Airframe Design and Construction

Sheet effectiveness and inter-rivet buckling

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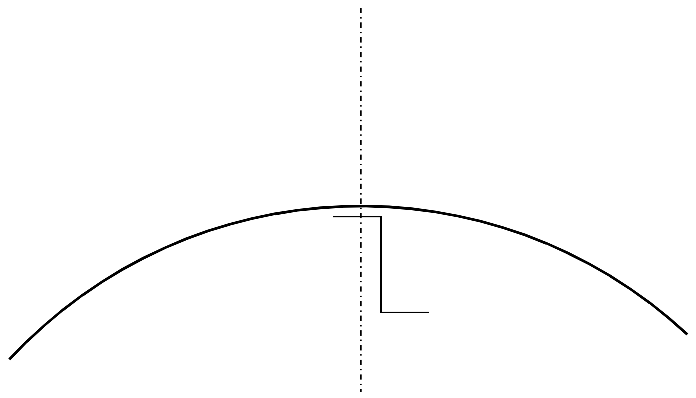
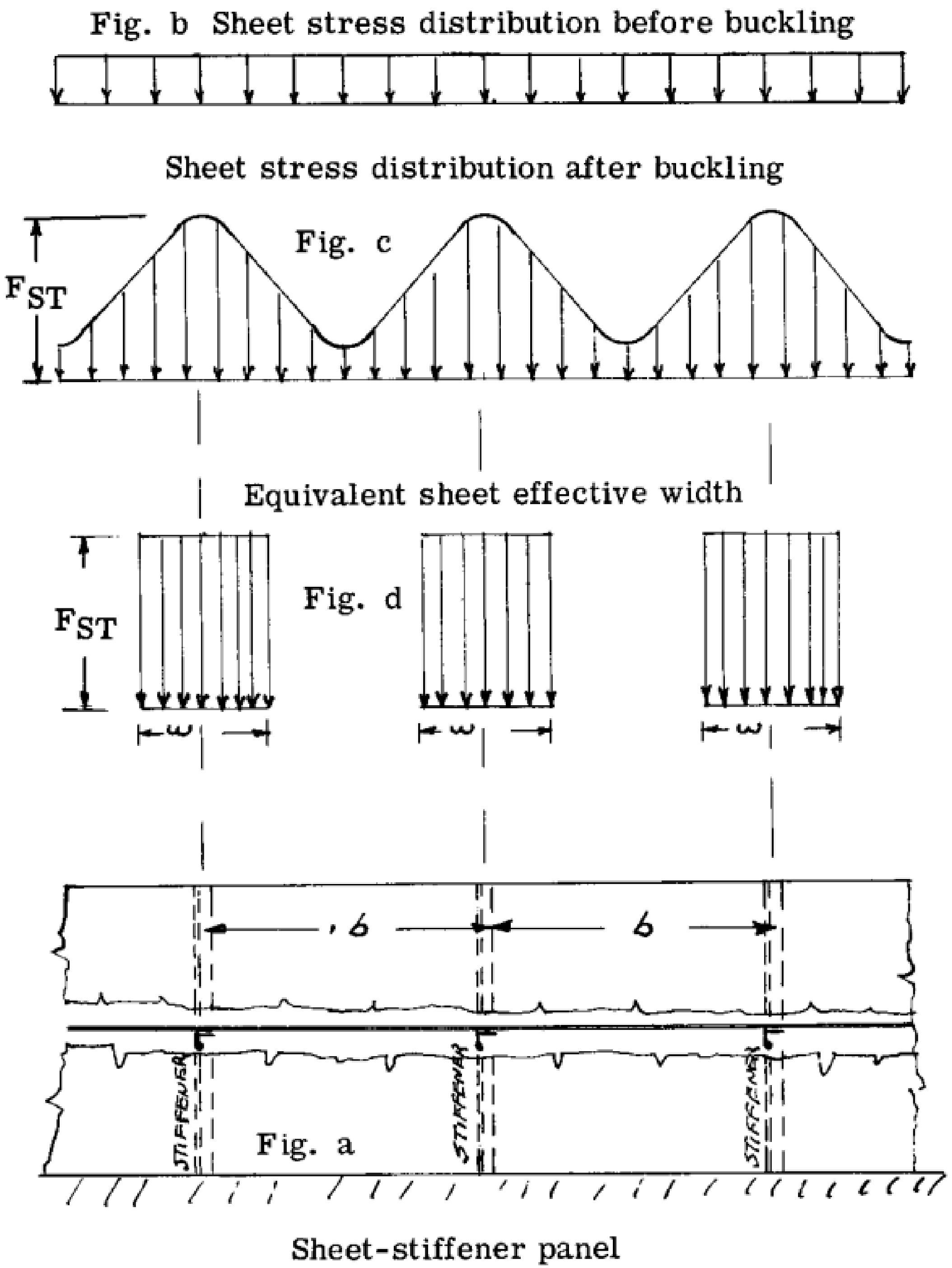
Effective sheet width

- In aerospace structures, Wing and fuselage skins are stiffened by stringers.
- The stringers are usually connected to skins using rivets.
- Therefore the skins add stiffness to the stringers even in buckling.
- This effect can be represented using what we call *Effective Width*.



