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47159

UNCLASSIFIED

Stress Analysis of Outer Wing Bulkheads and Auxiliary Spar - Model YB-36 and B-36A

47159

(None)

Lowrey, M.; Thomson, L. E.; Beard, N. W.
Consolidated Vultee Aircraft Corp., Fort Worth Div., Texas
USAF Contract W535-ac-22352 and Contract W33-038-ac-7

FZS-36-142

(None)

April '47 Unclass. U.S. English 119 tables, diagrs, graphs

This report contains an anlysis of the following outer wing panel structures for the YB-36 and B-36A bombers: the critical aileron support inter-spar bulkhead and trailing edge rib; typical airload inter-spar bulkhead and trailing edge rib; typical airload nose rib; and the wing auxiliary spar. For the inter-spar bulkheads the crushing loads due to bending are computed by the method of C.V.A.C. No. 1 from the bending stresses of a previous report No. FZS-36-141. These loads are combined with the loads obtained from the pressure distribution curves as final loads for the bulkheads. Included are results of the analysis which are presented in various graphs and diagrams.

Copies of this report obtainable from Central Air Documents Office; Attn: MCIDXD

Structures (7) B-36 - Stress analysis (14884.605);
Stress Analysis of Specific Aircraft (6) B-36A (14885); YB-36 (99854.3); Wings - Stresses (99180)

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47159

CONSOLIDATED VULTEE AIRCRAFT CORPORATION

FORT WORTH DIVISION • FORT WORTH 1, TEXAS

G3-50

MODEL YB-36
B-36A

REPORT FZS-36-142
DATE April 22, 1947
Addendum A

TITLE

STRESS ANALYSIS OF OUTER WING BULKHEADS
AND
AUXILIARY SPAR

SUBMITTED UNDER

Contract W535-ac-22352
and
Contract W33-038-ac-7

PREPARED BY: L.E. THOMSON, A. PERCHASKY, M. Lurey Jr., J. Penola, D.W. Beard

GROUP: STRUCTURES

REFERENCE:

CHECKED BY: H. ZINBERG

APPROVED BY: [signatures]

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INTRODUCTION

This report contains an analysis of the following outer wing panel structures for the YB-36 and B-36A Airplane.

1. The Critical Aileron Support Inter-Spar Bulkhead and Trailing Edge Rib at Wing Sta. No. 29(978)
2. Typical Airload Inter-Spar Bulkhead and Trailing Edge Rib at Sta. No. 30(1014)
3. Typical Airload Nose Rib at Sta. 1013
4. The Wing Auxiliary Spar from Sta. No. 26 to Sta. No. 40.

The chordwise pressure distribution curves are obtained for Wing Sta. 29 and Sta. 30 from the crossplots of $\frac{\Delta P}{q}$ Vs. C_N for various values of Mach No. as contained in Report FZS-36-139.

For the inter-spar bulkheads the crushing loads due to bending are computed by the method of C.V.A.C. No. 1 from the bending stresses of Report FZS-36-141, Add. A. These loads are combined with the loads obtained from the pressure distribution curves as final loads for the bulkheads.

The bulkhead at Sta. No. 29 is investigated for seven conditions of loading. Aileron roll condition is worked out in its entirety while a summary is shown for all other conditions. Aileron hinge loads are obtained from Report FZS-36-163.

For the bulkhead at Sta. No. 30 six conditions of loading are investigated with D.G. Wt. L.A.A. 30,000' High Speed shown and a summary only for the other conditions.

The typical airload rib (Sta. 1013) is a redundant closed frame and as such is solved for the critical condition of loading, D.G.W. - H.A.A. - 5,000', by the Elastic Energy Method.

The wing auxiliary spar, extending from Wing Sta. 26 to Sta. 40, is treated as a series of simply supported beams between aileron support ribs, with loads being applied from the trailing edge airload ribs as concentrated loads.

WING BULKHEAD NO. 29 (STA 91.7)

CONDITIONS TO BE INVESTIGATED
(REF. FZS-36-136).

NORMAL WING

$C\ell_o = -.032$ (REF. PG. 14 FZS-36-139), $C\ell_{a_1} = 1.068$ (REF. PG. 15 FZS-36-138)

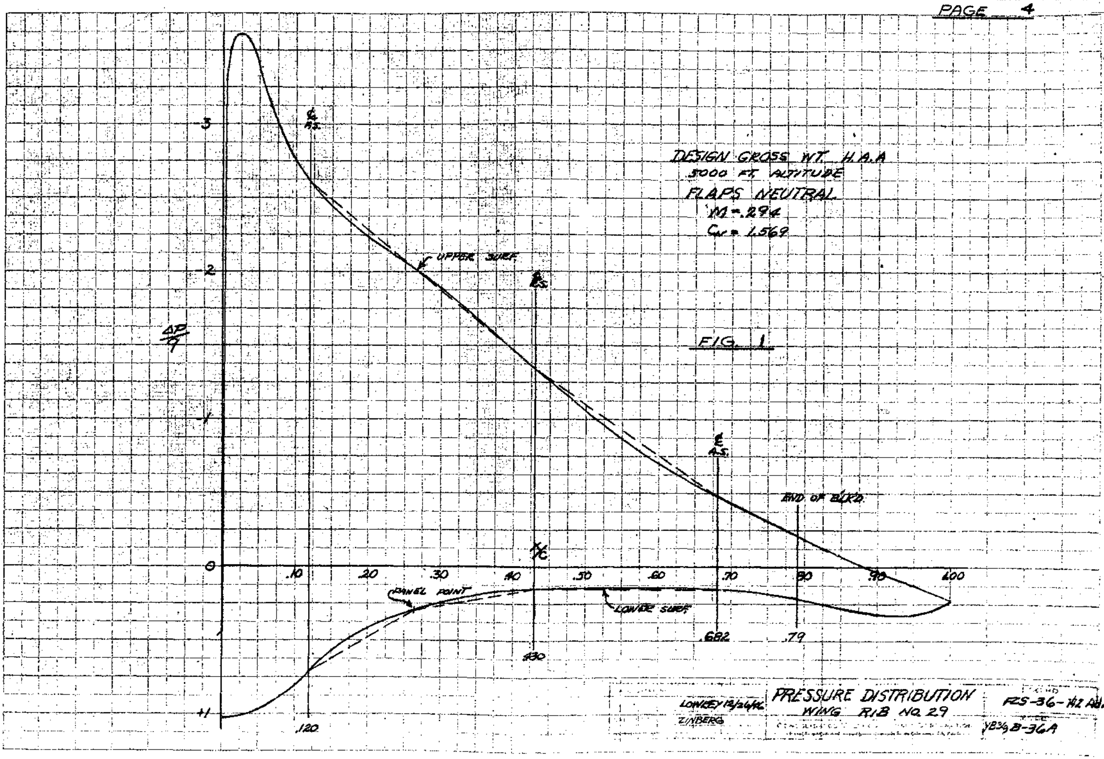
CONDITION	V_{TRUE}	n	C_L	$C\ell_o$	$C\ell_{a_1}$	* $C\ell$	q	$qC\ell$
D.G.W., HAA. 5000'	219.8	2.67	1.50	-.032	1.068	1.569	106.5	167.0
D.G.W., I.HAA. 5000'	202.8	-1.67	-1.10	-.032	1.068	-1.206	90.8	-109.5
D.G.W., LAA. 30,000' (HIGH SPEED)	338.2	2.67	1.4026	-.032	1.068	1.466	109.4	160.5
D.G.W., LAA. 5000' (LIMIT DIVE)	308	2.51	.7242	-.032	1.068	.741	209.0	155.0
D.G.W., I.LAA. 5000' (HIGH SPEED)	275	-1.67	-.5786	-.032	1.068	-.650	166.4	-108.2
D.G.W., I.LAA. 5000' (LIMIT DIVE)	308	-1.51	-.410	-.032	1.068	-.470	209.0	-98.3

AILERON ROLL

$C\ell_o = .262$ (REF. PG. 16 FZS-36-138A), $C\ell_{a_1} = 1.068$ (REF. PG. 15 FZS-36-138)

CONDITION	V_{TRUE}	n	C_L	$C\ell_o$	$C\ell_{a_1}$	* $C\ell$	q	$qC\ell$
$\delta_A = +20°$ SEA LEVEL	188.3	2.67	1.18	.262	1.068	1.522	90.6	137.9

$* \; C\ell = C\ell_o + C_L \, C\ell_{a_1}$


DESIGN GROSS WT. H.A.A
5000 FT. ALTITUDE
FLAPS NEUTRAL
M = .294
C_N = 1.569
FIG. 1
ΔP/q
UPPER SURF.
LOWER SURF.
PANEL POINT
℄ A.S.
END OF BLKD.
x/c
3
2
1
0
1
.10
.20
.30
.40
.50
.60
.70
.80
.90
1.00
.120
.430
.682
.79
LOWREY 12/26/46
ZINBERG
PRESSURE DISTRIBUTION
WING RIB NO. 29
FZS-36-142 Add. A
YB36 B-36A

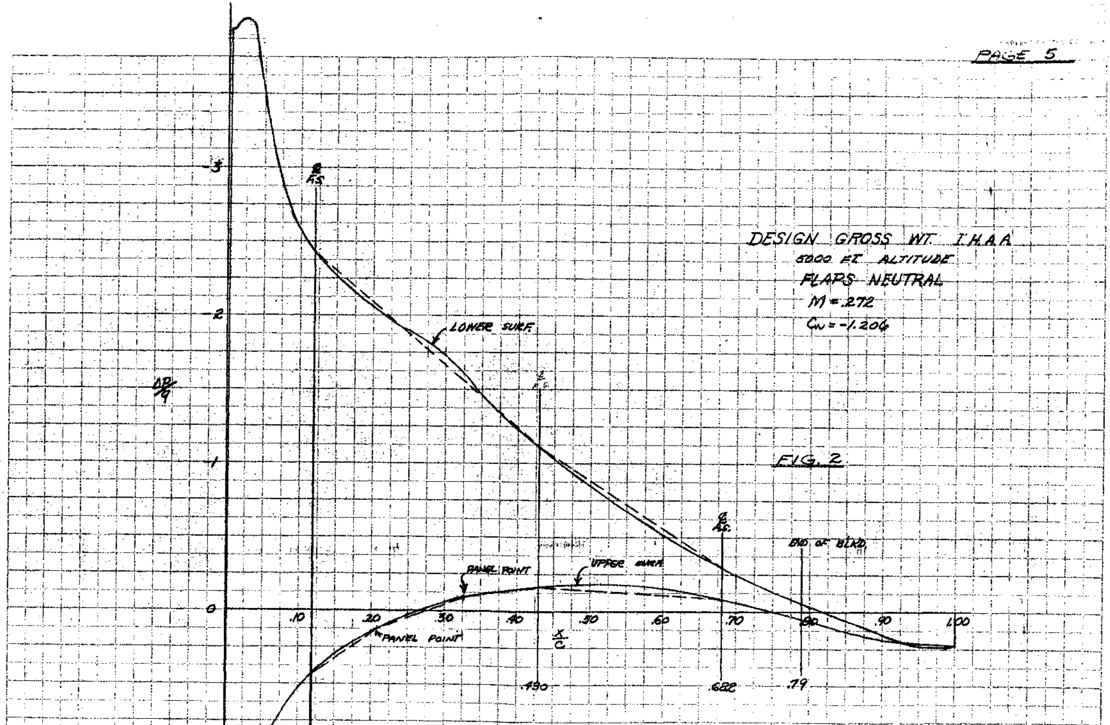
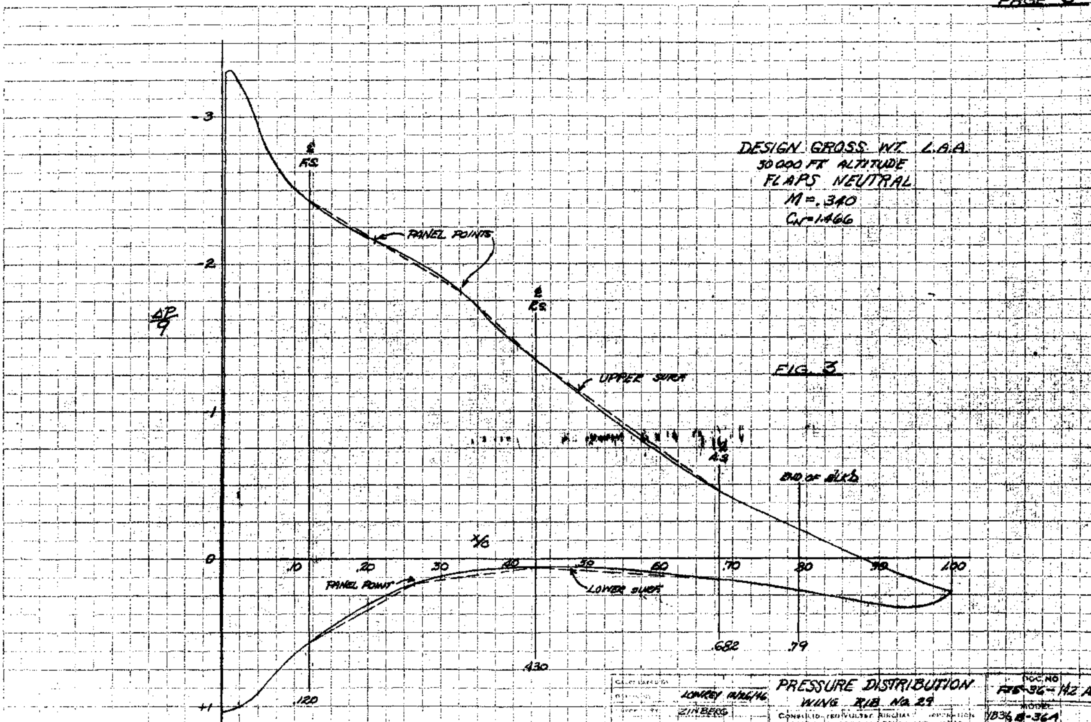


FIG. 2

LOWREY 10/29/46	PRESSURE DISTRIBUTION WING RIB No. 29	DOC NO. FZS-36-142 Add.A
ZINBERG	CONSOLIDATED VULTEE AIRCRAFT CORPORATION FORT WORTH DIVISION FORT WORTH, TEXAS	MODEL 103 B-36A



CALCULATED	LOWREY 10/26/46	PRESSURE DISTRIBUTION WING RIB No. 29	DOC. NO. FZS-36-142 A.L.L.A.
CHECKED			MODEL
	ZINBERG	CONSOLIDATED VULTEE AIRCRAFT CORPORATION FORT WORTH DIVISION FORT WORTH, TEXAS	B36 B-36A

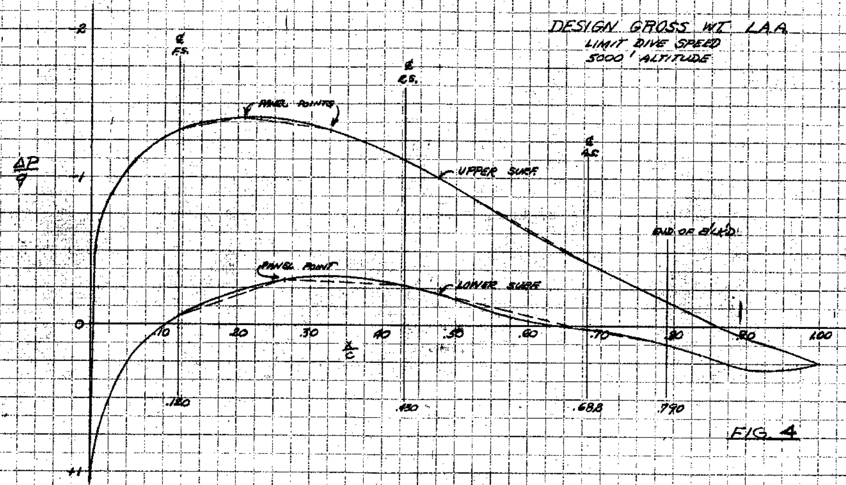


FIG. 4

CALCULATED BY			PRESSURE DISTRIBUTION WING RIB No. 29	DOC NO FZS-36-1½ A.A
DRAWN BY	LOWREY	1/2/47		
CHECKED BY	ZINBERG		CONSOLIDATED VULTEE AIRCRAFT CORPORATION FORT WORTH DIVISION FORT WORTH TEXAS	MODEL YB36, B-36A
APPROVED BY				

DESIGN GROSS WT. L.L.A.A.
5000 FT. ALTITUDE
FLAPS NEUTRAL
$M = .368$
$C_N = -.650$

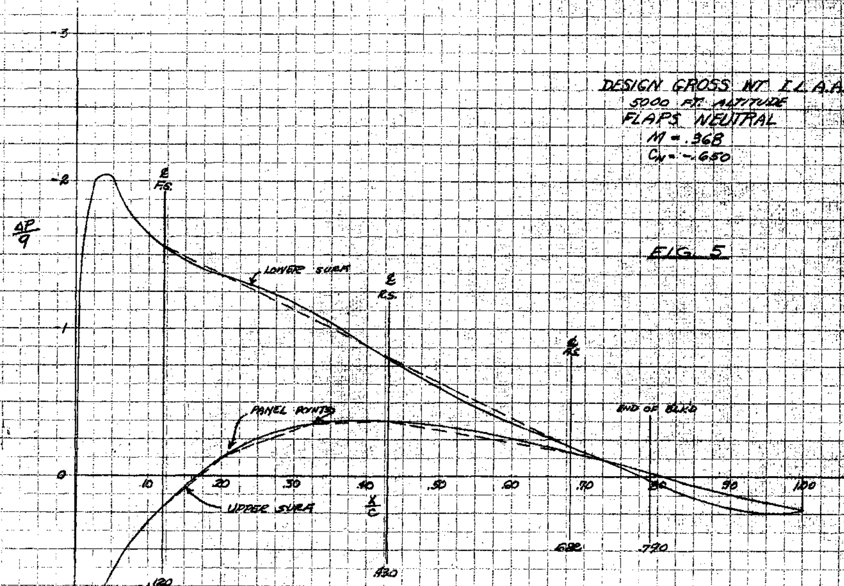
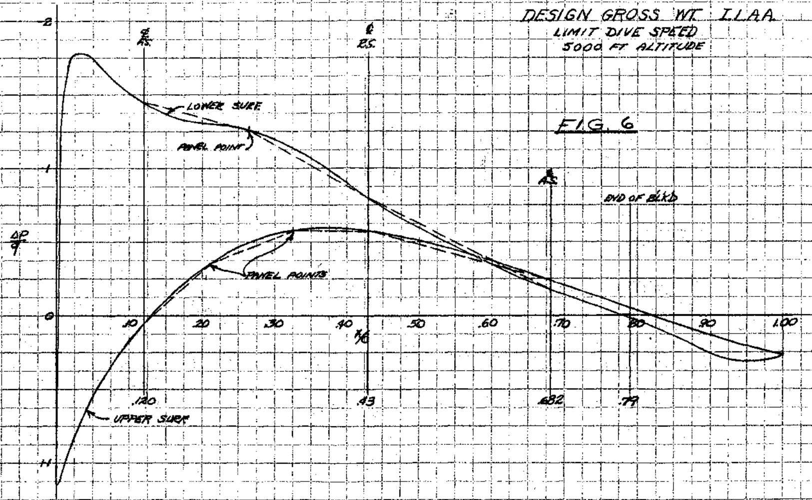


FIG. 5

CALCULATED BY / CHECKED BY	LOWREY 12/26/46	PRESSURE DISTRIBUTION WING RIB NO. 29	DOC NO. FZS-36-142 A
	ZIRBERG	CONSOLIDATED VULTEE AIRCRAFT CORPORATION FORT WORTH DIVISION FORT WORTH, TEXAS	MODEL YB & B-36A
APPROVED BY			

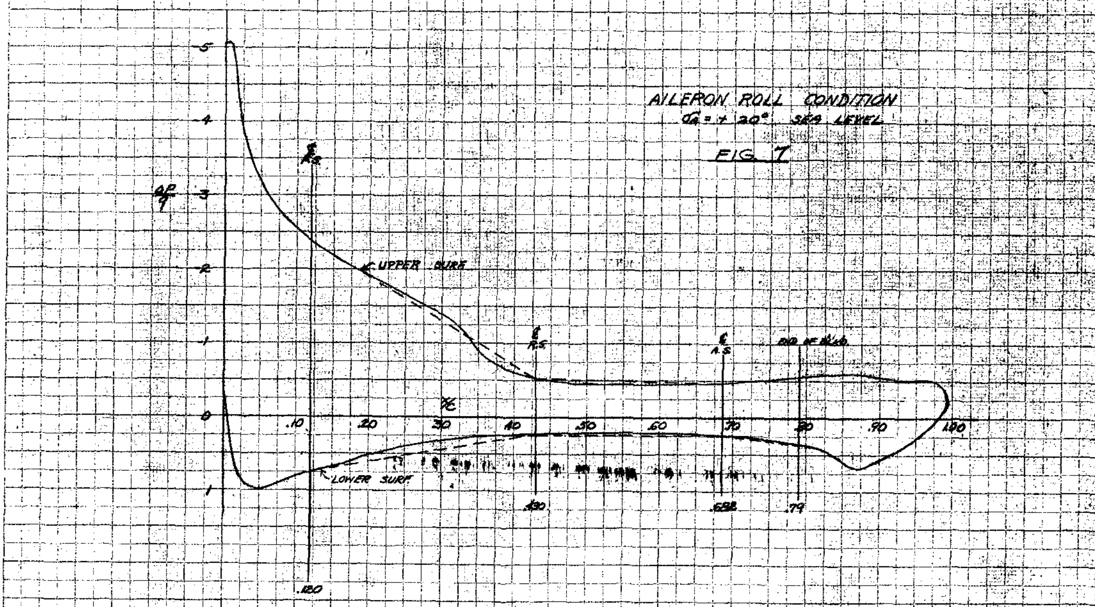


CALCULATED BY		
DRAWN BY	LOWREY	1/18/47
CHECKED BY	ZINBERG	
APPROVED BY		

PRESSURE DISTRIBUTION
WING RIB NO. 29

CONSOLIDATED VULTEE AIRCRAFT CORPORATION
FORT WORTH DIVISION, FORT WORTH, TEXAS

DOC. NO. FZS-36-142 ADD. A
MODEL B-36A YB-36



CALCULATED BY LOWREY 4/30/46	PRESSURE DISTRIBUTION	DOC. NO. FZS-36-142 Add A.
CHECKED BY ZINBERG	WING RIB NO. 29	MODEL B-36A, YB36
APPROVED BY	CONSOLIDATED VULTEE AIRCRAFT CORPORATION, FORT WORTH DIVISION, FORT WORTH, TEXAS	

INTERSPAR
WING BULKHEAD NO. 29

TRUSS DIMENSIONS
(REF. DWG. 36W629)

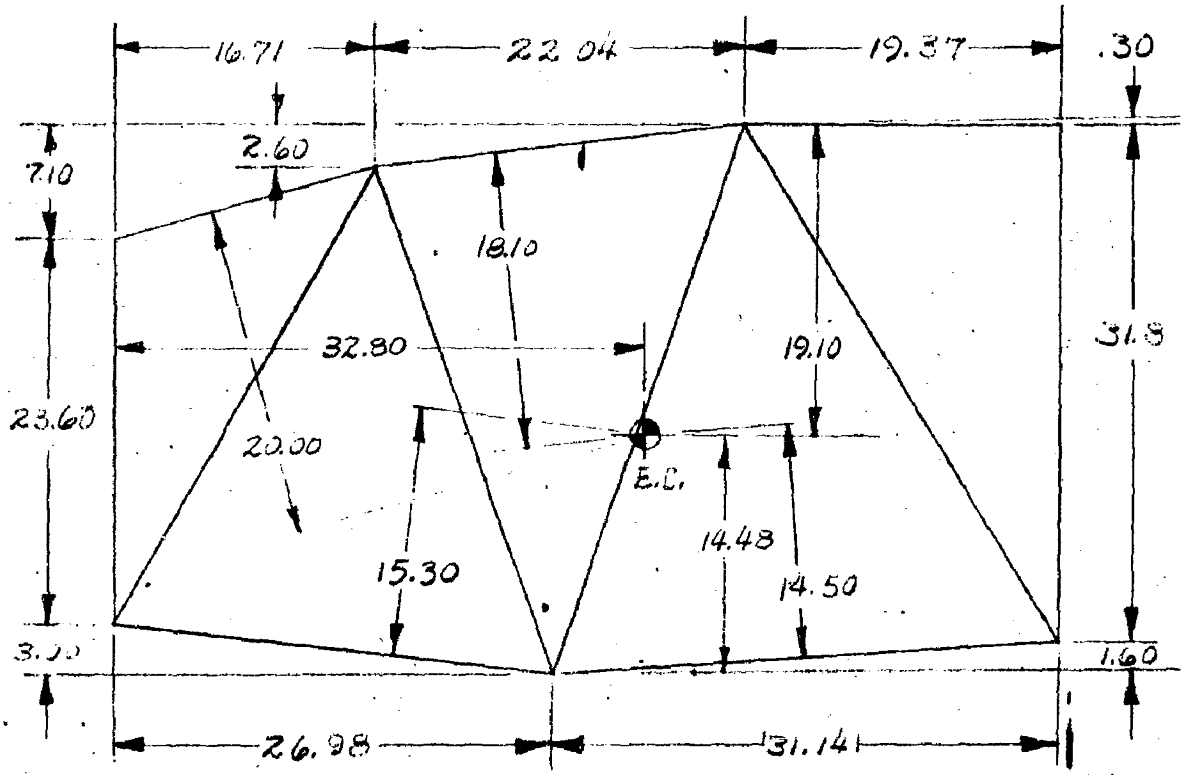


FIG. 8

WING BULKHEAD NO. 29

AILERON ROLL CONDITION

$$\text{LOAD AT R.S. } (\#/\text{IN}) = \frac{.76^{*} \times 90.6 \times 36 \times 1.5}{144} = 25.85 \ \#/\text{IN.}$$

$$\text{LOAD AT A.S. } (\#/\text{IN}) = \frac{.71^{*} \times 90.6 \times 36 \times 1.5}{144} = 24.10 \ \#/\text{IN.}$$

$$\text{LOAD AT T.E.}_{(A.S.)} (\#/\text{IN}) = \frac{.11^{*} \times 90.6 \times 36 \times 1.5}{144 \times 2} = 15.48 \ \#/\text{IN.}$$

* REF. PRESSURE DISTRIBUTION CURVE P. 10

LOAD FORWARD OF F.S.

X/C	⊛ΔP	S.M.	AREA	M.M.	MOM.
0	171.5	1	171.5	0	0
.01	179.0	4	716.0	1	716.0
.02	166.5	2	333.0	2	666.0
.03	157.0	4	628.0	3	1884.0
.04	148.5	2	297.0	4	1188.0
.05	142.3	4	569.2	5	2846.0
.06	134.5	2	269.0	6	1614.0
.07	128.2	4	512.8	7	3589.6
.08	122.3	2	244.6	8	1956.8
.09	118.2	4	472.8	9	4255.2
.10	113.8	2	227.6	10	2276.0
.11	109.8	4	439.2	11	4831.2
.12	106.3	1	106.3	12	1275.6
TOTAL			4987.0		27098.4

$$⊛ \ \Delta P = \frac{\frac{\Delta P}{q} \times q \times 36 \times 1.5}{144}$$

(RIB SPACING = 36")

WING BULKHEAD NO. 29

AILERON ROLL CONDITION (CONT'D)

LOAD FORWARD F.S. (CONT'D)

TOTAL LOAD = $\frac{47870 \times .01 \times 18.7478}{3}$ = 3125# (ULT)

DIST (FROM L.E.) TO C.P. = $\frac{570784 \times .01 \times 18.7478}{47870}$ = 10.2"

MOM. ABOUT F.S. = (22.5 - 10.2) 3125 = 38400"#

COUPLE = $\frac{38400}{23.6}$ = 1628#

LOAD ON BHD. UPPER SURF. BETWEEN F.S. & R.S.

LOAD AT F.S. = $\frac{2.38^{*} \times 9.06 \times 36 \times 1.5}{144}$ = 8.09#/IN.

LOAD AT R.S. = $\frac{.53^{*} \times 9.06 \times 36 \times 1.5}{144}$ = 1.80#/IN.

LOAD ON BHD. LOWER SURF. BETWEEN F.S. & R.S.

LOAD AT F.S. = $\frac{.23^{*} \times 9.06 \times 36 \times 1.5}{144}$ = 1.82#/IN.

LOAD AT R.S. = $\frac{.27^{*} \times 9.06 \times 36 \times 1.5}{144}$ = .915#/IN.

AILERON HINGE LOAD

HINGE LOAD = 5870# INCLINED 20° TO CHORD LINE (REF FZS-36-102)

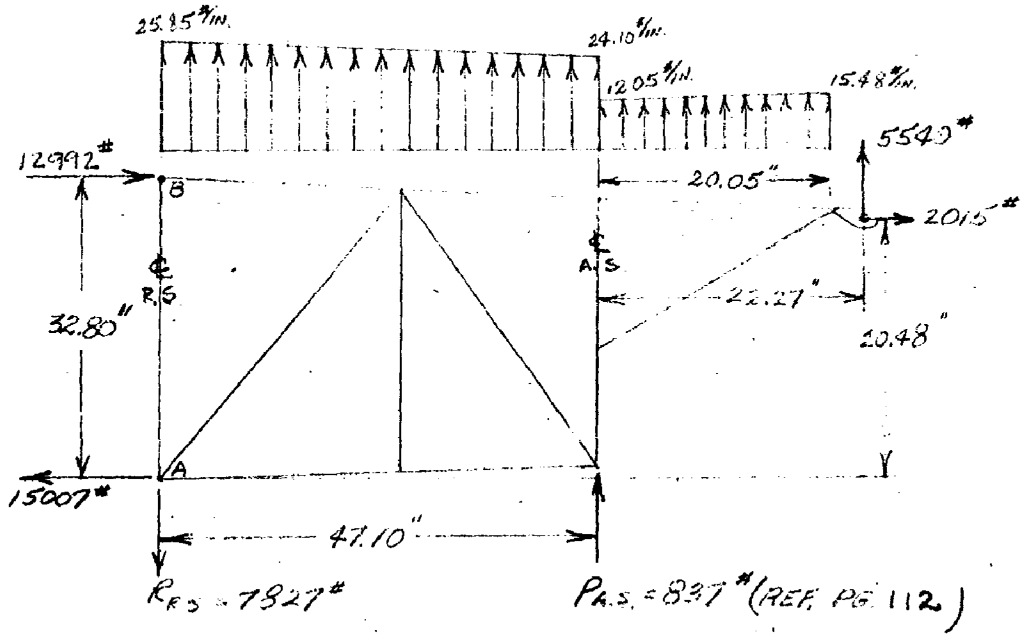
HORIZ. COMP. = 5870 SIN 20° = 2015#

VERT. COMP. = 5870 COS 20° = 5510#

* REF. PRESSURE DISTRIBUTION ..., P. 10

WING BULKHEAD NO. 27

AILERON ROLL CONDITION (CONT'D)



$$\Sigma MOM_A = 837 \times 47.10 + 5540 \times 69.37 + 24.10 \times 47.10 \times 23.55$$
$$+ 1.75 \times 23.55 \times 15.70 + 12.05 \times 20.05 \times 57.13$$
$$+ 3.43 \times 10.03 \times 60.47 - 2015 \times 20.48$$
$$= 425377 \text{ in-lb}$$

$$H_B = \frac{425377}{32.80} = 12992 \text{ lb} \leftarrow$$

$$H_A = 12992 + 2015 = 15007 \text{ lb} \rightarrow$$

$$R_{R.S.} = 47.10 \times 24.10 + 1.75 \times 23.55 + 12.05 \times 20.05$$
$$+ 3.43 \times 10.03 + 5540 + 837$$
$$= 7827 \text{ lb}$$

WING BULKHEAD NO. 27

AILERON ROLL CONDITION (CONT'D)

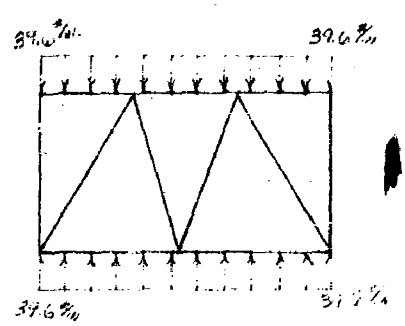
CRUSHING LOADS

$$\text{CRUSHING LOAD (PER ELEMENT)} = \frac{d f^2 A}{E Y}$$

f = BENDING STRESS.
A = AREA OF ELEMENT.
d = RIB SPACING.
Y = DIST. FROM N.A.
E = MODULUS OF ELASTICITY.

ELEMENT	* f	E	$\frac{f}{E}$	d	A	y	$\frac{d f^2 A}{E Y}$
W_{11}	27530	10.3×10^6	73.8	36	1.055	12.20	229.5
W_{17}	27560	10.3×10^6	85.5	36	1.152	14.04	247.5
W_{18}	31000	10.3×10^6	93.2	36	1.021	15.46	221.5
W_{19}	31800	10.3×10^6	99.2	36	1.087	16.51	233.0
W_{20}	32305	10.3×10^6	101.2	36	1.009	17.40	211.0
W_{21}	32210	10.3×10^6	100.5	36	1.029	17.79	206.5
W_{22}	31890	10.3×10^6	98.8	36	1.027	18.43	178.0
W_{23}	31230	10.3×10^6	94.7	36	.949	18.66	173.8
W_{24}	30135	10.3×10^6	88.0	36	1.079	18.53	186.8
W_{25}	28790	10.5×10^6	78.2	36	1.179	18.24	183.8
W_{26}	27190	10.3×10^6	71.7	36	1.498	18.21	212.0
TOTAL							2303.4

$$\text{CRUSHING LOAD} = \frac{2303.4}{58.118} = 39.6 \ \#/\text{IN.}$$



* NOTE: BENDING STRESSES FOR THIS CONDITION WERE FIGURED, WITH SECTION PROPERTIES FROM PG. 31 [illegible] -36-141 ADD A. BENDING MOMENTS ARE: $10^{-6} M_x = 12.575$, $10^{-6} M_y = -.993$.

