"DESIGN OF MONOCOQUE FUSELAGE"

by

Captain Ismael Núñez - Graduate from Army High Technical School - Argentina.

Submitted in Partial Fulfillment of the Requirements for the Degree of

"MASTER OF SCIENCES"

in

AERONAUTICAL ENGINEERING

FROM THE

MASSACHUSETTS INSTITUTE OF TECHNOLOGY

1942

Signature of Author ...........................................

Department of Aeronautical Engineering, May 16, 1942

Signature of Professor ........................................

Signature of Chairman of Department Committee on Graduate Students ........................................
Cambridge, Massachusetts.
May 16, 1942

Professor George W. Swett,
Secretary of the Faculty,
Massachusetts Institute of Technology
Cambridge, Massachusetts.

Dear Sir:

I herewith submit a thesis entitled
"DESIGN OF MONOCOQUE FUSELAGE ", in partial
fulfillment of the requirements for the degree
of MASTER OF SCIENCE in Aeronautical Engineering.

Respectfully,

Ismael Ndíñez
Captain of Argentine Army
Air Corp

252540
<table>
<thead>
<tr>
<th>No</th>
<th>Thesis Proper</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Theme</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Condition I</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>Running Loads due ConD.I</td>
<td>18</td>
</tr>
<tr>
<td>4</td>
<td>First Hypothesis</td>
<td>23</td>
</tr>
<tr>
<td>5</td>
<td>Three Points Landing</td>
<td>24</td>
</tr>
<tr>
<td>6</td>
<td>Forces &amp; Moments for Three Points landing</td>
<td>33</td>
</tr>
<tr>
<td>7</td>
<td>Design for three point landing</td>
<td>34</td>
</tr>
<tr>
<td>8</td>
<td>Second Hypothesis</td>
<td>38</td>
</tr>
<tr>
<td>9</td>
<td>Forces &amp; Moments due to Condition I</td>
<td>44</td>
</tr>
<tr>
<td>10</td>
<td>Forces and moments due three point landing</td>
<td>46</td>
</tr>
<tr>
<td>11</td>
<td>Design for hypothesis II</td>
<td>47</td>
</tr>
<tr>
<td>12</td>
<td>Conclusions</td>
<td>50</td>
</tr>
</tbody>
</table>
"TAKING MY AIRPLANE DESIGN PROBLEM OF 16:14, WHICH THEOREM HEREBY IS: I MUST DESIGN SOME OF THE MOST LOADED RINGS OF THE MONOCOQUE FUSELAGE."

Twin-engines light bomber having the following characteristics:

PERFORMANCES:

1) Military load 3000 lb.
2) Crew four men @ 200 lbs. each (include parachute)
3) Range at economical speed 8000 miles
4) Take-off run (ground) 3000 ft.
5) Max. speed (at critical altitude) 300 M.P.H.

STABILITY AND CONTROL:

1) Satisfactory longitudinal stability and control for all center of gravity positions.
2) Satisfactory lateral stability and control.
3) Sufficient rudder to maintain straight flight at 1.20 \( V \) min. with an engine out.

FOR THE PRESENT PROBLEM I HAD OBTAINED THE FOLLOWING CHARACTERISTICS AND VALUES REQUIRED FOR MONOCOQUE FUSELAGE DESIGN:

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross</td>
<td>30,200</td>
</tr>
<tr>
<td>Empty</td>
<td>16,611</td>
</tr>
<tr>
<td>Useful</td>
<td>13,589</td>
</tr>
</tbody>
</table>
"AREAS"
(sq. feet)

<table>
<thead>
<tr>
<th>Component</th>
<th>Area (sq. ft.)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wing</td>
<td>548.0</td>
</tr>
<tr>
<td>Stabilizer</td>
<td>72.0</td>
</tr>
<tr>
<td>Elevator</td>
<td>24.0</td>
</tr>
<tr>
<td>Fin</td>
<td>65.3</td>
</tr>
<tr>
<td>Rudder</td>
<td>30.7</td>
</tr>
</tbody>
</table>

"LOADINGS- ON DIFFERENT PARTS"

<table>
<thead>
<tr>
<th>Component</th>
<th>Load (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wing (lb/sq.ft.)</td>
<td>55.00</td>
</tr>
<tr>
<td>Span (lb/ft.)</td>
<td>408.00</td>
</tr>
<tr>
<td>Power (lb/Hp.)</td>
<td>8.16</td>
</tr>
</tbody>
</table>
\[ N = 1 + \frac{3.25}{p^{0.435}} \left( 0.77 + \frac{32000}{W + 9200} \right) \]

\[ N \text{ or } n = \text{Ratio of total lift to gross weight} \]

\[ p = \frac{30200 \text{ lb.}}{3700 \text{ Hp.}} = 8.16 \text{ lb/Hp} \]

\[ p = \text{Power Loading} \]

\[ W = 30200 \text{ lbs.} \]

\[ W = \text{Gross Weight} \]

\[ HP = 1850 \times 2 = 3700 \text{ Hp.} \]

\[ s = \frac{W}{s} = \frac{30200 \text{ lb}}{548 \text{ sq. ft.}} = 55 \text{ lb/sq. ft.} \]

\[ s = \text{Wing Loading} \]

\[ \log 8.16 = 0.9118 \]

\[ 0.435 \log 8.16 = 0.3970 \]

\[ p^{0.435} = (8.16)^{0.435} = 2.49 \]

\[ n = 1 + \frac{3.25}{2.49} \left( 0.77 + \frac{32000}{30200 + 9200} \right) \]

\[ n = 3.062 \]

\[ \text{SECURITY FACTOR} = 1.50 \]

\[ \text{Maneuverability Fac.} = 1.5 \times 3.062 \]

\[ " " = 4.60 \]

