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GOODYEAR

GOODYEAR AIRCRAFT CORPORATION

AKRON, OHIO

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FEASIBILITY INVESTIGATION OF INFLATABLE STRUCTURE FOR HIGH ALTITUDE AIRCRAFT

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SUMMARY

The purpose of this brief investigation was to demonstrate the feasibility of using airmat material for the construction of an aircraft which could operate at an altitude of 80,000 feet and a speed of Mach .8. In order to expedite this program, the test specimens used were made from available materials and merely simulated wing constructions.

Combinations of nylon, Dacron, Fortisam, and fiberglas in the form of test panels simulating wings with aspect ratios of 3.7 and 8.15 show that a considerable amount of leeway is available to the aeronautical engineer in choosing the construction desired. For the wing loadings of an aircraft performing a typical reconnaissance mission, it has been shown that airmat material can be provided which will supply the structural integrity required.

The next step would be to define a specific mission and make a parametric study of the variables concerned to enable the design of an optimum aircraft, which still retains the radar transparency capabilities and light weight properties of airmat construction.

INTRODUCTION

The aircraft designed to perform a high altitude reconnaisance mission should, among other items, have the capability of escaping radar detection in so far as practical. This requirement suggests as airframe materials airmat and fiberglas, both of which have relatively low radar reflectivity qualities.

As an airframe material airmat has been successfully used in Goodyear Aircraft's "Inflatoplane". This vehicle is a light weight, low speed aircraft with considerably less demanding aerodynamic and structural requirements than an aircraft capable of performing a high altitude reconnaisance mission. To offset this difference in requirements, an airmat designed to operate at internal pressures up to eight times greater than the airmat previously used has been proposed.

The initial buckling strength of airmat structure being primarily dependent upon the internal pressure, the proposed increase should satisfy the strength requirements. In order to satisfy the stiffness or deflection requirements, three approaches have been suggested, each having desirable features. The first approach employs airmat with neoprene coated Dacron cover plys which make it readily foldable when deflated yet increases the stiffness over the nylon airmat used in the Inflatoplane. The second approach employing Fortisan in place of Dacron is an improvement on the first with respect to stiffness because Fortisan has a greater modulus of elasticity. However, in this case the folding life will be reduced because the Fortisan fibers tend to break down under repeated foldings. The third approach employing fiberglas as cover ply material eliminates the folding feature but greatly increases the stiffness.

As substantiating evidence of the contractors belief that airmat in some form could feaseably be used as airframe material for an aircraft capable of performing a high altitude reconnaisance mission, a test program was requested by the Air Force.

Normally the first phase of a complete test program of this nature would be the determination of the optimum wing configuration. The second phase would then be the actual testing of test panels simulating this configuration, and the third phase would be the correlation and presentation of the results of the first two phases.

Due to the short time duration of this program, 15 October 1957 to 15 December 1957, the logical sequence of procedure noted above could not be followed. Instead it was necessary to make some basic assumptions concerning the wing configuration so that a test program could be initiated immediately. As a result, the panels tested do not represent optimum wing configurations.

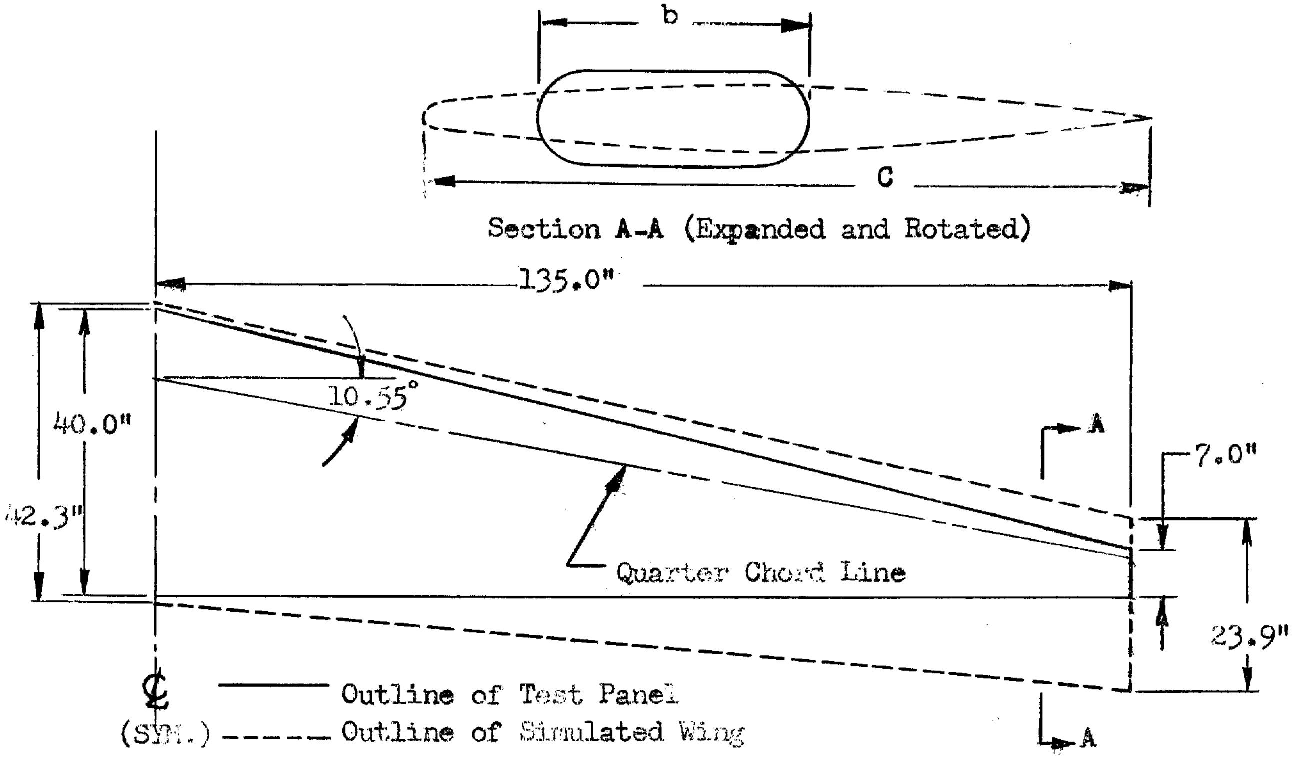
DETERMINATION OF SPECIMENS

In order to satisfy the time requirements, it was necessary to use materials which were readily available from Goodyear Tire and Rubber Company. Considering the advantage of a wide range of internal pressure capability, high pressure airmat was selected. This selection limited the specimen shapes to flat panels three inches thick with a maximum width of forty inches. This width limitation, in conjunction with the parametric requirements of an aspect ratio equal to nine and a maximum thickness ratio of ten per cent or less, prevented the choice of a very large sweep back angle. Based primarily upon the above noted limitations, two each of the test panels shown in Figures 1 and 2 were ordered from Goodyear Tire and Rubber Company.

All of these test panels have nylon as the basic airmat material. One each of the two configurations were ordered with three cover plys of Dacron, and the remainder with three cover plys of Fortisan. The top cover ply direction was along the length of the panel and the warp directions of the other two plys were on alternating forty-five degree biases.

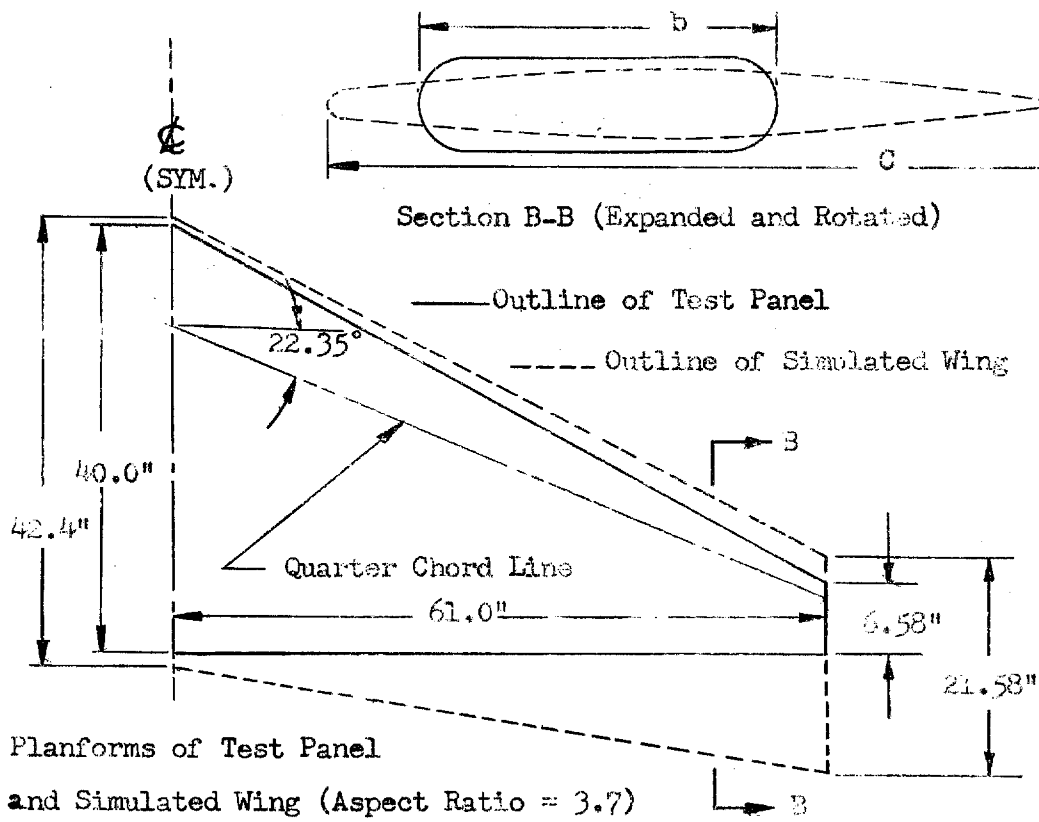
It should be noted that the actual aspect ratios of the two specimens are 5.24 and 11.5. However, as described later, the corresponding aspect ratios for the wings simulated by these test panels were determined as 3.7 and 8.15 respectively.

Since an aircraft utilizing airmat construction would probably have a through wing, the test panels were constructed to simulate the full span and thus more closely approximate the wing support conditions.



Planforms of Test Panel and Simulated Wing
(Aspect Ratio = 8.15)

Figure 1



Planforms of Test Panel
and Simulated Wing (Aspect Ratio = 3.7)

Figure 2

DETERMINATION OF SIMILITUDE FACTORS FOR TEST PANELS

Considering that the present state of the art for weaving of airmat limits the airfoil shapes to those which are symmetrical, an NACA 66-010 airfoil was selected as one which conceivably could be used in meeting the aerodynamic requirements. Based upon a chord length equal to "C" and only the forward eighty per cent of the airfoil structurally effective, the following values for the structural properties of the NACA 66-010 airfoil were calculated.

$I = .00273C^3$ = moment of inertia

$Z = .0546C^2$ = section modulus

$A = .0643C^2$ = enclosed cross-sectional area

and $N = 1.68C$ = length of perimeter of enclosed cross-sectional area

For the airmat test panels, which have a rectangular cross-sectional shape with a constant thickness of three inches, the section properties may be expressed in terms of the width, "b" as

$I = 4.5b - 2.9$ = moment of inertia

$Z = 3b - 1.93$ = section modulus

$A = 3b - 1.93$ = enclosed cross-sectional area

and $N = 2b - 3.43$ = length of perimeter of enclosed cross-sectional area

Equating the two values for moment of inertia results in

$I = .00273C^3 = 4.5b - 2.9$ and

$C = \sqrt[3]{1650b - 1060}$

Performing a similar operation on the other section properties gives

$C = \sqrt{55b - 35.3}$ for equivalent section modulii

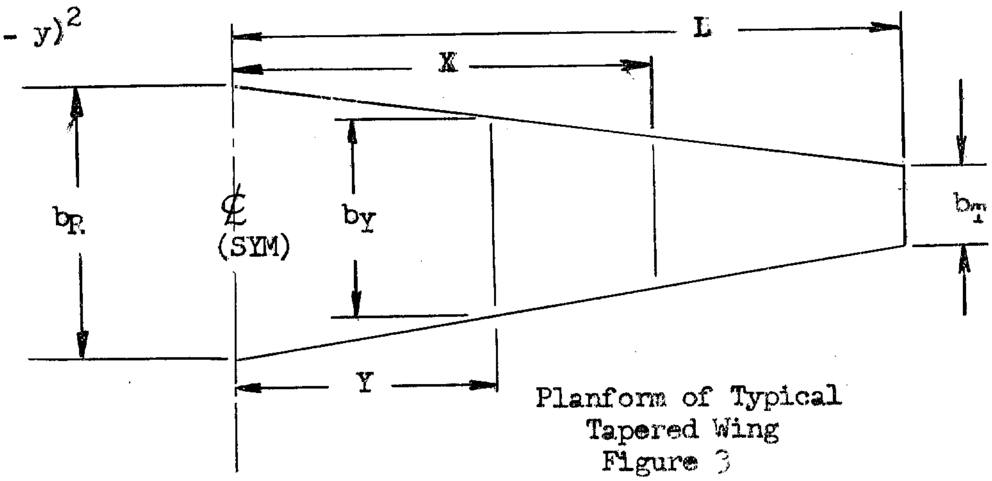
$C = \sqrt{46.7b - 30}$ for equivalent enclosed cross-sectional areas

and $C = 1.19b - 2.04$ for equivalent perimeter lengths.

Obviously, all these equations relating "C" and "b" cannot be satisfied with the same values for the variables. Thus it was necessary to compromise in the selection of these values and then determine comparison factors between the test specimen deflections and the wing deflections

To facilitate this comparison, theoretical deflection curves for both the test specimen and the wing will be determined. Neglecting for now, any torsional effects and assuming a uniform load, "w", in pounds per foot of span length on a test specimen of the planform shape shown in Figure 3, the moment at station "y" is

$$M_y = \frac{w}{2}(L - y)^2$$



Planform of Typical
Tapered Wing
Figure 3

The value of "b_y" may be expressed as

$$b_y = b_R - \left[\frac{b_R - b_T}{L}\right] y$$

Substitution of this value into the equation for moment of inertia gives

$$I_y = 4.5b_R - 2.9 - 4.5\left[\frac{b_R - b_T}{L}\right] y$$

The deflection at station "x" equals the moment of the $\frac{M}{EI}$ diagram about "x", that is

$$\Delta_x = \frac{w}{2E}\int_0^x \frac{(L - y)^2(x - y)\,dy}{(4.5b_R - 2.9 - 4.5\left[\frac{b_R - b_T}{L}\right] y)} \quad \text{or}$$

$$\Delta_x = \frac{w}{2E}\int_0^x \frac{(L^2x - 2Lxy + xy^2 - L^2y + 2Ly^2 - y^3)\,dy}{(4.5b_R - 2.9 - 4.5\left[\frac{b_R - b_T}{L}\right] y)}$$

Let $C_1 = L^2x$

$C_2 = -(2Lx + L^2)$

$C_3 = 2L + x$

$C_4 = 4.5b_R - 2.9$

and $C_5 = -4.5\left[\frac{b_R - b_T}{L}\right]$

Using these constants, the deflection equation may be rewritten as

$$\Delta_x = \frac{w}{2E}\int_0^x \frac{(C_1 + C_2y + C_3y^2 - y^3)\,dy}{(C_4 + C_5y)}$$

Integrated, the result is

$$\Delta_x = \frac{w}{2E}\left(\left[\text{Log}\left(\frac{C_4 + C_5x}{C_4}\right)\right]\left[\frac{C_1}{C_5} - \frac{C_2C_4}{C_5^2} + \frac{C_3C_4^2}{C_5^3} + \frac{C_4^3}{C_5^4}\right] + C_5x\left[\frac{C_2}{C_5^2} - \frac{2C_3C_4}{C_5^3} - \frac{2C_4^2}{C_5^4}\right] + \frac{1}{2}\left[2C_4C_5x + C_5^2x^2\right]\left[\frac{C_3}{C_5^3} + \frac{C_4}{C_5^4}\right] - \frac{x^3}{3C_5}\right)$$

The wing to be simulated has the same general planform and loading except that "b_R" and "b_T" become "C_R" and "C_T" respectively. Thus

$$C_y = C_R - \left[\frac{C_R - C_T}{L}\right] y$$

Substitution of this value into the equation for moment of inertia results in

$$I_y = .00273\left(C_R - \left[\frac{C_R - C_T}{L}\right] y\right)^3$$

Letting $C_1 = L^2x$

$C_2 = -(2Lx + L^2)$

$C_3 = 2L + x$

$K_1 = .1395C_R$

and $K_2 = -.1395\left[\frac{C_R - C_T}{L}\right]$

the deflection at "x" may be expressed as

$$\Delta_x = \frac{w}{2E}\int_0^x \frac{(C_1 + C_2y + C_3y^2 - y^3)\,dy}{(K_1 + K_2y)^3}$$

Integration of this equation gives

$$\Delta_x = \frac{W}{2E}\left(\left[\text{Log}\left(\frac{K_1 + K_2x}{K_1}\right)\right]\left[\frac{C_3}{K_2^3} + \frac{3K_1}{K_2^4}\right] + \frac{C_1}{2K_1^2K_2} + \frac{C_2}{2K_2^2K_1} - \frac{3C_3}{2K_2^3} - \frac{9K_1}{2K_2^4} \right.$$
$$+ \left[\frac{2C_3K_1}{K_2^3} + \frac{6K_1^2}{K_2^4} + \frac{C_2}{K_2^2}\right]\left[\frac{1}{K_1 + K_2x}\right] - \left[\frac{C_1}{2K_2} - \frac{C_2K_1}{2K_2^2} + \frac{C_3K_1^2}{2K_2^3} + \frac{3K_1^3}{2K_2^4}\right]$$
$$\left. \left[\frac{1}{K_1 + K_2x}\right]^2 - \frac{x^3}{K_2(K_1 + K_2x)^2} \right)$$

Division of the deflection equation for the wing by the deflection equation for the test panel and evaluation of the answer results in the comparison curves shown in Figures 4 and 5.

To compare the torsional stiffness of the test specimens with the wings which they are simulating requires a study of both the loading and geometric relationships.

All of the loads as applied during the test were with respect to the quarter chord line, this and the span length being the only parts of the geometry exactly the same for both the test specimen and the wing. Since the elastic axes of the test specimen and the wing do not coincide, it will be necessary to establish the relationship between the torque and these axes. Let the shear load at any spanwise station "y", for both the test specimen and the wing be denoted as "P". Then the torque at station "y" on the test specimen is Pd_y and on the wing Pe_y, where d_y equals the moment arm from the quarter chord line to the elastic axis of the test specimen and e_y is the same parameter for the wing. The elastic axis for the test specimen is located at the fifty per cent chord line and for the wing at the forty per cent chord line, thus the values for the moment arms may be expressed as

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$$d_y = .25b_y = .25(b_R - \left[\frac{b_R - b_T}{L}\right] y)$$

and $$e_y = .15C_y = .15(C_R - \left[\frac{C_R - C_T}{L}\right] y)$$

As previously determined, the perimeter length of the enclosed cross-sectional area for the test specimen is N = 2b - 3.43, from which

$$N_y = 2(b_R - \left[\frac{b_R - b_T}{L}\right] y) - 3.43$$

For the wing, this parameter was determined as N = 1.68C, which for station "y" becomes

$$N_y = 1.68(C_R - \left[\frac{C_R - C_T}{L}\right] y)$$

Similiarly expressing the enclosed cross-sectional areas as variables, from the values previously noted on page 20, results in

$$A_y = 3(b_R - \left[\frac{b_R - b_T}{L}\right] y) - 1.93$$ for the test specimen and

$$A_y = .0643(C_R - \left[\frac{C_R - C_T}{L}\right] y)^2$$ for the wing.

Reference to any aircraft structural textbook will reveal the equation,

$$\theta_x = \int_0^L \frac{T\ N\ dy}{4A^2\ Gt}$$ as the expression for the twist of a thin shelled structure. Substitution into this equation gives

$$\theta_x = \int_0^x \frac{P\left[.25(b_R - \left[\frac{b_R - b_T}{L}\right] y)\right]\left[2(b_R - \left[\frac{b_R - b_T}{L}\right] y) - 3.43\right] dy}{4Gt\ \left[3(b_R - \left[\frac{b_R - b_T}{L}\right] y) - 1.93\right]^2}$$ for the test specimen and

$$\theta_x = \int_0^x \frac{P\left[.15(C_R - \left[\frac{C_R - C_T}{L}\right] y)\right]\left[1.68(C_R - \left[\frac{C_R - C_T}{L}\right] y)\right] dy}{4Gt\ \left[.0643(C_R - \left[\frac{C_R - C_T}{L}\right] y)^2\right]^2}$$ for the wing.

Since only the relationship between the torsional deflections for the test specimen and the wing is desired, the shear "P" may be considered as a constant. Also, for simplifying the solution of these torsional deflection equations, let

$$E_1 = .25\, b_R \qquad \text{and} \qquad H_1 = .15C_R$$

$$E_2 = -.25\left(\frac{b_R - b_T}{L}\right) \qquad H_2 = -\ .15\left(\frac{C_R - C_T}{L}\right)$$

$$E_3 = 2b_R - 3.43 \qquad H_3 = 1.68C_R$$

$$E_4 = -2\left(\frac{b_R - b_T}{L}\right) \qquad H_4 = -\ 1.68\left(\frac{C_R - C_T}{L}\right)$$

$$E_5 = 3b_R - 1.93 \qquad H_5 = .2535C_R$$

$$E_6 = -\ 3\left(\frac{b_R - b_T}{L}\right) \qquad H_6 = -\ .2535\left(\frac{C_R - C_T}{L}\right)$$

Substitution of these constants and integration of the twist equations results in

$$\theta_x = \frac{P}{4Gt}\left(\left[\frac{E_1E_3}{E_5E_6} - \frac{E_1E_4 + E_2E_3}{E_6^2} + \frac{E_2E_4E_5}{E_6^3}\right]\left[1 - \left(\frac{E_5}{E_5 + E_6x}\right)\right] + \frac{E_2E_4x}{E_6^2} + \left[\frac{E_1E_4 + E_2E_3}{E_6^2} - \frac{2E_2E_4E_5}{E_6^3}\right]\left[\text{Log}\left(\frac{E_5 + E_6x}{E_5}\right)\right]\right)$$

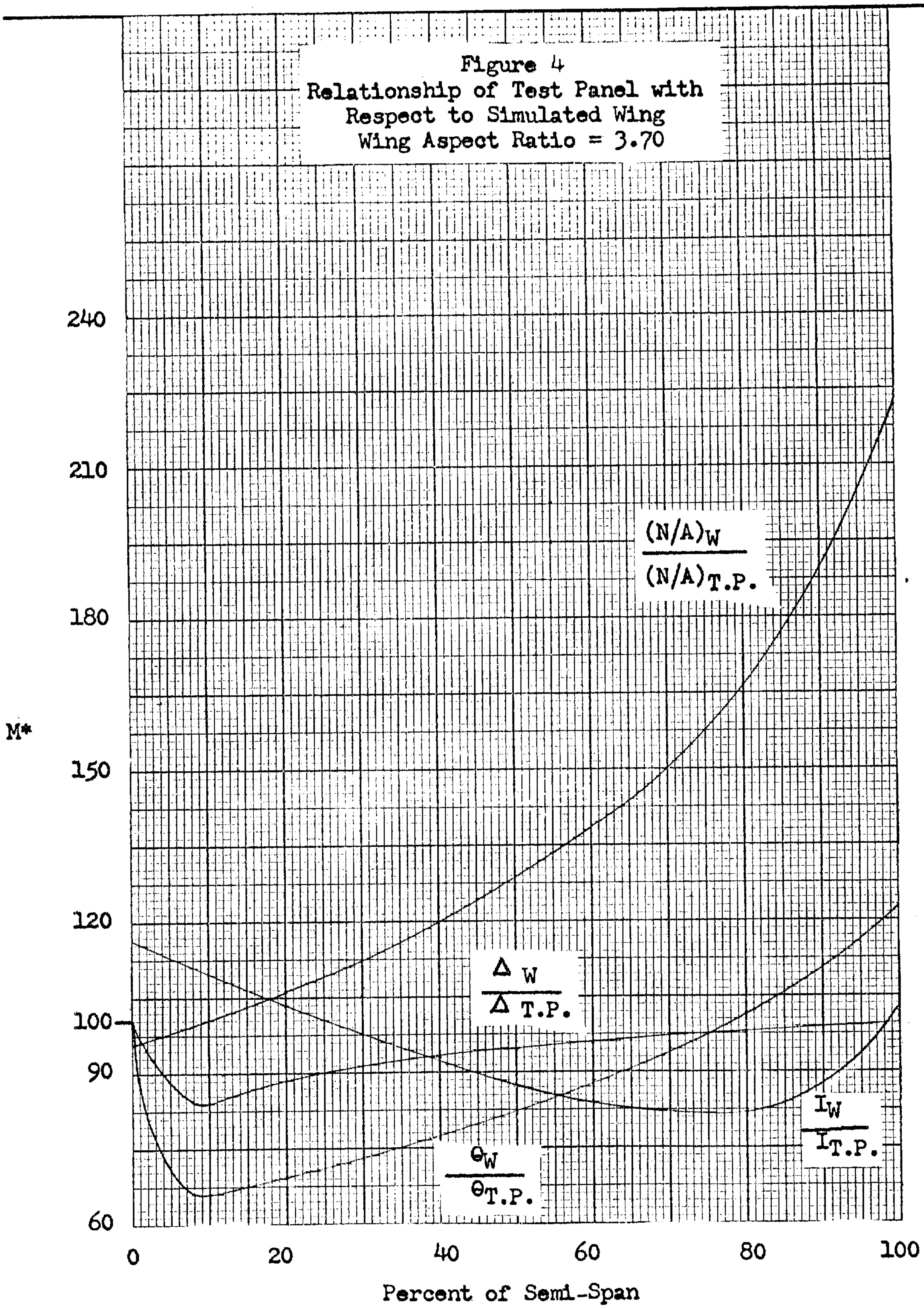
for the test panel

and

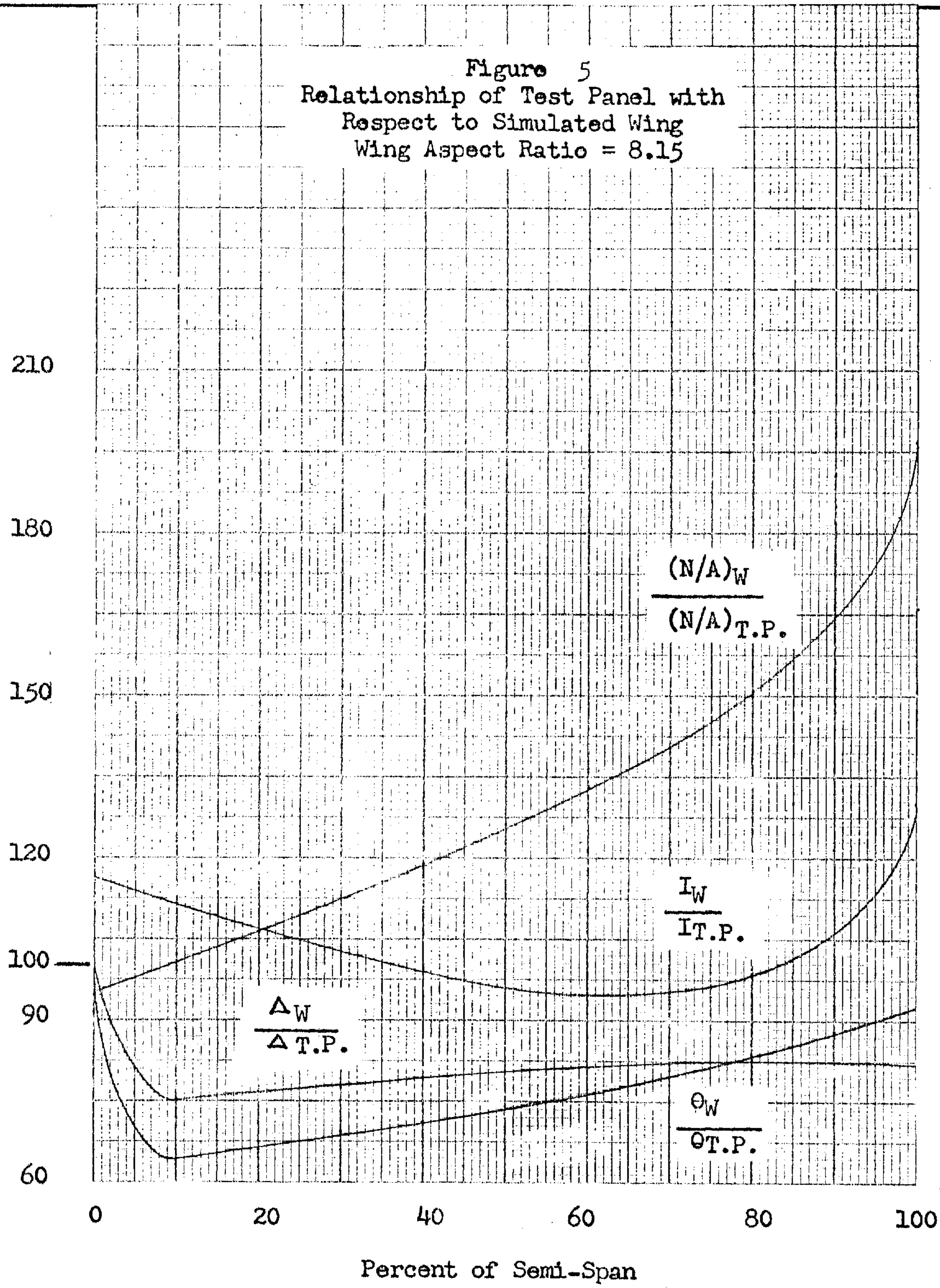
$$\theta_x = \frac{P}{4Gt}\left(\left[-\frac{H_2H_4}{H_6^3}\right]\left[\frac{1}{H_5 + H_6x}\right] - \left[\frac{H_1H_4 + H_2H_3}{2H_6^2} - \frac{H_2H_4H_5}{H_6^3}\right]\left[\frac{1}{H_5 + H_6x}\right]^2 - \left[\frac{H_1H_3}{3H_6} - \frac{H_5(H_1H_4 + H_2H_3)}{3H_6^2} + \frac{H_2H_4H_5^2}{3H_6^3}\right]\left[\frac{1}{H_5 + H_6x}\right]^3 + \frac{H_2H_4}{3H_5H_6^3} + \frac{H_1H_4 + H_2H_3}{6H_5^2H_6^2} + \frac{H_1H_3}{3H_5^3H_6}\right)$$

for the wing.

Dividing the twist equation for the wing by the twist equation for the test specimen and evaluating the solution results in the comparison curves shown in Figures 4 and 5.



*Non-dimensional multiplication factor for converting test panel parameters to corresponding simulated wing parameters.



*Non-dimensional multiplication factor for converting test panel parameters to corresponding simulated wing parameters.

DETERMINATION OF AERODYNAMIC LOADS

It was necessary to define a structural design criteria so that the airloads on the wings could be determined. The intentional maneuver requirements of the aircraft are considered to be quite small since only a reconnaisance mission was assumed. An incremental load factor over level flight of $\pm$ 1.0 should be adequate, this permits the performance of 60 degree level flight banked turns and any other minor pitch maneuvers that may be required such as in take-off and landing. The wing shall also be capable of accepting an unsymmetrical spanwise loading condition that is realized when full aileron is applied during level flight.

The aircraft and of course the wing, must also be capable of accepting the airloads when gusts are encountered. It is recognized that the probability of gust occurance during the performance of this mission is less than conventional aircraft, therefore it is reasonable to consider a design derived gust value of 30 ft. per sec. which changes with altitude as shown in Figure 6.

The geometry of the aerodynamic equivalents of the test specimens are shown in Figures 1 and 2. A parametric analysis of the aircraft utilizing wings of the form shown in these figures yielded the following initial cruise lift coefficients for the best L/D.

Aspect Ratio	Sweep Angle @ $\frac{C}{4}$	C_L
8.15	9.6	.32
3.70	22.5	.35

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These best lift coefficients are based on the performance of the following assumed mission:

$$M = .8$$

$$h = 80{,}000 \text{ feet}$$

$$R = 4{,}000 \text{ nautical miles}$$

It should be noted that the optimization of C_L is based on the best L/D when the initial wing loading is permitted to change rather than on the usual parameter $\frac{\sqrt{C_L}}{C_D}$ when the initial wing loading is fixed. This can be seen in the following equations:

$$R_{max} = \frac{2}{sfc} \left(\frac{\sqrt{C_L}}{C_D} \right)_{max} \sqrt{\frac{W}{S}} \sqrt{\frac{295}{\delta}} \left[1 - \left(\frac{W_1}{W_0} \right)^{\frac{1}{2}} \right] \quad \sqrt{\frac{W}{S}} = \sqrt{C_L q}$$

$$R_{max} = \frac{2}{sfc} \left(\frac{C_L}{C_D} \right)_{max} \sqrt{\frac{295q}{\delta}} \left[1 - \left(\frac{W_1}{W_0} \right)^{\frac{1}{2}} \right]$$

The result of this parametric study is shown in Figures 7 and 8. The initial wing loading ($n_z = 1.0$ flight) for each wing is as follows:

$$\frac{W}{S} = C_L q \qquad q = 27.2 \ \#/\text{ft.}^2 \ (M = .8 \text{ at } 80{,}000 \text{ ft altitude})$$

Aspect Ratio	W/S = #/ft.^{2}
8.15	8.70
3.70	9.52

By the consideration of the gust criteria as defined above and level flight not to exceed the dynamic pressure (q) of M = .8 at 80,000 ft altitude, the load factor ($1 + n_{z\ gust}$) as a function of altitude are shown in Figures 9 and 10 respectively for the aspect ratio 8.15 and 3.70 wings.

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The method and equations which were used for this calculation are from Reference 1 and are as follows:

$$n_z = \frac{Kg\ Ve\ Ude\ a}{498\ \frac{W}{S}}$$

Where Kg is the alleviation factor obtained from Reference 1 which required the calculation of the mass parameter (μ_g).

$$\mu_g = \frac{2\ W/S}{p\ g\ \bar{c}\ a}$$

It will be noted that the load factor from gust considerations are in excess of the maneuver requirements. The design load factors are as follows:

Aspect Ratio	n_z
8.15	2.82
3.70	2.26

The unit symmetrical spanwise loading on each wing panel was determined by the graphical method outlined in Reference 2. The spanwise loadings for the wings for a lift coefficient of 1.0 are shown in Figures 11 and 12. For the design load factor and the dynamic pressure of the flight condition, the spanwise loading is determined as follows:

$$C_L C q = n_z \left[(C_L)_{n_z} = 1.0 \right] \frac{\bar{c}\ q\ C_L\ c}{C_L\ \bar{c}}$$

Figures 13 and 14 are then the symmetrical spanwise loadings for the two wing panels.

As noted in the above section on the structural design criteria the wing must be capable of accepting an unsymmetrical spanwise loading when ailerons are deflected. Some estimate of the aileron requirements however, must be made.

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The helix angle criteria $\frac{pb}{2V}$ of .09 for the observer - light plane catagory was assumed to be desirable for this aircraft. With an aileron spanning the outboard 50% of the semispan and with an aileron chord ration of .2 and with a total deflection of 30 degrees (15 degrees each side) this helix angle can be accomplished. For both wing panels this is calculated as follows:

$$\left(\frac{pb}{2V}\right)_{effective} = .8\left[\gamma'\left(\frac{d\alpha}{d\delta}\right)\Delta\delta\right]$$

$$= .8\left[.0096 \times .4 \times 30\right] = .092$$

In the above equation, the factor .8 accounts for the consideration of elasticity of the structure; the balance of the equation and the numerical values are from Reference 3.

Another criteria of aileron design is the desire of a $\frac{pb}{2}$ of 10'/sec. which is the value associated with bomber aircraft at a level flight speed corresponding to .8 $C_{L\,max}$. With $C_{L\,max}$'s of 1.2 and 1.0 for aspect ratio's of 8.15 and 3.70 respectively, the $\frac{pb's}{2}$ are as follows:

Aspect Ratio	$\frac{pb}{2}$
8.15	8.1
3.70	9.2

This is deemed satisfactory for the purpose of this estimate.

The spanwise loading for the unsymmetrical case is determined on the basis that the deflection of the aileron is equivalent to a basic loading on the wing caused by a sudden twist of the wing in the aileron section. The Shrenk method of calculation of the spanwise loading was used as described in Reference 4. The additional loading for a load factor of 1.0

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plus the incremental basic loading due to aileron are shown in Figures 15 and 16 for the dynamic pressure of 27.2 $\#/ft.^2$ associated with flight at M = .8 at 80,000 ft. altitude. This dynamic pressure was assumed to be realized at low altitude where full aileron is likely to be applied.