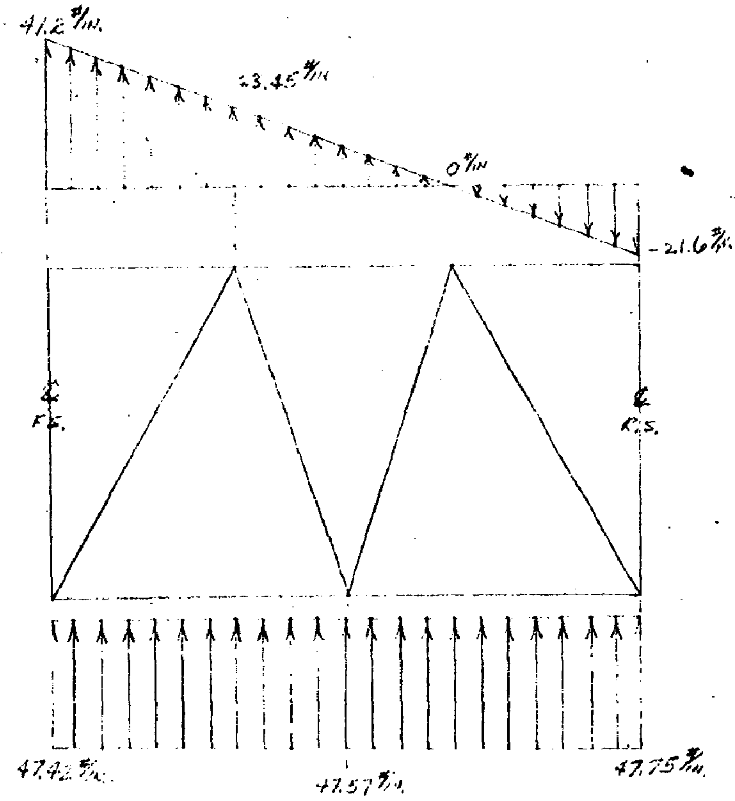
WING BULKHEAD NO. 24

AILERON ROLL CONDITION (CONT'D)

NET AIRLOAD ON BLK'D

NET AIRLOAD AT F.S. = 80.8 - 39.6 = 41.2 #/in ↑ } UPPER SURFACE
NET AIRLOAD AT R.S. = 18.0 - 39.6 = -21.6 #/in ↓ }

NET AIRLOAD AT F.S. = 7.82 + 39.6 = 47.42 #/in ↑ } LOWER SURFACE
NET AIRLOAD AT R.S. = 8.15 + 39.6 = 47.75 #/in ↑ }

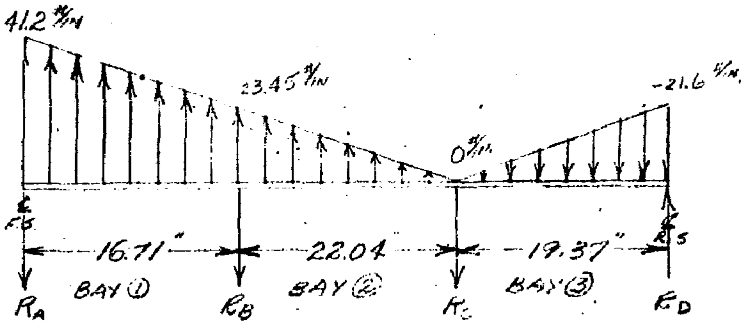


THE RIB CAPS ARE CONSIDERED AS CONTINUOUS BEAMS WITH CONSTANT MOMENTS OF INERTIA. THE PANEL POINT LOADS ARE COMPUTED BY THE THREE MOMENT EQUATION.

WING BULKHEAD NO. 29

AILERON ROLL CONDITION (CONT'D.)

PANEL POINT LOADS (UPPER SURF.)



$$M_A L_1 + 2M_B(L_1+L_2) + M_C L_2 = \frac{W_B L_1^3}{4} + \frac{7W_{A-B} L_1^3}{60} + \frac{2W_B L_2^3}{15}$$

$$0 + 2M_B(16.71+22.04) + 22.04M_C = \frac{23.45(16.71)^3}{4} + \frac{7(17.75)(16.71)^3}{60} + \frac{2(23.45)(22.04)^3}{15}$$

$$77.5M_B + 22.04M_C = 70570$$

$$M_B L_2 + 2M_C(L_2+L_3) + M_D L_3 = \frac{7W_B L_2^3}{60} + \frac{7W_C L_3^3}{60}$$

$$22.04M_B + 2M_C(22.04+19.37) + 0 = \frac{7(23.45)(22.04)^3}{60} + \frac{7(-21.6)(19.37)^3}{60}$$

$$22.04M_B + 82.82M_C = 11050$$

$$3.75\,(77.5M_B + 22.04M_C = 70570)$$
$$22.04M_B + 82.82M_C = 11050$$

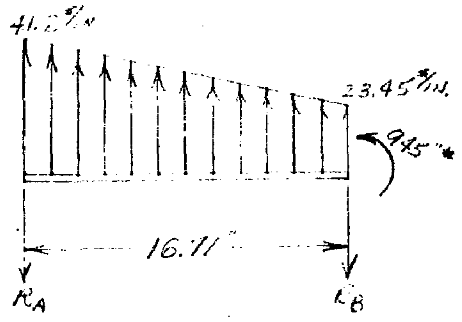
$$290.5M_B + 82.82M_C = 2[illegible]00$$
$$-22.04M_B - 82.82M_C = -11050$$
$$268.46M_B = [illegible],750$$
$$M_B = 945\ \text{in-lb}$$
$$M_C = -11[illegible]\ \text{in-lb}$$

WING BULKHEAD NO. 29

AILERON HINGE CONDITION (CONT'D)

PANEL POINT LOADS (UPPER SURF)(CONT'D)

BAY ①



$R_A = \frac{23.45 \times 8.36 + 17.75 \times 8.36 \times 11.14}{16.71} - \frac{945}{16.71}$

$= 196 + 91 - 57$

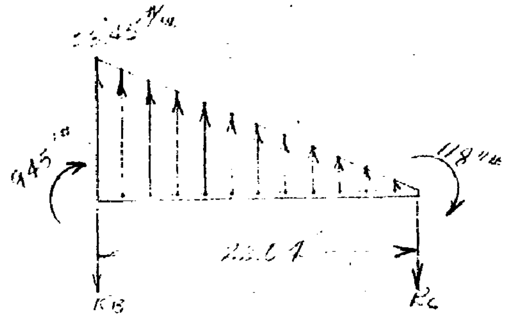
$= 238^{\#}\downarrow$

$R_B = \frac{23.45 \times 8.36 + 17.75 \times 8.36 \times 5.57}{16.71} + \frac{945}{16.71}$

$= 196 + 50 + 57$

$= 303^{\#}\downarrow$

BAY ②



$R_B = \frac{23.45 \times 11.02 \times 14.70}{22.04} + \frac{945 + 118}{22.04}$

$= 172 + 48$

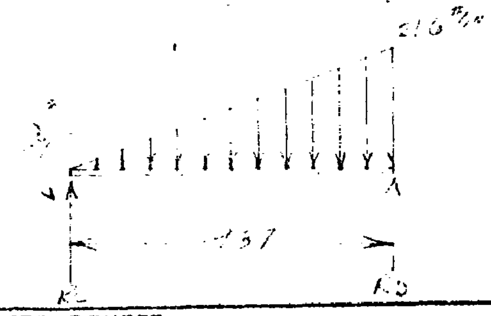
$= 220^{\#}\downarrow$

$R_C = \frac{23.45 \times 11.02 \times 7.35}{22.04} - \frac{945 + 118}{22.04}$

$= 86 - 48$

$= 38^{\#}\downarrow$

BAY ③



$R_C = \frac{21.6 \times 9.68 \times 6.47}{19.37} + \frac{118}{19.37}$

$= 70 + 6$

$= 76^{\#}\uparrow$

$R_D = \frac{21.6 \times 9.68 \times 12.14}{19.37} - \frac{118}{19.37}$

$= 140 - 6$

$= 134^{\#}\uparrow$

WING BULKHEAD NO. 29

AILERON ROLL CONDITION (CONT'D)

PANEL POINT LOADS (UPPER SURF.)(CONT'D)

NET REACTIONS:

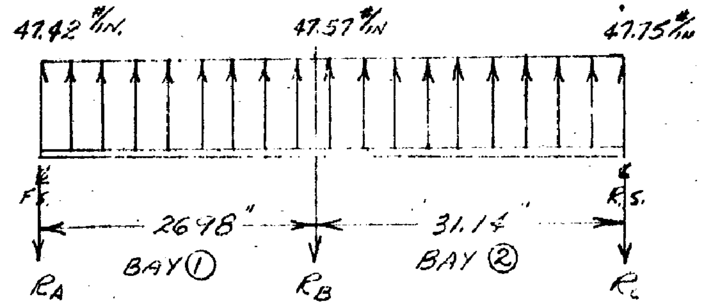
$R_A = 238^{\#}\downarrow$

$R_B = 303^{\#}\downarrow + 220^{\#}\downarrow = 523^{\#}\downarrow$

$R_C = 76^{\#}\uparrow - 38^{\#}\downarrow = 38^{\#}\uparrow$

$R_D = 134^{\#}\uparrow$

PANEL POINT LOADS (LOWER SURF.)



$$M_A L_1 + 2M_B(L_1+L_2) + M_3 L_2 = \frac{W_A L_1^3}{4} + \frac{2W_{B-A} L_1^3}{15} + \frac{W_B L_2^3}{4} + \frac{7W_{C-B} L_2^3}{60}$$

$$0 + 2M_B(26.98+31.14) + 0 = \frac{47.42(26.98)^3}{4} + \frac{2(.15)(26.98)^3}{15} + \frac{47.57(31.14)^3}{4} + \frac{7(.18)(31.14)^3}{60}$$

$$116.24\, M_B = 592.027$$

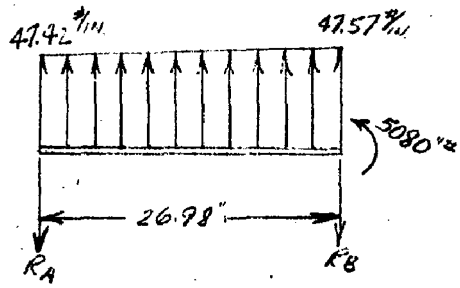
$$M_B = 5080''^{\#}$$

WING BULKHEAD NO. 29

AILERON ROLL CONDITION (CONT'D)

PANEL POINT LOADS (LOWER SURF.)(CONT'D)

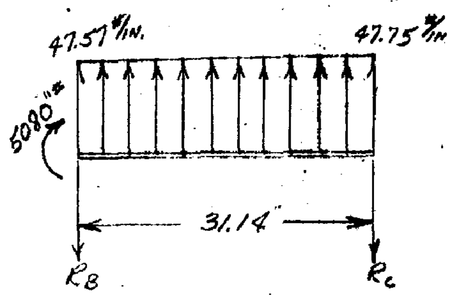
BAY ①



$$R_A = 47.42 \times 13.49 + \frac{.15 \times 13.49 \times 8.99}{26.98} - \frac{5080}{26.98}$$
$= 640 + 1 - 188$
$= 453$ # ↓

$$R_B = 47.42 \times 13.49 + \frac{.15 \times 13.49 \times 17.18}{26.98} + \frac{5080}{26.98}$$
$= 640 + 1 + 188$
$= 829$ # ↓

BAY ②



$$R_B = 47.57 \times 15.57 + \frac{.18 \times 15.57 \times 10.38}{31.14} + \frac{5080}{31.14}$$
$= 741 + 1 + 163$
$= 905$ # ↓

$$R_C = 47.57 \times 15.57 + \frac{.18 \times 15.57 \times 20.76}{31.14} - \frac{5080}{31.14}$$
$= 741 + 1 - 163$
$= 579$ # ↓

NET REACTIONS:

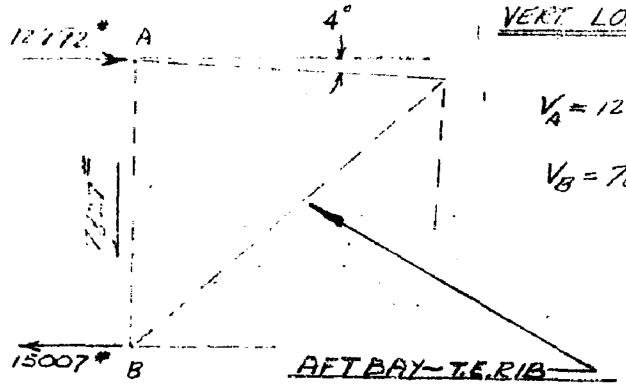
$R_A = 453$ # ↓
$R_B = 829$ # ↓ $+ 905$ # ↓ $= 1734$ # ↓
$R_C = 579$ # ↓

WING BULKHEAD NO. 29

AILERON ROLL CONDITION (CONT'D)

DISTRIBUTION OF VERT. LOAD AT R.S. TO PANEL POINTS

VERT. LOAD AT R.S. = 7827# ↑ (REF. P. 14)



VERT. LOAD TO POINT A + B

$V_A = 12992 \times TAN\ 4° = 908^{\#} \uparrow$

$V_B = 7827 - 908 = 6919^{\#} \uparrow$

DISTRIBUTION OF VERT. LOAD AT F.S. TO PANEL POINTS

THE VERT. LOAD FROM THE L.E. RIB APPLIED TO THE F.S. IS DIVIDED EQUALLY TO THE UPPER AND LOWER PANEL POINTS.

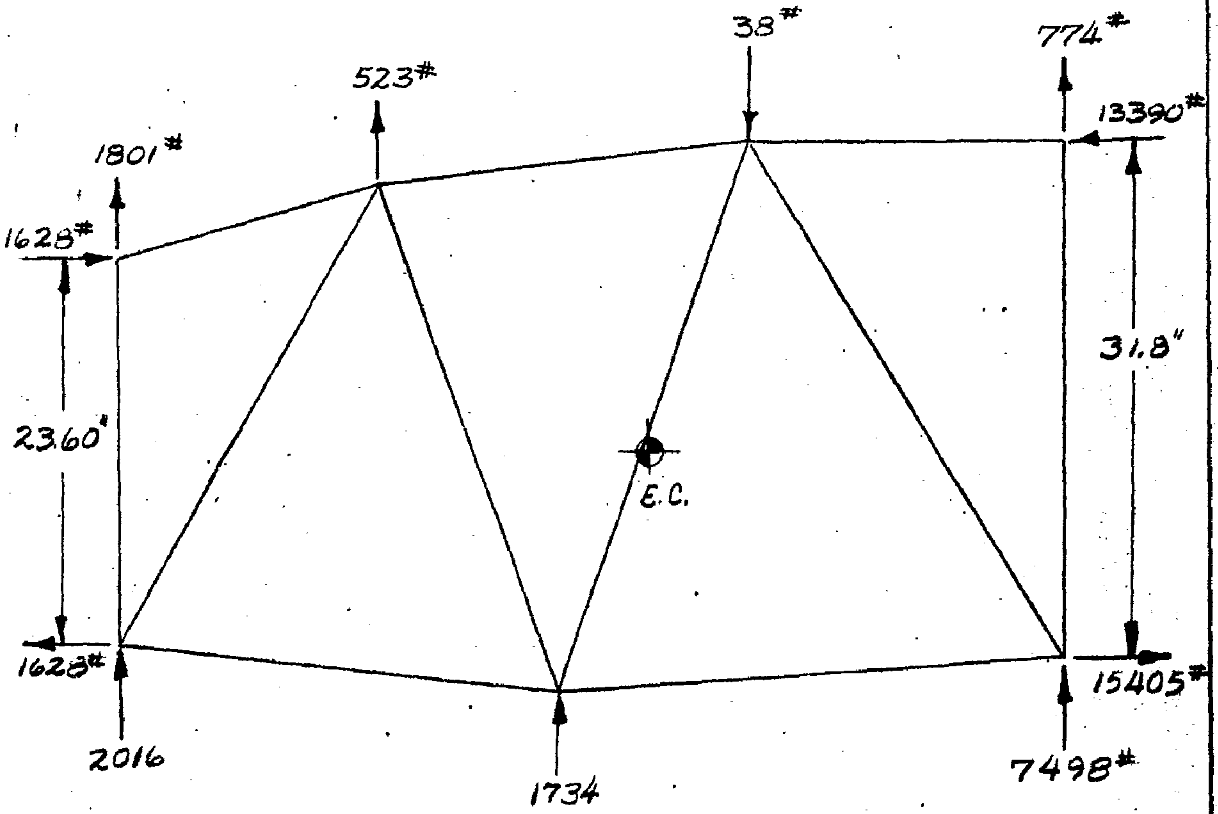
VERT. LOAD TO F.S. = 3125# ↑ (REF. P. 13)

$V_A = \frac{3125}{2} = 1563^{\#} \uparrow$

$V_B = \frac{3125}{2} = 1563^{\#} \uparrow$

WING BULKHEAD NO 29

AILERON ROLL CONDITION (CONT'D)



MOMENT ABOUT F.S. = 38,400 "# (REF. P. 13)

MOMENT ABOUT R.S. = 425,377 "# (REF. P. 14)

COUPLE F.S. $= \frac{38400}{23.60} = 1628$

R.S. (UPPER PANEL POINT) $= \frac{425377}{31.8}$ 13,390# ←

R.S (LOWER PANEL POINT) = 13390 + 2015 = 15405# →

ANALYSIS: WING
PREPARED BY: LOWREY
CHECKED BY: THOMSON
REVISED BY:

Consolidated Vultee Aircraft Corporation
FORT WORTH DIVISION
FORT WORTH, TEXAS

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MODEL YB36, B36A
DATE 1/14/47

WING BULKHEAD NO. 29

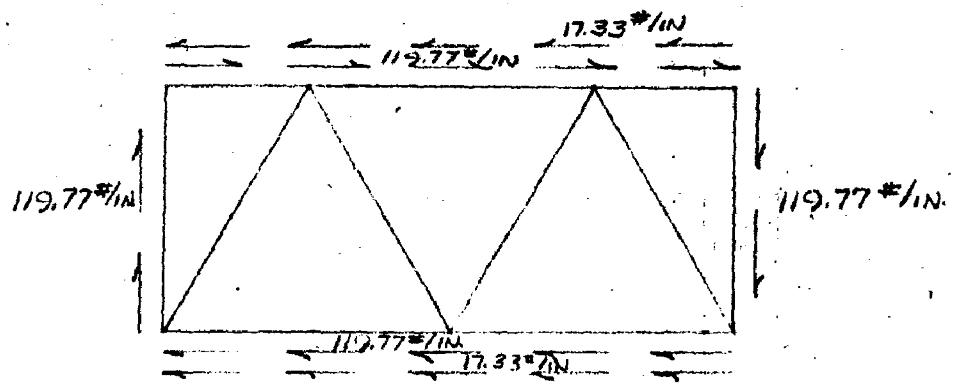
AILERON ROLL CONDITION (CONT'D.)

$\Sigma MOM_{EC} = 7498 \times 25.32 + 774 \times 25.32 + 13390 \times 18.92$
$+ 1542.5 \times 12.38 - 38 \times 5.95 - 1734 \times 5.82$
$- 2016 \times 32.80 - 523 \times 16.09 - 1801 \times 32.80$
$- 1623 \times 12.12 - 1628 \times 11.48 = 478,852''\#$)

AREA = 1999 SQ. IN.

$$q = \frac{T}{2A} = \frac{478852}{2 \times 1999} = 119.77 \ \#/\text{IN.}$$

$$q \ (\text{FROM UNBAL. HORIZ. LOAD}) = \frac{2016}{166.24} = 17.33 \ \#/\text{IN.}$$



NET SHEAR FLOW ON TOP = 119.77 − 17.33 = 102.44 #/IN.

NET SHEAR FLOW ON BOTTOM = 119.77 − 17.33 = 137.10 #/IN.

WING BULKHEAD NO. 29

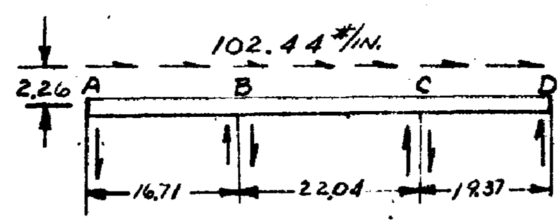
AILERON ROLL CONDITION (CONT'D.)

TRANSFER OF SHEAR FLOW TO TRUSS

THE UPPER SKIN IS ECCENTRIC TO THE UPPER CHORD MEMBER BY 2.26" WHILE THE LOWER SURFACE IS ECCENTRIC TO THE LOWER CHORD MEMBER BY 2.0".

THE MOMENTS CAUSED BY TRANSFER OF LOAD FROM THE SKIN TO THE CHORD MEMBERS ARE REACTED AS COUPLES AT THE PANEL POINTS.

UPPER SURFACE:



REACT. AT A = 102.44 × 2.26 = 232#

REACT. AT B = 0

REACT. AT C = 0

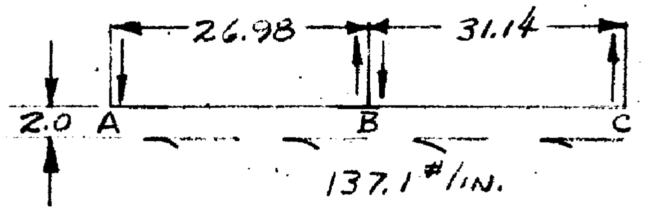
REACT. AT D = 102.44 × 2.26 = 232#

WING BULKHEAD #29

AILERON ROLL CONDITION (CONT'D)

TRANSFER OF SHEAR FLOW TO TRUSS (CONT'D)

LOWER SURFACE



REACTION @ A = 371.1 × 2 = 274#

REACTION @ B = 0

REACTION @ C = 371.1 × 2 = 274#

UNBALANCED VERTICAL LOAD

2016 + 1734 + 7498 + 774 + 523 + 1801 − 38 − 31.8 × 119.77 + 23.6 × 119.77 + (7.1 − .3) 102.4 + (3 − 1.6) 137.1 = 14213#↑

LOAD TO F.S. = $\frac{14213 \times 2532}{58.12}$ = 6192#

LOAD TO R.S. = 14213 − 6192 = 8021#

WING BULKHEAD #29

AILERON ROLL CONDITION (CONT'D)

LOADS TO BE DISTRIBUTED EQUALLY TO UPPER & LOWER PANEL POINTS

F.S. $\frac{6192}{2} = 3096^{\#}\downarrow$

R.S. $\frac{8021}{2} = 4010^{\#}\downarrow$

NET TRUSS LOADS

POINT A: $V = 3096^{\#}\downarrow - 1801^{\#}\uparrow - 232^{\#}\uparrow - \frac{119.77 \times 23.6}{2}\uparrow$
$= 351^{\#}\uparrow$

POINT B: $V = 523^{\#}\uparrow$

POINT C: $V = 38^{\#}\downarrow$

POINT D: $V = 4010\downarrow - 774\uparrow + 232\downarrow + \frac{119.77 \times 31.8}{2}\downarrow$
$= 5373^{\#}\downarrow$

POINT E: $V = 4010\downarrow - 7498\uparrow + 274\downarrow + 1405\downarrow = 1309^{\#}\uparrow$

POINT F: $V = 1734\uparrow$

POINT G: $V = 2016\uparrow + 274\uparrow + 1414\uparrow - 3096\downarrow = 608^{\#}\uparrow$

WING BULKHEAD #29

AILERON ROLL CONDITION (CONT'D)

LOADS TO BE DISTRIBUTED EQUALLY TO UPPER & LOWER PANEL POINTS

F.S. $\frac{6192}{2} = 3096^{\#}\downarrow$

R.S. $\frac{8021}{2} = 4010^{\#}\downarrow$

NET TRUSS LOADS

POINT A: $V = 3096^{\#}\downarrow - 1801^{\#}\uparrow - 232^{\#}\uparrow - \frac{119.77 \times 23.6}{2}\uparrow$
$= 351^{\#}\uparrow$

POINT B: $V = 523^{\#}\uparrow$

POINT C: $V = 38^{\#}\downarrow$

POINT D: $V = 4010\downarrow - 774\uparrow + 232\downarrow + \frac{119.77 \times 31.8}{2}\downarrow$
$= 5373^{\#}\downarrow$

POINT E: $V = 4010\downarrow - 7498\uparrow + 274\downarrow + 1905\downarrow = 1309^{\#}\uparrow$

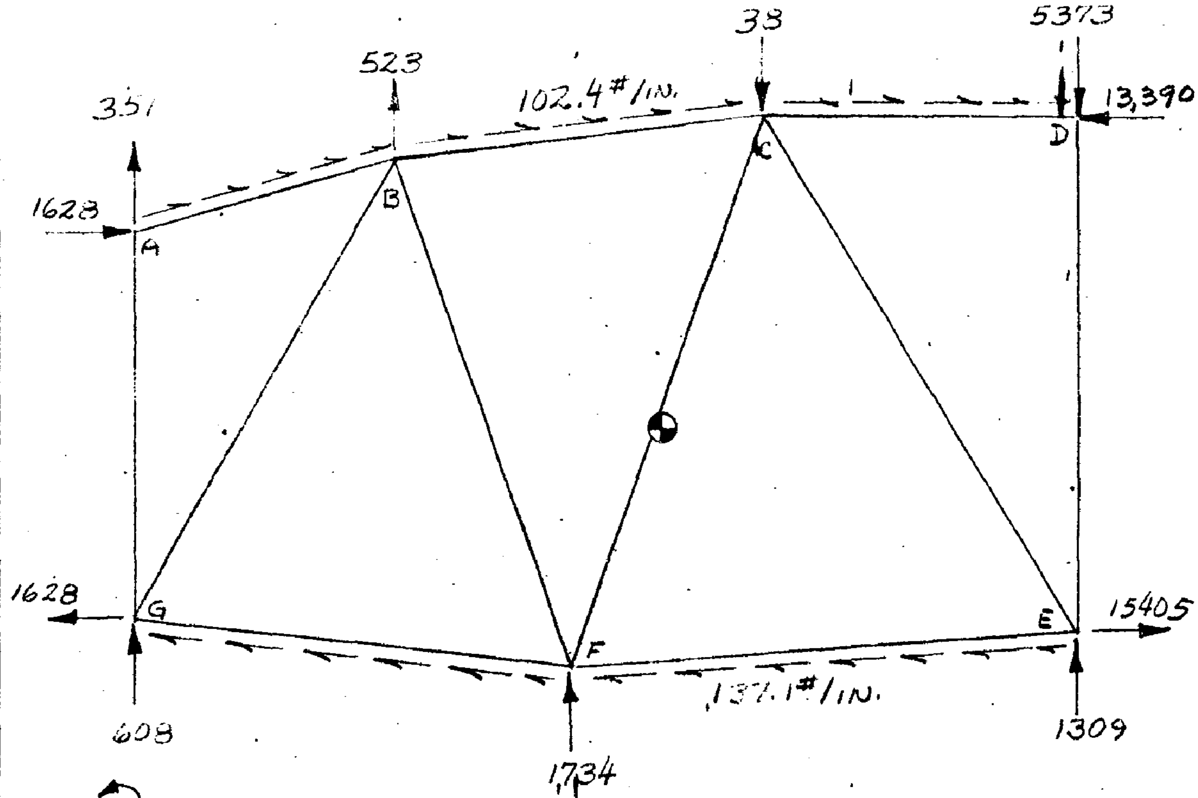
POINT F: $V = 1734\uparrow$

POINT G: $V = 2016\uparrow + 2744\uparrow + 1414\uparrow - 3096\downarrow =$ 6[illegible]# ↑

ANALYSIS WING PREPARED BY LOWREY CHECKED BY THOMSON REVISED BY	**Consolidated Vultee Aircraft Corporation** FORT WORTH DIVISION FORT WORTH, TEXAS	PAGE 27 REPORT NO. FZS-36-142 ADD A MODEL YB36, B36A DATE 1-16-47

WING BULKHEAD NO. 29

AILERON ROLL CONDITION (CONT'D)



$$\Sigma MOM_{EC} = 13.09 \times 25.32 + 15405 \times 12.88 + 13390 \times 18.92$$

$$- 5373 \times 25.32 - 38 \times 5.95 - 523 \times 16.09$$

$$- 351 \times 32.80 - 1628 \times 23.6 - 608 \times 32.8$$

$$- 1734 \times 5.82 - 102.4\left[(17.28 \times 20) + (22.2 \times 18.1) + (19.3 \times 19.1)\right]$$

$$- 137.1\left[(31.2 \times 14.5) + (27.13 \times 15.3)\right] = 26,897 \text{ ''\#}$$

$$q = \frac{26897}{2 \times 1997} = 6.72 \text{ \#/in.}$$

FW 444 6-46 UTILITY REPORT SHEET

WING BULKHEAD NO. 29

AILERON ROLL CONDITION (CONT'D)

TRANSFERING SHEAR FLOW TO PANEL POINTS:

$A = 6.72 \times 2.26 = 15.7 \downarrow$

$B = 0$

$C = 0$

$D = 6.72 \times 2.26 = 15.7 \uparrow$

$E = 6.72 \times 2.0 = 13.44 \uparrow$

$F = 0$

$G = 6.72 \times 2.0 = 13.44 \downarrow$

UNBALANCED VERTICAL LOAD:

$\Sigma V = 1296 + 523 + 335 + 595 + 1734 + 31.8 \times 6.72$

$+ 6.8 \times 102.4 + 1.4 \times 137.1 - 23.6 \times 6.72 - 5389 - 38$

$= 59^{\#}$

WING BULKHEAD NO. 29

AILERON ROLL CONDITION (CONT'D)

NET TRUSS LOADS

POINT A: $V = 351\uparrow + 16\uparrow + \frac{23.6 \times 6.72}{2}\uparrow = 446\uparrow$

$H = 1628 \rightarrow$

B: $V = 523\uparrow$

C: $V = 38\downarrow$

D: $V = 5373\downarrow + 16\downarrow + \frac{31.8 \times 6.72}{2}\downarrow = 5496\downarrow$

$H = 1390 \leftarrow$

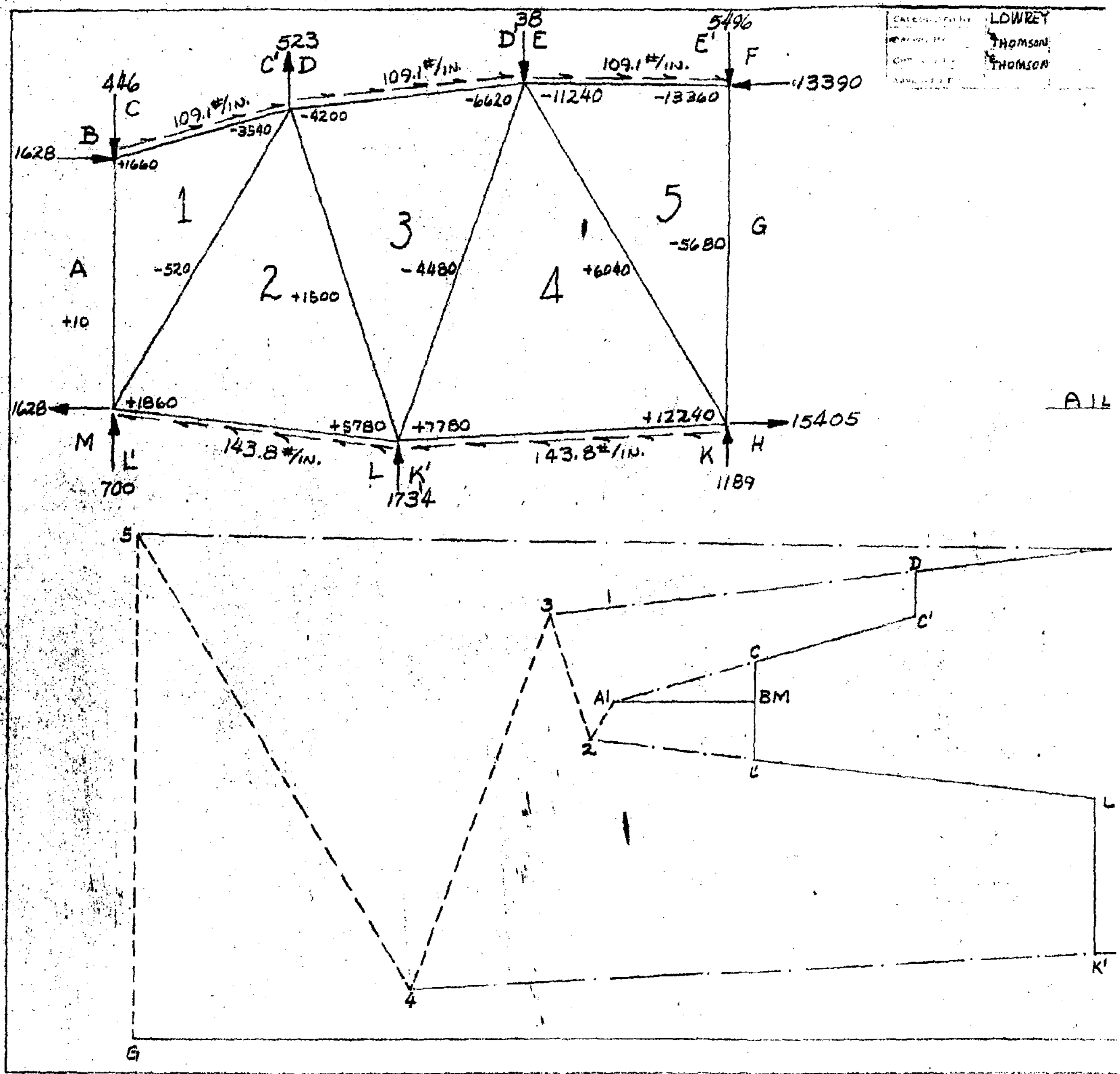
E: $V = 1309\uparrow - 13\downarrow - \frac{31.8 \times 6.72}{2}\downarrow = 1189\uparrow$

$H = 15405 \rightarrow$

F: $V = 1734\uparrow$

G: $V = 608\uparrow + 13\uparrow + \frac{23.6 \times 6.72}{2}\uparrow = 700\uparrow$

$H = 1628 \leftarrow$


LOWREY
THOMSON
THOMSON
523
C' D
38
D E
5496
E'
F
-13390
446
C
109.1#/IN.
109.1#/IN.
109.1#/IN.
B
1628
-3540
-4200
-6620
-11240
-13360
+1660
1
2
3
4
5
G
A
-520
+1500
-4480
+6040
-5680
+10
1628
+1860
+5780
+7780
+12240
15405
M
L'
143.8#/IN.
143.8#/IN.
L
K'
K
H
700
1734
1189
5
3
D
C'
C
A1
BM
2
L'
L
4
K'
G

A I L

ANALYSIS. WING	**Consolidated Vultee Aircraft Corporation**	PAGE 31
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WING BULKHEAD NO. 29

AILERON ROLL CONDITION (CON'T'D)

