SNS COLLEGE OF TECHNOLOGY

Coimbatore-35

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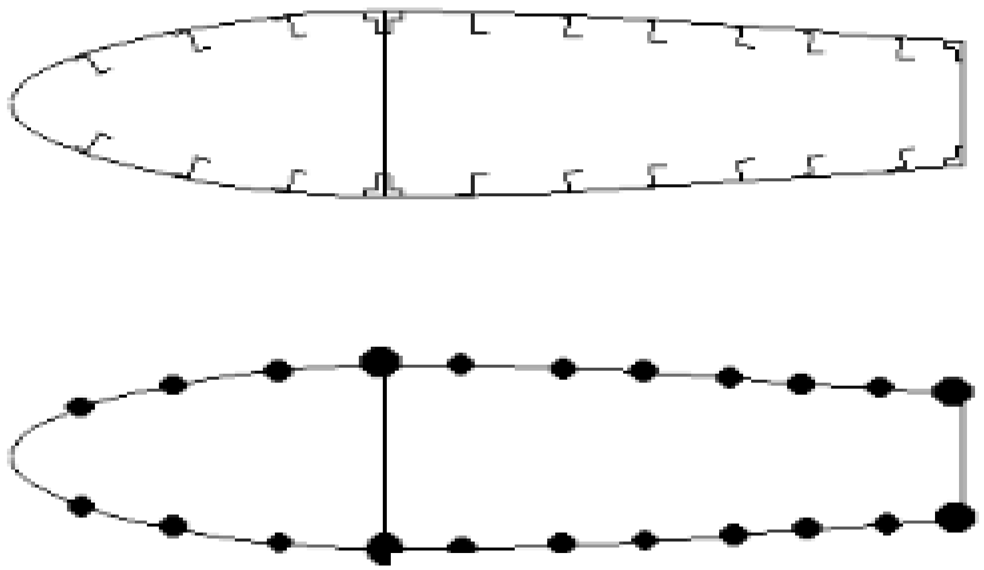
DEPARTMENT OF AEROSPACE ENGINEERING

23AST205 Aerospace Structures

BUCKLING – CRIPPLING STRESS ESTIMATION

STRUCTURAL IDEALISATION

1) The longitudinal stiffeners and spar flanges carry only axial stresses
2) The web, skin and spars webs carry only shear stresses
3) The axial stress is constant over the cross section of each longitudinal stiffener
4) The shearing stress is uniform through the thickness of the webs
5) Transverse frames and ribs are rigid within their own planes and have no rigidity normal to their plane.

