Zach Dischner

ASEN 5007 Introduction To Finite Elements - Fall 2013

Homework Assignment #3   Chapters 6–7 of Notes

Due Tuesday Sep 24, 2013 for on-campus students; Sep 26 for CAETE students

Please dont forget to attach this cover sheet to your returned homework and write your name(s) on it

Exercises:

7.1 (easy, about one minute)

7.2 remember that *no triangles are allowed* when you draw a mesh within region ABCD. Several acceptable solutions with quadrilaterals are possible; some are a bit tricky.

7.3

7.4 (long by hand, may be helped by computer (Matlab, Mathematica, etc) or programmable calculator)

7.7 (see Notes below)

Grading weights: given at the start of each Exercise.

Note 1: please do all necessary sketches for 7.1, 7.2 and 7.7 on your own paper. Engineering paper should be used. You should start each Exercise on a new page to help grading, but don't need to start a new page for items of an Exercise.

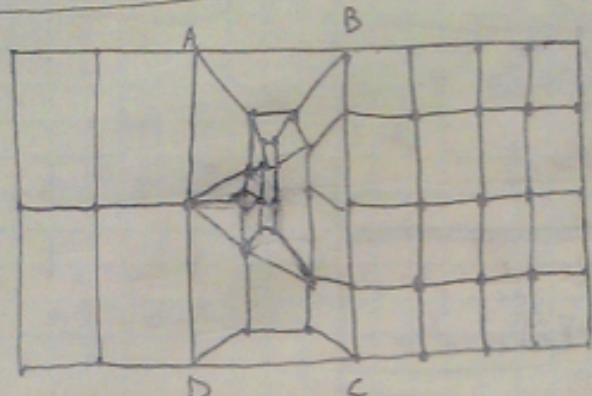
Note 2: For 7.7(d) and 7.7(e) truncate the mesh at a sufficiently large distance from the loads. (The mesh should occupy a rectangular region and use rectangular elements, since that is easy to draw). No need to use infinite elements, but be careful that vertical rigid-body motions be restrained as necessary. As regards what BC to place on truncated boundaries, use your judgement.

1. Book 7.1

Trouble spots	: Reason
D, N, I	: Vicinity of point load
B, F	: Entrant corners

2. Book 7.2

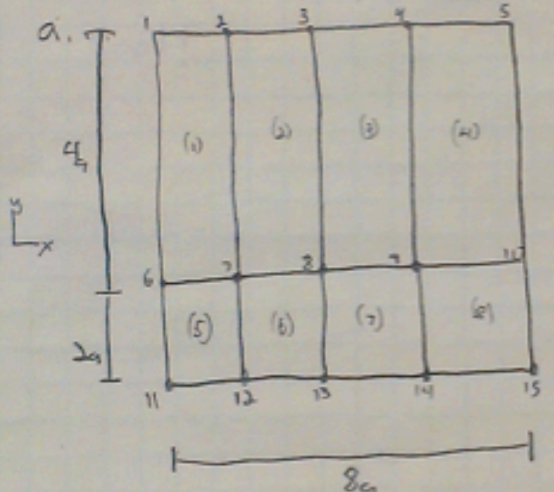
Draw transition mesh in ABCD with NO TRIANGLES



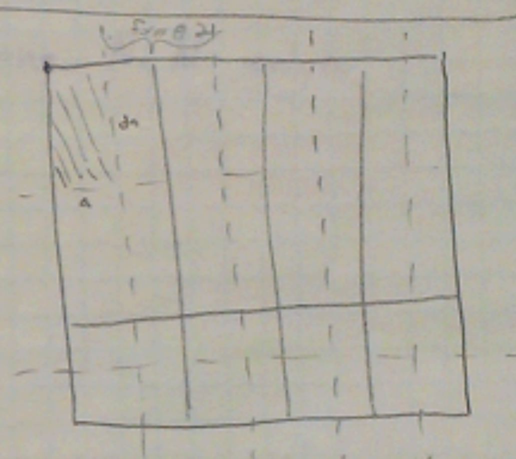
3. Book 7.3

thickness h, specific weight γ ($=\rho g$)

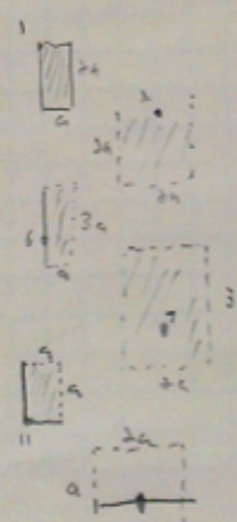
a.