LOAD IN TRUSS MEMBERS

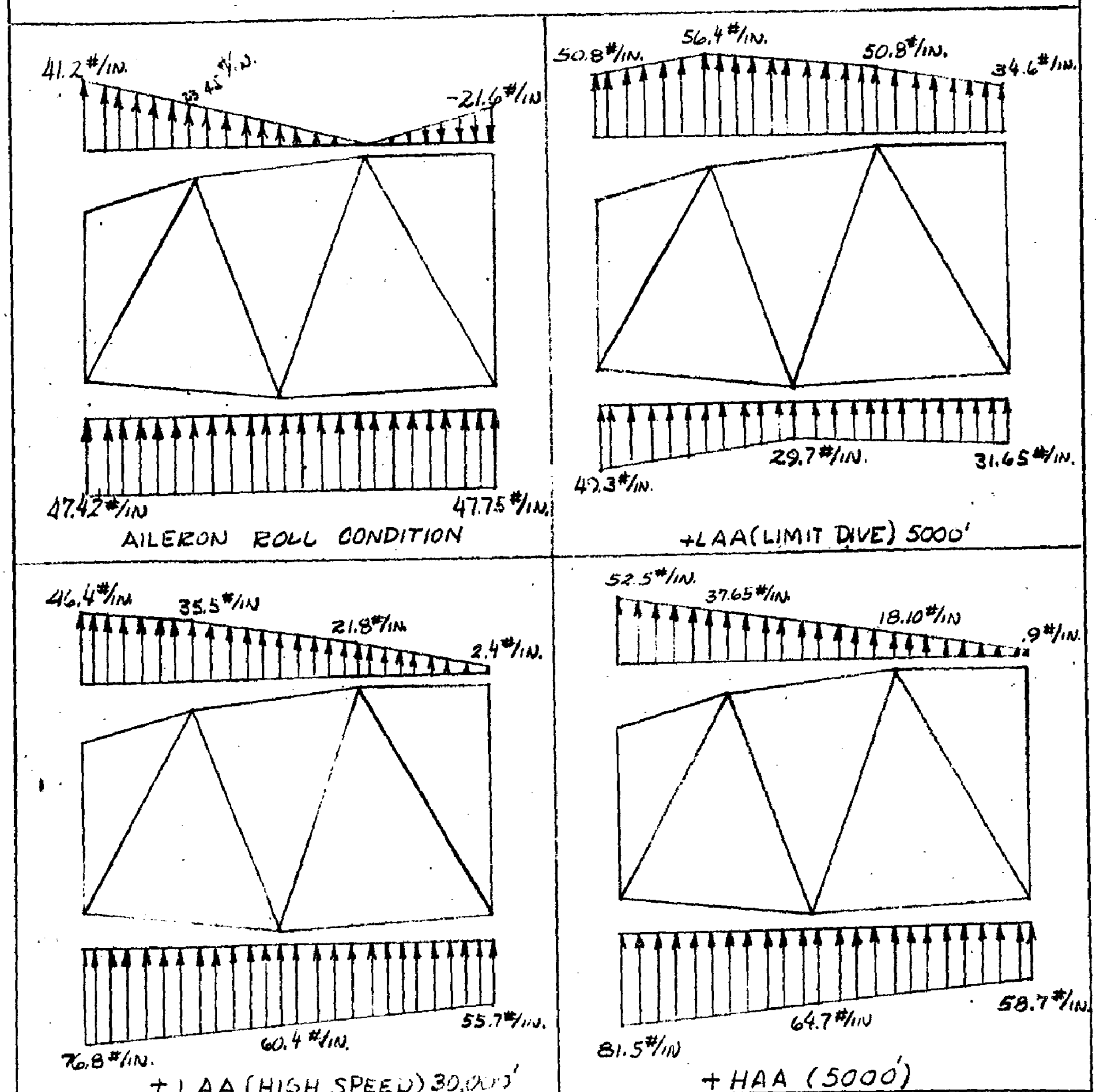
A1 = +10	3D' = -6620
1C = +1660	34 = -4480
1C' = -3540	4K = +12240
12 = -520	4K' = +7780
2L = +5730	45 = +6040
2L' = +1860	5E = -11240
23 = +1500	5E' = -13360
3D = -4200	5G = -5680

ANALYSIS WING
PREPARED BY LOWREY
CHECKED BY THOMSON
REVISED BY

Consolidated Vultee Aircraft Corporation
FORT WORTH DIVISION
FORT WORTH, TEXAS

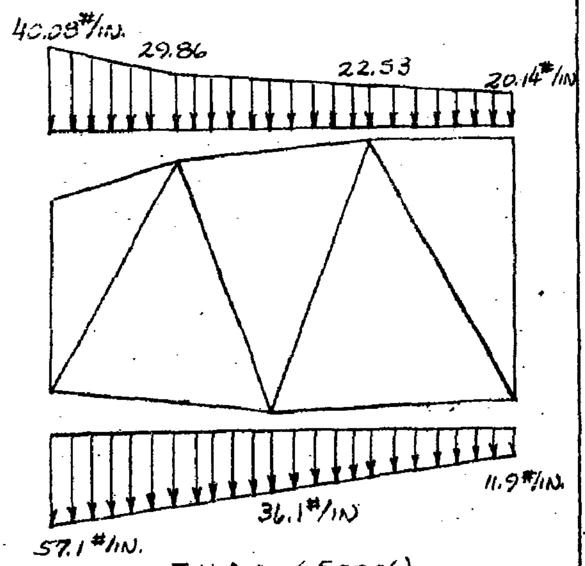
WING BULKHEAD NO. 29

NET LOADS ON BULKHEAD

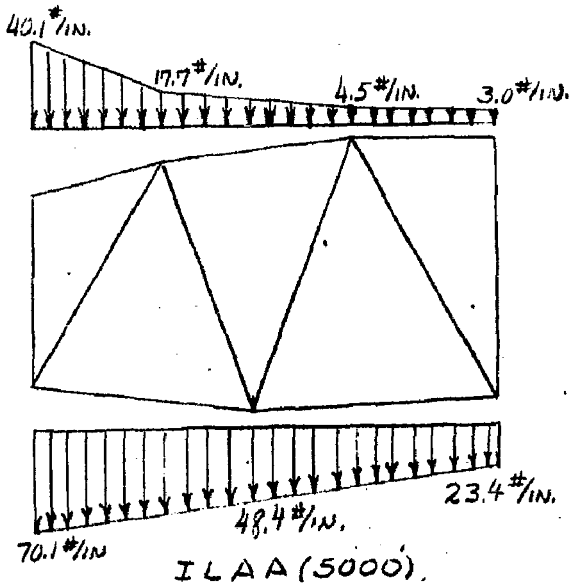


WING BULKHEAD NO. 29

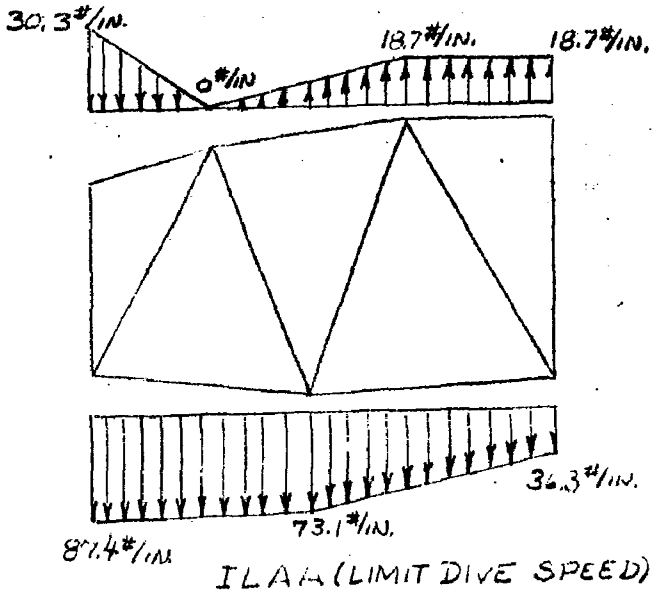
NET LOADS ON BULKHEAD (CONT'D)



IHAA (5000')



ILAA (5000')



ILAA (LIMIT DIVE SPEED)

ANALYSIS WING	**Consolidated Vultee Aircraft Corporation**	PAGE 34
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CHECKED BY THOMSON	FORT WORTH, TEXAS	MODEL YB 36, B36A
REVISED BY		DATE 1-17-4?

WING BULKHEAD NO. 29

SUMMARY OF LOADS IN MEMBERS

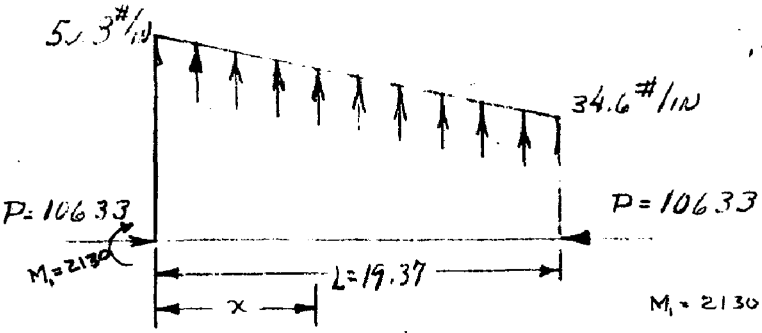
TABLE NO. I

MEMBER	AILERON ROLL CONDITION	+LAA LIMIT DIVE 5000'	+LAA HIGH SPEED 30,000'	+ HAA 5000'	IHAA 5000'	ILAA 5000'	ILAA LIMIT DIVE
A-1	+10	-340	-600	-870	+570	+390	+425
1-2	-520	+575	+710	+1130	-580	-120	+150
2-3	+1500	+1175	+640	+280	-500	-700	-625
3-4	-4480	-3185	-3825	-3280	+2150	+3030	+3800
4-5	+6040	+5725	+5600	+4580	-3280	-4050	-4400
5-G	-5690	-5400	-5230	-4250	+2500	+3290	+3550
C1	-1660	-1100	-1720	-1840	+1630	+1730	+1975
1C'	-3540	-3060	-3200	-2510	+1880	+2380	+2630
D3	-4200	-3020	-2970	-1960	+1680	+2480	+2830
3D'	-6620	-5530	-4890	-2320	+2000	+3320	+3680
E5	-11240	-9535	-9120	-6260	+4390	+6420	+7200
5E'	-13360	-11730	-10800	-7020	+4680	+7140	+7950
K4	+12240	+8960	+8030	+4750	-2900	-4920	-5500
4K'	+7780	+5365	+5300	+3490	-2480	-3820	-4400
L2	+5730	+3980	+3790	+2320	-1640	-2580	-2950
2L'	+1860	+800	+1380	+1220	-1280	-1630	-1980

WING BULKHEAD NO. 24

TRUSS MEMBER "E-5" – CRITICAL FOR UPPER FLANGE

CRITICAL LOADING DGW +LAA LIMIT DIVE

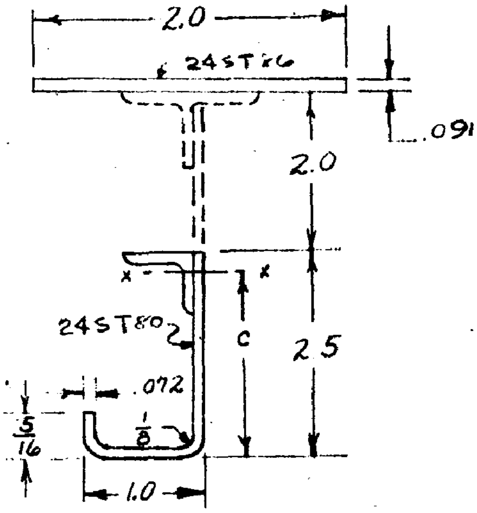


"E-5" = -9535#
"E-5" = -11730#
-21265 } (REF P. 34)

AVE. LOAD = $-\frac{21265}{2} = -10633$#

$W_1 = 34.6$ #/IN
$W_2 = 16.2$ #/IN

$M_1 = 2130$"# (REF METHOD SHOWN ON P. 17).



$A = .5494$ SQ. IN.
$I_{xx} = 1.484$ IN^4
$c = 2.316$

$$j = \sqrt{\frac{10.3 \times 10^6 \times 1.484}{10633}} = 37.915$$

$$\frac{L}{j} = \frac{19.37}{37.915} = .51088$$

$\sin \frac{L}{j} = .48895$ $\cos \frac{L}{j} = .87231$ $\tan \frac{L}{j} = .56052$

$$C_1 = \frac{D_2 - D_1 \cos L/j}{\sin L/j} + \frac{wj^2}{\tan L/j}$$

$D_1 = M_1 - wj^2 = 2130 - (34.16)(37.915)^2 = -47670$

$D_2 = M_2 - wj^2 = 0 - (34.16)(37.915)^2 = -49800$

$$C_1 = \frac{-49800 - (-47670)(.872)}{(.489)} + \frac{(16.2)(37.915)^2}{(.561)} = +24560$$

$C_2 = D_1 - wj^2 = -47670 - (16.2)(37.915)^2 = -70720$

WING BULKHEAD NO. 29

TRUSS MEMBER (E-5) CONT'D

$$f_{(w)} = wj^2 + wj^2(1 - x/L) = (34.6)(37.915)^2 + (16.2)(37.915)^2(1 - x/19.37)$$

$$f_{(w)} = 73050 - 1200x$$

$$M = C_1 \sin x/j + C_2 \cos x/j + f(w)$$

PRELIMINARY INVESTIGATION SHOWED THAT THE MAX. MOM IS AT POINT $x = 0''$

$$M = 2130 \text{ ''-\#}$$

$$f_b = \frac{MY}{I} = \frac{2130 \times 2.275}{1.484} = 3260 \text{ \#/□''}$$

$$F_b = F_{cr} = 69{,}000 \text{ \#/□''}$$

$$R_b = \frac{f_b}{F_b} = \frac{3260}{69000} = .0473$$

$$f_c = \frac{P}{A} = \frac{10633}{.5494} = 19400 \text{ \#/□''} \qquad F_{cr} = 43{,}100 \text{ \#/□''} \left(\text{TOTAL SECT}\right)$$

$$F_c = F_{cr}\left(1 - \frac{F_{cr}(L/\rho)^2}{4\pi^2 E}\right) \qquad \rho = \sqrt{\frac{1.484}{.5494}} = 1.65$$

$$= 43100\left(1 - \frac{43100\left(\frac{19.37}{1.65}\right)^2}{4\pi^2 \times 10.3 \times 10^6}\right)$$

$$F_c = 42{,}400 \text{ \#/□''}$$

$$R_c = \frac{f_c}{F_c} = \frac{19400}{42400} = .458$$

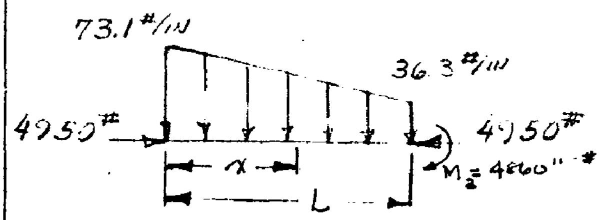
$$M.S. = \frac{1}{R_b + R_c} - 1 = \frac{1}{.0473 + .458} - 1$$

$$M.S. = \underline{\underline{+.98}}$$

WING BULKHEAD NO. 29

TRUSS MEMBER "K-4" - CONDITION: I.L.A.A - LIMIT DIVE

THIS WAS FOUND TO BE THE MOST CRITICALLY STRESSED LOWER MEMBER



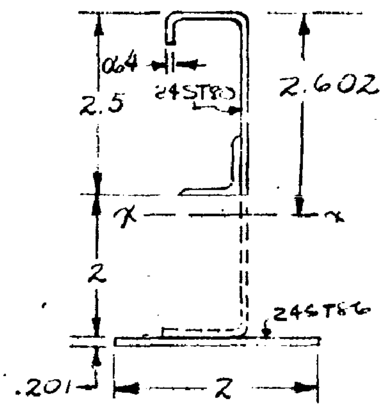
"K-4" = -5500#
"K'-4" = -4400#
-9900#
(REF P. 34)

AVE. LOAD = $-\frac{9900}{2} = -4950$#

$W_1 = 36.3$ #/"

$W_2 = 36.8$ #/"

$M_2 = 4860$"# (REF METHOD SHOWN ON P. 17)



$A = .5523$

$I = 1.515$

$E = 10.3 \times 10^6$

$L = 31.14$

$\bar{y} = 2.602$

$$j = \sqrt{\frac{EI}{P}} \quad \sqrt{\frac{10.3 \times 10^6 \times 1.515}{4950}} = 56.146$$

$$\frac{L}{j} = \frac{31.14}{56.146} = .55462$$

$\sin \frac{L}{j} = .52662 \qquad \cos \frac{L}{j} = .85009 \qquad \tan \frac{L}{j} = .61950$

$$C_1 = \frac{D_2 - D_1 \cos L/j}{\sin L/j} + \frac{Wj^2}{\tan L/j}$$

$D_1 = M_1 - Wj^2 = 0 - (36.3)(56.146)^2 = -114500$

$D_2 = M_2 - Wj^2 = 4860 - (36.3)(56.146)^2 = -109640$

$$C_1 = \frac{-109640 - (-114500)(.850)}{(.527)} + \frac{(36.8)(56.146)^2}{(.620)}$$

$C_1 = +163400$

$C_2 = D_1 - Wj^2 = -114500 - (36.8)(56.15)^2 = -230500$

WING BULKHEAD NO. 29

TRUSS MEMBER (K-4) CONT'D

$f(w) = wj^2 + w_j j^2 (1 - x/L) = (36.3)(56.146)^2 + (36.6)(56.146)^2 (1 - x/31.14)$

$f(w) = 230500 - 3730X$

$M = C_1 \sin x/L + C_2 \cos x/L + f(w)$

PRELIMINARY INVESTIGATION SHOWED THAT THE MAX. MOM. IS AT POINT X=L. DUE TO A LOWER ALLOWABLE BENDING STRESS THE MOM. AT POINT X=14.7 IN. GIVES THE CRITICAL MARGIN OF SAFTEY.

$X = 14.04''$ $\sin x/j = .247$ $\cos x/j = .969$

$M = 163400 \times .247 - 230500 \times .969 + 230500 - 3730 \times 14.04$

$M = -4600$ "-#

$f_b = \frac{MY}{I} = \frac{4600 \times 2.602}{1.515} = 7900$ #/□"

$F_b = F_{cr} = 55,500$ #/□"

$R_b = \frac{f_b}{F_b} = \frac{7900}{55500} = .142$

$F_{cr} = 45,800$ #/□" (TOTAL SECT.) $\rho = \sqrt{I/A} = \sqrt{\frac{1.515}{.5523}} = 1.655$

$F_c = F_{cr}\left(1 - \frac{F_{cr}\,(L/\rho)^2}{4\pi^2 E}\right)$

$F_c = 45800\left(1 - \frac{45800\left(\frac{31.14}{1.655}\right)^2}{4\pi^2 \times 10.3 \times 10^6}\right) = 31,670$

$f_c = \frac{P}{A} = \frac{4950}{.5523} = 8963$ #/□"

$R_c = \frac{f_c}{F_c} = \frac{8963}{31670} = .283$

$M.S. = \frac{1}{.142 + .283} - 1 = \underline{\underline{+1.35}}$

WING BULKHEAD NO. 29

MARGINS OF SAFETY IN DIAGONALS

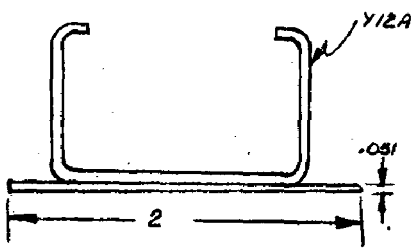
TABLE II

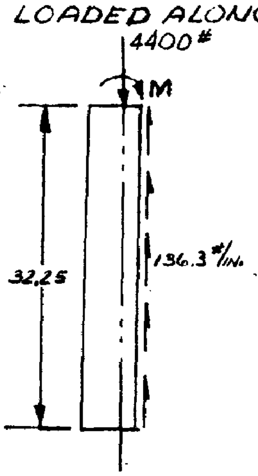
MEMBER	TENSION LOAD (P.34)	COMP. LOAD (P.34)	TENS.* ALLOW.	COMP.* ALLOW.	M. S.
1-2	1130	580	6710	4560	+4.9
2-3	1500	700	5950	2370	+2.4
3-4	3800	4400	9400	6380	+.42

*REF. REPORT DEVF 275-594

DIAGONAL MEMBER 4-5

THIS MEMBER IS ATTACHED TO .051 SKIN WHICH RUNS BETWEEN THE MEMBER AND THE REAR SPAR. IT IS ASSUMED THAT THE DIAGONAL FEEDS ITS LOAD INTO THE WEB AS A UNIFORM SHEAR FLOW. THE MEMBER IS LOADED ALONG ITS BACK, MAKING IT ECCENTRIC.





$A = .3324 \square''$

$\bar{y} = .3185''$

$I_{xx} = .0455 \text{ IN.}^4$

$\rho_{xx} = .370$

$L/\rho = \frac{32.25}{.370} = 87.2$

$M = 4400 \times .3185 = 1400''\#$

$$f_c = \frac{4400}{.3324} = 13250 \text{ \#/□"}$$

FOR A LOAD REACTED BY A SHEAR FLOW, THE ALLOWABLE COMPRESSIVE STRESS IS TWICE THE EULER ~ REF. "THEORY OF ELASTIC STABILITY" P.122

$$F_c = \frac{2\pi^2 \times 10.3 \times 10^6}{(87.2)^2} = 26,760 \text{ \#/□"}$$

$$f_b = \frac{1400 \times .3185}{.0455} = 9800 \text{ \#/□"}$$

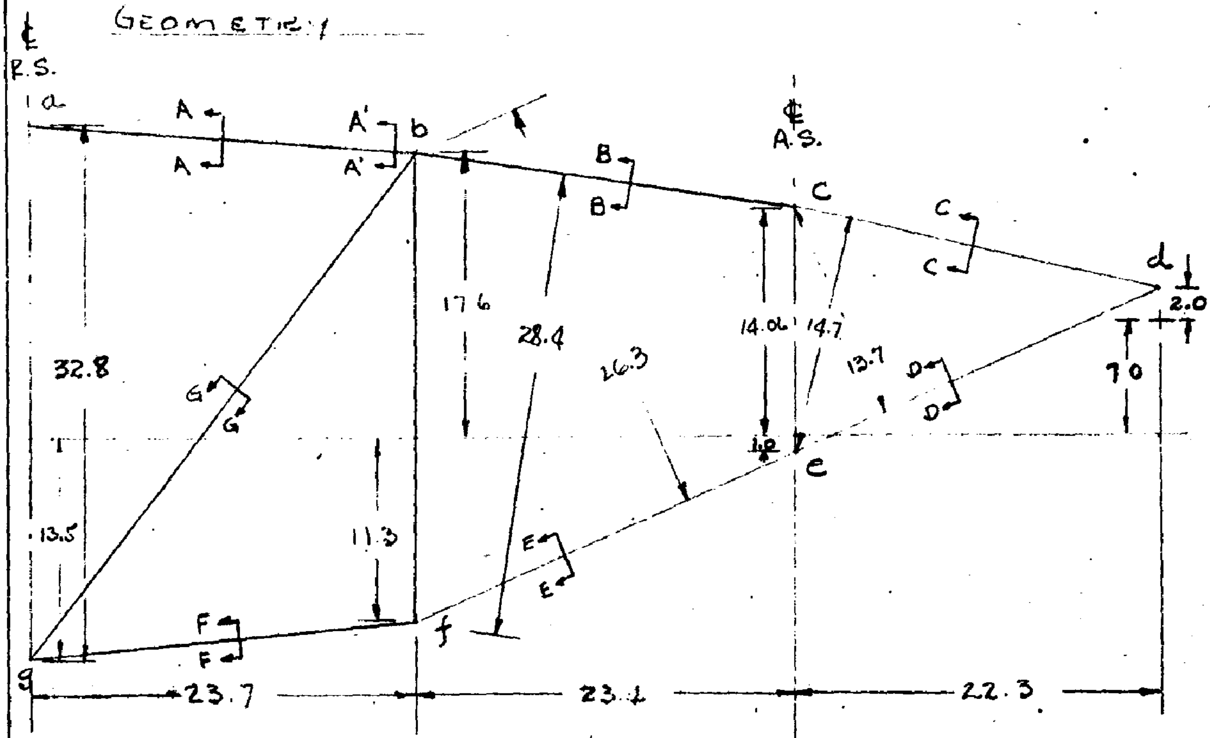
THE ALLOW. F_c IS BASED ON $\frac{b}{t\sqrt{k}}$ OF THE BACK OF THE CHANNEL (REF. C.V.A.C. #1)

$$F_c = 58000 \text{ \#/□"}$$

$$M.S. = \frac{1}{\frac{13250}{26760} + \frac{9800}{58000}} - 1. = \underline{+.50}$$

TRAILING EDGE RIB STA. 29
(REF. DWG. 36 W-1929)

GEOMETRY



ADJACENT BULKHEAD SPACING = 36 IN.

AIR LOADS DETERMINED FROM PRESSURE DISTRIBUTION CURVES REF. PAGE 10

CONCENTRATED AUXILIARY SPAR LOADS REF AUXILIARY SPAR ANALYSIS PAGE 112

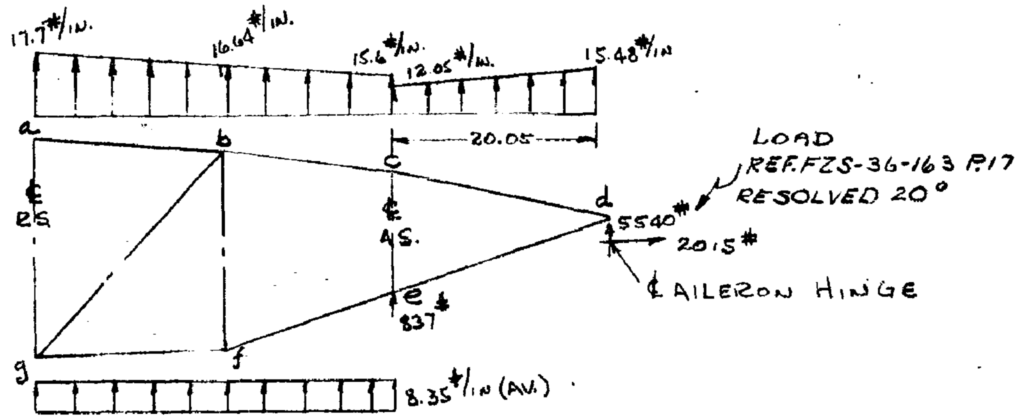
AILERON HINGE LOADS REF. PAGE 17 FZS-36-163

ANALYSIS WING
PREPARED BY BEARD
CHECKED BY ZINBERG
REVISED BY

Consolidated Vultee Aircraft Corporation
FORT WORTH DIVISION
FORT WORTH, TEXAS

T.E. RIB STA NO 29

AILERON ROLL



LOAD ON UPPER SURFACE AT R.S.

$$= \frac{.52 \times 90.6 \times 36 \times 1.5}{144} = 17.7\ \#/\text{IN} \uparrow$$

LOAD ON LOWER SURFACE AT R.S.

$$= \frac{.24 \times 90.6 \times 36 \times 1.5}{144} = 8.2\ \#/\text{IN} \uparrow$$

LOAD ON UPPER SURFACE AT A.S.

$$= \frac{.46 \times 90.6 \times 36 \times 1.5}{144} = 15.6\ \#/\text{IN} \uparrow$$

LOAD ON LOWER SURFACE AT A.S.

$$= \frac{.25 \times 90.6 \times 36 \times 1.5}{144} = 8.5\ \#/\text{IN} \uparrow$$

$\Sigma M @ "e"$

5,540 × 22.3 =	123,500
2,015 × 8 =	16,120
12.05 × 20.05 × 10.025 =	2,420
3.43 × 10.025 × 13.37 =	460
MOM. =	110,260

AXIAL LOAD MEMBER "cd" $= \frac{110,260}{14.7} = 7,500\#$ COMP.

T.E. RIB STA. NO. 29

AILERON ROLL

ΣM @ "c"

5540 × 22.3 = 123,500
2015 × 7.06 = 14,230
12.05 × 20.05 × 10.025 = 2,420
3.43 × 10.025 × 13.37 = 460
MOM. = 140,610

AXIAL LOAD MEMBER "de" = $\frac{140,610}{13.7}$ = 10,260# TEN.

ΣM @ "f"

837 × 23.4 = 19,600
8.35 × 23.4 × 11.7 = 2,285
5540 × 45.7 = 253,500
2015 × 18.3 = 36,850
12.05 × 20.05 × 33.45 = 8,080
3.43 × 10.025 × 36.77 = 1,265
15.6 × 23.4 × 11.7 = 4,270
1.04 × 11.7 × 7.8 = 95
MOM. = 252,245

ΣV

837 + 5540 + 196 + 242 + 34 + 365 + 12 = 7,226# ↑

AXIAL LOAD MEMBER "bc" = $\frac{252,245}{28.4}$ = 8,890# COMP.

$H_b = \frac{252,245}{28.9}$ = 8,740# ←

H_f = 8,740 + 2,015 = 10,755# →

FOR MEMBER "fe"

$L = \sqrt{(23.4)^2 + (10.3)^2} = 25.58$

AXIAL LOAD MEMBER "fe" = $\frac{25.58}{23.4} \times 10,755$ = 11,750# TEN.

V/L COMPONENT OF MEMBER "fe" = $\frac{10.3}{25.58}$ = .403

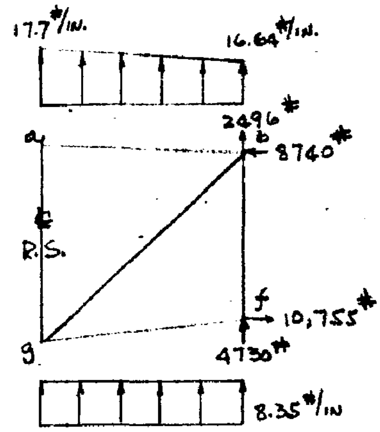
COMPONENT OF VERTICAL SHEAR APPLIED TO TRUSS AT POINT "f" = .403 × 11,750 = 4,730# ↑

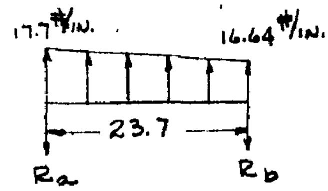
VERT. LD. AT L = 7,226 − 4,730 = 2,496# ↑

T.E. RIB STA. NO. 29

AILERON ROLL

LOADS TO RIB TRUSS

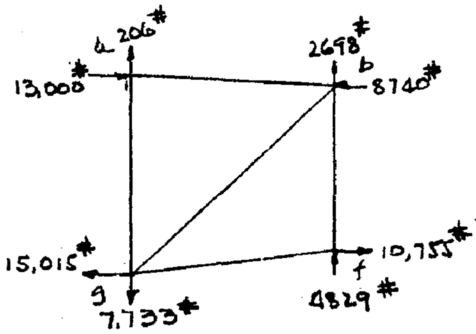




$R_b = 16.64 \times 11.85 + 1.06 \times 11.85 \times .333$
$= 197.3 + 4.2 = 202\#\downarrow$
$R_a = 197.3 + 8.4 = 206\#\downarrow$

$R_g = R_f = 8.35 \times 11.85 = 99\#\downarrow$

PANEL LOADS



$V_b = 2496 + 202 = 2698\#\uparrow$
$V_a = 206\#\uparrow$
$V_f = 4730 + 99 = 4829\#\uparrow$

$\Sigma M @ g$
$(2698 + 4829) \times 23.7 = 178,300$
$8,740 \times 31.1 = 271,900$
$10,755 \times 2.2 = 23,660$
$Mom = 426,540$

$H_a = \dfrac{426,540}{32.8} = 13,000\#\leftarrow$

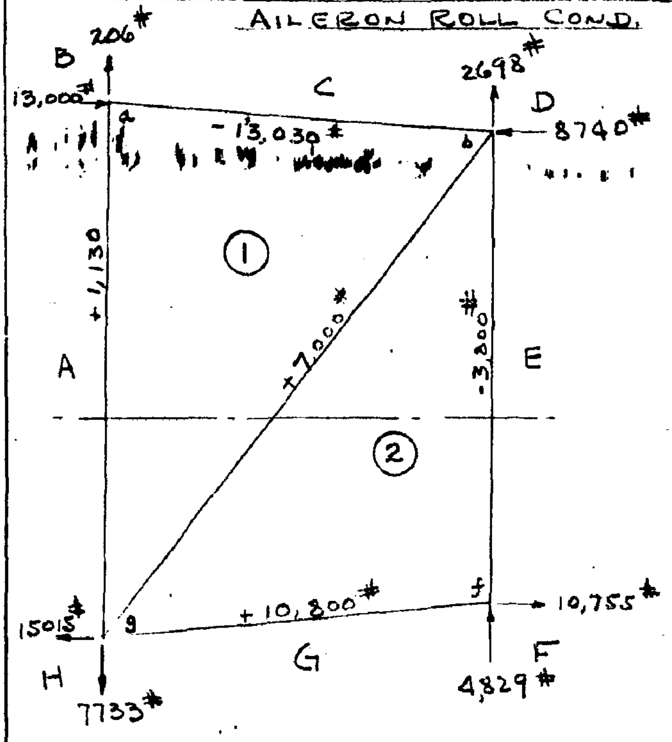
$H_g = 13,000 + 10,755 - 8,740 = 15,015\#\leftarrow$

$V_g = 206 + 2,698 + 4829 + 99 - 99 = 7733\#$

$R_{R.S.} = 7733 + 99 = 7832\#\downarrow$

TRAILING EDGE RIB No. 29

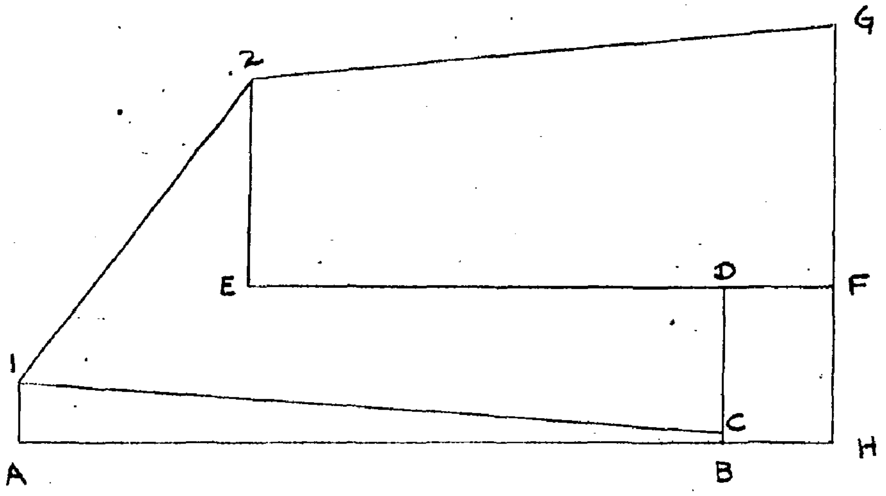
AILERON ROLL COND.



