deck.

05 4000 Cold-Formed Metal Framing
Load-bearing and exterior non-load-bearing wall studs; floor, ceiling, and roof joists; and rafters.

05 4400 Cold-Formed Metal Trusses
Cold-formed steel trusses for roofs and floors.

DIVISION 06 - WOOD, PLASTICS, AND COMPOSITES

06 1000 Rough Carpentry
Wood framing, furring, grounds, nailers, and blocking.

06 1053 Miscellaneous Rough Carpentry
Minor wood framing, furring, grounds, nailers, and blocking.

06 1063 Exterior Rough Carpentry
Wood fences and other exterior wood construction.

06 1323 Heavy Timber Construction
Solid timber framing.

06 1516 Wood Roof Decking
Solid and laminated T & G decking.

06 1600 Sheathing
Roof and wall sheathing, subflooring, and underlayment. Includes wood, non-wood, and composite products.

06 1753 Shop-Fabricated Wood Trusses
Metal-plate-connected members.

Types of Construction (e.g. Structural Steel, Timber, Concrete, Masonry)

According to the International Building Code, “buildings and structures erected or to be erected” must be classified in one of ___ construction types.

a. 3

b. 5

c. 7

d. 9

Solution:

Refer to the International Building Code section 602 – Construction Classification

Solution is “b”

Types of Construction (e.g. Structural Steel, Timber, Concrete, Masonry)

An architect is planning on utilizing Type IV –HT (heavy timber) construction on a new building. As dictated by the code, the minimum size/type columns that can be used to support floor loads is:

a. 6”x6”; sawn or glued laminated

b. 8”x6”; glued laminated

c. 8”x8”; sawn or glued laminated

d. 8”x8”; sawn

Solution:

Refer to the International Building Code section 602 – Construction Classification

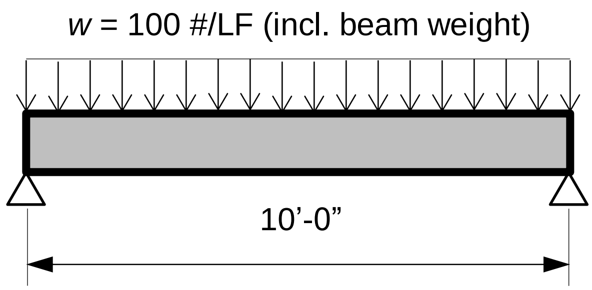
Solution is “c”

Components (e.g. Tension, Compression, Bending, Shear)

A nominal 2x10 is shown as a simply supported beam. The allowable bending stress is 1200 psi.

Determine:

1. The maximum moment of the beam
2. The maximum actual bending stress on the beam



a. 1520 lb-ft; 701.26 psi
b. 1120 lb-ft; 601.26 psi
c. 1250 lb-ft; 701.26 psi
d. 1250 lb-ft; 601.26 psi

Solution:

M_{max} = (w x L^2) ÷ 8 = 100 #/LF x $(10\ ft)^2$ ÷ 8 = 1250.0 lb-ft

Refer to Design Values for Wood Construction

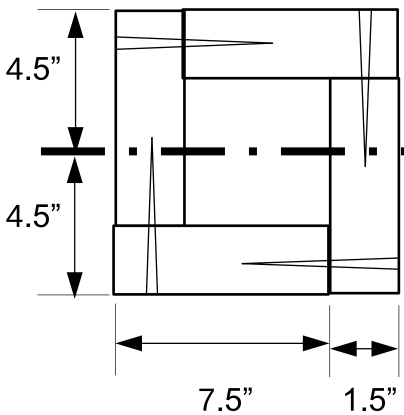
Page 14, Table 1B – Section Properties of Standard Dressed (S4S) Sawn Lumber

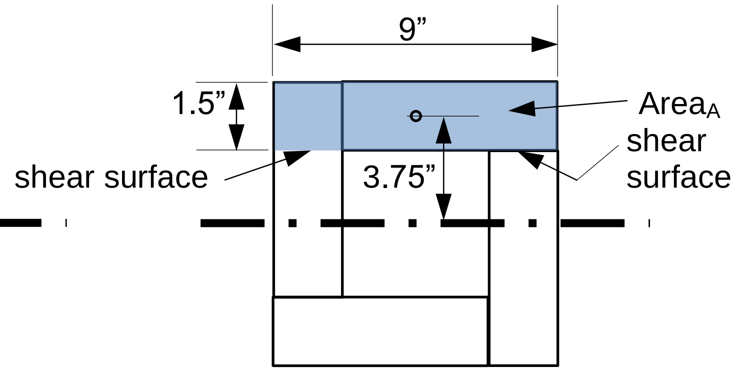
The section modulus (S) for a 2 x 10 is 21.39 in^3

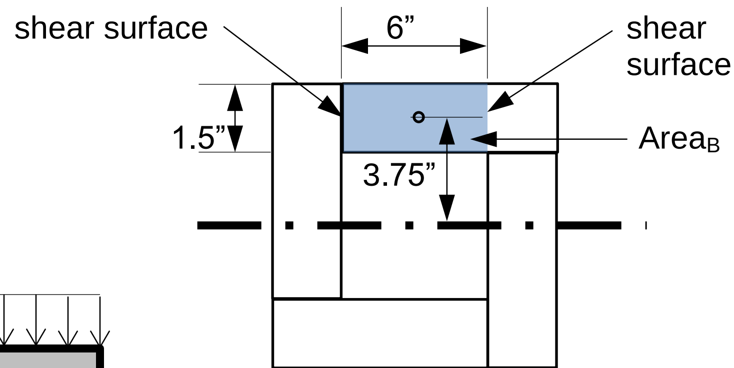
σ_b = M ÷ S = [1250 lb-ft x (12in./ft.)] ÷ 21.39 in^3 = 701.26 psi

Solution is "c"

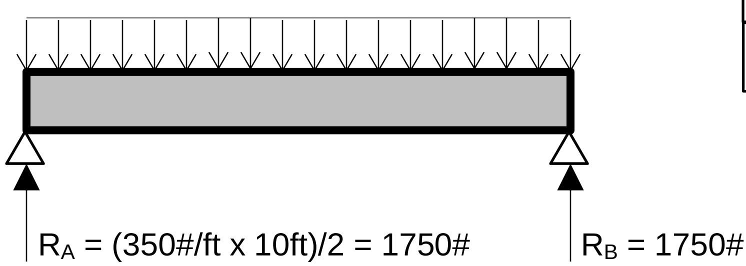
Components (e.g. Tension, Compression, Bending, Shear)







Given:
Box beam made of 2 x 8’s
Each screw can carrier 750lb.
Load on beam 350 #/ft
Beam length = 10 ft



What screw spacing Should be used?

a. 7½”; 11”
b. 8”; 12”
c. 7¼”; 11”
d. 8½”; 8½”

Solution:

$Q_{area\ A}$ = $Area_A$ x Y_A = (9” x 1.5”) x (3.75”) = 50.625in^3

$Q_{area\ B}$ = $Area_B$ x Y_B = (6” x 1.5”) x (3.75”) = 33.75in^3

Moment of Inertia:
$I = [(h_1)^3 \times b_1]/12 - [(h_2)^3 \times b_2]/12 = [(9^3) \times 9]/12 - [(6^3) \times 6]/12 = 438.75\ in^4$

Shear:
$t_A = (V \times Q_A)/(I \times b) = (1{,}750\# \times 50.625in^3)/[438.75in^4 \times (2 \times 1.5”)] = 67.3psi$
$t_B = (V \times Q_B)/(I \times b) = (1{,}750\# \times 33.75in^3)/[438.75in^4 \times (2 \times 1.5”)] = 44.9psi$

Minimum spacing can be found using equation:
F_{screw} = t x area
(1) 750# = (67.3psi) x (1.5” x Y_a) ➔ Y_a = 7.4” ➔ 7¼”
(2) 750# = (44.9psi) x (1.5” x Y_b) ➔ Y_b = 11.1” ➔ 11”

Therefore, the screws should be placed 7¼” apart on the horizontal surface and 11” apart on the vertical surface.

Solution is “c”

Structural Load Effects on Overall Electrical, Mechanical, and Structural Systems (e.g. Seismic, Wind, Thermal, Vibrations)

Given the four identically constructed buildings below and based on ASCE 7-05 Table 1-1 (or International Building Code table 1604.5) and ASCE 7-05 Table 11.5-1 (shown below), which one would have the highest importance factor (*I*)?

a. Church with a sanctuary capacity of 450

b. Elementary school with a capacity of 700

c. Water treatment facility

d. An air traffic control tower

Solution:

The Church, elementary school and water treatment facility are all Occupancy Category III with an Importance Factor of 1.25. The air traffic control tower is an Occupancy Category IV with an Importance Factor of 1.5.

Solution is "d"

TABLE 11.5-1 IMPORTANCE FACTORS*

Occupancy Category	*I* (importance factor)
I or II	1.0
III	1.25
IV	1.5
*from ASCE 7-05 Chapter 11	

Structural Load Effects on Overall Electrical, Mechanical, and Structural Systems (e.g. Seismic, Wind, Thermal, Vibrations)

In a building with Seismic Design Category D and an Importance Factor (I_p) = 1.0, mechanical and electrical components are exempt from the requirements of chapter 13 if:

I. Components are provided with flexible connections to associated ductwork, piping and conduit
II. Components are rigid secured to the building structure
III. Components are mounted at 4 ft or less above a floor level
IV. Components weigh 400 lbs or less

a. I only
b. I, II & III
c. I, III & IV
d. I & II

Solution:

Refer to ASCE 7-05 Minimum Design Loads for Buildings and Other Structures, Chapter 13, Section 13.1.4 – Exemptions ➔ exemption 4a & 4b

Solution is "c"

Connections (e.g. Bolted, Welded, Base Plates, Brackets)

Determine the strength of the following 3/4” weld:

a. 56.81

b. 61.18

c. 66.81

d. 76.81

Solution:

$\varphi R_n = \varphi F_W \times A_W = \varphi \times [0.707 \times w \times L] \times F_W$ where $\varphi = 0.75$

$F_W = 0.60 \times F_{EXX} \times [1.0 + 0.5 \times Sin^{1.5}\Theta]$

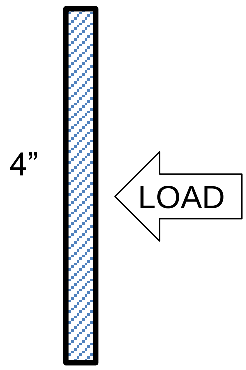
$F_W = 0.60 \times 70 \times [1.0 + 0.5 \times Sin^{1.5}0] = 0.6 \times 70 \times [1.0 + 0.0] = 42$

$\varphi R_n = 0.75 \times [0.707 \times 3/4" \times 4”] \times 42 = 66.81$ kips

Solution is “c”

Connections (e.g. Bolted, Welded, Base Plates, Brackets)

Determine the strength of the following 3/4" weld:



a. 75.22
b. 83.38
c. 100.22
d. 108.83

Solution:

$\varphi R_n = \varphi F_W \times A_W = \varphi \times [0.707 \times w \times L] \times F_W$ where $\varphi = 0.75$

$F_W = 0.60 \times F_{EXX} \times [1.0 + 0.5 \times \text{Sin}^{1.5}\Theta]$

$F_W = 0.60 \times 70 \times [1.0 + 0.5 \times \text{Sin}^{1.5}90] = 0.6 \times 70 \times [1.0 + 0.5] = 63$

$\varphi R_n = 0.75 \times [0.707 \times 3/4" \times 4"] \times 63 = 100.22$ kips

Solution is "c"

Loads (e.g. Gravity, Lateral, Temperature, Settlement, Construction)

Loads due to gravity are:

- Weight of the construction materials
- Weight of the means and methods to perform construction
- Snow and rain loads
- Eventual live and dead loads

Lateral loads are those loads imposed by:

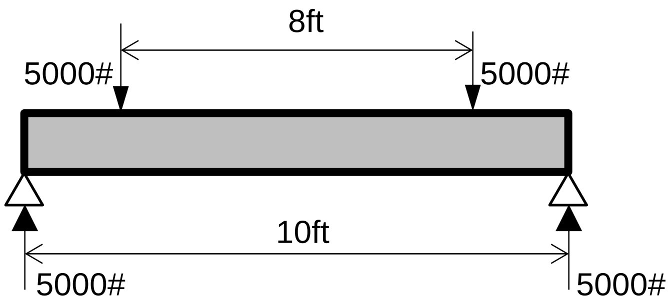
- Wind
- Earthquake
- Soil pressure against a foundation wall

Temperature loads are those loads that will be experienced by the structure due to contraction and expansion of building materials during changing weather conditions.