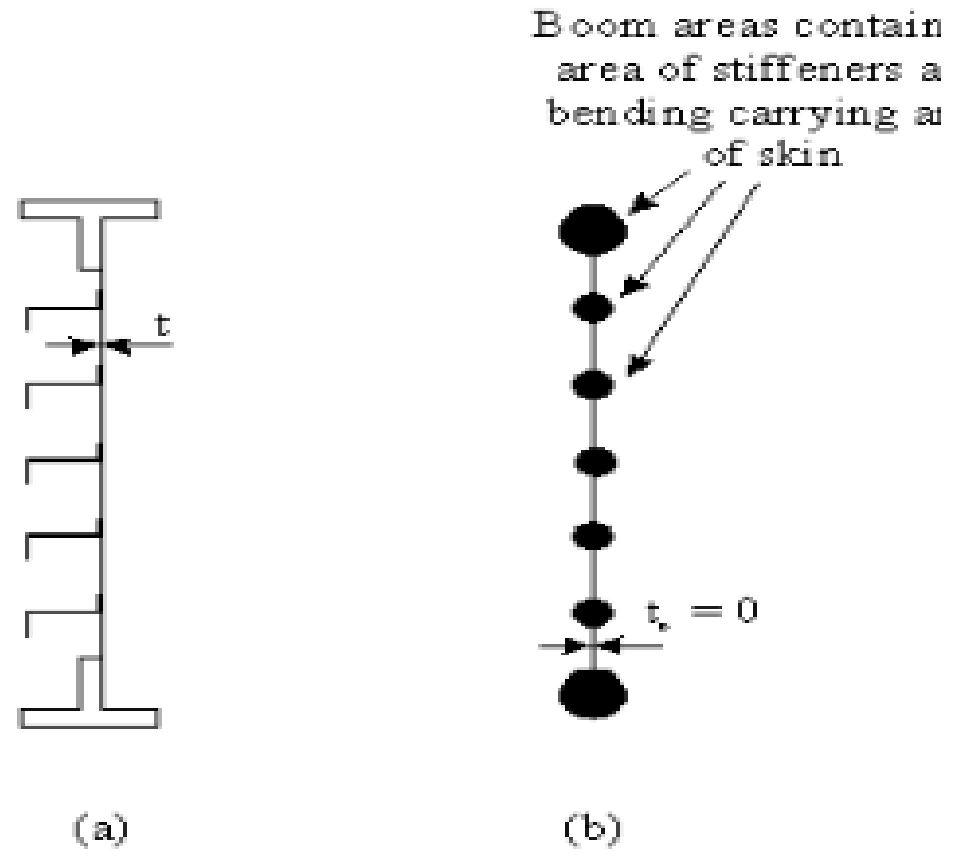


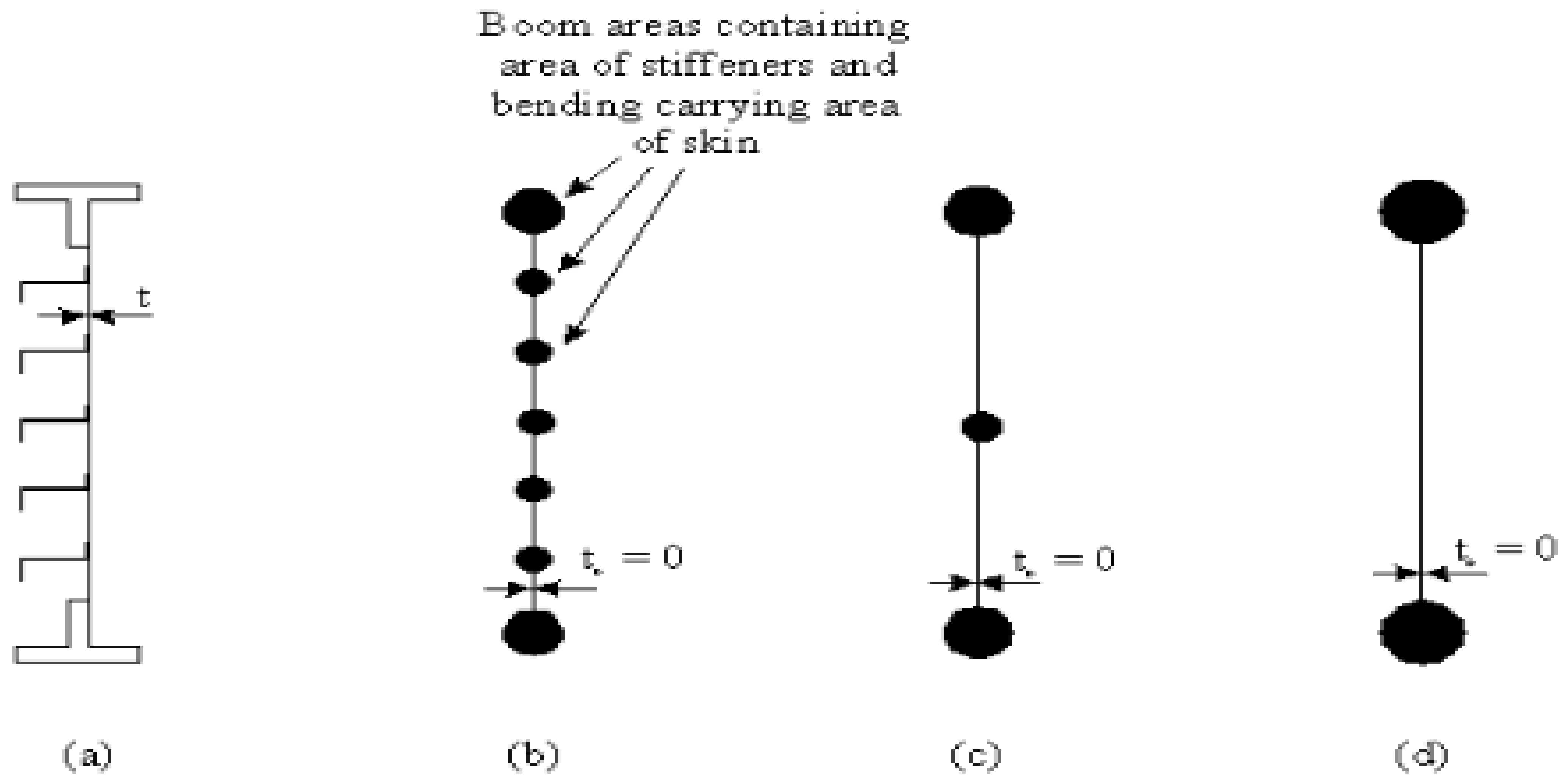
Original and Idealised wing sections

•The stiffeners are represented by circles called booms, which have a concentrated mass in the plane of the skin.

•The direct stresses are calculated at the centroid of these booms and are assumed to have constant stress through their cross-section.

•Shear stresses are assumed uniform through the thickness of the skins and webs.