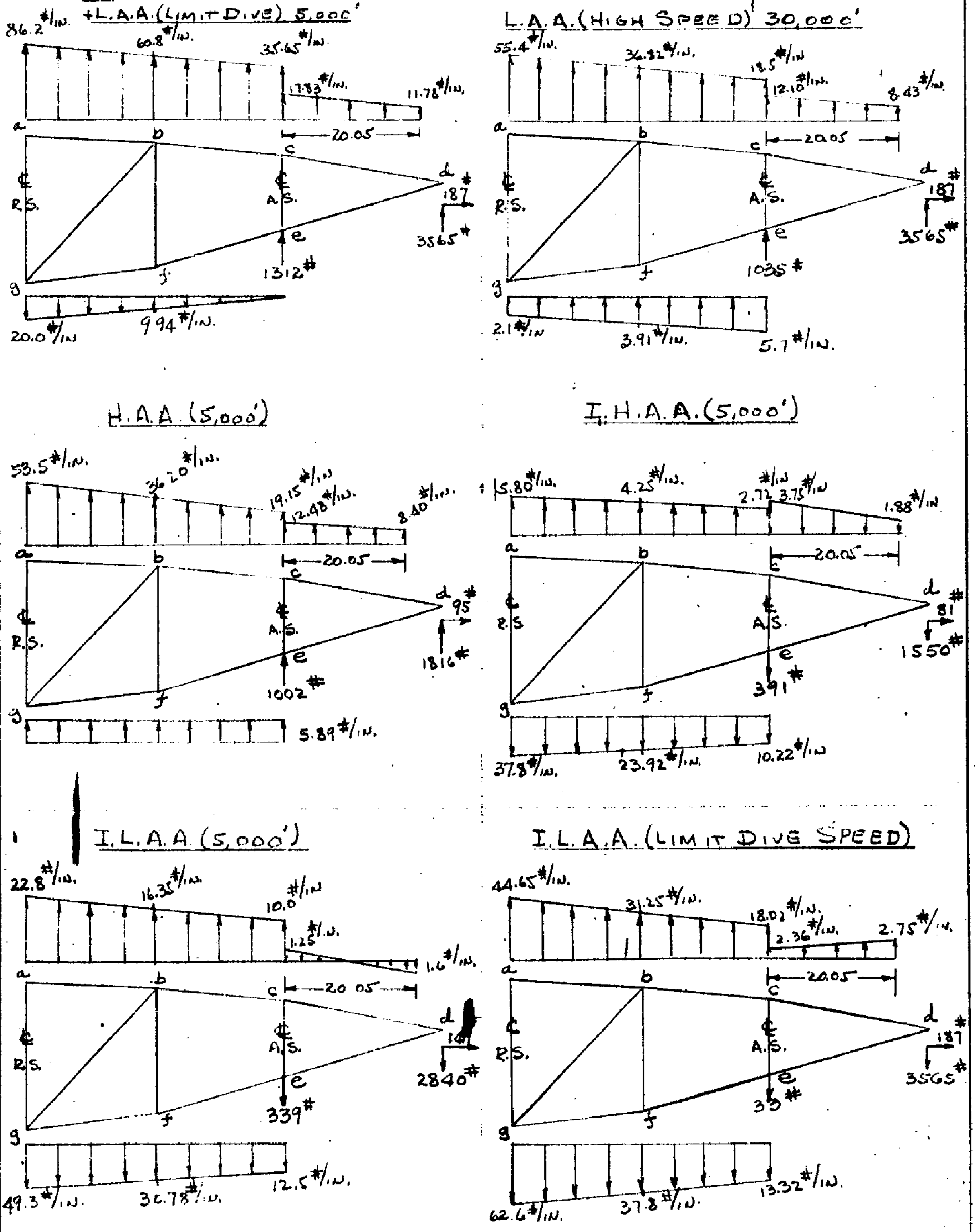
TRUSS SCALE 1" = 10"

FORCE SCALE 1" = 3,000#

FIG. 10



T.E. RIB STA. NO. 29 - LOADING SUMMARY



T.E. RIB STA. NO. 29

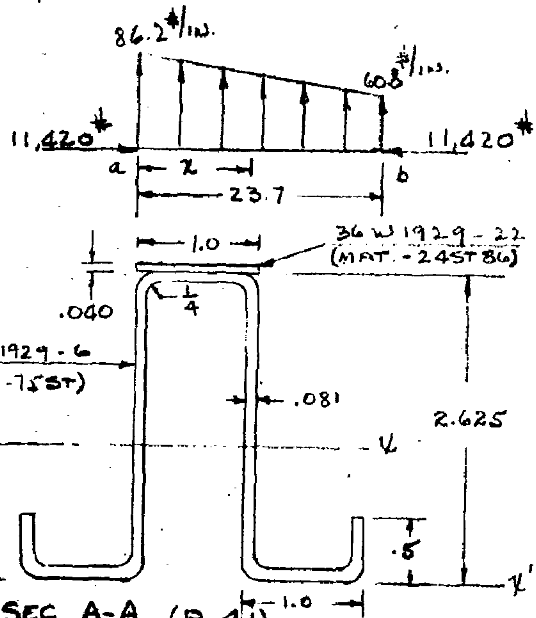
MEMBER LOAD SUMMARY

TABLE No. III

TRUSS MEMBER	DESIGN CONDITION						
	AILERON ROLL	+ L.A.A. (5000') LIMIT DIVE	+ L.A.A. (30,000') HIGH SPEED	+ H.A.A. (5,000')	I.H.A.A. (5,000')	I.L.A.A. (5,000')	I.L.A.A. LIMIT DIVE SPEED
a b	-13,030#	- 11,420#	-10,480#	- 6,830#	+ 4,500#	+6,950#	+7,740#
b c	- 8,890#	- 7,440#	- 7,000#	-4,225#	+ 3,000#	+5,005#	+5,820#
c d	- 7,500#	- 5,500#	- 5,440#	-2,840#	+2,430#	+4,385#	+5,460#
d e	+10,260#	+ 6,100#	+6,040#	+3,150#	- 2,520#	-4,545#	-5,625#
e f	+11,750#	+ 8,160#	+7,760#	+4,665#	-3,150#	-5,240#	-6,075#
f g	+10,800#	+ 7,500#	+7,100#	+4,270#	-2,880#	-4,820#	-5,550#
a g	+1,130#	+ 1,800#	+1,320#	+1,060#	- 260#	- 250#	- 100#
g b	+7,000#	+ 6,720#	+5,950#	+4,400#	-2,540#	-3,280#	-3,260#
b f	- 3,800#	- 2,500#	-2,520#	- 1,560#	+1,360#	+2,060#	+2,480#

T.E. RIB STA NO. 29

TRUSS MEMBER "ab"
CRITICAL LOADING + L.A.A. (LIMIT DIVE) 5,000'
(REF. PAGE 47 & 46)



SEC. A-A (P. 41)

MOMENT DUE TO CURVATURE OF MEMBER = 11,420 × .125
= 1,430 IN. LBS.

$A = .7112\ in^2$
$I_{xx} = .651\ in^4$
$\rho_{xx} = .956\ in$

$j = \sqrt{\frac{EI}{P}} = \sqrt{\frac{10.3\times10^6 \times .651}{11,420}}$
$= 24.4$

$L/j = \frac{23.7}{24.4} = .971$

$\sin L/j = .82545$, $\cos L/j = .56447$, $\tan L/j = 1.46238$

$C_1 = \frac{wj^2(\cos L/j - 1)}{\sin L/j} + \frac{w_1 j^2}{\tan L/j} = \frac{60.8(24.4)^2(-.43553)}{.82545} + \frac{25.4(24.4)^2}{1.46238}$

$= -19,100 + 10,340 = -8,760$

$C_2 = -wj^2 - w_1 j^2 = -60.8(24.4)^2 - 25.4(24.4)^2 = -51,320$

$f(w) = wj^2 + w_1 j^2 (1 - x/L)$

x WAS FOUND TO BE = 11.71 (PT. M (MAX))

$x/L = \frac{11.71}{23.7} = .495$

$f(w) = 60.8(24.4)^2 + 25.4(24.4)^2(.505)$
$= 43,840$

$x/j = \frac{11.71}{24.4} = .48$

$\sin x/j = .46178$
$\cos x/j = .88699$

$M = C_1 \sin x/j + C_2 \cos x/j + f(w)$

$M_{(MAX)} = -8,760 \times .46178 - 51,320 \times .88699 + 43,840$
$= -5,705''\#$

TOTAL M = 5705 + 1430 = 7,135 "#

T.E. RIB STA. No. 29
TRUSS MEMBER "ab" (CONT'D.)

$$f_b = \frac{7,135 \times 1.168}{.651} = 12,800 \text{ p.s.i.}$$

$F_a = 54,600$ p.s.i. (REF. C.V.A.C. #1)

$$R_b = \frac{12,800}{54,600} = .234$$

$$f_c = \frac{11,420}{.7112} = 16,040 \text{ p.s.i.}$$

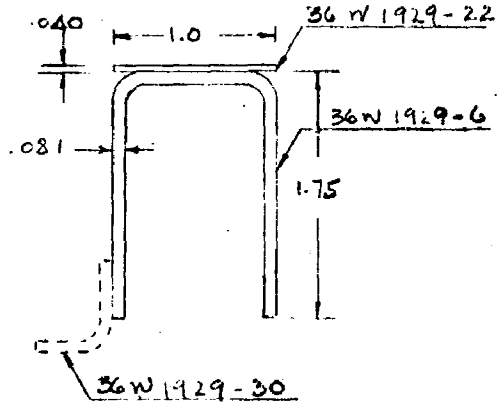
$$L/\rho = \frac{23.7}{.956} = 24.78$$

$$F_c = 54,600\left[1 - \frac{54,600 \times (24.78)^2}{4\pi^2 \times 10.3 \times 10^6}\right] = 50,100 \text{ p.s.i.}$$

$$R_c = \frac{16,040}{50,100} = .32$$

$$M.S. = \frac{1}{.234 + .32} - 1 = \underline{+.80}$$

CRIPPLING AT SEC A-A' (REF. PAGE 41)
CRITICAL LD = -13,030# (AILERON ROLL PAGE 47)



$A = .378 \text{ in}^2$

$$f_c = \frac{13,030}{.378} = 34,500 \text{ p.s.i.}$$

$F_a = 46,000$ p.s.i. (C.V.A.C No. 1)

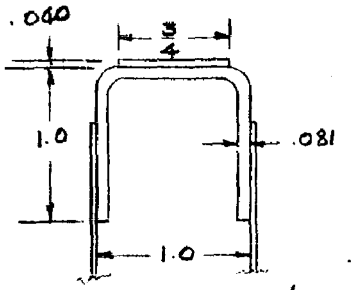
$$M.S. = \frac{46,000}{34,500} - 1 = \underline{+.33}$$

T.E. RIB STA. NO. 29

MEMBER "bc"

CRITICAL LOADING AILERON ROLL COND.

AXIAL LD. = 8,890# COMP. (PAGE 47)



SEC. B-B (PAGE 41)

A = .2398 IN²

$f_c = \frac{8,890}{.2398} = 37,100$ p.s.i.

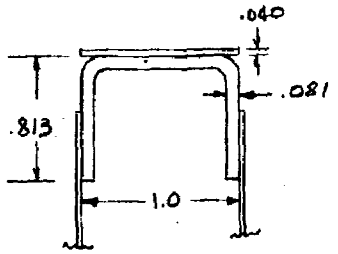
$F_a = 51,000$ p.s.i.

$M.S. = \frac{51,000}{37,100} - 1 = \underline{+.37}$

MEMBER "cd"

CRITICAL LOADING AILERON ROLL COND.

AXIAL LD. = 7,500# COMP. (PAGE 47)



SEC. C-C (PAGE 41)

A = .2264 IN²

$F_a = 62,000$ p.s.i.

$f_c = \frac{7500}{.2264} = 33,100$ p.s.i.

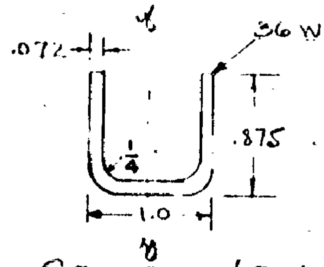
$M.S. = \frac{51,000}{33,100} - 1 = \underline{+.54}$

IT IS ASSUMED IN THE ANALYSIS THAT THE WEB OF THE RIB & SKIN PREVENT THE ABOVE MEMBERS FROM FAILING AS A COLUMN.

T.E. RIB STA. NO. 29

MEMBER "de"

MAX. LD = 10,260# TEN. AILERON ROLL COND (P. 47)
= −5,625# COMP. I.L.A.A. LIMIT DIVE SPEED



SEC. D-D (PAGE 41)

$A = .178 \text{ in}^2$

$f_t = \frac{10,260}{.178} = 57,600$ p.s.i.

$F_t = .85^* \times 74,000 = 62,900$ p.s.i.

$M.S. = \frac{62,900}{57,600} - 1 = \underline{+.09}$

$I_{yy} = .0288 \text{ in}^4 \quad \rho_{yy} = .401 \text{ in.} \quad L = 18.0$

$L/\rho = \frac{18}{.401} = 44.9 \quad F_{co} = F_{cy} = 62,000$ p.s.i.

$F_c = 62,000\left[1 - \frac{62,000\,(44.9)^2}{4\pi^2 \times 10.3 \times 10^6}\right] = 43,000$ p.s.i.

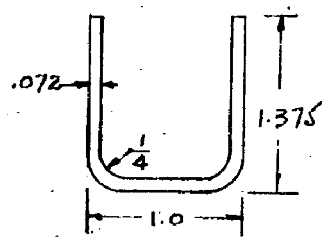
$f_c = \frac{5,625}{.178} = 31,600$ p.s.i.

$M.S. = \frac{43,000}{31,600} - 1 = \underline{+.36}$

MEMBER "ef"

MAX. TEN. LOAD = 11,750# AILERON ROLL
MAX. COMP. LD = 6,075# I.L.A.A LIMIT DIVE } (PAGE 47)

$A = .250 \text{ in}^2$



$f_t = \frac{11,750}{.250} = 47,000$ p.s.i.

$M.S. = \frac{62,900}{47,000} - 1 = \underline{+.34}$

$f_c = \frac{6,075}{.250} = 24,300$ p.s.i.

SEC. E-E
(PAGE 41)

$F_{co} = 47,100$ p.s.i.

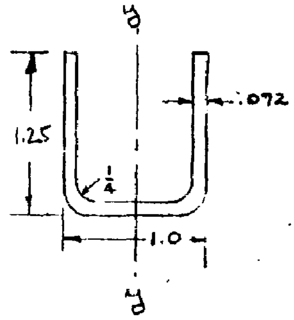
$M.S. = \frac{47,100}{24,300} - 1 = \underline{+.94}$

* RIVET FACTOR

T.E. RIB STA NO. 29

MEMBER "f g"

MAX TEN. LD. = 10,800# AILERON ROLL } (PAGE 47)
MAX. COMP. LD. = 5,550# I.L.A.A. LIMIT DIVE }



$A = .231\ in^2$

$I_{yy} = .0402\ in^4$

$\rho_{yy} = .418\ in.$

$F_{cc} = 54,450$ p.s.i. (C.V.A.C. No. 1)

$L/\rho = \frac{23.7}{.418} = 56.7$

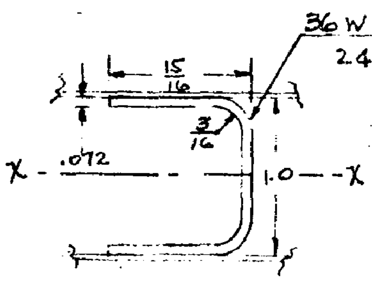
SEC. F-F (PAGE 41) $F_c = 54,450\left[1 - \frac{54,450 \times (56.7)^2}{4\pi^2 \times 10.3 \times 10^6}\right] = 31,000$ p.s.i.

$f_c = \frac{5,550}{.231} = 24,000$ p.s.i. $\qquad M.S. = \frac{31,000}{24,000} - 1 = +.29$

$f_t = \frac{10,800}{.231} = 46,750$ p.s.i. $\qquad M.S. = \frac{62,900}{46,750} - 1 = +.34$

MEMBER "g b"

MAX. TEN. LD. = 7,000# AILERON ROLL } (PAGE 47)
MAX. COMP. LD. = 3,280# I.L.A.A. (5,000') }



$A = .186\ in^2$

$I_x = .0306\ in^4$ $\qquad L/\rho = \frac{23}{.405} = 56.75$

$\rho_x' = .405\ in.$

CRITICAL "L" (BETWEEN STFNRS) = 23 IN.

$F_{cc} = 52,000$ p.s.i. (C.V.A.C. No. 1)

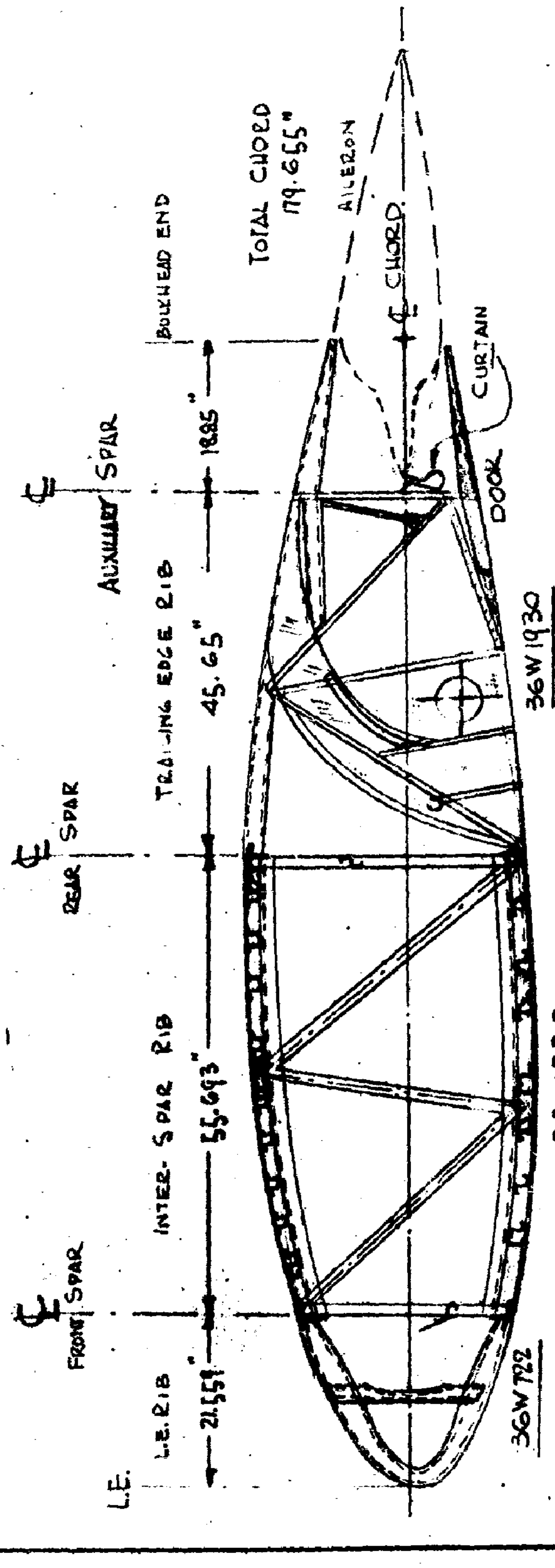
SEC. G-G. (PAGE 41) $F_c = 52000\left[1 - \frac{52,000 \times (56.75)^2}{4\pi^2 \times 10.3 \times 10^6}\right] = 30,650$ p.s.i.

$f_c = \frac{3280}{.186} = 17,630$ p.s.i. $\qquad M.S. = \frac{30,650}{17,630} - 1 = +.74$

$f_t = \frac{7000}{.186} = 37,600$ p.s.i., $F_t = .85^* \cdot 65,000 = 55,200$ p.s.i.

$M.S. = \frac{55,200}{37,600} - 1 = +.47$

*RIVET FACTOR.



WING BULKHEAD No 30.0

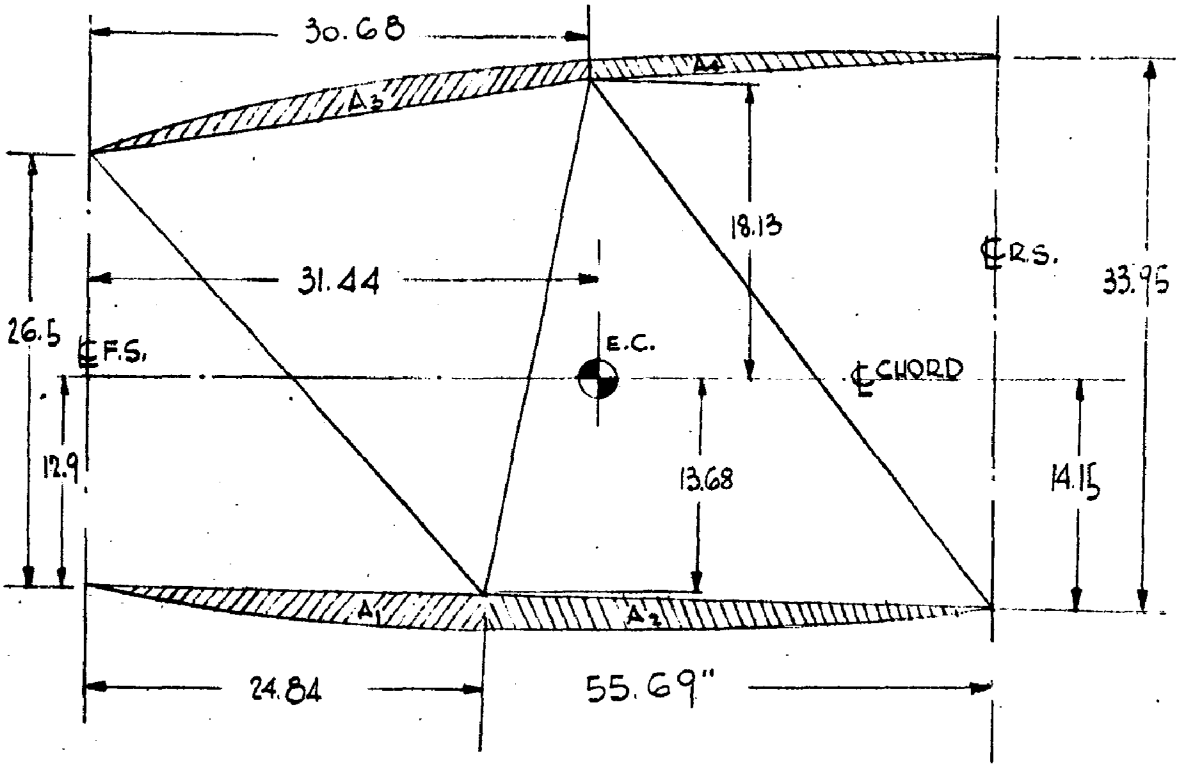
STATION 1014

AIR LOAD RIB OUTER PANEL

FIG. 11

WING BULKHEAD 30

(REF. DWG. 36W630)



STA	S.M.	ORDINATE ABOVE CHORD	AREA FUNCT.	ORDINATE BELOW CHORD	AREA FUNCT.
0	1	13.55	13.55	12.90	12.90
1	4	15.20	60.80	13.80	55.20
2	2	16.65	33.30	14.60	29.00
3	4	17.80	71.20	15.10	60.40
4	2	[illegible]	37.50	15.45	30.90
5	4	19.40	77.60	15.70	62.80
6	2	19.90	39.80	15.65	31.30
7	4	21.00	84.00	15.50	62.00
8	2	21.50	43.00	15.20	30.40
9	4	20.00	80.00	14.70	58.80
10	1	19.75	19.75	14.20	14.20
			Σ = 560.50		Σ = 447.90

AREA ABOVE CHORD = $5.569/3 \times 560.5$ = 1040.46

AREA BELOW CHORD = $5.569/3 \times 447.9$ = 831.44

TOTAL 1871.90 □"

A_1 = 30.88 □".

A_2 = 41.48 □".

A_3 = 42.48 □".

A_4 = 25.48 □".

WING BULKHEAD 30.0
STA. 1014

CONDITIONS TO BE INVESTIGATED

1. NORMAL WING :-

C_{l_b} = -.037 (REF. FZS-36-138, Pg. 14).
$C_{l_{a_1}}$ = 1.067 (REF. FZS-36-138, Pg. 15).

CONDITION	REF. FZS-36-136			C_l*	q	qC_l	M
	VTRUE	n	C_L				
D.G.WT. H.A.A. 5000 ft.	219.8	2.67	1.50	1.563	106.5	166.5	.294
D.G.WT. I.H.A.A. 5000 ft.	202.8	-1.67	-1.10	-1.210	90.8	-110	.272
D.G.WT. L.A.A. 30000 ft HIGH SPEED	338.2	2.67	1.4026	1.458	109.4	160	.340
D.G.WT. I.L.A.A. 5000 ft LIMIT DIVE	308	-1.51	.410	-.474	209	-99.1	.412
D.G.WT. L.A.A. 5000 ft. LIMIT DIVE	308	2.51	.7242	.736	209	154	.412

2. D.G.WT. AILERON ROLL:- δ_A = +20°.

C_{l_b} = +.273 (REF. FZS-36-138A, Pg. 16).
$C_{l_{a_1}}$ = 1.067 (REF. FZS-36-138, Pg. 15).

VTRUE = 188.3 m.p.h. @ SEA LEVEL.
n = 2.67 (REF. FZS-36-138 A, Pg. 5).
C_L = 1.18 (REF. FZS-36-138A, Pg. 6).
C_l = 1.532
q = 90.6 p.s.f.
qC_l = 139.1

* ASSUMED EQUAL TO C_n.
$\therefore C_n = C_{l_b} + C_L C_{l_{a_1}}$

DESIGN GROSS WT. L.A.A.
LIMIT DIVE SPEED,
5000' ALTITUDE
FLAPS NEUTRAL
M = .412
C_N = .736

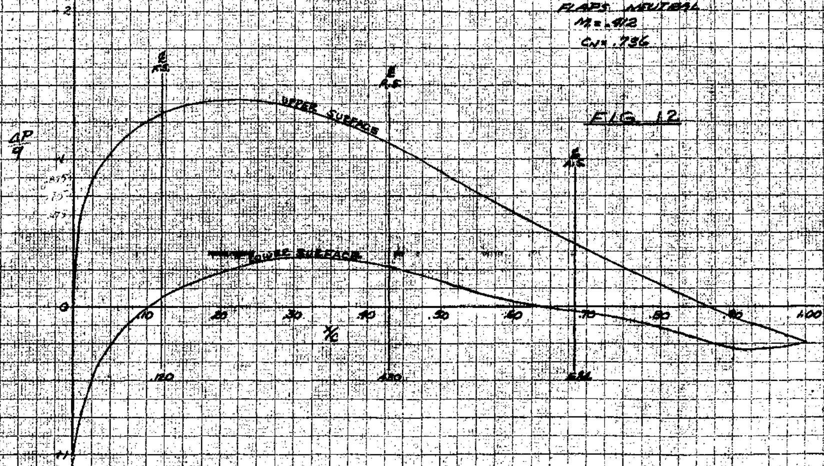


FIG. 12

LOWERY 1/2/47		PRESSURE DISTRIBUTION WING RIB STA 30	DOC NO. ...-86-14CA
ZINBERG		CONSOLIDATED VULTEE AIRCRAFT CORPORATION FORT WORTH DIVISION FORT WORTH, TEXAS	MODEL B-36A

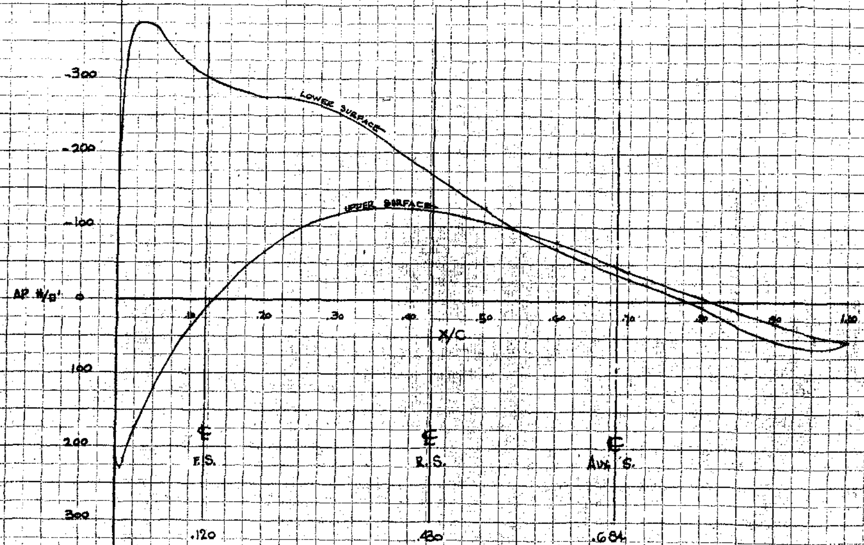


FIGURE 13

CALCULATED BY	PEROHSKY	[illegible]	D.G. WT. I.L.A.A. - WING 5000 ft. LIMIT DIVE - Sta 30	DOC. NO. [illegible]
DRAWN BY	PEROHSKY			MODEL
CHECKED BY	Z.WEBERG		CONSOLIDATED VULTEE AIRCRAFT CORPORATION FORT WORTH DIVISION, FORT WORTH, TEXAS	TB-36 B-36A
APPROVED BY				

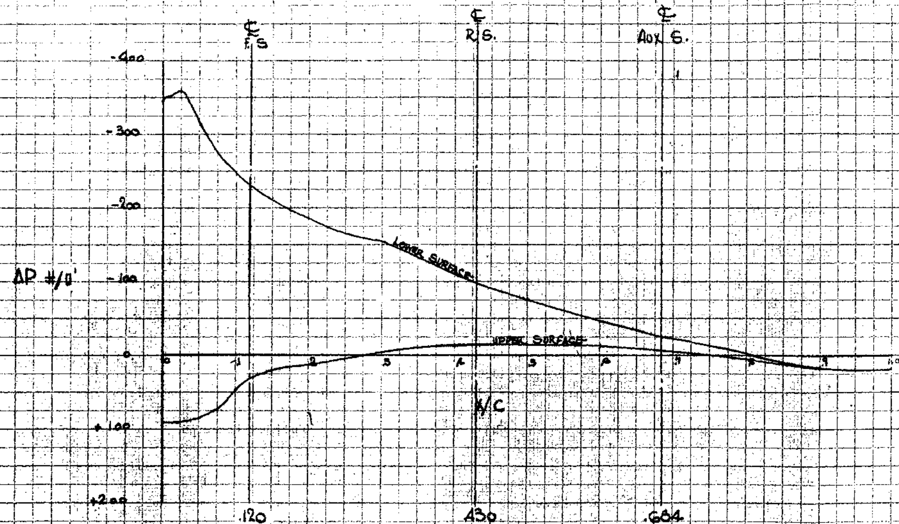
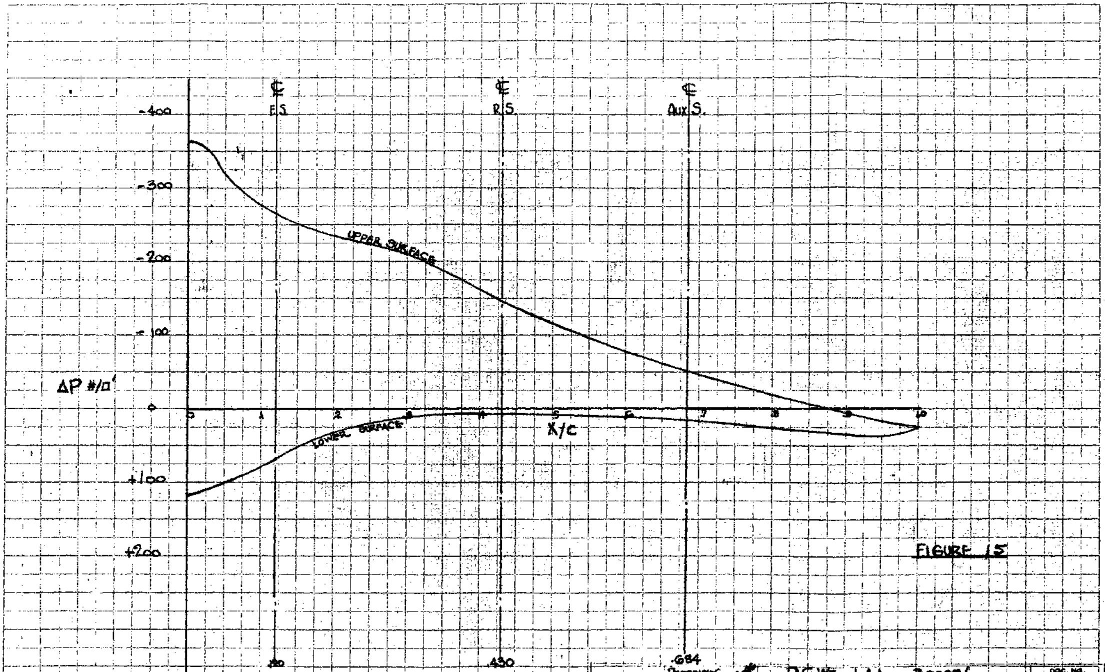


FIGURE 14

CALCULATED BY	PERCHASKY	1-12-47	D.G.WT. - I.H.A.A. - 5000 ft	DOC. NO. F2S-36-142
DRAWN BY	PERCHASKY		WING	
CHECKED BY	ZINBERG		CONSOLIDATED VULTEE AIRCRAFT CORPORATION	MODEL
APPROVED BY			FORT WORTH DIVISION, FORT WORTH, TEXAS	YB-36,B-36A



CALCULATED BY	PERCINSKY	D.G.WT. - L.A.A. - 30000'	DOC. NO. F29-36-142 APP. A
DRAWN BY	PERCINSKY	HIGH SPEED - WING	MODEL YB-36, B-36A
CHECKED BY	ZINBERG	CONSOLIDATED VULTEE AIRCRAFT CORPORATION	
APPROVED BY		FORT WORTH DIVISION / FORT WORTH, TEXAS	

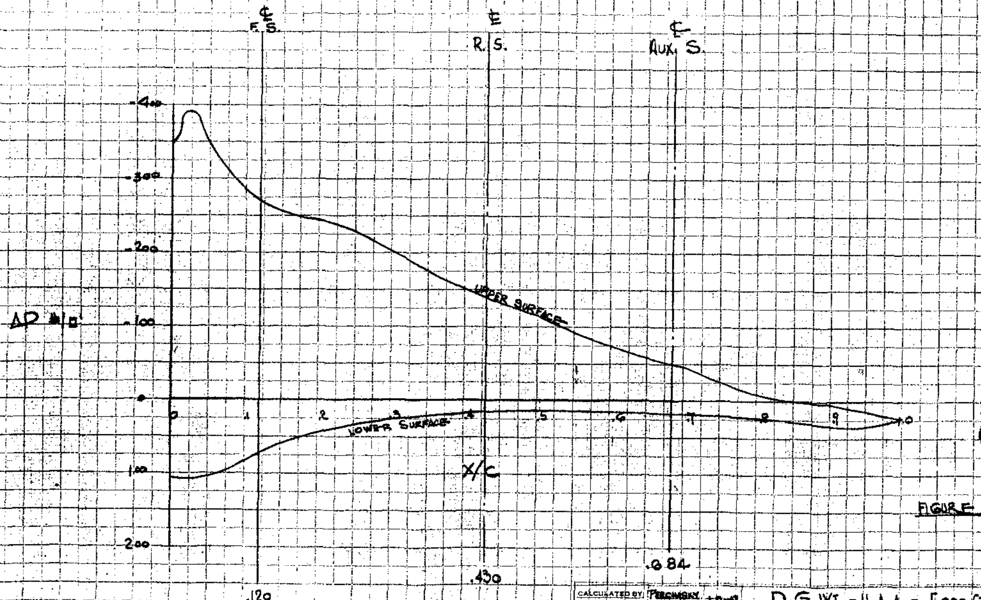


FIGURE 16

CALCULATED BY	PERCHISKY	1-12-42	D.G. WT. - H.A.A. - 5000 FT. -WING — STA. 30
DRAWN BY	PERCHISKY		
CHECKED BY	EINBERG		CONSOLIDATED VULTEE AIRCRAFT CORPORATION FORT WORTH DIVISION, FORT WORTH, TEXAS
APPROVED BY			

DOC. NO F28-36-142

MODEL YB-36, B-36A

BULKHEAD Nº 30, STA. 1014

(REF DWG. 36W630)

INTER-SPAR CHORD = 55.693 INCHES.
ELASTIC-AXIS = .295 OF WING CHORD, AFT OF L.E.
F.S. LOCATED AT .120 WING CHORD.
R.S. LOCATED AT .430 WING CHORD.
AUXILIARY SPAR LOCATED AT .684 WING CHORD.
WING CHORD AT STA. 1014 = 179.655 INCHES
ADJACENT RIB SPACING = 36.0 INCHES.