The aerodynamic loadings shown in Figures 13, 14, 15, and 16 were simulated by the load schedules shown in Tables 1, 2, 3, and 4. These load schedules were developed by dividing the symmetrical portions of the aerodynamic lift curves into load increments in the spanwise direction. Each load increment was chosen as a multiple of five or ten pounds and its spanwise and chordwise location was made to coincide with the center of pressure of the aerodynamic load it was simulating. The antisymmetrical portions of the lift curves were simulated in the same manner as that noted above except that the load increments were not chosen as multiples of five or ten pounds. It should be noted that an assumed unit weight for the wing of six tenths of a pound per square foot times the appropriate load factor was subtracted from the aerodynamic lift curves before the load schedules were determined.

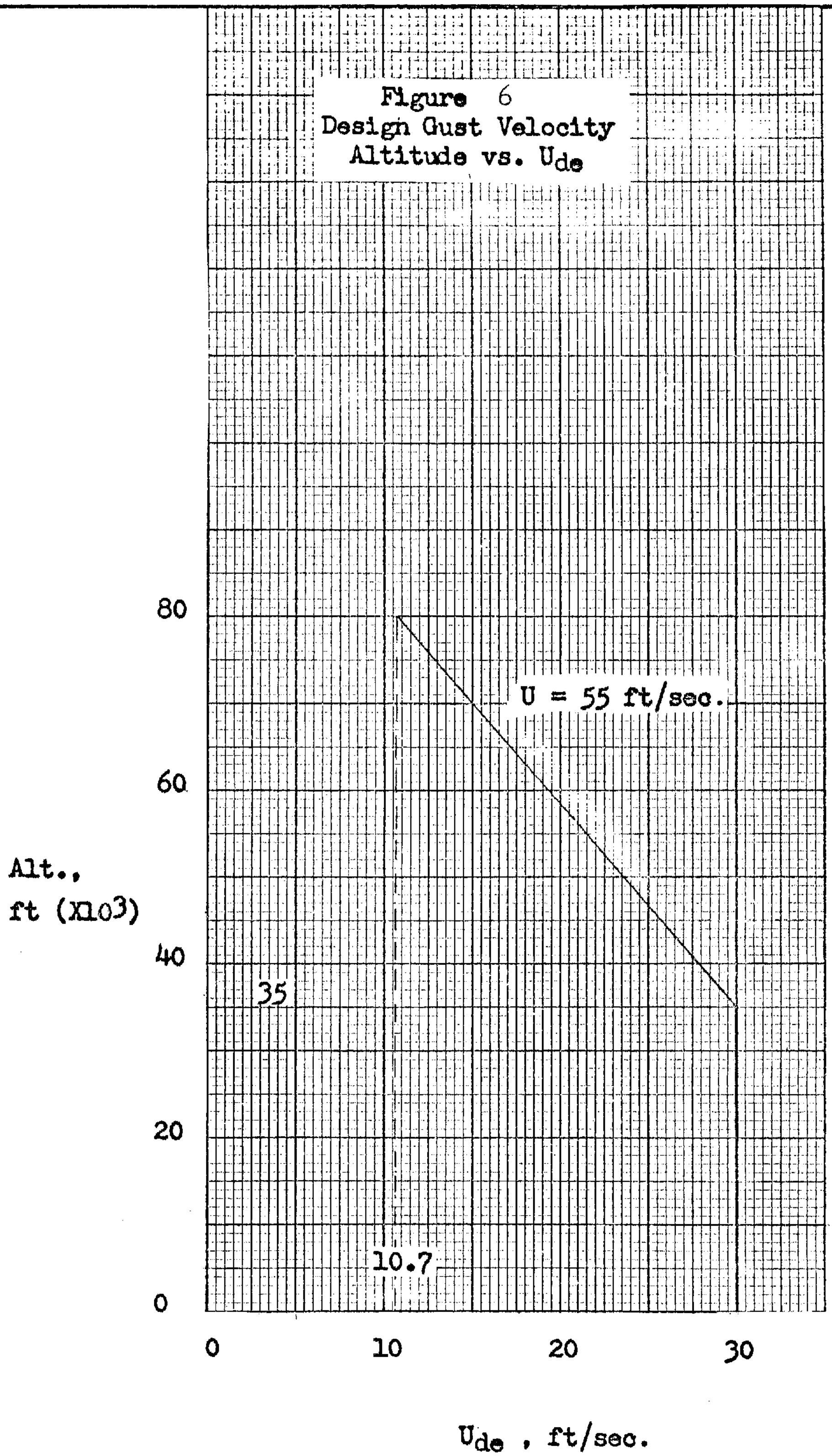


Figure 6
Design Gust Velocity
Altitude vs. Ude
80
60
40
20
0
Alt.,
ft (X10³)
35
U = 55 ft/sec.
10.7
0
10
20
30
Ude , ft/sec.

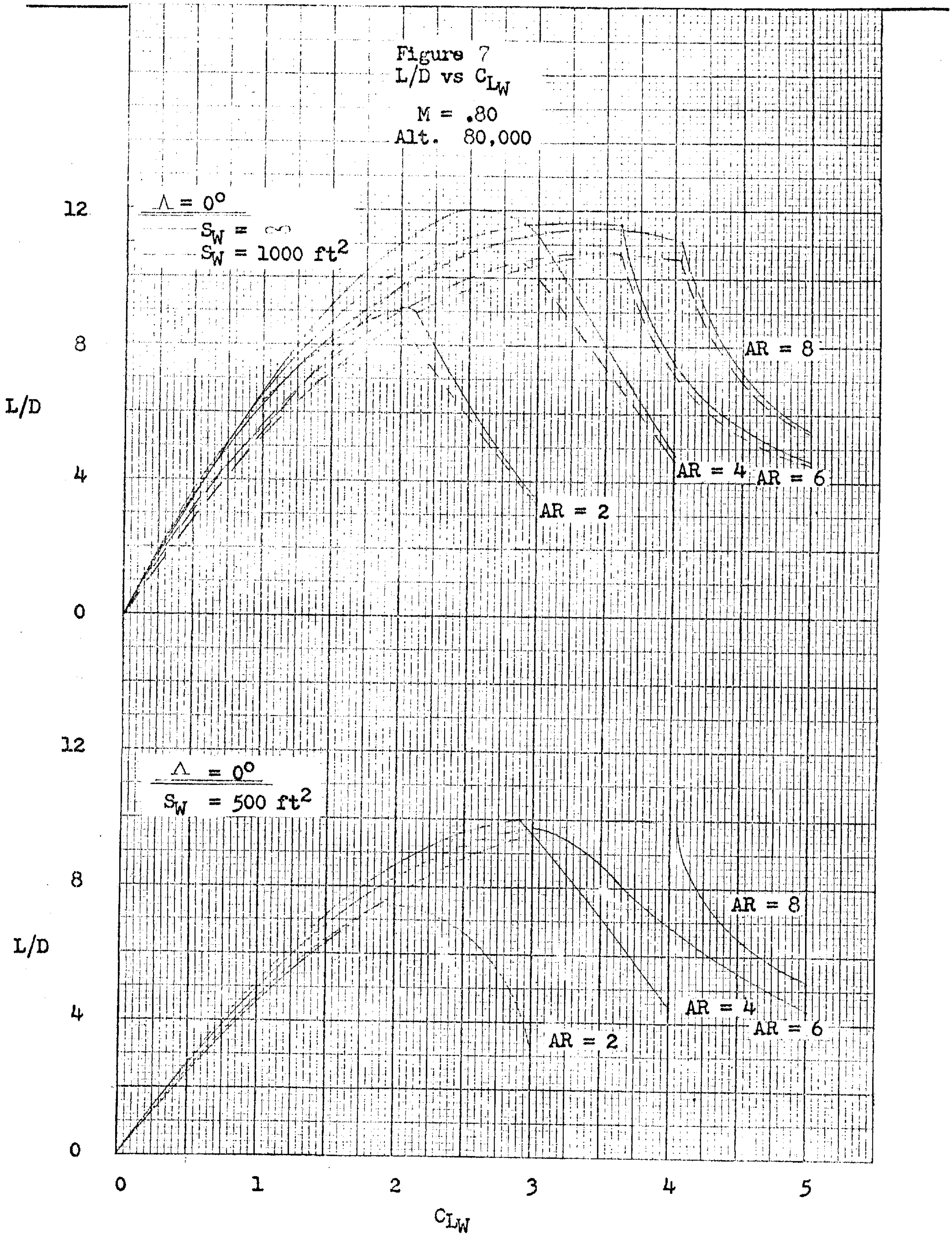


Figure 7
L/D vs C_{L_W}
M = .80
Alt. 80,000
$\Lambda = 0°$
$S_W = \infty$
$S_W = 1000\ ft^2$
AR = 8
AR = 4
AR = 6
AR = 2
$\Lambda = 0°$
$S_W = 500\ ft^2$
AR = 8
AR = 4
AR = 6
AR = 2
L/D
12
8
4
0
L/D
12
8
4
0
0
1
2
3
4
5
C_{L_W}

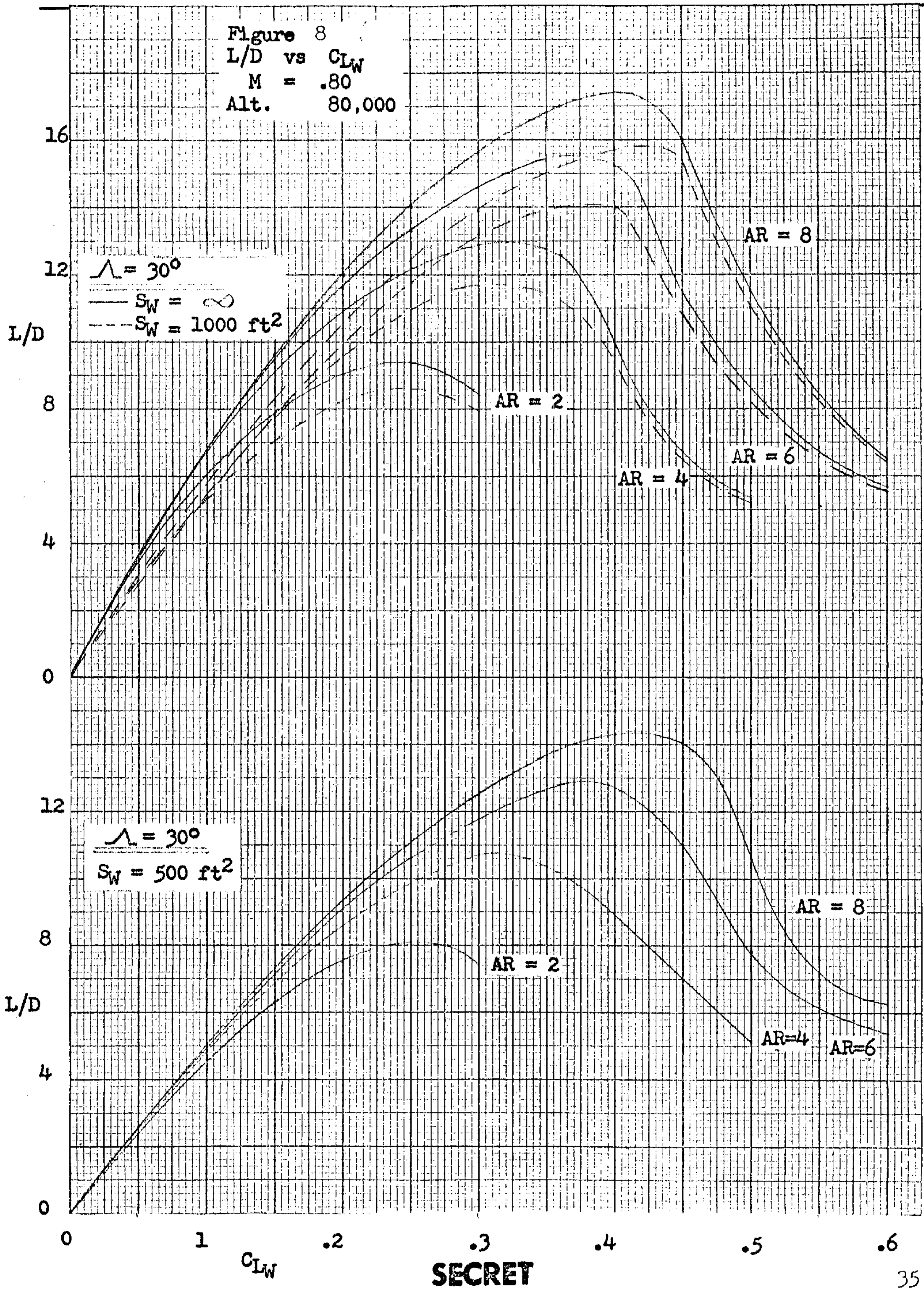
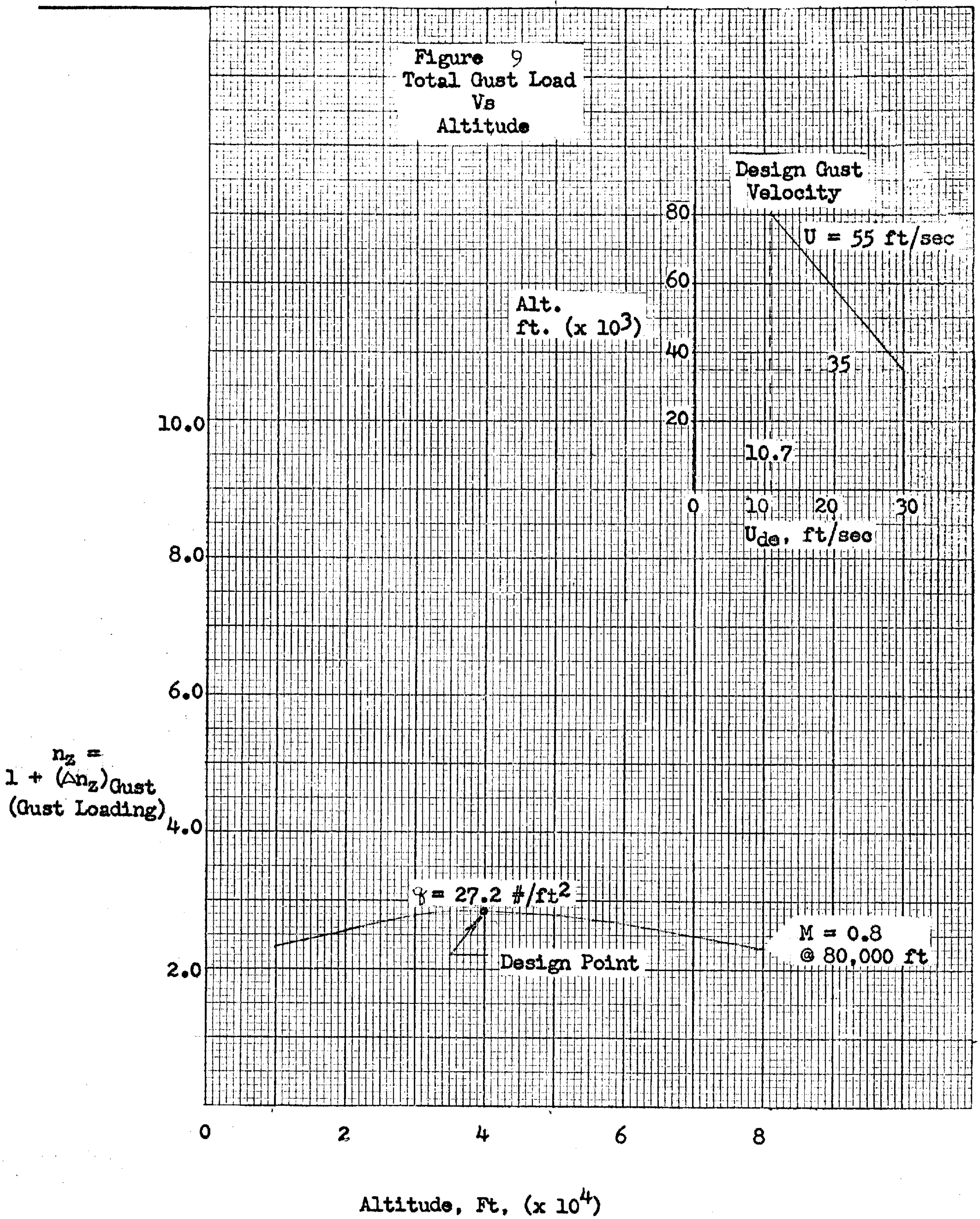
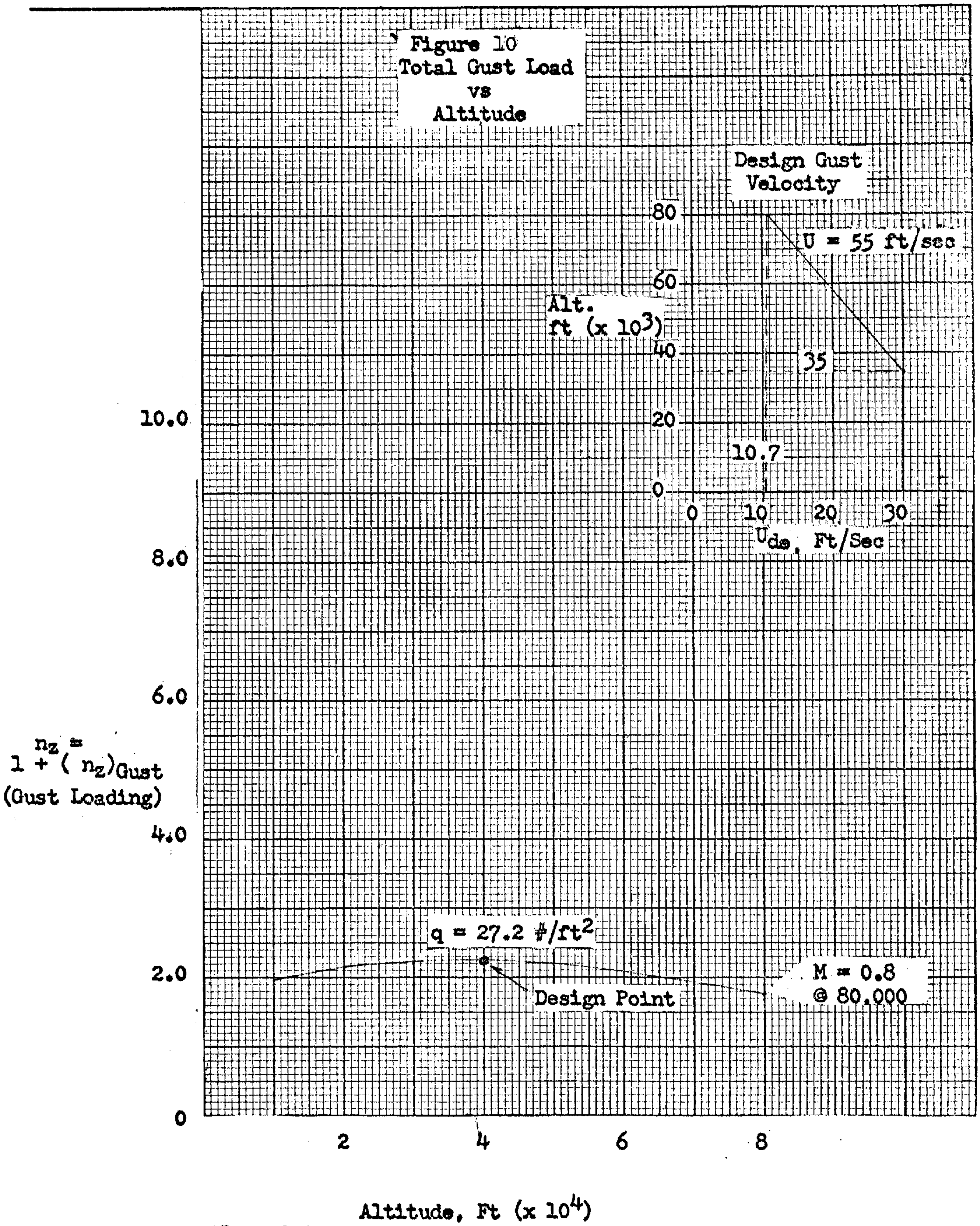


Figure 8
L/D vs C_{L_W}
M = .80
Alt. 80,000
Λ = 30°
S_W = ∞
S_W = 1000 ft²
Λ = 30°
S_W = 500 ft²
AR = 8
AR = 6
AR = 4
AR = 2
AR=4
AR=6
L/D
C_{L_W}
0
4
8
12
16
0
.1
.2
.3
.4
.5
.6

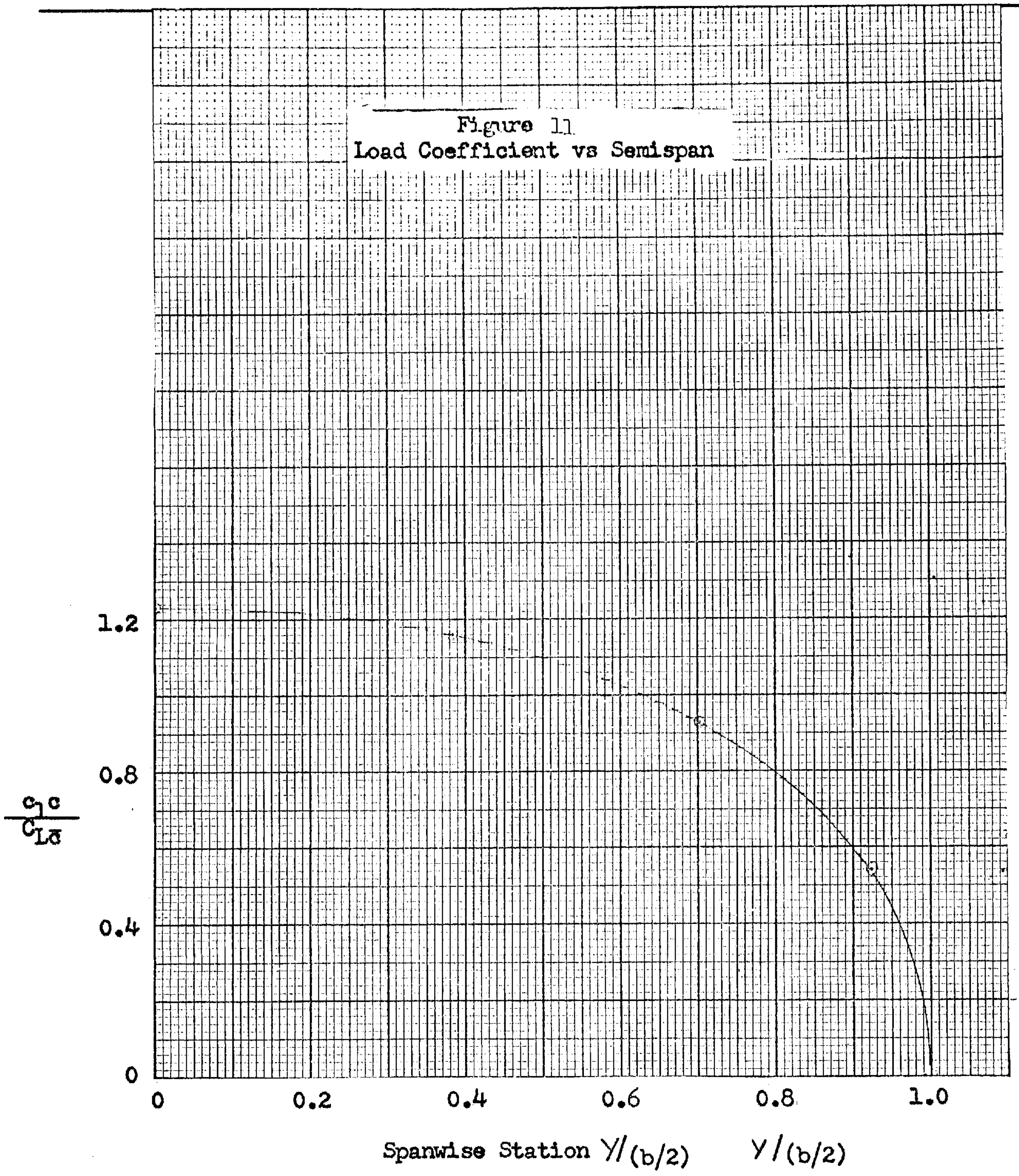


AR = 8.15
$\Lambda_{c/4} = 9.55°$



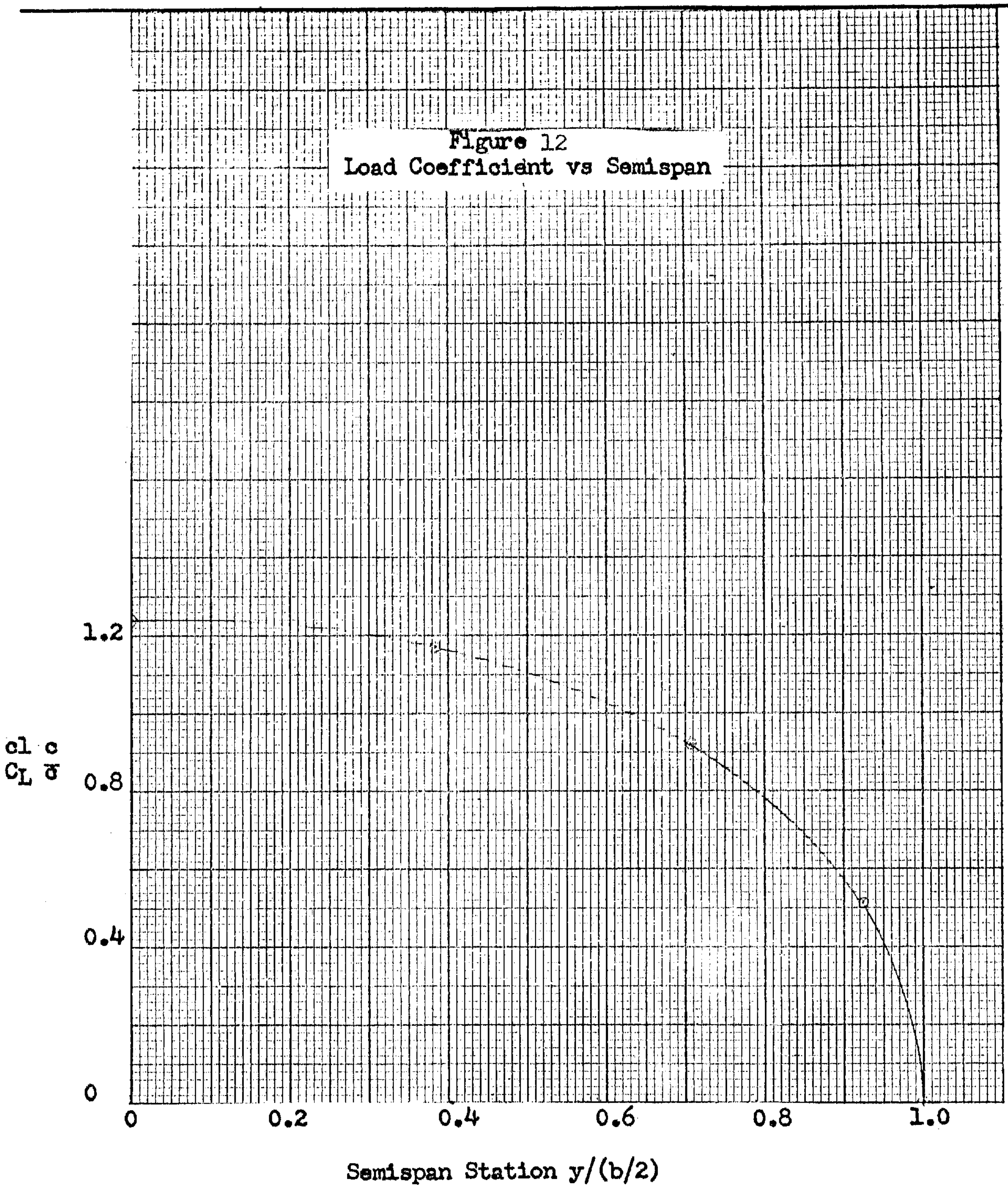
AR = 3.7
$\Lambda_{c/4}$ = 22.35°

Figure 11
Load Coefficient vs Semispan



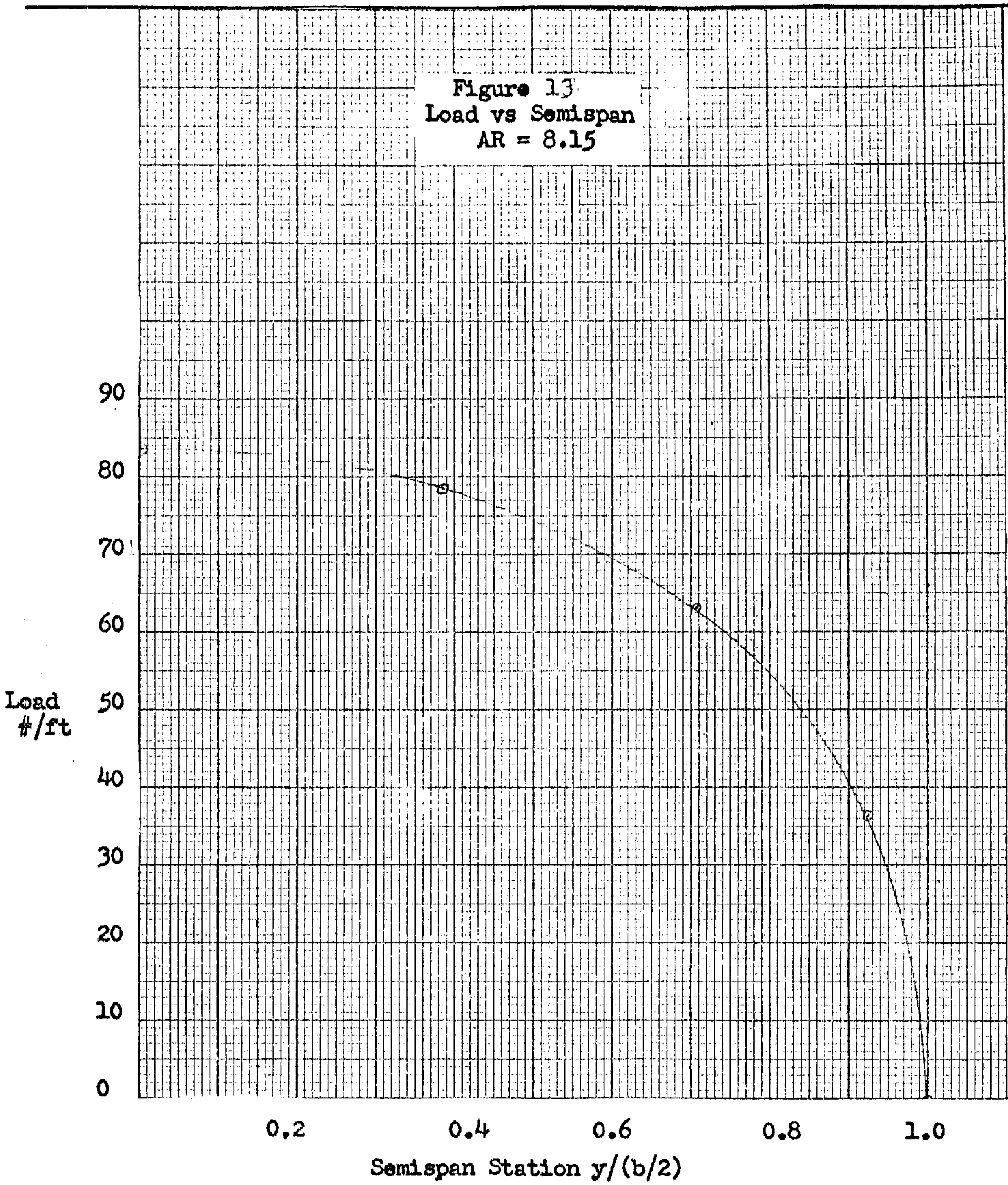
$\Lambda_{\frac{c}{4}} = 9.56^{\circ}$ M = 0.80

$\lambda = 0.565$ AR = 8.15



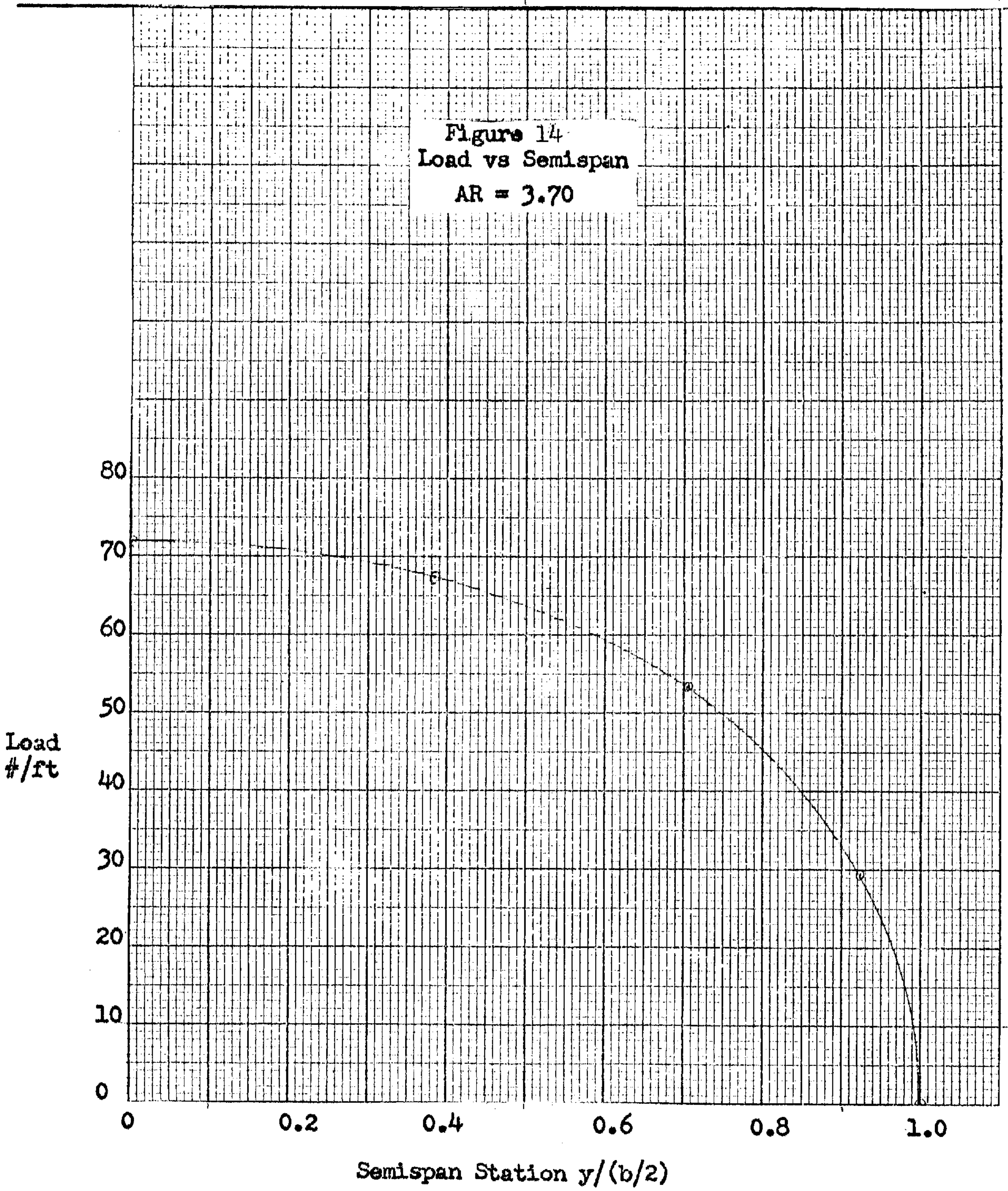
$\Lambda_{\frac{c}{4}} = 22.35°$ AR = 3.70

$\lambda = 0.510$ M = 0.80



R_z = 2.82 @ 40,000 Ft

q = 27.2 $\#/ft^2$



n_z = 2.26 @ 40,000 Ft.