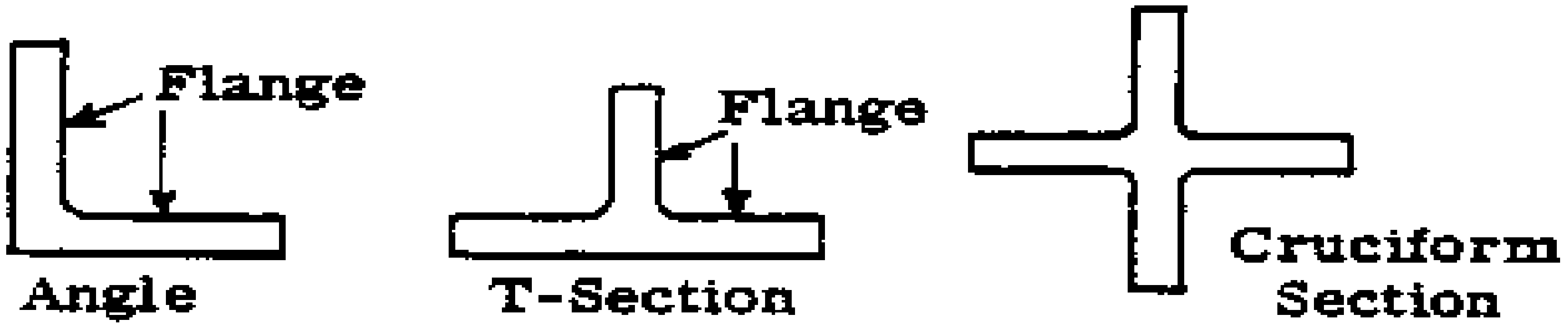


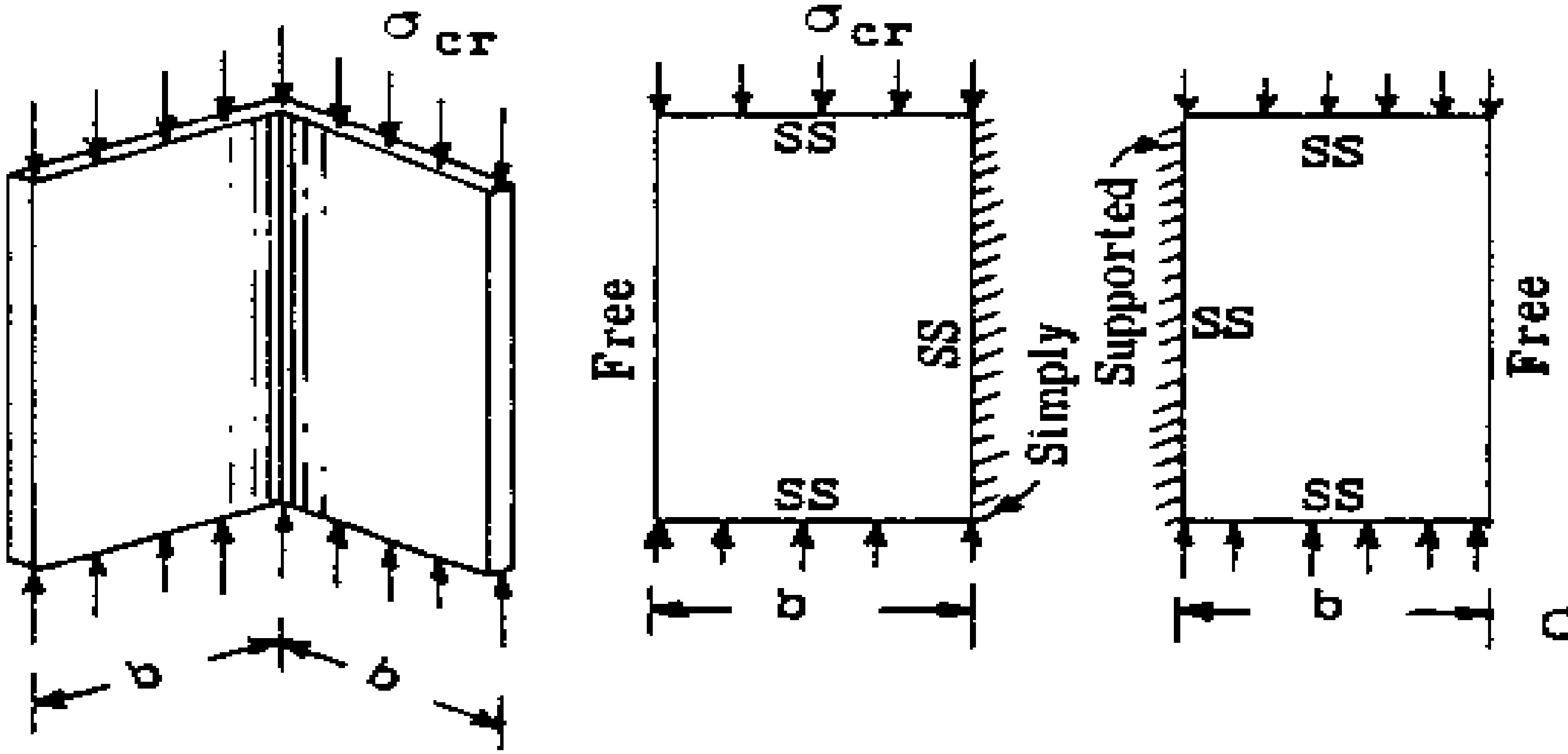


a) Actual panel,b) Idealised panel with same number of stiffeners and booms,c) Idealised panel with reduced boom number,d) Further Idealised panel with all stiffener and bending carrying areas lumped into two booms