SAMPLE CALCULATION :-

D. G. WT., L.A.A. 30,000 FT, HIGH SPEED :-

LOAD & C.P. FWD FRONT SPAR
(REF. PRESSURE DIST. CURVE FIG. 15 P. 59)

$d = .030\,C$

STA.	Y	S.M.	AREA FUNCT.	M.M.	MOM. AREA
0	477	1	477	0	0
1	455	4	1820	1	1820
2	403	2	806	2	1612
3	367	4	1468	3	4404
4	335	1	335	4	1340
			Σ=4906		Σ=9176

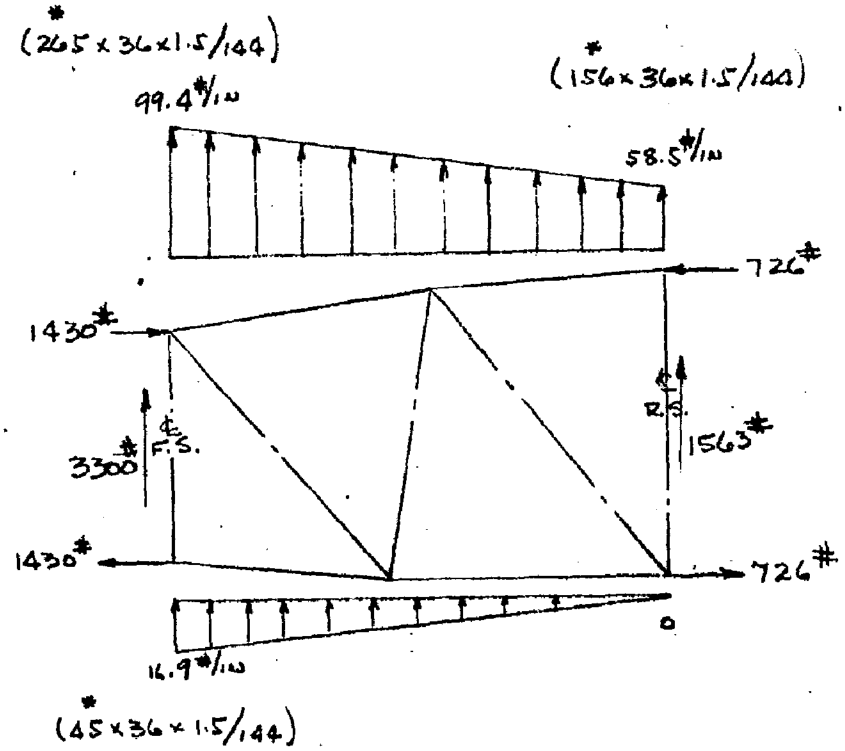
C.P. = 9176 × .03 × 179.655/4906 = 10.07" AFT L.E
= 11.489" FWD ℄ F.S.

LOAD = 4906 × .03 × 179.655 × 36 × 1.5/3 × 144 =
3300 # ULT.

COUPLE AT F.S. =

3300# × 11.489"/26.5 = 1430#

BULKHEAD 30 STA. 1014
D.G.W. L.A.A. 30,000' HIGH SPEED



SUMMARY - AIR LOADS TO BULKHEAD

SHEAR & COUPLE AT R.S. REF. PAGE 106

* REF. PG. 59, FIG. 15.

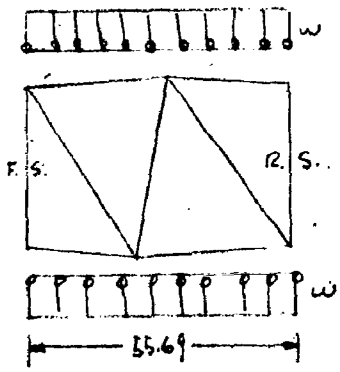
BULKH'D 30. STA 1014

D.G. WT. L.A.A. 30000' HIGH SPEED

CRUSHING LOADS DUE TO BENDING STRESSES

(REF. FZS-36-141, Add. A, Pg. 58).

$$P = d f^2 A / E Y \ *$$



CRUSHING LOADS					
	STR. & SKIN	AREA	f	Y	P
UPPER STRS. & EFF. SKINS	A 11	.785	-28961	11.05	195
	A 17	.955	-30832	12.93	254
	A 18	.908	-32587	13.82	243
	A 19	.982	-33874	14.94	266
	A 20	.902	-35085	16.04	242
	A 21	.931	-35034	16.54	241
	A 22	.933	-34490	17.02	235
	A 23	.851	-34512	17.34	205
	A 24	.932	-33530	17.39	210
	A 25	.977	-33805	18.06	216
	A 26	1.427	-30722	17.09	275

$w = 2582/55.69 = \underline{46.40 \ \#/IN.}$

$\Sigma = \underline{2582}$

THE CRUSHING LOADS FROM THE UPPER STRS. & EFF SKINS EQUALS CRUSHING LOADS FROM LOWER STRS. & EFF. SKINS.

* P = CRUSHING LOAD FROM ONE BENDING ELEMENT (STR. & EFF. SKIN).
f = AXIAL STRESS IN ONE BENDING ELEMENT.
d = BULKHEAD SPACING IN INCHES.
A = AREA OF BENDING ELEMENT.
E = YOUNG'S MODULUS.
Y = DIST. FROM N.A. TO CENTROID OF BENDING ELEMENT.

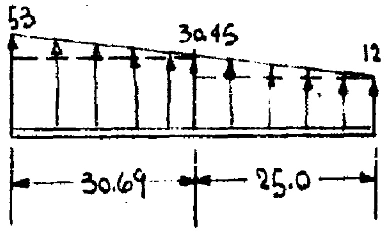
BULKH'D 30, STA 1040

D.G.WT. L.A.A. 30000' HIGH-SPEED

PANEL POINT LOADS

AIR LOADS & CRUSHING LOADS COMBINED

UPPER SURFACE



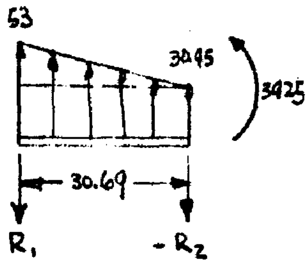
$M_1 = M_3 = 0$

$$M_1 L_1 + 2M_2(L_1 + L_2) + M_3 L_3 = \frac{w_1 L_1^3}{4} + \frac{w_2 L_2^3}{4} + \frac{7 w_1' L_1^3}{60} + \frac{2 w_2' L_2^3}{15}$$

$$2M_2(30.69 + 25) = \frac{30.45 \times \overline{30.69}^3}{4} + \frac{12.1 \times \overline{25}^3}{4} + \frac{7 \times (53 - 30.45) \times \overline{30.69}^3}{60} + \frac{2 \times (30.45 - 12.10)\overline{25}^3}{15}$$

$M_2 = \underline{\underline{3425}}$ "-#

SPAN I



$$-R_2 = \frac{3425}{30.69} + \frac{30.45 \times 30.69 \times 30.69 \times .5}{30.69} + \frac{22.55 \times 30.69 \times .5 \times 30.69 \times \frac{1}{3}}{30.69} =$$

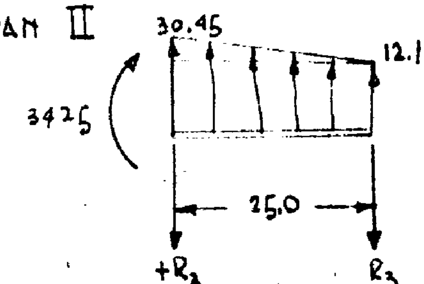
$-R_2 = 694\#\downarrow$

$$R_1 = \frac{30.45 \times 30.69 \times 30.69 \times .5}{30.69} - \frac{3425}{30.69} + \frac{22.55 \times 30.69 \times 30.69 \times 2/3}{30.69} =$$

$R_1 = 586.5\#\downarrow$

BULKH'D 30, STA 1014
D.G.WT. L.A.A. 30000' HIGH-SPEED

SPAN II



$$+R_2 = \frac{3425}{25} + \frac{12.1 \times 25 \times 25 \times .5}{25} + \frac{18.35 \times 12.5 \times \frac{2}{3} \times 25}{25} =$$

$$+R_2 = 441\#\downarrow$$

$$R_3 = \frac{-3425}{25} + \frac{12.1 \times 25 \times 25 \times .5}{25} + \frac{18.35 \times 12.5 \times \frac{1}{3} \times 25}{25} =$$

$$R_3 = 90.5\#\downarrow$$

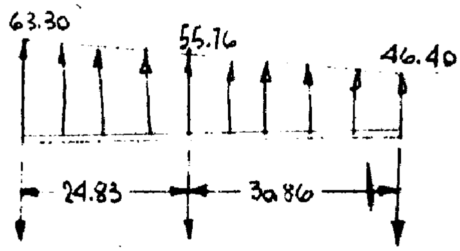
$R_1 =$ 586.5 # ↓
$R_2 = 694 + 441 =$ 1135 # ↓
$R_3 =$ 90.5 # ↓ TOTAL 1812 # ↓

AIR & CRUSHING LOADS $= \left(\frac{53 + 12.1}{2}\right) \times 55.69 =$ 1812 # ↑

BULKHD 30, STA. 1014
D. G. WT. L.A.A. 30000' HIGH SPEED

AIR LOADS & CRUSHING LOADS COMBINED

LOWER SURFACE



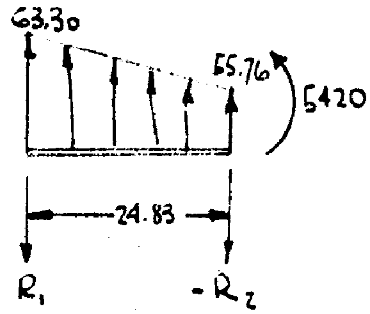
$M_1 = M_3 = 0.$

$$M_1 L_1 + 2M_2(L_1 + L_2) + M_3 L_3 = \frac{w_1 L_1^3}{4} + \frac{w_2 L_2^3}{4} + \frac{7 w_1' L_1^3}{60} + \frac{2 w_2' L_2^3}{15}.$$

$$2M_2(24.83 + 30.86) = \frac{55.76 \times \overline{24.83}^3}{4} + \frac{46.40 \times \overline{30.86}^3}{4} + \frac{7 \times 7.54 \times \overline{24.83}^3}{60} + \frac{2 \times 9.36 \times \overline{30.86}^3}{15}.$$

$$M_2 = 5420 \text{ ''-\#}$$

SPAN I



$$-R_2 = \frac{55.76 \times 24.83 \times 24.83 \times .5}{24.83} + \frac{5420}{24.83} + \frac{7.54 \times 24.83 \times .5 \times 24.83 \times \frac{1}{3}}{24.83}$$

$$-R_2 = 941.7\# \downarrow$$

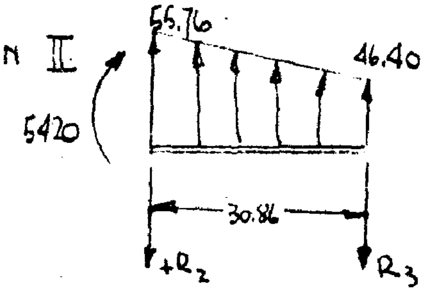
$$R_1 = \frac{55.76 \times 24.83 \times 24.83 \times .5}{24.83} + \frac{7.54 \times 24.83 \times .5 \times 24.83 \times \frac{2}{3}}{24.83} - \frac{5420}{24.83}$$

$$R_1 = 535.9\# \downarrow$$

BULKHEAD 30, STA 1014

D.G.WT. L.A.A. 30000' HIGH SPEED

SPAN II



$$+R_2 = \frac{46.40 \times 30.86 \times 30.86 \times .5}{30.86} + \frac{9.36 \times 30.86 \times .5 \times 30.86 \times \frac{2}{3}}{30.86} + \frac{5420}{30.86} =$$

$+R_2 = 988.3$ # ↓

$$R_3 = \frac{46.40 \times 30.86 \times 30.86 \times .5}{30.86} + \frac{9.36 \times 30.86 \times .5 \times 30.86 \times \frac{1}{3}}{30.86} - \frac{5420}{30.86} =$$

$R_3 = 588.2$ # ↓

$R_1 = 535.9$ # ↓

$R_2 = 941.7 + 988.3 = 1930$ # ↓

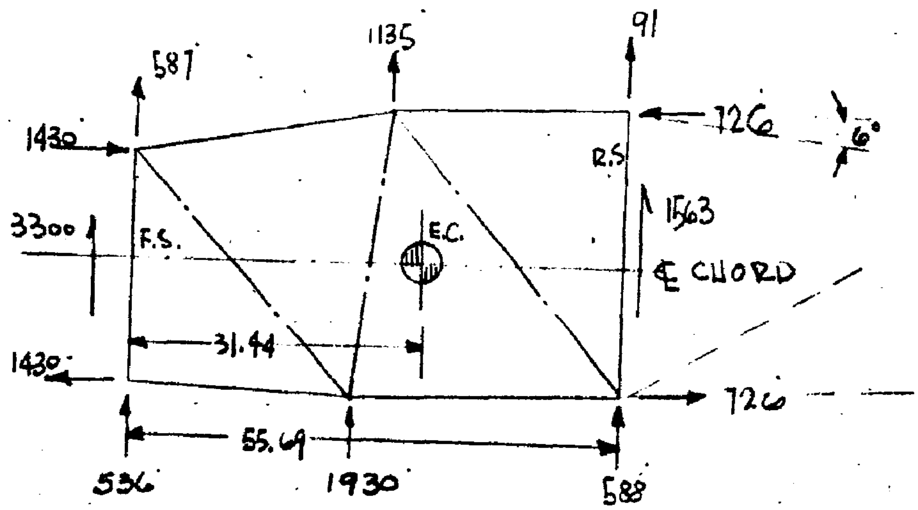
$R_3 = 588.2$ # ↓ TOTAL 3054.1 # ↓

AIR & CRUSHING LOADS $= \left[\frac{63.3 + 46.4}{2}\right] \times 55.69 = 3054$ # ↑

BULKH'D 30 STA 1014

D.G.WT. L.A.A. 30800' HIGH SPEED

q & PANEL POINT NET LOADS



2A = 3743.8 □" (REF. Pg 54).

ΣFv=0 :-

587 + 1135 + 91 + 1563 + 588 + 1930 + 536 + 3300 = 9730# ↑

VERTICAL LD. OF 9730# IS TRANSFERED TO THE E.C. & THEN REACTED AT THE F.S. & R.S. AS SHEAR FLOW. —

THE LOAD OF 1563# AT R.S. IS APPORTIONED AT UPPER CAP BY THE AMOUNT OF THE VERTICAL COMP. OF THE LOAD IN THE TRAILING EDGE CHORD MEMBER; THE REMAINDER IS APPLIED AT THE LOWER CAP, BECAUSE OF THE TRAILING EDGE DIAGONAL TIEING IN AT THAT POINT.

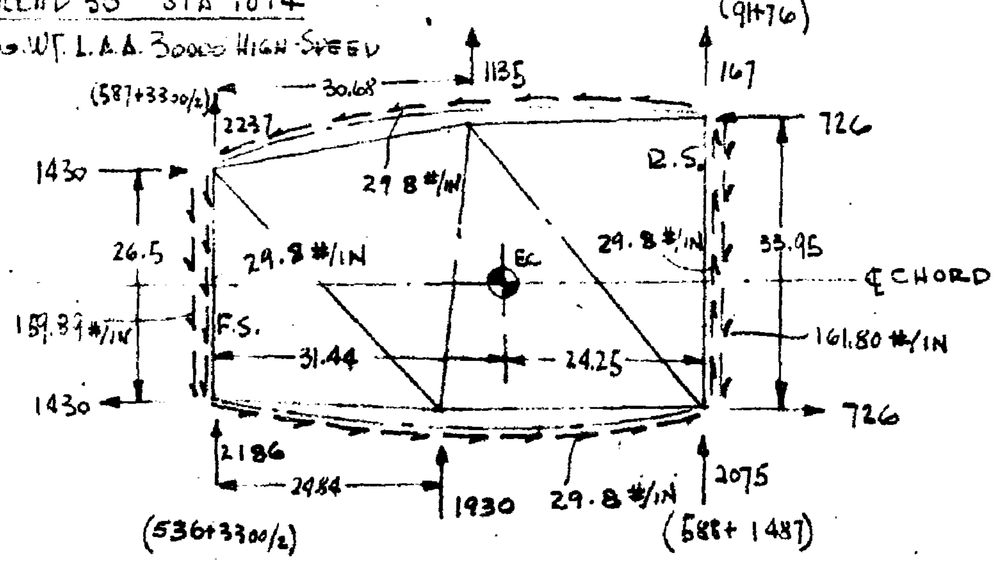
THE LOAD OF 3300# AT F.S. IS APPLIED AT SPAR CAPS 50-50.

R.S. { UPPER CAP = TAN 6° × 726 = 76# P
LOWER CAP = 1563 - 76 = 1487# P

AT R.S. = 31.44/55.69 × 9730 = 5493# ↓.
AT F.S. = 9730 - 5493 = 4237# ↓.

q_{RS} = 5493/33.95 = 161.80 #/IN.
q_{FS} = 4237/26.5 = 159.89 #/IN.

BULKH'D 30 STA 1014
D.G.WT. L.A.A. 30000 HIGH-SPEED



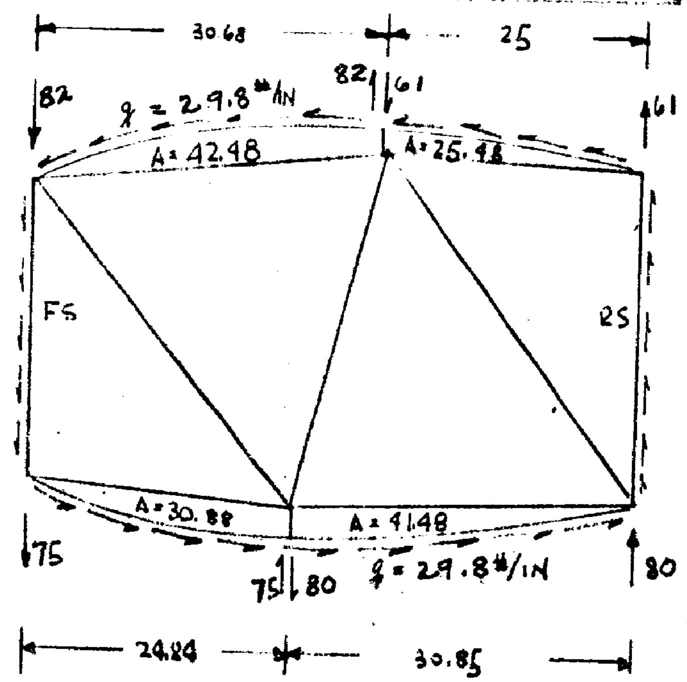
TORQUE DUE TO EXTERNAL LOADS

1430 x 26.5	=	37895 ↱
(2237 + 2186) x 31.44	=	139059 ↱
1135 x .76	=	863 ↱
1930 x 6.60	=	12738 ↱
(167 + 2075) 2425	=	54369 ↰
726 x 33.95	=	24648 ↰
5493 x 24.25	=	133205 ↱
4237 x 31.44	=	133205 ↰
"T"	=	111,538 in-# ↱

$q = 111538/3743.8 = 29.8$ #/IN

BULKHD 30 STA 1014
DG. WT. L.A.A. 30000' HIGH SPEED

TORQUE DUE TO TRANSFERING SHEAR FLOW TO ℄ CHORD MEMBER



$T = 2Aq$.

UPPER SURFACE

T = 2 × 29.8 × 42.48 = 2531"-# ; 2531/30.68 = 82#
T = 2 × 29.8 × 25.48 = 1518"-# ; 1518/25 = 61#

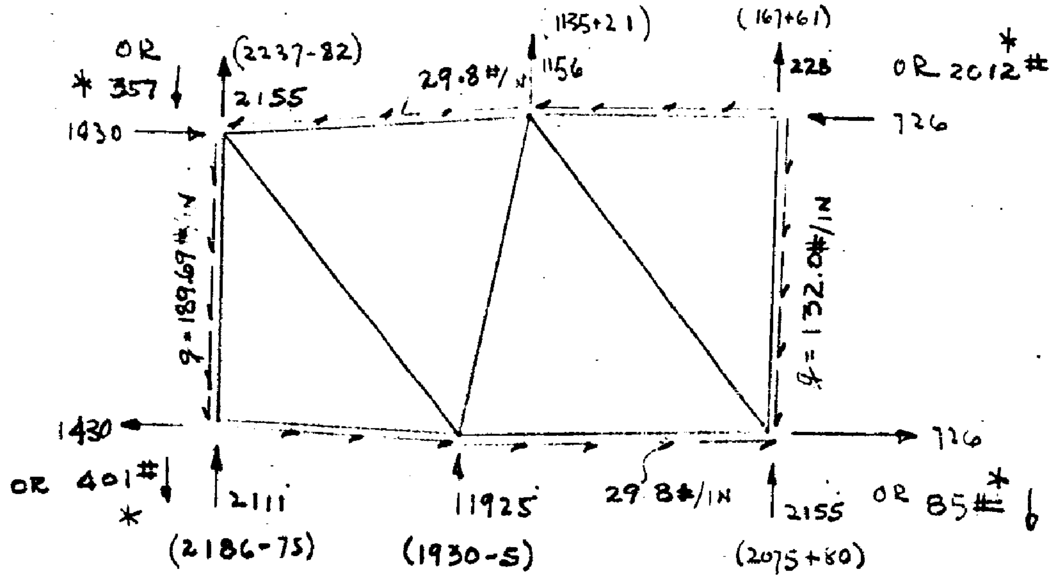
LOWER SURFACE

T = 2 × 29.8 × 30.88 = 1840"-# ; 1840/24.54 = 75#
T = 2 × 29.8 × 41.48 = 2470"-# ; 2470/30.85 = 80#

COUPLES APPLIED TO PANEL POINTS AS SHOWN ABOVE.

BULKH'D 30, STA 1014
D. G. WT. L.A.A. 30000' HIGH-SPEED

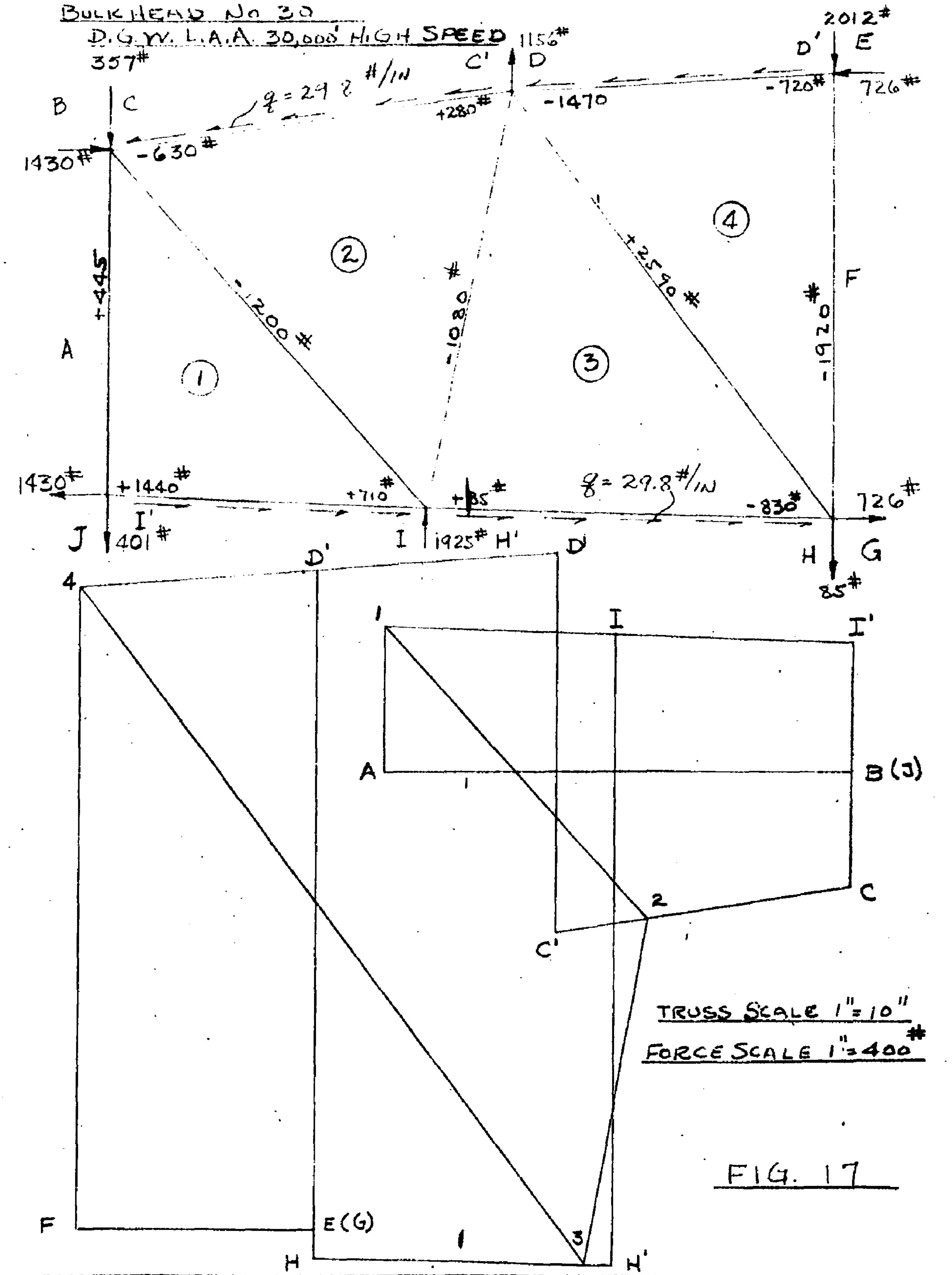
NET PANEL POINT LOADS



$\Sigma F_V = 0$

↑	↓
2155	189.69 X 26.5 = 5025
1156	132.0 X 33.95 = 4480
228	29.8 X 4.53 = 135
2155	29.8 X 1.67 = 50
1925	29.8 X .70 = 21
2111	29.8 X .47 = 14
9730# ↑	9725# ↓

* DISTRIBUTING SHEAR FLOW ON F.S. & R.S. TO SPAR CAPS 50-50. THESE BECOME THE NEW PANEL POINT LDS. IN DIRECTION SHOWN.