$\rightarrow$



Forces are areas acting on nodes



$\boxed{f_{y_1} = f_{y_5} = -2a^2\gamma h}$

$\boxed{f_{y_2} = f_{y_3} = f_{y_4} = -4a^2\gamma h}$

$\boxed{F_{y_6} = F_{y_{10}} = -3a^2\gamma h}$

$\boxed{F_{y_7} = F_{y_8} = F_{y_9} = -6a^2\gamma h}$

$\boxed{F_{11} = F_{15} = -a^2\gamma h}$

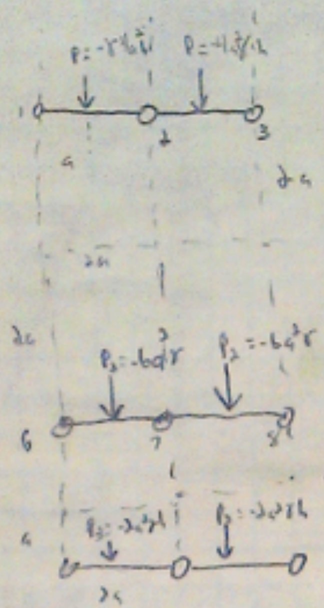
$\boxed{F_{12} = F_{13} = F_{14} = -2a^2\gamma h}$

as a check, sum all forces

$$\sum_{i=1}^{15} F_i = -48a^2\gamma h \quad \checkmark$$

3 cont
3 b.

Repeat doing EbE method



$$\boxed{\begin{aligned} F_1 = F_5 &= \frac{a}{2a}(-\gamma 4a^2)h = \underline{-2a^2\gamma h} \\ F_2 = F_3 = F_4 &= \frac{a}{2a}(-\gamma 4a^2)h + \frac{a}{2a}(-\gamma 4a^2)h = \underline{-4a^2\gamma h} \end{aligned}}$$

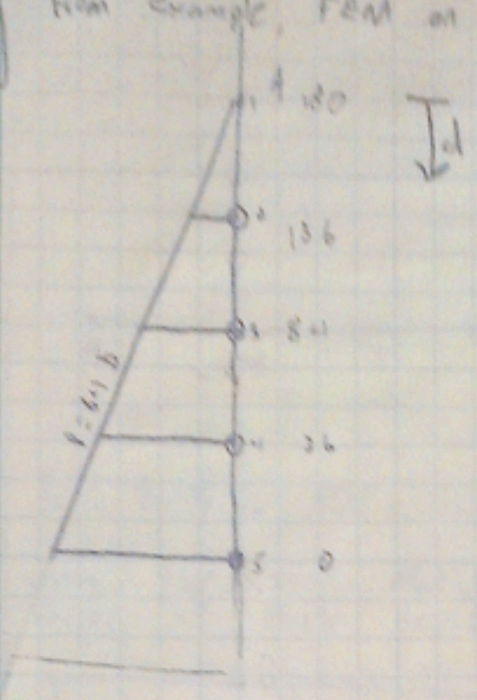
$$\boxed{\begin{aligned} F_6 = F_{10} &= \frac{a}{2a}(-6a^2\gamma)h = \underline{-3a^2\gamma h} \\ F_7 = F_8 = F_9 &= \frac{a}{2a}(-6a^2\gamma)h + \frac{a}{2a}(-6a^2\gamma)h = \underline{-6a^2\gamma h} \end{aligned}}$$

$$\boxed{\begin{aligned} F_{11} = F_{15} &= \frac{a}{2a}(-2a^2\gamma h) = \underline{-a^2\gamma h} \\ F_{12} = F_{13} = F_{15} &\left(\frac{a}{2a}\right)(-2a^2\gamma h) + \left(\frac{a}{2a}\right)(-2a^2\gamma h) = \underline{-2a^2\gamma h} \end{aligned}}$$

These Results agree with a), doing NbN analysis.
cool!

