CE 3202 Fall 2010 Exam 1 Name SOLUTIONS

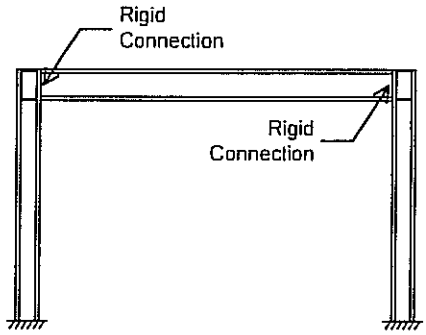
Closed Book; Closed Notes
3"x5" Note Card Allowed; Calculator Allowed
100 points are possible

Answer all questions to the best of your ability. State any assumptions you feel are necessary. Attach extra sheets, if used. Show your work!

Problem 1.

For each structure shown, state if the structure is unstable, stable-determinate, or stable-indeterminate (if stable-indeterminate, state the degree of indeterminacy). Defend your answers! Hint: 2 of these structures are designed to trick you. (15 points)

(a) Frame structure (members carry internal shears, moments and axial loads). Base reactions are fixed-end type connections:



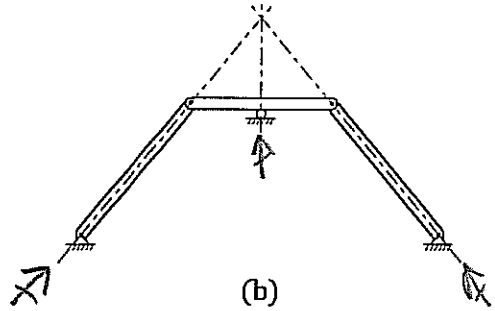
(a)

STABLE, INDETERMINATE, 3°

R = 6, NO PARALLEL OR CONC, FORCE SYSTEM

6 - 3 = 3

(b) All members are truss bars (axial load only):

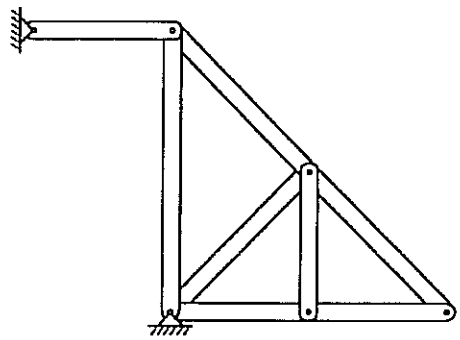


(b)

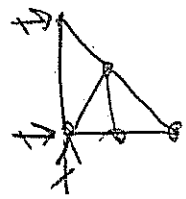
UNSTABLE

CONC. FORCE SYS

(c) All members are truss bars (axial load only):



(c)



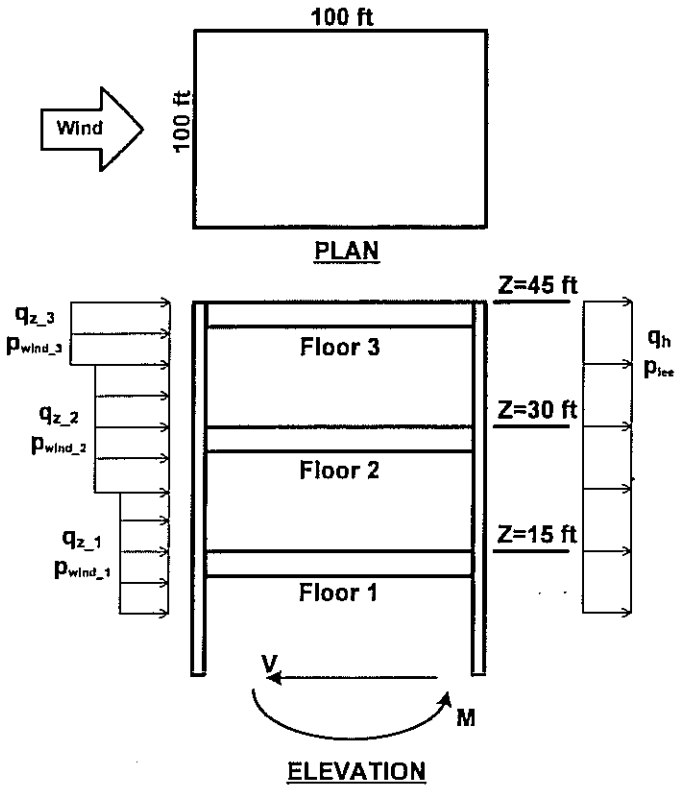
r = 3, b = 7, n = 5

r + b = 2n

10 = 10 ✓

STABLE - DET,

Problem 2. Wind loads.



Apartment Building
Steel Frame Structure
V = 90 mph
Exposure B
Flat Ground
(Do not use the simplified procedure.)