Effective sheet width

- ➢Before skin buckling both the skin and stringers carry the same compressive loads as in Fig. a.
- ➢As the load increase, the skin buckles and cannot carries more than the buckling load, as in Fig. c.
- ➢But at the skin-stinger connection, the skin stiffened by the stringers that help carry higher loads.



Effective sheet width

- Assume skins are simply supported to the stringers, then the effective width takes the form,

$$w = 1.90t\sqrt{E/F_{ST}}$$

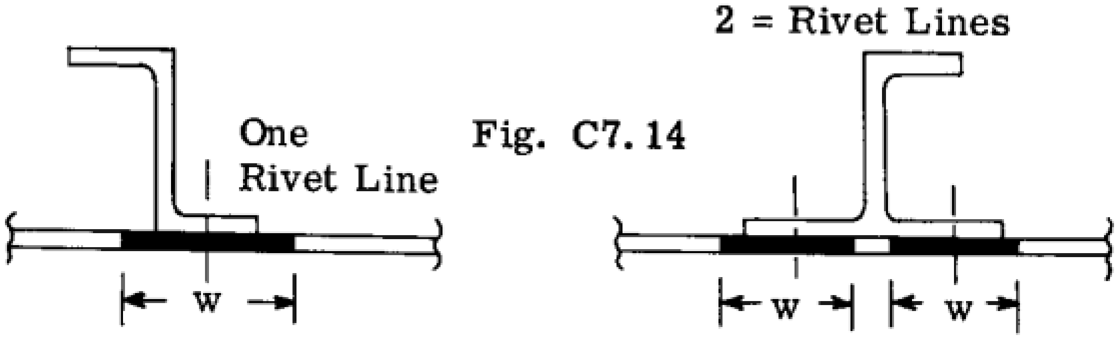


Fig. C7.14

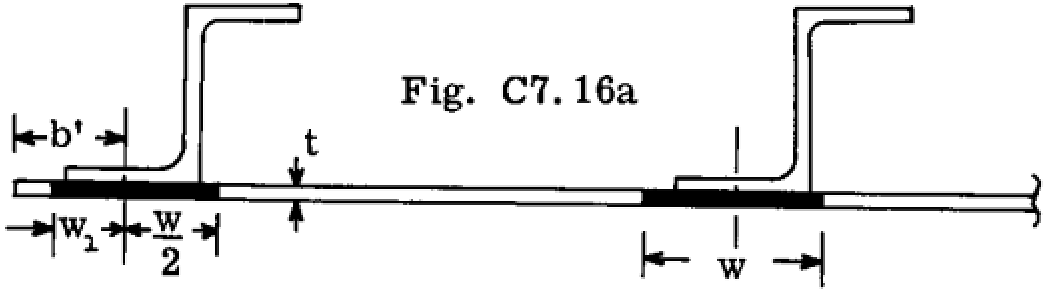
- For light stringers the factor 1.9 is replaced by 1.7.
- If a clamped connection is assumed between skins and stringers

$$w = 2.52t\sqrt{E/F_{ST}}$$

Effective sheet width

- When calculating the effective sheet at the end of the skin (free skin edge), we use the equation