q = 2.72 #/Ft

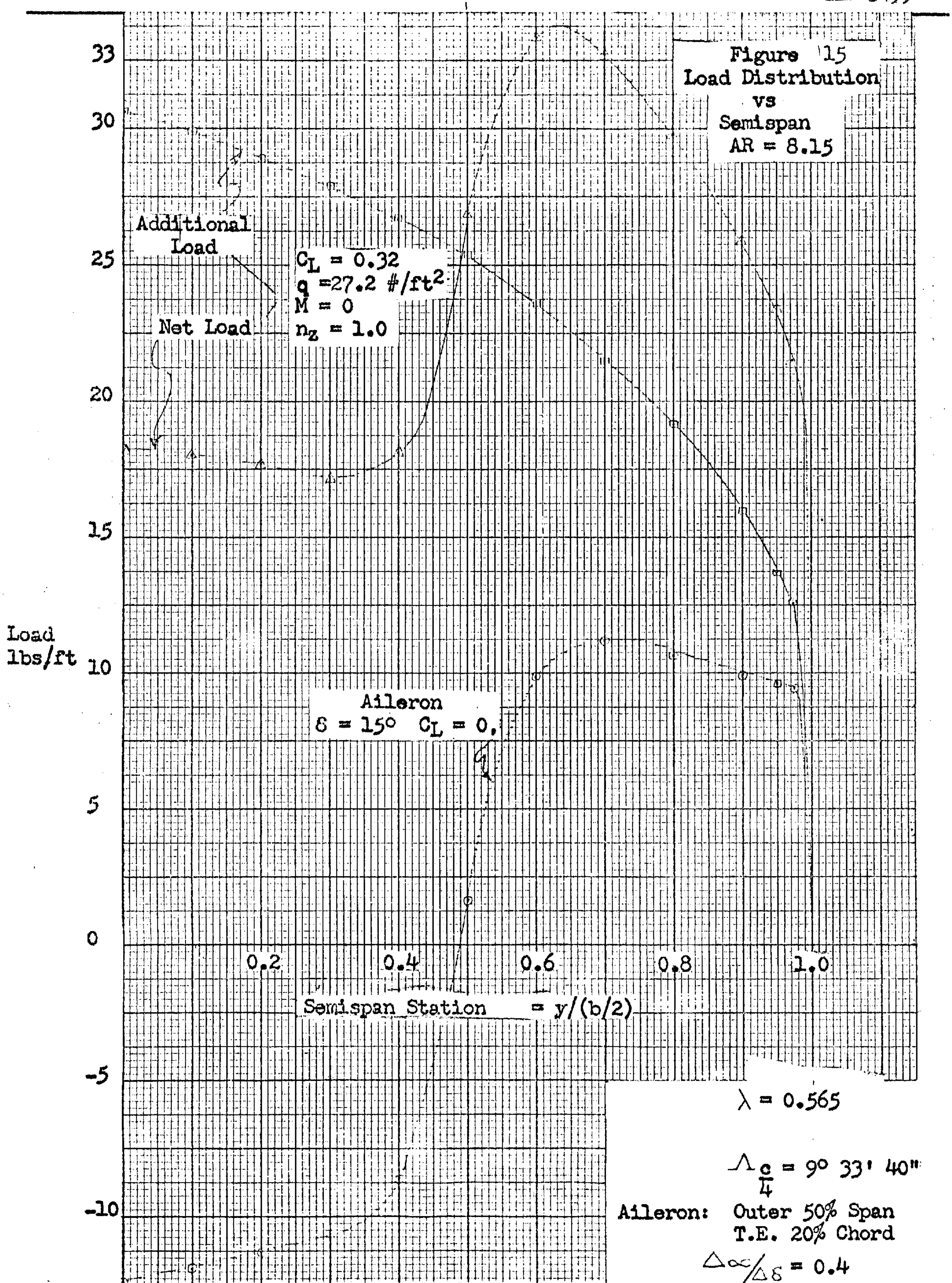


Figure 15
Load Distribution
vs
Semispan
AR = 8.15
Additional Load
Net Load
C_L = 0.32
q = 27.2 #/ft²
M = 0
n_z = 1.0
Aileron
δ = 15° C_L = 0.
Load lbs/ft
33
30
25
20
15
10
5
0
-5
-10
0.2
0.4
0.6
0.8
1.0
Semispan Station = y/(b/2)
λ = 0.565
Λ c/4 = 9° 33' 40"
Aileron: Outer 50% Span
T.E. 20% Chord
Δα/Δδ = 0.4

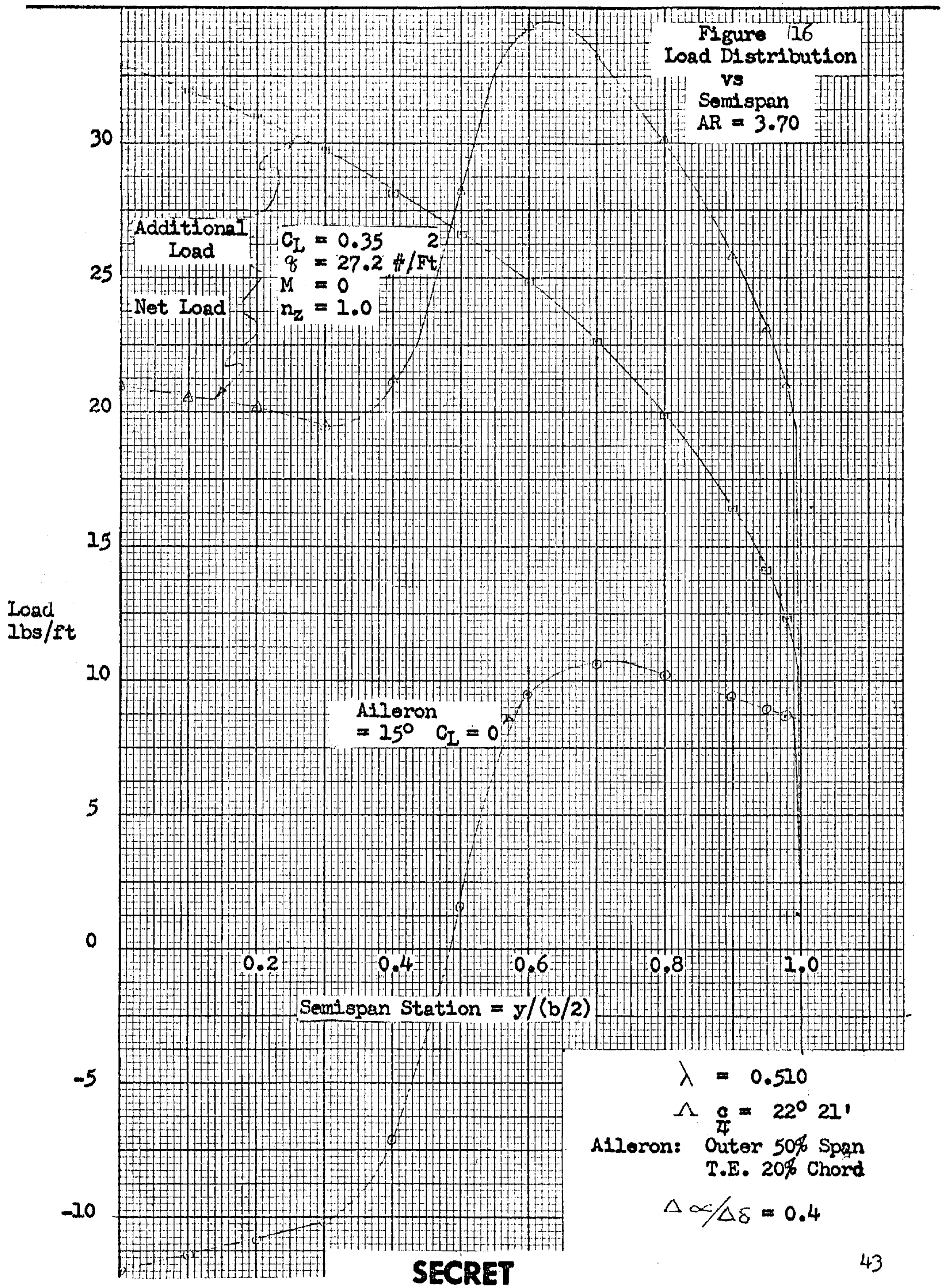


Figure 16
Load Distribution
vs
Semispan
AR = 3.70
Additional Load
Net Load
C_L = 0.35
q = 27.2 #/Ft2
M = 0
n_z = 1.0
Aileron
= 15° C_L = 0
Load lbs/ft
30
25
20
15
10
5
0
-5
-10
0.2
0.4
0.6
0.8
1.0
Semispan Station = y/(b/2)
λ = 0.510
$\Lambda_{\frac{c}{4}}$ = 22° 21'
Aileron: Outer 50% Span
T.E. 20% Chord
$\Delta\alpha/\Delta\delta$ = 0.4

Table 1
Symmetrical Load Schedule*
Wing Aspect Ratio = 3.70

Station**	20% of Load In Pounds	40% of Load In Pounds	60% of Load In Pounds	80% of Load In Pounds	100% of Load In Pounds
4.7		20	30	40	50
5.2	10				
13.9			30	40	50
14.4		20			
15.4	10				
23.5		20	30	40	50
25.8	10				
33.2					
34.3		20	30	40	50
36.7	10				
44.5			30	40	50
46.2	5	20			
54.0	5				
55.0			10	16	21
56.5		5			
Total Load For Half Span	50	105	160	216	271

*All loads applied along the quarter chord line

**Measured in spanwise direction from test panel centerline in inches

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Table 2
Symmetrical Load Schedule**
Wing Aspect Ratio = 8.15

Station Inches From Centerline	15%* Load	30%* Load	45%* Load	60%* Load	75%* Load	88%* Load	100%* Load
2.7		10	15	20	25	30	35
6.0	10						
8.1		10	15	20	25	30	35
13.5		10	15	20	25	30	35
18.0	10						
18.9			15	20	25	30	35
19.5		10					
24.7		10	15	20	25	30	35
29.7	10	10	15	20	25	30	35
35.1		10	15	20	25	30	35
41.0	10	10	15	20	25	30	35
45.9		10	15	20	25	30	35
51.6			15	20	25	30	
53.6	10	10					35
57.5		10	15	20	25	30	35
63.0		10	15	20	25	30	35
69.0	10	10	15	20	25	30	35
75.0			15	20	25	30	35
78.6	10	10			25		
80.5			15	20		30	35
87.0		10	15	20	25	30	

Continued on Following Page

*All loads in pounds.
**All loads applied along the quarter chord line

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Continuation Table 2
Symmetrical Load Schedule**
Wing Aspect Ratio = 8.15

Station Inches From Centerline	15%* Load	30%* Load	45%* Load	60%* Load	75%* Load	80%* Load	100%* Load
89.3		10					35
93.0	10		15	20	25	30	
96.1		10					35
100.0			15	20	25	30	
103.5		10					35
107.5	10		15	20	25	30	
111.8		10			25		35
116.0			15	20		30	
121.5	6	10					35
126.0			12	18	26	25	
129.5		3					8
Total Load For Half Span	96	203	312	418	526	625	708

*All loads in pounds.
**All loads applied along the quarter chord line

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Table 3
Unsymmetrical Load Schedule*
Wing Aspect Ratio = 3.70

Station**	20% of Load In Pounds	40% of Load In Pounds	60% of Load In Pounds	80% of Load In Pounds	100% of Load In Pounds
5.0			15	20	25
5.5		10			
6.6	5				
9.0***	34.5R	69R	103.5R	138R	173R
12.0****	-4.6L 4.6R	-9.2L 9.2R	-13.8L 13.8R	-18.4L 18.4R	-23L 23R
15.5			15	20	25
16.7		10			
20.1	5				
26.2			15	20	25
28.5		10			
34.4	5				
38.3				20	25
41.6		10	15		
46.3*****	4.6L -4.6R	9.2L -9.2R	13.8L -13.8R	18.4L -18.4R	23L -23R
50.1	5				
52.1				16	23
54.3		5	9		
Total Load On Specimen	40	90	138	192	246

* All loads applied along quarter chord line except as noted

** Measured in spanwise direction from test panel centerline in inches

*** Station at outside edge of center support. Load at this station applied by restraining vertical motion. "R" denotes right side of test panel when looking forward

**** "L" and "R" denote left and right side respectively of the test panel when looking forward. Minus indicates up load. At this station loads are applied 13.05 inches aft of the quarter chord line

***** Same as preceding footnote except at this station loads are applied 9.05 inches aft of the quarter chord line

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Table 4
Unsymmetrical Load Schedule*
Wing Aspect Ratio = 8.15

Station**	20% of Load In Pounds	40% of Load In Pounds	60% of Load In Pounds	80% of Load In Pounds	100% of Load In Pounds
5.9		10			
6.5				25	30
7.3	5		20		
9.0***	176R	352R	529R	705R	881R
14.0****	-5.8L 5.8R	-11.6L 11.6R	-17.4L 17.4R	-23.2L 23.2R	-29L 29R
17.7		10			
19.2					30
20.5	5		20	25	
29.8		10			
33.4				25	30
37.0	5		20		
42.1		10			
44.1*****	-5L 5R	-10L 20R	-15L 20R	-20L 20R	-25L 25R
46.0					30
48.8				25	

Continued on following page

* All loads applied along the quarter chord except as noted

** Measured in spanwise direction from test panel centerline in inches

*** Station at outside edge of center support. Load at this point applied by restraining vertical motion. "R" denotes right side of test panel when looking forward.

**** "L" and "R" denote left and right side respectively of the test panel when looking forward. Minus indicates up load. At this station loads are applied 14.1 inches aft of the quarter chord line

***** Same as preceding footnote except at this station loads are applied 12.7 inches aft of the quarter chord line

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Continuation of Table 4
Unsymmetrical Load Schedule*
Wing Aspect Ratio = 8.15

Station**	20% of Load In Pounds	40% of Load In Pounds	60% of Load In Pounds	80% of Load In Pounds	100% of Load In Pounds
51.2	5				
54.3		10	20		
60.2					30
64.0				25	
66.5	5				
68.0		10			
70.7			20		
75.1					30
81.3	5	10		25	
86.5***	5L -5R	10L -10R	15L -15R	20L -20R	25L -25R
90.1			20		30
97.2	5	10		25	
110.0			20		30
114.0		10			
114.2****	5.8L -5.8R	11.6L -11.6R	17.4L -17.4R	23.2L -23.2R	29L -29R
119.5	5			26	
127.5		3	7		15
Total Load On Specimen	80	186	294	402	510

* All loads applied along the quarter chord line except as noted

** Measured in spanwise direction from test panel centerline in inches

*** "L" and "R" denote left and right side respectively of the test panel when looking forward. Minus indicates up load. At this station loads are applied 10.7 inches aft of the quarter chord line

***** Same as preceding footnote except at this station loads are applied 9.4 inches aft of the quarter chord line.

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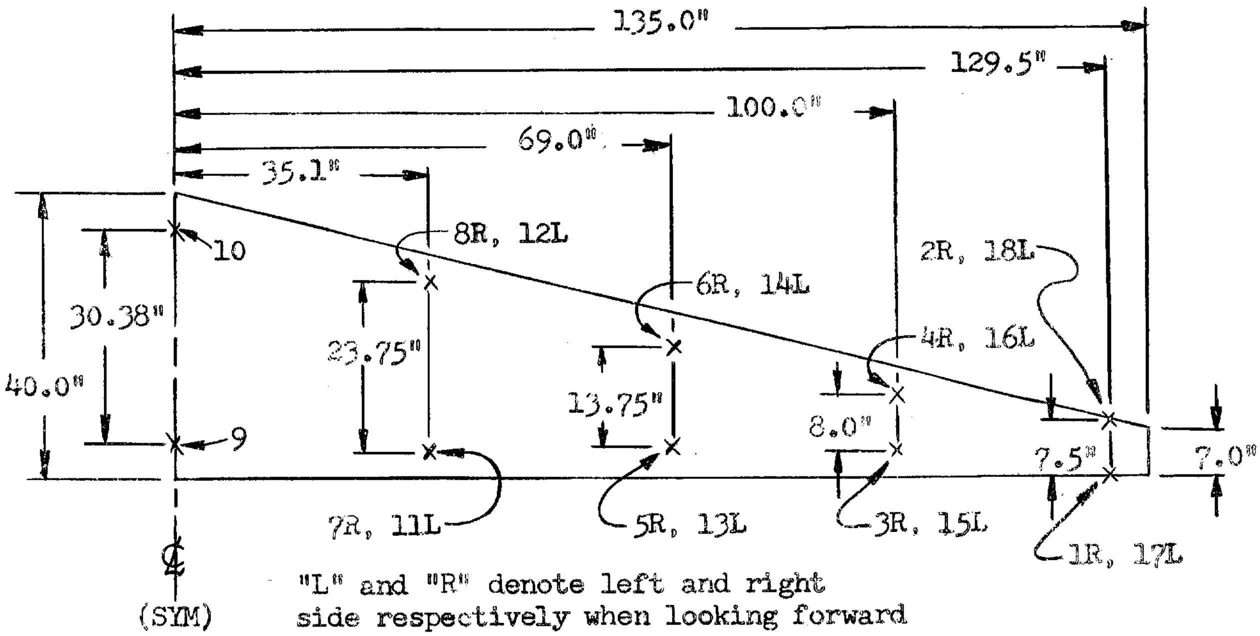
TEST PROCEDURE

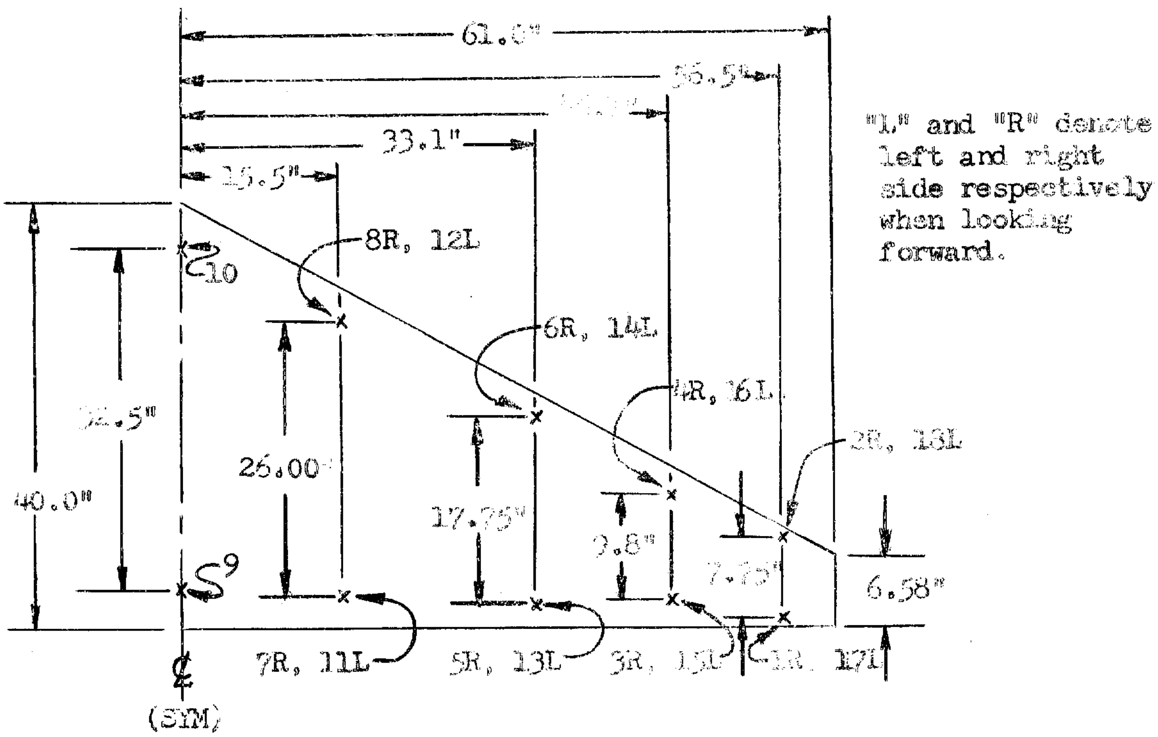
Reference is made to the photographs on pages 122 through 134 for the method of load application and the test jig used. The test procedure consisted of first marking the test speciman with masking tape at locations defining the load application points and attaching scales to the bottom of the test panel so that both torsional and bending deflection readings could be made. The location of these scale attachment points is shown in Figures 17 and 18.

Following this, the specimen was placed in the test jig, rasied, and warp readings recorded for the specimen at the internal pressure under consideration. The test panel was then lowered to the supporting structure of the test jig and the lowest load increment applied. Readings of the scales were taken while the speciman was on the test jig supporting structure. The specimen was then raised until clear of all supporting structure and new readings taken. After reduction of these three sets of readings, the deflection curve for the test panel was obtained. For all load increments at the pressure under consideration, the procedure just described with respect to readings was repeated with the exception that new warp readings were not taken. To get the deflection curves for different internal pressures, it was necessary to repeat the preceding procedure with the exception of the specimen marking and scale attachment.

Two sets of readings were taken to check the contour stability of the large Fortisan test panel while under an internal pressure of forty pounds per square inch. The test panel was placed on two tables twenty-two inches apart. The centerline of the test panel was made to coincide with the midline of the twenty-two inches between the tables. Five readings along the centerline of both the top and bottom of the specimen were taken for zero, sixty, and one-hundred and twenty pound loadings. The sixty and one hundred and twenty pound loads were distributed along this centerline.



Scale Locations
(Aspect Ratio = 8.15)
Figure 17



Scale Locations
(Aspect Ratio = [illegible])
Figure 18

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TEST RESULTS

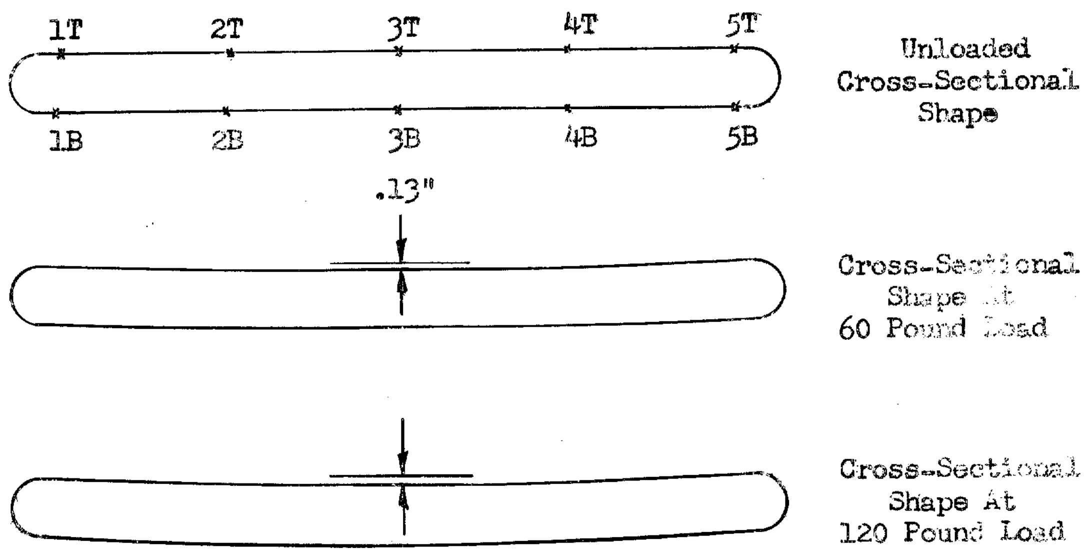
The test results are presented in two different forms in Appendices "A" and "B". In appendix "A" are tables 6 through 37, in which the measured data and its reduction for the test panels are shown. Also in this section are tables 38 through 41 showing the conversion of deflections for some of the test specimens to the corresponding values for the simulated wing. Appendix "B" are Figures 20 through 33 which graphically show the test specimen deflections. Also graphically presented in Figure 34 through 36 are some deflection curves to indicate internal pressure and cover ply material effects. The deflections which could be expected of the simulated wings are shown in Figures 37 through 40.

The measured values of the deflections were not entirely symmetrical. This can be attributed to two major sources. The first is the cover ply layups which were evidently not under a constant tension when they were attached to the airmat. As a result, the stiffness of the cover plys varied over the span length. The second source of error was the initial warp of the specimens. This error was undoubtedly reduced considerably by obtaining initial warp readings under zero external loads and correcting the deflections accordingly.

A total of thirty different tests were run for this program. This was the maximum number of tests which could be run in the short calendar time allotted. Since a complete envelope of test results covering all internal pressures and loadings for the specimen could not be obtained, it was necessary to choose which tests were to be run. For this reason specimens were, shortly after receipt and with only a few tests performed, sent to the Fiberglas Department to be covered. The Dacron test panel, representing the wing with an aspect ratio of 3.70, was damaged and could not be tested because it was cured at too high a temperature and internal pressure. The other Fiberglas covered specimen yielded results up to 60% of the maximum symmetrical load. At 80% of the maximum symmetrical load a shear failure in the Fiberglas skin at the wing root connection prevented continuation of the test.

The Fortisan covered specimen, representing the wing with the 8.15 aspect ratio, deflected at 15% of the maximum symmetrical load so much that it wasn't considered necessary to continue the tests on this specimen for any higher percentages of the maximum symmetrical load.

The results of the contour stability check are shown below in Figure 19 and Table 5.



Cross Section Of
Test Panel
Contour Stability Check
Figure 19

Table 5
Contour Change of
Fortisan Specimen
at 40 PSI Internal Pressure

Station*	Reading for Zero Loading	Reading for 60 Pound Loading	Reading for 120 Pound Loading	Deflection for 60 Pound Loading	Deflection for 120 Pound Loading
1T	6.38	6.41	6.44	.03	.06
2T	7.12	7.22	7.33	.10	.21
3T	7.56	7.69	7.84	.13	.28
4T	7.31	7.42	7.53	.11	.22
5T	6.88	6.84	6.80	.04	.08
1B	4.19	4.16	4.13	.03	.06
2B	3.28	3.18	3.07	.10	.21
3B	3.08	2.96	2.82	.12	.26
4B	3.13	3.02	2.91	.11	.22
5B	3.47	3.43	3.39	.04	.08

*Reference Figure 19.

It was not possible to actually simulate a wing cross-section, because the leading and trailing edge radii of the test panel have a shape stiffness whereas a comparable stiffness does not exist in the NACA 66-010 airfoil. The results of the contour check on the test panel merely indicate this leading and trailing edge stiffness and it is probable that even smaller contour deviations would occur on an airfoil shape.

CONCLUSIONS AND RECOMMENDATIONS

The test results obtained show the structural feasibility of using airmat, in some form, as an airframe material for an aircraft capable of flying under the loads and at the speeds described in the aerodynamic section of this report.

For wings with an aspect ratio of four of less, airmat in its simplest form will meet the structural requirements. The deflections measured in this test for the wing with the 3.70 aspect ratio are considerably more severe than a wing on an airplane would experience. This is because the airplane wing would have a better mass distribution; that is, weight in the form of nacelles properly located on the wing which would reduce the deflections.

High aspect ratio wings made of airmat employing fiberglas as a cover ply material and epoxy resins as the bonding agent are very stiff and thus feasible from the structural viewpoint. In a comparison of this wing construction and a fiberglas wing having a foam core, the airmat wing with the fiberglas cover plys should be lighter. In the airmat wing, better utilization may be made of the fiberglas strength. The reason for this is the elimination of buckling under compression as a problem and the ability to make full use of the high tensile strength of fiberglas. In the fiberglas covered airmat wing, the air plus the drop threads and the single nylon rubber impregnated cover ply would probably be lighter than the comparable foam core needed to stabilize the compression side of the fiberglas wing.

From these tests, the general conclusion may also be drawn that the stiffness of an airmat structure increases with the internal pressure.

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This suggests the possible use of conical shaped fabric spars under high internal pressures for achieving stiffness in conjunction with lightweight airmat for maintaining the airfoil shape.

Another possibility for obtaining a very stiff airmat structure is through the use of fiberglas cloth with a neoprene bonding agent, thereby taking advantage of the stiffness qualities of fiberglas yet yielding a material with limited folding capabilities.

Some further development work would be required for any of these suggested methods to yield optimum results with respect to strength, stiffness, weight and radar reflectivity. It should be noted though, that on the basis of the test results presented in this report, the success of such a development program seems assured.

With this in mind, and as a first step, it is recommended that a parametric study, encompassing the mission requirements and the suggested structures, be initiated.

The results of such a parametric study should further substantiate the feasibility of using airmat, in some form, as the airframe material for a high speed, high altitude reconnaisance airplane.

APPENDIX A

TEST RESULTS IN

TABULAR FORM

EXPLANATION OF COLUMN HEADINGS FOR DEFLECTION TABLES

SYMMETRICAL LOADINGS

(1) Points where deflections measured, reference Figures 17 and 18 on page 52.

(2) Zero readings taken when specimen loaded but resting on jig supporting structure.

(3) Loaded readings taken when specimen loaded and rasied clear of jig supporting structure.

(4) Difference of columns one and two which represent deflections plus initial warp of structure measured with respect to transit level.

(5) Initial warp of specimen measured with respect to a plane through the specimen centerline. Reference Tables 6 and 7 on pages 62 and 63.

(6) Summation of columns four and five which eliminates the initial warp of the specimen from the deflection readings.

(7) Subtraction of the deflection reading at point nine, column six, from the deflection readings at all odd numbered points in column six. Substraction of the reading at point ten from the readings at all even numbered points in column six. This operation changes the deflection reference plane from the transit level to a plane through the specimen centerline.

(8) Subtraction of the sum of the two tip deflections at one end from the sum of the two tip deflections at the other end of column seven divided by two represents the average difference between the tip deflections.

Division of this average difference between the tip deflections by the span length is the tangent of the angle through which the deflection reference plane should be rotated to make the center support level. Correction of all the deflection readings of column seven are made by the addition or substraction of the factor obtained by multiplying the distance from the centerline by the tangent of the angle through which the deflection reference plane should be rotated.

EXPLANATION OF COLUMN HEADINGS FOR DEFLECTION TABLES

UNSYMMETRICAL LOADINGS

(1) Points where deflections measured, reference Figures 17 and 18 on page 52 .

(2) Zero readings taken when specimen loaded with symmetrical portion of load but resting on jig supporting structure.

(3) Loaded readings taken when specimen loaded with both symmetrical and antisymmetrical portion of load and rasied clear of jig supporting structure.

(4) Difference of columns one and two which represent deflections plus initial warp of structure measured with respect to transit level.

(5) Initial warp of specimen measured with respect to a plane through the specimen centerline. Reference Tables 6 and 7 on pages 62 and 63 .

(6) Summation of columns four and five which eliminates the initial warp of the specimen from the deflection readings.

(7) Subtraction of the deflection reading at point nine, column six, from the deflection readings at all odd numbered points in column six. Subtraction of the readings at point ten from the readings at all even numbered points in column six. This operation changes the deflection reference plane from the transit level to a plane through the specimen centerline.

Table 6
Warp Readings
Wing Aspect Ratio = 8.15

Station***	20 PSI*		40 PSI**		60 PSI **	
	Reading ****	Corrected *****	Reading ****	Corrected *****	Reading ****	Corrected *****
1	18.10	-.70	7.95	+9.60	7.70	-6.90
2	18.10	-.70	8.70	+8.85	8.55	-6.20
3	17.90	-.50	11.32	+6.23	9.90	-4.70
4	17.85	-.45	11.74	+5.81	11.10	-3.65
5	17.50	-.10	14.20	+3.35	11.55	-2.05
6	17.50	+.10	15.50	+2.05	12.95	-1.80
7	17.30	+.10	16.70	+.85	13.15	-1.45
8	17.18	+.22	17.15	+.40	13.95	-.8
9	17.40	0	17.55	0	14.60	0
10	17.40	0	17.55	0	14.75	0
11	17.10	+.30	18.20	-.65	17.05	+2.45
12	17.30	+.10	16.75	+.80	15.60	+.85
13	16.70	+.70	20.10	-2.55	22.30	+7.70
14	17.45	-.05	17.50	+.05	19.60	+4.85
15	16.60	+.80	23.40	-5.85	29.90	+15.30
16	17.40	0	21.80	-3.25	27.70	+12.95
17	17.40	0	27.55	-10.00	35.50	+22.90
18	17.40	0	27.75	-10.20	37.70	+22.95

* Cover Ply Material - Dacron with Fiberglas
** Cover Ply Material - Fortisan
*** Reference Figure 17
**** Reading taken with scale against bottom of specimen. Specimen raised clear of test jig with no load on it.
***** Deflection reference plane moved from transit level to a plane through the centerline of the specimen.

Table 7
Warp Readings
Wing Aspect Ratio = 3.70

Station***	20 PSI*		40 PSI*		60 PSI**	
	Reading ****	Corrected *****	Reading ****	Corrected *****	Reading ****	Corrected *****
1	21.49	-.06	21.00	-.10	15.60	+4.85
2	21.46	-.09	20.95	-.15	15.50	+4.50
3	20.63	-.92	20.39	-.71	16.60	+3.55
4	20.53	-1.02	20.08	-1.15	17.08	+2.98
5	20.48	-1.07	20.03	-.60	18.30	+2.15
6	20.35	-1.20	19.90	-1.21	18.90	+1.10
7	21.07	-.48	20.71	-.39	19.60	+.85
8	20.99	-.56	20.68	-.42	20.05	-.05
9	21.55	0	21.10	0	20.45	0
10	21.55	0	21.10	0	20.00	0
11	22.09	+.54	21.49	+.39	21.10	-.65
12	22.11	+.56	21.52	+.42	19.90	+.10
13	22.62	+1.07	21.70	+.60	22.00	-1.55
14	22.75	+1.20	22.31	+1.21	20.55	-.55
15	22.91	+1.36	21.81	+.71	23.50	-3.05
16	22.57	+1.02	22.05	+.95	22.55	-2.55
17	21.59	+.04	21.17	+.07	25.45	-5.00
18	21.66	+.11	21.26	+.16	25.40	-5.40

* Cover Ply Material - Dacron
** Cover Ply Material - Fortisan
*** Reference Figure 18
**** Reading taken with scale against bottom of specimen. Specimen raised clear of test jig with no load on it.
***** Deflection reference plane moved from transit level to a plane through the centerline of the specimen.

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Table No. 8
Wing Aspect Ratio = 3.70
20% of Maximum Symmetrical Load
at 20 PSI Internal Pressure
Cover Ply Material - Dacron

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*	(8)*
1	3.25	1.42	-1.83	-.06	-1.89	-9.24	-4.86
2	4.12	2.55	-1.57	-.09	-1.66	-9.31	-4.93
3	3.10	4.58	1.48	-.92	- .56	-6.79	-3.21
4	4.10	5.93	1.83	-1.02	- .81	-6.84	-3.26
**5	-19.85	-11.30	4.28	-1.07	3.21	-4.14	-1.55
**6	-20.15	-10.90	4.62	-1.20	3.42	-4.23	-1.64
**7	-16.20	- 3.80	6.20	- .48	5.72	-1.63	- .41
8	3.00	9.53	6.53	- .56	5.97	-1.68	- .46
**9	-13.40	- 1.30	7.35	0	7.35	0	0
**10	-21.00	- 5.70	7.65	0	7.65	0	0
**11	-19.65	- 4.50	7.58	+ .54	8.12	+ .77	- .45
**12	-17.80	- 2.20	7.80	+ .56	8.36	+ .71	- .51
**13	-14.80	- .20	7.30	+1.07	8.37	+1.02	-1.57
14	5.40	12.85	7.45	+1.20	8.65	+1.00	-1.59
15	5.60	11.96	6.36	+1.36	7.72	+ .37	-3.21
16	4.68	11.76	7.08	+1.02	8.10	+ .45	-3.13
17	5.32	12.05	6.73	+ .04	6.77	- .58	-4.96
18	3.40	10.48	7.08	+ .11	7.19	- .46	-4.84

*Reference page 59 for explanation of column headings.

**These scales were half-scale and inverted.

77-10C(1-53)

Table No. 9
Wing Aspect Ratio = 3.70
40% of Maximum Symmetrical Load
at 20 PSI Internal Pressure
Cover Ply Material - Dacron

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*	(8)*
1	3.22	0	-3.22	-.06	-3.28	-12.53	- 8.08
2	4.04	.92	-3.12	-.09	-3.21	-13.02	- 8.57
3	2.81	4.20	1.39	-.92	.47	- 8.78	- 5.14
4	3.78	5.60	1.82	-1.02	.80	- 9.01	- 5.37
**5	-20.35	-9.95	5.21	-1.07	4.14	- 5.11	- 2.48
**6	-21.05	-9.60	5.73	-1.20	4.53	- 5.28	- 2.65
**7	-16.50	- .80	7.85	- .48	7.37	- 1.88	- .64
8	2.61	-11.81	9.20	- .56	8.64	- 1.17	+ .07
**9	-13.50	+5.00	9.25	0	9.25	0	0
**10	-21.68	-2.06	9.81	0	9.81	0	0
**11	-19.75	-1.45	9.14	+ .54	9.68	+ .43	- .81
**12	-17.70	+1.00	9.35	+ .56	9.91	+ 1.10	- .14
**13	-14.70	+1.40	8.05	+1.07	9.12	- .13	- 2.76
14	5.40	1.60	8.20	+1.20	9.40	- .41	- 3.04
15	5.64	12.40	6.76	+1.36	8.12	- 1.13	- 4.77
16	4.68	11.54	6.86	+1.02	7.88	- 1.93	- 5.57
17	5.30	10.85	5.55	+ .04	5.59	- 3.66	- 8.11
18	3.36	8.98	5.62	+ .11	5.73	- 4.08	- 8.53

*Reference page 59 for explanation of column headings.

