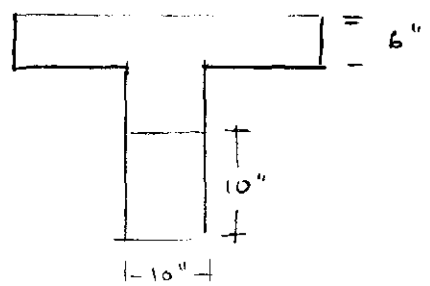
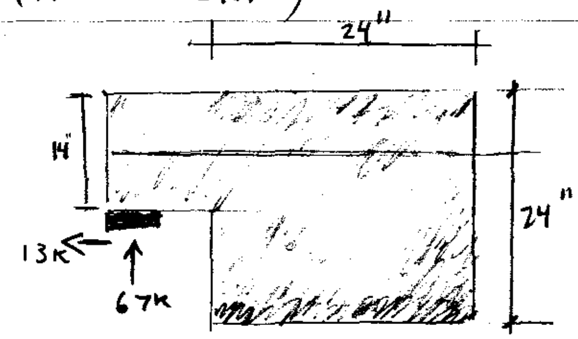
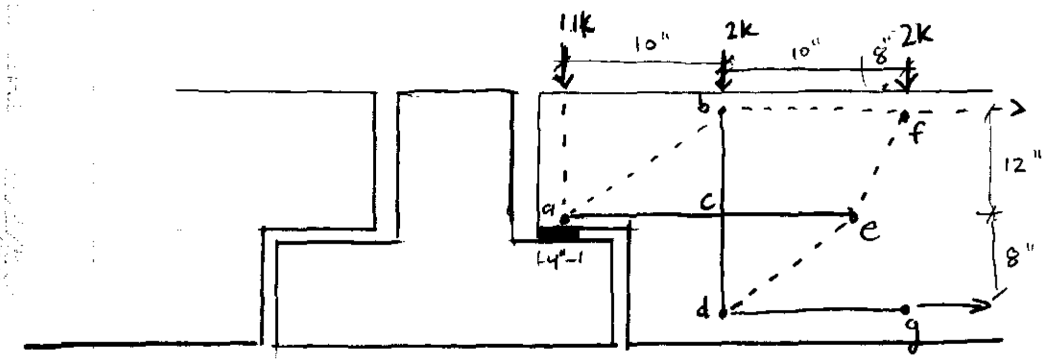
EXAMPLE 10.3 MODIFIED (FROM TEXT)





SHADED AREA D REGION

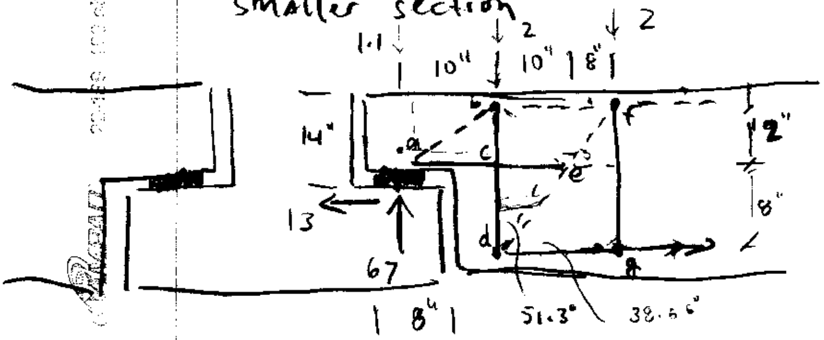


Problem is the same as 10-3 in TEXT EXCEPT TRUSS DIMENSIONS have changed slightly and a uniform load has been applied. The uniform load is assumed as several CONCENTRATED LOAD APPLIED ALONG THE SPAN. The CONCENTRATED LOAD AT The end of the dapped beam is smaller because of the shorter span between concentrated loads.