(a) For the structure shown above, find the pressure coefficients q_z (at each floor)and q_h. Take z_1 = 15 ft, z_2 = 30 ft, and z_3 = 45 ft. Use the appropriate value for h. (20 points)

$q_z = 0.00256 V^2 I K_z K_d K_{zt}$

$I = 1.0$

$V = 90$

$K_d = 0.85$

$K_{zt} = 1.0$

z	K_z
15	0.7
30	0.7
45	0.79

$(h = z_3 = 45')$

$q_z = 17.6 K_z$

$q_{z1} = 12.3$ $\quad q_h = 13.9$

$q_{z2} = 12.3$ $\quad (psf)$

$q_{z3} = 13.9$

(b) Using the q_z and q_h values you calculated in part (a), find the design windward and leeward wind pressures, p_{wind_1}, p_{wind_2}, p_{wind_3}, and p_{lee}. (10 points)

$p = G C_p q_z$ or q_h

$G = 0.85$

$C_{p\,Lee} = -0.5$

$C_{p\,wind} = 0.8$

$p_{wind_1} = 8.4$

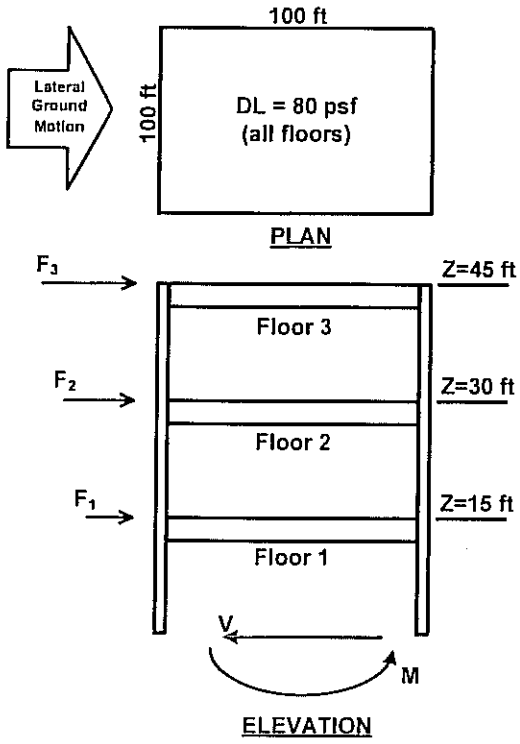
$p_{wind_2} = 8.4$

$p_{wind_3} = 9.5$

$p_{lee} = -5.9$

(psf)

Problem 3. Seismic Loads. For the following problems, assume Seismic Design Category B has been determined.



Apartment Building
Steel Frame Structure
Site Class D
Seismic Design Category B
$S_{DS} = 0.12$
$S_{D1} = 0.05$

(a) For the above structure, find the design seismically induced base shear, V. Be sure to check minimum and maximum values. (20 points).

$V = \frac{S_{DS} W}{T(R/I)}$

$W = (100')(100')(80\ psf)(3\ floors)\left(\frac{1k}{1000lb}\right) = 2400k$

$R = 8$

$I = 1$

$T = C_t h_n^x$ $\quad C_t = 0.028$, $x = 0.8$, $h = 45$

$T = (0.028)(45)^{0.8} = 0.59\ s$

$V = \frac{0.05(2400)}{.59(8/1)} = 25.4k$

$V_{min} = 0.044 S_{DS} I W = 0.044(.12)(1.0)(2400) = 12.7k < V$ use V

$V_{max} = \frac{S_{DS} W}{R/I} = \frac{.12(2400)}{8/1} = 36.0k > V$ use V

$V = 25.4k$

(b) Using your answer from part (a), find the design seismic equivalent static forces applied to each floor, F_1, F_2, and F_3. (10 points).