Loads due to settlement should be accounted for in the initial site preparation. Those loads that cannot be completely alleviated and will require expansion joints or other methods to relieve the associated stresses.

Loads (e.g. Gravity, Lateral, Temperature, Settlement, Construction)

A solid, 4 x 4 Douglas fir beam carries the load as shown in the following diagram:



What are is the shear stress and the bending stress in the beam (in psi)?

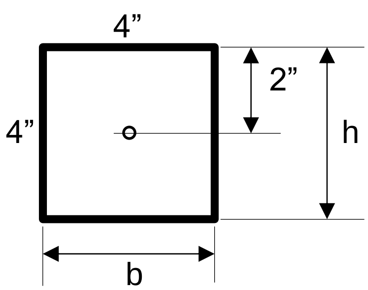
a. 1243.7, 3372.5

b. 1875.3, 5625.9

c. 1441.4, 2176.1

d. 2344.1, 2566.0

Solution:



Shear stress: t = (V x Q)/(I x b)

Q = Y x area = 2” x (4” x 4”) = 32in^3

I = (h^3 x b)/12 = (4^3 x 4)/12 = 21.33in^4

t = [(5000#) x (32in^3)]/(21.33in^4 x 4”) = 1875.3 psi

Bending stress: σ = -My/I

σ = (-5000 lb-ft) x (12 in/ft) x (-2in.)]/21.33 in^4

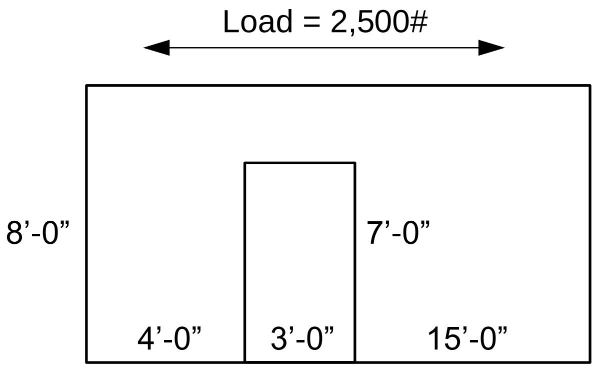
σ = 5625.9 psi

Solution is “b”

Analysis of Frames and Shear Walls

What is the minimum required unit shear wall capacity for the shear wall shown:

Ω = reduction factor = 0.5



a. 197.3 #/ft
b. 263.2 #/ft
c. 273.2 #/ft
d. 301.1 #/ft

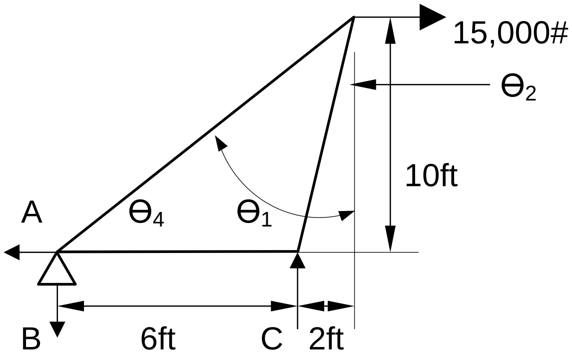
Solution:

Minimum required unit shear wall capacity

$v = P \div [\Omega \times (l_1 + l_2)] = 2,500 \div [0.5 \times (15 + 4)] = 263.2$ #/ft

Solution is "b"

Analysis of Frames and Shear Walls



In this simple frame, what are the reactions at A, B, & C?

a. 10,000/15,000/15,000

b. 14,559/23,987/23,987

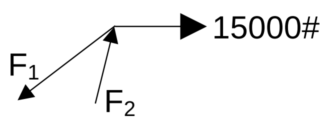
c. 15,547/25,076/25,076

d. 15,000/25,000/25,000

Solution:

Tan Θ_1 = (6ft + 2ft) ÷ 10ft ➔ Θ_1 = 38.66°

Tan Θ_2 = 2ft ÷ 10ft ➔ Θ_2 = 11.31° Tan Θ_4 = 10ft ÷ (6ft + 2ft) ➔ Θ_4 = 51.34°

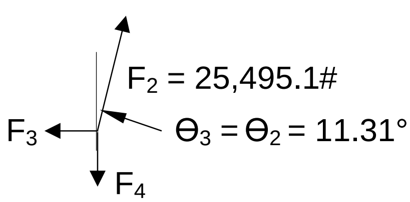


(1) (Sin Θ_1 x F_1) - (Sin Θ_2 x F_2) = 15000# ➔ $0.625F_1 - 0.196F_2 = 15000$
(2) (Cos Θ_1 x F_1) - (Cos Θ_2 x F_2) = 0 ➔ $0.781F_1 = 0.981F_2$ ➔ $F_1 = 1.256F_2$

Substituting equation (2) into equation (1):

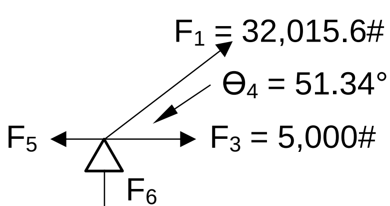
(0.625 x 1.256F_2) – 0.196F_2 = 15000 ➔ F_2 = 25,495.1# (compression)

F_1 = 32,015.6# (tension)



F_3 = Sin(11.31°) x 25,495.1 = 5,000#

F_4 = Cos (11.31°) x 25,495.1 = 25,000# = C



F_5 = [cos (51.34°) x 32,015.6] – 5,000 = 15,000# = A
F_6 = sin (51.34°) x 32,015.6 = 25,000# = B ➔ Solution is "d"

Analysis of Construction Systems (e.g. New and Existing Staging, Bracing and Loads)

The following “bracing” definitions come from the Contractor School Online (http://www.contractorschoolonline.com/Construction-Glossary.aspx):

Chevron Bracing. - That form of bracing wherein a pair of braces located either above or below a beam terminates at a single point within the clear beam span.

Core Bracing. - Vertical elements of a lateral bracing system such as the walls for stairs, elevators, or duct shafts.

Cross Brace. - Bracing with two intersecting diagonals; slender diagonal member within a framed wall or partition, to support the wall or partition and to withstand structural loads imposed by wind and suction loads, building loads, movement, and deflection of structure.

Diagonal Bracing. - That form of bracing that diagonally connects joints at different levels.

Diagonal. - 1. Running in an oblique direction from a reference line. 2. Inclined member of a truss or bracing system used for stiffening or wind bracing.

Eccentrically Braced Frame (EBF). - A diagonal braced frame in which a least one end of each bracing member connects to a beam a short distance from a beam-to-column connection or from another beam-to-brace connection.

K Bracing. - That form of bracing where a pair of braces located on one side of a column terminates at a single point within the clear column height.

Shoring. - 1. Temporary bracing to hold the sides of an excavation and prevent it from caving. 2. The timbers used as bracing against a wall or under a beam for temporary support.

Sway Brace. - Diagonal bracing to prevent lateral movement caused by horizontal forces.

Wood Diagonal Bracing. - Diagonal wood member used to prevent buckling or rotation of wood studs.

X Bracing. - That form of bracing wherein a pair of diagonal braces cross near mid-length of the bracing members.

Analysis of Stability

Column critical buckling load is given by Euler's formula:

$P_{cr} = (E \times I \times \pi^2) \div L_e^2$, where E = Young's modulus of the column material, I is the area moment of inertia of the cross-section, and L_e is the effective length of the column.

Given:

A 12 foot long, 10 x 10 steel tube column pinned at both ends. The area of the column is 18.4 in^2, E = 30,000 ksi, I = 271 in^4. Since the column can buckle in either direction, the effective length (L_e) = 2 x L. What critical load will buckle the column?

a. 623 kips
b. 680 kips
c. 862 kips
d. 967 kips

Solution:

$L_e = 2 \times L = 2 \times 12ft = 24ft$

$P_{cr} = (E \times I \times \pi^2) \div L_e^2 = (30{,}000{,}000psi \times 271\ in^4 \times \pi^2) \div [(24ft)^2 \times 144in^2/ft^2]$

P_{cr} = 967,398 # = 967 kips

Solution is "d"

Analysis of Stability

From the previous example, the allowable concentric load for the 10 x 10 steel tube column (with effective length = 24ft) is 348 kips. The maximum Yield Stress for this column is 27.23 ksi. Will the column Buckle or Yield, and at what load?

a. Buckle at 52.55 ksi
b. Yield at 967 kips
c. Buckle at 18.91 kips
d. Yield at 348 kips

Solution:

Maximum Yield Stress:

Allowable concentric load ÷ area = 348 kips ÷ 18.4 in^2 = 18.9 ksi

Critical Buckling Stress = σ_{cr} = P_{cr} ÷ area = 967 kips ÷ 18.4in^2 = 52.55 ksi

- If σ_{cr} < 18.91 ksi, the column will buckle since as the load is applied, the buckling stress is reached first.
- If σ_{cr} > 18.91 ksi, the column will yield since the yield stress is reached first.

The column will yield before it buckles. Therefore, the highest concentric load for this column is 18.91 ksi or 348 kips.