**These scales were half-scale and inverted.

Table No. 10
Wing Aspect Ratio = 3.70
60% of Maximum Symmetrical Load
at 20 PSI Internal Pressure
Cover Ply Material - Dacron

(1) *	(2) *	(3) *	(4) *	(5) *	(6) *	(7) *	(8) *
1	3.01	.60	-2.48	-.60	-2.54	-16.19	-12.44
2	4.00	.90	-3.10	-.09	-3.19	-17.49	-13.74
3	2.74	6.00	3.26	-.92	2.34	-11.31	- 8.24
4	3.80	7.30	3.50	-1.02	2.48	-11.82	- 8.75
**5	-20.48	-3.70	8.37	-1.07	7.30	- 6.35	- 4.13
**6	-21.10	-3.70	8.70	-1.20	7.50	- 6.80	- 4.58
**7	-16.70	+7.30	12.00	- .48	11.52	- 2.13	- 1.09
8	2.61	14.98	12.37	- .56	11.81	- 2.49	- 1.45
**9	-13.70	+13.60	13.65	0	13.65	0	0
**10	-22.00	+ 6.60	14.30	0	14.30	0	0
**11	-19.75	+ 6.10	12.93	+ .54	13.47	- .18	- 1.22
**12	-18.00	+ 8.50	13.25	+ .56	13.81	- .49	- 1.53
**13	-14.70	+ 5.40	10.05	+1.07	11.12	- 2.53	- 4.75
14	5.40	4.20	10.80	+1.20	12.00	- 2.30	- 4.52
15	3.32	11.40	8.08	+1.36	9.44	- 4.21	- 7.28
16	4.76	12.60	7.84	+1.02	8.86	- 5.44	- 8.51
17	5.30	10.15	4.85	+ .04	4.89	- 8.76	-12.51
18	3.88	8.65	4.27	+ .11	4.38	- 9.92	-13.67

*Reference page 59 for explanation of column headings.

**These scales were half-scale and inverted.

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Table No. 11
Wing Aspect Ratio = 3.70
40% of Maximum Symmetrical Load
at 40 PSI Internal Pressure
Cover Ply Material - Dacron

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*	(8)*
1	3.20	3.40	.20	-.10	.10	-9.90	-8.26
2	3.70	3.60	-.10	-.15	-.25	-10.41	-8.77
3	2.90	6.95	4.05	-.71	3.34	- 6.66	-5.32
4	3.52	8.20	4.68	-1.15	3.53	- 6.63	-5.29
**5	-20.10	-6.50	6.80	- .60	6.20	- 3.80	-2.83
**6	-21.30	-5.10	8.10	-1.21	6.89	- 3.27	-2.30
**7	-15.95	+2.75	9.35	- .39	8.96	- 1.04	- .59
8	2.75	12.30	9.55	- .42	9.13	- 1.03	- .58
**9	-13.00	+7.00	10.00	0	10.00	0	0
**10	-21.00	+ .10	10.16	0	10.16	0	0
**11	-19.30	- .90	9.20	+ .39	9.59	- .41	- .86
**12	-17.28	+1.55	9.42	+ .42	9.84	- .32	- .77
**13	-15.35	- .60	7.37	+ .60	7.97	- 2.03	3.00
14	4.66	12.20	7.54	+1.21	8.75	- 1.41	-2.38
15	3.16	8.36	5.20	+ .71	5.91	- 4.09	-5.43
16	3.17	8.26	5.09	+ .95	6.04	- 4.12	-5.46
17	3.94	7.20	3.26	+ .07	3.33	- 6.67	-8.31
18	4.10	7.00	2.90	+ .16	3.06	- 7.10	-8.74

*Reference page 59 for explanation of column headings.

**These scales were half-scale and inverted.

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Table No. 12
Wing Aspect Ratio = 3.70
60% of Maximum Symmetrical Load
at 40 PSI Internal Pressure
Cover Ply Material - Dacron

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*	(8)*
1	3.25	4.65	1.40	-.10	1.30	-11.80	-11.23
2	3.60	4.80	1.20	-.15	1.15	-12.62	-12.05
3	2.90	8.96	6.06	-.71	5.35	-7.75	-7.28
4	3.42	10.20	6.77	-1.15	5.63	-8.14	-7.67
**5	-19.90	-.10	9.90	-.60	9.30	-3.80	-3.46
**6	-21.40	.20	10.80	-1.21	9.59	-4.18	-3.84
**7	-15.80	9.10	12.45	-.39	12.06	-1.04	-.88
8	2.70	15.81	13.11	-.42	12.69	-1.08	-.92
**9	-12.90	13.3	13.10	0	13.10	0	0
**10	-19.55	6.45	13.77	0	13.77	0	0
**11	-19.10	4.35	11.72	+.39	12.11	-.99	-1.15
**12	-17.30	7.50	12.40	+.42	12.82	-.95	-1.11
**13	-15.2	2.9	9.05	+.60	9.65	-3.45	-3.79
14	5.38	14.60	9.22	+1.21	10.43	-3.34	-3.68
15	3.90	8.95	5.05	+.71	5.76	-7.34	-7.81
16	3.95	8.95	5.00	+.95	5.95	-7.82	-8.29
17	3.90	6.20	2.30	+.07	2.37	-10.73	-11.30
18	4.14	6.35	2.21	+.16	2.37	-11.40	-11.97

*Reference page 59 for explanation of column headings.

**These scales were half-scale inverted.

Table No. 13
Wing Aspect Ratio = 3.70
80% of Maximum Symmetrical Load
at 40 PSI Internal Pressure
Cover Ply Material - Dacron

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*	(8)*
1	3.23	3.50	.27	-.10	.17	-14.35	-14.75
2	3.80	3.65	-.15	-.15	-.30	-15.39	-15.79
3	2.91	8.75	5.84	-.71	5.13	- 9.39	- 9.71
4	3.68	10.05	6.37	-1.15	5.22	- 4.87	-10.19
**5	- 20.25	1.00	10.62	- .60	10.02	- 4.50	- 4.73
**6	- 21.10	1.35	11.22	-1.21	10.01	- 5.08	- 5.31
**7	-16.40	11.10	13.75	- .39	13.36	- 1.16	- 1.27
8	2.66	16.84	14.18	- .42	13.76	- 1.33	- 1.44
**9	-13.6	15.35	14.52	0	14.52	0	0
**10	-21.65	8.55	15.10	0	15.10	0	0
**11	-19.70	5.30	12.50	+ .39	12.89	- 1.63	- 1.52
**12	-17.80	8.70	13.25	+ .42	13.67	- 1.42	- 1.31
**13	-15.10	2.60	8.85	+ .60	9.45	- 5.07	- 4.84
14	5.36	14.20	8.84	+1.21	10.05	- 5.04	- 4.81
15	3.26	7.45	4.19	+ .71	4.90	- 9.62	- 9.30
16	3.40	7.48	4.08	+ .95	5.03	-10.06	- 9.74
17	4.04	3.35	-.69	+ .07	-.62	-15.14	-14.74
18	4.35	3.1	-1.25	+ .16	-1.09	-16.18	-15.78

*Reference page 59 for explanation of column headings.

**These scales were half-scale inverted.

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Table No. 14
Wing Aspect Ratio = 3.70
100% of Maximum Symmetrical Load
at 40 PSI Internal Pressure
Cover Ply Material - Dacron

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*	(8)*
1	3.18	4.40	1.22	-.10	1.12	-18.68	-18.92
2	3.20	4.35	1.15	-.15	1.00	-18.06	-18.30
3	2.90	10.56	7.66	-.71	6.95	-10.85	-11.05
4	3.20	11.82	8.62	-1.15	7.47	-11.59	-11.79
**5	-19.65	6.70	13.18	- .60	12.58	- 5.22	- 5.36
**6	-21.90	7.00	14.45	-1.21	13.24	- 5.82	- 5.96
**7	-15.4	18.1	16.75	- .39	16.36	- 1.44	- 1.51
8	2.46	20.52	18.06	- .42	17.62	- 1.44	- 1.51
**9	-12.5	23.1	17.80	0	17.80	0	0
**10	-17.3	14.8	19.06	0	19.06	0	0
**11	-18.80	12.10	15.45	+ .39	15.84	- 1.96	- 1.89
**12	-17.9	14.8	16.35	+ .42	16.77	- 2.29	- 2.22
**13	-14.9	6.80	10.85	+ .60	11.45	- 6.35	- 6.21
14	5.16	16.5	10.34	+1.21	11.55	- 7.51	- 7.37
15	3.34	8.65	5.31	+ .71	6.02	-11.78	-11.58
16	3.20	8.55	5.35	+ .95	6.30	12.76	-12.56
17	4.00	3.15	-.85	+ .07	-.78	-18.58	-18.34
18	4.14	3.4	-.74	+ .16	-.58	-19.64	-19.40

*Reference page 59 for explanation of column headings.

**These scales were half-scale and inverted.

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Table No. 15
Wing Aspect Ratio =13.70
20% of Maximum Symmetrical Load
at 60 PSI Internal Pressure
Cover Ply Material - Fortisan

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*	(8)*
1	6.00	23.03	17.03	4.85	21.88	.12	-1.02
2	5.90	23.61	17.71	4.50	22.21	.45	-.69
3	4.52	23.00	18.48	3.55	22.03	.27	-.59
4	6.32	25.58	19.26	2.98	22.24	.48	-.38
5	-15.04	24.66	19.85	2.15	22.00	.24	-.33
6	-13.98	28.10	21.04	1.10	22.14	.38	-.19
7	-13.14	29.12	21.13	.85	21.98	.22	-.06
8	6.52	27.78	21.26	-.05	21.21	-.55	-.27
9	-11.52	32.00	21.76	0	21.76	0	0
10	-15.70	27.82	21.76	0	21.76	0	0
11	-13.00	31.16	22.08	-.65	21.43	-.33	-.05
12	-17.02	25.64	21.33	+.10	21.43	-.33	-.05
13	-12.40	32.92	22.66	-1.55	21.11	-.65	-.08
14	4.40	25.88	21.48	-.55	20.93	-.83	-.26
15	4.80	28.13	23.33	-3.05	20.28	-1.48	-.62
16	3.52	26.33	22.81	-2.55	20.26	-1.50	-.64
17	6.02	30.80	24.78	-5.00	19.78	-1.98	-.84
18	6.50	31.66	25.16	-5.40	19.76	-2.00	-.86

*Reference page 59 for explanation of column headings.

Table No. 16
Wing Aspect Ratio = 3.70
40% of Maximum Symmetrical Load
at 60 PSI Internal Pressure
Cover Ply Material - Fortisan

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*	(8)*
1	6.02	21.50	15.48	4.85	20.33	-2.52	-2.50
2	5.90	22.00	16.10	4.50	20.60	-2.25	-2.23
3	4.54	22.19	17.65	3.55	21.20	-1.65	-1.64
4	6.33	24.68	18.35	2.98	21.33	-1.52	-1.51
5	-15.02	24.58	19.80	2.15	21.95	-.90	-.89
6	-13.96	27.84	20.90	1.10	22.00	-.85	-.84
7	-13.10	30.50	21.80	.85	22.65	-.20	-.20
8	6.54	29.09	22.55	-.05	22.50	-.35	-.35
9	-11.50	34.20	22.85	0	22.85	0	0
10	-15.68	30.02	22.85	0	22.85	0	0
11	-12.98	33.72	23.35	-.65	22.70	-.15	-.15
12	-17.00	28.10	22.55	.10	22.65	-.20	-.20
13	-12.40	35.00	23.70	-1.55	22.15	-.70	-.71
14	4.40	26.95	22.55	-.55	22.00	-.85	-.86
15	4.81	29.06	24.25	-3.05	21.20	-1.65	-1.65
16	3.52	27.27	23.75	-2.55	21.20	-1.65	-1.66
17	6.03	31.58	25.55	-5.00	20.55	-2.30	-2.32
18	6.50	32.35	25.85	-5.40	20.45	-2.40	-2.42

*Reference page 59 for explanation of column headings.

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Table No. 17
Wing Aspect Ratio = 3.70
60% of Maximum Symmetrical Load
at 60 PSI Internal Pressure
Cover Ply Material - Fortisan

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*	(8)*
1	6.03	20.63	14.60	4.85	19.45	-4.60	-4.60
2	5.91	20.96	15.05	4.80	19.55	-4.50	-4.50
3	4.56	22.12	17.55	3.55	21.10	-2.95	-2.95
4	6.34	24.68	18.35	2.98	21.33	-2.72	-2.72
5	-15.00	26.00	20.50	2.15	22.65	-1.40	-1.40
6	-13.96	28.90	21.43	1.10	22.53	-1.52	-1.52
7	-13.08	32.72	22.90	.85	23.75	-.30	-.30
8	6.55	30.10	23.55	-.05	23.50	-.55	-.55
9	-11.50	36.60	24.05	0	24.05	0	0
10	-15.68	32.42	24.05	0	24.05	0	0
11	-12.96	35.74	24.35	-.65	23.70	-.35	-.35
12	-16.98	30.12	23.55	.10	23.65	-.40	-.40
13	-12.38	36.10	24.24	-1.55	22.69	-1.36	-1.36
14	4.41	27.56	23.15	-.55	22.60	-1.45	-1.45
15	4.82	29.12	24.30	-3.05	21.25	-2.80	-2.80
16	3.53	27.28	23.75	-2.55	21.20	-2.85	-2.85
17	6.04	30.59	24.55	-5.00	19.55	-4.50	-4.50
18	6.51	31.36	24.85	-5.40	19.45	-4.60	-4.60

*Reference page 59 for explanation of column headings.

Table No. 18
Wing Aspect Ratio = 3.70
80% of Maximum Symmetrical Load
at 60 PSI Internal Pressure
Cover Ply Material - Fortisan

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*	(8)*
1	6.05	20.36	14.31	4.85	19.16	-6.58	-6.82
2	5.93	20.54	14.61	4.00	19.11	-6.63	-6.87
3	4.57	22.63	18.06	3.55	21.61	-4.13	-4.31
4	6.35	24.78	18.44	2.98	21.42	-4.32	-4.50
5	-14.98	27.84	21.41	2.15	23.56	-2.18	-2.30
6	-13.94	30.66	22.30	1.10	23.40	-2.34	-2.46
7	-13.06	35.86	24.46	.85	25.31	-.43	-.49
8	6.57	31.53	24.96	-.05	24.91	-.83	-.89
9	-11.48	40.00	25.74	0	25.74	0	0
10	-15.66	35.82	25.74	0	25.74	0	0
11	-12.94	38.78	25.86	-.65	25.21	-.53	-.47
12	-16.96	33.26	25.11	.10	25.21	-.53	-.47
13	-12.38	38.08	25.23	-1.55	23.68	-2.06	-1.96
14	4.42	28.48	24.06	-.55	23.51	-2.23	-2.09
15	4.83	29.39	24.56	-3.05	21.51	-4.23	-4.05
16	3.54	27.40	23.86	-2.55	21.31	-4.43	-4.25
17	6.05	29.86	23.81	-5.00	18.81	-6.93	-6.69
18	6.52	30.43	23.91	-5.40	18.51	-7.23	-6.99

*Reference page 59 for explanation of column headings.

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Table No. 19
Wing Aspect Ratio = 3.70
100% of Maximum Symmetrical Load
at 60 PSI Internal Pressure
Cover Ply Material - Fortisan

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*	(8)*
1	6.07	28.06	11.99	4.85	16.84	-10.14	-8.22
2	5.95	27.98	12.03	4.00	16.53	-10.45	-8.53
3	4.03	31.16	16.57	3.55	20.12	-6.87	-5.43
4	6.36	33.25	16.89	2.98	19.87	-7.11	-5.67
5	-14.96	27.12	21.04	2.15	23.19	-3.79	-2.83
6	-13.92	29.94	21.93	1.10	23.07	-3.95	-2.99
7	-13.04	37.08	25.06	.85	25.91	-1.07	-.59
8	6.58	32.21	25.63	-.05	25.58	-1.40	-.92
9	-11.46	42.50	26.98	0	26.98	0	0
10	-15.64	38.32	26.98	0	26.98	0	0
11	-12.92	41.46	27.19	-.65	26.54	-.44	-.92
12	-16.94	36.12	26.53	.10	26.63	-.35	-.83
13	-12.36	41.78	26.57	-1.55	25.02	-1.96	-2.92
14	4.43	29.86	25.43	-.55	24.88	-2.10	-3.06
15	4.84	30.73	25.89	-3.05	22.84	-4.14	-5.58
16	3.55	28.88	25.33	-2.55	22.78	-11.20	-5.64
17	6.06	31.75	25.69	-5.00	20.69	-6.29	-8.21
18	6.52	32.30	25.78	-5.40	20.38	-6.60	-8.52

*Reference page 59 for explanation of column headings.

Table No. 20
Wing Aspect Ratio = 3.70
20% of Unsymmetrical Load
at 60 PSI Internal Pressure
Cover Ply Material - Fortisan

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*
1	6.00	21.25	15.25	4.85	20.10	.35
2	5.88	21.68	15.80	4.80	20.30	.55
3	4.50	21.10	16.60	3.55	20.15	.40
4	6.30	23.60	17.30	2.98	20.28	.53
5	-15.06	20.54	17.80	2.15	19.95	.20
6	-14.00	24.04	19.02	1.10	20.12	.37
7	-13.16	24.54	18.85	.85	19.70	-.05
8	6.50	25.88	19.38	-.05	19.33	-.42
9	-11.50	28.00	19.75	0	19.75	0
10	-15.70	23.80	19.75	0	19.75	0
11	-13.02	27.98	20.50	-.65	19.85	.10
12	-17.00	22.00	19.50	.10	19.60	-.15
13	-12.40	29.90	21.15	-1.55	19.60	-.15
14	4.41	24.46	20.05	-.55	19.50	-.25
15	4.81	27.06	22.25	-3.05	19.20	-.55
16	3.51	25.26	21.75	-2.55	19.20	-.55
17	6.01	30.01	24.00	-5.00	19.00	-.75
18	6.48	30.88	24.40	-5.40	19.00	-.75

*Reference page 61 for explanation of column headings.

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Table No. 21
Wing Aspect Ratio = 3.70
40% of Unsymmetrical Load
at 60 PSI Internal Pressure
Cover Ply Material - Fortisan

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*
1	6.01	22.37	16.36	4.85	21.21	.35
2	5.88	22.39	16.51	4.50	21.01	.15
3	4.48	22.19	17.71	3.55	21.26	.40
4	6.28	24.44	18.16	2.98	21.14	.28
5	-15.10	22.82	18.96	2.15	21.11	.25
6	-14.02	25.84	19.93	1.10	21.03	.17
7	-13.18	27.04	20.11	.85	20.96	.10
8	6.48	27.36	20.88	-.05	20.83	-.03
9	-11.52	30.20	20.86	0	20.86	0
10	-15.72	26.00	20.86	0	20.86	0
11	-13.04	29.78	21.41	-.65	20.76	-.10
12	-17.02	23.64	20.33	.10	20.43	-.43
13	-12.42	30.80	21.81	-1.55	20.26	-.60
14	4.40	24.93	20.53	-.55	19.98	-.88
15	4.80	27.34	22.54	-3.05	19.49	-1.37
16	3.49	25.22	21.73	-2.55	19.18	-1.68
17	6.00	29.81	23.81	-5.00	18.81	-2.05
18	6.46	30.34	23.88	-5.40	18.48	-2.38

*Reference page 61 for explanation of column headings.

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Table No. 22
Wing Aspect Ratio = 3.70
60% of Unsymmetrical Load
at 60 PSI Internal Pressure
Cover Ply Material - Fortisan

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*
1	6.00	23.52	17.52	4.85	22.37	.35
2	5.87	23.62	17.75	4.00	22.25	.23
3	4.46	23.37	18.91	3.55	22.46	.44
4	6.26	25.52	19.26	2.98	22.24	.22
5	-15.12	25.26	20.19	2.15	22.34	.32
6	-14.04	28.04	21.04	1.10	22.14	.12
7	-13.20	29.36	21.28	.85	22.13	.11
8	6.47	28.55	22.08	-.05	22.03	.01
9	-11.54	32.60	22.02	0	22.02	0
10	-15.74	28.30	22.02	0	22.02	0
11	-13.06	31.56	22.31	-.65	21.66	-.36
12	-17.04	25.98	21.51	.10	21.61	-.41
13	-12.44	32.36	22.40	-1.55	20.85	-1.17
14	4.38	25.63	21.25	-.55	20.70	-1.32
15	4.78	27.46	22.68	-3.05	19.63	-2.39
16	3.48	25.46	21.98	-2.55	19.43	-2.59
17	5.99	29.46	23.47	-5.00	18.47	-3.55
18	6.45	30.04	23.59	-5.40	18.19	-3.83

*Reference page 61 for explanation of column headings.

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Table No. 23
Wing Aspect Ratio = 3.70
80% of Unsymmetrical Load
at 60 PSI Internal Pressure
Cover Ply Material - Fortisan

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*
1	5.99	25.46	19.47	4.85	24.32	.35
2	5.87	25.62	19.75	4.50	24.25	.28
3	4.46	25.33	20.87	3.55	24.42	.45
4	6.25	26.73	20.47	2.98	23.45	-.52
5	-15.14	27.60	21.32	2.15	23.47	-.50
6	-14.06	30.44	22.25	1.10	23.35	-.62
7	-13.22	31.62	22.42	.85	23.27	-.70
8	6.46	29.71	23.25	-.05	23.20	-.77
9	-11.54	36.50	23.97	0	23.97	0
10	-15.74	32.20	23.97	0	23.97	0
11	-13.08	35.06	24.07	-.65	23.42	-.55
12	-17.06	29.68	23.37	.10	23.47	-.50
13	-12.46	35.08	23.77	-1.55	22.22	-1.75
14	4.37	27.12	22.75	-.55	22.20	-1.77
15	+.78	28.40	23.62	-3.05	20.57	-3.40
16	3.47	26.59	23.12	-2.55	20.57	-3.40
17	5.99	30.11	24.12	-5.00	19.12	-4.85
18	6.44	30.61	24.17	-5.40	18.77	-5.20

*Reference page 61 for explanation of column headings.

Table No. 24
Wing Aspect Ratio = 3.70
100% of Unsymmetrical Load
at 60 PSI Internal Pressure
Cover Ply Material - Fortisan

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*
1	5.96	26.12	20.16	4.85	25.01	.15
2	5.86	25.92	20.06	4.50	24.56	-.30
3	4.42	25.98	21.56	3.55	25.11	.25
4	6.24	27.95	21.71	2.98	24.69	-.17
5	-15.19	30.93	23.06	2.15	25.21	.35
6	-14.16	33.26	23.71	1.10	24.81	-.05
7	-13.26	35.26	24.26	.85	25.11	.25
8	6.43	31.29	24.86	-.05	24.81	-.05
9	-11.60	38.12	24.86	0	24.86	0
10	-15.80	33.92	24.86	0	24.86	0
11	-13.14	36.28	24.71	-.65	24.06	-.80
12	-17.06	30.86	23.96	.10	24.06	-.80
13	-12.41	35.01	23.71	-1.55	22.16	-2.70
14	4.34	27.05	22.71	-.55	22.16	-2.70
15	.72	23.48	22.76	-3.05	19.71	-5.15
16	3.43	25.59	22.16	-2.55	19.61	-5.25
17	5.95	28.31	22.36	-5.00	17.36	-7.50
18	6.43	28.79	22.36	-5.40	16.96	-7.90

*Reference page 61 for explanation of column headings.

Table No. 25
Wing Aspect Ratio = 8.15
15% of Maximum Symmetrical Load
at 40 PSI internal Pressure
Cover Ply Material - Fortisan

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*	(8)*
1	6.58	-8.85	-15.43	9.60	-5.83	-40.76	-43.41
2	6.55	-8.95	-15.50	8.85	-6.65	-41.68	-44.33
3	4.85	8.40	3.55	6.23	9.78	-25.15	-27.20
4	6.60	10.30	3.70	5.81	9.51	-25.52	-27.57
**5	-15.30	21.20	18.25	3.35	21.60	-13.33	-14.74
**6	-13.90	22.80	18.35	2.05	20.40	-14.63	-16.04
**7	-14.30	46.40	30.35	.85	31.10	-3.83	-4.55
8	6.58	35.85	29.27	.40	29.67	-5.36	-6.08
**9	-10.90	58.95	34.93	0	34.93	0	0
**10	-14.33	55.73	35.03	0	35.03	0	0
**11	-13.97	43.30	28.63	-.65	29.28	-5.65	-4.93
**12	-17.40	40.10	28.75	.80	29.55	-5.48	-4.76
**13	-12.97	23.50	18.23	-2.55	15.68	-19.25	-17.84
14	4.43	22.46	18.03	.05	18.08	-16.95	-15.54
15	4.16	12.20	8.04	-5.85	2.19	-32.74	-30.69
16	3.04	11.26	8.12	-3.25	4.87	-30.16	-28.11
17	5.06	3.80	-1.26	-10.00	-11.26	-46.19	-43.54
18	5.67	4.05	-1.62	-10.20	-11.82	-46.85	-44.20

*Reference page 59 for explanation of column headings.

**These scales were half-scale inverted.

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Table No. 26
Wing Aspect Ratio = 8.15
15% of Maximum Symmetrical Load
at 60 PSI Internal Pressure
Cover Ply Material - Fortisan

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*	(8)*
1	-6.53	3.15	-9.68	-6.90	-2.78	25.88	34.82
2	-5.63	3.75	-9.38	-6.20	-3.18	26.27	35.21
3	5.4	6.90	+1.50	-4.70	+6.20	16.90	23.80
4	6.39	8.15	+1.76	-3.65	+5.41	17.68	24.58
5	-15.00	8.50	+11.75	-2.05	+13.80	9.30	14.07
6	-14.33	9.67	+12.00	-1.8	+13.80	9.29	14.06
7	-13.80	25.92	+19.86	-1.45	21.31	1.79	4.21
8	-6.50	14.40	+20.90	-.8	+21.70	1.39	3.81
9	-9.60	36.6	+23.10	0	23.10	0	0
10	-13.98	32.20	23.09	0	23.09	0	0
11	-12.62	21.35	+16.98	+2.45	+14.53	8.57	6.15
12	-17.52	17.46	+17.49	+ .85	+16.64	6.45	4.03
13	-11.92	11.15	+11.53	+7.70	+ 3.83	19.27	14.50
14	4.33	16.05	+11.72	+4.85	+ 6.87	16.22	11.45
15	4.82	11.40	+ 6.58	+15.30	- 8.72	31.82	24.92
16	3.76	10.60	+ 6.84	+12.95	- 6.11	29.20	22.30
17	8.80	10.80	+ 2.00	+22.90	+22.90	44.00	35.06
18	6.18	8.30	+ 2.12	+22.95	-20.83	43.92	34.98

*Reference page 59 for explanation of column headings.

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Table No. 27
Wing Aspect Ratio = 8.15
20% of Unsymmetrical Load
at 40 PSI Internal Pressure
Cover Ply Material - Fortisan

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*
1	6.32	9.12	2.80	9.60	11.40	-4.20
2	6.26	9.03	2.77	8.85	11.62	-4.18
3	5.37	12.64	7.27	6.23	13.50	-2.10
4	7.06	13.82	6.76	5.81	12.57	-3.23
**5	-14.00	+8.20	11.10	3.35	14.45	-1.15
**6	-12.96	+9.65	11.30	2.05	13.35	-2.45
**7	-12.95	+15.15	14.05	.85	14.90	- .70
8	6.94	20.61	13.67	.40	14.07	-1.73
**9	-11.68	+19.51	15.60	0	15.60	0
**10	-16.20	+15.57	15.80	0	15.80	0
**11	-12.88	+13.40	13.14	-.65	12.49	-3.11
**12	-17.00	+ 9.85	13.42	+.80	14.22	-1.58
**13	-10.43	+ 6.50	8.46	-2.55	5.91	-9.89
14	5.36	14.02	8.66	+ .05	8.71	-7.09
15	7.19	10.83	3.64	-5.85	-2.21	-17.81
16	5.97	9.76	3.79	-3.25	.54	-15.26
17	10.27	9.12	1.15	-10.00	-8.85	-24.45
18	10.80	9.85	.95	-10.20	-9.25	-25.05

*Reference page 61 for explanation of column headings.

**These scales were half-scale and inverted.

Table No. 28
Wing Aspect Ratio = 8.15
40% of Unsymmetrical Load
at 40 PSI Internal Pressure
Cover Ply Material - Fortisan

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*
1	6.14	5.12	-1.02	9.60	8.58	-20.91
2	6.08	4.97	-1.11	8.85	7.74	-22.23
3	4.89	14.20	9.31	6.23	15.54	-13.95
4	6.58	16.15	9.57	5.81	15.38	-14.59
**5	-14.82	+22.00	18.41	3.35	21.76	- 7.73
**6	-13.78	+24.00	18.64	2.05	20.69	- 9.28
**7	-13.00	+39.30	26.15	.85	27.00	- 2.49
8	6.91	33.48	26.57	.40	26.97	- 3.00
**9	-11.18	+47.80	29.49	0	29.49	0
**10	-15.50	+44.44	29.97	0	29.97	0
**11	-12.85	+29.40	21.12	-.65	20.47	- 9.02
**12	-16.98	+28.20	22.59	.80	23.39	- 6.10
**13	-12.15	+ .85	6.50	-2.55	3.95	-25.54
14	4.54	12.20	7.66	.05	7.71	-22.26
15	+4.97	-4.05	-9.02	-5.85	-14.87	-44.36
16	+3.68	-4.30	-7.98	-3.25	-11.23	-41.20
17	+6.28	-17.10	-23.38	-10.00	-33.38	-62.87
18	+6.77	-17.60	-24.37	-10.20	-34.57	-64.54

*Reference page 61 for explanation of column headings.

**These scales were half-scale and inverted.

Table No. 29
Wing Aspect Ratio = 8.15
20% of Unsymmetrical Load
at 60 PSI Internal Pressure
Cover Ply Material - Fortisan

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*
1	6.20	23.93	17.73	6.90	24.63	-2.90
2	6.10	24.73	18.63	6.20	24.83	-2.70
3	4.85	25.88	21.03	4.70	25.73	-1.80
4	6.55	28.68	22.13	3.65	25.78	-1.75
**5	-14.76	34.70	24.73	2.05	26.78	-.75
**6	-13.62	37.04	25.33	1.80	27.13	-.40
**7	-12.86	40.00	26.43	1.45	27.88	+.35
8	6.85	34.08	27.23	.80	28.03	+.50
**9	-11.06	44.00	27.53	0	27.53	0
**10	-15.38	35.22	27.53	0	27.53	0
**11	-12.76	36.90	24.83	-2.45	22.38	-5.15
**12	-16.86	30.80	23.83	-.85	22.98	-4.55
**13	-12.06	28.80	20.43	-7.70	12.73	-14.80
14	4.56	22.79	18.23	-4.88	13.38	-14.15
15	4.95	22.28	17.33	-15.30	2.03	-25.50
16	3.66	19.39	15.73	-12.95	2.78	-24.75
17	6.27	20.30	14.73	-22.90	-8.17	-35.70
18	6.77	21.10	14.33	-22.95	-8.62	-36.15

*Reference page 61 for explanation of column headings.

**These scales were half-scale and inverted.

Table No. 30
Wing Aspect Ratio = 8.15
40% of Unsymmetrical Load
at 60 PSI Internal Pressure
Cover Ply Material - Fortisan

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*
1	6.10	16.30	10.20	6.90	17.10	-12.40
2	6.00	17.00	11.00	6.20	17.20	-12.30
3	4.80	20.80	16.00	4.70	20.70	-8.80
4	6.50	23.70	17.20	3.65	20.85	-8.65
**5	-14.80	28.60	21.70	2.05	23.75	-5.75
**6	-13.64	32.96	23.30	1.80	25.10	-4.40
**7	-12.90	41.50	27.20	1.45	28.65	-.85
8	6.82	34.92	28.10	.80	28.90	-.60
**9	-11.10	48.00	29.50	0	29.50	0
**10	-15.40	43.60	29.50	0	29.50	0
**11	-12.80	36.00	24.40	-2.45	21.95	-7.55
**12	-16.90	31.50	23.70	-.85	22.85	-6.65
**13	-12.10	17.90	15.00	-7.70	7.30	-22.20
14	4.52	17.32	12.80	-4.85	7.95	-21.55
15	4.92	10.12	5.20	-15.30	-10.10	-39.60
16	3.64	7.34	3.70	-12.95	-9.25	-38.75
17	6.24	1.94	-4.30	-22.90	-27.20	-56.70
18	6.72	1.82	-4.90	-22.95	-27.85	-57.35

*Reference page 61 for explanation of column headings.

**These scales were half-scale and inverted.

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Table No. 31
Wing Aspect Ratio = 8.15
15% of Maximum Symmetrical Load
at 20 PSI Internal Pressure
Cover Ply Material - Dacron with Fiberglas

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*	(8)*
1	8.55	13.70	5.15	-.70	4.45	+.52	-1.21
2	8.72	13.90	5.18	-.70	4.48	+.55	-1.18
3	7.08	11.92	4.88	-.50	4.38	+.45	-.88
4	6.88	11.77	4.89	-.45	4.44	+.51	-.82
**5	-14.00	-4.95	4.53	-.10	4.43	+.50	-.42
**6	-15.02	-5.82	4.60	-.10	4.50	+.57	-.35
**7	-14.75	-6.40	4.18	+.10	4.28	+.35	-.12
8	6.00	10.30	4.30	+.22	4.52	+.59	+.12
**9	-13.30	-5.44	3.93	0	3.93	0	0
**10	-14.74	-6.88	3.93	0	3.93	0	0
**11	-15.76	-9.30	3.23	+.30	3.53	-.40	+.07
**12	-17.00	-10.38	3.31	+.10	3.41	-.52	-.05
**13	-16.32	-11.50	2.41	+.70	3.11	-.82	+.10
14	5.83	8.32	2.49	-.05	2.44	-1.49	-.57
15	3.80	5.28	1.48	+.80	2.22	-1.71	-.38
16	3.53	5.56	1.03	0	2.03	-1.90	-.57
17	4.81	5.80	.99	0	.99	-2.94	-1.21
18	4.56	5.60	1.04	0	1.04	-2.89	-1.16

*Reference page 59 for explanation of column headings.

**These scales were half-scale inverted.

Table No. 32
Wing Aspect Ratio = 8.15
30% of Maximum Symmetrical Load
at 20 PSI Internal Pressure
Cover Ply Material - Dacron with Fiberglas

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*	(8)*
1	7.85	14.97	7.12	-.70	6.42	-.10	-2.78
2	8.42	15.86	7.44	-.70	6.74	-.47	-3.15
3	6.64	13.96	7.32	-.50	6.82	+.30	-1.77
4	6.96	13.98	7.02	-.45	6.57	-.64	-2.71
**5	-14.05	-.22	6.91	-.10	6.81	+.29	-1.14
**6	-15.50	-.80	7.35	-.10	7.25	+.04	-1.39
**7	-14.72	-1.25	6.74	+.10	6.84	+.32	-.41
8	5.71	13.00	7.29	+.22	7.51	+.30	-.43
**9	-11.18	+1.85	6.52	0	6.52	0	0
**10	-15.65	-1.25	7.21	0	7.21	0	0
**11	-15.62	-4.96	5.33	+.30	5.63	-.89	-.16
**12	-17.68	-5.72	5.98	+.10	6.08	-1.13	-.40
**13	-16.10	-8.28	3.41	+.70	4.61	-1.91	-.48
14	5.62	10.10	4.48	-.05	4.43	-2.78	-1.35
15	3.97	6.36	2.39	+.80	3.19	-3.33	-1.26
16	3.76	6.67	2.91	0	2.91	-4.30	-2.23
17	5.04	6.12	1.08	0	1.08	-5.44	-2.76
18	4.62	5.98	1.36	0	1.36	-5.85	-3.17

*Reference page 59 for explanation of column headings.

**These scales were half-scale inverted.

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Table No. 33
Wing Aspect Ratio = 8.15
45% of Maximum Symmetrical Load
at 20 PSI Internal Pressure
Cover Ply Material - Dacron with Fiberglas

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*	(8)*
1	7.40	13.84	6.44	-.70	5.74	-2.17	-3.49
2	8.03	14.56	6.52	-.70	5.82	-2.12	-3.44
3	6.68	13.52	6.84	-.50	6.34	-1.57	-2.59
4	6.46	13.36	6.90	-.45	6.45	-1.49	-2.51
**5	-14.18	+.30	7.24	-.10	7.14	-.77	-1.47
**6	-15.55	-.80	7.38	-.10	7.28	-.66	-1.36
**7	-14.65	+.70	7.67	+.10	7.77	-.14	-.50
8	5.80	13.50	7.70	+.22	7.92	-.02	-.38
**9	-10.90	+4.92	7.91	0	7.91	0	0
**10	-15.05	+.83	7.94	0	7.94	0	0
**11	-15.48	-1.74	6.87	+.30	7.17	-.74	-.38
**12	-17.48	-3.22	7.13	+.10	7.23	-.71	-.35
**13	-16.12	-5.20	5.46	+.70	6.06	-1.85	-1.15
14	5.62	11.39	5.77	-.05	5.72	-2.22	-1.52
15	4.74	8.80	4.06	+.80	4.86	-3.05	-2.03
16	3.68	8.00	4.32	0	4.32	-3.62	-2.60
17	5.12	8.54	3.42	0	3.42	-4.49	-3.17
18	4.38	7.24	2.86	0	2.86	-5.08	-3.76

*Reference page 59 for explanation of column headings.