$$F_x = \frac{w_x h_x^k}{\sum_{i=1}^{n} w_i h_i^k} V$$

$$k = 1 + \frac{0.59 - 0.50}{2}$$

$$= 1.05$$

$$w_1 = w_2 = w_3 = (100')(100')(80psf)\left(\frac{1k}{1000lb}\right) = 800k$$

$$\sum_{i=1}^{3} w_i h_i^k = 800(15)^{1.05} + 800(30)^{1.05} + 800(45)^{1.05}$$

$$= 13740 + 28449 + 43547$$

$$= 85736$$

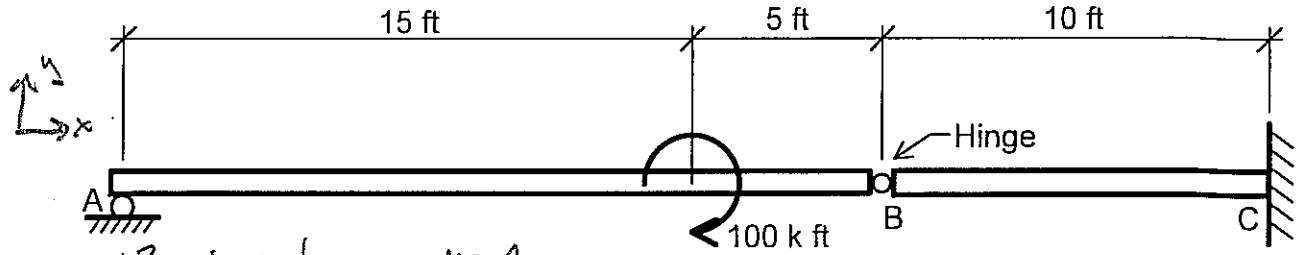
$$F_1 = \frac{13740}{85736}(25.4) = 4.1k = F_1$$

$$F_2 = \frac{28449}{85736}(25.4) = 8.4k = F_2$$

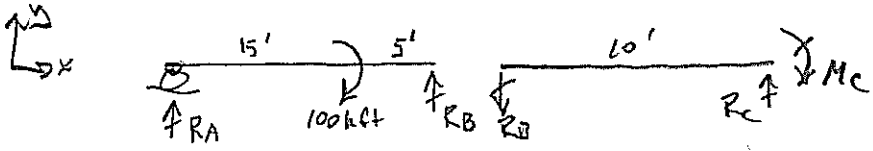
$$F_3 = \frac{43547}{85736}(25.4) = 12.9k = F_3$$

check $\Sigma = 25.4 = V$ OK

Problem 4. For the beam depicted below, draw the shear and moment diagram.
Hint: you should really draw two free-body diagrams to solve for the reactions.
Hint: When you sum moments around a point, be sure to include any concentrated moments that appear on your free-body diagram. (25 points)



By inspection, x-dir forces = 0



$\circlearrowleft + \Sigma M_A = 0] \quad -100 + 20R_B = 0$

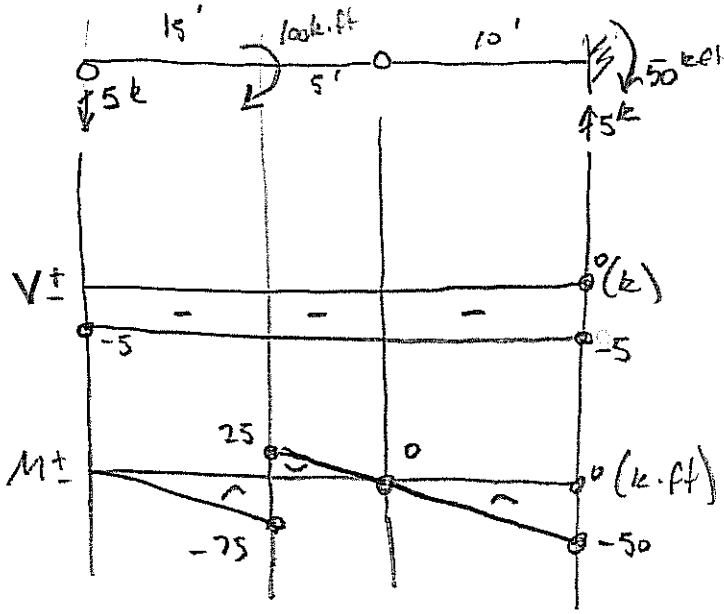
$R_B = 5^k$

$\Sigma F_y = 0] \quad R_A + R_B = 0 \rightarrow R_A = -5^k$

$\rightarrow \Sigma F_y = 0] \quad -5 + R_C = 0 \rightarrow R_C = 5^k$

$\circlearrowleft + \Sigma M_B = 0] \quad 10R_C - M_C = 0$

$M_C = 50 \text{ k·ft}$



15 5 10
×-5 ×5 -5
-75 -25 -50

Useful Tables From ASCE 7-05 for CE3202

Live Load

Live Load Element Factor (K_{LL}) — *Table 4-2*

Interior Columns	4
Exterior Columns without cantilever slabs	4
Edge Columns with canteliver slabs	3
Corner Columns with cantelever slabs	2
Edge Beams without cantelever slabs	2
Interior Beams	2
Other members:	1
Edge beams with cantilever slabs	
Cantilever Beams	
Slabs	
Members without provisions for continuous shear transfer normal to their span	