Crippling stress

- Compressive buckling stress for equal length angle section



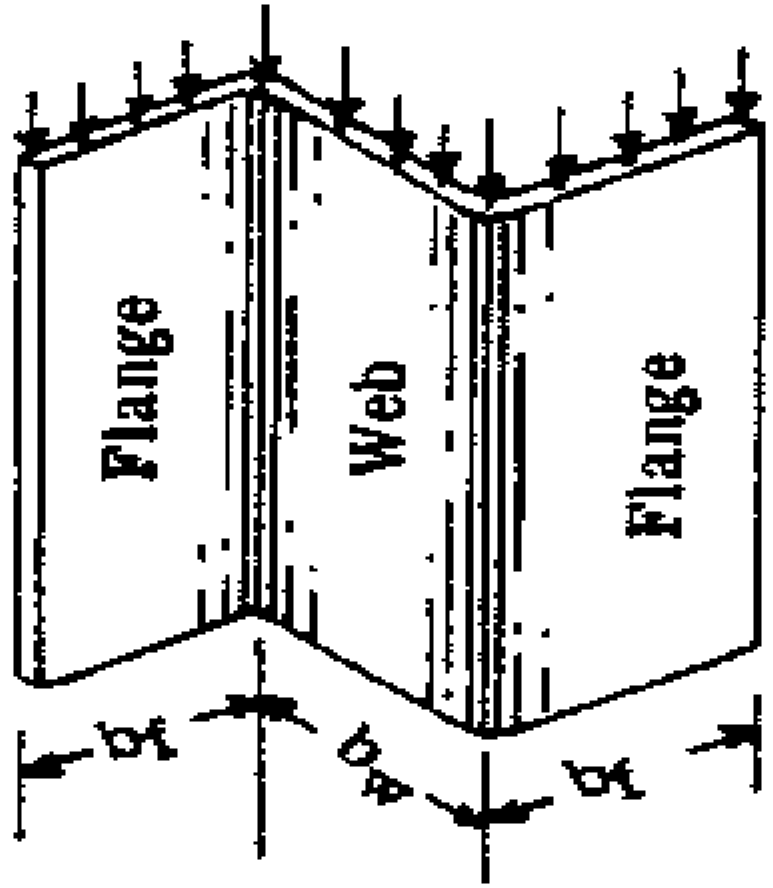


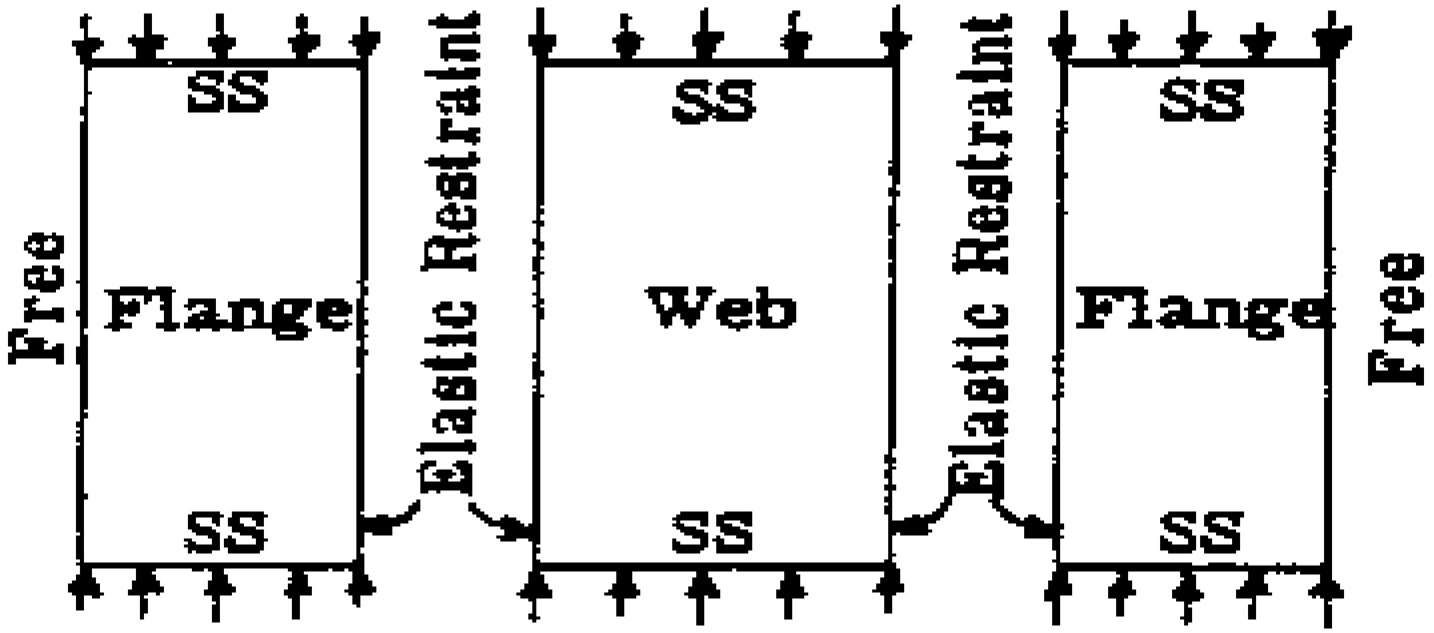
$$\sigma_{cr} = \frac{\pi^2 k_c E}{12(1-\nu_e^2)} \left(\frac{t}{b}\right)^2$$