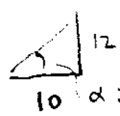
Dapped-end T-beam supported by an inverted T-beam

At the end of the beam, load is transferred from the support to the beam (For dapped this is a D-region) [This is difficult to represent]

- Parking structures
- Shear at end of beam must be carried by a much smaller section



$f'_c = 5$ ksi
GR60



$\alpha = 50.2$

DEFINITION OF D REGION

APPROX 1 STRUCTURAL DEPTH IN FROM END OF NOTCH
The bearing plate will have longitudinal reinforcement welded to it to facilitate load transfer R11.8.1
So effective depth ≈ 13.5" at the notch

Max shear capacity (allow) is $V_u = \phi V_n = \phi 10 \sqrt{f'_c}\, b_w d$

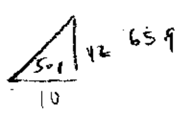
CODE 11.8.1 $= 0.75\,(10)\sqrt{5000} \times 10 \times 13.5 = 71.6$ kips

This exceeds applied 65.9k → proceed.

Force resultants on D region boundaries AND THE truss model

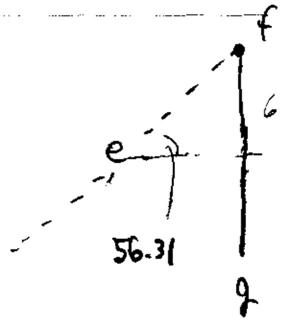
Minimum energy solutions → fewer tension ties

TRUSS FORCES



$\sin 50.2 = \frac{67}{ab} \Rightarrow ab = 85.27$ k
bd = 67.9
ae = 54.9 + 13 = 67.9k
bf = 54.9 k

de = 108.6 k
dg = 84.75 k
ef = 81.5 k
fg = 69.9 k



$\sin 38.66 = \frac{y}{108.6} \Rightarrow y = 67.8$

$\sin 56.31 = \frac{67.8}{ef} \Rightarrow ef = 81.5\ k$

$fg = bd + 2k$

Selecting dimensions for strut and nodal zones

Nodal zone stress is established at the bearing plate since bearing area is known

Stress is $p = V_u / A_b = \frac{65.9\ k}{4(10)} = 1.65\ ksi$

Width of strut is given as $w_{ab} = F_{u,ab} / (p \times 10) = 5.17\ in$

All are calculated same way → see table

Additional explanation on pg. 8

Capacity of struts

Strut design capacity is based on bottle shaped strut, ($\beta_s = 0.75$)

For strut ab $\phi F_{ns,ab} = \phi \beta_s\, 0.85 f'_c\, w_{ab}\, b$

$= 0.75 \times 0.75 \times 0.85 \times 5 \times 5.17 \times 10$

$= 123.6\ k > 85.3$ ✓ ok

All others are same → see table

Design ties + Anchorage

for tie bd $A_s = F_{u,bd} / \phi f_y$ coming from $F_u = \phi A_s f_y$

$$= \frac{67.9}{0.75(60)} = 1.51 \text{ in}^2$$

2 # 6's gives $A_s = 1.76 \text{ in}^2$ (2 legs):

Max width for tie bd = $W_{bd} = F_{bd} / \rho b = 4.11''$

spacing of 2" gives

$$(2 \times .75) + 2'' \doteq 3.5''$$

ties will fit within the maximum tie width for bd

Tie ae carries horizontal component of ab + 13 k

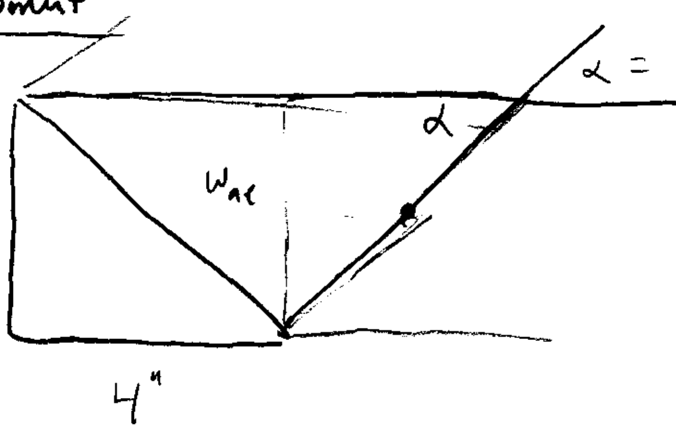
$$A_s = F_{u,ae} / \phi f_y = \frac{67.9}{0.75(60)} = 1.51 \text{ in}^2$$