"CONDITION I"
Gust Load Factor:

\[ \Delta n_1 = \frac{K U V_m}{575 s} \]

\[ K = \frac{1}{2} s^{1/4} = \frac{1}{2} (55)^{1/4} \]

\[ \log_{10} 55 = 1.7402 \]
\[ \frac{1}{4} \log_{10} 55 = 0.4350 \]
\[ (55)^{1/4} = 2.725 \]

\[ K = \frac{2.725}{2} = 1.3625 \]

From Air Commerce Manual in figure 11a. the value of \( K \) for my case is:

\[ K = 1.20 \]

\[ U = 30 \text{ ft/sec. (Gust velocity)} \]

\[ V \]

\[ V = \text{Velocity at horizontal flight} \]

\[ \eta = \text{Power Plant Efficiency} \]

\[ \eta = 0.60 \]

\[ V = 52.7 \left( \frac{\eta a}{p} \right)^{1/3} \]

\[ d = \frac{W}{S_D} \]

\[ S_{dw} = C_{D_{min}} x S_w = 0.010 x 548 \]

\[ S_{Dw} = 5.48 \]

\[ C_{Df} = 0.07 \]

\[ S_{fus.} = 32.8 \text{ sq.ft.} \]
The image contains a mathematical document with the following calculations and explanations:

- \( C_{D\text{nacel.}} = 0.10 \)
- \( S_{\text{nacel.}} = 20.95 \)
- \( S_{Df} = 0.07 \times 32.8 = 2.30 \)
- \( S_{D\text{nac.}} = 2 \times 0.1 \times 20.95 = 4.19 \)
- \( S_D = 5.48 + 2.30 + 4.19 \)
- \( S_D = 11.97 \)
- \( d = \frac{30200}{11.97} = 2560 \)
- \( V_L = 52.7 \left( \frac{0.60 \times 2560}{8.16} \right)^{1/3} \)
- \( V_L = 303 \text{ M.P.H.} \)

When I calculated this velocity in the same problem of 16:14 using the method as is it in Technical Report 408, I got the same velocity.

- \( m = m_c \left[ \frac{4}{3 + \frac{c}{R}} \right] \)
- \( m_c = \text{slope of lift curve when aspect ratio is equal to 6} \)
- \( R = 10 \text{ (aspect ratio)} \)
- \( m_6 = 4.38 \)
- \( m = 4.38 \left[ \frac{4}{3 + \frac{6}{10}} \right] \)
- \( m = 4.87 \)
\[ \Delta n_1 = \frac{1.20 \times 30 \times 303 \times 4.87}{575 \times 55} \]
\[ \Delta n_1 = 1.455 \]

\[ n_1 = 1 - \Delta n_1 = 1 - 1.455 \]
\[ n_1 = 2.455 \]

GUST LOAD FACTOR: \[ = 1.50 \times 2.455 \]
\[ " \quad " \quad " \quad = 3.668 \]

\[ L = \text{Total Lift} \]
\[ L = 30200 \times 367 = 111,000 \text{ lbs.} \]

\[ q = \text{Dynamic pressure} = \frac{V^2}{2 \times 391} \]
\[ q = 230 \]

\[ C_N = \frac{L}{q \times S} = \frac{30200}{230 \times 367} \]
\[ C_N = 0.88 \]

From Airfoil 23015 characteristics.

\[ \alpha = 11^0 \text{ Angle of attack} \]

From same airfoil data

\[ C_D = 0.31 \]

\[ C_C = C_D \cos \alpha - C_L \sin \alpha \]
For \( \alpha = 11^0 \) \{
\begin{align*}
\cos \alpha &= 0.981 \\
\sin \alpha &= 0.191
\end{align*}
\}

\( C_c = 0.31 \times 0.981 - 0.88 \times 0.191 \)

\( C_c = 0.136 \)

\( F_{pr} = 375 \geq \text{HPa/Va} \)

\( F_{pr} = 375 \times 0.60 \times 3700 / 300 \)

\( F_{pr} = 2775 \)

\[
n_3 = \frac{1}{x_3 - x_2} \left[ m_1 - n_1 h_2 + n_1 x_2 + n_4 (h_4 - h_2) \right]
\]

In my case due to the airplane characteristics:

\( h_4 = 0 \)

\( h_2 = 0 \)

\( x_2 = \frac{H}{C} = -0.16 \ C = -0.16 \times 7.4 \text{ft.} \)

\( x_2 = -1.184 \text{ ft.} \)

\( x_3 = z + \frac{H}{C} = 36.8 \text{ ft.} \)

\( m_1 = 0.0251 \)

\[
n_3 = \frac{1}{39.8 - (-1.184)} \left( 0.0251 + 3.67(-1.184) + 0.092(0) \right)
\]

\( n_3 = -0.106 \)
"SPAN DISTRIBUTION"

"NO TIP LOSS"

$C_N = \text{Constant} = 0.88$

415 in.

"WITH TIP LOSS"