Snow Load

Importance Factor (I) — *Table 7-4*

Occupancy Category	
I	0.80
II	1.00
III	1.10
IV	1.20

Thermal Factor (C_t) — *Table 7-3*

Heated Buildings	1.0
Unheated Structures	1.2

Exposure Factor (C_e) — Table 7-2

Windy Site	0.7
Non-windy Site	1.0
Sheltered Site	1.3

Slope Factor (C_s) — *Figure 7-2*

Flat roof	1.0

All Loads

Occupancy Category — *Table 1-1*	
Structures representing low risk to human life *e.g.*, agricultural facilities some tempory facilities minor storage facilities	I
Structures not in categories I, III, or IV	II
Buildings representing substantial hazard to human life (*i.e.*, gathering places) *e.g.*, schools, day-care centers, auditoriums, jails, nursing homes Buildings representing substantial economic impact or disruption if damaged *e.g.*, power generation stations, water and sewage treatment facilities, telecom	III
Buildings designated as essential facilities *e.g.*, hospitals, fire, rescue, and police stations, emergency shelters, designated emergency response stations, and national defense facilities	IV

Wind Load

Importance Factor (I) — *Table 6-1*

Occupancy Category	
I	0.87
II	1.00
III	1.15
IV	1.15

Exposure Category

Urban Centers	B
Surburban and wooded areas	B
Open terrain, some obstructions	C
Beachfront property	D

Velocity Pressure Exposure Coefficient (K_z) for MWFRS — *Table 6-3*

Height above grade (z)	Exposure B		Exposure C	Exposure D
	Low-Rise	Non Low-Rise	All	All
0-15	0.70	0.57	0.85	1.03
20	0.70	0.62	0.90	1.08
25	0.70	0.66	0.94	1.12
30	0.70		0.98	1.16
40	0.76		1.04	1.22
50	0.81		1.09	1.27
60	0.85		1.13	1.31
70	0.89		1.17	1.34
80	0.93		1.21	1.38
90	0.96		1.24	1.40
100	0.99		1.26	1.43
120	1.04		1.31	1.48
140	1.09		1.36	1.52
160	1.13		1.39	1.55
180	1.17		1.43	1.58
200	1.20		1.46	1.61
250	1.28		1.53	1.68
300	1.35		1.59	1.73
350	1.41		1.64	1.78
400	1.47		1.69	1.82
450	1.52		1.73	1.86
500	1.56		1.77	1.89

(Linear interpolation of K_z allowed)

Topographical Factor (K_{zt})

Flat Ground	1

Figure 6-4

Gust Factor (G)

Rigid Structures	0.85

Directionality Factor (K_d)

Buildings	0.85

Table 6-4

External Pressure Coefficient (C_p) — *Figure 6-6*

Surface	L/B	Cp	Use With
Windward Wall	All	0.8	q_z
Leeward Wall	0-1	-0.5	q_h
	2	-0.3	
	≥ 4	-0.2	
Side Wall	All	-0.7	q_h

(Positive values point into structure, negative values point away)

(Linear interpolation of C_p allowed)

Seismic Load

Importance Factor (I) — *Table 11.5-1*

Occupancy Category	
I	1.00
II	1.00
III	1.25
IV	1.50

Site Coefficient, Short-Period (F_a) — *Table 11.4-1*

	Mapped (MCE) Spectral Response Acceleration Parameter				
Site Class	$S_s \le 0.25$	$S_s = 0.5$	$S_s = 0.75$	$S_s = 1.0$	$S_s \ge 1.25$
A	0.80	0.80	0.80	0.80	0.80
B	1.00	1.00	1.00	1.00	1.00
C	1.20	1.20	1.10	1.00	1.00
D	1.60	1.40	1.20	1.10	1.00
E	2.50	1.70	1.20	0.90	0.90
F	Site Specific				

(Linear interpolation of F_a allowed)

Site Coefficient, 1s-Period (F_v) — *Table 11.4-2*

	Mapped (MCE) Spectral Response Acceleration Parameter				
Site Class	$S_1 \le 0.1$	$S_1 = 0.2$	$S_1 = 0.3$	$S_1 = 0.4$	$S_1 \ge 0.5$
A	0.80	0.80	0.80	0.80	0.80
B	1.00	1.00	1.00	1.00	1.00
C	1.70	1.60	1.50	1.40	1.30
D	2.40	2.00	1.80	1.60	1.50
E	3.50	3.20	2.80	2.40	2.40
F	Site Specific				

(Linear interpolation of F_v allowed)

Design Category, Based on Short-Period Response Acceleration Parameter — *Table 11.6-1*

	Occupancy Category		
value of S_{DS}	I or II	III	IV
$S_{DS} < 0.167$	A	A	A
$0.167 \le S_{DS} < 0.33$	B	B	C
$0.33 \le S_{DS}$ 0.50	C	C	D
$0.50 \le S_{DS}$	D	D	D

Design Category, Based on 1s-Period Response Acceleration Parameter — *Table 11.6-2*

	Occupancy Category		
value of S_{D1}	I or II	III	IV
$S_{D1} < 0.067$	A	A	A
$0.067 \le S_{D1} < 0.133$	B	B	C
$0.133 \le S_{D1}$ 0.20	C	C	D
$0.20 \le S_{D1}$	D	D	D