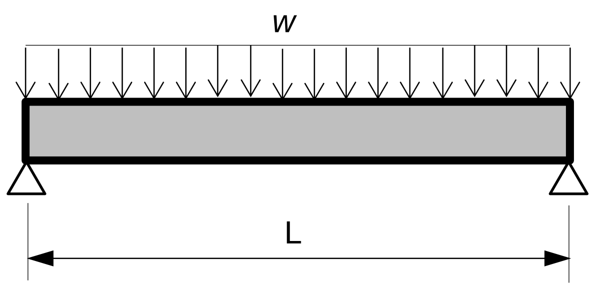
Solution is "d"

Analysis of Deflection

Beam Deflection – simple beam, uniformly distributed load

E = modulus of elasticity

I = moment of inertia of beam



Maximum deflection (at the center of the beam) = $(5wL^4) \div (384 \times E \times I)$

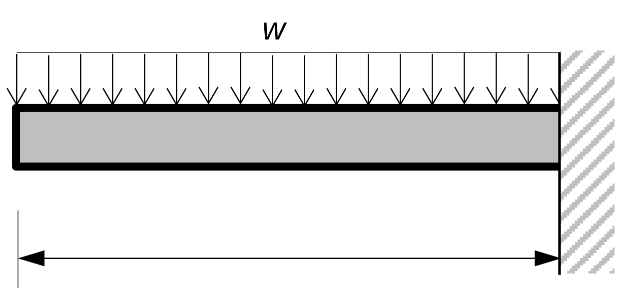
Deflection at any point along beam (X in. from left end)

= $[(w \times X) \div (24 \times E \times I)] \times (L^3 - 2LX^2 + X^3)$

Beam Deflection – cantilever beam, uniformly distributed load

E = modulus of elasticity

I = moment of inertia of beam

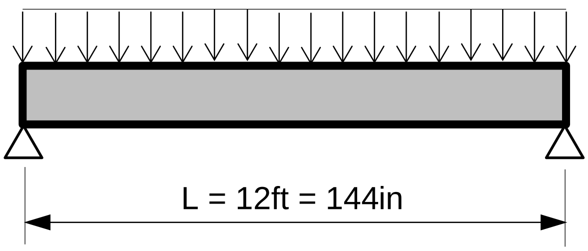


Maximum deflection (at the free end of the beam) = $(wL^4) \div (8 \times E \times I)$

Deflection at any point along beam (X in. from left end)

= $[(w) \div (24 \times E \times I)] \times (X^5 - 5L^4X + 4L^5)$

Analysis of Deflection



What is the deflection at the center of the beam shown? The beam is a W12x22.

a. 0.57in.

b. 0.84in.

c. 1.02in.

d. 1.13in.

Solution:

Maximum deflection (at the center of the beam) = $(5wL^4) \div (384 \times E \times I)$

E = 30,000 ksi

$$I = \frac{[(h_1)^3 \times b_1] + [(h_2)^3 \times b_2] + [(h_3)^3 \times b_3]}{12};\ h_1 = h_3\ \&\ b_1 = b_3$$

$$I = \frac{(2 \times [(h_1)^3 \times b_1]) + [(h_2)^3 \times b_2]}{12}$$

$$I = \frac{(2 \times [(0.425)^3 \times 4.03] + [(12.31 - (2 \times 0.425))^3 \times 0.26]}{12} = 32.66\text{in}^4$$

Maximum deflection (at the center of the beam) = $(5wL^4) \div (384 \times E \times I)$

$$\Delta = \frac{(5 \times 100 \times 144^4)}{(384 \times 30{,}000{,}000\text{psi} \times 32.66\text{in}^4)} = \mathbf{0.57in.}$$

Solution is "a"

Foundations (e.g. Piles, Shafts, Spread)

The new structure under design requires spread footing on the interior of the foundation. What are the length and width of these footings?

Dead Load = 400 kips

Live Load = 250 kips

The net allowable soil pressure available under to footing = 3,000 psf

a. 201.3 ft^2

b. 216.7 ft^2

c. 225.0 ft^2

d. 252.2 ft^2

Solution:

Area of the footing = (400 kips + 250 kips) ÷ (3000 psf ÷ 1000#/kip) = 216.7 ft^2

Use 15 ft x 15 ft footing ➔ 225 ft^2

Solution is "c"

Foundations (e.g. Piles, Shafts, Spread)

The new building being designed has a 7½" thick, 8 foot high concrete foundation wall. The lateral soil load is 42psf per foot of depth. If the unbalanced backfill is 7 feet high, what type of vertical reinforcement is required?

a. No reinforcement required

b. #5 at 38 inches on center

c. #5 at 41 inches on center

d. #6 at 43 inches on center

Solution:

As per the International Building Code, Chapter 18 – Soils and Foundations, Table 1807.1.6.2 – Concrete Foundation Walls, the required reinforcement would be #5 rebar spaced at 41 inches on center.

From the International Code Council (ICC), unbalanced backfill is defined as:

"Unbalanced backfill height is the difference in height between the exterior finish ground level and the lower of the top of the concrete footing that supports the foundation wall or the interior finish ground level. Where an interior concrete slab on grade is provided and is in contact with the interior surface of the foundation wall, the unbalanced backfill height shall be permitted to be measured from the exterior finish ground level to the top of the interior concrete slab."

Solution is "c"

Materials Characteristics (e.g. Strength, Stiffness, Hardness, Environmental Concerns, Fatigue Concerns) of Steel, Concrete, Masonry, and Timber

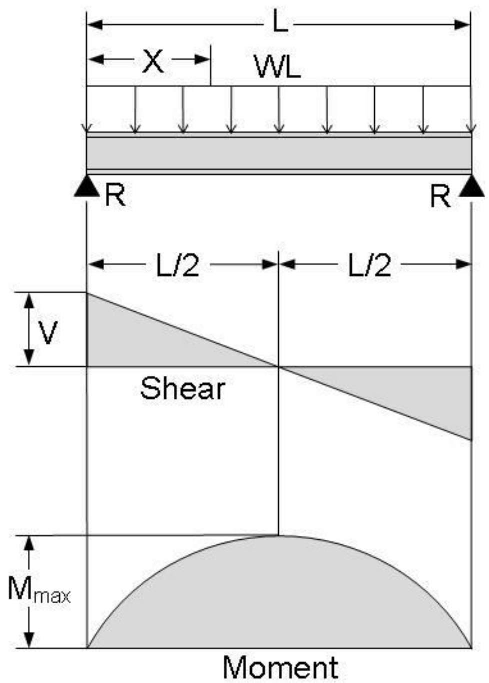
This portion of the exam deals primarily with the inherit benefits or disadvantages of steel, concrete, masonry and timber as they relate to ease of use in construction, cost, durability, effectiveness and practicality.

You should also be familiar with the fire resistance capabilities of each of these materials (including the addition of fire treatments i.e. spray on fire protective insulation, etc.)

Questions in this section examine the suitable choice of one material over another with respect to the parameters discussed above as well as to the aesthetic relevance of the material with respect to the architecture.

EQUATIONS, RULES OF THUMB, SHORTCUTS

STRUCTURAL SYSTEMS



Simple Beam with Uniformly Distributed Load:

W = load in kips/in & L in inches
E = Modulus of Elasticity (for steel use 29,000 ksi)
I = Moment of Inertia (in^4)

Total Equivalent Uniform Load = WL

R = V = (WL)÷2

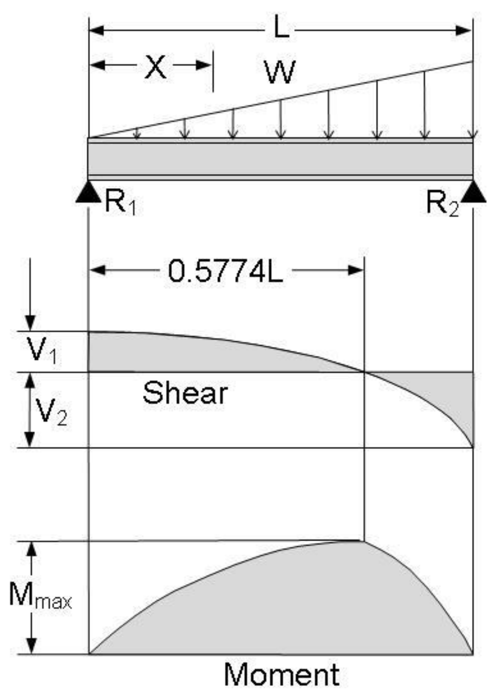
V_X = W * [(L÷2) - X)

M_{max} (at center of beam) = (WL^2)÷8

M_X = [(WX)÷2] * (L - X)

Δ_{max} (at center of beam) = (5WL^4)÷(384EI)

Δ_X = [(WX)÷(24EI)] * [L^3 – (2LX^2) + X^3]



Simple Beam with Uniformly Increasing Load:

W = load in kips/in & L in inches
E = Modulus of Elasticity (for steel use 29,000 ksi)
I = Moment of Inertia (in^4)

Total Equivalent Uniform Load = (16W)÷(9√3)
= 1.0264W

$R_1 = V_1$ = W÷3

$R_2 = V_2$ max = (2W)÷3

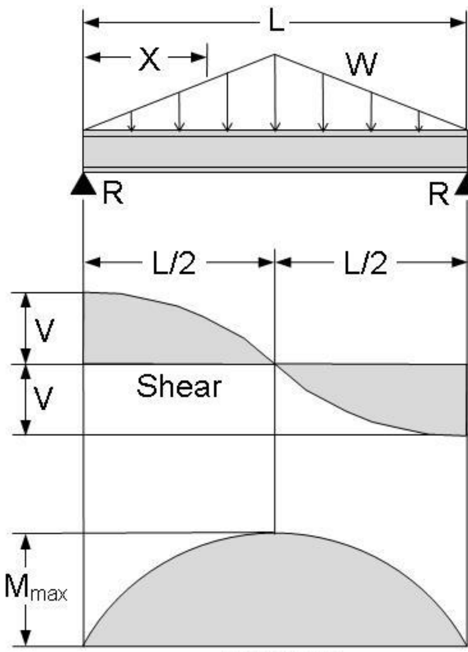
V_X = (W÷3) - [(WX^2)÷L^2]

M_{max} (at x = L÷√3 = 0.5774L) = (2WL)÷(9*√3)
= 0.1283WL

M_X = [(WX)÷(3L^2)] * (L^2 - X^2)

Δ_{max} (x = L*$\sqrt{(1-\sqrt{(8/15)}}$ = 0.5193L)
= 0.01304 * [(WL^3)÷(EI)]

Δ_X = [(WX)÷(180EIL^2)] * [3X^4 - ([10L^2] * X^2)+7L^4]



Simple Beam with Uniformly Increasing Load:

W = load in kips & L in inches
E = Modulus of Elasticity (for steel use 29,000 ksi)
I = Moment of Inertia (in^4)

Total Equivalent Uniform Load = (4W)÷3

R = V = W÷2

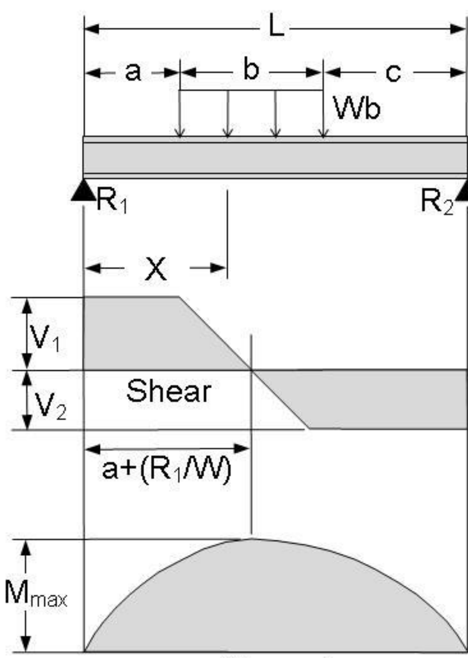
V_X (when X < L÷2) = $[W÷(2L^2)] * (L^2 - 4X^2)$

M_{max} (at center) = (WL)÷6

M_X (when X < L÷2) = $WX*(0.5 – [(2X^2)÷(3L^2)])$

Δ_{max} (at center) = $(WL^3)÷(60EI)$

Δ_X (when X < L÷2)
= $[(WX)÷(480EIL^2)] * (5L^2 - 4X^2)^2$



Simple Beam with Uniform Load Partially Distributed:

W = load in kips/in & L in inches
E = Modulus of Elasticity (for steel use 29,000 ksi)
I = Moment of Inertia (in^4)

$R_1 = V_1$ (max when a < c) = $[(Wb)÷2L] * (2c + b)$

$R_2 = V_2$ (max when a > c) = $[(Wb)÷2L] * (2a + b)$

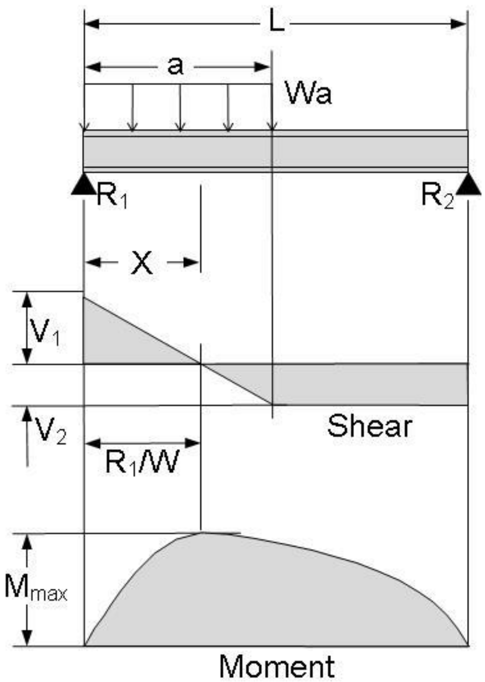
V_X = (when x > a & < [a + b]) = $R_1 - W*(X - a)$

M_{max} (at x = a + R_1÷W) = $R_1*[a + R_1÷(2W)]$

M_X = (when x < a) = R_1*X

M_X = (when x > a & < [a + b])
= $(R_1*X) - [(W÷2) * (X - a)^2]$

M_X = (when x > [a + b]) = $R_2*(L - X)$



Simple Beam with Uniform Load Partially Distributed at One End:

W = load in kips/in & L in inches
E = Modulus of Elasticity (for steel use 29,000 ksi)
I = Moment of Inertia (in^4)

$R_1 = V_1$ max = [(Wa)÷2L] * (2L - a)

$R_2 = V_2$ = (Wa^2)÷(2L)

V_X = (when x < a) = R_1 - WX

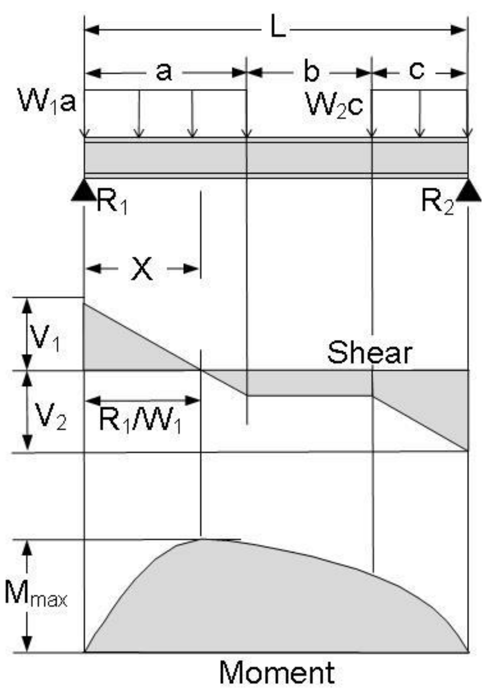
M_{max} (at x = R_1÷W) = $(R_1)^2$÷(2W)

M_X = (when x < a) = R_1*X - WX^2÷2

M_X = (when x > a) = R_2*(L - X)

Δ_X = (when x < a)
= [(WX)÷(24EIL)] * [(a^2)*(2L - a)^2 - (2aX^2) * (2L - a) + (LX^3)]

Δ_X = (when x > a)
= [(Wa^2) * (L - X)]÷(24EIL)] * (4XL - 2X^2 - a^2)



Simple Beam with Uniform Load Partially Distributed at Each End:

W = load in kips/in & L in inches
E = Modulus of Elasticity (for steel use 29,000 ksi)
I = Moment of Inertia (in^4)

$R_1 = V_1$ = [(W_1*a) * (2L - a) + (W_2*c^2)]÷(2L)

$R_2 = V_2$ = [(W_2*c) * (2L - c) + (W_1*a^2)]÷(2L)

V_X = (when x < a) = R_1 - W_1*X

V_X = (when x > a & < [a+b]) = R_1 - W_1*a

V_X = (when x > [a+b]) = R_2 - W_2 * (L - X)

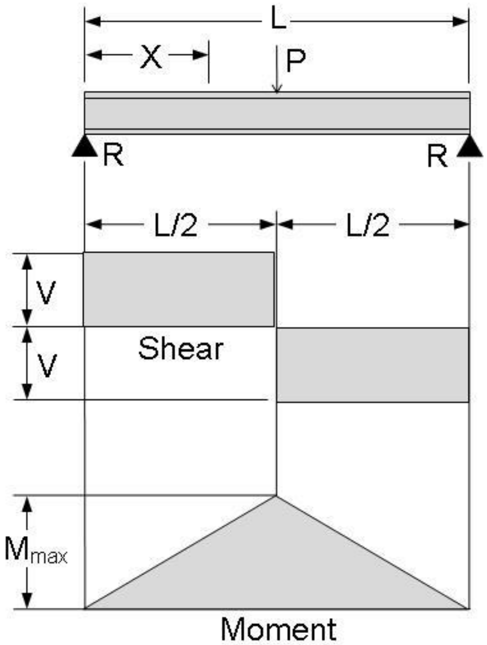
M_{max} (at x = R_1÷W_1 when R_1 < W_1*a)
= $(R_1)^2$÷(2W_1)

M_{max} (at x = L - R_2÷W_2 when R_2 < W_2*c)
= $(R_2)^2$÷(2W_2)

M_X = (when x < a) = R_1*X - (W_1*X^2)÷2

M_X = (when x > a & < [a+b])
= R_1*X - [(W_1*a)÷2]*(2X - a)

M_X = (when x > [a+b]) = R_2*(L - X) - ([W_2*(L - X)^2]÷2)



Simple Beam with Concentrated Load at Center:

W = load in kips/in & L in inches
E = Modulus of Elasticity (for steel use 29,000 ksi)
I = Moment of Inertia (in^4)

Total Equivalent Uniform Load = 2P

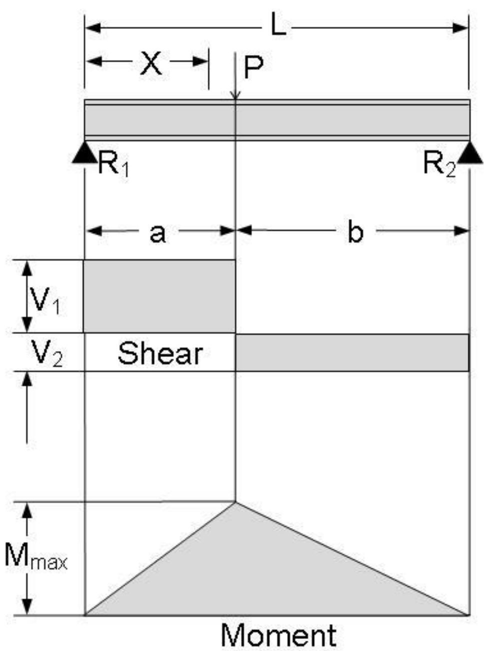
R = V = P÷2

M_{max} (at center of beam) = (PL)÷4

M_X = (when x < [L÷2]) = (PX)÷2

Δ_{max} (at center of beam) = $(PL^3)\div(48EI)$

Δ_X = (when x < [L÷2])
= $[(PX)\div(48EI)] * [3L^2 - (4X^2)]$



Simple Beam with Concentrated Load at Any Point:

W = load in kips/in & L in inches
E = Modulus of Elasticity (for steel use 29,000 ksi)
I = Moment of Inertia (in^4)

Total Equivalent Uniform Load = $(8Pab)\div L^2$

$R_1 = V_1$ (max when a < b) = (Pb)÷L

$R_2 = V_2$ (max when a > b) = (Pa)÷L

M_{max} (at point of load) = (Pab)÷L

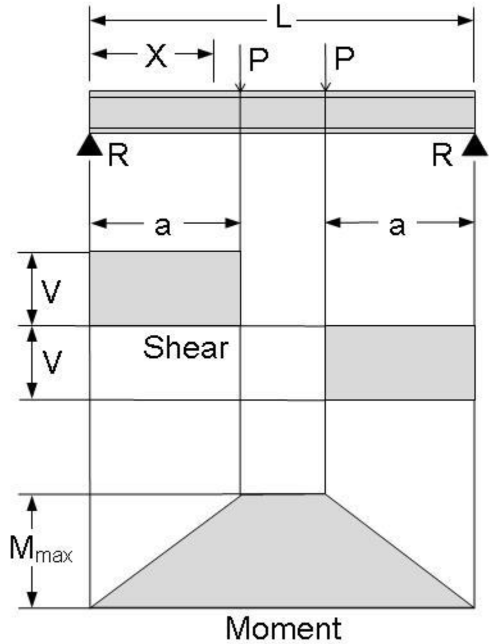
M_X (when x < a) = (PbX)÷L

Δ_{max} (at $x = (\sqrt{[a*(a + 2b)]\div 3}$ when a > b)

$$= \frac{(Pab)*(a + 2b)*\sqrt{3a*(a + 2b)}}{(27EIL)}$$

Δ_a (at point of load) = $\frac{P*(a^2)*b^2}{3EIL)}$

Δ_X (when X < a) = $[(PbX)\div(6EIL)] * (L^2 - b^2 - x^2)$



Simple Beam with Two Symmetrical & Equal Concentrated Loads:

W = load in kips/in & L in inches
E = Modulus of Elasticity (for steel use 29,000 ksi)
I = Moment of Inertia (in^4)

Total Equivalent Uniform Load = (8Pa)÷L

R = V = P

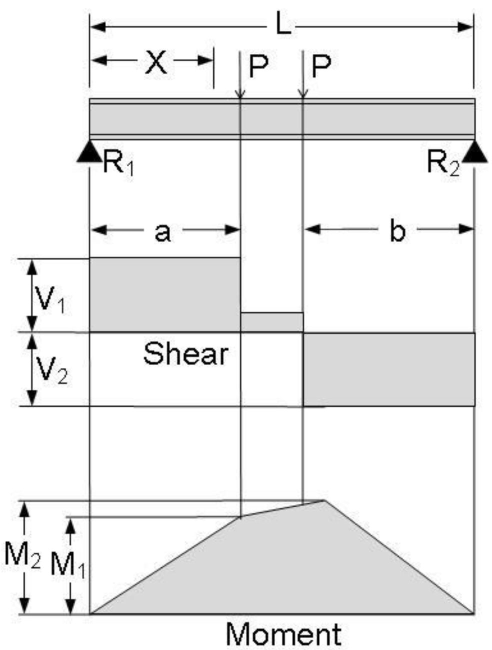
M_{max} (between loads) = Pa

M_X (when x < a) = PX

Δ_{max} (at center) = [(Pa)÷(24EI)] * ($3L^2$ - $4a^2$)

Δ_X (when X < a) = [(PX)÷(6EI)] * (3La - $3a^2$ - X^2)

Δ_X (when X > a & < [L - a])
= [(Pa)÷(6EI)] * (3LX - $3X^2$ - a^2)