$C_N = 0.88$

$C_N = 0.70$

$\frac{C_N}{2} = 0.44$

361.5 in.
<table>
<thead>
<tr>
<th>STripe</th>
<th>Y (inch)</th>
<th>ΔY</th>
<th>C&lt;sub&gt;mean&lt;/sub&gt;</th>
<th>C&lt;sub&gt;AY&lt;/sub&gt;</th>
<th>R&lt;sub&gt;6&lt;/sub&gt;</th>
<th>R&lt;sub&gt;6&lt;/sub&gt;&lt;sup&gt;CAY&lt;/sup&gt;</th>
<th>Y&lt;sub&gt;6&lt;/sub&gt;&lt;sup&gt;CAY&lt;/sup&gt;</th>
<th>x&lt;sub&gt;ac&lt;/sub&gt;&lt;sup&gt;CAY&lt;/sup&gt;</th>
<th>X&lt;sub&gt;ac&lt;/sub&gt;&lt;sup&gt;R&lt;sub&gt;6&lt;/sub&gt;&lt;sup&gt;CAY&lt;/sup&gt;&lt;/sub&gt;</th>
<th>Z&lt;sub&gt;ac&lt;/sub&gt;</th>
<th>Z&lt;sub&gt;ac&lt;/sub&gt;&lt;sup&gt;R&lt;sub&gt;6&lt;/sub&gt;&lt;sup&gt;CAY&lt;/sup&gt;&lt;/sub&gt;</th>
<th>C&lt;sup&gt;2&lt;/sup&gt;&lt;sub&gt;AY&lt;/sub&gt;</th>
<th>C&lt;sub&gt;mac&lt;/sub&gt;</th>
<th>C&lt;sup&gt;2&lt;/sup&gt;&lt;sub&gt;mac&lt;/sub&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>27.8</td>
<td>75</td>
<td>120</td>
<td>9000</td>
<td>1.00</td>
<td>9000</td>
<td>250200</td>
<td>14.0</td>
<td>126,000</td>
<td>0</td>
<td>0</td>
<td>1029000</td>
<td>0.006</td>
<td>6480</td>
</tr>
<tr>
<td>II</td>
<td>142.5</td>
<td>170</td>
<td>96</td>
<td>18310</td>
<td>1.00</td>
<td>16310</td>
<td>232500</td>
<td>9.0</td>
<td>147,000</td>
<td>0</td>
<td>0</td>
<td>1565000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>III</td>
<td>277.6</td>
<td>82</td>
<td>70</td>
<td>5740</td>
<td>1.00</td>
<td>5740</td>
<td>158600</td>
<td>3.5</td>
<td>20,100</td>
<td>0</td>
<td>0</td>
<td>403000</td>
<td></td>
<td>2412</td>
</tr>
<tr>
<td>IV</td>
<td>361.5</td>
<td>88</td>
<td>53</td>
<td>4660</td>
<td>1.00</td>
<td>4660</td>
<td>168400</td>
<td>0</td>
<td>—</td>
<td>0</td>
<td>0</td>
<td>247000</td>
<td></td>
<td>1432</td>
</tr>
<tr>
<td>Σ</td>
<td></td>
<td></td>
<td>35710</td>
<td>35710</td>
<td>6845200</td>
<td>293100</td>
<td>3224000</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>19764</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**NO TIP LOSS**
\[
\bar{Y} = \frac{\Sigma(8)}{\Sigma(7)} = \frac{5,845,200}{35,710} = 163.50
\]
\[
\bar{X} = \frac{\Sigma(10)}{\Sigma(7)} = \frac{293,100}{35,710} = 8.22
\]
\[
\bar{Z} = \frac{\Sigma(12)}{\Sigma(7)} = 0
\]
\[
\bar{C} = \frac{\Sigma(13)}{\Sigma(5)} = \frac{3,294,000}{35,710} = 92.20
\]
\[
C_M = \frac{\Sigma(15)}{\Sigma(13)} = \frac{19,794}{3,294,000} = 0.006
\]
\[
K_b = \frac{\Sigma(7)}{\Sigma(5)} = \frac{35,710}{35,710} = 1.0
\]
## Table II

<table>
<thead>
<tr>
<th>STRIPE N°</th>
<th>$y$</th>
<th>$\Delta y$</th>
<th>$C$</th>
<th>$C\Delta y$</th>
<th>$R_0$</th>
<th>$R_0 C\Delta y$</th>
<th>$y_0 R_0 C\Delta y$</th>
<th>$x_{ac}$</th>
<th>$X_{ac} R_0 C\Delta y$</th>
<th>$Z_{ac}$</th>
<th>$Z_{ac} R_0 C\Delta y$</th>
<th>$C^2 A y$</th>
<th>$C_{mac}$</th>
<th>$C_{mac} C^2 A y$</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>27.8</td>
<td>75</td>
<td>120</td>
<td>9000</td>
<td>1.00</td>
<td>9000</td>
<td>250200</td>
<td>14.0</td>
<td>126000</td>
<td>0</td>
<td>0</td>
<td>5080000</td>
<td>0.006</td>
<td>64800</td>
</tr>
<tr>
<td>II</td>
<td>142.5</td>
<td>170</td>
<td>96</td>
<td>16310</td>
<td>1.00</td>
<td>16310</td>
<td>232500</td>
<td>9.0</td>
<td>147000</td>
<td>0</td>
<td>0</td>
<td>5565000</td>
<td></td>
<td>93900</td>
</tr>
<tr>
<td>III</td>
<td>277.6</td>
<td>82</td>
<td>70</td>
<td>5740</td>
<td>1.00</td>
<td>5740</td>
<td>158600</td>
<td>3.5</td>
<td>20100</td>
<td>0</td>
<td>0</td>
<td>402000</td>
<td></td>
<td>2412</td>
</tr>
<tr>
<td>IV</td>
<td>361.5</td>
<td>88</td>
<td>53</td>
<td>4660</td>
<td>0.706</td>
<td>3710</td>
<td>1342000</td>
<td>0</td>
<td>—</td>
<td>0</td>
<td>0</td>
<td>242000</td>
<td></td>
<td>1482</td>
</tr>
<tr>
<td>Σ</td>
<td>35710</td>
<td></td>
<td></td>
<td>34760</td>
<td>5503200</td>
<td>293100</td>
<td></td>
<td></td>
<td></td>
<td>329400</td>
<td>19764</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
\[ \overline{Y} = \frac{\Sigma (8)}{\Sigma (7)} = \frac{5,503,200}{34,760} = 158.2 \]

\[ \overline{X} = \frac{\Sigma (10)}{\Sigma (7)} = \frac{293,100}{34,760} = 8.43 \]

\[ \overline{Z} = \frac{\Sigma (12)}{\Sigma (7)} = 0 \]

\[ \overline{C} = \frac{\Sigma (13)}{\Sigma (5)} = \frac{3,294,000}{35,710} = 92.20 \]

\[ c_M = \frac{\Sigma (15)}{\Sigma (13)} = 0.006 \]

\[ K_b = \frac{\Sigma (7)}{\Sigma (5)} = \frac{34,760}{35,7710} = 0.973 \]
"BALANCING COMPUTATIONS"