$$k_c = .43,$$

$$\sigma_{cr} = \frac{0.43\,\pi^2 E}{12(1-0.3^2)} \left(\frac{t}{b}\right)^2 = 0.388\, E\left(\frac{t}{b}\right)^2$$

Compressive buckling stress for simple flange web Elements

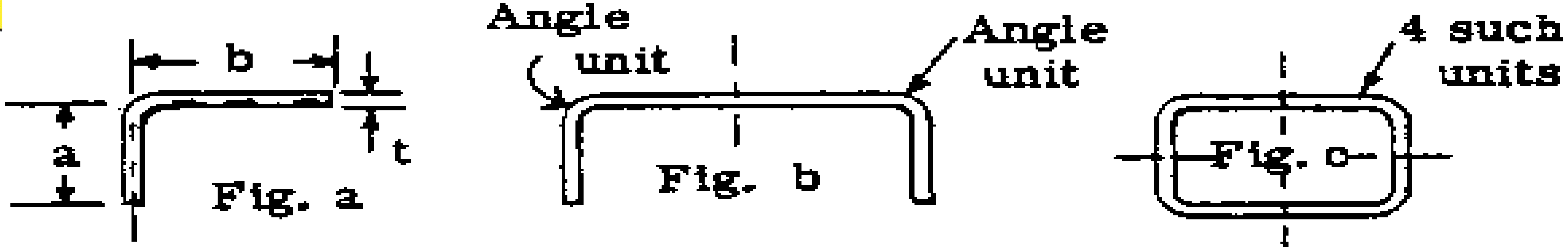




Breakdown of Z into Flange and Web Elements.

$$\sigma_{cr} = \frac{\pi^2 k_c E}{12(1-\nu_e^2)} \left(\frac{t}{b}\right)^2$$

The Needham's method



Basic Angle Unit. Two edges free.

Basic Angle Unit. One edge free.

Basic Angle Unit. No edge free.

$$F_{cs}/F_{cy}E = C_e/\left(\frac{b'}{t}\right)^{0.75}$$

F_{cs} = crippling stress (psi)

F_{cy} = compression yield stress (psi)

E = Young's modulus of elasticity in compression (psi)

b'/t = equivalent b/t of section = $(a + b)/2t$

C_e = coefficient that depends on the degree of edge support along the edges of contiguous angle units. Specifically they are:-

C_e = 0.316 (two edges free)

C_e = 0.342 (one edge free)

C_e = 0.366 (no edge free)