width area must fit into is same as bd (4.11") but in the 10" plane

use 2 # 8 bars

$2(.79) = 1.58 \text{ in}^2$ → will fit in 10" width

Development



Anchorage length provided is $4'' + \frac{1}{2} W_{ae} \cos \alpha$

$= 5.32''$

check table A10 on pg. 744

BOTTOM BAR # 8 or larger 5 ksi GR60

book would have used other → OTHER CASES because not enough cover

assuming cover is supplied

$l_d = 42 d_b$ 42" > 5.32"

cant use hook. must use either mechanical anchor or weld

Book uses a weld.

Ties BD and fg are detailed as closed stirrups

AND MUST BE ADDED TO ANY SHEAR reinforcement from B-Region of beam

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Design details and minimum reinforcement requirements

BOOK TALK ABOUT THE HORIZONTAL STRUT FORCE of ab NEEDING TO BE TRANSFERRED BY HEADED STUDS

$A_{vf} = V_{uf} / \phi f_y \mu$ $\mu = 0.7$ BETWEEN STEEL + CONCRETE

$V_u =$ 

$= F_{u,ab} \cos 50.2$ $f_y = 50$ ksi

$= 1.7 \text{ in}^2$ 4 3/4" × 5 in HEADED STUDS welded on to plate

TIE DG is AN extension of main long reinf.

$$A_{s,req.DG} = \frac{84.75\text{ k}}{0.75 \times 60} \geq 1.88 \text{ in}^2$$

This should be checked against requirements from B-region

For similar reasons as befor a mechanical anchor or A 90° hook is required at node d to provide full development

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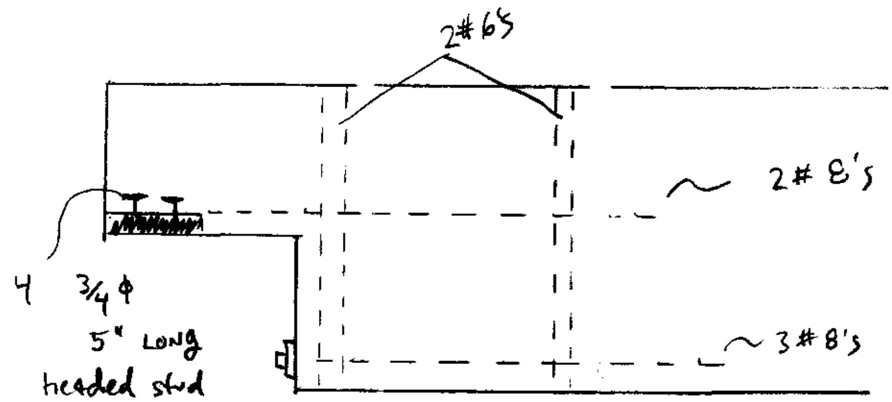
Minimum reinforcement in dapped end is

$$A_{v\,min} = 0.0025\, b_w\, s = .0025\,(10)\,(12")$$
$$= 0.30 \text{ in}^2/\text{ft}$$

#4 bars @ 12" provides $0.4 \text{ in}^2/\text{ft}$ — we have 2#6 bars at

beam is only 2' high so no more horizontal reinforcement required



Member Type	Member	β_s (10.1)	β_n (TBL 10.2)	FORCE (K)	w_i, in	CAPACITY (K)	A_s req'd in²	$A_{s\,prov}$
STRUT	ab	.75	0.8	85.3	5.17 in	123.6		
	bf	1.0	0.8	54.9	3.33 in	106.1		
BOUND BY TOP OF BEAM	de	0.75	0.6	108.6	6.58	157.3		
	ef	0.75	0.8	81.5	4.94	118.1		
Tie	ae			67.9	4.11		1.51	
	bd			67.9	4.11		1.51	
	dg			84.75	5.14		1.89	
	fg			69.9	4.24		1.55	