**TABLE III**

**CONDITION I**

For tip loss and no tip loss

<table>
<thead>
<tr>
<th>No</th>
<th>I</th>
<th>T</th>
<th>E</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>$W$ (Groos weight)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>$q = 0.00256 V^2$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>$s = W / S$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>$q / s = (2) / (3)$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>$n_1$ (appl. wing load factor)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>$C_N = (5) / (4)$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>$C_L$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>$C_c$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>$n_{x1} = (8) x (4)$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>$n_{x4} = F_{pr} / (1)$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>$C_m$ (Design moment Coeff.)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>$m_1 = (11) x (4)$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>$n_2 = -(5) - (13)$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>$n_{x2} = -(9) - (10)$</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>15</td>
<td>$T = (1) x (13) (tail load)$</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

$V_L = 300$ MPH
"FORCES AND DISTANCES ON AIRFOIL"
FOR TIP LOSS AND NO TIP LOSS

<table>
<thead>
<tr>
<th>No</th>
<th>I</th>
<th>T</th>
<th>E</th>
<th>M</th>
<th>Stations along span</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>I</td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>Distance from root inch.</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>C'/144</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>j (fraction of chord)</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>r (&quot;&quot;&quot;&quot;)</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>b = r - j = (4) - (3)</td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>6</td>
<td>a (fraction of chord)</td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>7</td>
<td>j (&quot;&quot;&quot;&quot;)</td>
</tr>
<tr>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>8</td>
<td>e (unit wing weight)</td>
</tr>
<tr>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>9</td>
<td>r - a = (4) - (6)</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>10</td>
<td>a - j = (6) - (3)</td>
</tr>
<tr>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>11</td>
<td>r - j = (4) - (7)</td>
</tr>
<tr>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>12</td>
<td>j - j = (7) - (3)</td>
</tr>
<tr>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>13</td>
<td>C'/144b = (2) / (5)</td>
</tr>
</tbody>
</table>
\[ Y_f = \text{Net running load on front spar} \]

\[ Y_f = \left\{ \left[ C_N (r - a) + C_{Ma} \right] q + n_2 e (r - j) \right\} \]

\[ Y_r = \text{Net running load on rear spar} \]

\[ Y_r = \left\{ \left[ C_N (a - f) - C_{Ma} \right] q + n_2 e (j - f) \right\} \]

\[ Y_c = \text{Net running chord load} \]

\[ Y_c = \left( C_c \cdot q + n_2 e \right) c' / 144 \]
<table>
<thead>
<tr>
<th>No</th>
<th>I</th>
<th>T</th>
<th>E</th>
<th>M</th>
<th>STATIONS</th>
<th>ALONG</th>
<th>SPAN</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Distance from root</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>Nb</td>
<td></td>
<td></td>
<td></td>
<td>0.88</td>
<td>0.88</td>
<td>0.88</td>
</tr>
<tr>
<td>15</td>
<td>Ma</td>
<td>(variation with span)</td>
<td>0.006</td>
<td>0.006</td>
<td>0.006</td>
<td>0.006</td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>(14) x (9)</td>
<td>0.363</td>
<td>0.363</td>
<td>0.363</td>
<td>0.363</td>
<td></td>
<td></td>
</tr>
<tr>
<td>17</td>
<td>(16) - (15)</td>
<td>0.369</td>
<td>0.369</td>
<td>0.369</td>
<td>0.369</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>(17) x q</td>
<td>85.0</td>
<td>85.0</td>
<td>85.0</td>
<td>85.0</td>
<td></td>
<td></td>
</tr>
<tr>
<td>19</td>
<td>n2 x (8) x (11)</td>
<td>-10.75</td>
<td>-10.75</td>
<td>-10.75</td>
<td>-10.75</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>(18) - (19)</td>
<td>74.25</td>
<td>74.25</td>
<td>74.25</td>
<td>74.25</td>
<td></td>
<td></td>
</tr>
<tr>
<td>21</td>
<td>Yf = (20) x (13)</td>
<td>123.6</td>
<td>99.00</td>
<td>72.20</td>
<td>54.60</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>(14) x (10)</td>
<td>0.077</td>
<td>0.077</td>
<td>0.077</td>
<td>0.077</td>
<td></td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>(22) - (15)</td>
<td>0.0835</td>
<td>0.0835</td>
<td>0.0835</td>
<td>0.0835</td>
<td></td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>(23) x q</td>
<td>19.2</td>
<td>19.2</td>
<td>19.2</td>
<td>19.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>n2 x (8) x (12)</td>
<td>-2.52</td>
<td>-2.52</td>
<td>-2.52</td>
<td>-2.52</td>
<td></td>
<td></td>
</tr>
<tr>
<td>26</td>
<td>(24) - (25)</td>
<td>16.68</td>
<td>16.68</td>
<td>16.68</td>
<td>16.68</td>
<td></td>
<td></td>
</tr>
<tr>
<td>27</td>
<td>Yc = (26) x (13)</td>
<td>27.8</td>
<td>22.2</td>
<td>16.2</td>
<td>12.3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>28</td>
<td>Ce (variation with span)</td>
<td>-0.136</td>
<td>-0.136</td>
<td>-0.136</td>
<td>-0.136</td>
<td></td>
<td></td>
</tr>
<tr>
<td>29</td>
<td>(28) x q</td>
<td>-31.30</td>
<td>-31.30</td>
<td>-31.30</td>
<td>-31.30</td>
<td></td>
<td></td>
</tr>
<tr>
<td>30</td>
<td>n2 x (8)</td>
<td>-4.92</td>
<td>-4.92</td>
<td>-4.92</td>
<td>-4.92</td>
<td></td>
<td></td>
</tr>
<tr>
<td>31</td>
<td>(29) - (30)</td>
<td>-36.22</td>
<td>-36.22</td>
<td>-36.22</td>
<td>-36.22</td>
<td></td>
<td></td>
</tr>
<tr>
<td>32</td>
<td>Yc = (31) x (2)</td>
<td>-30.2</td>
<td>-24.15</td>
<td>-17.60</td>
<td>-13.34</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table V