Simple Beam with Two Unsymmetrical, Equal Concentrated Loads:

W = load in kips/in & L in inches
E = Modulus of Elasticity (for steel use 29,000 ksi)
I = Moment of Inertia (in^4)

$R_1 = V_1$ (max when a < b) = (P/L) * (L - a + b)

$R_2 = V_2$ (max when a > b) = (P/L) * (L - b + a)

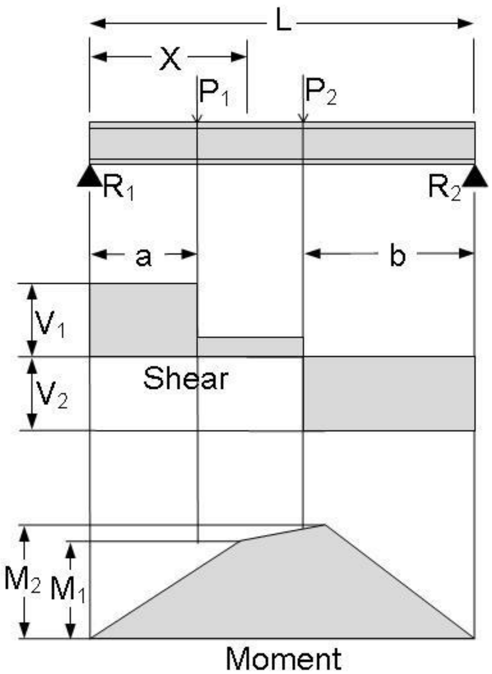
V_X (when X > a & < [L - b]) = (P/L) * (b - a)

M_1 (max when a > b) = R_1 * a

M_2 (max when a < b) = R_2 * b

M_X (when X < a) = R_1 * X

M_X (when X > a & < [L - b]) = (R_1 * X) - (P * [X - a])



Simple Beam with Two Unsymmetrical, Unequal Concentrated Loads:

W = load in kips/in & L in inches
E = Modulus of Elasticity (for steel use 29,000 ksi)
I = Moment of Inertia (in^4)

$R_1 = V_1 = [P_1 * (L - a) + (P_2 * b)] \div L$

$R_2 = V_2 = [P_2 * (L - b) + (P_1 * a)] \div L$

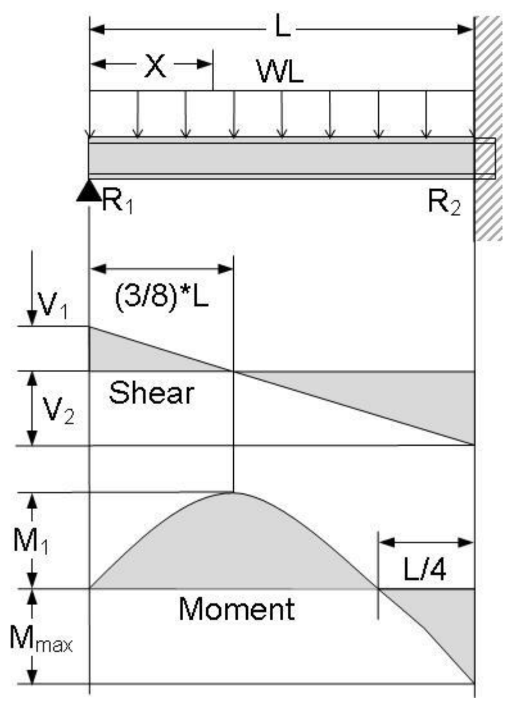
V_X (when $X > a$ & $< [L - b]$) $= R_1 - P_1$

M_1 (max when $R_1 < P_1$) $= R_1 * a$

M_2 (max when $R_2 < P_2$) $= R_2 * b$

M_X (when $X < a$) $= R_1 * X$

M_X (when $X > a$ & $< [L - b]$) $= (R_1 * X) - (P_1 * [X - a])$



Beam Fixed at One End & Supported at the Other End with Uniformly Distributed Load:

W = load in kips/in & L in inches
E = Modulus of Elasticity (for steel use 29,000 ksi)
I = Moment of Inertia (in^4)

Total Equivalent Uniform Load = WL

$R_1 = V_1 = (3WL) \div 8$

$R_2 = V_2$ (max) $= (5WL) \div 8$

$V_X = R_1 - (WX)$

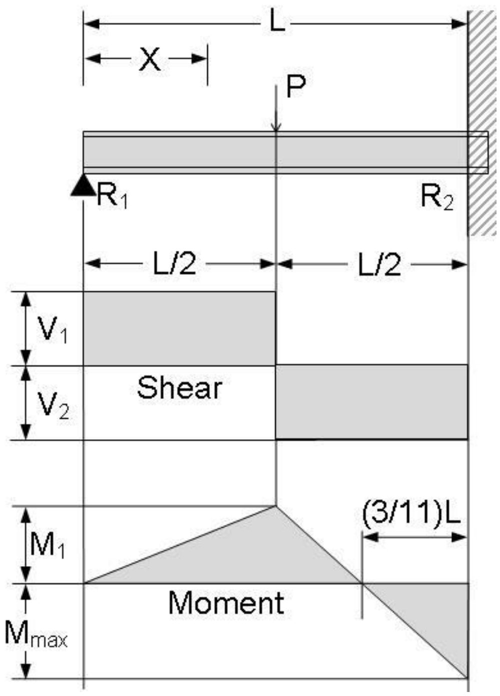
$M_{max} = (WL^2) \div 8$

M_1 (at $X = [3/8] * L$) $= (9/128) * WL^2$

$M_X = (R_1 * X) - [(WX^2) \div 2]$

Δ_{max} (at $X = (L/16) * (1 + \sqrt{33}) = 0.4215L$)
$= (WL^4) \div (185EI)$

$\Delta_X = [(WX) \div (48EI)] * [L^3 – (3LX^2) + 2X^3]$



Beam Fixed at One End & Supported at the Other with Concentrated Load at the Center:

W = load in kips/in & L in inches
E = Modulus of Elasticity (for steel use 29,000 ksi)
I = Moment of Inertia (in^4)

Total Equivalent Uniform Load = 3P/2

$R_1 = V_1 = 5P/16$

$R_2 = V_2$ (max) = 11P/16

M_{max} (at fixed end) = (3PL)/16

M_1 (at point of load) = (5PL)/32

M_X (when x < L/2) = (5PX)/16

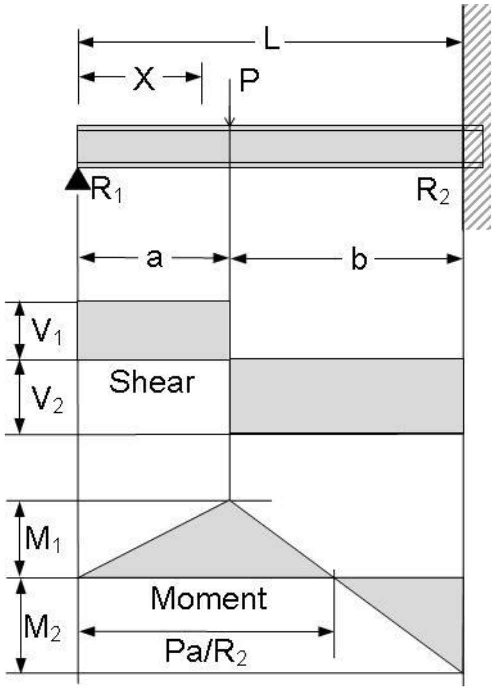
M_X (when x > L/2) = P * [(L/2) – (11X/16)]

Δ_{max} (at $X = L * \sqrt{(1/5)}$) = $(PL^3) \div (48EI * \sqrt{5})$
$= (0.009317PL^3) \div (EI)$

Δ_X (at point of load) = $(7PL^3) \div (768EI)$

Δ_X (when X < L/2) = $[(PX) \div (96EI)] * (3L^2 – 5X^2)$

Δ_X (when X > L/2) = $\dfrac{P * [(X – L)^2] * (11X – 2L)}{(96EI)}$



Beam Fixed at One End & Supported at the Other with Concentrated Load at any Point:

W = load in kips/in & L in inches
E = Modulus of Elasticity (for steel use 29,000 ksi)
I = Moment of Inertia (in^4)

$R_1 = V_1 = [(Pb^2) \div (2L^3)] * (a + 2L)$

$R_2 = V_2 = [(Pa) \div (2L^3)] * (3L^2 - a^2)$

M_1 (at point of load) = $R_1 * a$

M2 (at fixed end) = $[(Pab) \div (2L^2)] * (a + L)$

M_X (when X < a) = $R_1 * X$

M_X (when X > a) = $(R_1 * X) - [P * (X - a)]$

Δ_{max} (when a < 0.414L at X = $L * \frac{(L^2 + a^2)}{(3L^2 - a^2)}$

$= \frac{(Pa)}{3EI} * \frac{(L^2 - a^2)^3}{(3L^2 - a^2)^2}$

Δ_{max} (when a > 0.414L at X = $L * \sqrt{a} \div [2L + a]$)

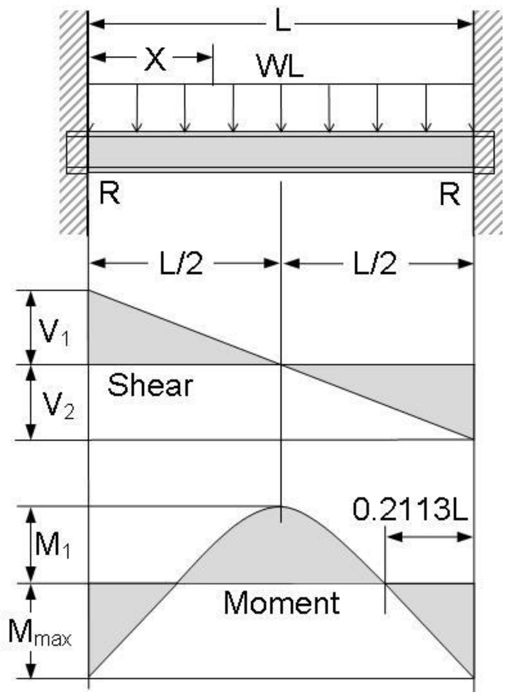
$= \frac{(Pab^2) * \sqrt{a} \div [2L + a]}{6EI}$

Δ_a (at point of load) = $\frac{(Pa^2b^3) * (3L + a)}{12EIL^3}$

Δ_X (when X < a) = $\frac{(Pb^2X) * (3aL^2 - 2LX^2 - aX^2)}{12EIL^3}$

Δ_X (when X > a)

$= \frac{(Pa) * (L - X)^2 * (3L^2X - a^2X - 2a^2L)}{12EIL^3}$



Beam Fixed at Both Ends with Uniformly Distributed Load:

W = load in kips/in & L in inches
E = Modulus of Elasticity (for steel use 29,000 ksi)
I = Moment of Inertia (in^4)

Total Equivalent Uniform Load = (2WL)/3

R = V = (WL)/2

V_X = W * [(L/2) - X]