4.
7.4

From example, FEM on Norfolk Dam. Compute the rest of the node Forces



Assumptions

· AB is vertical

· $p = 64 \cdot d \quad \frac{lb}{ft^2}$

so

· $p_1 = 0$

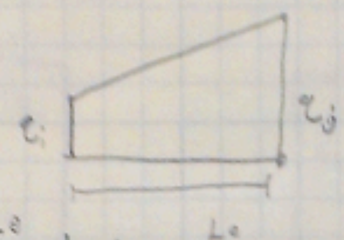
· $p_2 = 62.4 \times 44 = 2745.6$ psf

· $p_3 = 62.4 \times 96 = 5590.4$

· $p_4 = 62.4 \times 144 = 8.985 \times 10^3$ psf

· $p_5 = 62.4 \times 180 = 11232$

EB_3E



$$F_i^e = \frac{L_e}{6}(2q_i + q_j) \qquad F_j^e = \frac{L_e}{6}(q_i + 2q_j)$$

From example:

$$f_{x_1}^{(1)} = \left(\frac{44}{6}\right)(2 \cdot 0 + 2745.6\,psf) = 20134 \text{ lbs}$$

$$f_{x_2}^{(1)} = \left(\frac{44}{6}\right)(0 + 2 \cdot 2745.6) = 40269 \text{ lb}$$

$$f_{x_2}^{(2)} = \left(\frac{136-84}{6}\right)(2 \times 2745.6 + 5990.4) = 99507 \text{ lb}$$

⋮

$$\boxed{\begin{array}{l} F_{x_1} = 20134 \\ F_{x_2} = 139776 \end{array}}$$

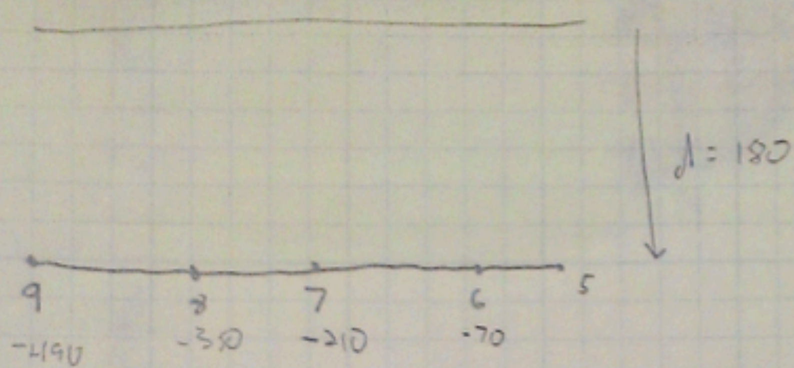
Using the above as a guideline, I wrote a Matlab script to compute loads for the rest of the nodes

$$\boxed{\begin{array}{l} F_{x_3} = 295360 \text{ lbs} \\ F_{x_4} = 366912 \text{ lbs} \\ F_{x_5} = 188697.6 \text{ lbs} \end{array}}$$

$\Sigma F_x = 1010880$ lbs, matches solution ✓

4 (cont) 7.4

now for y forces



$P_5 = P_6 = P_7 = P_8 = P_9 = 180 \times 62.4 = 11232$ lbs PSF

using the same Matlab utilities (attached) I solved for the node forces at each position

$F_{y5} = -393120$ lbs

$F_{y6} = -1179360$ lbs

$F_{y7} = -1572480$ lbs

$F_{y8} = -1572480$

$F_{y9} = -786240$ lbs

$\Sigma F_y = -5503680$ lbs

matches book soln ✓

Contents


```
%>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>>
%                         quickFEM.m
% Author      : Zach Dischner
% Date        : 9/24/2013
% Description : quick Matlab checker script for Problem 4, HW 3
%
%                 __...____________________          ,
%                `(\ [ ===NCC-1700===--|__|) ___..--"_`--..______
%                  `""""""""""""""""""| |""` [_""_-____________"_/
%                                    | |   /..../`'-._.-'`
%                                ____| |__/::..'_
%                               |\ ".`"` '_____//\
%                               `"'-.   """"""  \\/
%                                    `""""""""""""`
% <<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<<
```