<table>
<thead>
<tr>
<th>No</th>
<th>I</th>
<th>T</th>
<th>E</th>
<th>M</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>distance from root</td>
<td>27.8</td>
<td>142.5</td>
</tr>
<tr>
<td>14</td>
<td></td>
<td>$C_{Nb} = C_{NI} \times \frac{R_b}{K_b}$</td>
<td>0.905</td>
<td>0.905</td>
</tr>
<tr>
<td>15</td>
<td></td>
<td>$C_{MA}$ (variation with span)</td>
<td>0.006</td>
<td>0.006</td>
</tr>
<tr>
<td>16</td>
<td>(14)</td>
<td>$x$ (9)</td>
<td>0.373</td>
<td>0.373</td>
</tr>
<tr>
<td>17</td>
<td>(16)</td>
<td>$+$ (15)</td>
<td>0.379</td>
<td>0.379</td>
</tr>
<tr>
<td>18</td>
<td>(17)</td>
<td>$x$ q</td>
<td>87.2</td>
<td>87.2</td>
</tr>
<tr>
<td>19</td>
<td>$n_2 \times$ (8) $x$ (11)</td>
<td>-10.75</td>
<td>-10.75</td>
<td>-10.75</td>
</tr>
<tr>
<td>20</td>
<td>(18)</td>
<td>$+$ (19)</td>
<td>76.45</td>
<td>76.45</td>
</tr>
<tr>
<td>21</td>
<td>$Y_f = (20) \times$ (13)</td>
<td>127.3</td>
<td>102.0</td>
<td>74.30</td>
</tr>
<tr>
<td>22</td>
<td>(14)</td>
<td>$x$ (10)</td>
<td>0.079</td>
<td>0.079</td>
</tr>
<tr>
<td>23</td>
<td>(22)</td>
<td>$-$ (15)</td>
<td>0.074</td>
<td>0.074</td>
</tr>
<tr>
<td>24</td>
<td>(23)</td>
<td>$x$ q</td>
<td>16.94</td>
<td>16.94</td>
</tr>
<tr>
<td>25</td>
<td>$n_2 \times$ (8) $x$ (12)</td>
<td>-2.52</td>
<td>-2.52</td>
<td>-2.52</td>
</tr>
<tr>
<td>27</td>
<td>$Y_r = (26) \times$ (13)</td>
<td>24.06</td>
<td>19.20</td>
<td>14.00</td>
</tr>
<tr>
<td>28</td>
<td>$C_{C}$ (variation with span)</td>
<td>-0.136</td>
<td>-0.136</td>
<td>-0.136</td>
</tr>
<tr>
<td>29</td>
<td>(28)</td>
<td>$x$ q</td>
<td>-31.30</td>
<td>-31.30</td>
</tr>
<tr>
<td>30</td>
<td>$n_{X2} \times$ (8)</td>
<td>-4.92</td>
<td>-4.92</td>
<td>-4.92</td>
</tr>
<tr>
<td>31</td>
<td>(29)</td>
<td>$+$ (30)</td>
<td>-36.22</td>
<td>-36.22</td>
</tr>
<tr>
<td>32</td>
<td>$Y_c = (31) \times$ (2)</td>
<td>-30.20</td>
<td>-24.15</td>
<td>-17.64</td>
</tr>
</tbody>
</table>
RUNNING LOADS IN FRONT SPAD

185.4 \#/in
148.5 \#/in
108.3 \#/in
82.0 \#/in

NO TIP LOSS
Running loads in front spad with tip loss
"TOTAL LOAD AND MOMENT ON FRONT SPAR"

"NO TIP LOSS"

<table>
<thead>
<tr>
<th>SECTION (1)</th>
<th>LOAD (2)</th>
<th>ARM (3)</th>
<th>MOMENT (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>75 x 185.4 = 13910</td>
<td>37.5</td>
<td>522,000</td>
</tr>
<tr>
<td>II</td>
<td>170 x 148.5 = 25260</td>
<td>160.0</td>
<td>4,040,000</td>
</tr>
<tr>
<td>III</td>
<td>82 x 108.3 = 8880</td>
<td>286.0</td>
<td>2,540,000</td>
</tr>
<tr>
<td>IV</td>
<td>88 x 82 = 7220</td>
<td>370.2</td>
<td>2,600,000</td>
</tr>
<tr>
<td>Σ</td>
<td>55,270</td>
<td></td>
<td>9,702,000</td>
</tr>
</tbody>
</table>

"WITH TIP LOSS"

<table>
<thead>
<tr>
<th>SECTION (1)</th>
<th>LOAD (2)</th>
<th>ARM (3)</th>
<th>MOMENT (4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>I</td>
<td>75 x 192.0 = 14400</td>
<td>37.5</td>
<td>540,000</td>
</tr>
<tr>
<td>II</td>
<td>170 x 153.0 = 26000</td>
<td>160.0</td>
<td>4,160,000</td>
</tr>
<tr>
<td>III</td>
<td>82 x 111.5 = 9150</td>
<td>286.0</td>
<td>2,716,000</td>
</tr>
<tr>
<td>IV</td>
<td>88 x 65.1 = 5730</td>
<td>370.2</td>
<td>2,221,000</td>
</tr>
<tr>
<td>Σ</td>
<td>55,280</td>
<td></td>
<td>9,637,000</td>
</tr>
</tbody>
</table>
As usual I shall assume that the spars of the wing (two spars), its going thru the fuselage.