The Gerard method

distorted unloaded edges

$$F_{cs}/F_{cy} = 0.56 \left[(gt^2/A)(E/F_{cy})^{1/2}\right]^{0.85}$$

straight unloaded edges

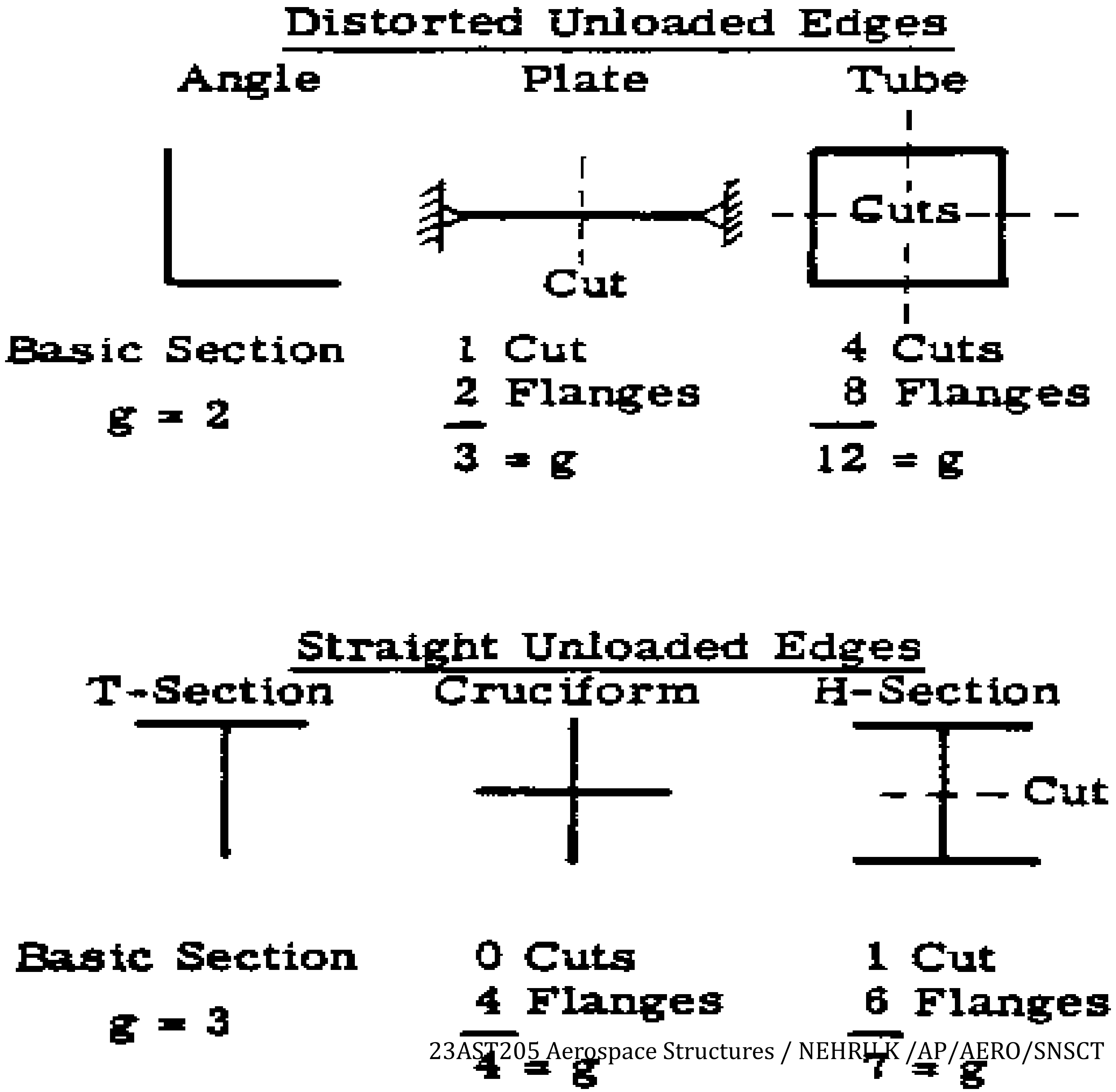
$$F_{cs}/F_{cy} = 0.67 \left[(gt^2/A)(E/F_{cy})^{1/2}\right]^{0.40}$$

