Corrections for:

Practical Analysis or Aircraft Composites

February 10, 2023

Each item is classified by the **PRIORITY-ITEM NUMER**, where:

PRIORITY

H = High

M = Medium

L = Low

For example, a heading of **M-1** is the first correction that has a **Medium** priority.

The highest priority items are listed first. This document contains **corrections**. A companion document contains clarifications and updates.

*NOTE: Only technical issues are considered. Grammar is not considered.

M-1 CORRECTION **Priority: Medium** **Date Added: October 1, 2018**

p. 666, 667, 668, Section F.6

The "b" and "t" variables are defined in an inconsistent (and incorrect) manner with the rest of the book. The entire section (Section F.6) is updated as follows:

F.6 UNSYMMETRIC CROSS SECTIONS (CATEGORY 3)

Sections F.4 and F.5 consider the case where the overall cross section is symmetric. A Category 3 cross section may have an overall asymmetry about the horizonal axis (I, Tee, Pi, other), but must be symmetric about the vertical axis. An example is the case of an I-beam with one flange wider/thicker than the other (See also Appendix G—Example G.F.3). If the individual elements are unsymmetric laminates, the effective properties (E_x and E_{xb}) must be used (Equations F.6, F.8, and F.10). E_x and E_{xb} are determined in Section F.5.

F.6.1 **Axial Stiffness.** Figure F.3 demonstrates the geometric parameters for a typical section. For elements that are *either* symmetric or unsymmetric laminates, the general axial stiffness in the X-direction (in/out of page) is:

$$\overline{EA}_X = \sum_{i=1}^{n} \left(E_x A\right)_i = \left(E_x\right)_1 b_1 t_1 + \left(E_x\right)_2 b_2 t_2 + \left(E_x\right)_3 b_3 t_3 + \ \dots \qquad \text{(F.6)}$$

$\overline{EA}_X$ = axial stiffness of cross section, x-direction

E_x = effective axial modulus of individual element, x-direction (See Section F.5)

A = area of an individual element

b = base of an individual element (See Figure F.3)

t = thickness of an individual element

n = number of elements

Provided all the elements are *symmetric* laminates, the axial stiffness can also be expressed in terms of the laminate's $[a]$ matrix property, a_{11}. For n elements:

$$\overline{EA}_X = \sum_{i=1}^{n} \left(\frac{b}{a_{11}} \right)_i = \frac{b_1}{(a_{11})_1} + \frac{b_2}{(a_{11})_2} + \frac{b_3}{(a_{11})_3} + \ldots \qquad \text{(F.7)}$$

F.6.2 **Neutral Axis.** The neutral axis for a cross section that is symmetric about the vertical axis is determined as follows. The neutral axis, as defined in Figure F.3, must be determined before the bending stiffness properties can be calculated. For elements that are *either* symmetric or unsymmetric laminates, and using effective properties as defined in Section F.5, the neutral axis is defined as follows. ω is the distance from the reference plane to the midpoint of each element.

$$\bar{\omega} = \frac{\sum_{i=1}^{n} (E_x A \cdot \omega)_i}{\sum_{i=1}^{n} (E_x A)_i} \qquad \text{(F.8)}$$

If the elements are *symmetric* laminates, the following alternate expression can be used:

$$\bar{\omega} = \frac{\sum_{i=1}^{n} \left(\frac{b}{a_{11}} \omega \right)_i}{\sum_{i=1}^{n} \left(\frac{b}{a_{11}} \right)_i} \qquad \text{(F.9)}$$

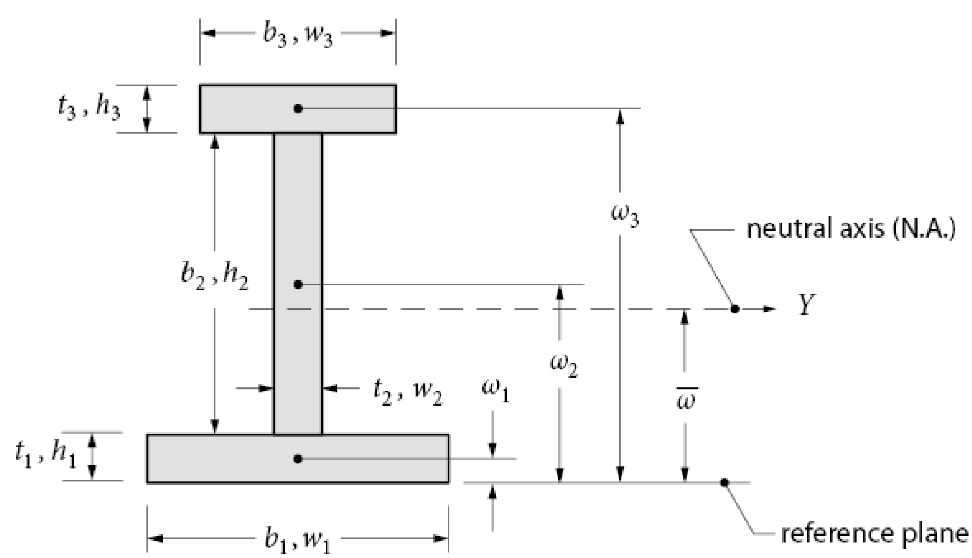


Figure F.3 Geometric properties and location of neutral axis for a general section.