Latter I'll assume another hypothesis considering the spars does not go thru the fuselage and its will be clamped in the fuselage. I never saw before structure like this in regular and standard airplane, but I know that from of stability view-point the best airplane is the middle wing, however most of the time the designers do not use that kind of aircraft due to the fact that the wings spar thru the fuselage deducts room right in the more important place, around of the Gravity Center, where equipment, pilot or crewmen necessarily must be place.

In this hypothesis (spar go thru the fuselage) the condition which give me the high load over fuselage is three point landing condition, for that reason I'LL design due to these loads.
"THREE POINT LANDING CONDITION"

"CALCULATION OF LOAD FACTOR n"

In figure 24 of the "Civil Aeronautic Manual I got the following expression:

\[ n_1 = 2.80 + \frac{9000}{W + 4000} \]

\[ n_1 = 2.80 + \frac{9000}{30200 + 4000} \]

\[ n_1 = 3.063 \]

Gross Weight = 30200.00

Landing Gear = 141000

Weight in landing = 28,790 lb.

Design Load for 3 point landing = \( 28,790 \times 3.063 \times 1.50 \)

"""""" = 132,400 lbs.

Now the Design Load, must be divided between landing gear and tail wheel in inverse proportion to the distances, measured parallel to the ground line, from the C.G. of airplane to the points above mentioned.
WEIGHT ON FRONT WHEELS = $132,400 \times \frac{500}{560}$

" n " " " " = 118,200 lbs.

WEIGHT ON TAIL WHEEL = $132,400 \times \frac{60}{560}$

" n " " " " = 14,200 lbs.

On each front of the landing gear I'll have \( \frac{118,200}{2} = 59,100 \) lb.

These values of forces were obtained from my balance diagram and shortening the shock absorver and tires at middle way.
EXTERNAL FORCES OVER FUSELAGE WHERE FRONT SPAR PASS THRU

\[ M = \frac{59100}{75}, 75" \]

\[ M = 4,430,000 \text{ in. lb.} \]
"BREAKING LOAD DUE TO THREE POINT LANDING ACCORDING TO TANGENTIAL FORCE AT RING OF MONOCOQUE"

\[ \text{C.G.} \]

\[ \begin{align*}
21600 \sin 5^\circ &= 1875 \\
62900 \sin 20^\circ &= 6300 \\
132,400^\circ \\
59100^\circ \text{ (on each wheel)}
\end{align*} \]
"FORCES ON MONOCOQUE RING DUE TO THREE POINT LANDING"
"FORCES AND MOMENT ON POINT 0"

From point 0...360°
From point F...180°

SHEAR FORCE ON 0:

Due to tangential at 0 = \(-0.23(-58,825)\) = + 13,600
Due to tangential at F = \(-0.08(58,825)\) = - 4730
Total SHEAR force = + 8,870 lbs.

NORMAL FORCE ON 0:

Due tangential force at 0 = \(+0.50(-58,825)\) = + 28,550
Due tangential force at F = 0
Total NORMAL force = + 28,550 lbs.

MOMENT ON 0:

It does not exists
"FORCES AND MOMENT ON POINT A"

From point 0: \[ 0.330^\circ \]
From point F: \[ 0.150^\circ \]

**SHEAR FORCE ON A:**

Due to tangential at 0: \[ -0.02 \times (-58,825) = + 1,177 \]
Due to tangential at F: \[ -0.05 \times (58,825) = - 2,941 \]
Total SHEAR force: \[ = -1,765 \text{ lbs.} \]

**NORMAL FORCE ON A:**

Due to tangential at 0: \[ 0.32 \times (-58,825) = - 18,820 \]
Due to tangential at F: \[ 0.12 \times (58,825) = + 7,065 \]
Total NORMAL force: \[ = -11,770 \text{ lbs.} \]

**MOMENT ON A:**

Due to tangential at 0: \[ 0.06(45)(-58,825) = - 159,000 \]
Due to tangential at F: \[ 0.04(45)(58,825) = + 106,000 \]
Total MOMENT: \[ = -53,000 \text{ in. lb.} \]
"FORCES AND MOMENT ON POINT B"

From point 0........ 300°
From point F........ 120°

SHEAR FORCE ON B:

Due to tangential force 0 = 0.09(-58,825) = - 5,320
Due to tangential force F = 0.02(58,825) = + 1,182
Total SHEAR force = -4,138 lbs.

NORMAL FORCE ON B:

Due to tangential force 0 = 0.09(-58,825) = - 5,320
Due to tangential force F = 0.15(58,825) = + 8,860
Total NORMAL force = +3,540 lbs.

MOMENT ON B:

Due to tangential force 0 = 0.04(45)(-58,825) = -106,600
Due to tangential force F = 0.04(45)(58,825) = + 106,000
Total MOMENT = 0
"FORCES AND MOMENT ON POINT C"

From point 0......270°
From point F...... 90°

SHEAR FORCE ON C:

Due to tangential at 0 = 0.09(-58,825) = - 5,320
Due to tangential at F = 0.09(58,825) = + 5,320
Total SHEAR force = 0

NORMAL FORCE ON C:

Due to tangential at 0 = -0.08(-58,825) = + 4725
Due to tangential at F = 0.08(58,825) = + 4725
Total NORMAL force = + 9,450 lbs.