**These scales were half-scale inverted.

Table No. 34
Wing Aspect Ratio = 8.15
60% of Maximum Symmetrical Load
at 20 PSI Internal Pressure
Cover Ply Material - Dacron with Fiberglas

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*	(8)*
1	7.36	13.90	6.54	-.70	5.84	-2.67	-5.37
2	7.91	13.95	6.04	-.70	5.34	-3.19	-5.89
3	6.69	13.90	7.21	-.50	6.71	-1.80	-3.88
4	6.42	13.70	7.28	-.45	6.83	-1.70	-3.78
**5	-14.23	1.20	7.72	-.10	7.62	-.89	-2.33
**6	-15.40	.40	7.90	-.10	7.80	-.73	-2.17
**7	-14.88	1.80	8.34	+.10	8.44	-.07	-.80
8	5.74	14.15	8.41	+.22	8.63	+.10	-.63
**9	-10.97	6.05	8.51	0	8.51	0	0
**10	-15.05	2.00	8.53	0	8.53	0	0
**11	-15.32	-1.80	6.76	+.30	7.06	-1.45	-.72
**12	-17.26	-3.10	7.08	+.10	7.18	-1.35	-.62
**13	-15.90	-6.80	4.55	+.70	5.25	-3.26	-1.82
14	5.70	10.68	4.98	-.05	4.93	-3.60	-2.16
15	3.66	6.10	2.44	+.80	3.24	-5.27	-3.19
16	3.62	6.21	2.59	0	2.59	-5.94	-3.86
17	4.93	5.00	.07	0	.07	-8.44	-5.74
18	4.48	4.81	.33	0	.33	-8.20	-5.50

*Reference page 59 for explanation of column headings.

**These scales were half-scale inverted.

Table No. 35
Wing Aspect Ratio = 8.15
40% of Unsymmetrical Load
at 20 PSI Internal Pressure
Cover Ply Material - Dacron with Fiberglas

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*
1	8.62	22.88	14.26	-.70	13.56	-.46
2	9.23	23.50	14.27	-.70	13.57	-.49
3	7.43	21.56	14.13	-.50	13.63	-.39
4	7.33	21.56	14.23	-.45	13.78	-.28
**5	-13.55	14.63	14.09	-.10	13.99	-.03
**6	-14.45	13.86	14.15	-.10	14.05	-.01
**7	-14.60	13.44	14.02	+.10	14.12	+.10
8	6.05	20.08	14.03	+.22	14.25	+.19
**9	-10.85	17.20	14.02	0	14.02	0
**10	-14.60	13.52	14.06	0	14.06	0
**11	-15.12	11.98	13.55	+.30	13.58	-.44
**12	-16.44	10.86	13.65	+.10	13.75	-.31
**13	-15.52	10.08	12.80	+.70	13.50	-.52
14	6.15	19.06	12.91	-.50	12.86	-1.20
15	3.98	16.02	12.04	+.80	12.84	-1.18
16	4.18	16.02	12.02	0	12.02	-2.04
17	5.29	16.54	11.25	0	11.25	-2.77
18	5.05	16.28	11.23	0	11.23	-2.83

*Reference page 61 for explanation of column headings.

**These scales were half-scale and inverted.

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Table No. 36
Wing Aspect Ratio = 8.15
80% of Unsymmetrical Load
at 20 PSI Internal Pressure
Cover Ply Material - Dacron with Fiberglas

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*
1	8.88	25.25	16.37	-.70	15.67	.43
2	9.45	25.88	16.43	-.70	15.73	.22
3	7.55	23.52	15.97	-.50	15.47	.23
4	7.40	23.53	16.13	-.45	15.68	.17
**5	-13.65	17.92	15.79	-.10	15.69	.45
**6	-14.55	17.20	15.87	-.10	15.77	.26
**7	-15.18	15.86	15.52	+.10	15.62	.38
8	5.72	21.32	15.60	+.22	15.82	.31
**9	-11.75	18.72	15.24	0	15.24	0
**10	-15.88	15.13	15.51	0	15.51	0
**11	-15.66	11.48	13.57	+.30	13.87	-1.377
**12	-17.38	10.44	13.91	+.10	14.01	-1.50
**13	-15.96	6.92	11.44	+.70	12.14	-3.10
14	5.86	17.65	11.79	-.05	11.74	-3.77
15	3.88	12.50	8.62	+.80	9.42	-5.82
16	4.00	13.40	9.40	0	9.40	-6.11
17	5.30	12.16	6.86	0	6.86	-8.38
18	5.02	12.02	7.00	0	7.00	-8.51

*Reference page 61 for explanation of column headings.

**These scales were half-sclae and inverted,

77-10C(1-53)M

Table No. 37
Wing Aspect Ratio = 8.15
100% of Unsymmetrical Load
at 20 PSI Internal Pressure
Cover Ply Material - Dacron with Fiberglas

(1)*	(2)*	(3)*	(4)*	(5)*	(6)*	(7)*
1	8.62	26.66	18.04	-.70	17.34	2.02
2	9.15	27.32	18.17	-.70	17.47	1.54
3	7.53	24.88	17.35	-.50	16.85	1.53
4	7.17	24.80	17.63	-.45	17.18	1.25
**5	-13.68	19.58	16.63	-.10	16.53	1.21
**6	-15.04	19.00	17.02	-.10	16.92	.99
**7	-15.03	16.84	15.94	+.10	16.04	.72
8	5.69	22.06	16.37	+.22	16.59	.66
**9	-11.60	19.04	15.32	0	15.32	0
**10	-15.87	16.00	15.93	0	15.93	0
**11	-15.80	10.56	13.18	+.30	13.48	-1.84
**12	-17.42	9.96	13.69	+.10	13.79	-2.14
**13	-16.25	4.28	10.27	+.70	10.97	-4.35
14	5.74	16.48	10.74	-.05	10.69	-5.24
15	3.69	10.94	7.25	+.80	8.05	-7.27
16	3.84	11.42	7.58	0	7.58	-8.35
17	5.06	9.34	4.28	0	4.28	-11.04
18	4.78	9.30	4.52	0	4.52	-11.41

*Reference page 61 for explanation of column headings.

**These scales were half-scale and inverted.

EXPLANATION OF COLUMN HEADINGS

COMPARISON DATA, TEST PANEL TO SIMULATED WING

(1) Points where deflections measured, reference Figures 17 and 18.

(2) Measured deflections of test panel.

(3) Twist of specimen in radians, determined by dividing difference of forward and aft deflection by appropriate distance indicated in either Figure 17 or 18.

(4) Deflection at 50% chord line of specimen. Determined by averaging forward and aft deflections.

(5) Non dimensional multiplication factor for converting twist of test specimen to twist of simulated wing. Reference Figures 4 and 5.

(6) Non dimensional multiplication factor for converting bending deflection of test specimen to bending deflection of simulated wing. Reference Figures 4 and 5.

(7) The twist of the simulated wing. Determined as the product of columns three and five.

(8) The bending deflection of the simulated wing. Determined as the product of columns four and six.

Table No. 38*
Wing Aspect Ratio = 3.70
100% of Unsymmetrical Load
at 60 PSI Internal Pressure
Cover Ply Material - Fortisan

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	.15	.164	-.075	113.5	99.0	.186	-.0742
2	-.30						
3	.25	.043	. 04	97.5	97.5	.0419	.039
4	-.17						
5	.35	.022	. 15	84.5	95.5	.0186	.143
6	-.05						
7	.25	.011	. 10	71.0	90.0	.0782	.090
8	-.05						
9	0	0	0	100	100	0	0
10	0						
11	-.80	0	-.80	71.0	90.0	0	-.72
12	-.80						
13	-2.70	0	-2.70	84.5	95.5	0	-2.58
14	-2.70						
15	-5.15	-.005	-5.20	97.5	97.5	-.00487	-5.07
16	-5.25						
17	-7.50	- .15	-7.70	113.5	99.0	-.17	-7.63
18	-7.90						

*Reference page 94 for explanation of column headings.

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Table No. 39*
Wing Aspect Ratio = 3.70
100% of Maximum Symmetrical Load
at 60 PSI Internal Pressure
Cover Ply Material - Fortisan

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	-8.22	.11	-8.37	113.5	99.0	.125	-8.29
2	-8.53						
3	-5.43	.024	-5.55	97.5	97.5	.0234	-5.41
4	-5.67						
5	-2.83	.009	-2.91	84.5	95.5	.0076	-2.78
6	-2.99						
7	- .59	.013	- .75	71.0	90.0	.0092	- .67
8	- .92						
9	0	0	0	1.00	1.00	0	0
10	0						
11	- .92	-.0023	- .87	71	90	-.0016	- .78
12	- .83						
13	-2.92	.0078	-2.99	84.5	95.5	.0066	-2.85
14	-3.06						
15	-5.58	.0065	-5.61	97.5	97.5	.0063	-5.48
16	-5.64						
17	-8.21	.119	-8.36	113.5	99.0	.135	-8.28
18	-8.52						

*Reference page 94 for explanation of column headings.

Table No. 40 *
Wing Aspect Ratio = 8.15
60% of Maximum Symmetrical Load
at 20 PSI Internal Pressure
Cover Ply Material - Dacron with Fiberglas

1	2	3	4	5	6	7	8
1	-5.37	.069	-5.63	90.3	82.0	.062	-4.61
2	-5.89						
3	-3.88	-.0125	-3.83	81.0	82.5	-.0101	-3.16
4	-3.78						
5	-2.33	-.0117	-2.20	74	80.5	-.0086	-1.77
6	-2.17						
7	- .80	-.0072	- .71	68	77.5	-.0049	- .55
8	- .63						
9	0	0	0	1.00	1.00	0	0
10	0						
11	- .72	-.0045	- .67	68	77.5	-.0031	- .52
12	- .62						
13	-1.82	.023	-1.99	74	80.5	.017	-1.60
14	-2.16						
15	-3.19	.086	-3.47	81	82.5	.070	-2.86
16	-3.86						
17	-5.74	.032	-5.62	90.3	82.0	-.029	-4.61
18	-5.50						

*Reference page 94 for explanation of column headings.

Table No. 41*
Wing Aspect Ratio = 8.15
100% of Unsymmetrical Load
at 20 PSI Internal Pressure
Cover Ply Material - Dacron with Fiberglas

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1	2.02	.064	1.78	90.3	82.0	.058	1.46
2	1.54						
3	1.53	.035	1.39	81.0	82.5	.028	1.14
4	1.25						
5	1.21	.016	1.10	74	80.5	.012	.88
6	.99						
7	.72	.0025	.69	68	77.5	.0017	.53
8	.66						
9	0	0	0	1.00	1.00	0	0
10	0						
11	-1.84	.013	-1.99	68	77.5	.0088	-1.54
12	-2.14						
13	-4.35	.06	-4.79	74	80.5	.004	-3.86
14	-5.24						
15	-7.27	.139	-7.81	81.0	82.5	.112	-6.44
16	-8.35						
17	-11.04	.049	-11.22	90.3	82.0	.044	-9.17
18	-11.41						

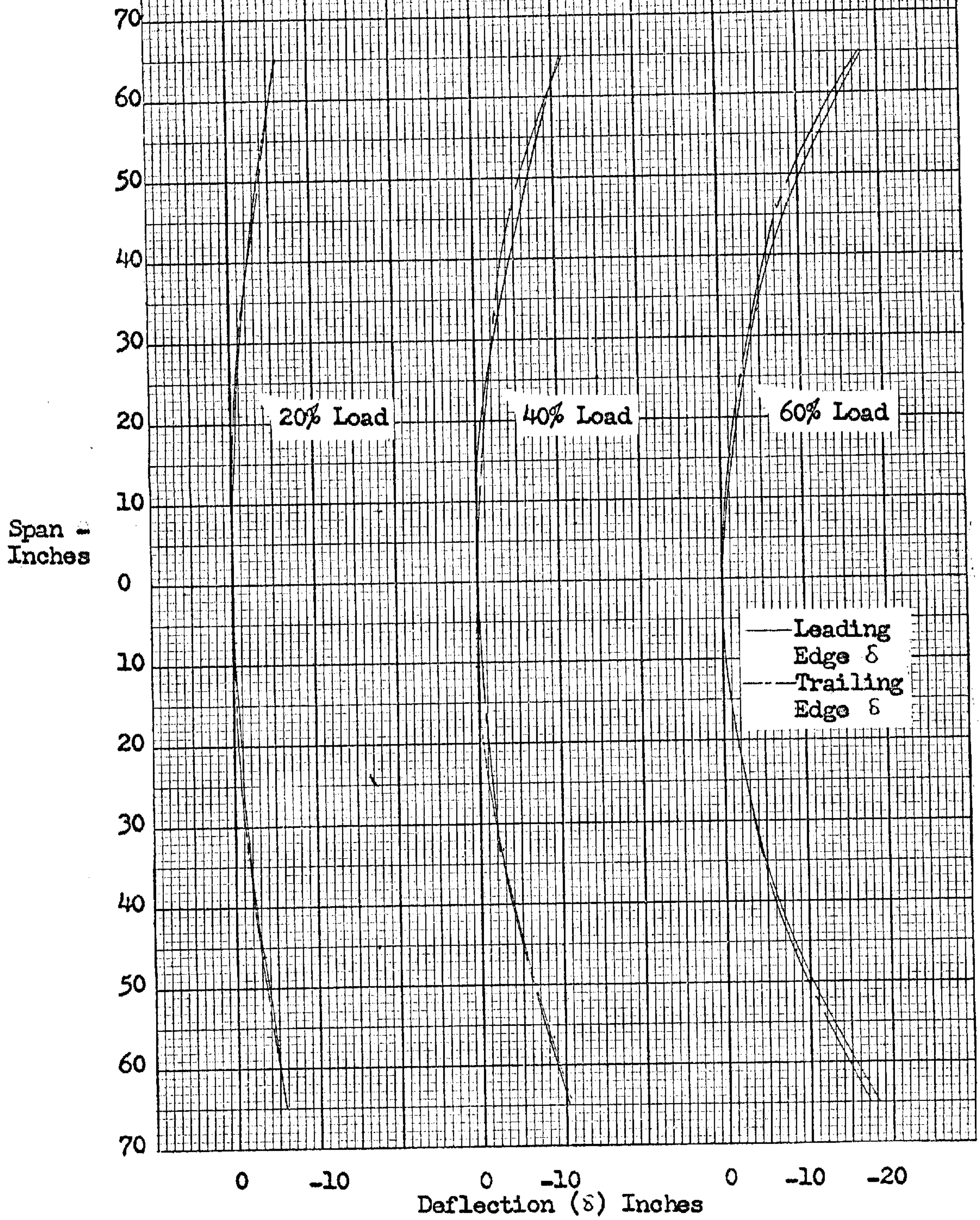
*Reference page 94 for explanation of column headings.

APPENDIX B

TEST RESULTS IN

GRAPHICAL FORM

Figure 20
Wing Aspect Ratio = 3.70
Deflections for 20%, 40%, 60% of Maximum Symmetrical Load at 20 PSI Internal Pressure
Cover Ply Material - Dacron



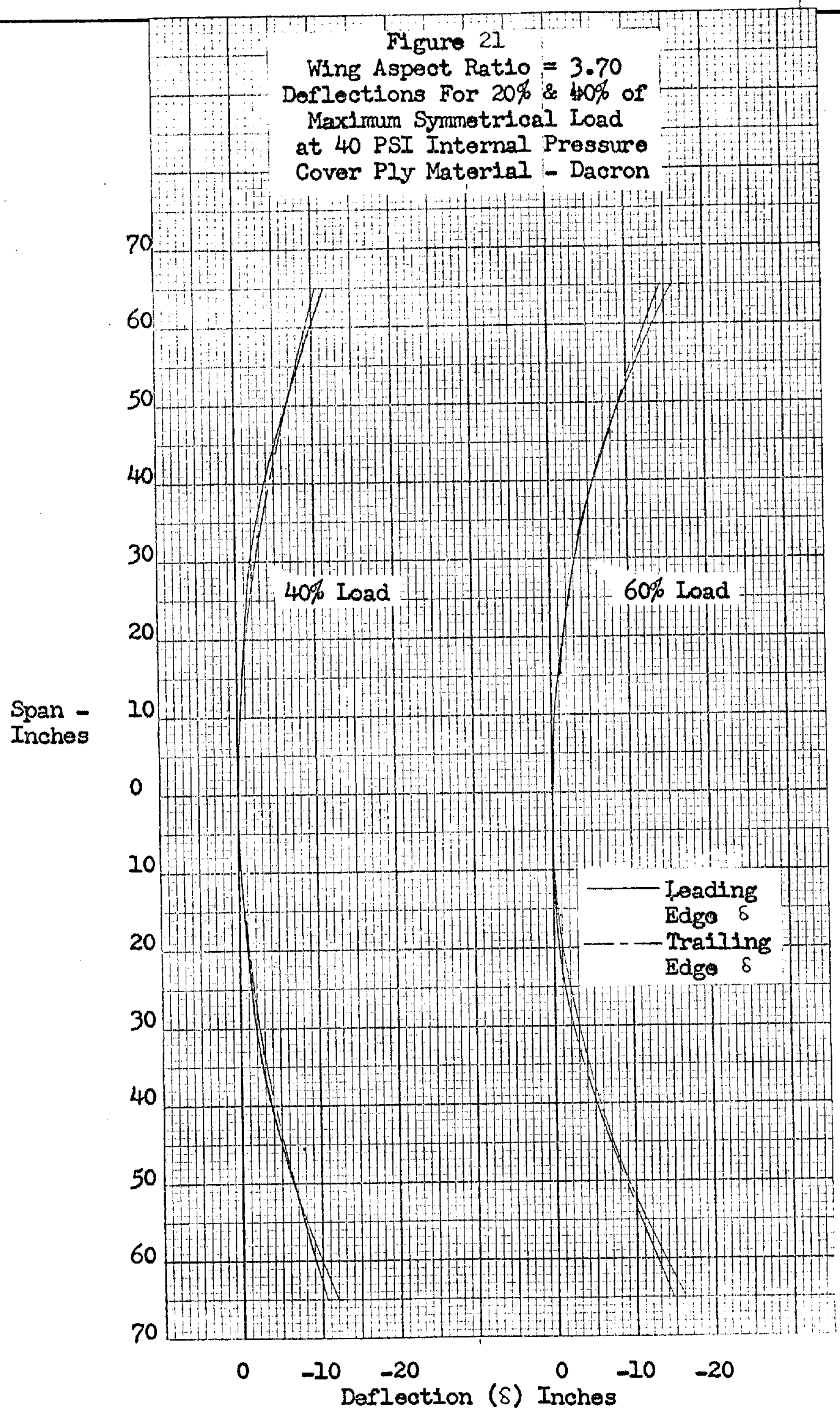


Figure 21
Wing Aspect Ratio = 3.70
Deflections For 20% & 40% of
Maximum Symmetrical Load
at 40 PSI Internal Pressure
Cover Ply Material - Dacron
70
60
50
40
30
20
10
0
10
20
30
40
50
60
70
Span - Inches
40% Load
60% Load
Leading Edge δ
Trailing Edge δ
0
-10
-20
0
-10
-20
Deflection (δ) Inches

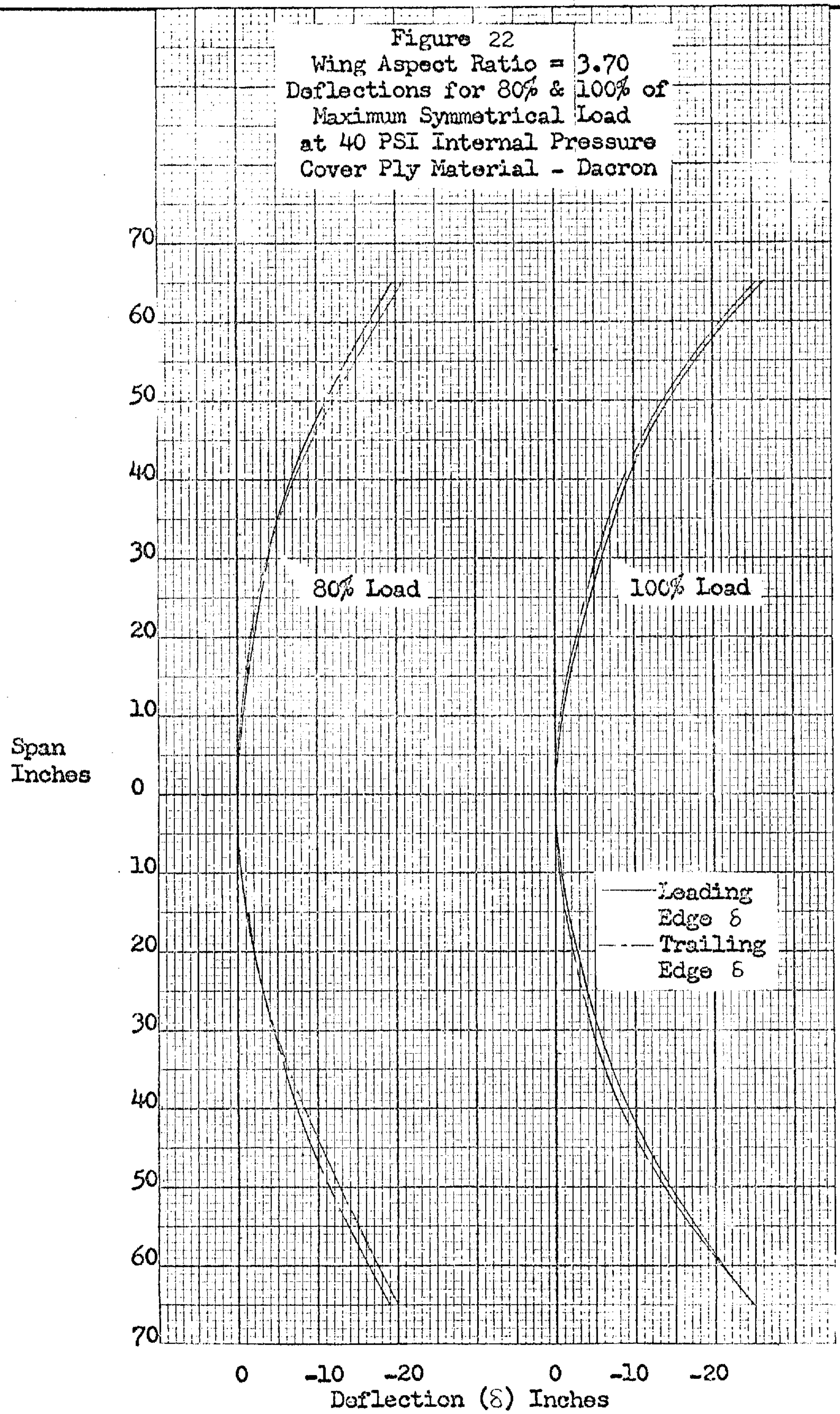


Figure 22
Wing Aspect Ratio = 3.70
Deflections for 80% & 100% of
Maximum Symmetrical Load
at 40 PSI Internal Pressure
Cover Ply Material - Dacron
70
60
50
40
30
20
10
0
10
20
30
40
50
60
70
Span Inches
80% Load
100% Load
Leading Edge δ
Trailing Edge δ
0
-10
-20
0
-10
-20
Deflection (δ) Inches

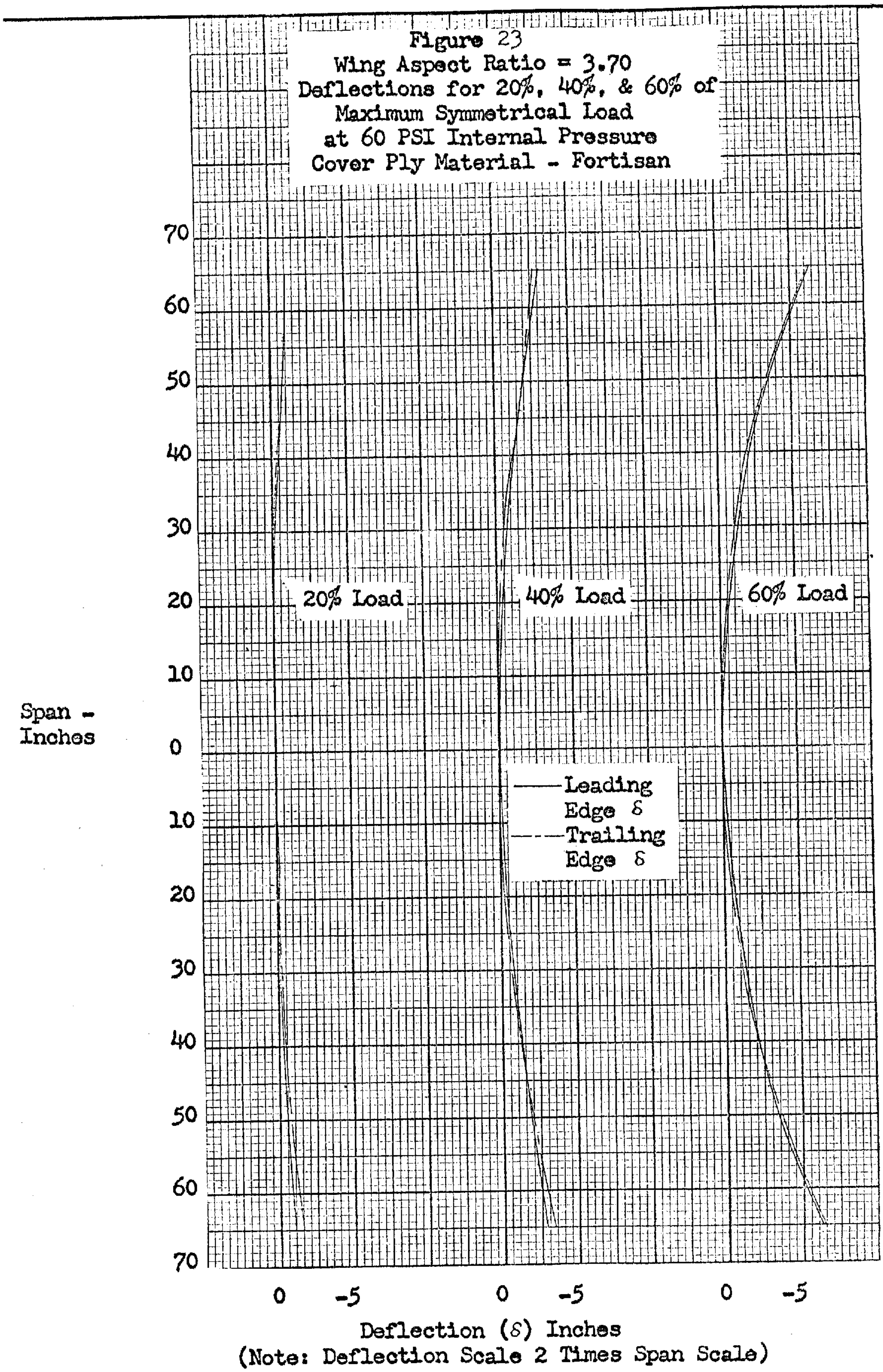


Figure 23
Wing Aspect Ratio = 3.70
Deflections for 20%, 40%, & 60% of
Maximum Symmetrical Load
at 60 PSI Internal Pressure
Cover Ply Material - Fortisan
70
60
50
40
30
20
10
0
10
20
30
40
50
60
70
Span - Inches
20% Load
40% Load
60% Load
Leading Edge δ
Trailing Edge δ
0
-5
0
-5
0
-5
Deflection (δ) Inches
(Note: Deflection Scale 2 Times Span Scale)

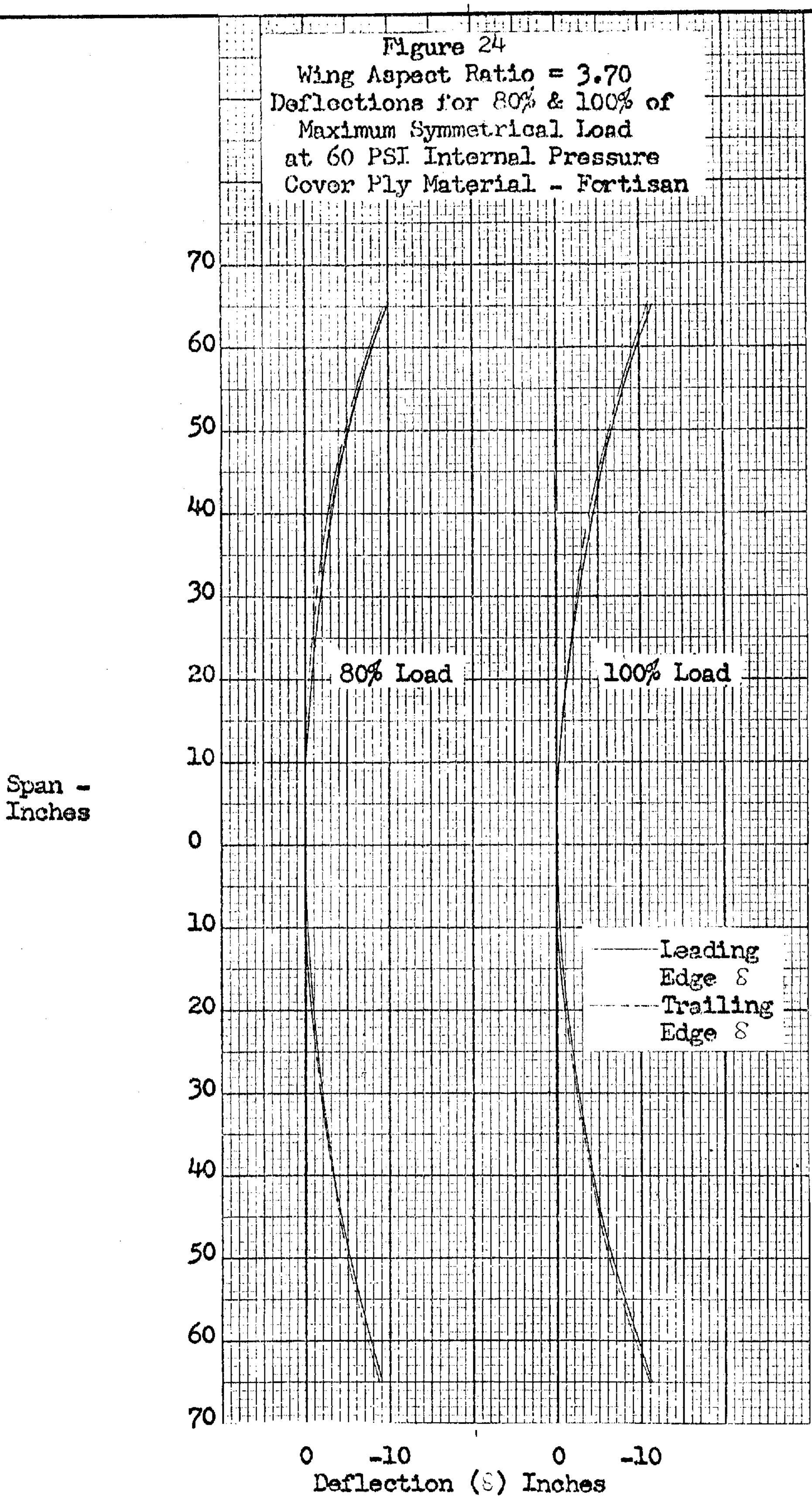
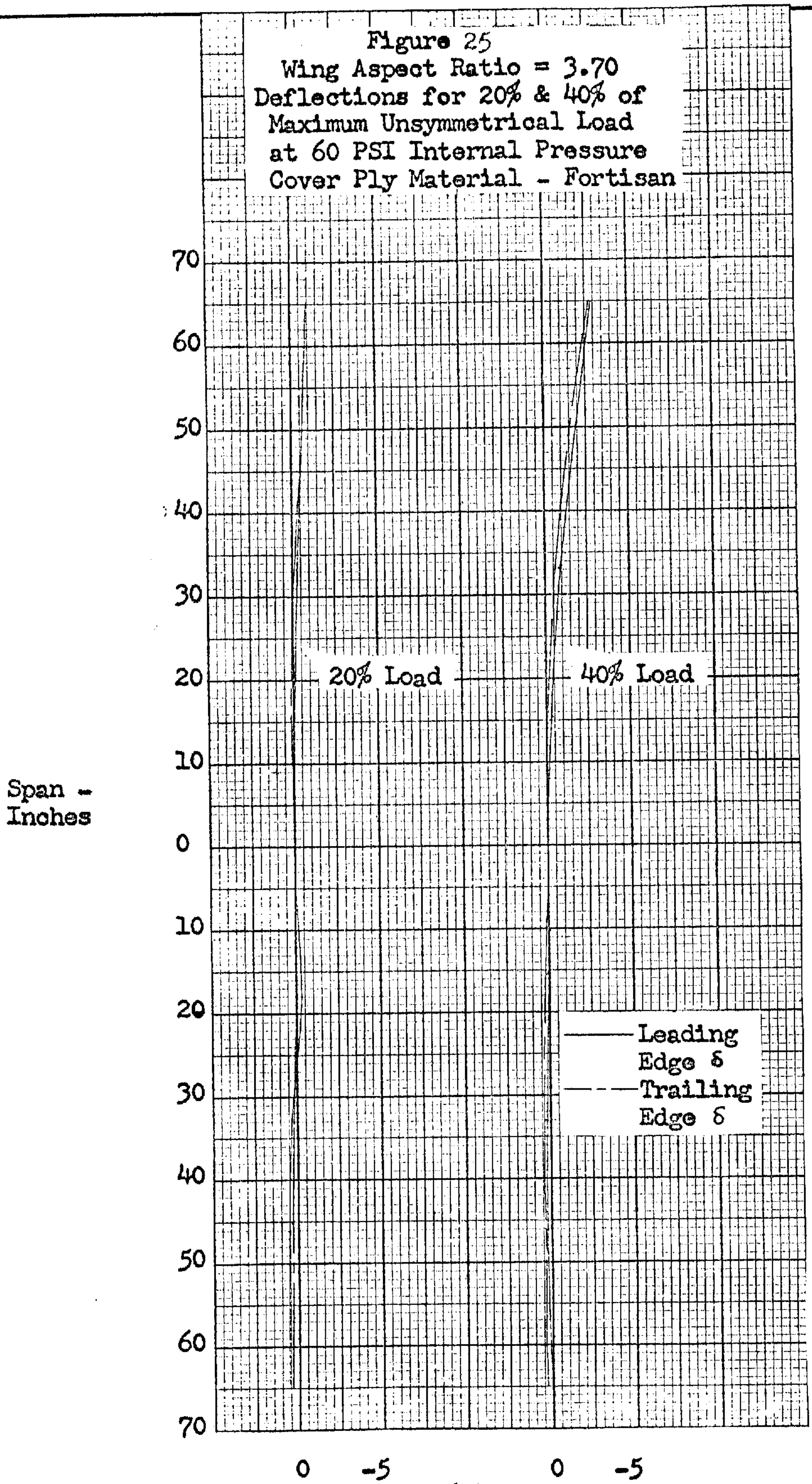


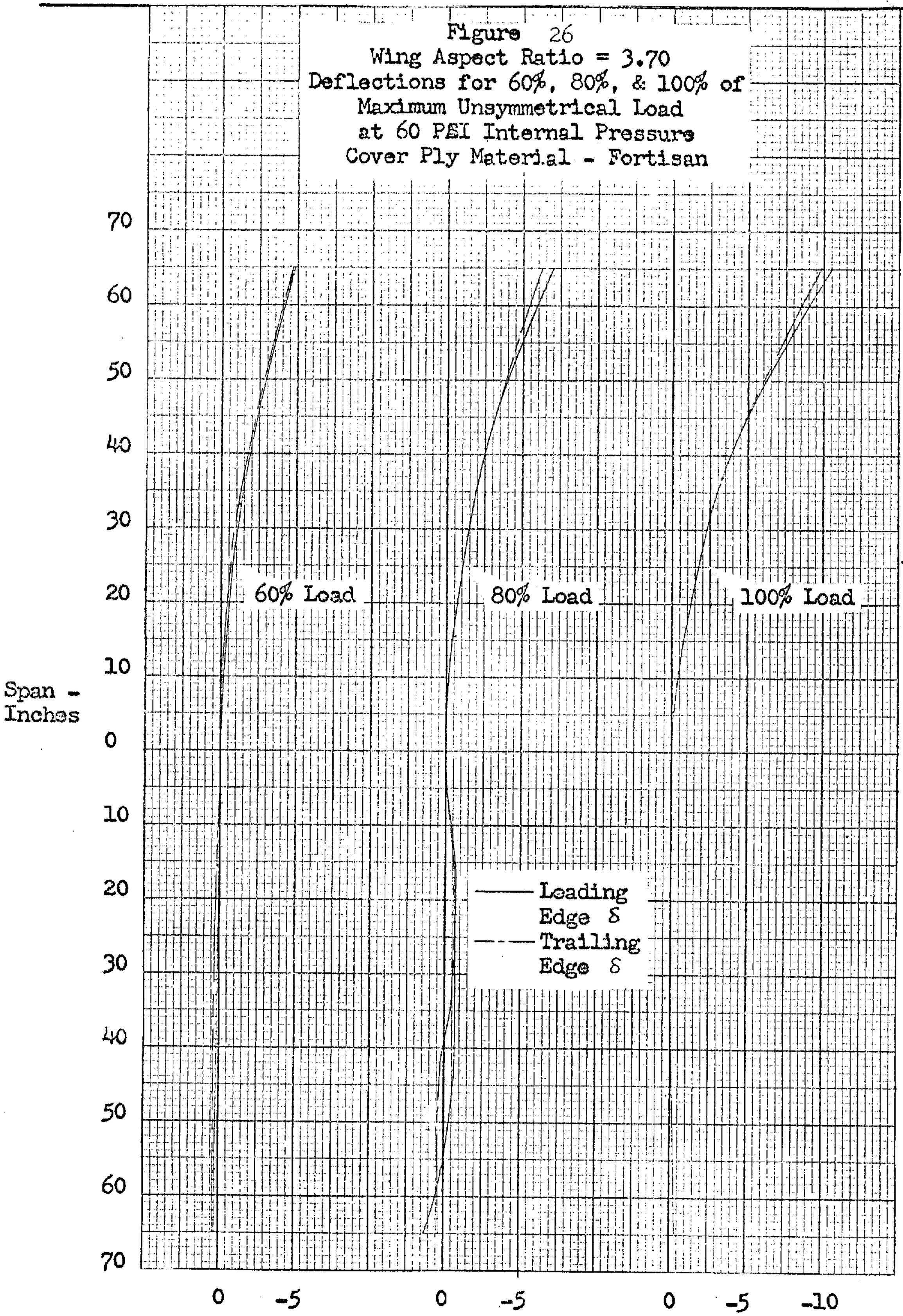
Figure 24
Wing Aspect Ratio = 3.70
Deflections for 80% & 100% of
Maximum Symmetrical Load
at 60 PSI Internal Pressure
Cover Ply Material - Fortisan
70
60
50
40
30
20
10
0
10
20
30
40
50
60
70
Span - Inches
80% Load
100% Load
Leading Edge δ
Trailing Edge δ
0
-10
0
-10
Deflection (δ) Inches