BULKHEAD No 30
D.G.W. L.A.A. 30,000' HIGH SPEED
357#
1156#
2012#
q = 29.8 #/IN
-630#
+280#
-1470
-720#
726#
1430#
+445
-1200#
-1080#
+2590#
-1920#
+1440#
+710#
+85#
q = 29.8#/IN
-830#
726#
401#
1925#
85#
A B C C' D D' E F G H H' I I' J
1 2 3 4
B(J)
E(G)
TRUSS SCALE 1" = 10"
FORCE SCALE 1" = 400#

FIG. 17

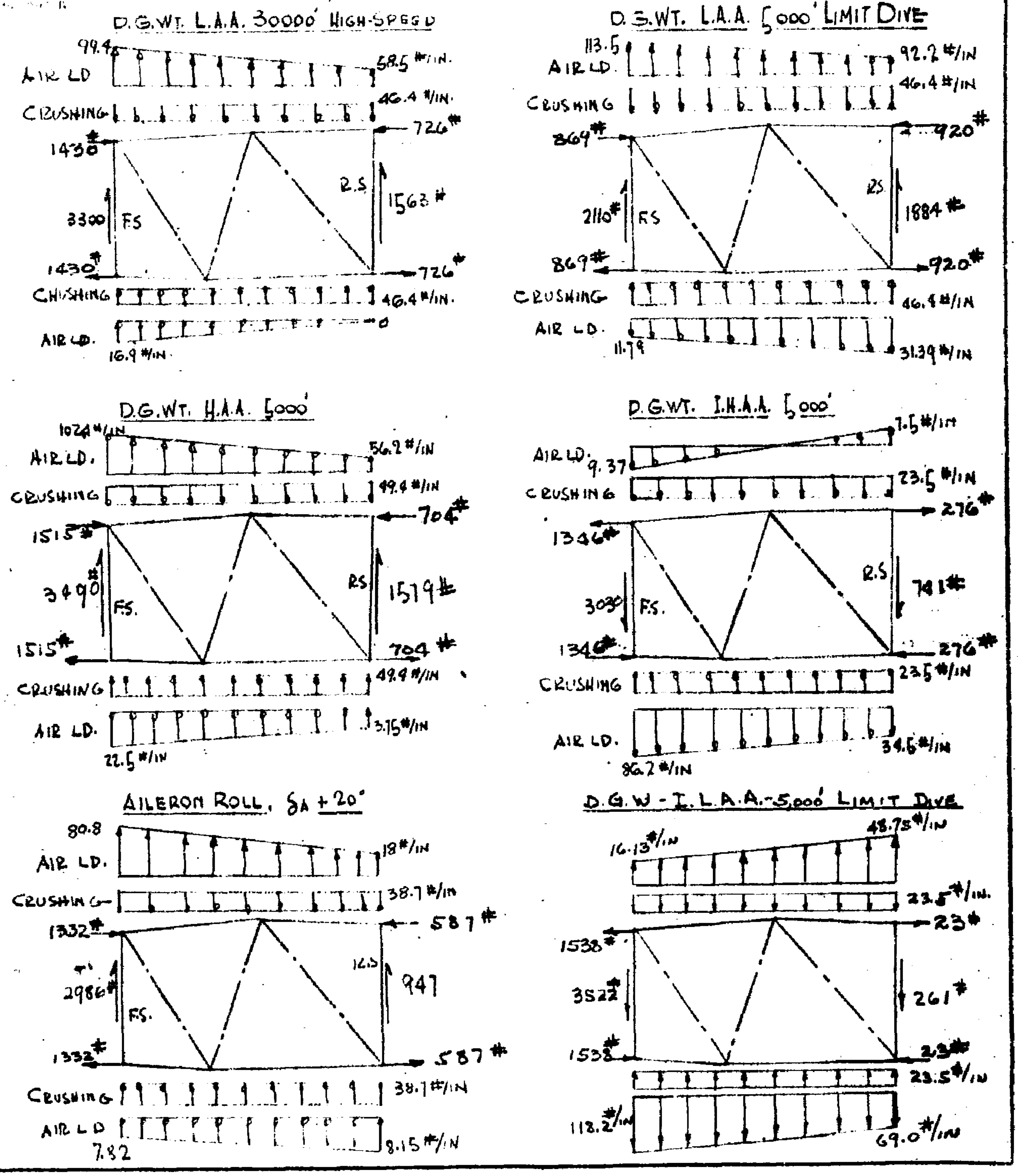
ANALYSIS WING
PREPARED BY PERCHASKY
CHECKED BY BEARD
REVISED BY

Consolidated Vultee Aircraft Corporation
FORT WORTH DIVISION
FORT WORTH, TEXAS

REPORT NO. FZS-36-142 Add. A
MODEL YB-36A, B-36A
DATE 1-7-47

WING BULKHEAD 30

AIR & CRUSHING LOADS FOR ALL CONDITIONS

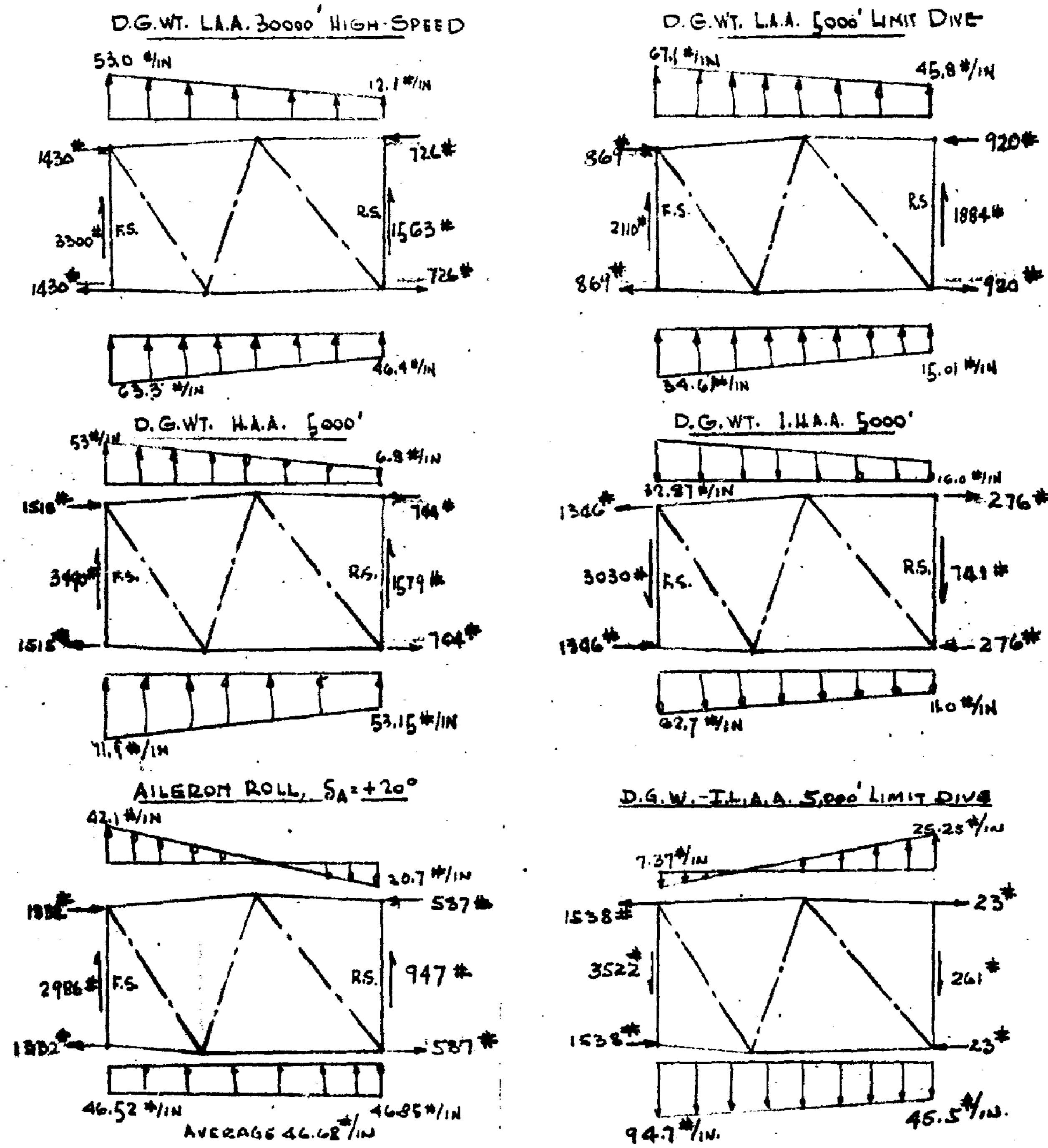


FW 444

WING BULKHEAD 30

COMBINED AIR & CRUSHING LOADS FOR ALL CONDITIONS

SUMMARY



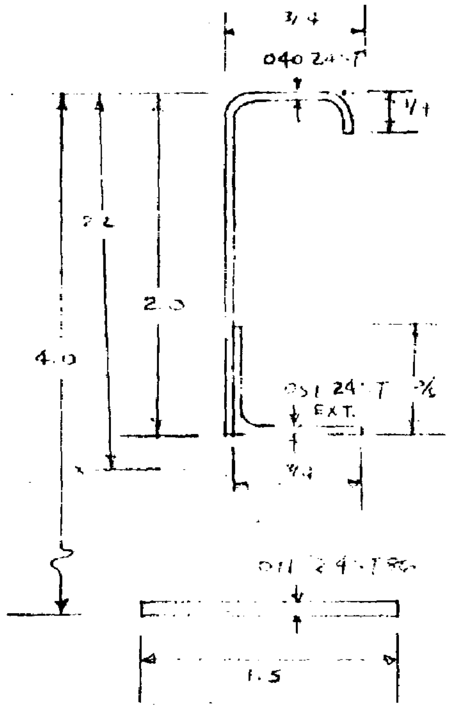
BULKHEAD NO. 30

MEMBER LOAD SUMMARY

TABLE NO. IV

MEMBER	DESIGN CONDITION: D.G.W. L.A.A. 20,000' HIGH SPEED	D.G.W.-H.A.A. 5,000'	AILERON ROLL	D.G.W.-L.A.A. 5,000' LIMIT DIVE	D.G.W. I.H.A.A. 5,000'	D.G.W.-I.L.A.A. 5,000' LIMIT DIVE
A-1	+ 445#	+ 470#	+195#	+ 680#	- 130#	+ 220#
1-2	- 1200#	- 1330#	-630#	- 1190#	+ 675#	+ 630#
2-3	- 1080#	- 1270#	-1210#	- 20#	+ 835#	+ 2,040#
3-4	+ 2590#	+ 2710#	+1870#	+ 2375#	- 1995#	- 1,980#
4-F	- 1920#	- 2090#	-1520#	- 1660#	+ 1170#	+ 1,350#
C-2	- 630# + 280#	- 640# + 380#	-920# +25#	- 55# + 265#	+ 900# - 205#	+ 1,130# - 350#
D-4	- 1470# - 720#	- 1520# - 700#	-1360# -590#	- 1190# - 930#	+ 1165# + 275#	+ 1,240# + 70#
H-3	+ 85# - 830#	- 950# + 50#	-565# +395#	- 205# - 530#	- 165# + 940#	+ 1,130# - 330#
I-1	+ 1440# + 710#	+ 701# + 1530#	+580# +1350#	+ 860# + 600#	- 1365# - 475#	- 1,530# - 360#

CHORD MEMBERS — D.G.W. - I.L.A.A. - 5000 FT. LIMIT DIVE



PRELIMINARY INVESTIGATION SHOWED THAT THE MAX MOM IS AT THE PANEL POINT IN LOWER CHORD. THIS MEMBER ALSO HAS LESS AREA AND I_{xx} THAN AT ANY OTHER POINT.

$A = .3176 \square''$ $\bar{Y} = 2.37$ IN. $I_{xx} = .694$ IN.^{4}

M = 6805"# (COMP OUTSIDE FIBER) (AS PER METHOD PAGE 64)
AVE. P = -94 #-I.L.A.A. 5000 FT LIMIT DIVE (REF P 75)

$\frac{Mc}{I} = \frac{6805 \times 1.63}{.694} = 16{,}000 \ \#/\square''$

$\frac{P}{A} = \frac{94 \times}{.3176} = 2980 \ \#/\square''$

$f_{TOTAL} = 16000 + 2980 = 18{,}980 \ \#/\square''$

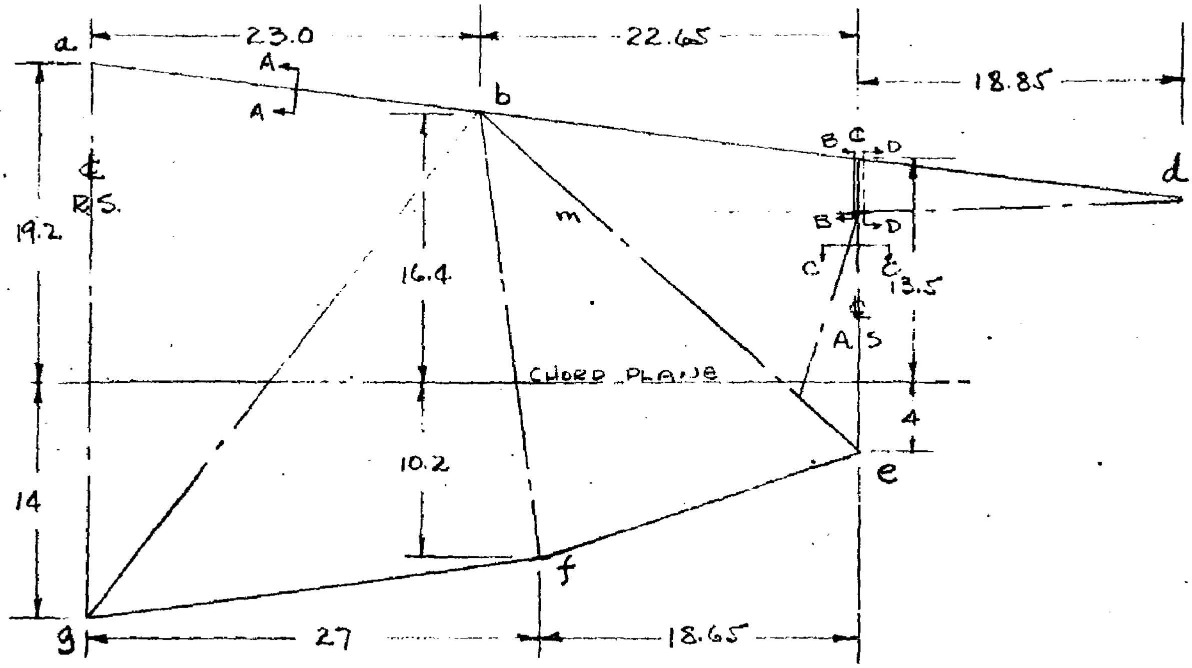
M.S. IS LARGE

RIB DIAGONALS

MEMBER	MAX COMP LOAD	ALLOW LOAD	M.S	NO. RIVETS TUBE TO FITTING	MAX. LOAD	RIVET ALLOW (BEARING)	ALLOW. LOAD	M.S.
(REF.)	P 75				P 75	AUC-5	DEVP 275-594	
1-2	1330	1780	.34	10-AD3	-1330	192	1920	.44
2-3	1270	1780	.54	14-AD3	2040	192	2688	.32
3-4	1995	2370	.19	18-AD3	2710	192	3456	.27

NOTE: COMPRESSION LOADS DESIGN THE DIAGONALS
3/32 RIVETS BEARING IN .020 24ST86

TRAILING EDGE RIB STA. No.30
(REF. DWG. 36W1930)



FOR PURPOSES OF ANALYSIS THE FOLLOWING ASSUMPTIONS ARE MADE FOR RIB ON THE YB-36 ONLY.

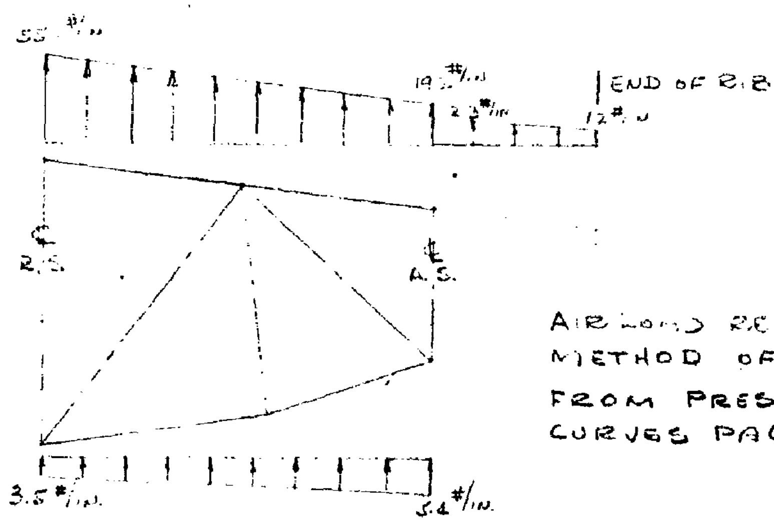
1. NO VERTICAL SHEAR IS TAKEN BY THE AUXILIARY SPAR, BUT IS REACTED WHOLLY BY THE REAR SPAR AS SHEAR PLUS A COUPLE.
2. THE LOADING ON THE RIB AFT OF THE A.S. INDUCES BENDING IN BEAM "bcmn." THIS MOMENT IS SUPERIMPOSED ON THE TRUSS AS A COUPLE LOAD AT POINTS "b" & "c".
3. FOR DETERMINING PANEL POINT LOADS THE UPPER CHORD MEMBER abc IS CONSIDERED AS A CONTINUOUS BEAM OVER THREE SUPPORTS, WHILE THE LOWER CHORD MEMBER IS CONSIDERED PINNED AT "g" "f" & "e".

NOTE: FOR B-36A, SEE PAGE 89

Trailing Edge Rib Sta No. 30

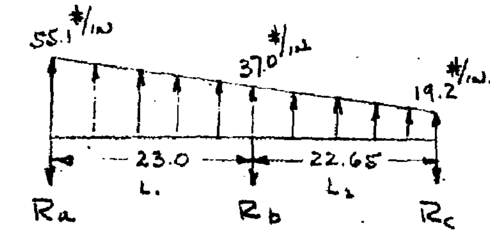
Chord at Sta. = 179.66 in.
R.S. located at .430 wing chord
A.S. located at .684 wing chord
Dist. between A.S. & R.S. = 45.65 in.

D.G.W. - L.A.A. - 30,000' - High Speed



Airload Ref. as per method of page 62 from pressure dist. curves page 59

Upper Surface



$M_a = M_c = 0$

$$M_A L_1 + 2M_b(L_1+L_2) + M_c L_2 = \frac{w_1 L_1^3}{4} + \frac{7w_1' L_1^3}{60} + \frac{w_2 L_2^3}{4} + \frac{2w_2' L_2^3}{15}$$

$$91.3 M_b = \frac{37(23)^3}{4} + \frac{7\times 18.1\times(23)^3}{60} + \frac{19.2(22.65)^3}{4} + \frac{2\times 17.8(22.65)^3}{15}$$

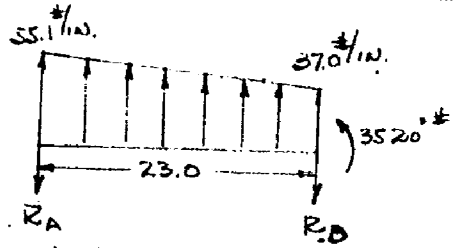
$$= 112,500 + 25,680 + 55,800 + 27,600 = 321,580$$

$$M_B = 3,520\text{"\#}$$

TRAILING EDGE RIB STA. NO 30.

D.G.W.-L.A.A. - 30,000' - HIGH SPEED

UPPER SURFACE (CONT'D)

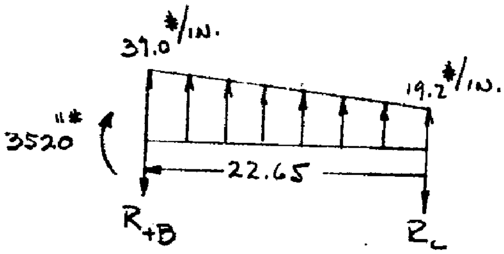


L.H. BAY

$R_A = 37.0 \times 11.5 + 18.1 \times 11.5 \times .667 - \frac{3520}{23}$

$= 425 + 139 - 153 = 411^{\#}\downarrow$

$R_{-B} = 425 + 69 + 153 = 647^{\#}\downarrow$



$R_{+B} = 19.2 \times 11.325 + 17.8 \times 11.325 \times .667 + \frac{3520}{22.65}$

$= 218 + 134 + 155 = 507^{\#}\downarrow$

$R_C = 218 + 67 - 155 = 130^{\#}\downarrow$

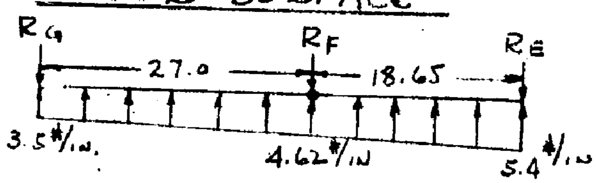
SUMMARY

$R_A = 411^{\#}\downarrow$

$R_B = 647 + 507 = 1154^{\#}\downarrow$

$R_C = 130^{\#}\downarrow$

LOWER SURFACE



BEAM PINNED AT "F"

$R_G = 3.5 \times 13.5 + 1.12 \times 13.5 \times .334 = 47 + 5 = 52^{\#}\downarrow$

$R_{-F} = 3.5 \times 13.5 + 1.12 \times 13.5 \times .667 = 47 + 10 = 57^{\#}\downarrow$

$R_{+F} = 4.62 \times 9.325 + .78 \times 9.325 \times .334 = 43 + 2 = 45^{\#}\downarrow$

$R_E = 4.62 \times 9.325 + .78 \times 9.325 \times .667 = 43 + 5 = 48^{\#}\downarrow$

SUMMARY

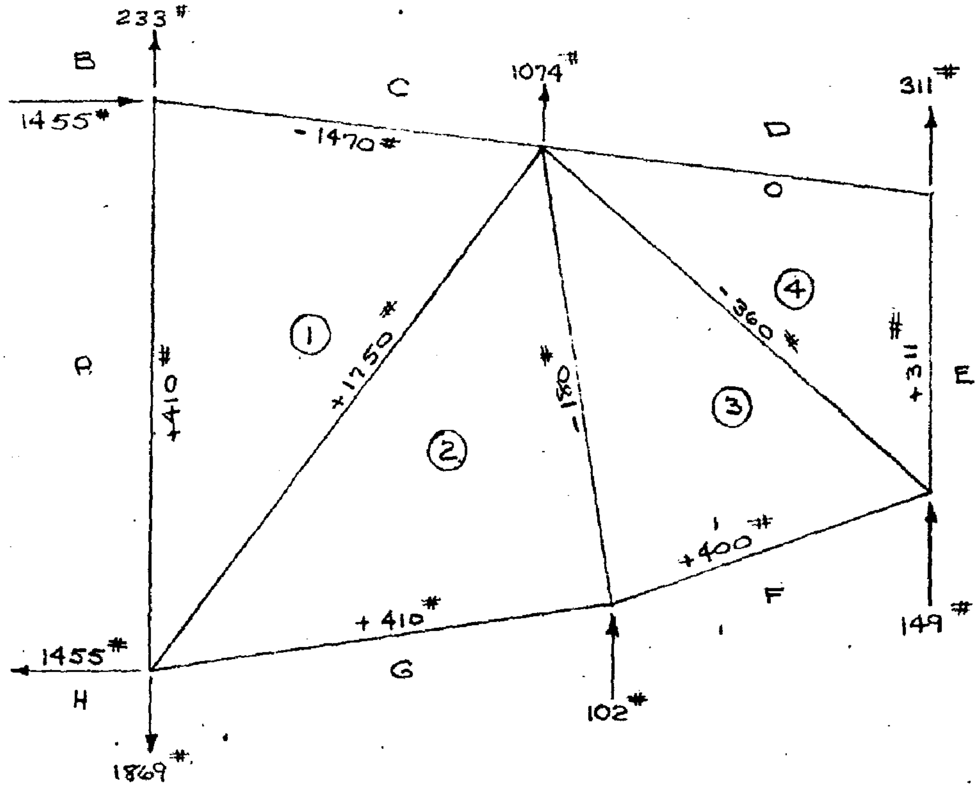
$R_G = 52^{\#}\downarrow$

$R_F = 57 + 45 = 102^{\#}\downarrow$

$R_E = 48^{\#}\downarrow$

TRAILING EDGE RIB STA NO. 30

D.G.W. - L.A.A. 30,000 FT. HIGH SPEED



TRUSS SCALE 1" = 10"
FORCE DIAG SCALE 1" = 600#

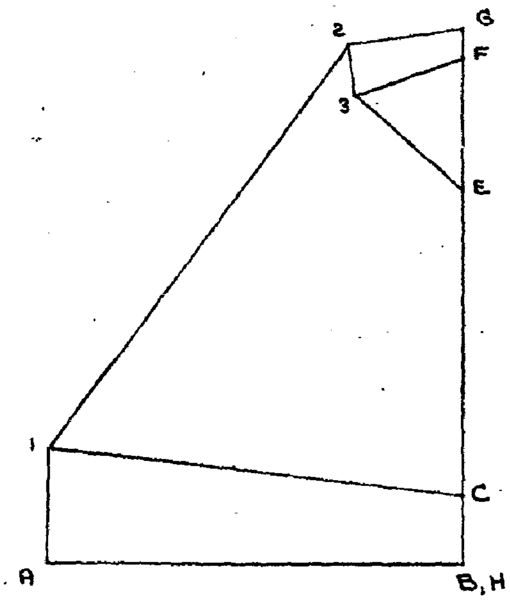


FIG. 18

TRAILING EDGE RIB STA NO. 30

D.G.W. – L.A.A. 30,000 FT. HIGH SPEED

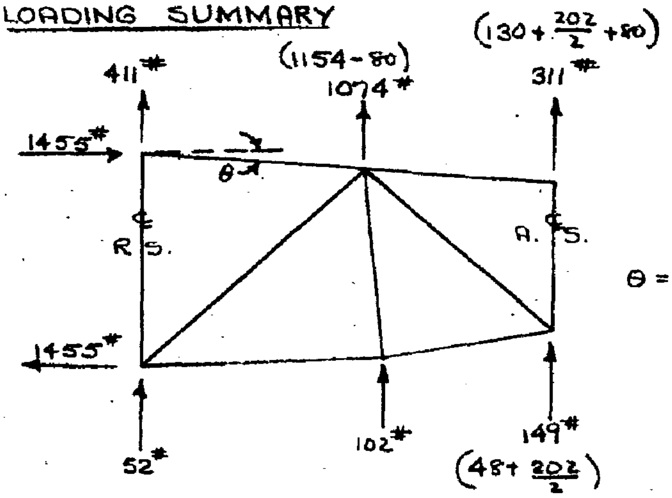
LOAD AFT AUXILIARY SPAR (REF. PAGE 78)

$S = 9.2 \times 18.85 + 3.1 \times 9.425 = 202^{\#}\uparrow$

MOM. @ ℄ A.S. $= 9.2 \times 18.85 \times 9.425 + 3.1 \times 9.425 \times 6.28 = 1816''\text{-}\#$

$R_B = \frac{1816}{22.65} = 80^{\#}\downarrow \qquad R_C = 80^{\#}\uparrow$

LOADING SUMMARY



TOTAL VERTICAL SHEAR $= 2099^{\#}\uparrow$

$\theta = \tan^{-1} \frac{A.2 - 16.4}{23} = .122$

COMP. OF VERTICAL SHEAR REACTED AT UPPER R.S. CAP $= .122 \times 1455 = 178^{\#}\downarrow$

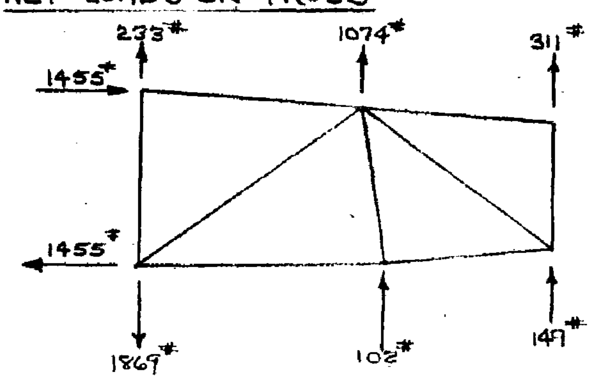
COMP. REACTED AT LOWER R.S. CAP $= 2099 - 178 = 1921^{\#}\downarrow$

MOM. @ ℄ R.S.

$1074 \times 23 = 24700$
$(311 + 149)45.65 = 21000$
$102 \times 27 = 2755$
$48{,}455''\text{-}\#$

COUPLE @ R.S. $= \frac{48455}{33.2} = 1{,}455^{\#}$

NET LOADS ON TRUSS



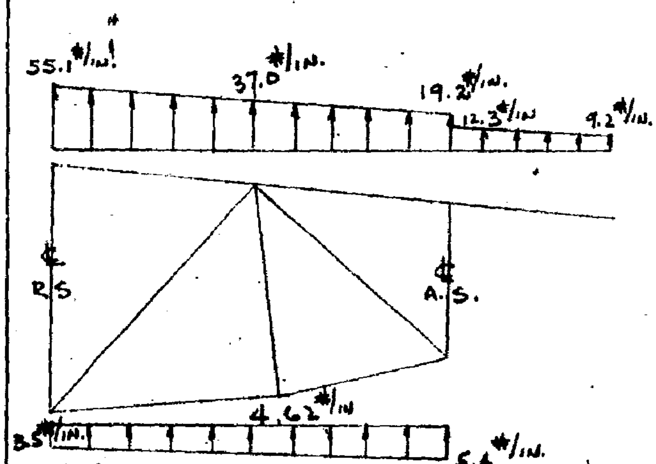
NET LOAD TO UPPER R.S. CAP $= 411 - 178 = 233^{\#}\uparrow$

NET LOAD TO LOWER R.S. CAP $= -1921 + 52 = -1869^{\#}\downarrow$

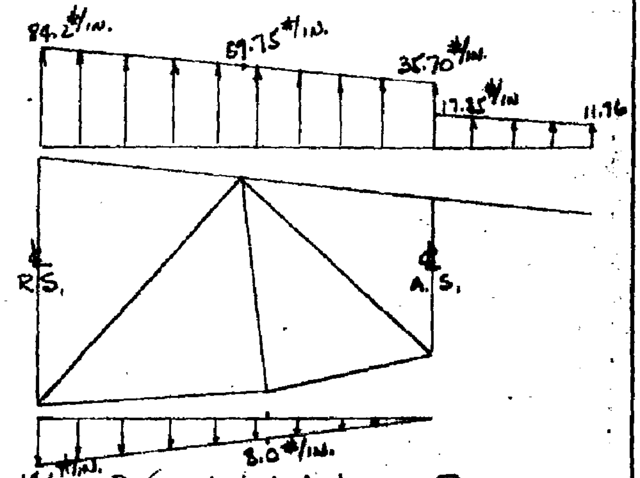
ANALYSIS WING	**Consolidated Vultee Aircraft Corporation**	PAGE	82
PREPARED BY BEHRND	FORT WORTH DIVISION	REPORT NO.	FZS-36-142ADDA
CHECKED BY KENCH	FORT WORTH, TEXAS	MODEL	YB-36 B-36A
REVISED BY		DATE	1-24-47

TRAILING EDGE RIB STA. NO. 30

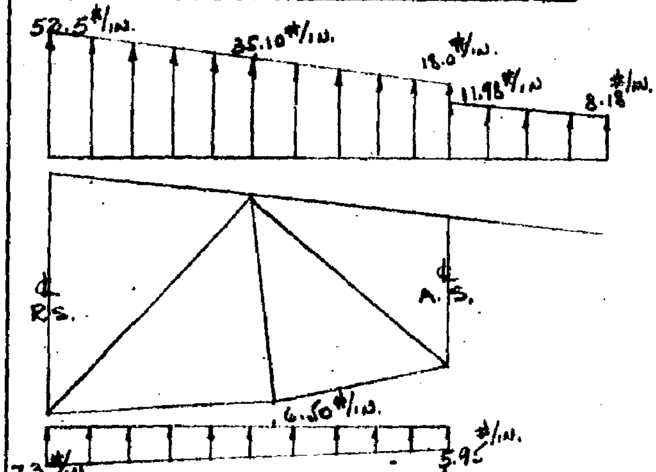
LOADING SUMMARY



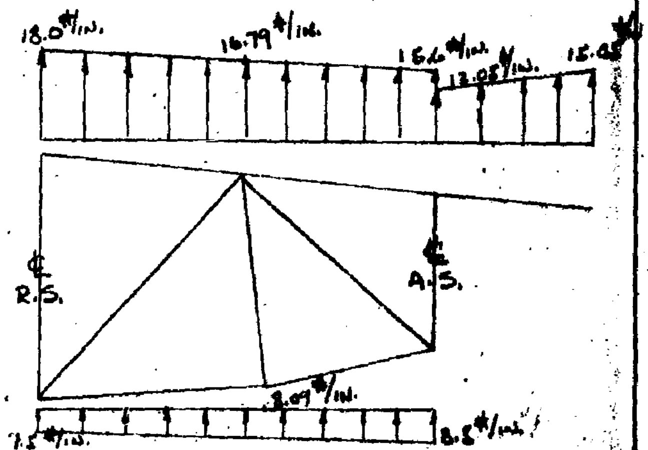
D.G.W. L.AA.-30,000'-HIGH SPEED



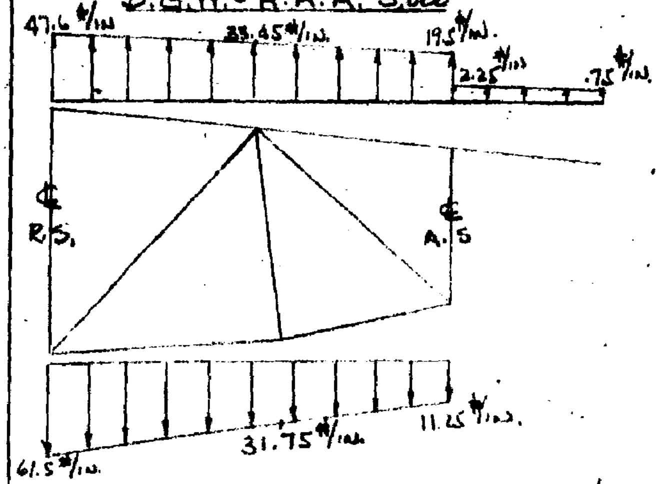
D.G.W.-L.A.A. LIMIT DIVE



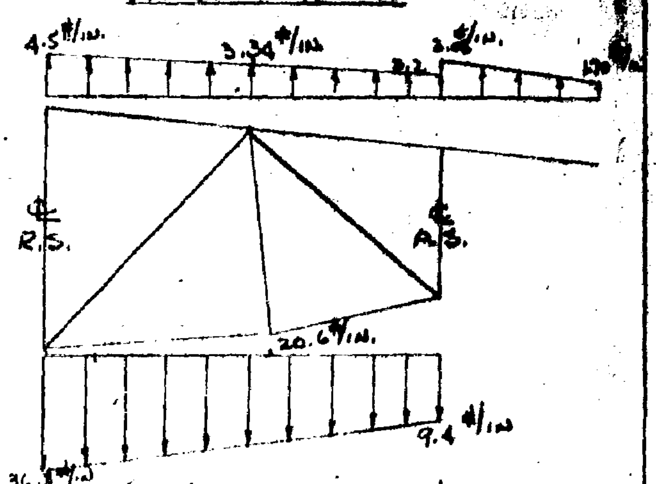
D.G.W.-H.A.A.-5,000



AILERON ROLL



D.G.W.-I.L.A.A. LIMIT DIVE 5000'



D.G.W. I.H.A.A. 5,000'

TRAILING EDGE RIB STA. NO. 30

MEMBER LOAD SUMMARY

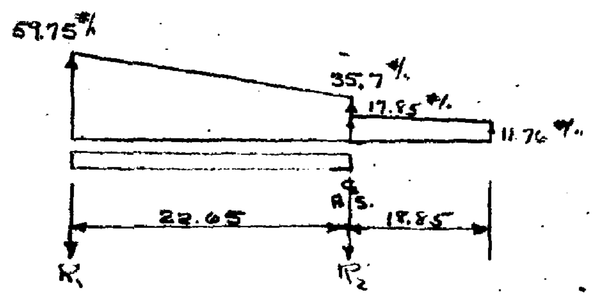
TABLE NO. V

MEMBER	DESIGN CONDITION					
	D.G.W.-L.A.A. 30,000 FT HIGH SPEED	D.G.W.-L.A.A. LIMIT DIVE	AILERON ROLL	D.G.W. H.A.A. 5,000 FT.	D.G.W. I.H.A.A. 5,000 FT.	D.G.W. I.L.A.A. LIMIT DIVE 5,000 FT.
C-1	-1470 #	-1900 #	-1210 #	-1450 #	+570 #	-800 #
D-4	0	0	0	0	0	0
G-2	+410 #	+560 #	+510 #	+430 #	-220 #	+80 #
F-3	+400 #	+600 #	+490 #	+420 #	-145 #	+45 #
A-1	+410 #	+710 #	+170 #	+450 #	+30 #	+405 #
E-4	+311 #	+570 #	+376 #	+335 #	-21 #	+201 #
1-2	+1750 #	+2220 #	+1140 #	+1670 #	-575 #	+250 #
2-3	-180 #	+100 #	-270 #	-220 #	+530 #	+780 #
3-4	-510 #	-760 #	-630 #	-590 #	+185 #	-55 #

(-) COMPRESSION MEMBER
(+) TENSION MEMBER

DESIGN OF BEAM "bcmn"

CONDITION: D.G.W.-L.A.A. LIMIT DIVE (REF. P. 82)