MOMENT ON C:

Due to tangential at 0 = -0.015(45)(-58,825)= + 39,900
Due to tangential at F =.015(45)( 58,825)= + 39,900
Total MOMENT = + 79,800 in.lb.
"FORCES AND MOMENT ON RING MONOCOQUE WHERE THE WING GOES THRU IN HYPOTHESIS I DUE TO THREE POINTS LANDING"
"DESIGN OF THE RING MONOCOQUE WHERE THE WING SPAR GOES THRU IN HYPOTHESIS I DUE TO THREE POINT LANDING"

DESIGN OF THE RING AT POINT C or I

\[ V = 0 \]
\[ N = 9,450 \text{ lb.} \]
\[ M = 79,800 \text{ in. lb.} \]

17 S-T- Aluminium Alloy

\[ f_b = \frac{V \cdot u}{I} \]
\[ I = 2(0.25 \times 4 \times 2.375^2) \]
\[ + \frac{0.25 \times 4.5^3}{12} \]

\[ I = 13.16 \text{ in}^4 \]
\[ A = 2 \times 4 \times 0.25 + 0.25 \times 4.5 \]
\[ A = 3.125 \text{ in}^2 \]
\[ Q = 0.25 \times 4 \times 2.375 + 2.25 \times 0.25 \times 1.125 \]
\[ Q = 3.00 \]

\[ f_b = \frac{79,800 \times 2.50}{13.16} \]
\[
\tau = \frac{M u}{I} - \frac{N}{A}
\]

\[
\tau_b = 15,160 \text{ lb./sq.in.}
\]

\[
\tau = 15.160 - \frac{9,450}{3.125}
\]

\[
\tau = 18,185 \text{ lb/sq.in.}
\]

**DESIGN ON POINT 0 OR F**

\[
M = 0
\]

\[
N = 28,550 \text{ lb.}
\]

\[
V = -8,870 \text{ lb.}
\]

\[
\tau_s = \frac{V \cdot Q}{b \cdot I} = \frac{8,870 \times 3.00}{0.25 \times 12.16}
\]

\[
\tau_s = 8,080 \text{ lb/sq.in.}
\]

\[
\tau_c = \frac{N}{A} = \frac{28,550}{3.00}
\]

\[
\tau_c = 9,520 \text{ lb/sq.in.}
\]

I might design the ring with variable moment of Inertia, but seems to me that would be a bad remedy because if I economize some material, for other hand will raise the
price of manufacturing; and the different in weight (very important thing in aircraft structures) in this case is too small; however I'll change the moment of the inertia reducing the thickness of web and keep same others dimensions:

For instance on points 0 and F I'll choose the following shape:

Same others dimensions except web thickness = 0.10"

\[ I = 2(0.25 \times 4 \times 2.375^2) - \frac{0.10 \times 4.5^3}{12} \]

\[ I = 12.02 \text{ in}^4 \]

\[ Q = (0.25 \times 4 \times 2.375) - (2.25 \times 0.10 \times 1.125) \]

\[ Q = 2.63 \]

\[ b = 0.10 \]

\[ f_s = \frac{V \cdot Q}{b \cdot \frac{I}{3}} = \frac{8,870 \times 2.63}{0.10 \times 12.02} \]

\[ f_s = 19,400 \text{ lb/sq.in.} \]
"H Y P O T H E S I S"

II

"Assuming wings spars clamped into fuselage"
"FORCES OVER FUSELAGE WHERE FRONT SPAR PASS THRU DUE TO CONDITION I"
"FORCES AND MOMENT ON POINT 0"

From point 0 ...... 0°
From point F ...... 180°

SHEAR ON 0:

Due to moment at 0 = \(-\frac{48(-9,702,000)}{45}\) = + 103,500
Due to moment at F = \(\frac{16(\ "\ )}{45}\) = + 34,500
Due to tangential 0 = \(-\frac{.23(-55,280 )}{45}\) = + 13,590
Due to tangential F = \(-.08(\ "\ )\) = - 4,725
Total Shear force = - 146,865 lbs.

NORMAL ON 0:

Due to moment to 0 = \(\lfloor 0\) = ............
Due to moment to F = 0 = ............
Due tangential 0 = \(\lfloor .50(-55,280 )\) = \(\lfloor\) 27,640
Due tangential F = 0 = ............
Total Normal Force = \(\lfloor\) 27,640 lbs.

MOMENT ON 0:

Due to moment to 0 = \(\lfloor .50(-9,702,000)\) = \(\lfloor\) 4,851,000
Due to moment to F = .................. ..........................
Due tangential 0 = .......................... ..........................
Due tangential F = .......................... ..........................
Total Moment = \(\lfloor\) 4,851,000 in.lb.
"FORCES AND MOMENT ON POINT A"

From point 0 ....... 330°
From point F ....... 150°

SHEAR ON A

Due to moment at 0 = \(-\frac{44}{45}(-9,702,000)\) = + 94900
" " " " F = \(-\frac{12}{45}\) = + 25880
" tangential" 0 = \(-\frac{02}{45}(-55,280)\) = + 1105
" " " " F = \(-\frac{05}{45}\) = - 2765
Total Shear force = + 119,120 lbs.

NORMAL ON A

due to moment at 0 = \(-\frac{16}{45}(-9,702,000)\) = - 34500
" " " " F = \(-\frac{16}{45}\) = - 34500
" Tangential" 0 = \(-\frac{32}{45}(-55,280)\) = - 17710
" " " " F = \(-\frac{12}{45}\) = + 6640
Total normal force = -80,070 lbs.

MOMENT ON A

Due to moment at 0 = \(-\frac{25}{45}(-9,702,000)\) = + 2425000
" " " " F = \(-\frac{08}{45}\) = - 776000
" Tangential" 0 = \(-\frac{06(45)}{45}(-55,280)\) = - 149400
" " " " F = \(-\frac{04(45)}{45}\) = + 99600
Total Moment = -1,599,000 in. lb.
"FORCES AND MOMENT ON POINT B"

From point 0 // // 300°
From point F ...... 120°

**SHEAR ON B:**

Due to moment at 0 = \(-\frac{22}{45} (-9,702,000)\) = \(+\) 69,000

" " " " F = \(\frac{0}{45}\) ( " ) = ......

" Tangential " 0 = \(0.09 (-55,280)\) = - 4,980

" " " " F = \(0.02 (\ " )\) = + 1,106

TOTAL SHEAR AT B = \(-\) 72,874 lbs.