Figure 25
Wing Aspect Ratio = 3.70
Deflections for 20% & 40% of
Maximum Unsymmetrical Load
at 60 PSI Internal Pressure
Cover Ply Material - Fortisan



Deflection (δ) - Inches
(Note: Deflection Scale 2 Times Span Scale)

Figure 26
Wing Aspect Ratio = 3.70
Deflections for 60%, 80%, & 100% of
Maximum Unsymmetrical Load
at 60 PSI Internal Pressure
Cover Ply Material - Fortisan



Deflection (δ) Inches
(Note: Deflection Scale 2 Times Span Scale)

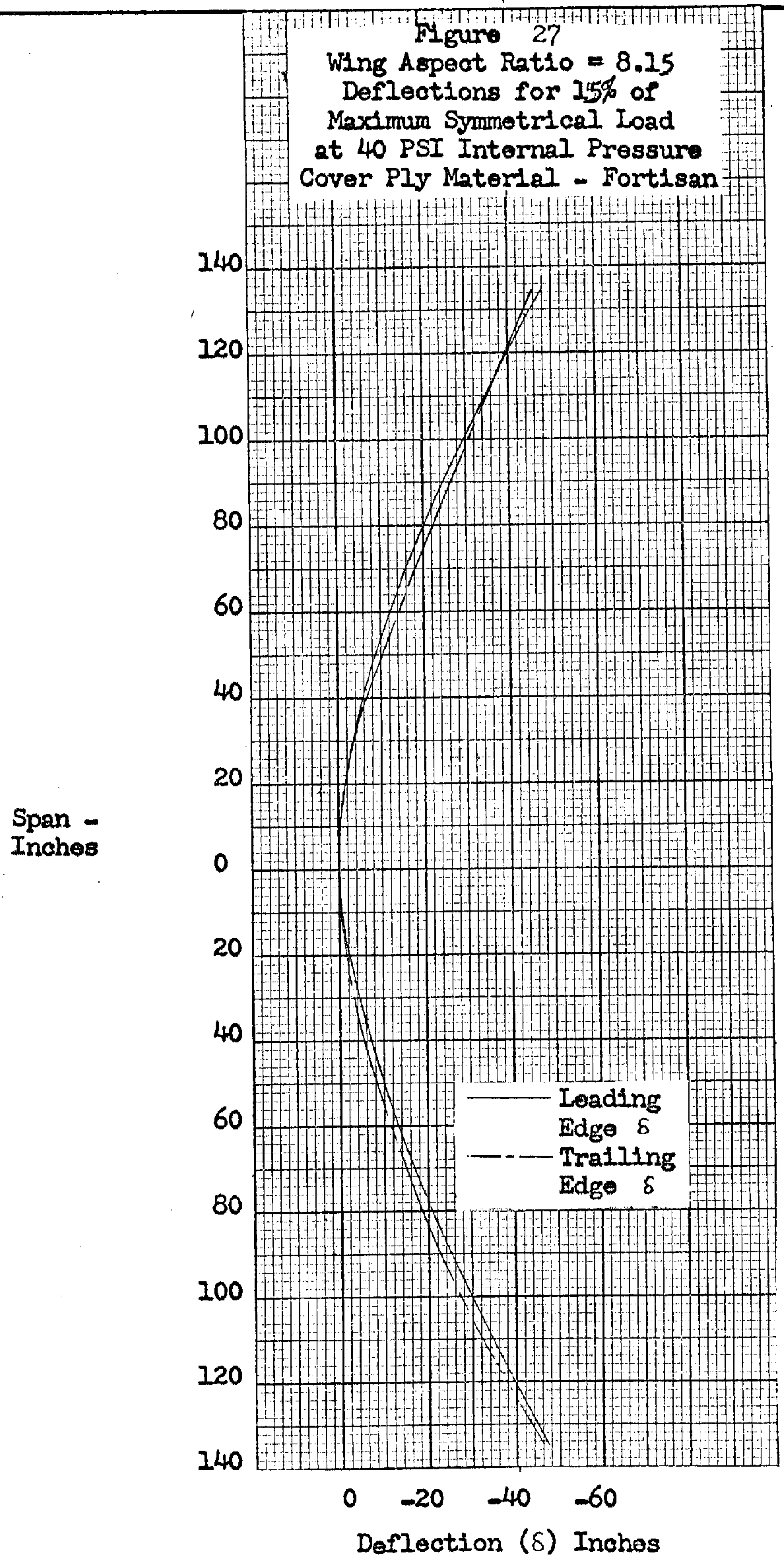


Figure 27
Wing Aspect Ratio = 8.15
Deflections for 15% of
Maximum Symmetrical Load
at 40 PSI Internal Pressure
Cover Ply Material - Fortisan
140
120
100
80
60
40
20
0
20
40
60
80
100
120
140
Span -
Inches
Leading
Edge δ
Trailing
Edge δ
0
-20
-40
-60
Deflection (δ) Inches

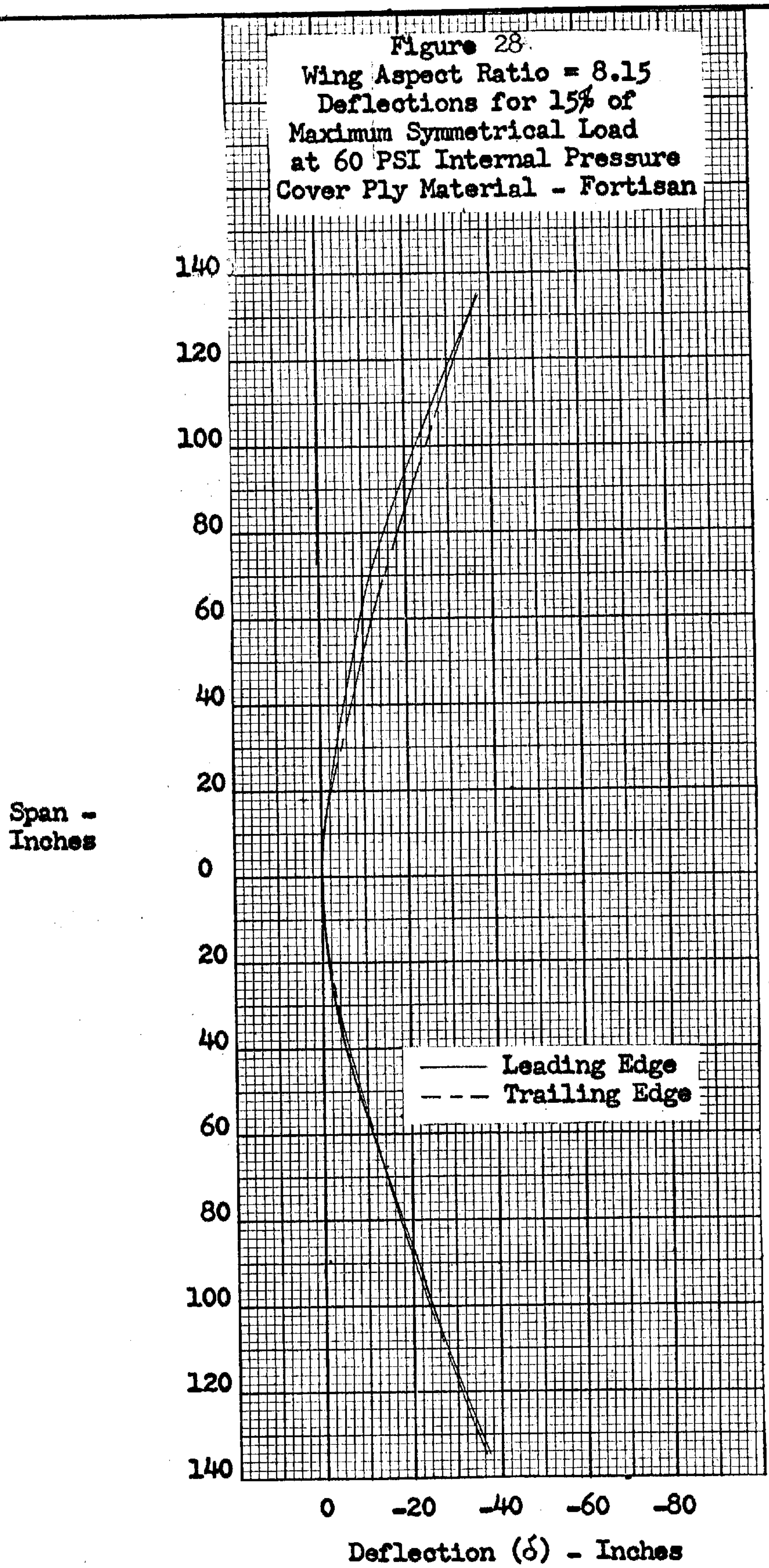


Figure 28
Wing Aspect Ratio = 8.15
Deflections for 15% of
Maximum Symmetrical Load
at 60 PSI Internal Pressure
Cover Ply Material - Fortisan
140
120
100
80
60
40
20
0
20
40
60
80
100
120
140
Span - Inches
Leading Edge
Trailing Edge
0
-20
-40
-60
-80
Deflection (δ) - Inches

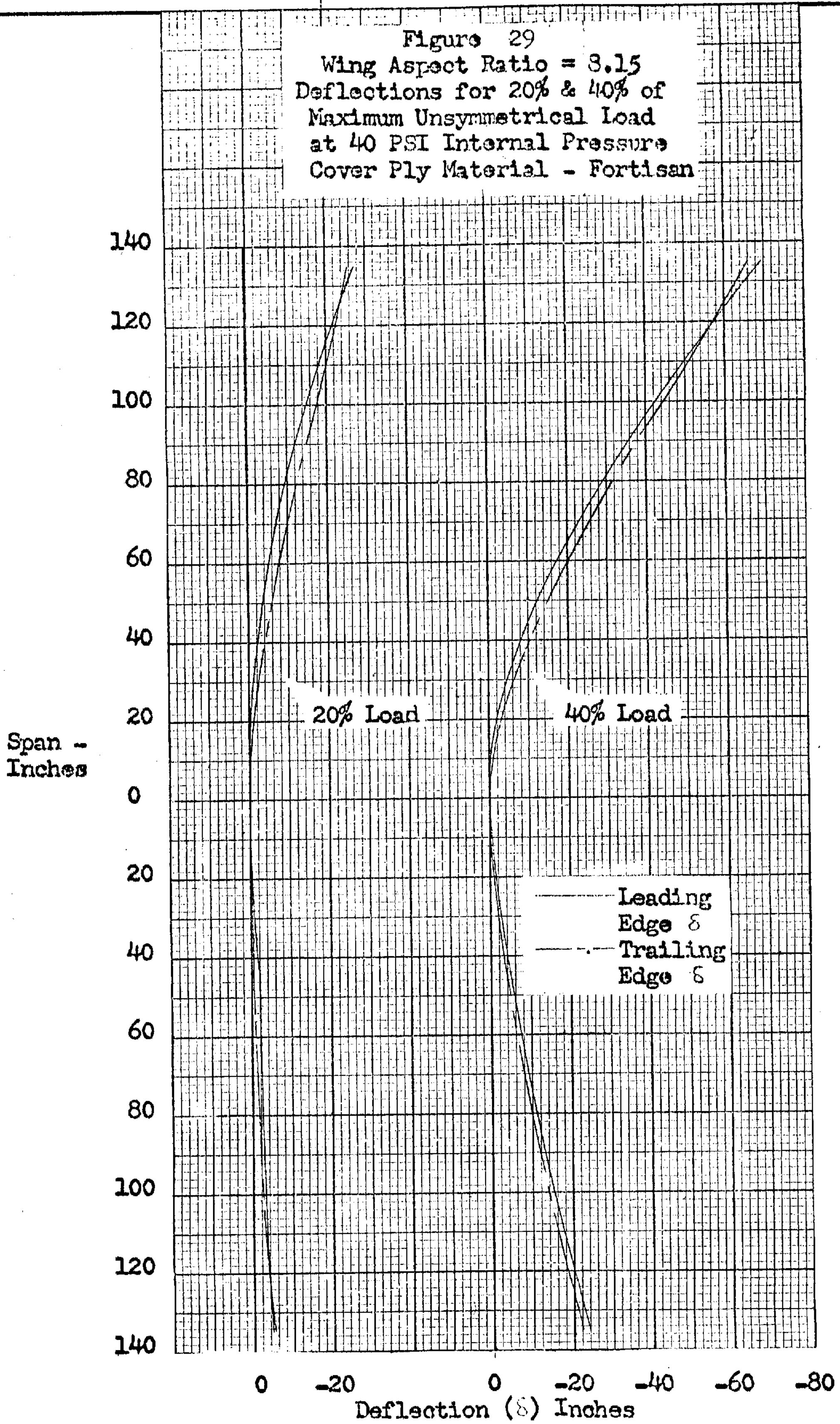


Figure 29
Wing Aspect Ratio = 3.15
Deflections for 20% & 40% of
Maximum Unsymmetrical Load
at 40 PSI Internal Pressure
Cover Ply Material - Fortisan
140
120
100
80
60
40
20
0
20
40
60
80
100
120
140
Span - Inches
20% Load
40% Load
Leading Edge δ
Trailing Edge δ
0
-20
0
-20
-40
-60
-80
Deflection (δ) Inches

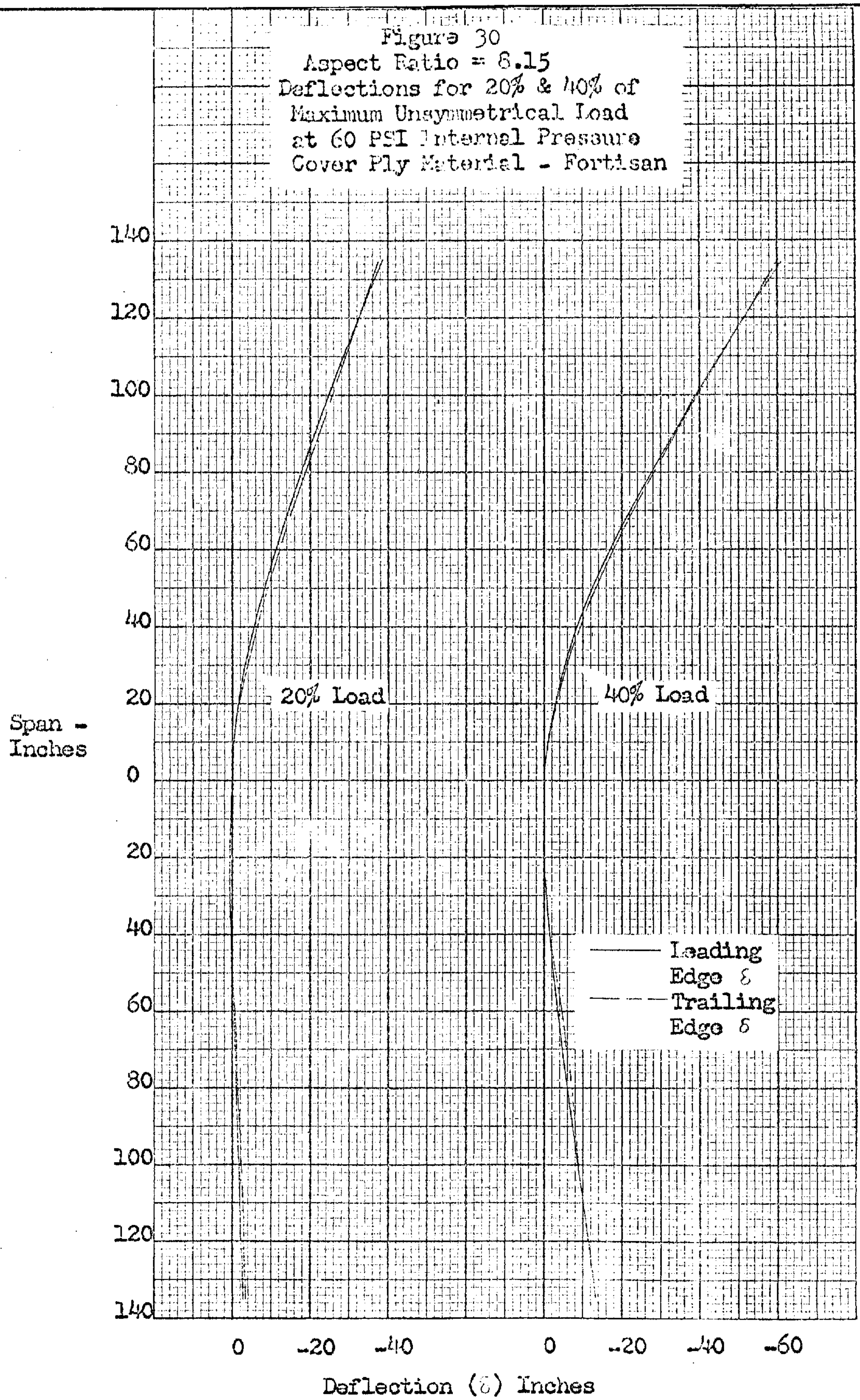


Figure 30
Aspect Ratio = 8.15
Deflections for 20% & 40% of
Maximum Unsymmetrical Load
at 60 PSI Internal Pressure
Cover Ply Material - Fortisan
140
120
100
80
60
40
20
0
20
40
60
80
100
120
140
Span - Inches
20% Load
40% Load
Leading Edge δ
Trailing Edge δ
0
-20
-40
0
-20
-40
-60
Deflection (δ) Inches

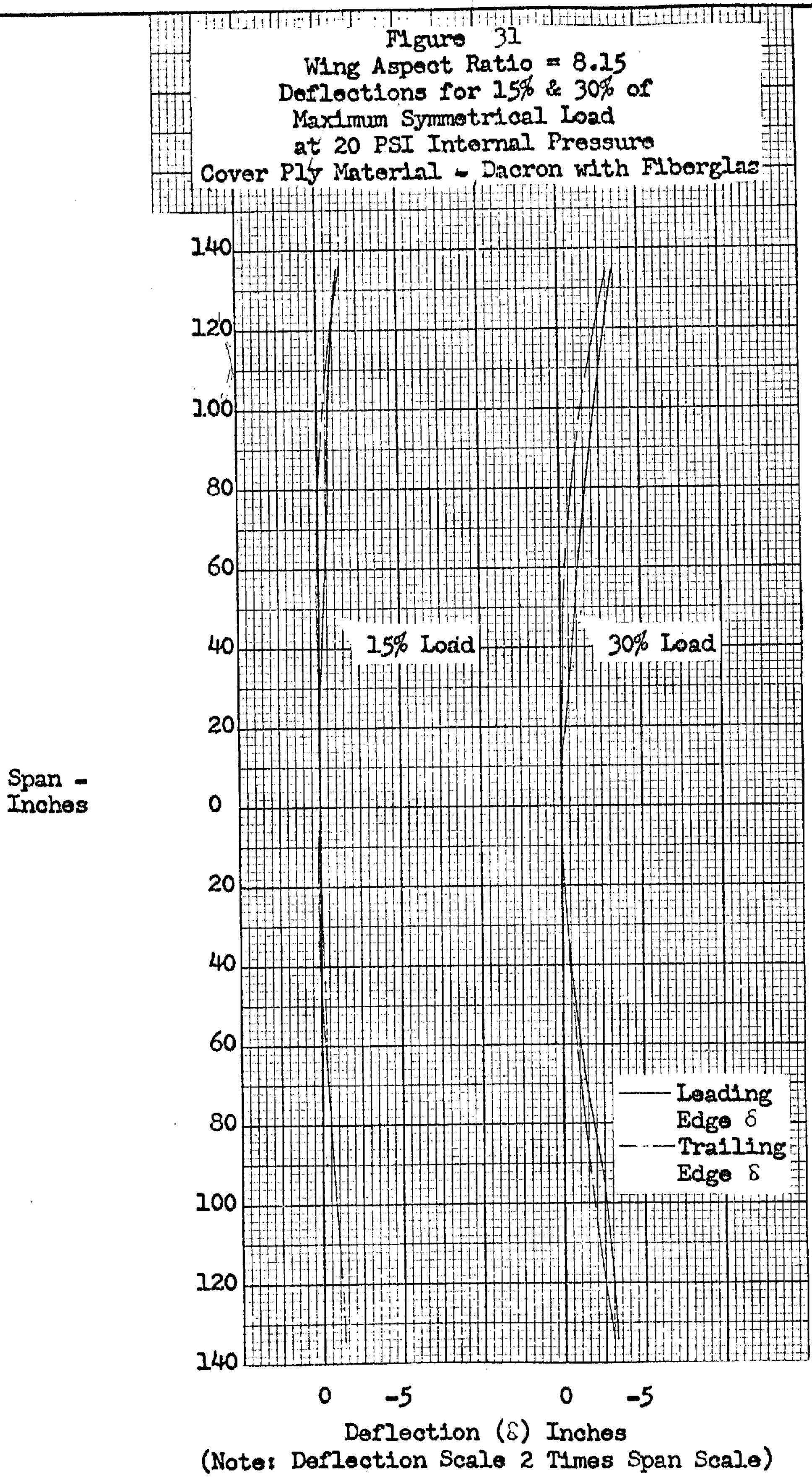


Figure 31
Wing Aspect Ratio = 8.15
Deflections for 15% & 30% of
Maximum Symmetrical Load
at 20 PSI Internal Pressure
Cover Ply Material - Dacron with Fiberglas
140
120
100
80
60
40
20
0
20
40
60
80
100
120
140
Span - Inches
15% Load
30% Load
Leading Edge δ
Trailing Edge δ
0
-5
0
-5
Deflection (δ) Inches
(Note: Deflection Scale 2 Times Span Scale)

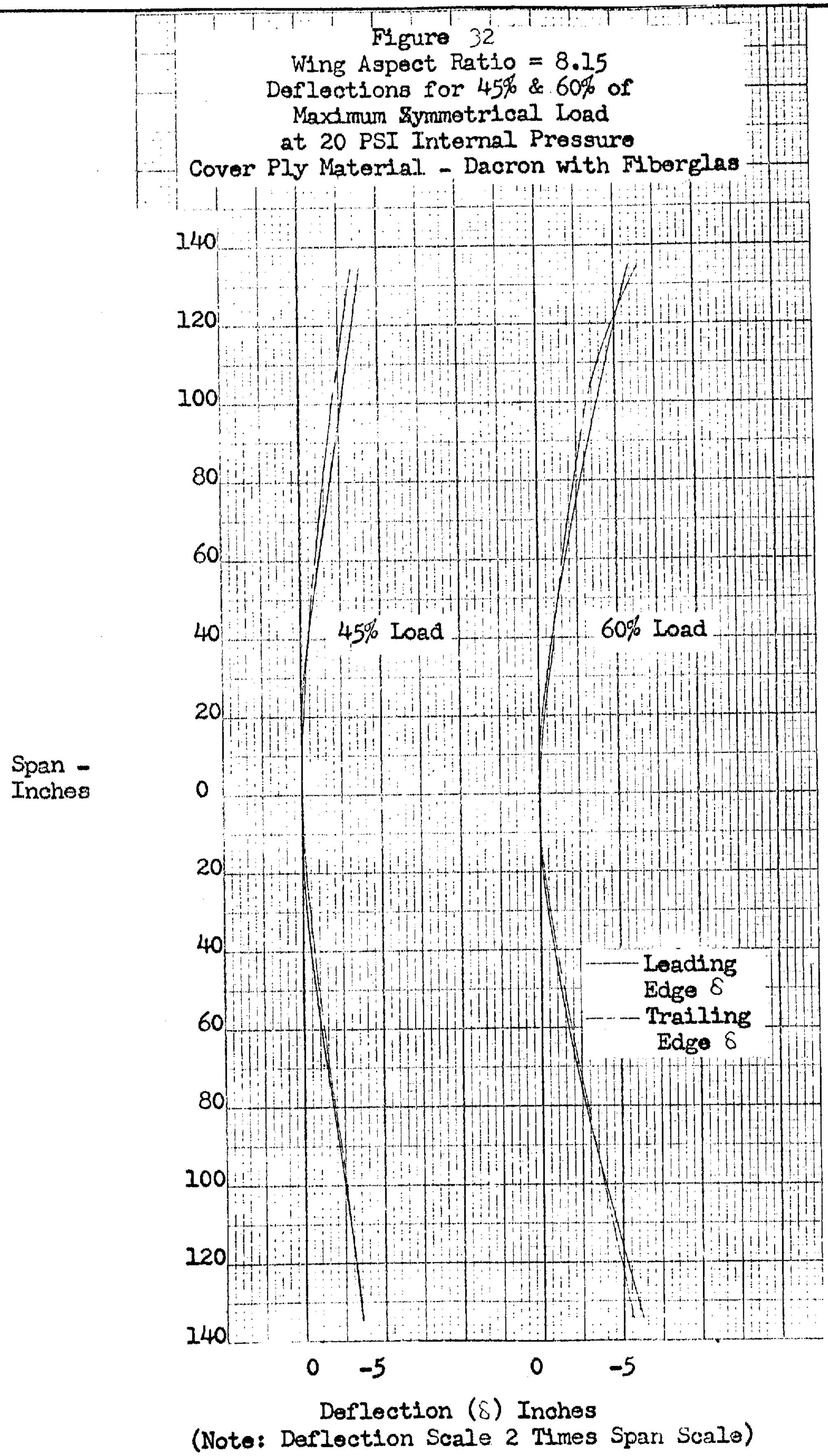


Figure 32
Wing Aspect Ratio = 8.15
Deflections for 45% & 60% of
Maximum Symmetrical Load
at 20 PSI Internal Pressure
Cover Ply Material - Dacron with Fiberglas
140
120
100
80
60
40
20
0
20
40
60
80
100
120
140
Span - Inches
45% Load
60% Load
Leading Edge δ
Trailing Edge δ
0
-5
0
-5
Deflection (δ) Inches
(Note: Deflection Scale 2 Times Span Scale)

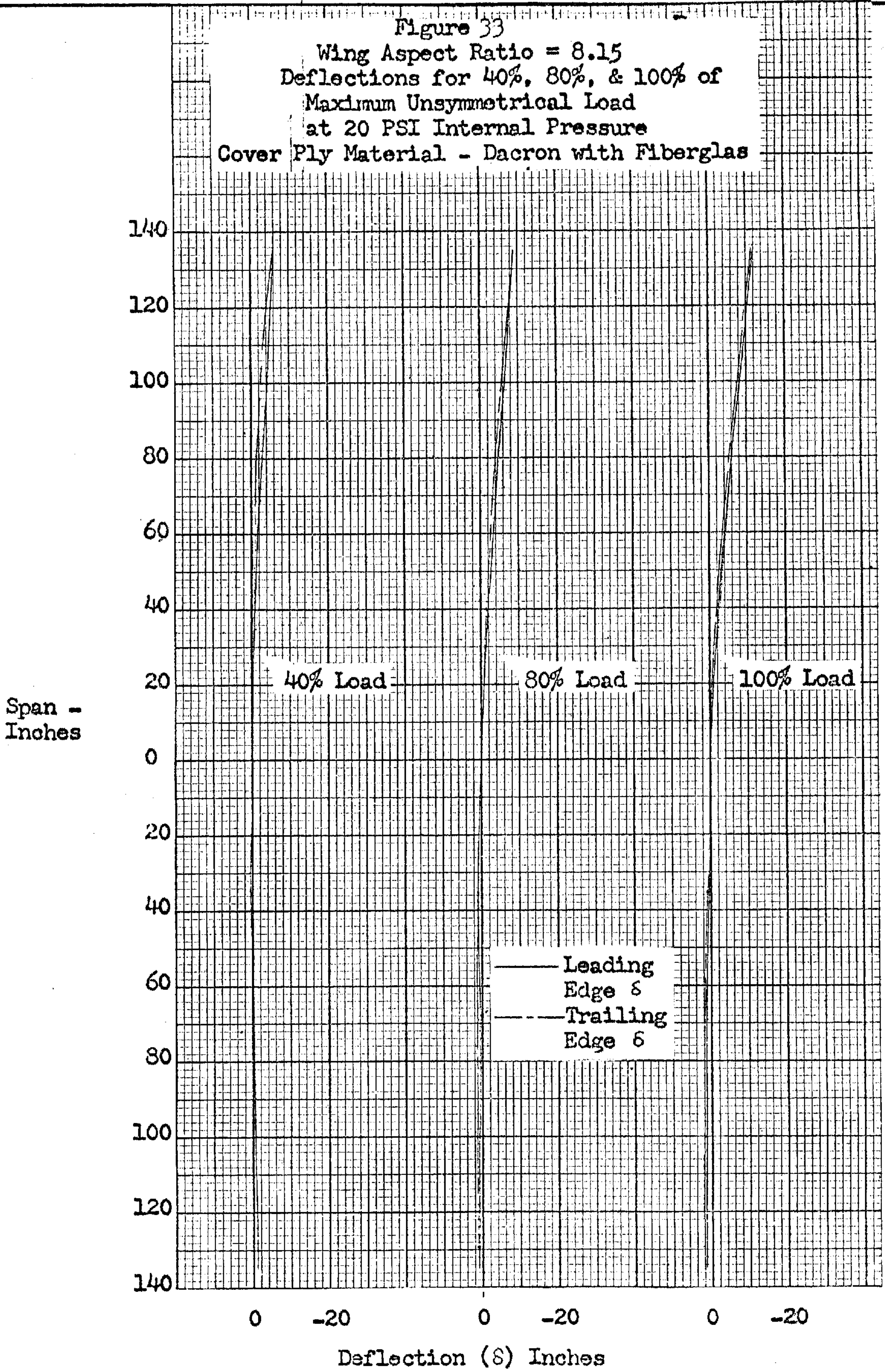
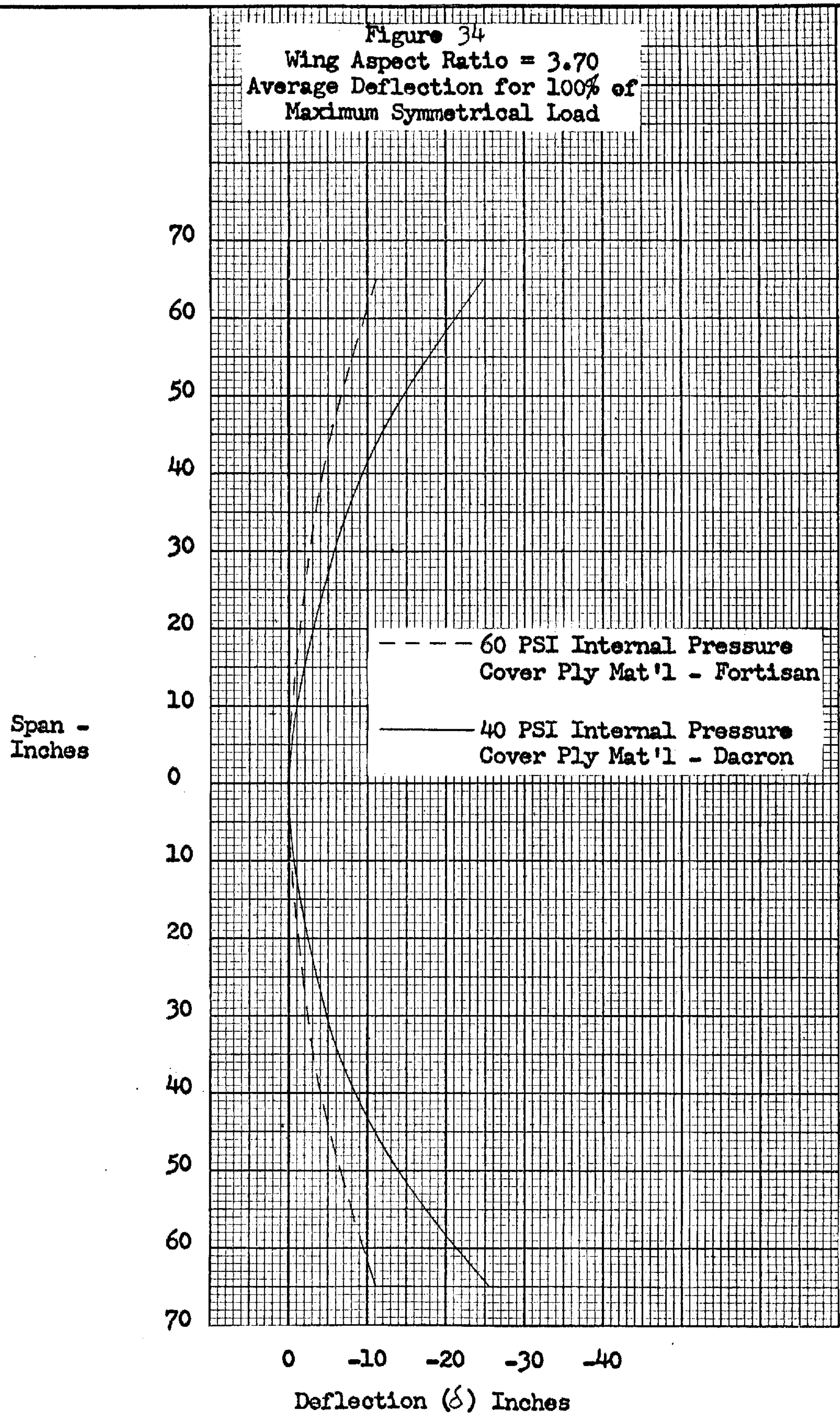


Figure 33
Wing Aspect Ratio = 8.15
Deflections for 40%, 80%, & 100% of
Maximum Unsymmetrical Load
at 20 PSI Internal Pressure
Cover Ply Material - Dacron with Fiberglas
Span - Inches
140
120
100
80
60
40
20
0
20
40
60
80
100
120
140
40% Load
80% Load
100% Load
Leading Edge δ
Trailing Edge δ
0
-20
0
-20
0
-20
Deflection (δ) Inches

Figure 34
Wing Aspect Ratio = 3.70
Average Deflection for 100% of
Maximum Symmetrical Load



