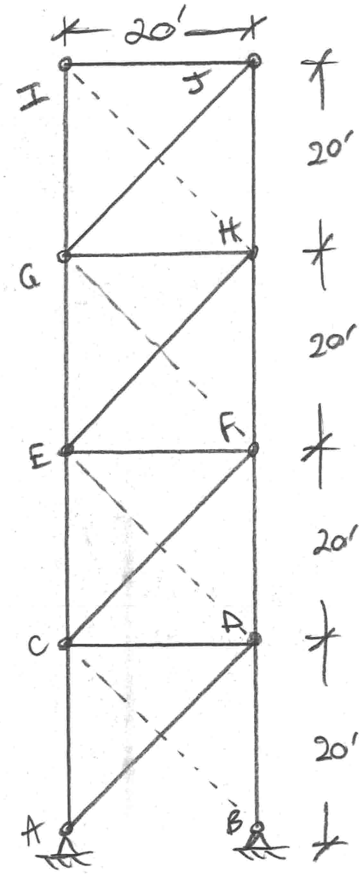
ASCE 7-16 : SECT 29.4

DESIGN WIND LOADS : OTHER STRUCTURES

TRUSSED TOWERS → FIG. 29.4-3

GIVEN: 20′ × 20′ × 80′ TALL BRACED TOWER (OPEN STRUCTURE)



ELEVATION

- RISK CATEGORY = II
- BASIC WIND SPEED, $V = 107$ mph
- GUST EFFECT FACTOR, $G = 0.85$
- WIND DIRECTIONALITY FACTOR, $K_d = 0.85$
- TOPOGRAPHIC FACTOR, $K_{zt} = 1.0$
- GROUND ELEVATION FACTOR, $K_e = 1.0$
- SURFACE ROUGHNESS = C
- EXPOSURE = C
- VELOCITY PRESSURE EXPOSURE COEFFICIENT: K_z:

z (ft)	K_z	q_z (psf)
0-15	0.85	21.1
20	0.9	22.5
30	0.98	24.5
40	1.04	26.0
50	1.09	27.2
60	1.14	28.3
70	1.17	29.2
80	1.21	30.1

- VELOCITY PRESSURE:

$$q_z = 0.00256 K_z K_{zt} K_d K_e V^2 \text{ (psf)}$$

$$q_z @ 80\text{ft} = 0.00256(1.21)(1)(0.85)(1)(107 \text{ mph})^2$$

$$q_z @ 80\text{ft} = 30.1 \text{ psf}$$

(SEE TABLE)

ASCE 7-16 SECT. 29.4:

DESIGN WIND FORCE, $F = q_z G C_f A_f$ (lb)

USE FIG. 29.4-3 FOR C_f

ASCE 7-16: SECT. 29.4

FIG. 29.4-3: C_f FOR OPEN STRUCTURES - TRUSSED TOWERS

FOR SQUARE TOWER CROSS SECTION, $C_f = 4\varepsilon^2 - 5.9\varepsilon + 4$

$$\varepsilon = \frac{\text{SOLID AREA}}{\text{GROSS AREA}}$$ ← OF ONE TOWER FACE ONLY

EQ. 29.4-1: $F = q_z G C_f A_f$

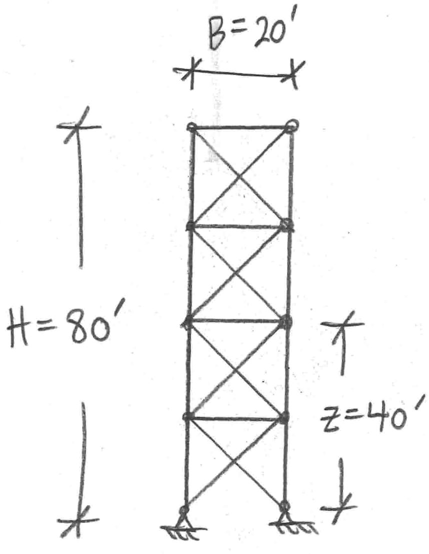
F = DESIGN WIND FORCE

G = GUST EFFECT FACTOR

C_f = FORCE COEFFICIENT (FIG. 29.4-3)

A_f = PROJECTED AREA NORMAL TO WIND EXCEPT WHERE C_f IS SPECIFIED FOR THE ACTUAL SURFACE AREA

q_z = VELOCITY PRESSURE EVALUATED AT HEIGHT z OF THE CENTROID OF AREA A_f



WINDWARD FACE ELEVATION

$A_f = HB = 80\text{ft}(20\text{ft}) = A_f = 1600\ \text{ft}^2$

q_z @ 40 ft = 26 psf

G = 0.85

FOR ε, ASSUME COLUMNS & STRUTS HAVE AN 8" DIMENSION FACING WIND

→ SOLID AREA: $(8''/12)(20')(4) + (8''/12)(80')(2)$

$= 160\ \text{ft}^2$ (STRUTS & COLUMNS)