Part 1, the X forces

```
d = 180-[180 136 84 36 0];
pp=62.4;
p = pp*d;
p = [0 p 0];
d = [0 d 0];
L = (d - [d(end) d(1:end-1)]); L(L<0) = 0;
for ii = 2:length(p)-1
    Fx(ii-1) = computeLoadEbE(p(ii-1),p(ii), p(ii+1),L(ii),L(ii+1));
end
fprintf('Computed X Node loads are:\n')
Fx
```

```
Computed X Node loads are:

Fx =

  Columns 1 through 3

                 20134.4                   139776                   295360

  Columns 4 through 5

                  366912                 188697.6
```

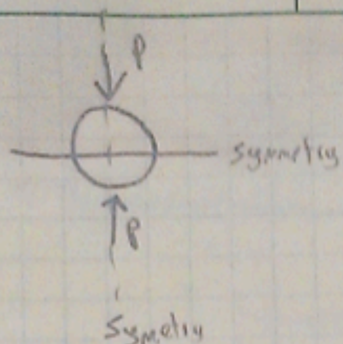
Part 2, the Y forces

```
d = [0 70 210 350 490];
p = -1*ones(length(d),1)'*180*pp;
p = [0 p 0];
d = [0 d 0];
L  = d - [d(end) d(1:end-1)]; L(L<0) = 0;
for ii = 2:length(p)-1
    Fy(ii-1) = computeLoadEbE(p(ii-1),p(ii), p(ii+1),L(ii),L(ii+1));
end
fprintf('Computed Y Node loads are:\n')
Fy
```

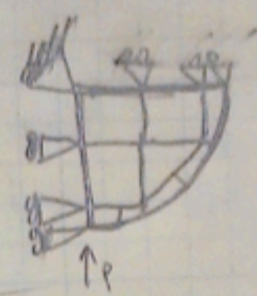
```
Computed Y Node loads are:

Fy =

     -393120    -1179360    -1572480    -1572480     -786240
```

Published with MATLAB® R2013b

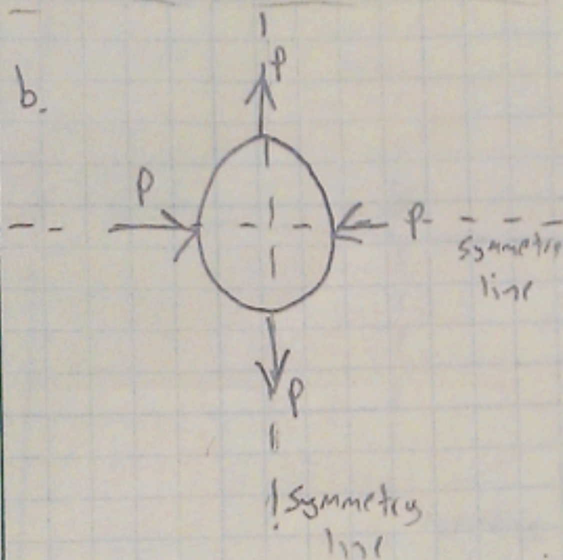
a.



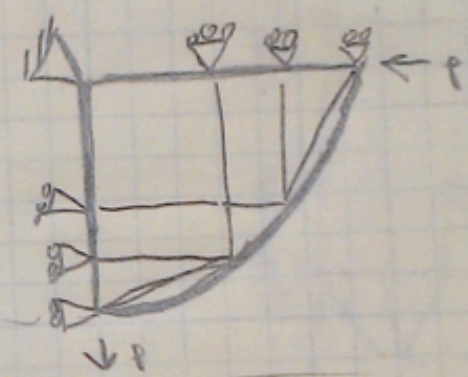
Yes, possible to section structure



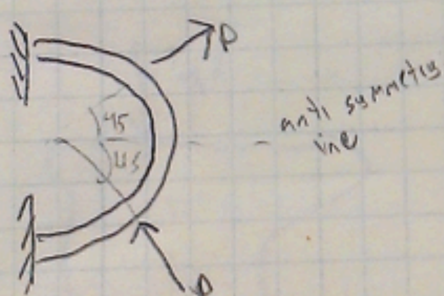
b.