F.6.3 **Bending Stiffness (Flexural Rigidity).** The cross section's bending stiffness (flexural rigidity) can be determined by summing the bending stiffness of each i element about the cross section's neutral axis, as follows; the parallel axis theorem is used. This solution is appropriate for elements that are *either* symmetric or unsymmetric laminates (effective properties as defined in Section F.5).

$$\overline{EI}_{YY} = \sum_{i=1}^{n} \left[(E_x)\, A\, \Delta^2 + \frac{(E')wh^3}{12} \right]_i \tag{F.10}$$

$\overline{EI}_{YY}$ = bending stiffness of cross section, bending about the Y-axis

E_x = effective axial modulus of individual element, x-direction (See Section F.5)

E' = E_{xb} (in the element's local system) for *horizontal* elements and E_x for *vertical* elements (See Section F.5)

Δ = distance from the neutral axis to the midpoint of each element (See Figure F.4)

w = width of each element (See Figure F.3)

h = height of each element (See Figure F.3)

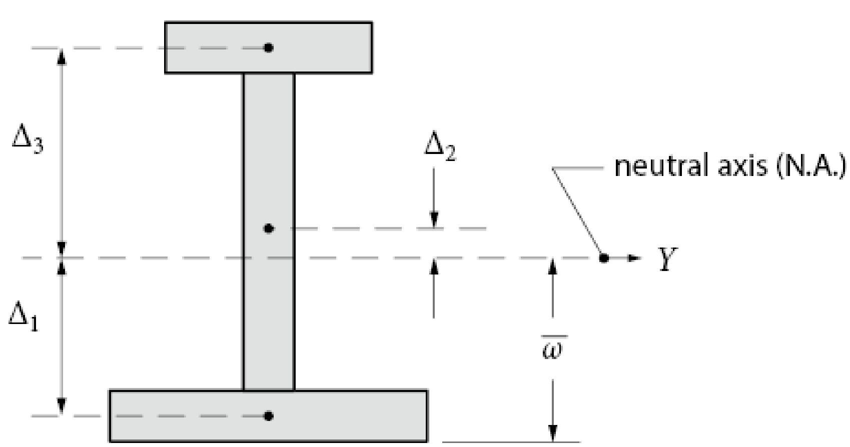


Figure F.4 Distance from neutral axis to the midpoint of each element.

M-2 CORRECTION   Priority: Medium   Date Added: October 1, 2018

p. 684 (Equation G.12) and p. 687 (Equation G.18)

The ply percentages for the 45° and 90° directions are incorrect

Current:

$$
\begin{aligned}
0^\circ \text{ direction} &= (33/44/22)\% \\
45^\circ \text{ direction} &= (25/56/22)\% \\
90^\circ \text{ direction} &= (22/44/44)\% \\
-45^\circ \text{ direction} &= (22/56/22)\%
\end{aligned}
$$

Correction:

$$
\begin{aligned}
0^\circ \text{ direction} &= (33/44/22)\% \\
45^\circ \text{ direction} &= (22/56/22)\% \\
90^\circ \text{ direction} &= (22/44/33)\% \\
-45^\circ \text{ direction} &= (22/56/22)\%
\end{aligned}
$$

M-3 CORRECTION Priority: Medium Date Added: February 10, 2023

p. 180 (**Section 9.10.2: Truncated Max Strain Criterion (TMS)—Laminate Based**) and (Eqn 9.10)

Current: ν_{LT} is stated to be the Poisson's ratio of the *laminate* in the long transverse direction.

Correction: ν_{LT} should be Poisson's ratio of a *unidirectional ply* as per: Hart-Smith, L.J., "The First Fair Dinkum Macro-Level Fibrous Composite Failure Criteria," Proceedings of ICCM–11, Gold Coast, Australia, 14th-18th, July, 1997. More specifically, per Steve Ward, per CMH-17, V3, Ch8, 8.6.2.2, ν_{LT} is believed to be the Poisson's ratio of a ply for a unidirectional carbon fiber polymer composite (not for a fabric ply and not for a laminate).