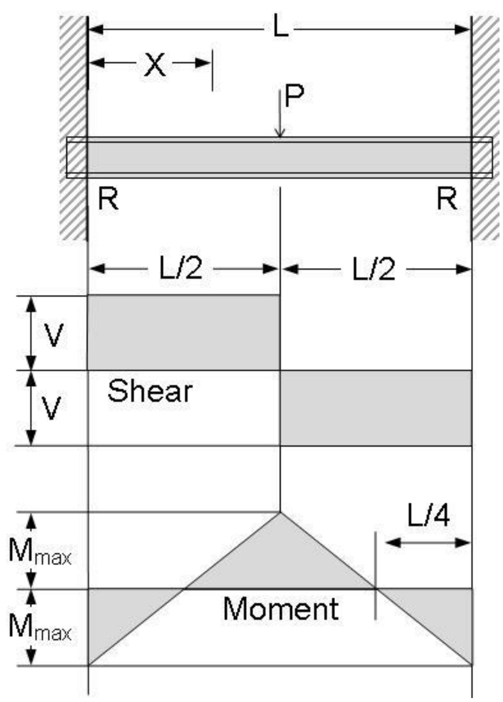
M_{max} (at ends) = (WL^2)/12

M_1 (at center) = (WL^2)/24

M_X = (W/12) * (6LX - L^2 - 6X^2)

Δ_{max} (at center) = (WL^4) ÷ (384EI)

$$\Delta_X = \frac{(WX^2) * (L - X)^2}{24EI}$$



Beam Fixed at Both Ends with Concentrated Load at Center:

W = load in kips/in & L in inches
E = Modulus of Elasticity (for steel use 29,000 ksi)
I = Moment of Inertia (in^4)

Total Equivalent Uniform Load = P

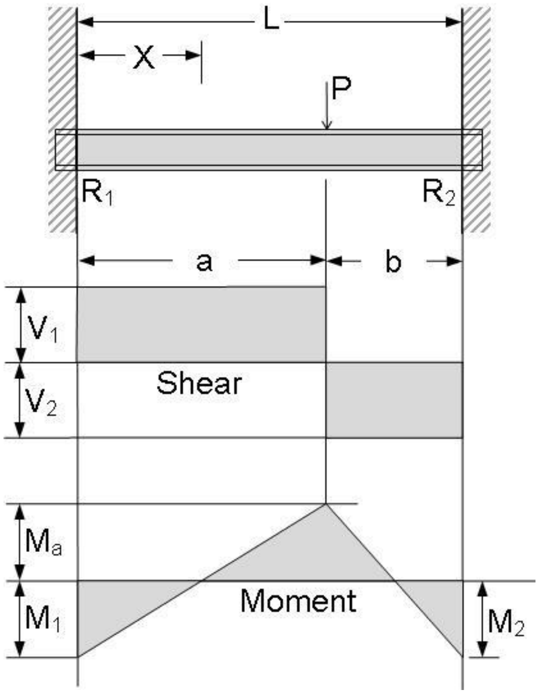
R = V = P/2

M_{max} (at center & ends) = PL)/8

M_X (when X < L/2) = (P/8) * (4X - L)

Δ_{max} (at center) = (PL^3) ÷ (192EI)

$$\Delta_X \text{ (when } X < L/2) = \frac{(PX^2) * (3L - 4X)}{48EI}$$



Beam Fixed at Both Ends with Concentrated Load at any Point:

W = load in kips/in & L in inches
E = Modulus of Elasticity (for steel 29,000 ksi)
I = Moment of Inertia (in^4)

$R_1 = V_1$ (max when a < b) = $(Pb^2 \div L^3) * (3a + b)$

$R_2 = V_2$ (max when a > b) = $(Pa^2 \div L^3) * (a + 3b)$

M_1 (max when a < b) = $(Pab^2) \div L^2$

M_2 (max when a > b) = $(Pa^2b) \div L^2$

M_a (at point of load) = $(2Pa^2b^2) \div L^3$

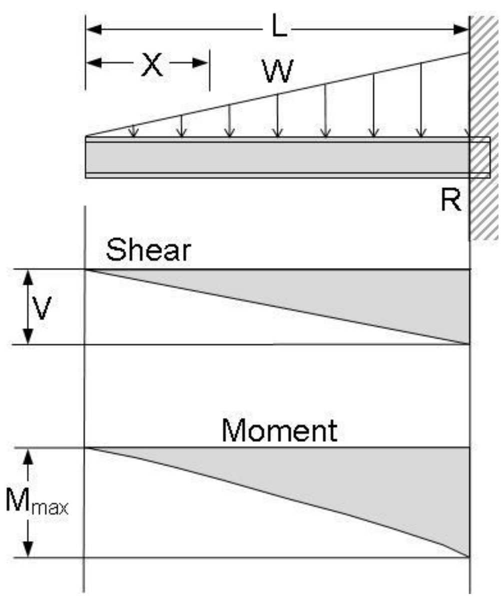
M_X (when X < a) = $R_1X - [(Pab^2) \div L^2]$

Δ_{max} (when a > b at X = [(2aL) ÷ (3a + b)]

$$= \frac{(2Pa^3b^2)}{(3EI) * (3a + b)^2}$$

Δ_a (at point of load) = $\frac{(Pa^3b^3)}{(3EIL^3)}$

Δ_X (when X < a) = $\frac{(Pb^2X^2) * (3aL - 3aX - bX)}{6EIL^3}$



Cantilever Beam Load Increasing Uniformly to Fixed End:

W = load in kips/in & L in inches
E = Modulus of Elasticity (for steel use 29,000 ksi)
I = Moment of Inertia (in^4)

Total Equivalent Uniform Load = (8/3)W

R = V = W

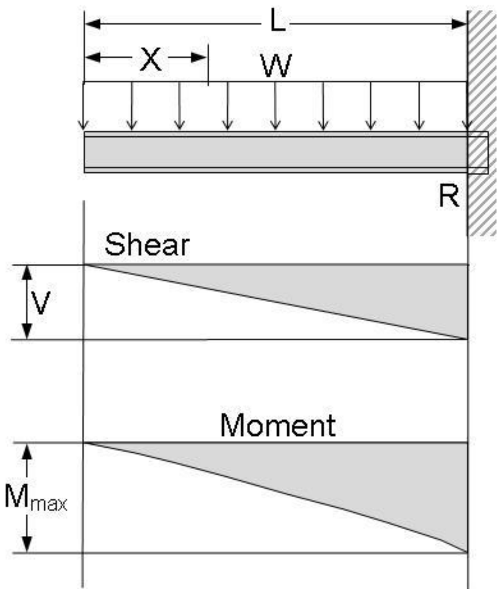
$V_X = W * (X^2/L^2)$

M_{max} (at fixed end) = (WL)/3

$M_X = (WX^3) \div 3L^2$

Δ_{max} (at free end) = $(WL^3) \div (15EI)$

$\Delta_X = \frac{W * (X^5 - 5L^4X + 4L^5)}{60EIL^2}$



Cantilever Beam with Uniformly Distributed Load:

W = load in kips/in & L in inches
E = Modulus of Elasticity (for steel use 29,000 ksi)
I = Moment of Inertia (in^4)

Total Equivalent Uniform Load = 4WL

R = V = WL

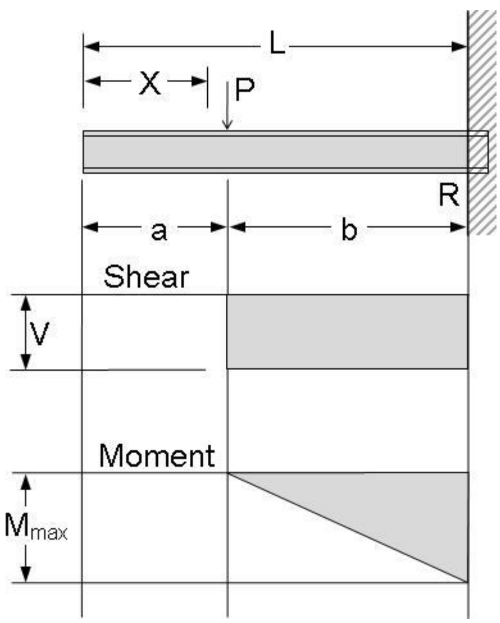
$V_X = WX$

M_{max} (at fixed end) = $(WL^2)/2$

$M_X = (WX^2) \div 2$

Δ_{max} (at free end) = $(WL^4) \div (8EI)$

$\Delta_X = \dfrac{W * (X^4 - 4L^3X + 3L^4)}{24EI}$



Cantilever Beam with Concentrated Load at any point:

W = load in kips/in & L in inches
E = Modulus of Elasticity (for steel use 29,000 ksi)
I = Moment of Inertia (in^4)

Total Equivalent Uniform Load = 8Pb/L

R = V = P

M_{max} (at fixed end) = Pb

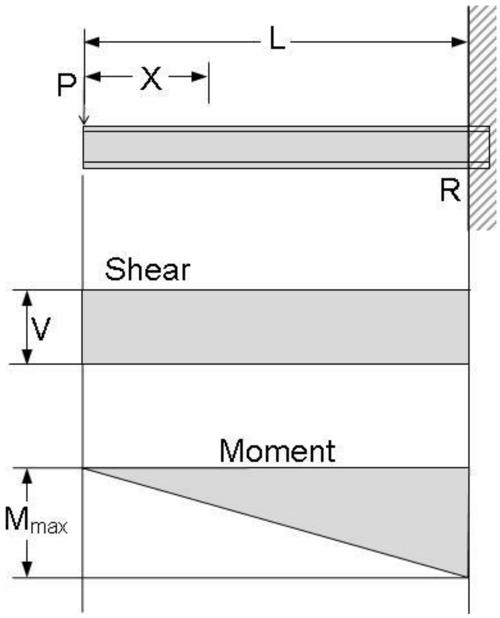
M_X (when X > a) = P * (X - a)

Δ_{max} (at free end) = $\dfrac{(Pb^2) * (3L - b)}{68EI}$

Δ_a (at point of load) = $Pb^3/3EI$

Δ_X (when X < a) = $\dfrac{Pb^2 * (3L - 3X - b)}{6EI}$

Δ_X (when X > a) = $\dfrac{P * (L - X)^2 * (3b - L + X)}{6EI}$



Cantilever Beam with Concentrated Load at Free End:

W = load in kips/in & L in inches
E = Modulus of Elasticity (for steel use 29,000 ksi)
I = Moment of Inertia (in^4)

Total Equivalent Uniform Load = 8P

R = V = P

M_{max} (at fixed end) = PL

M_X = PX

Δ_{max} (at free end) = $(PL^3) \div 3EI$

$$\Delta_X = \frac{P * (2L^3 - 3L^2X + X^3)}{6EI}$$

Moment of Inertia

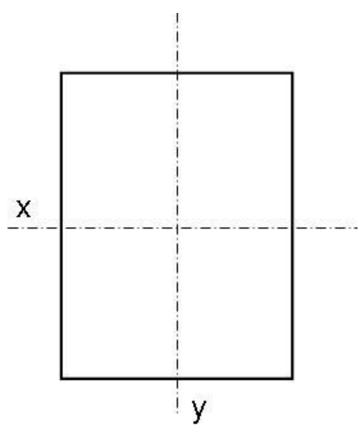
Rectangular Beam:

Height = h

Width = b

$I_x = bh^3/12$

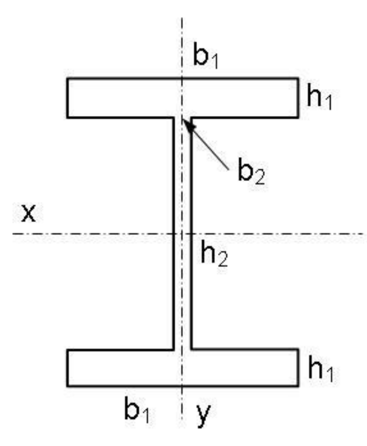
$I_y = b^3h/12$



I – Beam (W shape):