2 corner sections

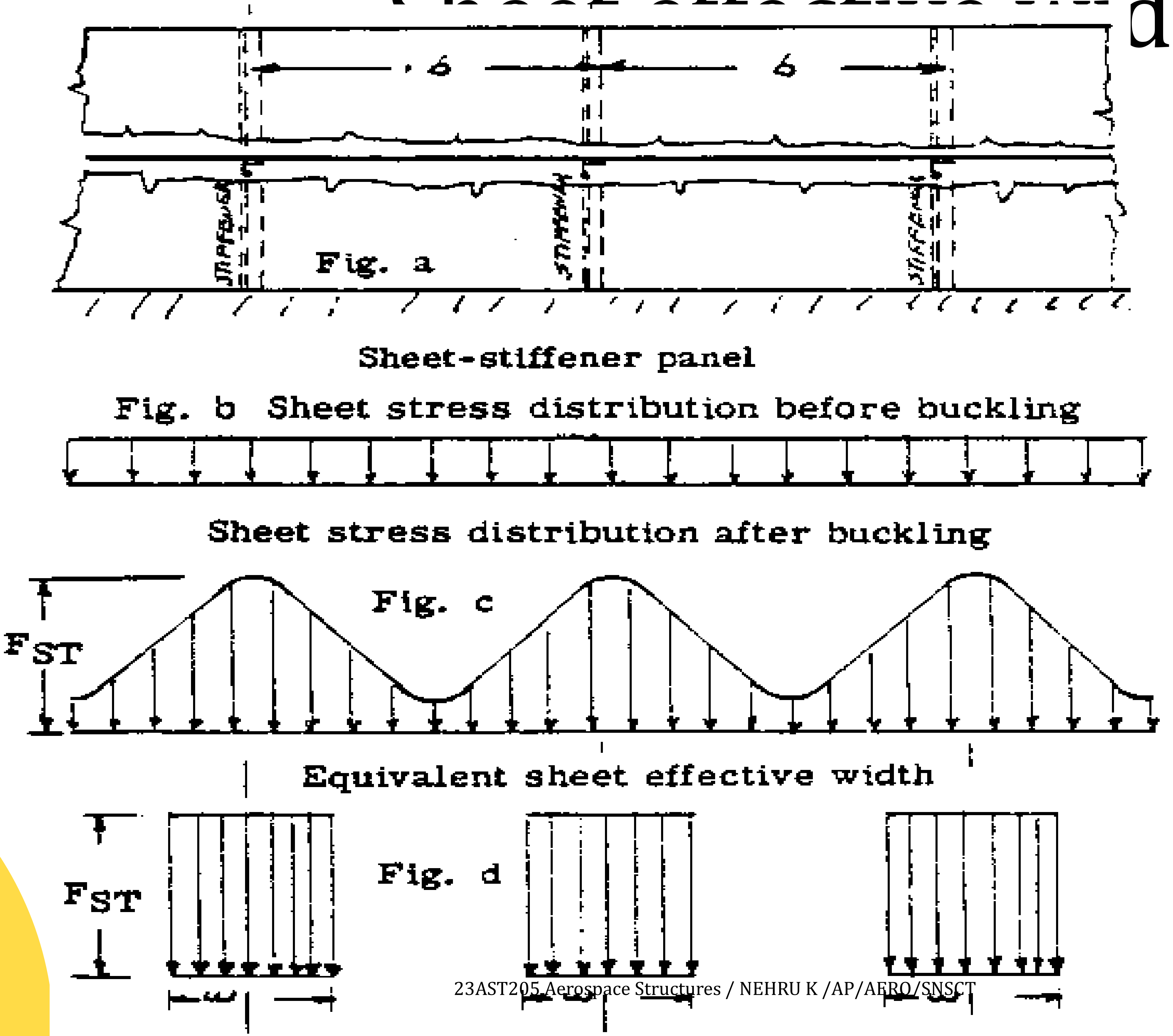
$$F_{cs}/F_{cy} = 3.2 \left[(t^2/A)(E/F_{cy})^{1/3}\right]^{0.75}$$

F_{cs} = crippling stress for section (psi)
F_{cy} = compressive yield stress (psi)
t = element thickness (inches)
A = section area (in.^{2})
E = Young's modulus of elasticity
g = number of flanges which compose the composite section, plus the number of cuts necessary to divide the section into a series of flanges. See Fig. C7.6 for method of cutting composite sections to determine value of g.

Determination of g



Sheet effective width



S.NO	QUESTION	ANSWER
1	Gerard method	
2	Crippling stress	
3	Needham’s method