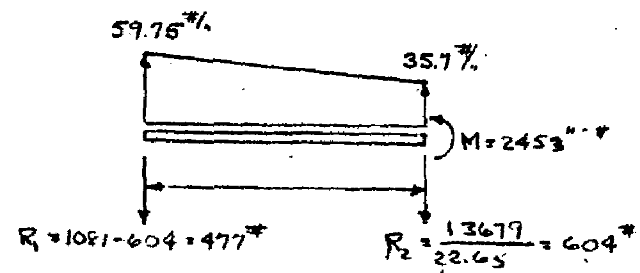
MOM @ ℄ AUX. SPAR

11.76 x 18.85 x 9.425 = 2095
6.09 x 9.425 x 6.28 = 358
2453 "-#

ΣV = 35.7 x 22.65 = 809
24.05 x 11.325 = 272
1081 #

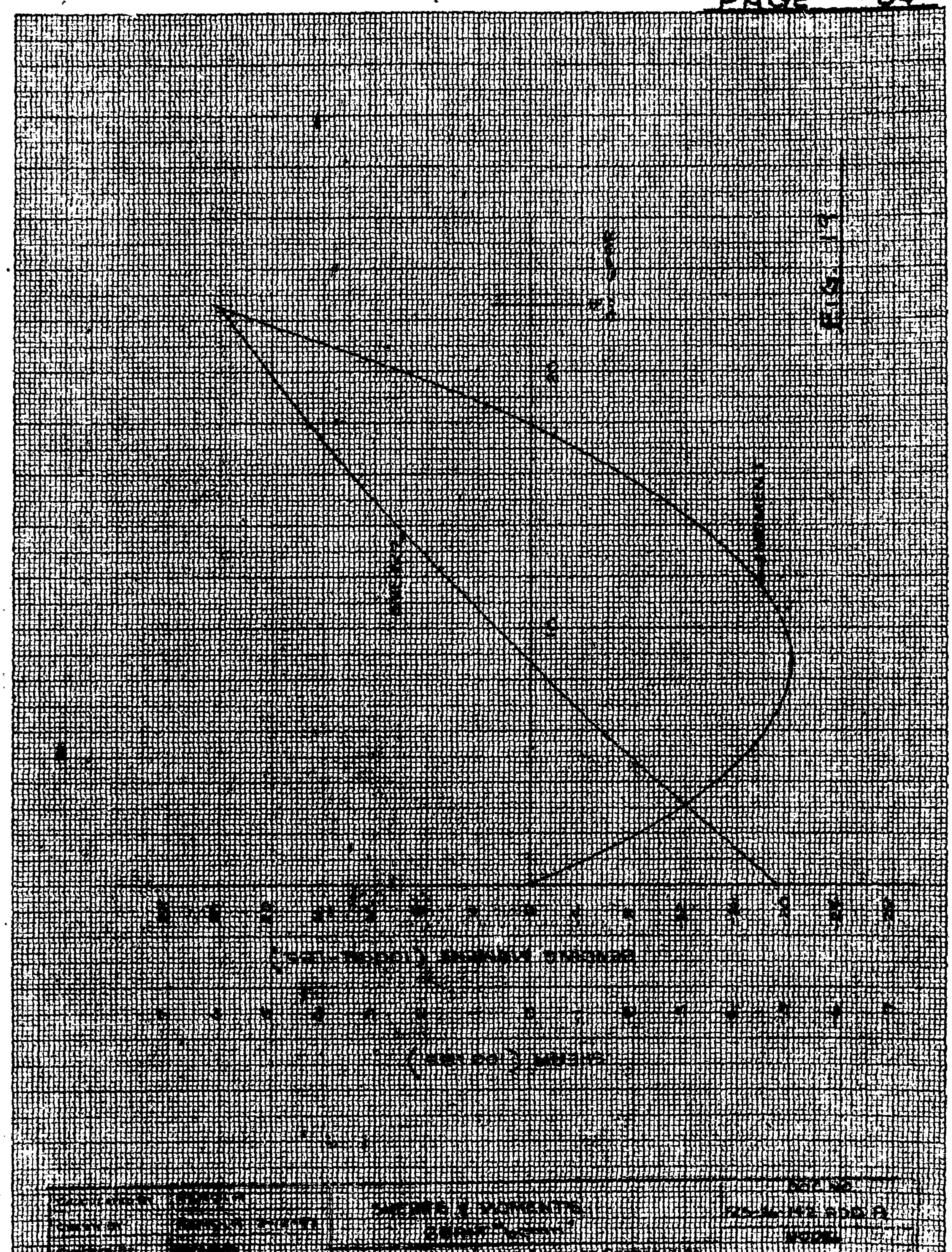
MOM. @ R_1

809 x 11.325 = 9162
272 x 7.55 = 2054
2453
13,679 "-#



$R_1 = 1081 - 604 = 477$ #

$R_2 = \frac{13679}{22.65} = 604$ #



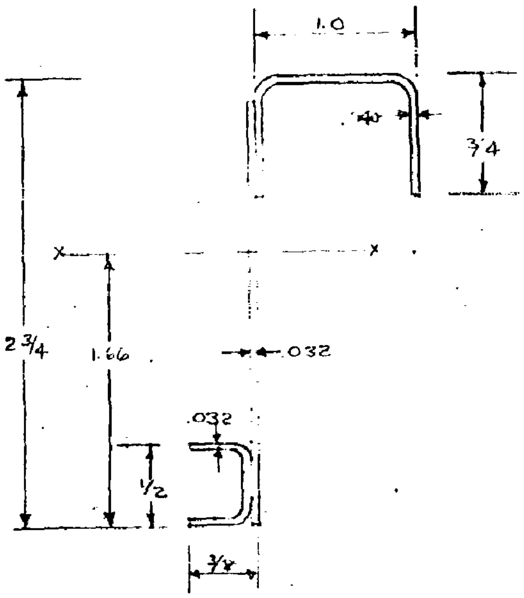
SHEARS & MOMENTS

TRAILING EDGE RIB STA. NO. 30   BEAM "bcmn" CONT'D

MAX. MOMENT AND SHEAR @ AUX. SPAR (D.G.W. - L.A.A. LIMIT DIVE)

MOM. = 2453"-#   SHEAR = 604# (REF. PAGE 83)

$f_s = \frac{604}{2.38 \times .032} = 7{,}300\ \#/\square$ SHEAR RESISTANT



$A = .2430$ $I_{xx} = .209\ IN^4$ $\bar{Y} = 1.66$

COMP. IN UPPER FIBERS

$f_b = \frac{Mc}{I} = \frac{2453 \times 1.09}{.209} = 12{,}800\ \#/\square$"

ALLOWABLE $F_b = F_{cc}$

$\frac{b}{t\sqrt{K}} = \left(\frac{.67}{.04}\right)(.525) = 8.8$

MAT. - 75ST $F_{cy} = 62{,}000\ \#/\square$"

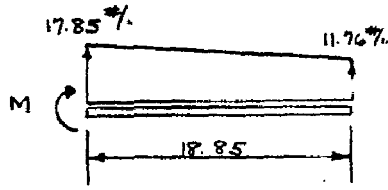
$F_{cc} = F_b = 55{,}000\ \#/\square$"

M.S. IS HIGH

SECTION B-B (PAGE 77)

DESIGN OF CANTILEVER BEAM

CONDITION: D.G.W. - L.A.A. LIMIT DIVE (REF. P. 82)



MOM. = 2453"-# COMP. IN UPPER FIBERS

$A = .146\ \square$" $I_{xx} = .158\ IN^4$ $\bar{Y} = 1.57$

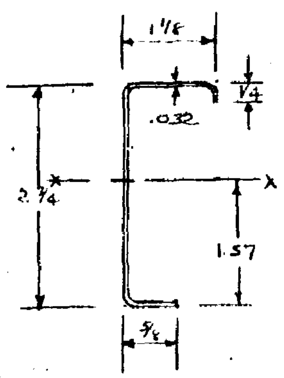
$f_b = \frac{Mc}{I} = \frac{2453 \times 1.18}{.158} = 18{,}300\ \#/\square$"

ALLOWABLE MAT. 24ST $F_b = F_{cc}$ $F_{cy} = 41{,}000\ \#/\square$"

$\frac{a}{t} = \frac{.25}{.032} = 7.8$ $\frac{1}{\sqrt{K}} = .578$

$\frac{b}{t\sqrt{K}} = \left(\frac{.968}{.032}\right)(.578) = 5.2$ $F_b = F_{cc} = 41{,}000\ \#/\square$"

$M.S. = \frac{41000}{18300} - 1 = +1.24$

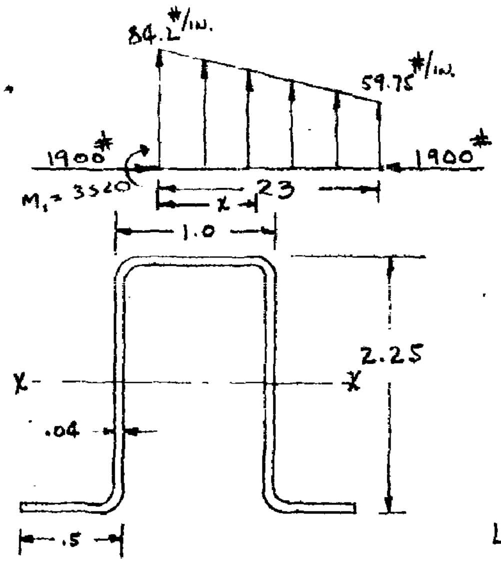


SECTION D-D
(P. 77)

T.E. RIB STA. NO. 30

TRUSS MEMBER (C-1) ("a b")

CRITICAL LOADING D.G.W. - L.A.A. LIMIT DIVE
(REF. PAGE 82 & 83)



SEC. A-A. (P 77)

$M_1 = 3520''\text{-}\#$ (REF. P. 78)

REF. 36W 1930-8

$A = .247\ IN^2$ MAT. 75 ST.

$I_{xx} = .1577\ IN^4$

$\rho_{xx} = .799$ IN.

$$j = \sqrt{\frac{10.3\times10^6 \times .1577}{1900}} = 29.25$$

$$L/j = \frac{23}{29.25} = .786$$

$\sin L/j = .70752$ $\cos L/j = .70667$ $\tan L/j = 1.00125$

$$C_1 = \frac{D_2 - D_1 \cos L/j}{\sin L/j} + \frac{wj^2}{\tan L/j}$$

$D_1 = M_1 - wj^2 = 3520 - (59.75)(29.25)^2 = -47550$

$D_2 = M_2 - wj^2 = 0 - (59.75)(29.25)^2 = -51100$

$$C_2 = -wj^2 - wj^2 = -(59.75)(29.25)^2 - (24.45)(29.25)^2 = -68480$$

$$f(w) = wj^2 + wj^2(1 - x/L) = (59.75)(29.25)^2 + (24.45)(29.25)^2(1 - x/23)$$

$$f(w) = 72000 - 910x$$

$$M = C_1 \sin x/j + C_2 \cos x/j + f(w)$$

MAX. MOM. WAS FOUND TO BE AT POINT $x = 0''$

$M = 3520''\text{-}\#$

T.E. RIB STA. NO. 30

TRUSS MEMBER (c-1) CONT'D ("a b")

FOR THE TOP OF THE HAT SEC. A-A $F_{cc} = 55,500$ #/□"

FOR ENTIRE SECTION WEIGHTED $F_{cc} = 33,900$ #/□" (REF. C.V.A.C. NO. 1)

COLUMN LENGTH = 23" $\frac{L}{\rho} = \frac{23}{.799} = 28.8$

$$F_c = 33900\left[1 - \frac{33900(28.8)^2}{4\pi^2 \times 10.3\times10^6}\right] = 31,600 \text{ \#/□"}$$

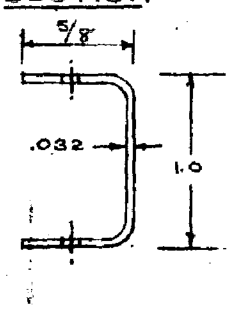
$f_b = \frac{3520 \times 1.125}{.1577} = 25,100$ #/□" $R_b = \frac{25100}{55500} = .453$

$f_c = \frac{1900}{.247} = 7,700$ #/□" $R_c = \frac{7700}{31600} = .244$

$$M.S. = \frac{1}{.453 + .244} - 1 = \underline{\underline{+.43}}$$

DIAGONAL MEMBER (1-2) ("g b")

SECTION



D.G.W.-L.A.A. LIMIT DIVE P = +2220# (REF. P. 83)

AREA MINUS RIVET HOLES = .058 □"

$f_t = \frac{2220}{.058} = 38,300$ #/□"

MAT. - 75ST $F_{ty} = 62,000$ #/□"

$$M.S. = \frac{62000}{38300} - 1 = \underline{\underline{+.62}}$$

D.G.W. - I.H.A.A. 5,000 FT. P = -575# (REF. P. 83)

A = .0671 □" L = 36.5" $\rho = .350$ $L/\rho = \frac{36.5}{.350} = 104$

$$F_c = \frac{\pi^2 10.3\times10^6}{(104)^2} = 9,370 \text{ \#/□"}$$

$f_c = \frac{575}{.0671} = 8,580$ #/□"

$$M.S. = \frac{9370}{8580} - 1 = \underline{\underline{+.09}}$$

T.E. RIB STA. NO. 30

DIAGONAL MEMBER (2-3) ("bf")

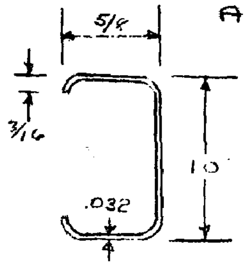
D.G.W. - I.L.A.A. LIMIT DIVE 5000 FT. P = +780# (REF. P 83)
AILERON ROLL P = -270# (REF. P 83)

BOTH COMPRESSION AND TENSION LOADS ARE SMALLER THAN IN MEMBER (1-2). DIAGONAL MEMBER (2-3) IS SHORTER AND HAS MORE AREA, CONSEQUENTLY, THE MARGIN OF SAFETY WILL BE LARGER THAN IN MEMBER (1-2).

DIAGONAL MEMBER (3-4) ("be")

D.G.W. - L.A.A. LIMIT DIVE P = -760# (REF. P 83)

IT IS ASSUMED THAT THE WEB AND STIFFENERS AFFORD SUFFICIENT STIFFNESS TO REDUCE THE COLUMN LENGTH TO L = 22 INCHES.



$A = .076\,\square''$ $\quad \rho = .229''$ $\quad L/\rho = \frac{22}{.229} = 96$

$$F_c = \frac{\pi^2 E}{(L/\rho)^2} = \frac{\pi^2 \times 10.3 \times 10^6}{(96)^2} = 11{,}030\ \#/\square''$$

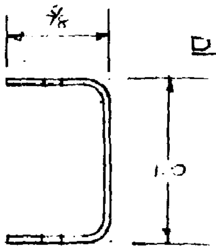
$$f_c = \frac{760}{.076} = 10{,}000\ \#/\square''$$

$$M.S. = \frac{11030}{10000} - 1 = \underline{+.10}$$

CHORD MEMBER (G-2) ("gf")

SECTION

DUE TO THE INTERCONNECTING WEB AND STIFFENERS, LOCAL BENDING IN THE CHORD MEMBER IS NOT CONSIDERED.



D.G.W. - I.H.A.A. 5000 FT. P = -220# (REF. P 83)

$$\frac{P}{A} = \frac{220}{.0671} = 3{,}280\ \#/\square''$$

M.S. IS LARGE

D.G.W. - L.A.A. LIMIT DIVE P = +560# (REF. P 83)

$$\frac{P}{A} = \frac{560}{.058} = 9{,}650\ \#/\square''$$

MAT. 75ST
$F_{ty} = 62{,}000\ \#/\square''$

M.S. IS LARGE

TRAILING EDGE RIB STA. NO. 30
(REF. DWG. 36W1930)

STRUCTURALLY THE TRAILING EDGE RIBS ON THE B-36A AIRPLANES DIFFER SLIGHTLY FROM THE RIBS ON THE YB-36 AIRPLANE. TRUSS MEMBER "ce" (REF. PAGE 77) IS REINFORCED (REF. E.O. # 9327) TO CARRY IN BENDING THE LOAD AFT OF THE AUXILIARY SPAR, FOR THE B-36A AIRPLANES. THE ASSUMPTIONS MADE ON PAGE 77, FOR THE YB-36 AIRPLANE, ARE FOLLOWED, WITH THE EXCEPTION THAT THE MOMENT AFT OF THE AUXILIARY SPAR IS REACTED BY THE RIB TRUSS AS A COUPLE AT PANEL POINTS "c" AND "e".

T.E. RIB STA. No. 30
D.G.W. - L.A.A. 30,000' HIGH SPEED

LOAD AFT AUXILIARY SPAR
(REF. PAGE 78)

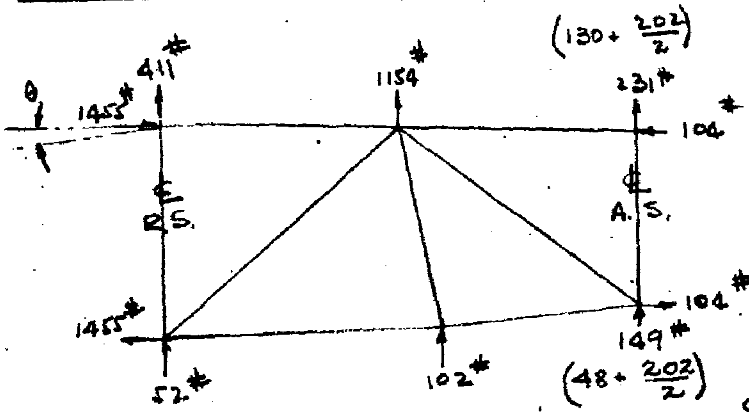
S = 4.2 × 18.85 + 3.1 × 9.425 = 202#↑

MOM. @ ℄ A.S. = 173.3 × 9.425 + 29.2 × 6.28 = 1816"#

COUPLE = $\frac{1816}{17.5}$ = 104#

LOADING SUMMARY

(LOADS REF. PAGE 79)



TOTAL VERT. SHEAR = 2,099#↑

θ = tan⁻¹ .0668

COMP. OF VERT. SHEAR REACTED AT UPPER R.S. CAP = .0668 × 1455 = 10#↑

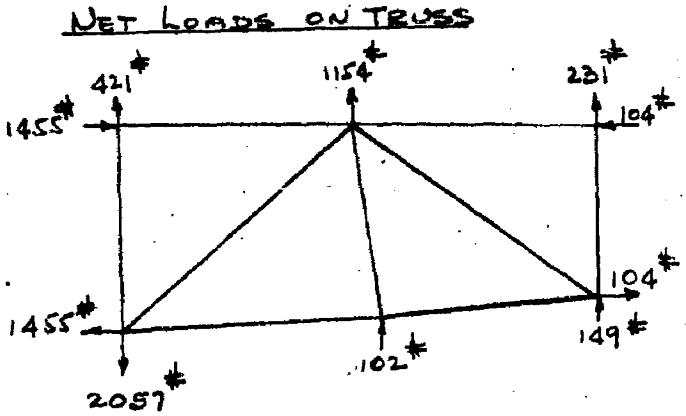
COMP. REACTED AT LOWER R.S. CAP = 2,099 + 10 = 2,109#↓

MOM @ ℄ R.S.

1154 × 23 =	26,400
(231 + 149) × 45.65 =	17,380
104 × 17.5 =	1,820
102 × 27 =	2,755
MOM =	48,355

COUPLE AT R.S. = $\frac{48,355}{33.2}$ = 1,455#

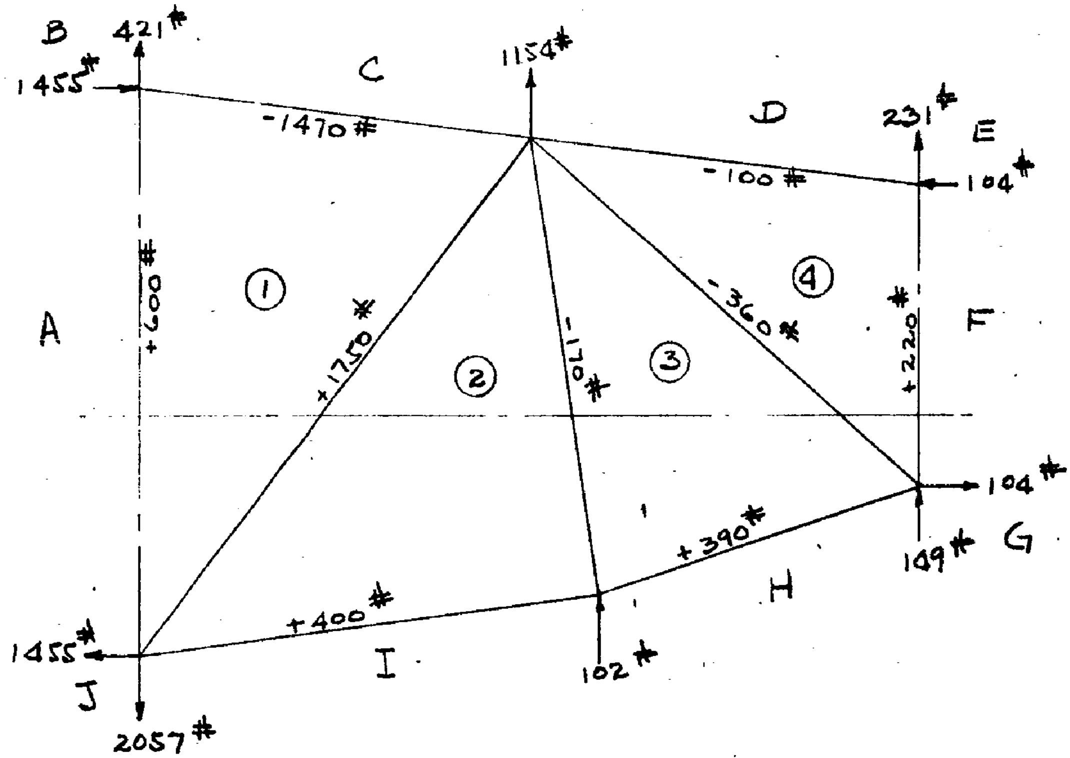
NET LOADS ON TRUSS



NET LD. TO UPPER R.S. CAP = 411 + 10 = 421#↑

NET LD. TO LOWER R.S. CAP = 2109 − 52 = 2057#↓

TRAILING EDGE RIB STA. No. 30
D.G.W. - L.A.A. 30,000' HIGH SPEED



TRUSS SCALE 1" = 10"
FORCE SCALE 1" = 600#

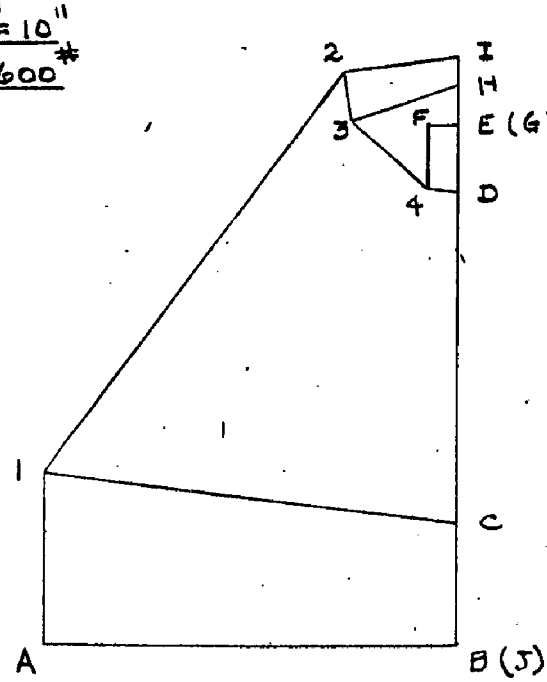


FIG. 20

TRAILING EDGE RIB STA. No. 30

MEMBER LOAD SUMMARY

TABLE No. VI

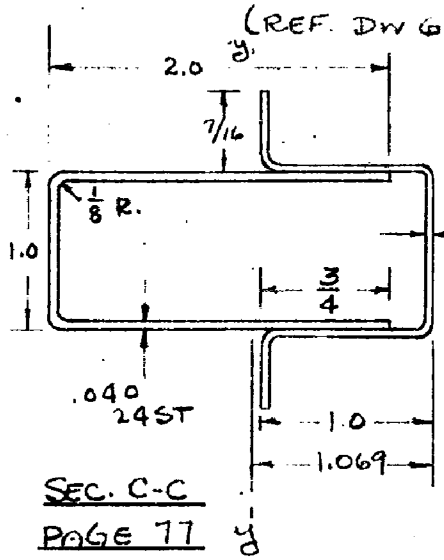
MEMBER	DESIGN CONDITION					
	D.G.W.-L.A.A. 30,000' HIGH SPEED	D.G.W.-L.A.A. LIMIT DIVE	AILERON ROLL	D.G.W. H.A.A. 5,000'	D.G.W. I.H.A.A. 5,000'	D.G.W.-I.L.A.A. LIMIT DIVE 5000'
"a g" A-1	+ 600#	+ 1070#	+ 380#	+ 700#	- 70#	+ 410#
"a b" 1-C	- 1470#	- 1900#	- 1210#	- 1330#	+ 570#	- 70#
"b c" 4-D	- 100#	- 140#	- 150#	- 100#	+ 25#	- 10#
"c e" 4-F	+ 220#	+ 440#	+ 240#	+ 260#	0	+ 180#
"e f" 3-H	+ 390#	+ 600#	+ 490#	+ 350#	- 140#	+ 30#
"f g" 2-I	+ 400#	+ 560#	+ 510#	+ 360#	- 215#	- 85#
"g b" 1-2	+ 1750#	+ 2200#	+ 1150#	+ 1580#	- 575#	+ 250#
"b f" 2-3	- 170#	+ 100#	- 265#	- 210#	+ 795#	+ 780#
"b e" 3-4	- 360#	- 560#	- 430#	- 310#	+ 150#	- 30#

TRAILING EDGE RIB STA. NO. 30

TRUSS MEMBER "CE"

CRITICAL CONDITION D.G.W.-L.A.A. LIMIT DIVE
AXIAL LD. = 440# TEN. (REF PAGE 92)
MOM. = 2453 IN. LBS. (REF. PAGE 82)

CRITICAL SECTION THRU MEMBER
(REF. DWG. 36W 1930 E.O. NO. 9327)



SEC. C-C
PAGE 77

$A = .3038 \text{ in}^2$
$I = .1565 \text{ in}^4$

FOR 24ST81 (ANC-5) $F_t = 65{,}000$ p.s.i. $F_{cy} = 57{,}000$ p.s.i.

FOR 24 ST (ANC-5) $F_t = 61{,}000$ p.s.i. $F_{cy} = 41{,}000$ p.s.i.

FOR SECTION $F_{cc} = 31{,}400$ p.s.i. (C.V.A.C. #1)

$$f_{b_t} = \frac{2453 \times 1.069}{.1565} + \frac{440}{.3038} = 18{,}200 \text{ p.s.i.}$$

$F_t = 65{,}000$

MARGIN HIGH

$$f_{b_c} = \frac{2453 \times 1.181}{.1565} - \frac{440}{.3038} = 17{,}050 \text{ p.s.i.}$$

$$M.S. = \frac{31{,}400}{17{,}050} - 1 = +\ .84$$

TRAILING EDGE RIB STA. No. 30

TRUSS MEMBER "ab" (1-C)
SAME AS FOR YB-36 (SEE PAGE 86)

TRUSS MEMBER "gb" (1-2)
SAME AS FOR YB-36 (SEE PAGE 87)

TRUSS MEMBER "bf" (2-3)
LOADING LESS CRITICAL THAN FOR YB-36 (PAGE 88)

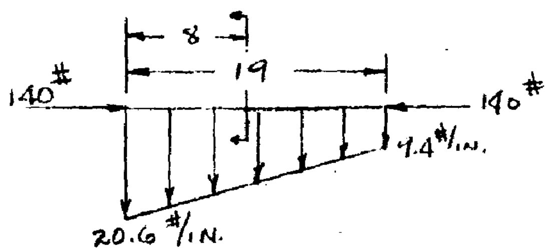
TRUSS MEMBER "be" (3-4)
LOADING LESS CRITICAL THAN YB-36 (PAGE 88)

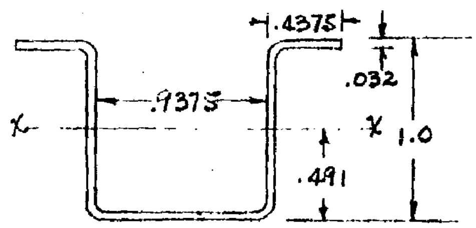
TRUSS MEMBER "gf" (2-I)
SAME AS FOR YB-36 (SEE PAGE 88)

AUXILIARY SPAR CANTILEVER
SAME AS FOR YB-36 (PAGE 85)

TRUSS MEMBER "fe" (3-H)
CRITICAL COND. D.G.N. - I.H.A.A. 5,000'
(PAGE 92)

CRITICAL SECTION 8 IN. FROM LEFT SUPPORT





$$j = \sqrt{\frac{10.3 \times 10^6 \times .0158}{140}} = 34.1$$

$A = .1101 \text{ IN}^2$

$I_{xx} = .0158 \text{ IN}^4$

$$L/j = \frac{19}{34.1} = .557$$

$\rho_{xx} = .379 \quad L/\rho = 50.1$

$\sin L/j = .52864 \quad \cos L/j = .84884 \quad \tan L/j = .62280$

TRAILING EDGE RIB STA. No. 20

TRUSS MEMBER "fe" (CONT'D.)

$x/j = \frac{8}{34.1} = .2345$

$\sin x/j = .23235$

$\cos x/j = .97262$

$$C_1 = \frac{w_j^2(\cos L/j - 1)}{\sin L/j} + \frac{w_1 j^2}{\tan L/j}$$

$$= \frac{9.4 \times (34.1)^2(-.15116)}{.52864} + \frac{11.2 \times (34.1)^2}{.6228} = 17,775$$

$$C_2 = -wj^2 - w_1 j^2 = -9.4(34.1)^2 - 11.2(34.1)^2 = -23,940$$

$$f(w) = wj^2 + w_1 j^2\left(1 - \frac{x}{L}\right) = 9.4(34.1)^2 + 11.2 \times (34.1)^2(.579) = 18,470$$

$$M = C_1 \sin x/j + C_2 \cos x/j + f(w)$$

$$= 17,775 \times .23235 - 23,940 \times .97262 + 18,470 = -650 \text{ in-\#}$$

$F_{cy} = 38,500$ p.s.i.

$$F_c = 38,500\left[1 - \frac{38,500\,(50.1)^2}{4\pi^2 \times 10.3 \times 10^6}\right] = 29,350 \text{ p.s.i.}$$

$$f_b = \frac{650 \times .509}{.0158} = 20,900 \text{ p.s.i.} \qquad R_b = \frac{20,900}{38,500} = .543$$

$$f_c = \frac{140}{.1101} = 1,270 \text{ p.s.i.} \qquad R_c = \frac{1,270}{29,350} = .043$$

$$M.S. = \frac{1}{.543 + .043} - 1 = \underline{+.71}$$

NOSE RIB STA. 1013
(Ref. Dwg. 36W722)

For the purpose of supporting the wing de-icer baffle plate a vertical stiffener is added to the nose ribs between upper and lower flanges at 5% wing chord. This vertical stiffener makes the rib a redundant structure and as such is solved by the method of elastic energy.

The vertical shear on the nose rib is reacted 50% at the upper front spar cap and 50% at the lower cap. The moment of the air loading forward of the front spar is reacted as a couple at upper and lower spar caps.

The section of the closed ring chosen for cutting is the intersection of the vertical stiffener with the wing chord line. Equations for solving the three redundants at the cut section, shear, moment, and axial load, are computed in tabular form in Table VII and final shear, moment and axial loads on the rib are tabulated in Table VIII.

NOSE RIB STA. 1013
(REF. DWG. 36W722)

MAT 24ST &C

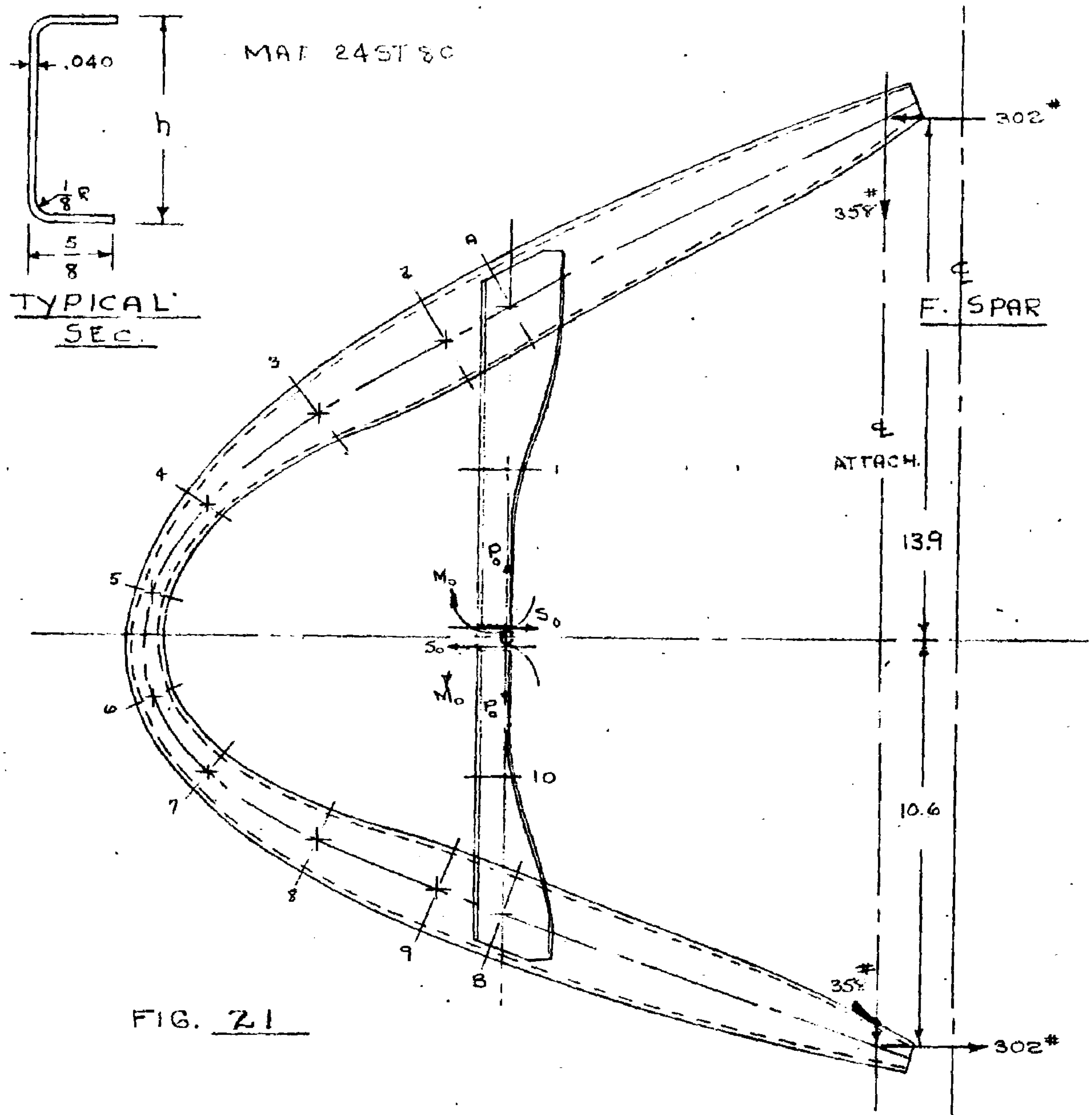


FIG. 21

CONDITION: D.G.W - H.A.A. - 500 FT. (REF P 60)
ASSUME TRAPEZOIDAL LOADING BETWEEN STATIONS

SCALE 1/4

ANALYSIS WING
PREPARED BY RENOLA
CHECKED BY BEARD
REVISED BY

Consolidated Vultee Aircraft Corporation
FORT WORTH DIVISION
FORT WORTH, TEXAS

REPORT NO. FZS-36-142-ADD. A
MODEL YB-36, B-36A
DATE 3-4-47

NOSE RIB STA. 1013

ADJACENT NOSE RIB SPACING = 8 IN.
WING CHORD AT STA = [illegible] IN.
DIST L.E. TO CENTROID OF ATTACHING RIVETS = 19.55 IN.
OR 10.[illegible] % OF CHORD AFT OF L.E.