ASSUME BRACES HAVE A 4" DIMENSION FACING WIND

→ $(4''/12)\sqrt{20^2 + 20^2}\,(8) = 75\ \text{ft}^2$

SOLID AREA = 160 + 75 = $235\ \text{ft}^2$

GROSS AREA = $A_f = 1600\ \text{ft}^2$

$$\therefore\ \varepsilon = \frac{235\text{ft}^2}{1600\text{ft}^2} = \varepsilon = 0.15$$

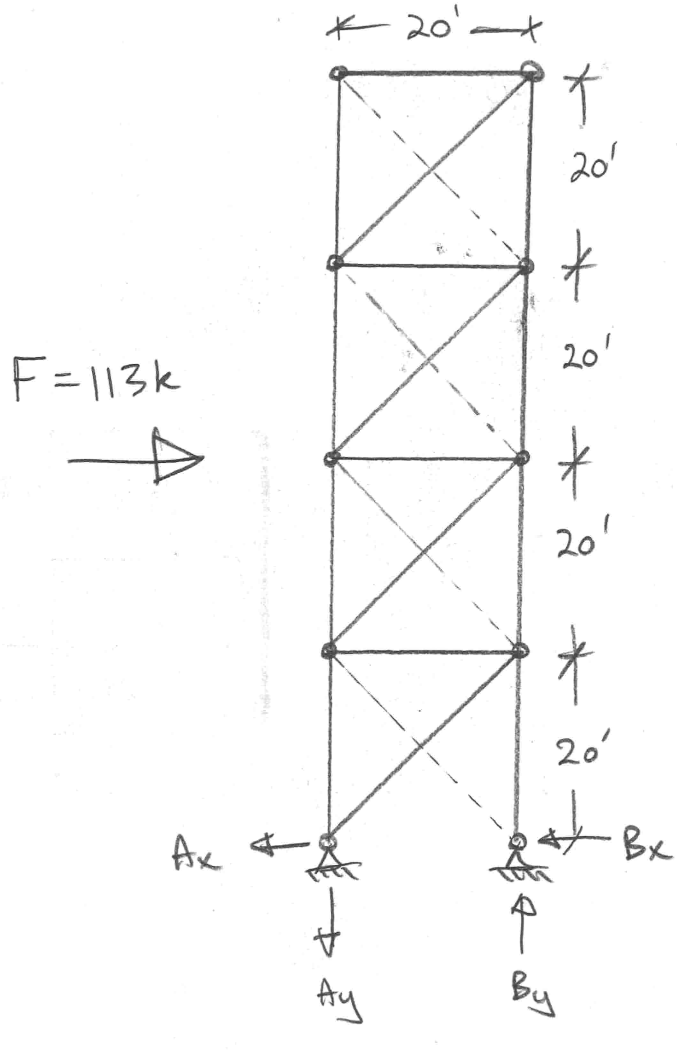
ASCE 7-16: SECT. 29.4

$\varepsilon = 0.15$ $\qquad C_f = 4\varepsilon^2 - 5.9\varepsilon + 4 = 4(0.15^2) - 5.9(0.15) + 4$

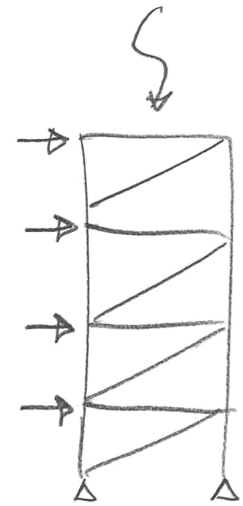
$C_f = 3.2$

$F = q_z G C_f A_f = 26\text{ psf}(0.85)(3.2)(1600\text{ ft}^2) = \boxed{F = 113\text{ kip}}$

DESIGN WIND FORCE



WOULD F BE DIVIDED & APPLIED EQUALLY AT EACH PANEL POINT?



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* WHAT IF $\varepsilon = 0.5$? (GREATER SOLID AREA TO GROSS AREA RATIO)

$C_f = 4(0.5^2) - 5.9(0.5) + 4 = C_f = 2.05$

$F = 26\text{ psf}(0.85)(2.05)(1600\text{ ft}^2) \approx \boxed{F = 72.5\text{ k}}$

WHY WOULD F BE SMALLER FOR A TOWER WITH MORE SOLID AREA FACING THE WIND?