deflection and crack control
ARE not Included in APP A

TRADITIONAL ELASTIC ANALYSIS CAN BE USED

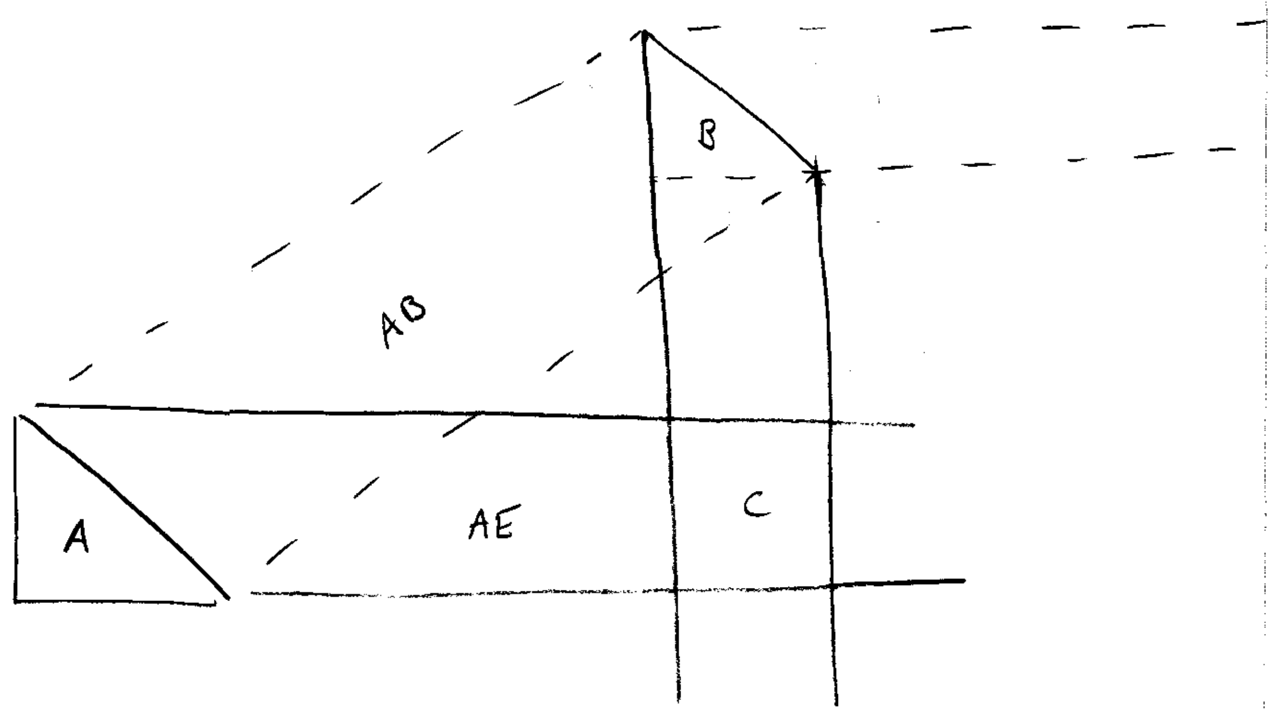
SELECTING DIMENSIONS FOR NODAL ZONES AND STRUTS (CONT.)

NODAL ZONE STRESS IS ESTABLISHED AT THE BEARING PLATE.

A HYDROSTATIC NODAL ZONE ASSUMES the same STRESS is ACTING ON ALL FACES OF THE NODE.

SINCE THE NODE IS IN HYDROSTATIC EQUILIBRIUM (IE. STRESS IS SAME ON ALL FACES), THE FORCE IN THE STRUT OR TIE ACTING AT THE NODAL ZONE DETERMINES THE WIDTH OF the respective STRUT or TIE.

BECAUSE STRUT + TIE MODELS ARE Designed AS PRISMATIC MEMBERS, ONCE THE STRESS AT ONE ZONE IS DETERMINED THAT STRESS IS CARRIED TO ALL OTHER NODAL ZONES.



STRESS IN A MUST = STRESS IN B