NOTE: The Poisson's ratio of a *unidirectional carbon fiber ply* is about 0.30. The Poisson's ratio of quasi-isotropic *laminate* is about 0.30. A bias in a laminate will change its Poisson's ratio, but many well-designed laminates have a Poisson's ratio that is not dramatically different than that of 0.3.

NOTE: This item appears in both the "Corrections" and "Clarifications" documents.

M-4 CORRECTION Priority: Medium Date Added: February 10, 2023

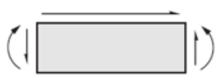
p. 413 (Table 17.6)

The two equations (center and bottom) are incorrect and need to be switched.

Current:

Table 17.6 Interaction equations for a plate with all edges simply supported.[6]

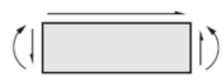
$$R_c = \frac{N_x}{N_x^{cr}} \qquad R_s = \frac{N_{xy}}{N_{xy}^{cr}} \qquad R_b = \frac{M}{M^{cr}}$$

Loading Condition	Interaction Equation (all edges simply supported)
	$R_c + R_s^2 = 1$
	$R_c + R_b^{1.76} = 1$
	$R_s^2 + R_b^2 = 1$

Correction:

Table 17.6 Interaction equations for a plate with all edges simply supported.[6]

$$R_c = \frac{N_x}{N_x^{cr}} \qquad R_s = \frac{N_{xy}}{N_{xy}^{cr}} \qquad R_b = \frac{M}{M^{cr}}$$

Loading Condition	Interaction Equation (all edges simply supported)
	$R_c + R_s^2 = 1$
	$R_s^2 + R_b^2 = 1$
	$R_c + R_b^{1.76} = 1$

L-1 CORRECTION Priority: Low Date Added: October 1, 2018

p. 683 (Equation G.10) and p. 687 (Equation G.18)

The numerical value is incorrect

Current:

6,249

Correction:

6,149

L-2 CORRECTION Priority: Low Date Added: October 1, 2018

p. 344, last line

The Section reference is incorrect

Current:

See Section 13.1.1

Correction:

See Section 13.11.1

L-3 CORRECTION Priority: Low Date Added: October 1, 2018

p. 361, first paragraph

The metric conversion is incorrect

Current:

0.25 inch (6.25 mm)

Correction:

0.25 inch (6.35 mm)

L-4 CORRECTION   Priority: Low   Date Added: February 1, 2019

p. 332, Equation 13.1, added the work term to the equation for G

Current:

$$G = -\frac{dU}{dA} \tag{13.1}$$

G = strain energy release rate

U = elastic strain energy stored in a crack member

A = crack area

Correction:

$$G = \frac{dW}{dA} - \frac{dU}{dA} \tag{13.1}$$

G = strain energy release rate

W = work associated with external forces

U = potential strain energy available for crack growth

A = crack area

L-5 CORRECTION **Priority: Low** **Date Added: August 25, 2020**

p. 677, Table G.2

All values for “E_x (Option 2)” should be 8.66 Msi

Current

E_x (Option 2)
8.66 Msi
8.66 Msi
8.66 Msi
8.86 Msi
8.86 Msi

Correction

E_x (Option 2)
8.66 Msi
8.66 Msi
8.66 Msi
8.66 Msi
8.66 Msi

L-6 CORRECTION **Priority: Low** **Date Added: August 25, 2020**

p. 114

The correct note and the end of the paragraph is “(note that $a_{12}=a_{21}$):”

Current

5.2.4 Effective In-Plane Elastic Constants—Symmetric Laminates. For a general symmetric laminate, the effective in-plane elastic constants are determined in a straightforward manner because $[B]=0$ and $[A]^{-1}=[a]$. The effective in-plane elastic constants (quasi-isotropic, orthotropic, or anisotropic laminates) are determined via Equation 5.5 and are as follows (note that $a_{12}=a_{22}$):

Correction

5.2.4 Effective In-Plane Elastic Constants—Symmetric Laminates. For a general symmetric laminate, the effective in-plane elastic constants are determined in a straightforward manner because $[B]=0$ and $[A]^{-1}=[a]$. The effective in-plane elastic constants (quasi-isotropic, orthotropic, or anisotropic laminates) are determined via Equation 5.5 and are as follows (note that $a_{12}=\boxed{a_{21}}$):

L-7 CORRECTION Priority: Low Date Added: August 25, 2020

p. 97

Equation 4.24 should read $[A]^{-1}=[a]$ and $[D]^{-1}=[d]$.

The corrected result is the same as Eqn. 4.15.

Current

$$[A]^{-1} = [a]^{-1}$$
$$[D]^{-1} = [d]^{-1} \tag{4.24}$$

Correction

$$[A]^{-1} = [a]$$
$$[D]^{-1} = [d] \tag{4.24}$$