Yes, it is possible to section this structure



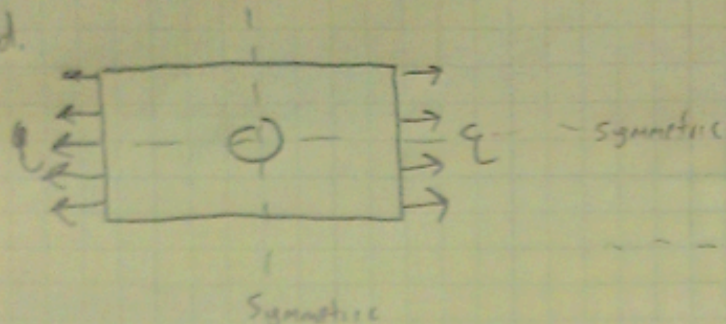
c.

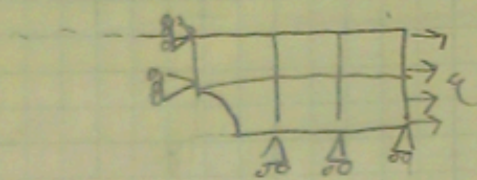


Yes, possible to cut structure

d.

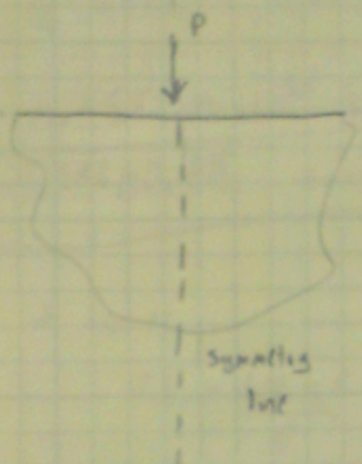
Yes, it is possible to section this structure

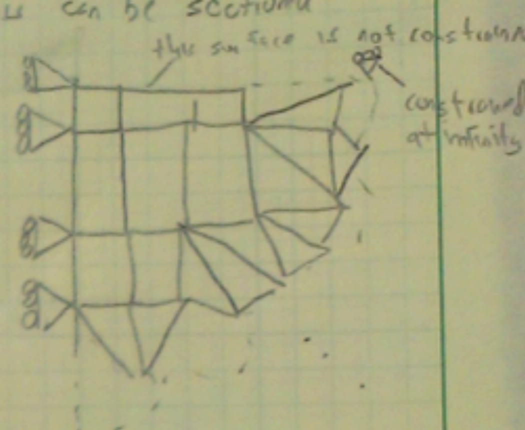




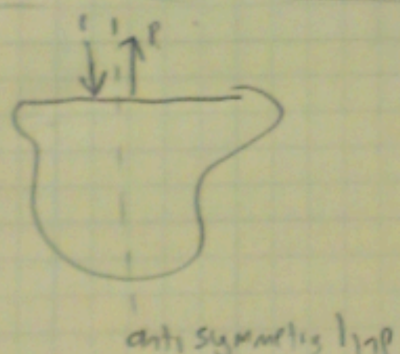
e.

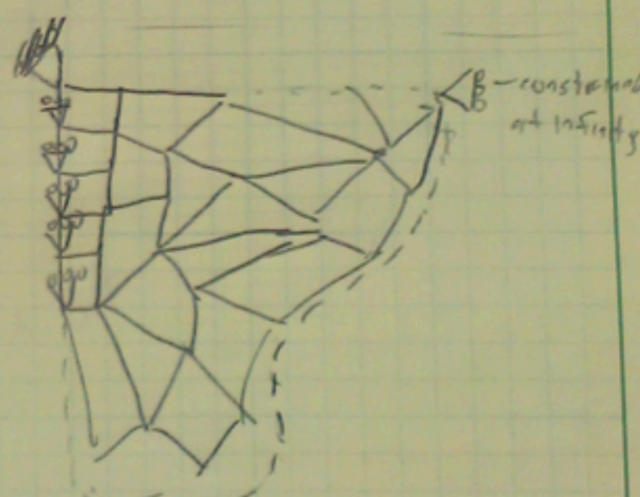
Yes, this can be sectioned





f.





Yes, can section This structure