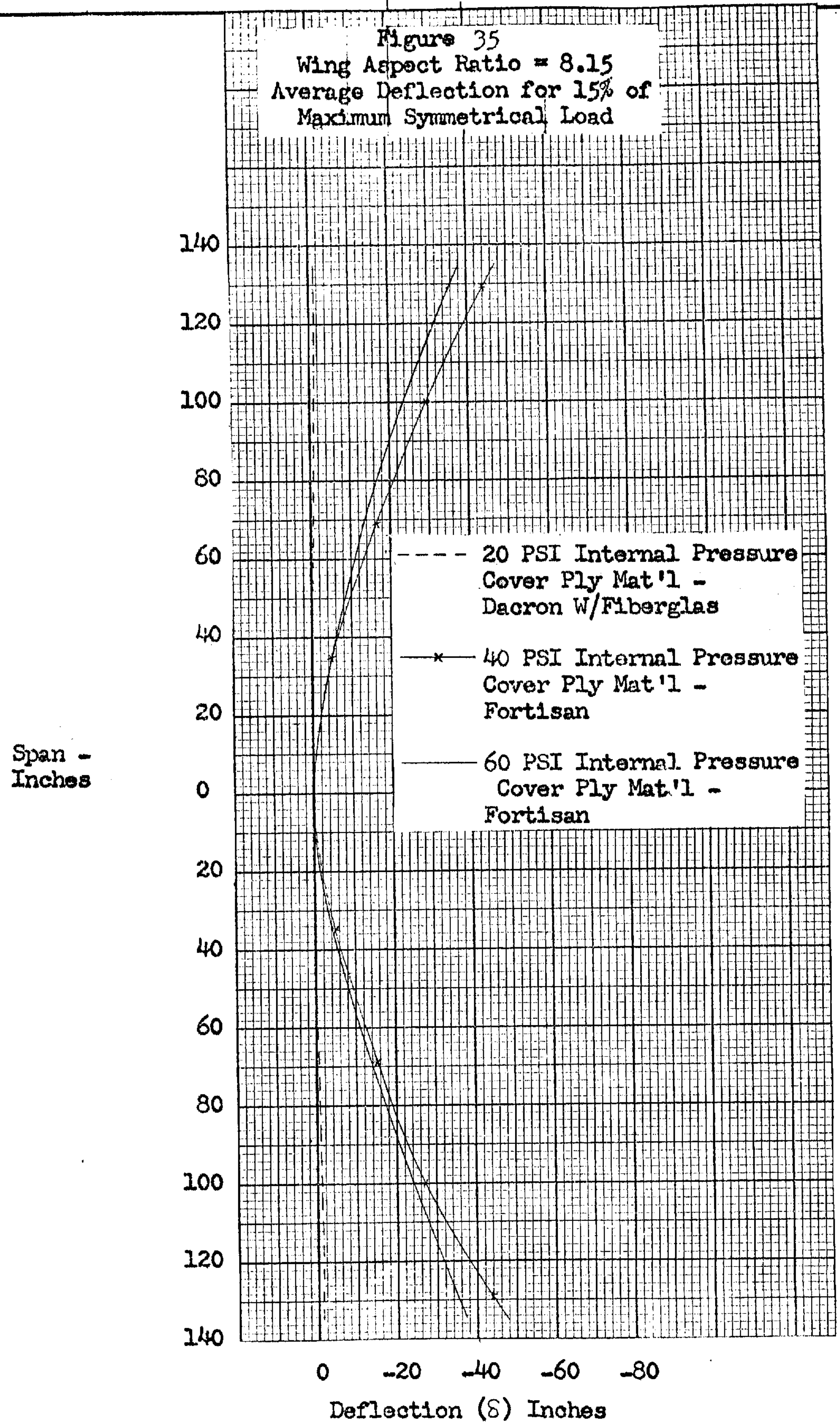


Figure 35
Wing Aspect Ratio = 8.15
Average Deflection for 15% of
Maximum Symmetrical Load
140
120
100
80
60
40
20
0
20
40
60
80
100
120
140
Span - Inches
20 PSI Internal Pressure Cover Ply Mat'l - Dacron W/Fiberglas
40 PSI Internal Pressure Cover Ply Mat'l - Fortisan
60 PSI Internal Pressure Cover Ply Mat'l - Fortisan
0
-20
-40
-60
-80
Deflection (δ) Inches

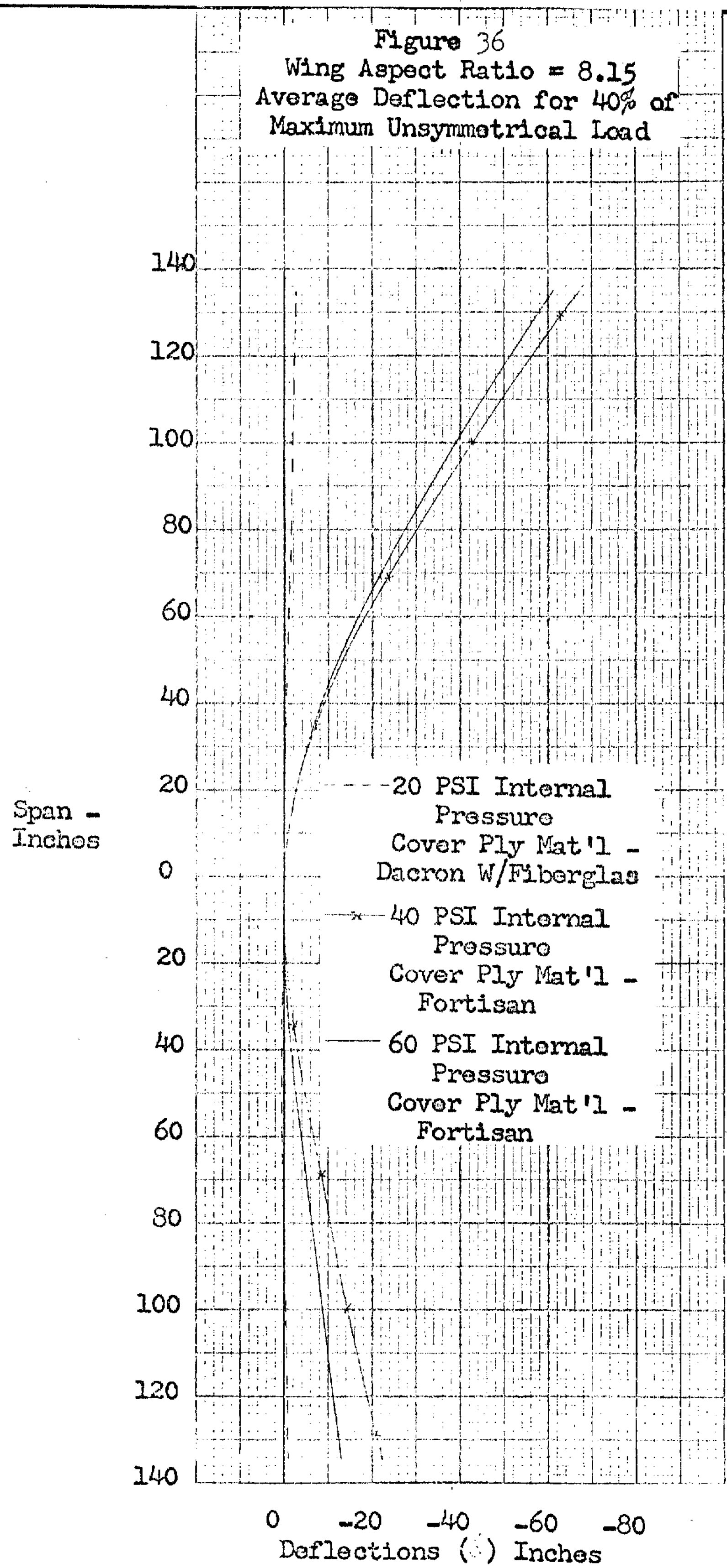


Figure 36
Wing Aspect Ratio = 8.15
Average Deflection for 40% of
Maximum Unsymmetrical Load
140
120
100
80
60
40
20
Span - Inches
0
20
40
60
80
100
120
140
-20 PSI Internal Pressure Cover Ply Mat'l - Dacron W/Fiberglas
40 PSI Internal Pressure Cover Ply Mat'l - Fortisan
60 PSI Internal Pressure Cover Ply Mat'l - Fortisan
0
-20
-40
-60
-80
Deflections (-) Inches

Figure 37
Wing Aspect Ratio = 3.70
Comparison of Twist and Deflection of Test Panel With Simulated Wing for 100% of Symmetrical Load at 20 PSI Internal Pressure
Cover Ply Material - Fortisan

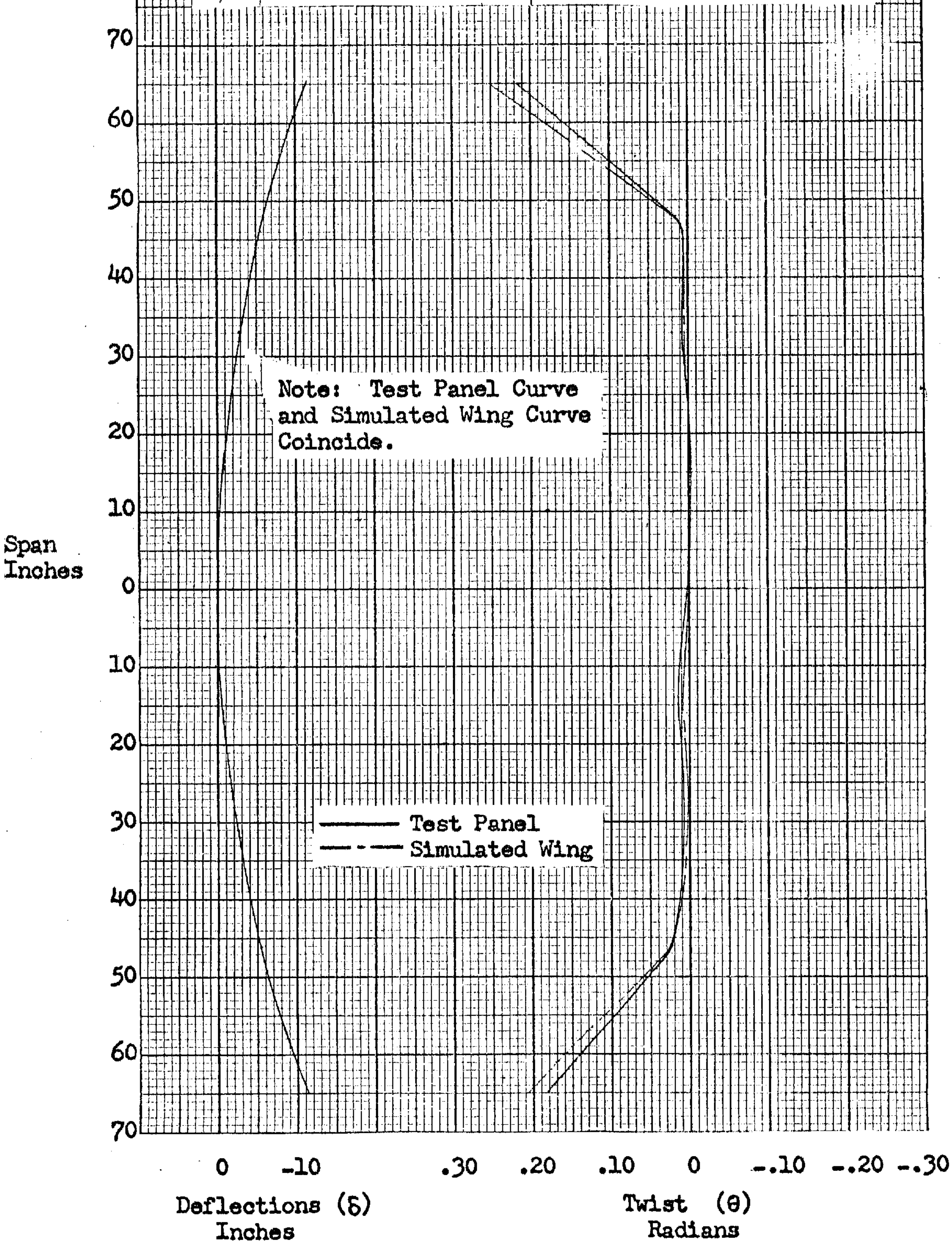


Figure 38
Wing Aspect Ratio = 3.70
Comparison of Twist and Deflection of Test Panel With Simulated Wing for 100% of Unsymmetrical Load at 60 PSI Internal Pressure
Cover Ply Material - Fortisan

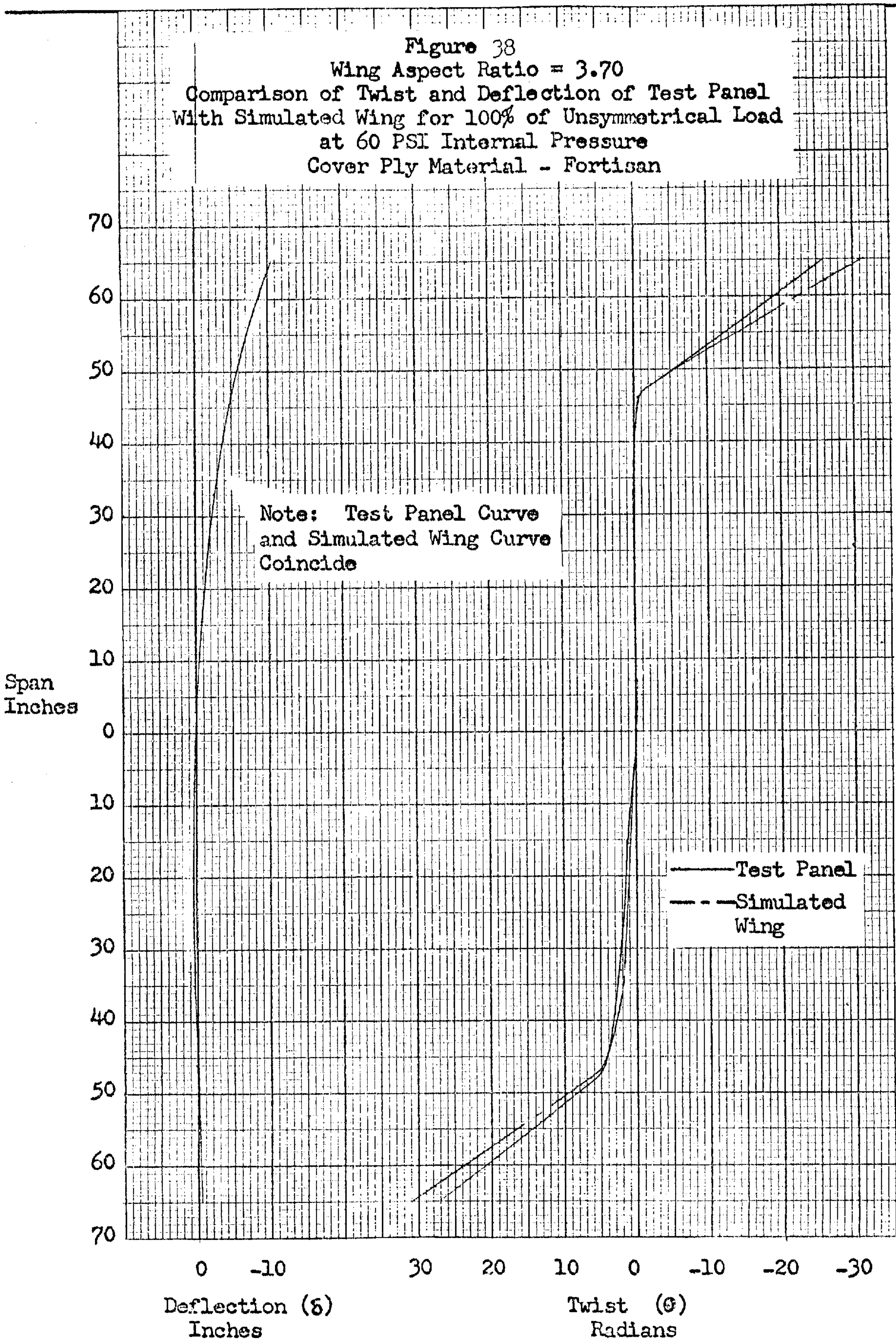


Figure 39
Wing Aspect Ratio = 8.15
Comparison of Twist and Deflection of Test Panel with Simulated Wing for 60% of Symmetrical Load at 20 PSI Internal Pressure
Cover Ply Material - Dacron with Fiberglas

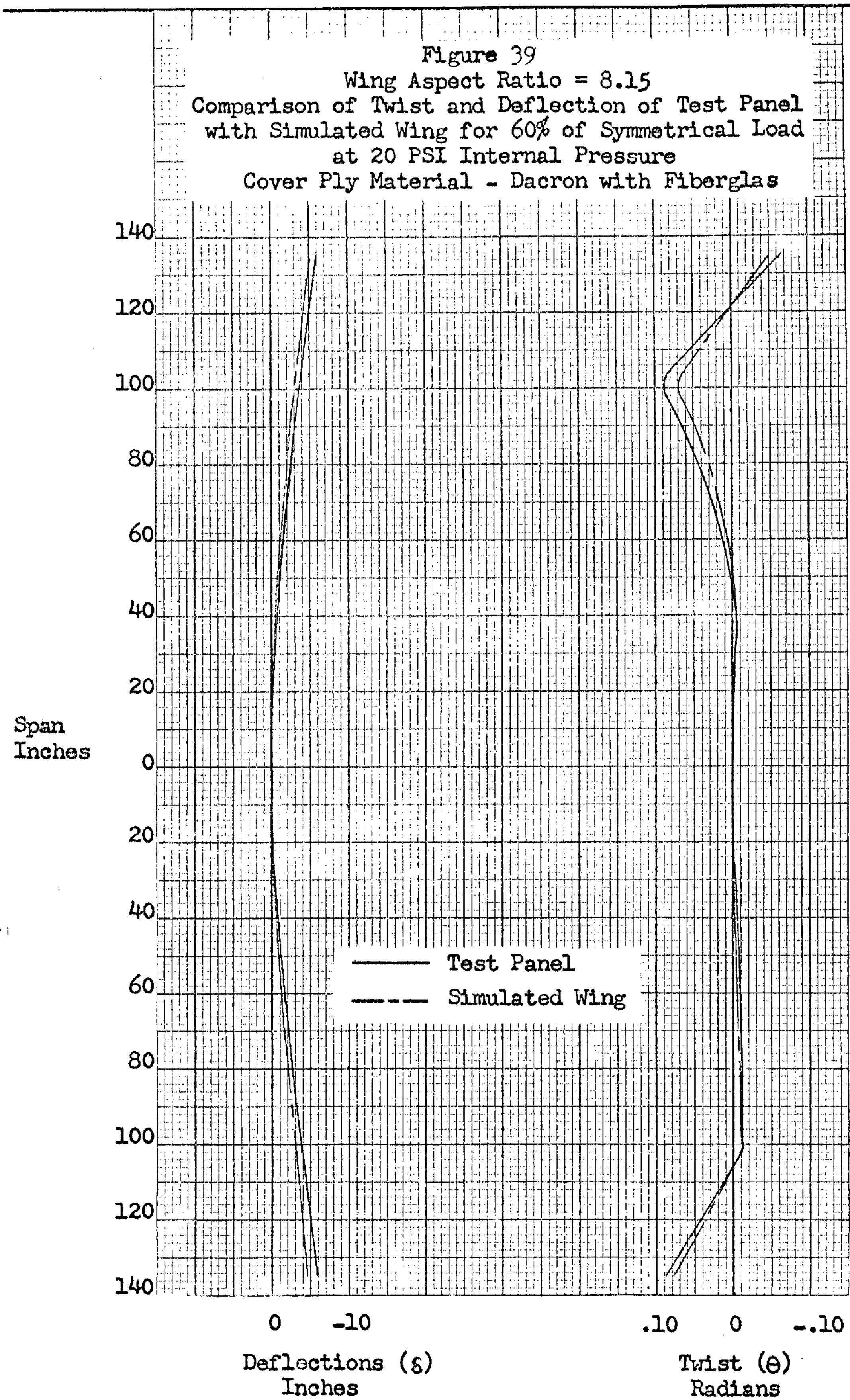
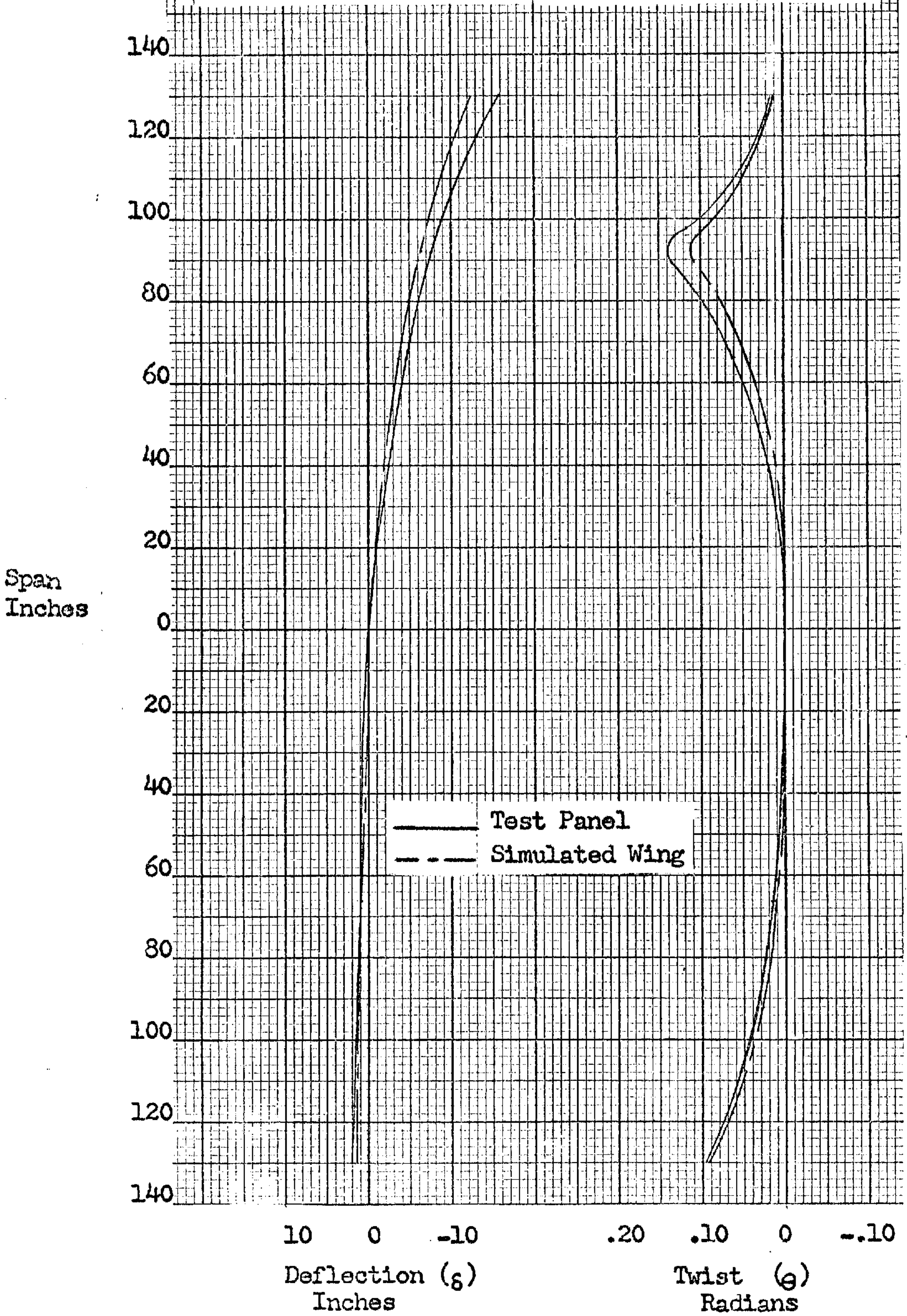


Figure 40
Wing Aspect Ratio = 8.15
Comparison of Twist and Deflection of Test Panel With Simulated Wing for 100% of Unsymmetrical Load at 20 PSI Internal Pressure
Cover Ply Material - Dacron with Fiberglas



APPENDIX C

PHOTOGRAPHS OF TESTS

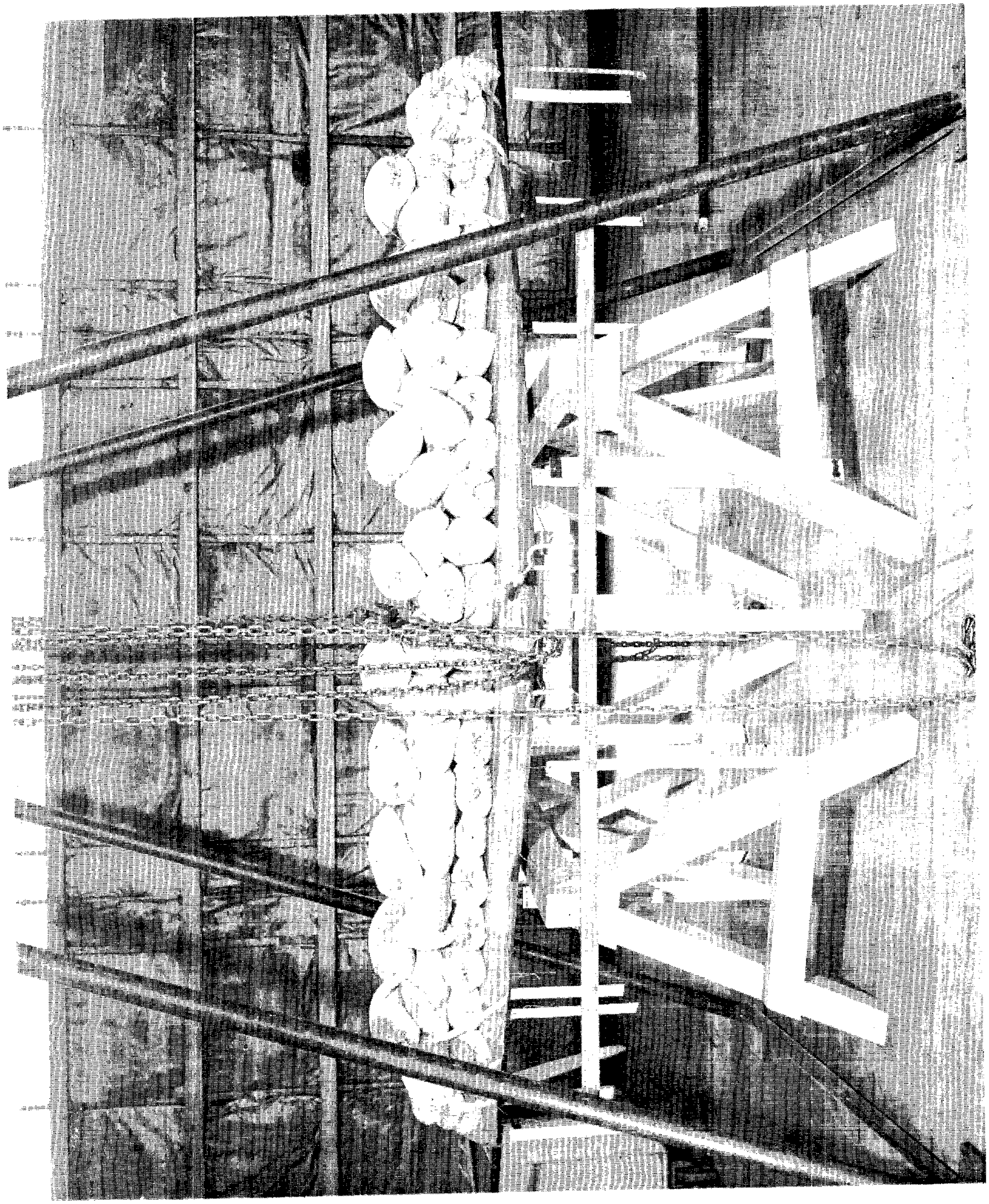


Photo 1
Zero Reading Position
Wing Aspect Ratio = 3.70
100% of Maximum Symmetrical Load
at 40 PSI Internal Pressure
Cover Ply Material - Dacron

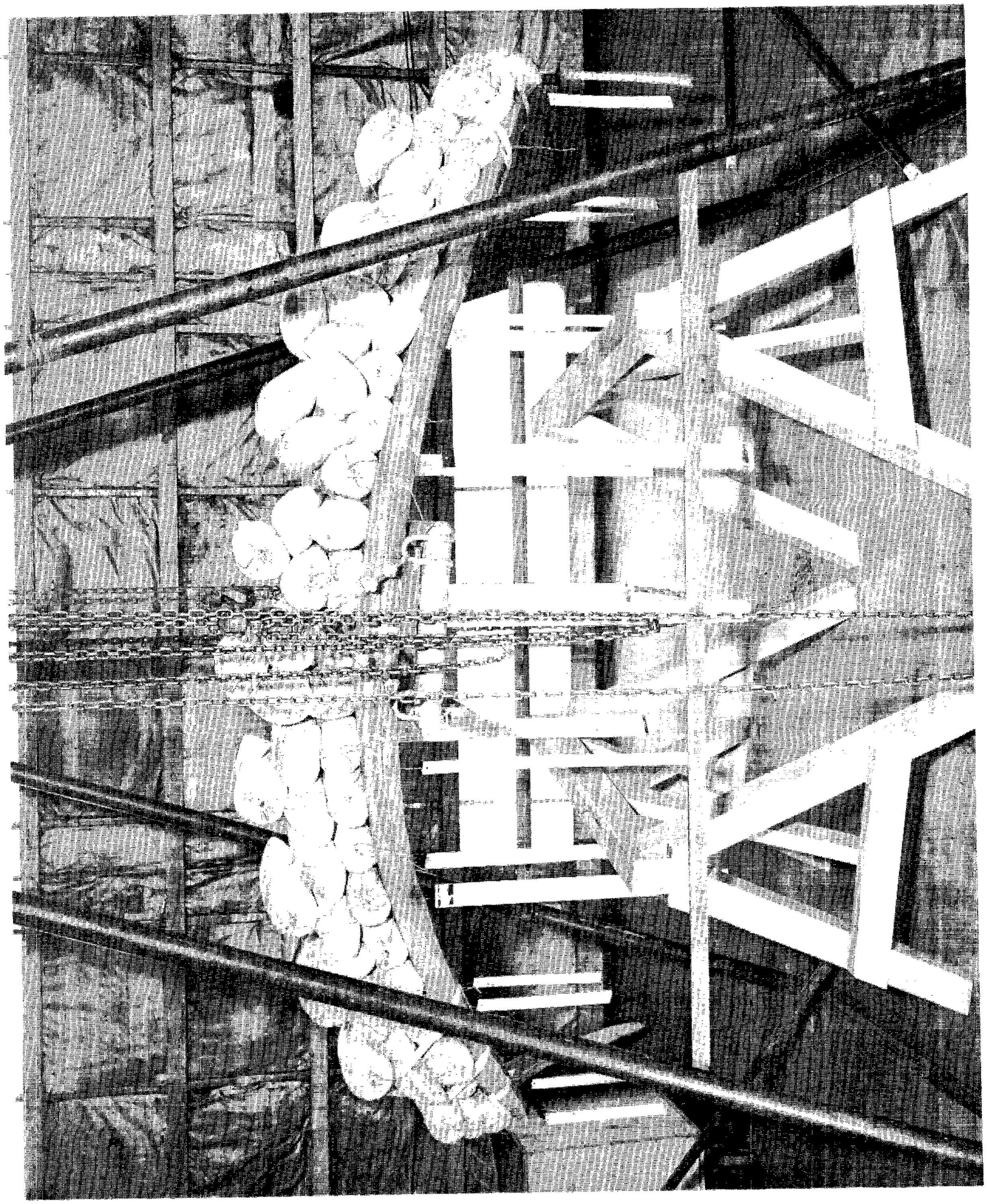


Photo 2
Deflected Reading Position
Wing Aspect Ratio = 3.70
100% of Maximum Symmetrical Load
at 40 PSI Internal Pressure
Cover Ply Material - Dacron

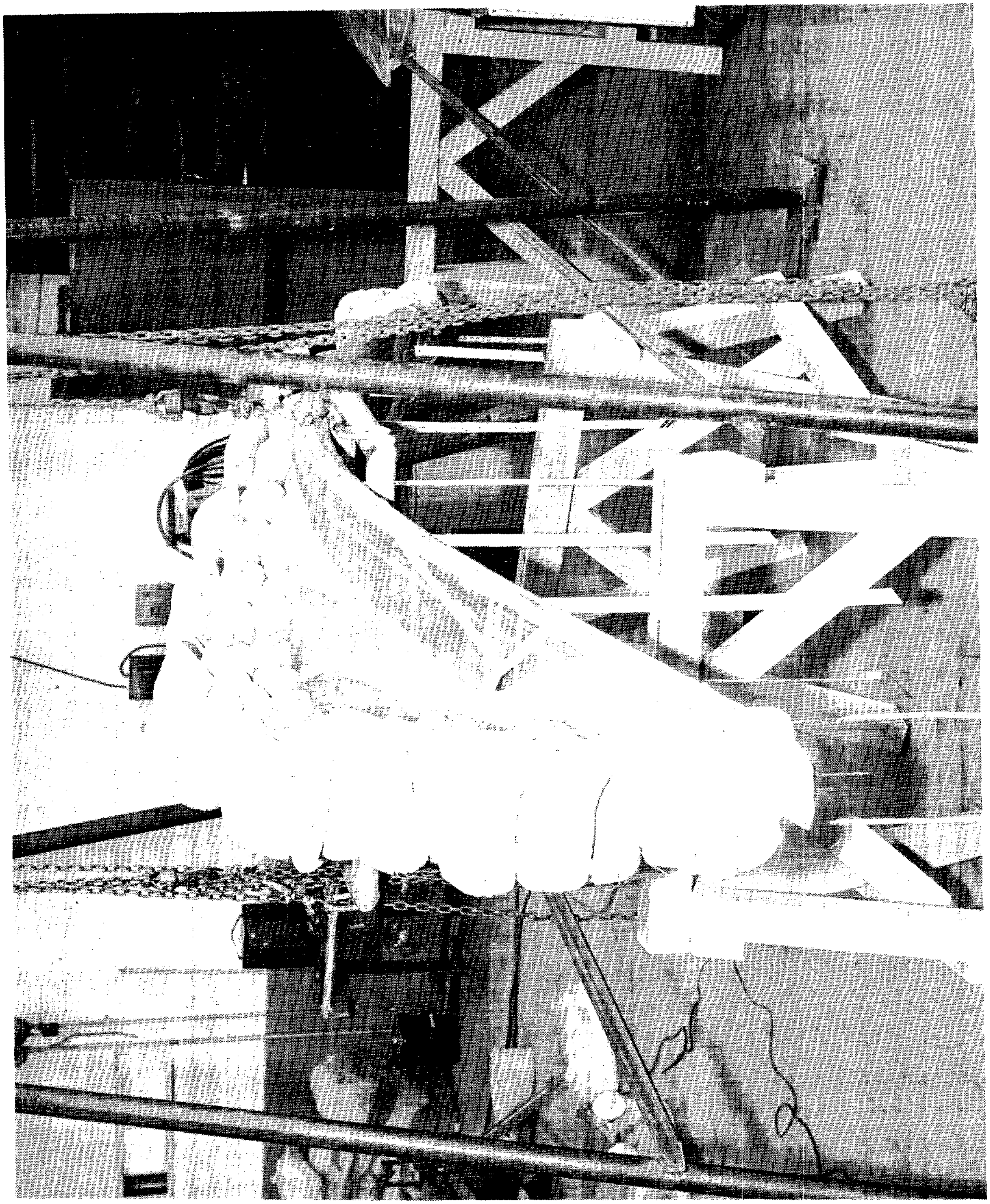


Photo 3
Deflected Reading Position
Wing Aspect Ratio = 3.70
100% of Maximum Symmetrical Load
at 40 PSI Internal Pressure
Cover Ply Material - Dacron

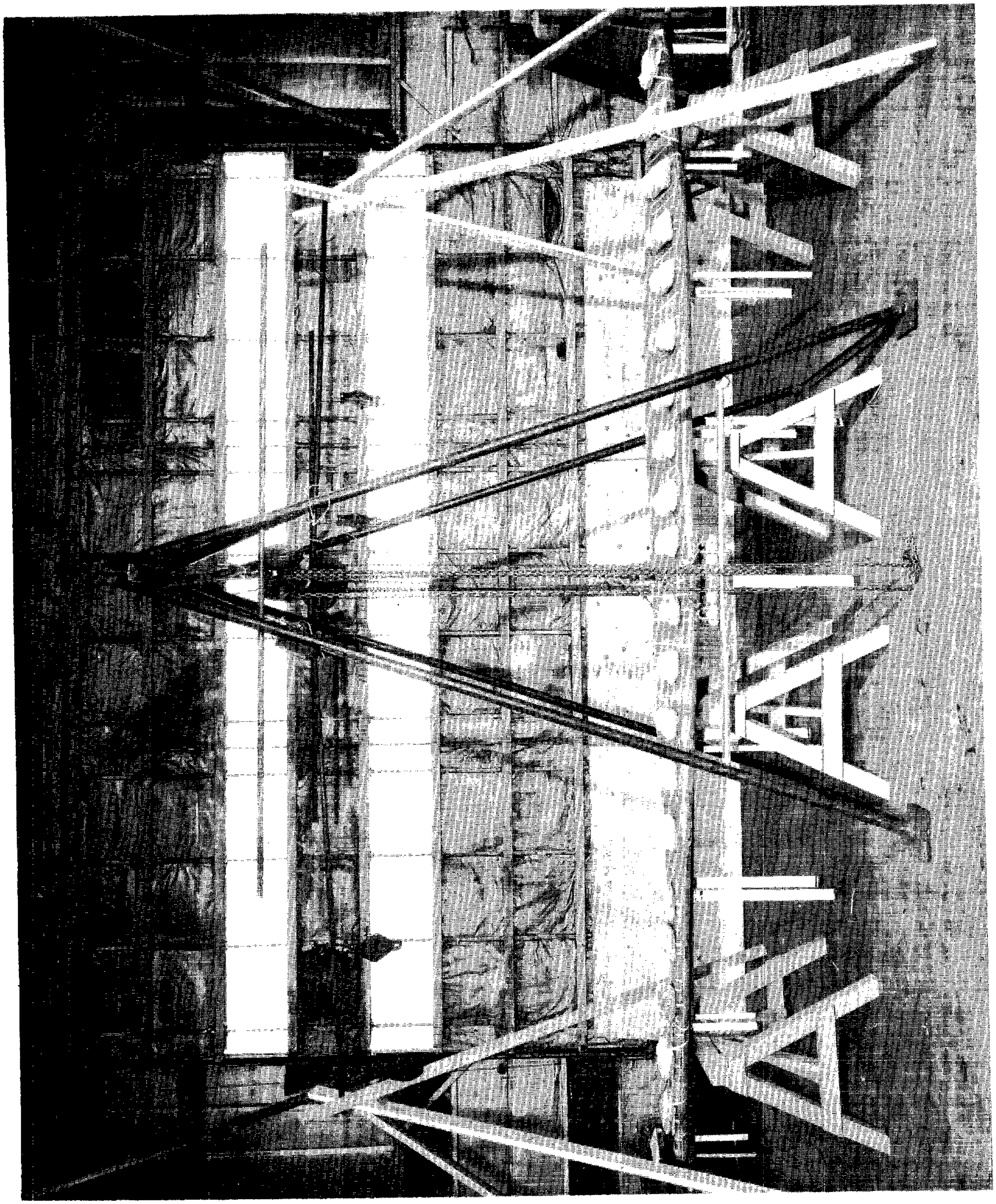


Photo 4
Zero Reading Position
Wing Aspect Ratio = 8.15
15% of Maximum Symmetrical Load
at 40 PSI Internal Pressure
Cover Ply Material - Fortisan