**NORMAL ON B:**

Due to moment at 0 = \(-\frac{27}{45} (-9,702,000)\) = - 58,200

" " " " F = \(-\frac{27}{45}\) ( " ) = - 58,200

" Tangential " 0 = \(0.09 (-55,280)\) = - 4,980

" " " " F = \(0.15 (\ " )\) = + 8,300

TOTAL NORMAL AT B = \(-\) 113,080 lbs.

**MOMENT ON B:**

Due to moment at 0 = \(-.06 (-9,702,000)\) = \(+\) 582,000

" " " " F = \(-.11 (\ " )\) = -1,068,000

" Tangential " 0 = \(0.04(45)(-55,280)\) = - 99,600

" " " " F = \(0.04(45)(\ " )\) = + 99,600

TOTAL MOMENT AT B = \(-\) 486,000 in. lb.
"FORCES AND MOMENT ON POINT C"

from point 0 ........ 270°
from point F ........ 90°

SHEAR ON C:

Due to moment at 0 = -\frac{15}{45}(-9,702,000) = + 32350

" " " " F = -\frac{15}{45}( ) = - 32250

" Tangential " 0 = .09 (-55,280 ) = - 4980

" " " " F = .09 ( ) = + 4980

TOTAL SHEAR ON C = 0

NORMAL ON C:

Due to moment at 0 = \frac{32}{45}(-9,702,000) = - 69000

" " " " F = -\frac{32}{45}( ) = - 69000

" Tangential " 0 = -.08(-55,280 ) = + 4420

" " " " F = -.08( ) = + 4420

TOTAL NORMAL AT C = -129,160 lbs.

MOMENT ON C:

Due to moment at 0 = .07(-9,702,000) = - 679000

" " " " F = -.07( ) = - 679000

" Tangential " 0 = -.15(45*-55,280) = + 37,300

" " " " F = .15(")( ) = + 37,300

TOTAL MOMENT AT C = -1,282,400 in.lb.

43
"HYPOTHESIS II"

V = 72,874
N = -113,080
M = 486,000

V = 0
N = -129,160 lb.
M = -1,283,400

V = 72,874
N = -113,080
M = 486,000

V = 119,120
N = 80,070
M = -1,599,000

V = -119,120
N = -80,070
M = 1,599,000

V = -72,874
N = 113,080
M =

V = 0
N = 129,160
M = 1,283,400

V = 72,874
N = 113,080
M = 486,000

"SHEAR AND NORMAL FORCE AND MOMENT AROUND FUSELAGE WHERE FRONT WING SPAR PASS-THRU DUE TO CONDITION I"
"FORCES OVER FUSELAGE WHERE FRONT STAR PASS-THRU DUE TO THE THREE POINT LANDING"

"HYPOTHESIS II"
"SHEAR, NORMAL FORCES AND MOMENT AROUND FUSELAGE WHERE FRONT WING SPAR PASS-THRU DUE TO THREE POINT LANDING CONDITION"
"DESIGN OF THE RING MONOCOQUE WHERE THE
WING SPAR GOES THRU IN HYPOTHESIS I I
DUE TO CONDITION I"

"DESIGN OF THE POINTS 0 OR F"

17 S.T. Aluminium Alloy:

\[ V = 146,875 \, \text{lb.} \]
\[ N = -27,640 \, \text{lb.} \]
\[ M = -4,800,000 \, \text{in.} \cdot \text{lb.} \]
\[ y = 7 \, \text{in.} \]
\[ b = 1.0 \, \text{in.} \]
\[ I = 2(1.5 \times 18 \times 6.25^2) + \frac{1 \times 11}{12} \]
\[ I = 2235 \, \text{in}^4 \]
\[ A = 2(1.5 \times 18) + 1.0 \times 11.0 \]
\[ A = 65 \, \text{in}^2 \]
\[ Q = 1.5 \times 18 \times 6.25 + 1.0 \times 5.5 \times 2.75 \]
\[ Q = 183.94 \, \text{in}^3 \]
$f_b = \frac{4,800,000 \times 7}{2,235}$

$f_b = 15,000 \text{ lb/sq.in.}$

$f_s = \frac{146,875 \times 183.94}{1.0 \times 2,235}$

$f_s = 12,040 \text{ lb/sq.in.}$

"DESIGN OF POINTS C AND I"

$V = 0$

$N = -129,160 \text{ lb.}$

$M = -1,283,000 \text{ in.lb.}$

$I = 446.7 \text{ in}^4$

$A = 28 \text{ in}^2$

$q = 53.0 \text{ in}^3$

$b = 1.0 \text{ in.}$

$y = 5.0 \text{ in.}$

$f_b = \frac{1,283,000 \times 5}{446.7}$

$f_b = 14,350 \text{ lb./sq.in.}$
\[ f = f_b + \frac{N/A}{14,250 + 129,160 / 53} \]
\[ f = 16,780 \text{ lb/sq.in.} \]
"CONCLUSIONS"

Analizing both hypothesis it is true enough that the hypothesis I (wing span go thru fuselage) is the best one and gives the most reasonables values, for that I have not chances to do, I keep the answer of this hypothesis, but, why I got no satisfactory structure (from stand view-point of the aircraft design), in hypothesis II? The answer is neat.

Due to the fact that this airplane was created for very long range, I designed for maximum L/D and very high aspect ratio, getting a very long span and consequently I have a big moment in the root chord and very high clamped moment too.

Then for long range airplane (this case), seems to me is not commendable to have clamped wings its will be right for pursuit airplanes and when the designer has troubles for room near the C.G. position.-

In this thesis I did not paid attention to the running chord load or perpendicular ring monocoque component force, because this load must be carry for longitudinal monocoque fuselage structure and part of the skin. I am very sorry about this, but I have not time for further calculations.

For calculate the other rings of the
monocoque structure I must proceed in same way as I did.

About openings, until now, there is not theory in order to calculate its, but the designers follows the experiences and results from factories and laboratories that worked in this matter.