$I_x = ((b_1)(h_1)^3/12) + ((b_2)(h_2)^3/12) + ((b_1)(h_1)^3/12)$

$I_y = ((b_1)^3(h_1)/12) + ((b_2)^3(h_2)/12) + ((b_1)^3(h_1)/12)$



RESOURCES

The Engineering Toolbox .... www.engineeringtoolbox.com

Resources such as:

- Formulas
- Charts
- Graphs
- Example problems

ARCOM ➔ Masterspec® .... www.masterspec.com

International Code Council .... www.iccsafe.org

- International Building Code

Whole Building Design Guide .... www.wbdg.org

American Society of Civil Engineers .... www.asce.org

- ASCE 7-05
- See also:
  - University of Delaware Department of Civil and Environmental Engineering.. http://www.ce.udel.edu/courses/CIEG407/CIEG_407_Protected/index.html
    - Access to Chapters 1 through 12 of ASCE 7 -05
  - Rose-Hulman Institute of Technology .... www.rose-hulman.edu/class/ce/Aidoo/ASCE%207/ASCE%207-05/ASCE003c13_p143-152.pdf
    - Access to Chapter 13 of ASCE 7-05

National Council of Examiners for Engineering and Surveying..........www.ncees.org

- Information on testing
- Acceptable Calculators:
    - **Casio:** All fx-115 models including, but not limited to:
        - fx-115 MS
        - fx-115 MS Plus
        - fx-115 MS SR
        - fx-115 ES
        - fx-115 ES Plus
    - **Hewlett Packard:** The HP 33s and HP 35s models, but no others.
    - **Texas Instruments:** All TI-30X and TI-36X models including , but 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

STATE BOARDS OF REGISTRATION

(Websites, contacts, phone numbers and email addresses may have changed. Check *www.ncees.org* for updated licensing board information.)

Alabama State Board of Licensure for Professional Engineers and Surveyors

Web site:	www.bels.alabama.gov
Contact:	Regina Dinger
Email:	regina.dinger@bels.alabama.gov
Phone/Fax:	(334) 242-5568 / (334) 242-5105
Office Address:	100 North Union Street, Suite 382 Montgomery, AL 36104-3762

Alaska State Board of Registration for Architects, Engineers, and Land Surveyors

Web site:	www.commerce.state.ak.us/occ/pael.cfm
Contact:	Richard (Vern) Jones
Email:	richard.jones@alaska.gov
Phone/Fax:	(907) 465-1676 / (907) 465-2974
Office Address:	333 Willoughby Ninth Floor State Office Building Juneau, AK 99811-0806

Arkansas Board of Licensure for Professional Engineers & Professional Surveyors

Web site:	www.pels.arkansas.gov
Contact:	Stephen (Steve) W. Haralson, P.E.
Email:	pelsboard@arkansas.gov
Phone/Fax:	(501) 682-2824 / (501) 682-2827
Office Address:	623 Woodlane Drive Little Rock, AR 72201

Arizona State Board of Technical Registration

Web site:	www.azbtr.gov
Contact:	Ronald W. Dalrymple
Email:	ron.dalrymple@azbtr.gov
Phone/Fax:	(602) 364-4930 / (602) 364-4931
Office Address:	1110 West Washington Street, Suite 240 Phoenix, AZ 85007

California Board for Professional Engineers, Land Surveyors, and Geologists

Web site:	www.pels.ca.gov
Contact:	Richard (Ric) B. Moore, P.L.S.
Email:	bpels_office@dca.ca.gov
Phone/Fax:	(866) 780-5370 / (916) 263-2221
Office Address:	2535 Capitol Oaks Drive, Suite 300 Sacramento, CA 95833-2944

Colorado State Board of Licensure for Architects, Professional Engineers, and Professional Land Surveyors

Web site:	www.dora.state.co.us/aes
Contact:	Angeline (Angie) Kinnaird Linn
Email:	aes@dora.state.co.us
Phone/Fax:	(303) 894-7775 / (303) 894-2310
Office Address:	Department of Regulatory Agencies 1560 Broadway, Suite 1350 Denver, CO 80202

Connecticut Board of Examiners for Professional Engineers and Land Surveyors

Web site:	www.ct.gov/dcp
Contact:	Barbara Syp-Maziarz
Email:	barbara.syp@ct.gov
Phone/Fax:	(860) 713-6142 / (860) 706-1367
Office Address:	The State Office Building Room 110 165 Capitol Avenue Hartford, CT 06106-1630

Delaware Association of Professional Engineers

Web site:	www.dape.org
Contact:	Peggy Abshagen
Email:	peggy@dape.org
Phone/Fax:	(302) 323-4588 / (302) 323-4590
Office Address:	92 Reads Way, Suite 208 New Castle, DE 19720

District of Columbia; Washington DC Department of Consumer and Regulatory Affairs

Web site: www.pearsonvue.com/dc/engineers
Contact: Theresa L. Ennis
Email: theresa.ennis@dc.gov
Phone/Fax: (202) 442-4333 / (202) 442-9448
Office Address: DC Department of Consumer and Regulatory Affairs
Occupational and Professional Licensing Division
1100 4th Street SW
4th Floor, E496
Washington, DC 20024

Florida Board of Professional Engineers

Web site: www.fbpe.org
Contact: Zana Raybon
Email: zraybon@fbpe.org
Phone/Fax: (850) 521-0500 / (850) 521-0521
Office Address: 2639 North Monroe Street, Suite B-112
Tallahassee, FL 32303

Georgia State Board of Registration for Professional Engineers and Land Surveyors

Web site: www.sos.ga.gov/plb/pels
Contact: Darren Mickler
Email: dmickler@sos.ga.gov
Phone/Fax: (478) 207-2440 / (866) 888-9718
Office Address: 237 Coliseum Drive
Macon, GA 31217-3858

Guam Board of Registration for Professional Engineers, Architects, and Land Surveyors

Web site: www.guam-peals.org
Contact: Sylvia Leon Guerrero
Email: info@guam-peals.org
Phone/Fax: (671) 646-3115 / (671) 649-9533
Office Address: East-West Business Center
Unit D-Suite 208
718 North Marine Drive
Upper Tumon, GU 96913

Hawaii Board of Professional Engineers, Architects, Surveyors, and Landscape Architects

Web site:	www.hawaii.gov/dcca/pvl
Contact:	James Kobashigawa
Email:	james.k.kobashigawa@dcca.hawaii.gov
Phone/Fax:	(808) 586-2702 / (808) 586-2689
Office Address:	335 Merchant Street Honolulu, HI 96813

Idaho Board of Professional Engineers and Professional Land Surveyors

Web site:	www.ipels.idaho.gov
Contact:	David L. Curtis, P.E.
Email:	dave.curtis@ipels.idaho.gov
Phone/Fax:	(208) 373-7210 / (208) 373-7213
Office Address:	1510 E. Watertower St. Suite 110 Meridian, ID 83642-7993

Illinois State Board of Professional Engineers

Web site:	www.idfpr.com/dpr/WHO/pe.asp
Contact:	M. David Brim
Email:	david.brim@illinois.gov
Phone/Fax:	(217) 524-3211 / (217) 782-7645
Office Address:	Department of Financial and Professional Regulation PSS/Design Unit Third Floor 320 W. Washington St Springfield, IL 62786

Indiana State Board of Registration for Professional Engineers

Web site:	www.pla.in.gov
Contact:	Christina (Tina) Wiseley
Email:	pla10@pla.in.gov
Phone/Fax:	(317) 234-3022 / (317) 233-4236
Office Address:	402 West Washington Street Room W072 Indianapolis, IN 46204

Iowa Engineering and Land Surveying Examining Board

Web site: www.state.ia.us/engls
Contact: Robert E. Lampe
Email: robert.lampe@iowa.gov
Phone/Fax: (515) 281-4126 / (515) 281-7411
Office Address: 1920 Southeast Hulsizer Road
Ankeny, IA 50021

Kansas State Board of Technical Profession

Web site: www.kansas.gov/ksbtp
Contact: Jean A. Boline
Email: jeanb@ksbtp.ks.gov
Phone/Fax: (785) 296-3053 / (785) 296-0167
Office Address: Landon State Office Building
900 Southwest Jackson, Suite 507
Topeka, KS 66612-1257

Kentucky State Board of Licensure for Professional Engineers and Land Surveyors

Web site: www.kyboels.ky.gov
Contact: B. David Cox
Email: bdavid.cox@ky.gov
Phone/Fax: (800) 573-2680 / (502) 573-6687
Office Address: Kentucky Engineering Center
160 Democrat Drive
Frankfort, KY 40601

Louisiana Professional Engineering and Land Surveying Board

Web site: www.lapels.com
Contact: Donna D. Sentell
Email: donna@lapels.com
Phone/Fax: (225) 925-6291 / (225) 925-6227
Office Address: 9643 Brookline Avenue, Suite 121
Baton Rouge, LA 70809-1433

Maine State Board of Licensure for Professional Engineers

Web site: www.maine.gov/professionalengineers/
Contact: Beatrice M. Labbe
Email: pengineers@prexar.com
Phone/Fax: (207) 287-3236 / (207) 287-3239
Office Address: 92 State House Station
Augusta, ME 04333-0092

Maryland State Board for Professional Engineers

Web site:	www.dllr.state.md.us
Contact:	Pamela J. Edwards
Email:	pamedwards@dllr.state.md.us
Phone/Fax:	(410) 230-6322 / (410) 333-0021
Office Address:	500 N. Calvert Street Room 308 Baltimore, MD 21202-3651

Massachusetts Board of Registration of Professional Engineers and Professional Land Surveyors

Web site:	www.mass.gov/dpl/boards/en
Contact:	Erin M. LeBel
Email:	susan.e.coco@state.ma.us
Phone/Fax:	(617) 727-9957 / (617) 727-1627
Office Address:	Division of Professional Licensure 1000 Washington Street, Suite 710 Boston, MA 02118-6100

Michigan State Board of Professional Engineers

Web site:	www.michigan.gov/engineers
Contact:	Gloria J. Keene
Email:	keeneg@michigan.gov
Phone/Fax:	(517) 373-7353 / (517) 373-1044
Office Address:	P. O. Box 30018 Lansing, MI 48909

Minnesota State Board of Architecture, Engineering, Land Surveying, Landscape Architecture, Geoscience, and Interior Design

Web site:	www.aelslagid.state.mn.us
Contact:	Doreen Frost
Email:	doreen.frost@state.mn.us
Phone/Fax:	(651) 296-2388 / (651) 297-5310
Office Address:	85 East Seventh Place, Suite 160 St. Paul, MN 55101

Mississippi Board of Licensure for Professional Engineers and Surveyors

Web site:	www.pepls.state.ms.us
Contact:	Rosemary Brister
Email:	information@pepls.state.ms.us
Phone/Fax:	(601) 359-6160 / (601) 359-6159
Office Address:	660 North Street, Suite 400 Jackson, MS 39202

Missouri Board for Architects, Professional Engineers, Professional Land Surveyors, and Landscape Architects

Web site:	pr.mo.gov/apelsla.asp
Contact:	Judy A. Kempker
Email:	moapels@pr.mo.gov
Phone/Fax:	(573) 751-0047 / (573) 751-8046
Office Address:	3605 Missouri Boulevard, Suite 380 Jefferson City, MO 65109