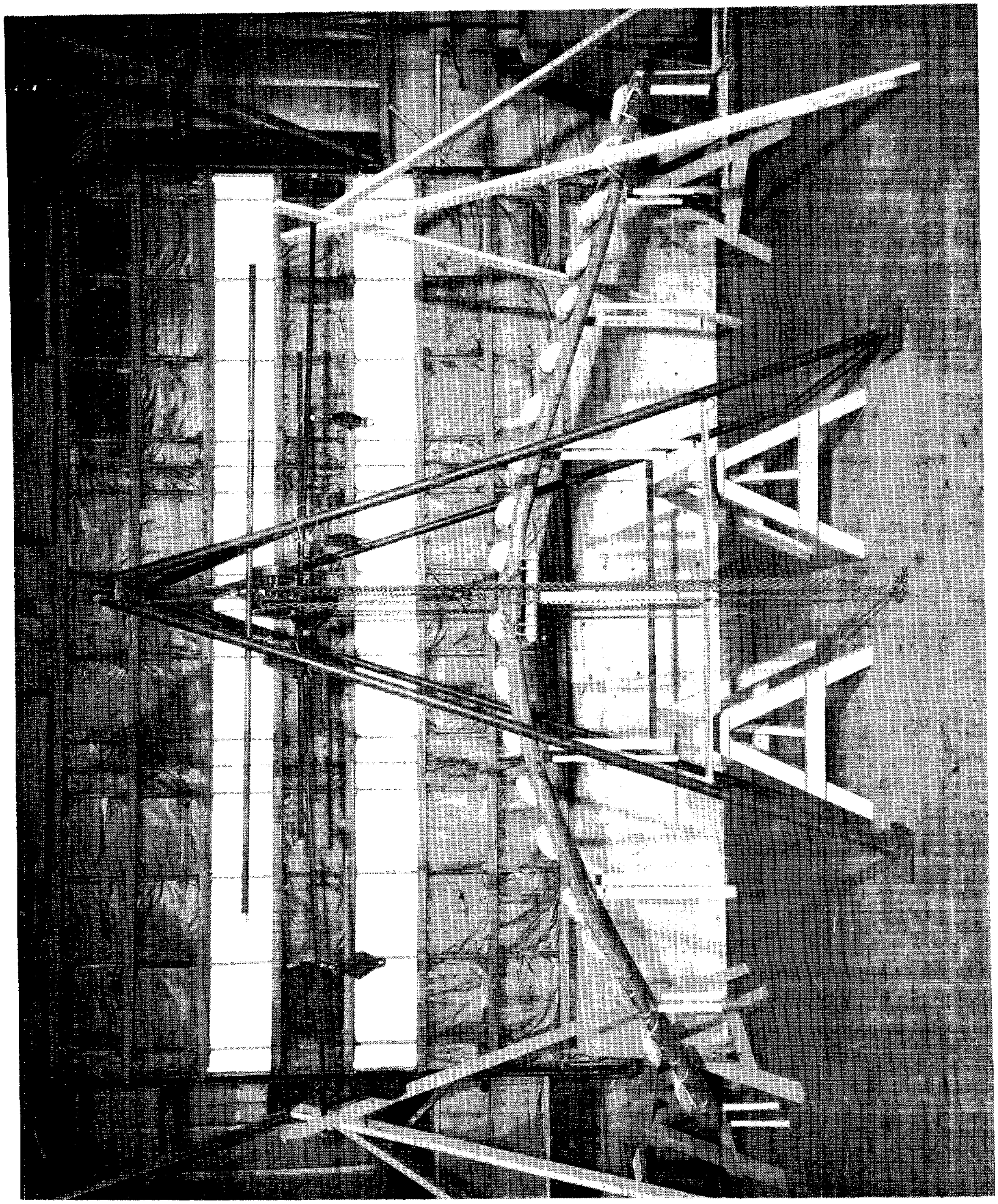


Photo 5
Deflected Reading Position
Wing Aspect Ratio = 8.15
15% of Maximum Symmetrical Load
at 40 PSI Internal Pressure
Cover Ply Material - Fortisan

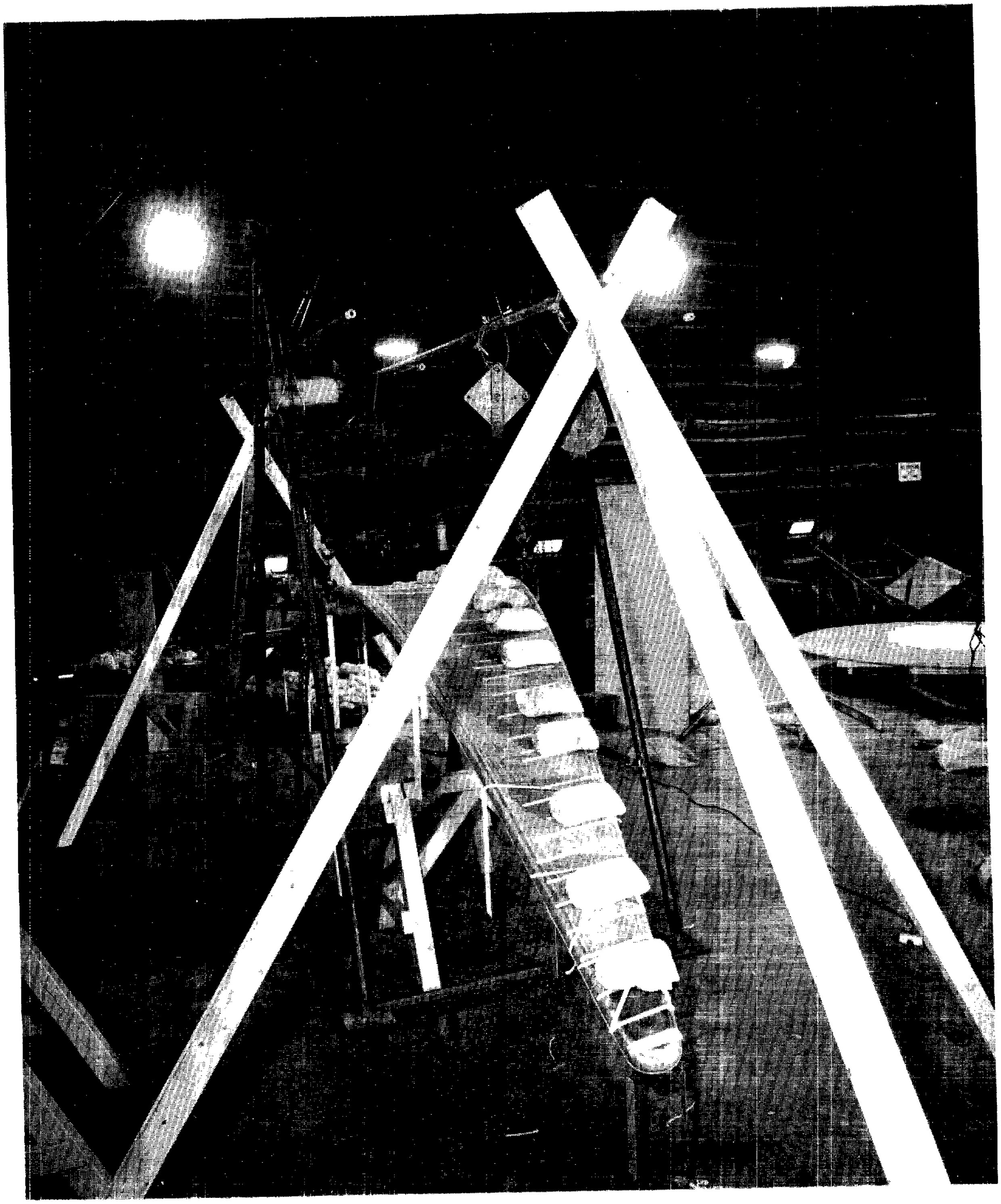


Photo 6
Deflected Reading Position
Wing Aspect Ratio = 8.15
15% of Maximum Symmetrical Load
at 40 PSI Internal Pressure
Cover Ply Material - Fortisan

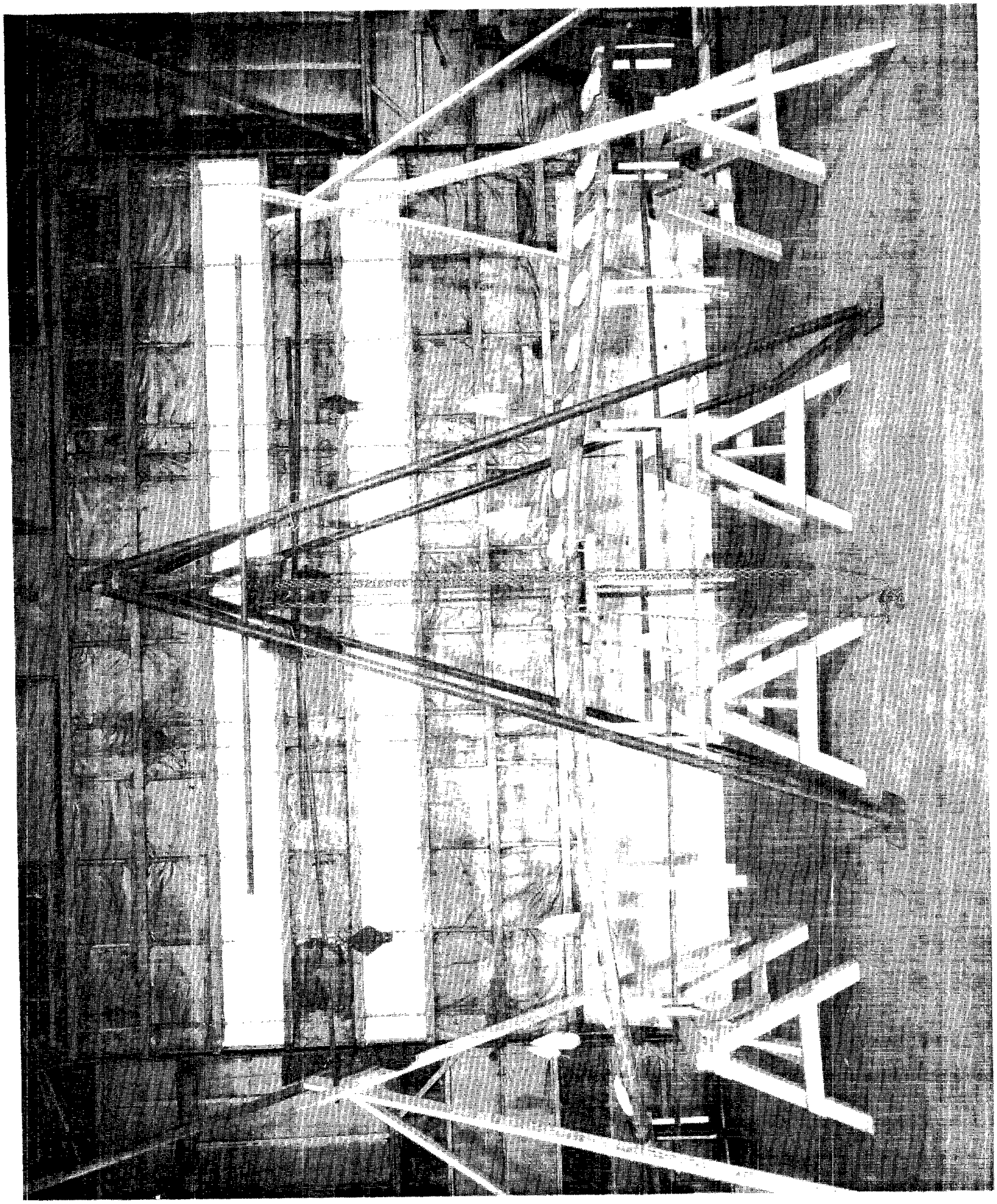


Photo 7
Deflected Reading Position
Wing Aspect Ratio = 8.15
20% of Maximum Unsymmetrical Load
at 40 PSI Internal Pressure
Cover Ply Material - Fortisan

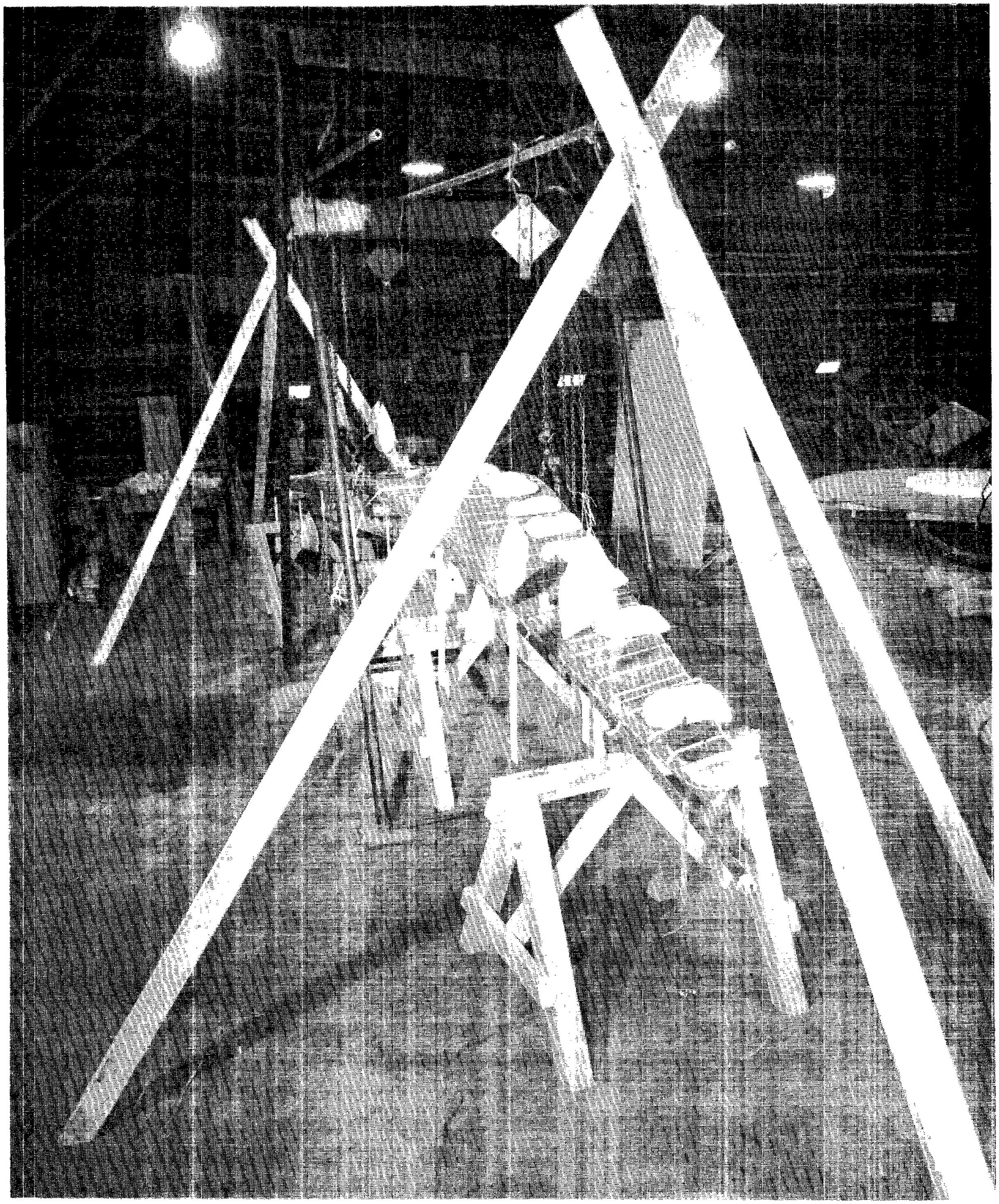


Photo 8
Deflected Reading Position
Wing Aspect Ratio = 8.15
20% of Maximum Unsymmetrical Load
at 40 PSI Internal Pressure
Cover Ply Material - Fortisan

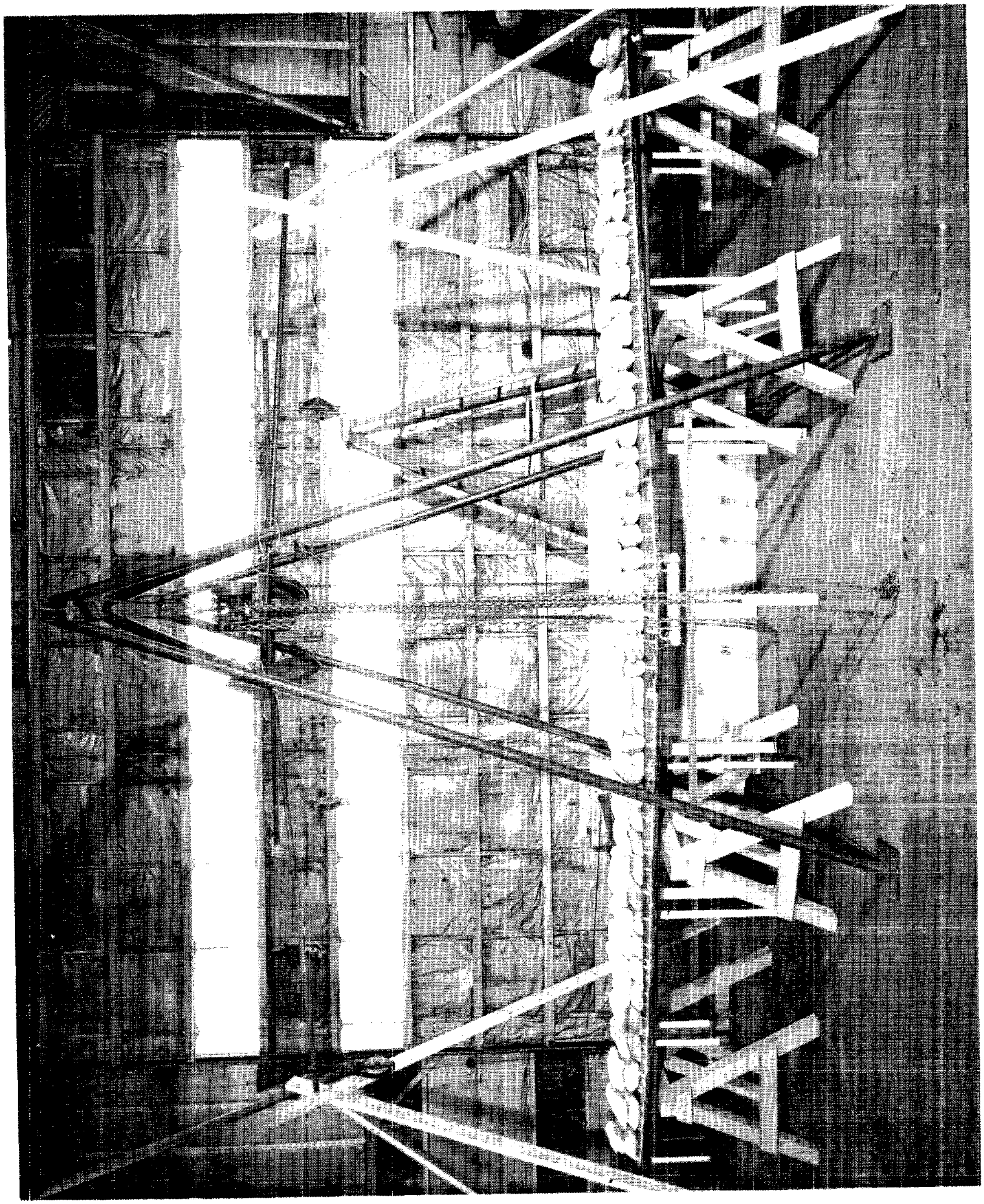


Photo 9
Zero Reading Position
Wing Aspect Ratio = 8.15
45% of Maximum Symmetrical Load
at 20 PSI Internal Pressure
Cover Ply Material - Dacron and Fiberglas

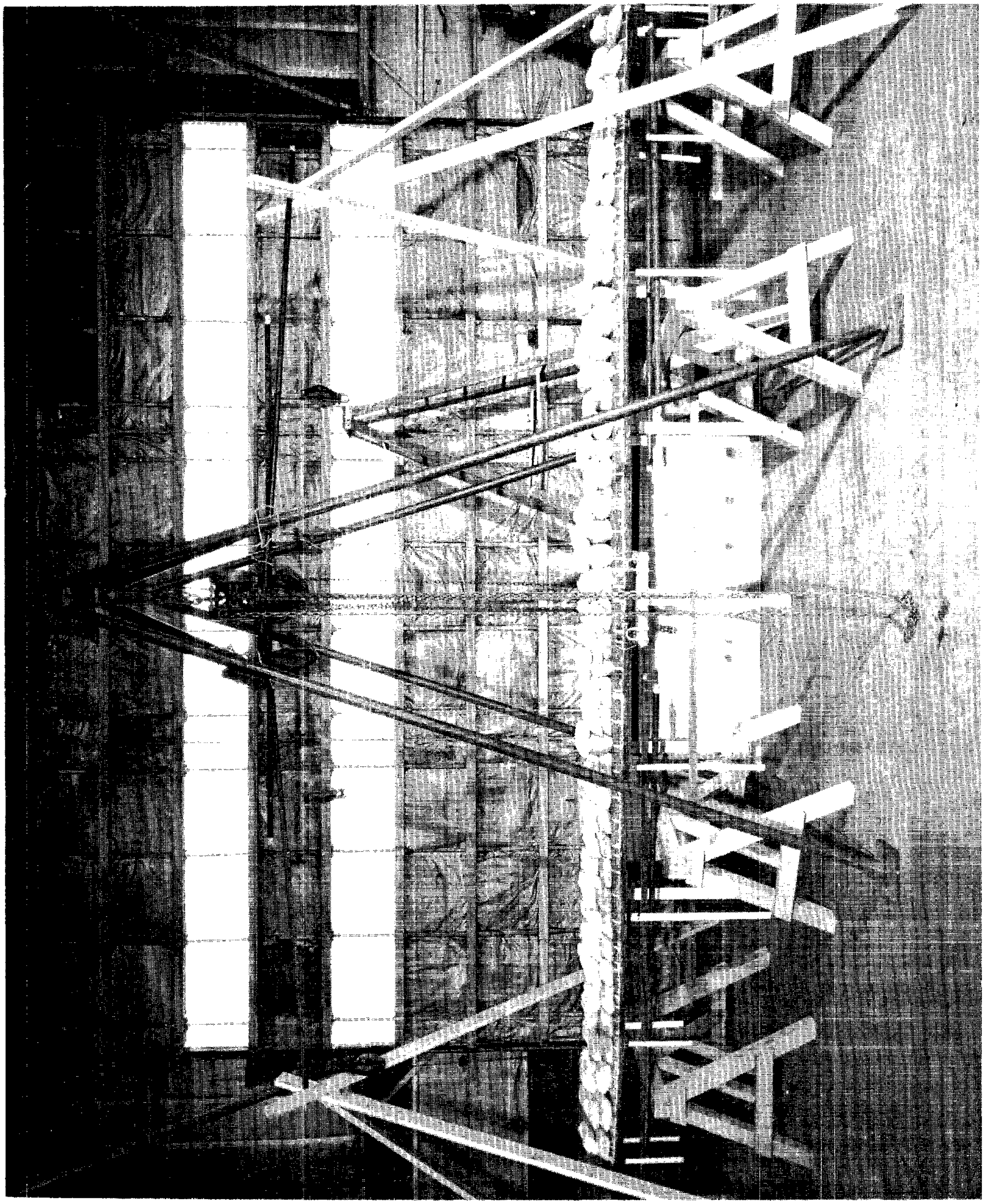


Photo 10
Deflected Reading Position
Wing Aspect Ratio = 8.15
45% of Maximum Symmetrical Load
at 20 PSI Internal Pressure
Cover Ply Material - Dacron and Fiberglas

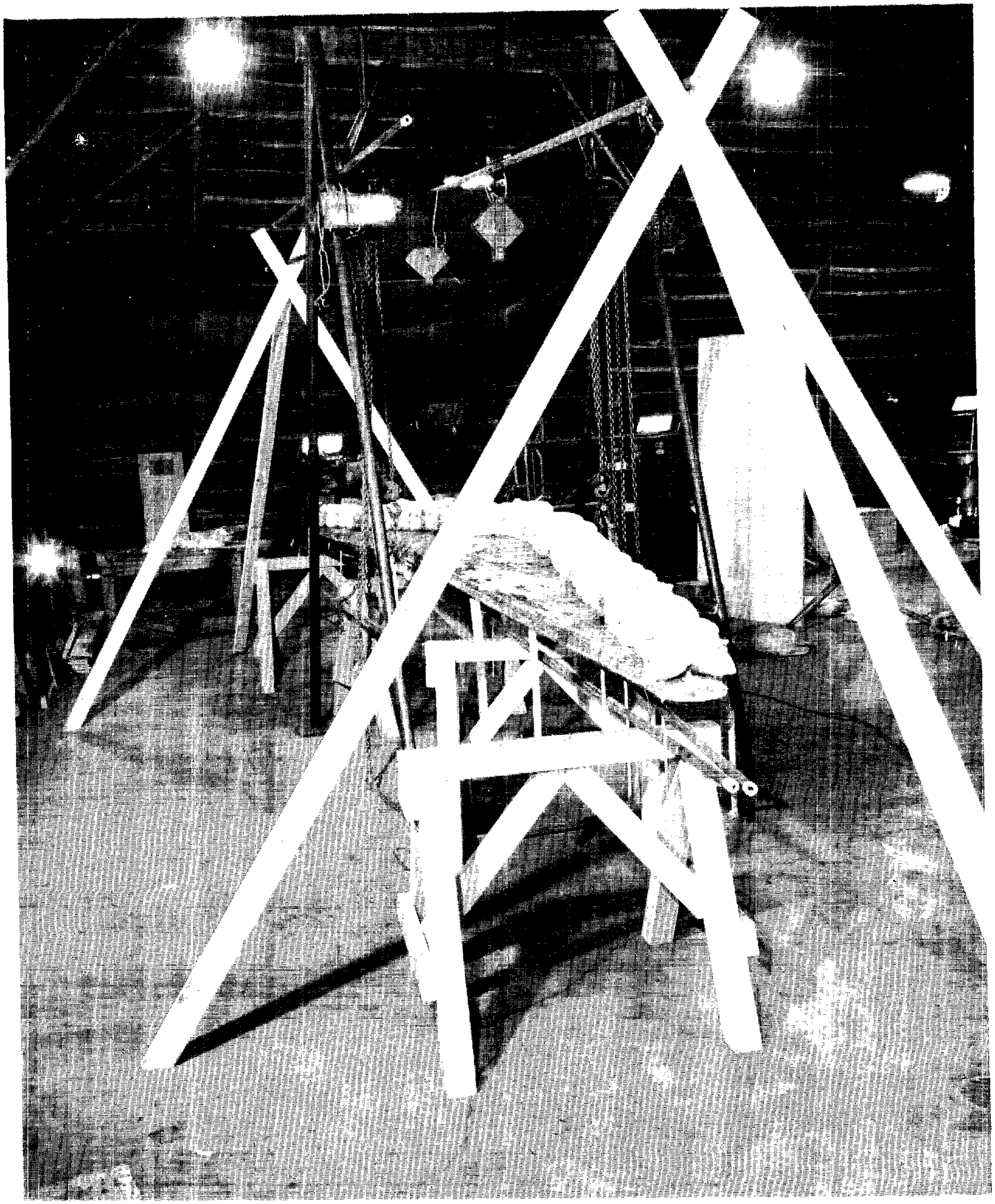


Photo 11
Deflected Reading Position
Wing Aspect Ratio = 8.15
45% of Maximum Symmetrical Load
at 20 PSI Internal Pressure
Cover Ply Material - Dacron and Fiberglass

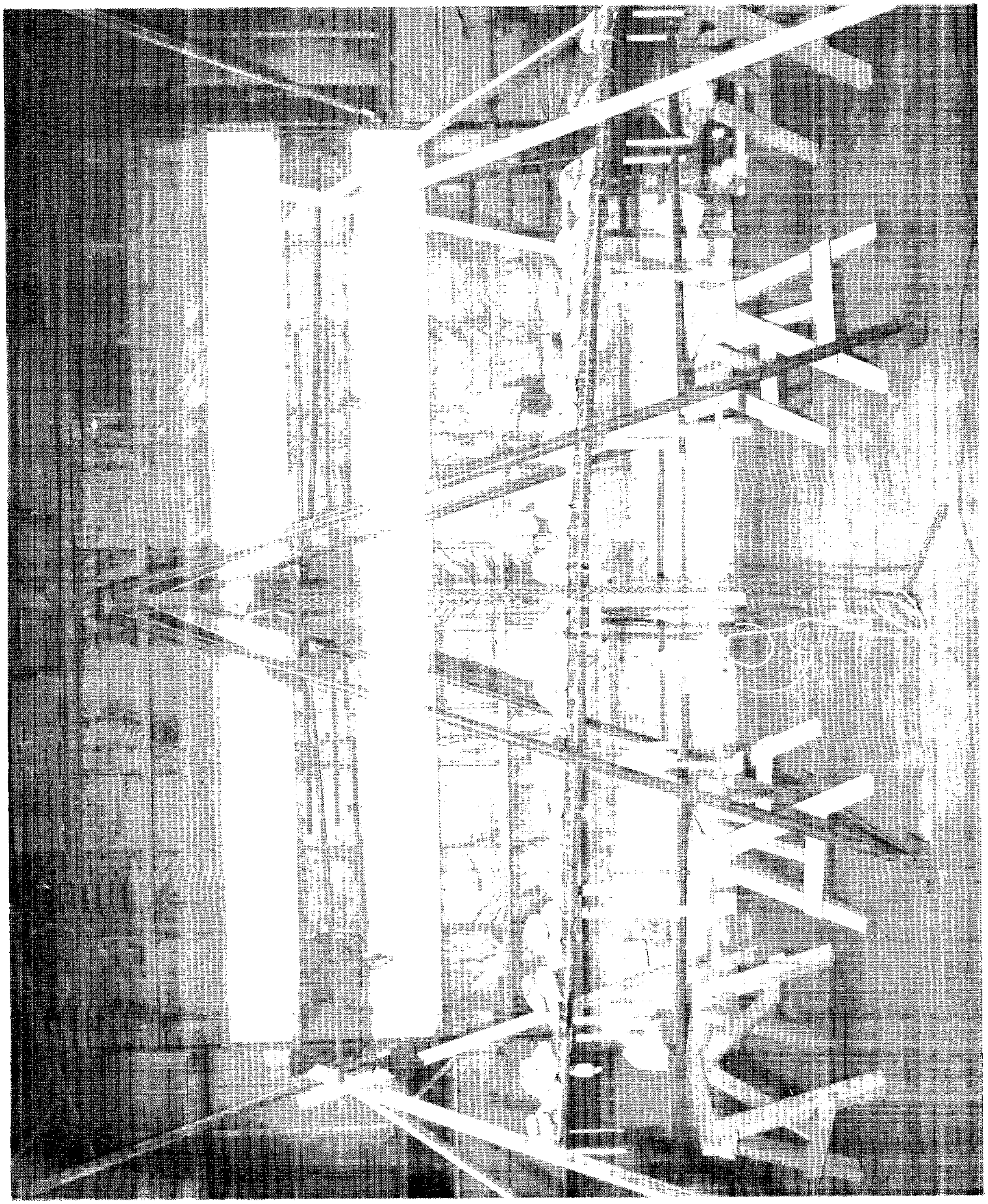


Photo 12
Deflected Reading Position
Wing Aspect Ratio = 8.15
100% of Maximum Unsymmetrical Load
at 20 PSI Internal Pressure
Cover Ply Material - Dacron and Fiberglas

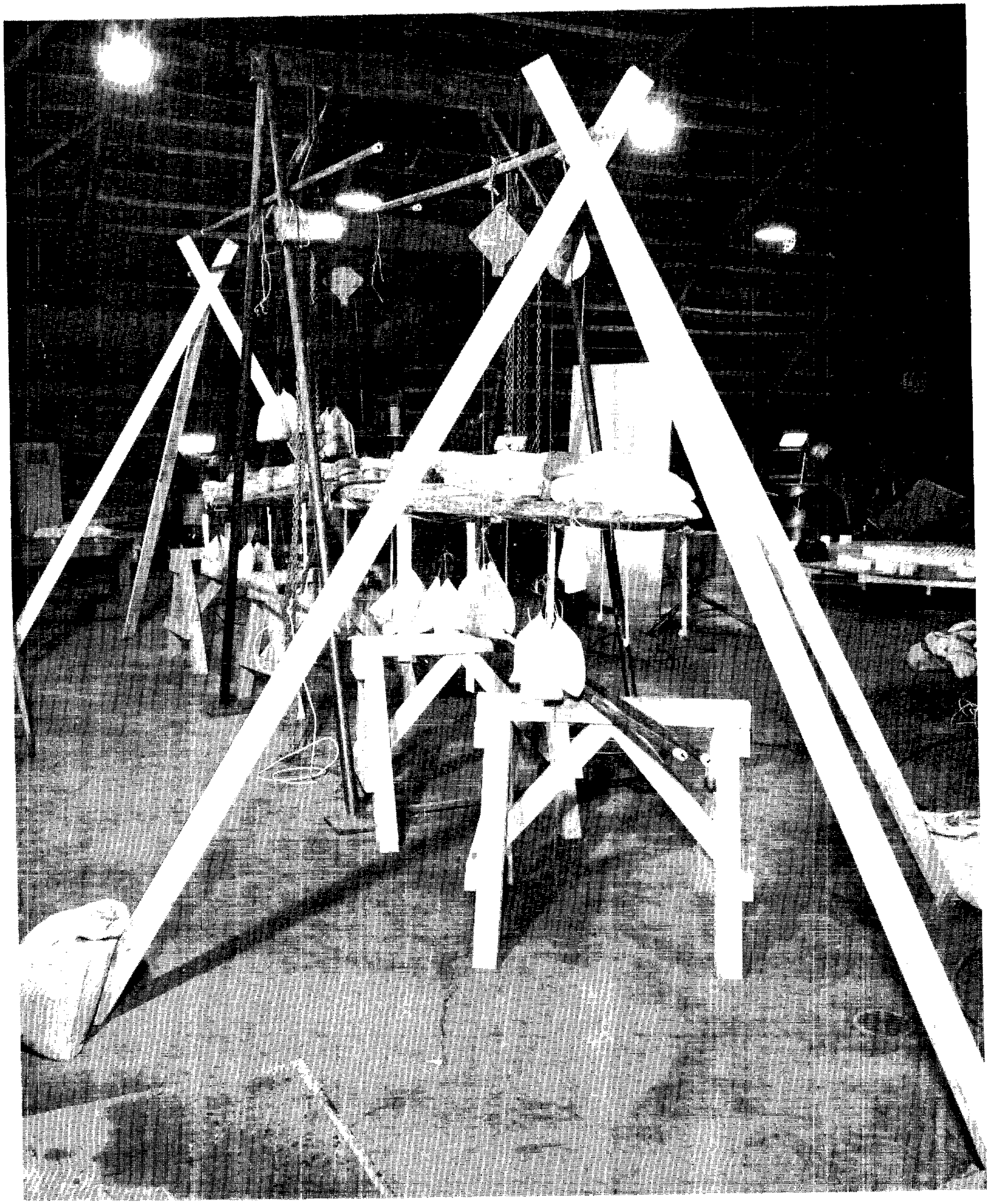


Photo 13
Deflected Reading Position
Wing Aspect Ratio = 8.15
100% of Maximum Unsymmetrical Load
at 20 PSI Internal Pressure
Cover Ply Material - Dacron and Fiberglas

REFERENCES

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3 Toll, Thomas A.: Summary of Lateral-Control Research: NACA Technical Report No. 868

4 Flat, J.: Eveluation of Methods for Determining Spanwise Lift Distribution; Army Air Forces Technical Report No. 4952