$$w_1 = .62t\sqrt{E/F_{ST}}$$

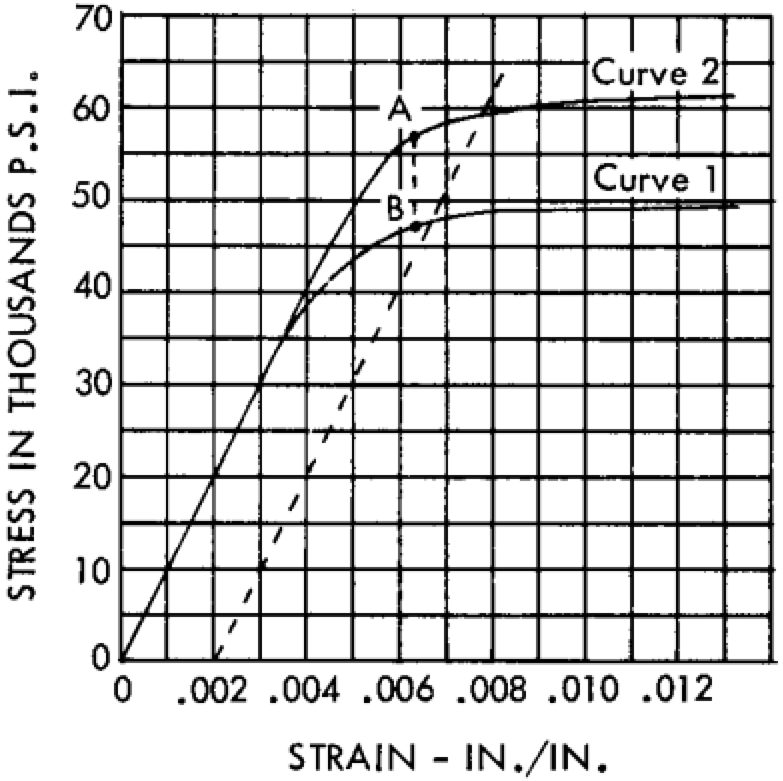


- Then, the total effective width for this particular stringer takes the form

$$w_1 + w/2$$

Effective sheet width

- If the stringers and skins have different material properties. We multiply the effective width equation by a correction factor $\frac{F_{sh}}{F_{st}}$.



$$w = 1.90t(F_{SH}/F_{ST})\left(\sqrt{\frac{E}{F_{ST}}}\right)$$

Notice that the symbol *F* used by Bruhn refers to stress which we usually refers to it by the symbol sigma σ

Inter-Rivet Buckling

Inter-Rivet Buckling

- If the distance between the skin rivets are too long, this can leads to inter-rivet buckling.

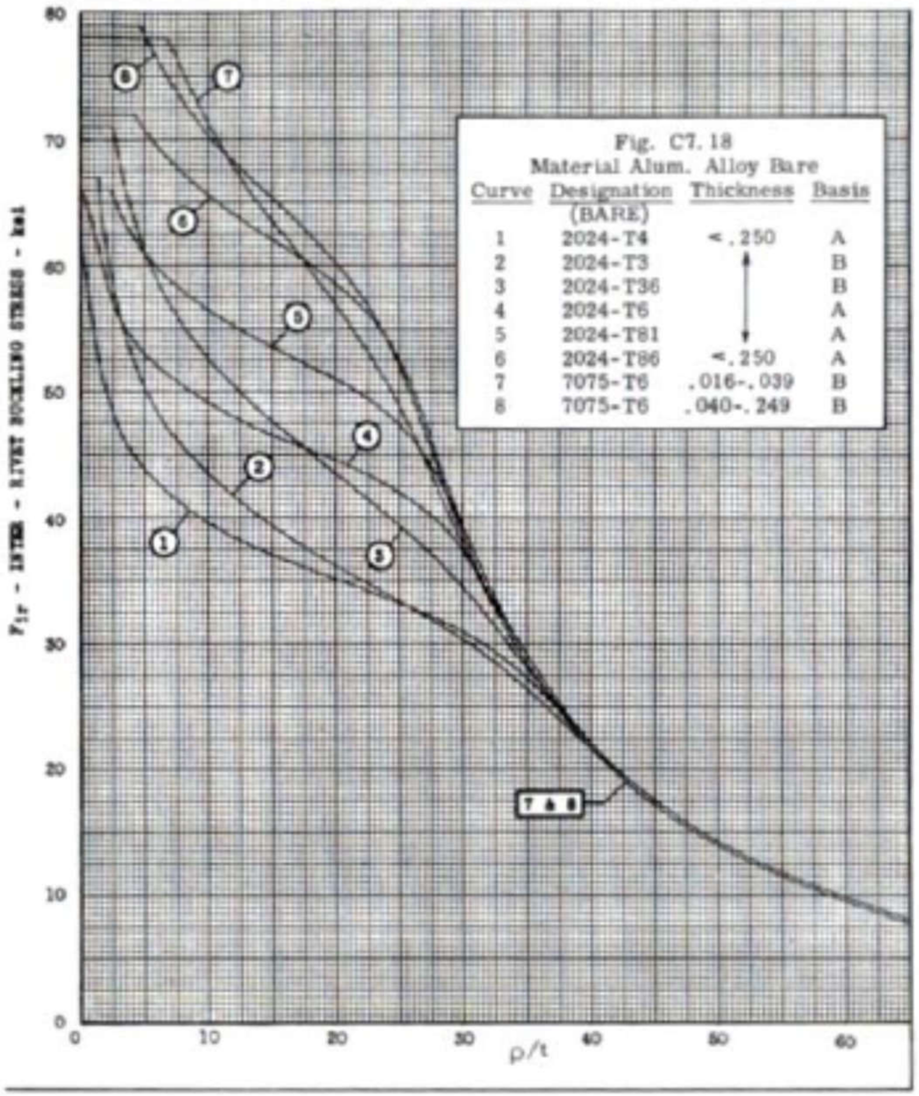
- Therefore, the rivet spacing is designed such that to prevent the inter-rivet buckling.