Montana Board of Professional Engineers and Professional Land Surveyors

Web site:	www.engineer.mt.gov
Contact:	Cecelia Whitney
Email:	cwhitney@mt.gov
Phone/Fax:	(406) 841-2351 / (406) 841-2309
Office Address:	PO Box 200513 301 S Park 4th Floor Helena, MT 59620-0513

Nebraska Board of Engineers and Architects

Web site:	www.ea.ne.gov
Contact:	Jon D. Wilbeck
Email:	jon.wilbeck@nebraska.gov
Phone/Fax:	(402) 471-2021 / (402) 471-0787
Office Address:	215 Centennial Mall South, Suite 400 PO Box 95165 Lincoln, NE 68509-5165

Nevada State Board of Professional Engineers and Land Surveyors

Web site:	www.nvboe.org
Contact:	Noni Johnson
Email:	nonijohnson@boe.state.nv.us
Phone/Fax:	(775) 688-1231 / (775) 688-2991
Office Address:	1755 East Plumb Lane, Suite 135 Reno, NV 89502

New Hampshire Board of Professional Engineers

Web site:	www.nh.gov/jtboard/home.htm
Contact:	Louise Lavertu
Email:	llavertu@nhsa.state.nh.us
Phone/Fax:	(603) 271-2219 / (603) 271-6990
Office Address:	57 Regional Drive Concord, NH 03301

New Jersey State Board of Professional Engineers and Land Surveyors

Web site: www.state.nj.us/lps/ca/nonmedical/pels.htm
Contact: Paul Ray
Email: rayp@dca.lps.state.nj.us
Phone/Fax: (973) 504-6460 / (973) 273-8020
Office Address: 124 Halsey Street
Third Floor
Newark, NJ 07102

New Mexico Board of Licensure for Professional Engineers and Professional Surveyors

Web site: www.sblpes.state.nm.us
Contact: Eva Baca
Email: eva.baca@state.nm.us
Phone/Fax: (505) 476-4565 / (505) 827-7566
Office Address: Toney Anaya Building
2nd Floor
2550 Cerrillos Rd.
Santa Fe, NM 87507

New York Board for Engineering and Land Surveying

Web site: www.op.nysed.gov/prof/pels/
Contact: Jane W. Blair, P.E.
Email: enginbd@mail.nysed.gov
Phone/Fax: (518) 474-3817 / (518) 473-6282
Office Address: Education Building
89 Washington Avenue
Second Floor Mezzanine
East-Wing
Albany, NY 12234-1000

North Carolina Board of Examiners for Engineers and Surveyors

Web site: www.ncbels.org
Contact: Andrew L. Ritter
Email: aritter@ncbels.org
Phone/Fax: (919) 791-2000 / (919) 791-2012
Office Address: 4601 Six Forks Road, Suite 310
Raleigh, NC 27609

North Dakota State Board of Registration for Professional Engineers and Land Surveyors

Web site: www.ndpelsboard.org
Contact: Candie L. Robinson
Email: candie@ndpelsboard.org
Phone/Fax: (701) 258-0786 / (701) 258-7471
Office Address: 723 Memorial Highway
Bismarck, ND 58504

Ohio State Board of Registration for Professional Engineers and Surveyors

Web site: www.peps.ohio.gov
Contact: John F. Greenhalge
Email: john.greenhalge@pes.ohio.gov
Phone/Fax: (614) 466-3651 / (614) 728-3059
Office Address: 50 West Broad Street, Suite 1820
Columbus, OH 43215

Oklahoma State Board of Licensure for Professional Engineers and Land Surveyors

Web site: www.pels.ok.gov
Contact: Kathy S. Hart
Email: khart@pels.ok.gov
Phone/Fax: (405) 521-2874 / (405) 523-2135
Office Address: Oklahoma Engineering Center
Room 120
201 NE 27th Street
Oklahoma City, OK 73105

Oregon State Board of Examiners for Engineering and Land Surveying

Web site: www.oregon.gov/osbeels
Contact: Mari Lopez
Email: lopezm@osbeels.org
Phone/Fax: (503) 362-2666 / (503) 362-5454
Office Address: 670 Hawthorne Avenue SE, Suite 220
Salem, OR 97301

Pennsylvania State Registration Board for Professional Engineers, Land Surveyors, and Geologists

Web site:	www.dos.state.pa.us/eng
Contact:	DeAndra Field
Email:	st-engineer@state.pa.us
Phone/Fax:	(717) 783-7049 / (717) 705-5540
Office Address:	2601 North Third Street Harrisburg, PA 17110

Puerto Rico Board of Examiners of Engineers and Land Surveyors

Web site:	http://www.estado.gobierno.pr
Contact:	Frank Hernandez-Flores, P.E.
Email:	fhernandez@uniproaep.net
Phone/Fax:	(787) 722-2122 / (787) 722-4818
Office Address:	Secretaria Auxiliar de Juntas Examinadoras P.O. Box 9023271 San Juan, PR 00902-3271

Rhode Island State Board of Registration for Professional Engineers

Web site:	www.bdp.state.ri.us
Contact:	Lois Marshall
Email:	loism@dbr.ri.gov
Phone/Fax:	(401) 462-9592 / (401) 462-9532
Office Address:	Division of Design Professionals 1511 Pontiac Avenue Building 68-2 Cranston, RI 02920

South Carolina Board of Registration for Professional Engineers and Surveyors

Web site:	www.llr.state.sc.us/pol/engineers
Contact:	Jan B. Simpson
Email:	jan.simpson@llr.sc.gov
Phone/Fax:	(803) 896-4422 / (803) 896-4427
Office Address:	P.O. Box 11597 Columbia, SC 29211-1597

South Dakota State Board of Technical Professions

Web site:	www.state.sd.us/dol/boards/engineer
Contact:	Mark Humphreys
Email:	mark.humphreys@state.sd.us
Phone/Fax:	(605) 394-2510 / (605) 394-2509
Office Address:	2040 West Main Street, Suite 304 Rapid City, SD 57702-2447

Tennessee State Board of Architectural and Engineering Examiners

Web site:	www.tn.gov/commerce/boards/ae
Contact:	John A. Cothron
Email:	john.cothron@tn.gov
Phone/Fax:	(615) 741-3221 / (615) 532-9410
Office Address:	Department of Commerce and Insurance 500 James Robertson Parkway Nashville, TN 37243-1142

Texas Board of Professional Engineers

Web site:	www.tbpe.state.tx.us
Contact:	Lance S. Kinney, P.E.
Email:	lance.kinney@engineers.texas.gov
Phone/Fax:	(512) 440-7723 / (512) 440-0417
Office Address:	1917 Interstate Highway 35 South Austin, TX 78741-3702

Utah Professional Engineers and Professional Land Surveyors Board

Web site:	www.dopl.utah.gov
Contact:	Richard Oborn
Email:	roborn@utah.gov
Phone/Fax:	(801) 530-6628 / (801) 530-6511
Office Address:	160 East 300 South First Floor Salt Lake City, UT 84111

Vermont Board of Professional Engineering

Web site:	www.vtprofessionals.org
Contact:	Terry Gray
Email:	terry.gray@sec.state.vt.us
Phone/Fax:	(802) 828-2191 / (802) 828-2368
Office Address:	Vermont Secretary of State, Office of Professional Regulation National Life Building, North, FL2 Montpelier, VT 05620-3402

Virgin Islands Board for Architects, Engineers, and Land Surveyors

Web site:	www.dlca.gov.vi
Contact:	H. Nathalie Hodge
Email:	nathalie.hodge@dlca.vi.gov
Phone/Fax:	(340) 773-2226 / (340) 713-8308
Office Address:	Department of Licensing and Consumer Affairs, Golden Rock Shopping Center Christiansted St. Croix, VI 00820

Virginia Board for Architects, Professional Engineers, Land Surveyors, Certified Interior Designers, and Landscape Architects

Web site:	www.dpor.virginia.gov
Contact:	Kathleen (Kate) R. Nosbisch
Email:	apelscidla@dpor.virginia.gov
Phone/Fax:	(804) 367-8506 / (866) 465-6206
Office Address:	Department of Professional and Occupational Regulation P.O. Box 29570 Richmond, VA 23242-0570

Washington State Board of Registration for Professional Engineers and Land Surveyors

Web site:	www.dol.wa.gov/business/engineerslandsurveyors/
Contact:	George A. Twiss, P.L.S.
Email:	engineers@dol.wa.gov
Phone/Fax:	(360) 664-1575 / (360) 664-2551
Office Address:	Board of Registration for PE & LS Department of Licensing PO Box 9025 Olympia, WA 98507-9025

West Virginia State Board of Registration for Professional Engineers

Web site:	www.wvpebd.org
Contact:	Lesley L. Rosier-Tabor, P.E.
Email:	lesley@wvpebd.org
Phone/Fax:	(304) 558-3554 / (304) 558-6232
Office Address:	300 Capitol Street, Suite 910 Charleston, WV 25301

Wisconsin Examining Board of Architects, Landscape Architects, Professional Engineers, Designers, and Land Surveyors

Web site:	drl.wi.gov
Contact:	Berni Mattsson
Email:	dspsboards@wisconsin.gov
Phone/Fax:	(608) 266-2112 / (608) 267-3816
Office Address:	PO Box 8935 Madison, WI 53708

Wyoming Board of Registration for Professional Engineers and Professional Land Surveyors

Web site:	engineersandsurveyors.wy.gov
Contact:	Christine Turk
Email:	wyopepls@wyo.gov
Phone/Fax:	(307) 777-6155 / (307) 777-3403
Office Address:	6920 Yellowtail Drive, Suite 100 Cheyenne, WY 82002

"The way to get started is to quit talking and begin doing."
~ *Walt Disney*

"It's kind of fun to do the impossible."
~ *Walt Disney*

ABOUT THE AUTHOR

Jeff Setzer, PE is a 1988 graduate of **Kansas State University** with a Bachelor's degree in Architectural Engineering and has been a practicing Architectural Engineer, Project Manager, Team Leader and Construction Manager for over 20 years. He has experience in retail, industrial, office, medical, educational, government and institutional design and construction management. He maintains an active professional engineering license and provides consulting services, construction management, and educational resources through his company, Facility Solutions, Inc.

You can find additional resources and study material along with design, project management and construction management resources on his website:

www.engineeringdesignresources.com

"You have brains in your head.
You have feet in your shoes.
You can steer yourself in any direction you choose.
You're on your own, and you know what you know.
And you are the guy who'll decide where to go."
~ Dr. Seuss

"The true sign of intelligence
is not knowledge
but imagination."
~Albert Einstein

EngineeringDesignResources.com

For engineers and engineers-in-training (EIT's) preparing to take the Civil Engineering – Construction PE Exam:

Do you:

- Know what to expect?
- Know what kind of questions will be asked?
- Know what resources will be helpful?
- Have useful references ready to go?

Are you adequately prepared?

If you answered no to any of these questions,

then you need the

Civil Engineering – Construction PE Exam Study Guide

The Civil Engineering – Construction PE Exam Study Guide was written to prepare PE candidates to take the engineering licensing examination by:

- Providing a recommended "test-day" resource library
- Showing example problems with solutions
- Offering commentary on many of the topics

This study guide will help you be successful on the

Civil Engineering – Construction PE Exam