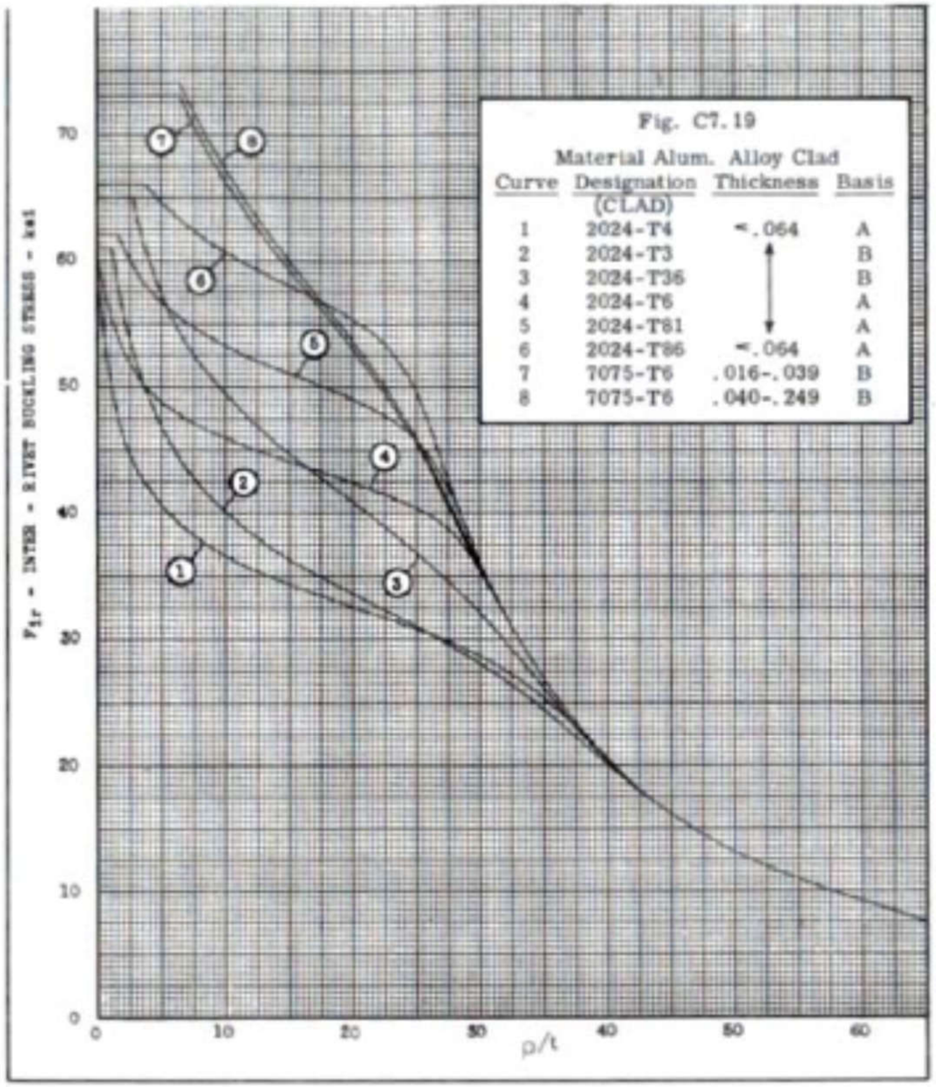
- To do so, we assume the sheets between rivets act as a column with restrained ends.

Inter-rivet buckling of sheets under compression

p is the rivet spacing

These charts are for clamped end conditions, i.e. flat-head rivets





Inter-rivet buckling of sheets under compression

For other end conditions we use equivalent rivet spacing

$$\frac{P}{t}_{eq} = \frac{P}{t}_{act} \sqrt{\frac{4}{C}}$$

where

C: rivets fixity coefficient

P: rivet spacing

And get Fir form figure C7.14

The rivets fixity coefficient	
For flat head	4
For spot welds	3.5
Brazier	3
counter-sunk	1

Inter-rivet buckling correction

- If $F_{ir} > F_{st}$ then no inter-rivet correction and

$$A_{eff} = wt + A_{st}$$

- If $F_{ir} < F_{st}$ then

$$w_{cor} = w\frac{F_{ir}}{F_{cs}} \;,\; A_{eff} = w_{cor}t + A_{st}$$