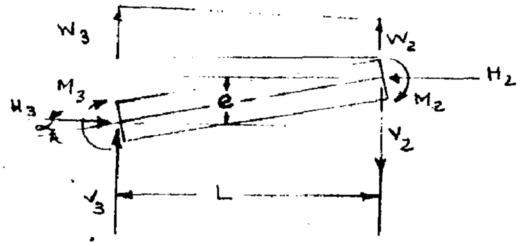
TOTAL LOAD FWD ℄ ATTACHMENT = 716# ↑

C.P. = 10.33 IN FWD ℄ ATTACH.

MOM @ ℄ ATTACH. = 716 x 10.33 = 7390"-#

COUPLE $\frac{7390}{24.5} = 302$#

GENERAL EQUATIONS :- MOMENTS, HORIZ. & VERT. COMPONENTS



$$M_3 = M_2 + V_2 L - H_2 e - \frac{W_2 L^2}{2} - \frac{(W_3 - W_2) L^2}{6}$$

$$H_3 = H_2$$

$$V_3 = V_2 - W_2 L - (W_3 - W_2) L/2$$

RESOLVE H & V THRU ANGLE α FOR AXIAL AND SHEAR LOADS

THE METHOD OF ANALYSIS IS BY ELASTIC ENERGY. THE NOSE RIB WAS CUT AT SECTION "C" AS SHOWN IN FIGURE 21 AND UNIT LOADS APPLIED AS FOLLOWS; $P_o = +1$#, $S_o = +1$# AND $M_o = +1$"-#. TABULAR FORMS FOR SOLVING THE REDUNDANT INTERNAL FORCES ARE TABLES VII & VIII.

SIGN CONVENTION

TENSION IN OUTSIDE FIBERS = + MOM.

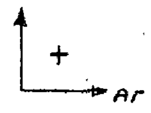


TABLE VII

SOLVING REDUNDANT INTERNAL FORCES ~ CONDITION: D.G.W. - H.A.A. - 50[illegible]

STA.	X	Y	ds	M_E	$P_o X$	$S_o Y$	TOTAL MOMENT 5 + M_o + 6 + 7	I (AVE)	$\frac{ds}{I}$
1	2	3	4	5	6	7	8	9	10
1	0	-4.35	8.7	0	0	-4.35 S_o	M_o - [illegible] S_o	.0225	38[illegible]
2	-1.6	-7.75	3.8	540	-1.6 P_o	-7.75 S_o	540 + M_o - 1.6 P_o - 7.75 S_o	.1068	35.58
3	-4.9	-5.8	3.8	-29	-4.9 P_o	-5.8 S_o	-29 + M_o - 4.9 P_o - 5.8 S_o	.0606	62.71
4	-7.7	-3.7	3.2	-920	-7.7 P_o	-3.7 S_o	-920 + M_o - 7.7 P_o - 3.7 S_o	.0167	191.62
5	-9.15	-1.2	2.5	-1904	-9.15 P_o	-1.2 S_o	-19[illegible]4 + M_o - [illegible] P_o - 1.2 S_o	.0134	186.57
6	-9.15	+1.2	2.4	-2543	-9.15 P_o	+1.2 S_o	-2543 + M_o - 9.15 P_o + 1.2 S_o	.0134	179.10
7	-7.7	+3.5	3.1	-2933	-7.7 P_o	+3.5 S_o	-2933 + M_o - 7.7 P_o + 3.5 S_o	.0204	151.96
8	-5.25	+5.3	3.6	-2919	-5.25 P_o	+5.3 S_o	-2919 + M_o - 5.25 P_o + 5.3 S_o	.060[illegible]	59.41
9	-1.73	+6.7	3.5	-2451	-1.73 P_o	+6.7 S_o	-2451 + M_o - 1.73 P_o + 6.7 S_o	.1015	34.48
10	0	+3.65	7.3	0	0	+3.65 S_o	+ M_o + 3.65 S_o	.026[illegible]	271.3[illegible]

ANALYSIS:- WIN[illegible]

PREPARED BY:- R[illegible]

CHECKED BY:- [illegible]

TABLE VII (CONT'D)

SOLVING REDUNDANT INTERNAL FORCES — CONDITION D, SYM. – H.A.H. – 50[illegible] FT. (CONT'D)

STA.	M_P (13)	$\frac{M_P\,ds}{I}$ (13)X(10) (14)	$\frac{M_1 M\,ds}{I}$ (8)x(14) (15)	M_S (16)	$\frac{M_S\,ds}{I}$ (16)X(10) (17)	$\frac{M_S M\,ds}{I}$ (17) x [illegible] (18)
1	0	0	0	-4.35	-433.01	$-1633.01 M_o + 7316.74 S_o$
2	-1.6	-56.93	$-30742.20 - 56.93 M_o + 91.09 P_o + 441.21 S_o$	-7.25	-275.75	$-14[illegible] - 275.75 M_o + 441.2[illegible] P_o + 2[illegible]37.06 S_o$
3	-4.9	-307.28	$8911.12 - 307.28 M_o + 1505.67 P_o + 1782.22 S_o$	-5.8	-363.72	$10547.88 + 363.72 M_o + 1782.23 P_o + 2109.58 S_o$
4	-7.7	-1475.47	$1357432.40 - 1475.47 M_o + 13682.94 P_o + 5459.24 S_o$	-3.7	-708.79	$652270.80 - 708.79 M_o + 5459.22 P_o + 2623.26 S_o$
5	-9.15	-1707.12	$3250336.48 - 1707.12 M_o + 15620.15 P_o + 2048.54 S_o$	-1.2	-223.88	$426267.52 - 223.88 M_o + 2048.50 P_o + 268.66 S_o$
6	-9.15	-1638.77	$4167372.11 - 1638.77 M_o + 14994.75 P_o - 1966.52 S_o$	+1.2	+214.92	$-546546.56 + 214.92 M_o - 1966.52 P_o + 257.90 S_o$
7	-7.7	-1170.09	$3431573.97 - 1170.09 M_o + 9009.69 P_o - 4095.32 S_o$	+3.5	+531.56	$-1559145.35 + 531.56 M_o - 4095.32 P_o + 1860.51 S_o$
8	-5.25	-311.90	$910436.10 - 311.90 M_o + 1637.48 P_o - 1653.07 S_o$	+5.3	+314.97	$-919105.55 + 314.97 M_o - 1653.07 P_o + 1669.61 S_o$
9	-1.73	-59.52	$145883.52 - 59.52 M_o + 102.97 P_o - 398.78 S_o$	+6.7	+231.02	$-566230.02 + 231.02 M_o - 399.66 P_o + 1547.83 S_o$
10	0	0	0	+3.65	+990.54	$+990.54 M_o + 3615.47 S_o$
			$13241543.50 - 6727.08 M_o + 56649.74 P_o + 1617.52 S_o$			$-2653323.32 - 971.14 M_o + 1616.55 P_o + 23406.72 S_o$

$$\begin{cases} -1673293 + 1559 M_o - 6727 P_o - 971 S_o = 0 & \text{(Ref. Col (12) P. 99)} \\ 13241544 - 6727 M_o + 56650 P_o - 1618 S_o = 0 & \text{(Ref. Col (15) Above)} \\ -2653323 - 971 M_o + 1617 P_o + 23407 S_o = 0 & \text{(Ref. Col (18) Above)} \end{cases}$$

$$\begin{cases} M_o = +269\ ''\text{-}\# \\ P_o = -206\ \# \\ S_o = +138\ \# \end{cases}$$

ANALYSIS: WING
PREPARED BY: RENOLA
CHECKED BY: BEARD

REPORT NO: F25-36-142 ADD. A
MODEL: YB-36, B-36A
DATE: 3-4-47

NET MOMENTS AND AXIAL LOADS

CONDITION: D.G.W. - H.A.A. - 5000 FT.

STA.	X	Y	P_0X (P_0 = -206#)	S_0Y (S_0 = 138#)	M_0	M_s	NET MOM. (4)+(5)+(6) + (7)	AXIAL LOAD
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1	0	-4.35	0	-600	+269	0	-331	206
2	-1.6	-7.75	330	-1070		540	+69	-367
3	-4.9	-5.8	1007	-800		-29	+447	-286
4	-7.7	-3.7	1586	-511		-920	+424	-257
5	-9.15	-1.2	1885	-166		-1904	+84	-372
6	-9.15	+1.2	1885	+166		-2543	-223	308
7	-7.7	+3.5	1586	+483		-2933	-595	222
8	-5.25	+5.3	1082	+731		-2919	-837	190
9	-1.73	+6.7	356	+925		-2451	-901	196
10	0	+3.65	0	+504	+269	0	+773	206

ANALYSIS: WING
PREPARED BY: KENOLA
CHECKED BY: BEARD
REPORT: FZS-36-142 ADD. A
MODEL: YB-36, B-36A
DATE: 3-5-47

NOSE RIB STA. 1013

SECTION @ STA. ④

h = 1.1 (REF. P. 97) A = .0876 □" I = .0167 IN⁴

MOM = 424 "-# AXIAL LOAD = -257# (REF. P. 101)

INSIDE FLANGE IN COMP. $f_c = \frac{Mc}{I} + \frac{P}{A}$

$$f_c = \frac{424 \times .55}{.0167} + \frac{257}{.0876} = 16{,}880\ \#/\square"$$

ALLOWABLE $\frac{b}{t\sqrt{K}} = \left(\frac{.625}{.040}\right)(1.612) = 25.2$ $F_{cc} = 25{,}500\ \#/\square"$ (C.V.A.C. No. 1)

$$M.S. = \frac{25500}{16880} - 1 = \underline{+.51}$$

SECTION @ STA. ⑩

h = 1.35 (REF. P. 97) A = .0976 □" I = .0269 IN⁴

MOM = +773 "-# AXIAL LOAD = 206# (REF. P. 101)

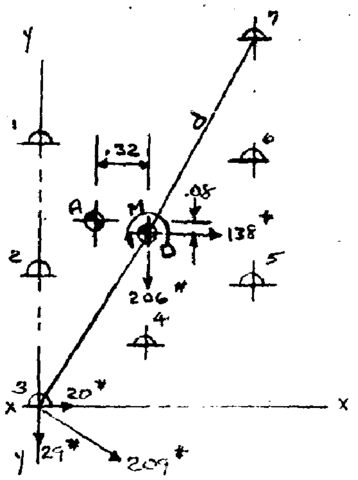
OUTSIDE FLANGE IN TENSION $f_t = \frac{Mc}{I} + \frac{P}{A}$

$F_t = 62{,}000\ \#/\square"$ $f_t = \frac{773 \times .625}{.0269} + \frac{206}{.0976} = 20{,}060\ \#/\square"$

$$M.S. = \frac{62000}{20060} - 1 = \underline{HIGH}$$

TYPICAL TOP & BOTTOM RIVET ATTACH. FOR L.E. RIBS TO VERT. STIFFENER

"A" - C.G. FLANGE
"D" - C.G. RIVETS



RIVET	X	Y	d^2
1	–	1.6	.74
2	–	.8	.49
3	–	–	1.56
4	.65	.38	.46
5	1.31	.75	.53
6	1.31	1.50	.64
7	1.31	2.25	1.78
Σ	4.58	7.28	6.20

$$\bar{X} = \frac{4.58}{7} = .654$$

$$\bar{Y} = \frac{7.28}{7} = 1.04$$

NOSE RIB STA. 1013

MOM. @ C G RIVETS = 269) - 138×9) - 206×.32) = 1033"-#)

HORIZ. LOAD = 138# →   VERT. LOAD = 206# ↓

HORIZ. LOAD PER RIVET = $\frac{138}{7}$ = 20#/RIVET

VERT LOAD PER RIVET = $\frac{206}{7}$ = 29#/RIVET

RIVET NO. 3 IS CRITICAL

LOAD DUE TO MOMENT = $\frac{1033 \times 1.25}{6.20}$ = 207#

RESULTANT = 240#

ALLOWABLE 5/32" RIVET S.S = 596#

M.S. IS HIGH

RIVET ATTACH. RIB TO FRONT SPAR

2 - 5/32" RIVETS ~ S.S. = 596#

HORIZ. LOAD = $\frac{302}{2}$ = 151#/RIVET

VERT. LOAD = $\frac{358}{2}$ = 179#/RIVET

RESULTANT LOAD = $\sqrt{(151)^2 + (179)^2}$ = 236#/RIVET

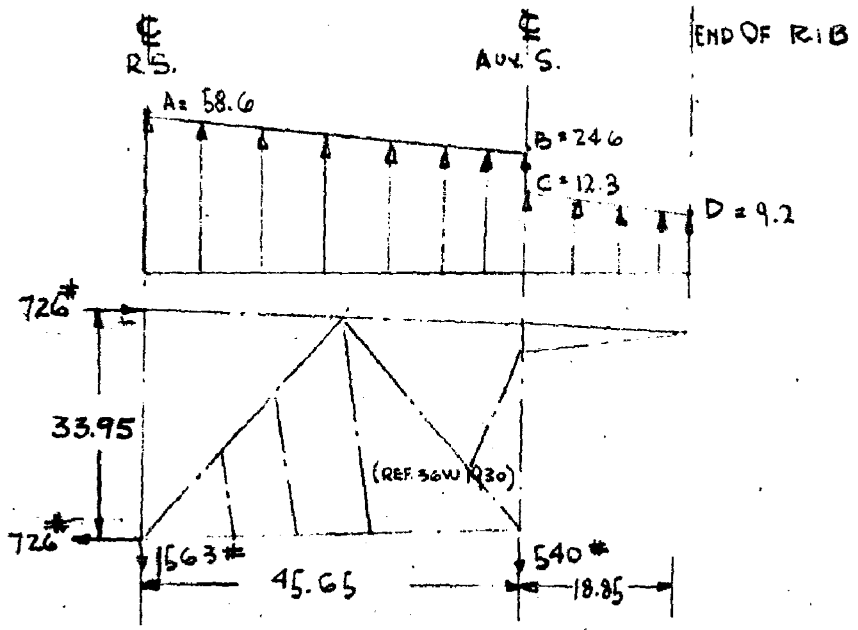
M.S. IS HIGH

AUXILIARY SPAR
(Ref. Dwg. 36W1956)

The wing auxiliary spar extends spanwise from just inboard of Station 26 to Station 40. Its chordwise location is just forward of the aileron leading edge. The spar is actually built as a series of simply supported beams between aileron support ribs. In each bay two air-load ribs load the spar, and this load is reacted at the aileron support ribs.

For purposes of analysis the section of the spar between Stations 29 and 32 is checked. In order to find spar loads the dimensions at Sta. 30 are used. The complete loading is worked out for the L.A.A., High Speed, 30,000' condition. A summary is shown on all other conditions. In order to find the loads at any station other than 30, it is assumed that the load would vary in the ratio of the chord at the station to that at Sta. 30.

AUXILIARY SPAR - STATION No. 30
D.G.W. - L.A.A. 30,000' HIGH SPEED



LOADS AT POINTS:-

A = (1.43* x 109.4■ x 36/144) 1.5 = 58.6 #/IN. ULT.
B = (.6 x 109.4 x 36/144) 1.5 = 24.6 #/IN ULT.
C = (.6 x 109.4 x 36/144) 1.5 x .5 = 12.3 #/IN ULT.
D = (.45 x 109.4 x 36/144) 1.5 x .5 = 9.2 #/IN ULT.

C.P. & LOAD BETWEEN R.S. & AUX. S.

$$\text{LOAD} = \left(\frac{58.6 + 24.6}{2}\right) \times 45.65 = 1900\# \text{ ULT.}$$

C.P.:- 58.6/24.6 = 2.38

X/L = .431 ; X = .431 X 45.65 = 20.1" AFT R.S.

■, REF. Pg. 55.
*, REF. PRESSURE DIST CURVE FIG. 15 P. 59
THE LOAD AT "C" IS ASSUMED 1/2 LOAD AT "B"

AUXILIARY SPAR - STATION No. 30
D.G.WT. L.A.A. 30000' HIGH SPEED

C.P. & LOAD BETWEEN AUX. S. & BULKHD END

$$LOAD = \left(\frac{12.3 + 9.2}{2}\right) \times 18.85 = \underline{203}\ \#$$

C.P. :- 12.3/9.2 = 1.34

X/L = .476 ; X = .476 × 18.85 = 8.97" AFT AUX. S.
= 54.62" AFT R.S.

LOADS AT AUX. SPAR & R.S

MOMENT AT R.S. = [20.1 × 1900 + 54.62 × 203] = 49300 ''-#.

LOAD AT AUX. SPAR :-
IT IS ASSUMED THAT AUX. SPAR REACTS ½ OF THE ABOVE MOMENT.

$$LOAD = \frac{1}{2} \times 49300/45.65 = \underline{540}\ \# \downarrow$$

REMAINDER OF MOMENT IS REACTED AT R.S.

$$H_A = H_B = \frac{49300 \times \frac{1}{2}}{33.95} = 726\#\ \leftrightarrows$$

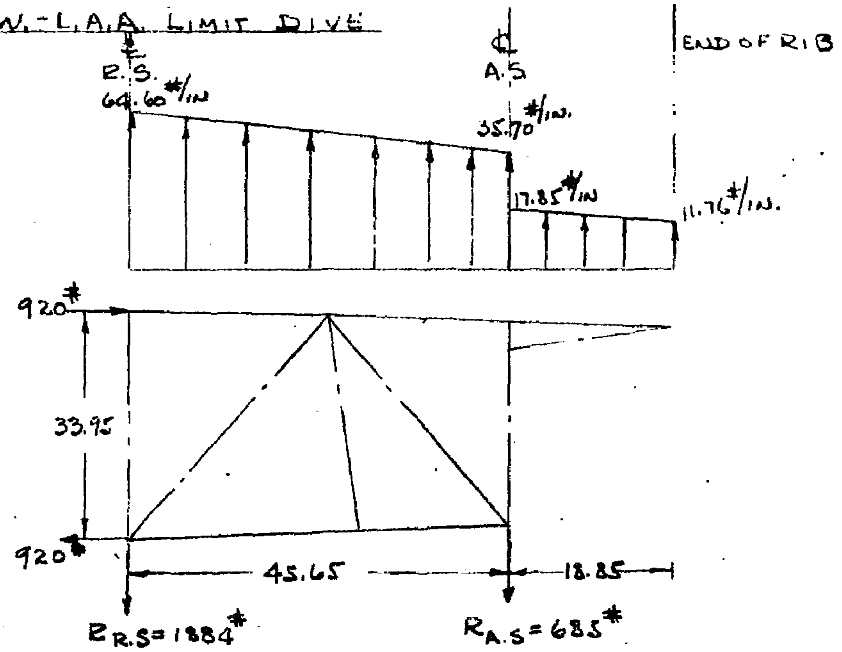
$$VERTICAL\ LOAD = (1900 + 203) - 540 = \underline{1563}\ \# \downarrow$$

AT REAR SPAR

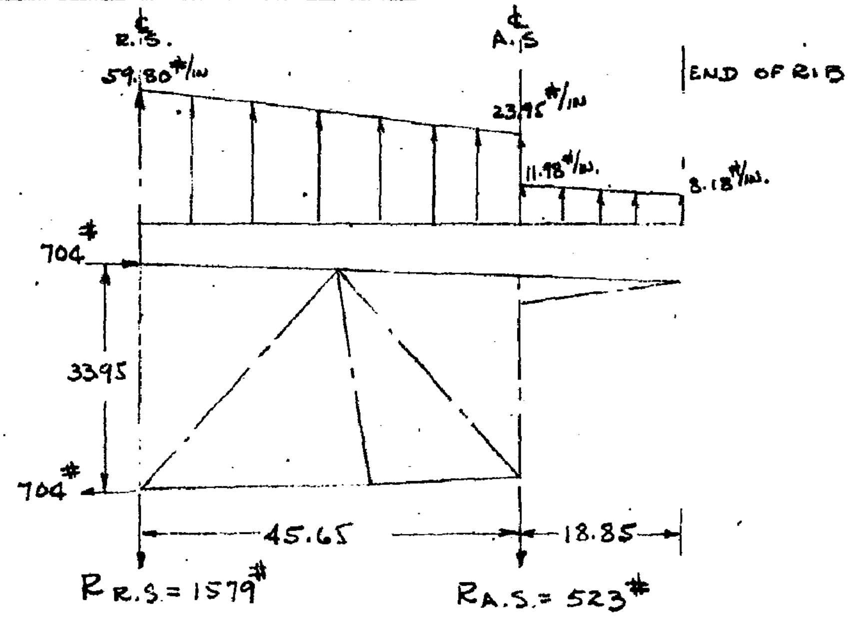
AUXILIARY SPAR - STATION NO. 30

LOADING SUMMARY

D.G.W. - L.A.A. LIMIT DIVE



D.G.W. - H.A.A. 5,000'



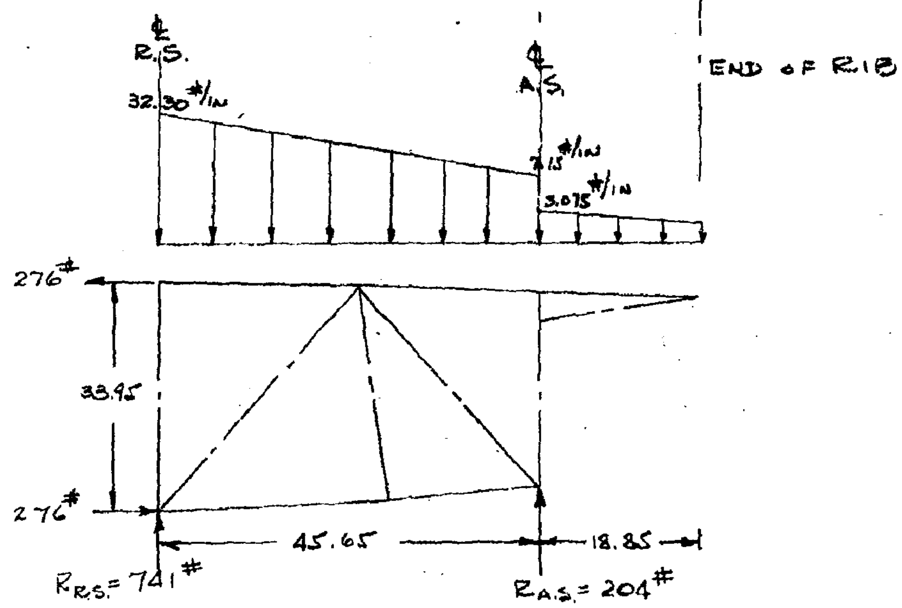
ANALYSIS WING
PREPARED BY LOWREY
CHECKED BY BEARD
REVISED BY

Consolidated Vultee Aircraft Corporation
FORT WORTH DIVISION
FORT WORTH, TEXAS

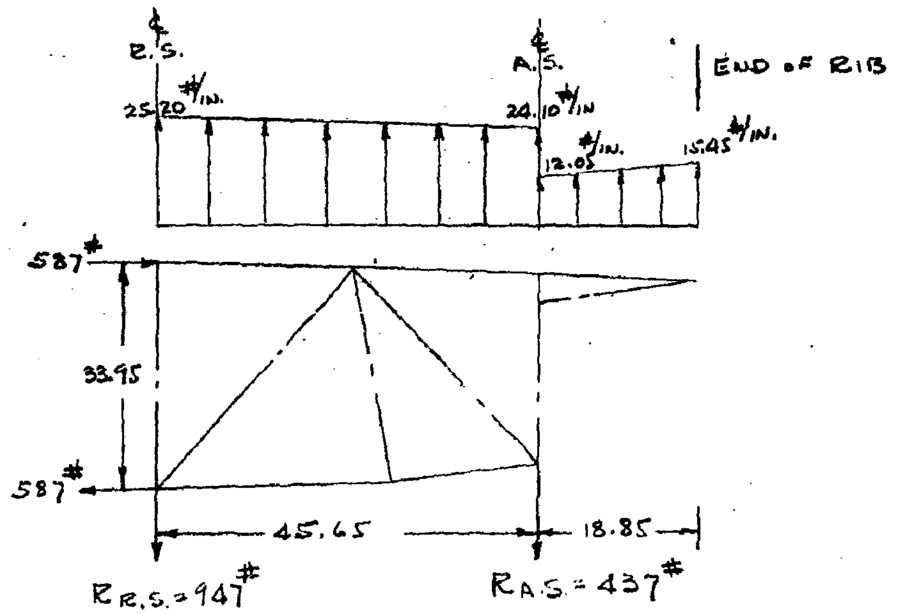
REPORT NO. FZS-36-142 ADD. A
MODEL YB-36A, B-36A
DATE 1-2-47

AUXILIARY SPAR - STATION No 30
LOADING SUMMARY (CONT'D)

D.G.W. I.H.A.A. 5,000'

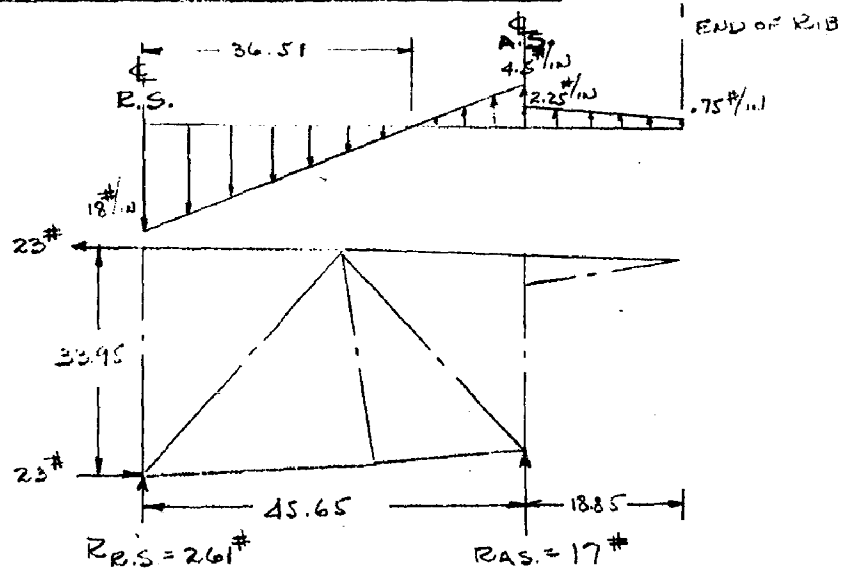


AILERON ROLL

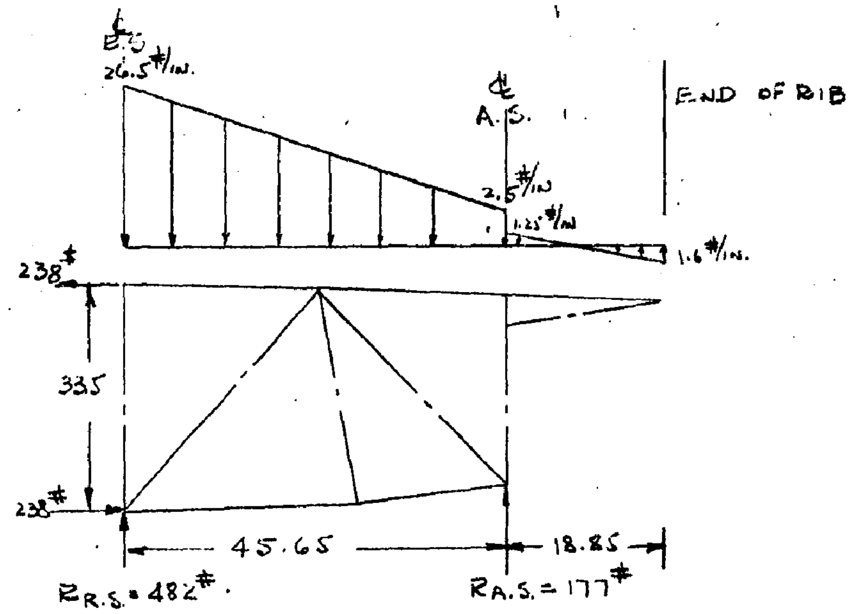


AUXILIARY SPAR STA. NO. 30
LOADING SUMMARY (CONT'D.)

D.G.W. - I.L.A.A. 5000' - LIMIT DIVE



D.G.W. - I.H.A.A. - 5000' HIGH SPEED



SUMMARY OF AUX. SPAR LOADS FROM AIRLOAD T.E. RIBS

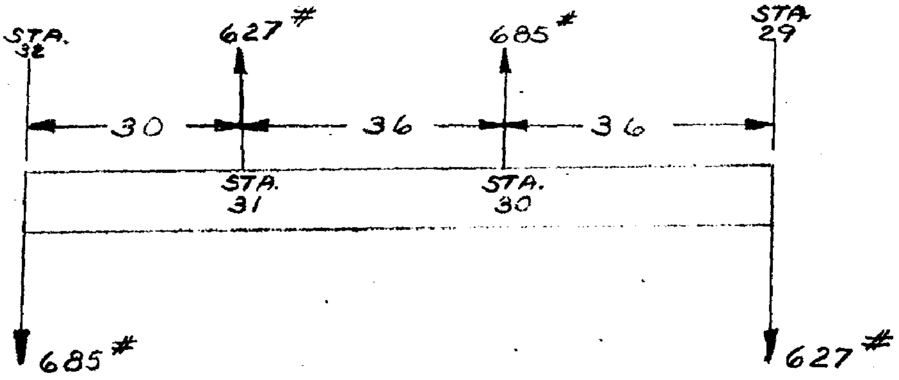
CONDITION	STA. 25 b=15	STA. 27 b=36	STA. 28 b=36	STA. 30 b=36	STA. 31 b=33	STA. 33 b=30	STA. 34 b=30	STA. 36 b=36	STA. 37 b=36	STA. 39 b=23	STA. 40 b=11.5
D.G.W.-H.S.-30000'	225	540	540	540	495	450	450	540	540	345	173
D.G.W.-H.A.A.	218	523	523	523	480	436	436	523	523	334	167
D.G.W.-I.H.A.A.	-85	-204	-204	-204	-187	-170	-170	-204	-204	-130	-65
AILERON ROLL	182	437	437	437	401	364	364	437	437	279	140
D.G.W.-L.A.A.-5000' (LIMIT DIVE)	285	685	685	685	627	571	571	685	685	437	218
D.G.W.-I.L.A.A.-5000' (LIMIT DIVE)	-7	-17	-17	-17	-16	-14	-14	-17	-17	-11	-5
D.G.W.-I.H.A.A. 5000 (HIGH SPEED)	-74	-177	-177	-177	-162	-147	-147	-177	-177	-113	-56

ANALYSIS: WING
PREPARED BY: ZINBERG
CHECKED BY: BEARD

REPORT No. FZS-36-142 ADD A
MODEL: YB-36, B-36A
DATE: 1-29-47

FOR PURPOSES OF ANALYSIS, THE SECTION OF THE SPAR BETWEEN AILERON SUPPORT RIBS STA. 29 AND 32 IS CHOSEN TO BE CHECKED FOR STRESSES AND MARGINS.

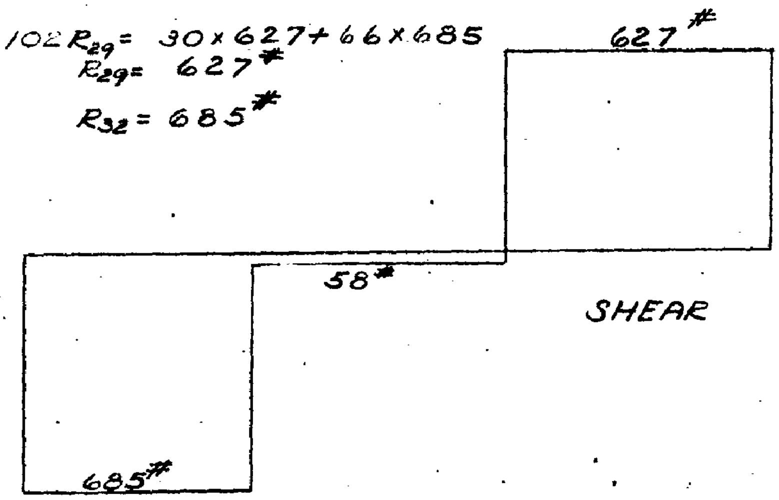
CRITICAL UP LOADS ~ D.G.W.-L.A.A. ~ 5,000′ (REF. P. 110)

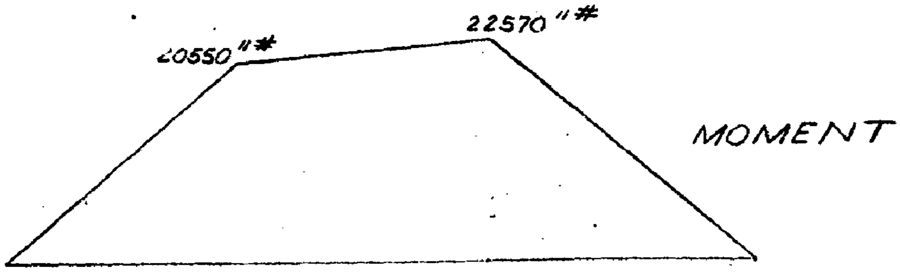


$102 R_{29} = 30 \times 627 + 66 \times 685$

$R_{29} = 627\#$

$R_{32} = 685\#$





AUXILIARY SPAR

LOADS TO WING RIB STA. 29 FROM AUXILIARY SPAR

D.G.W. - H.S. 30000'

$$L_{D_{29}} = \frac{30 \times 495 + 66 \times 540}{102} + 540 = 1035^{\#} \uparrow$$

D.G.W. - H.A.A.

$$L_{D_{29}} = \frac{30 \times 480 + 66 \times 523}{102} + 523 = 1002^{\#} \uparrow$$

D.G.W. - I.H.A.A.

$$L_{D_{29}} = \frac{30 \times 187 + 66 \times 204}{102} + 204 = 391^{\#} \downarrow$$

AILERON ROLL

$$L_{D_{29}} = \frac{30 \times 401 + 66 \times 437}{102} + 437 = 837^{\#} \uparrow$$

D.G.W. - L.A.A.

$$L_{D_{29}} = \frac{30 \times 627 + 66 \times 685}{102} + 685 = 1312^{\#} \uparrow$$

D.G.W. - I.L.A.A. 5000' LIMIT DIVE

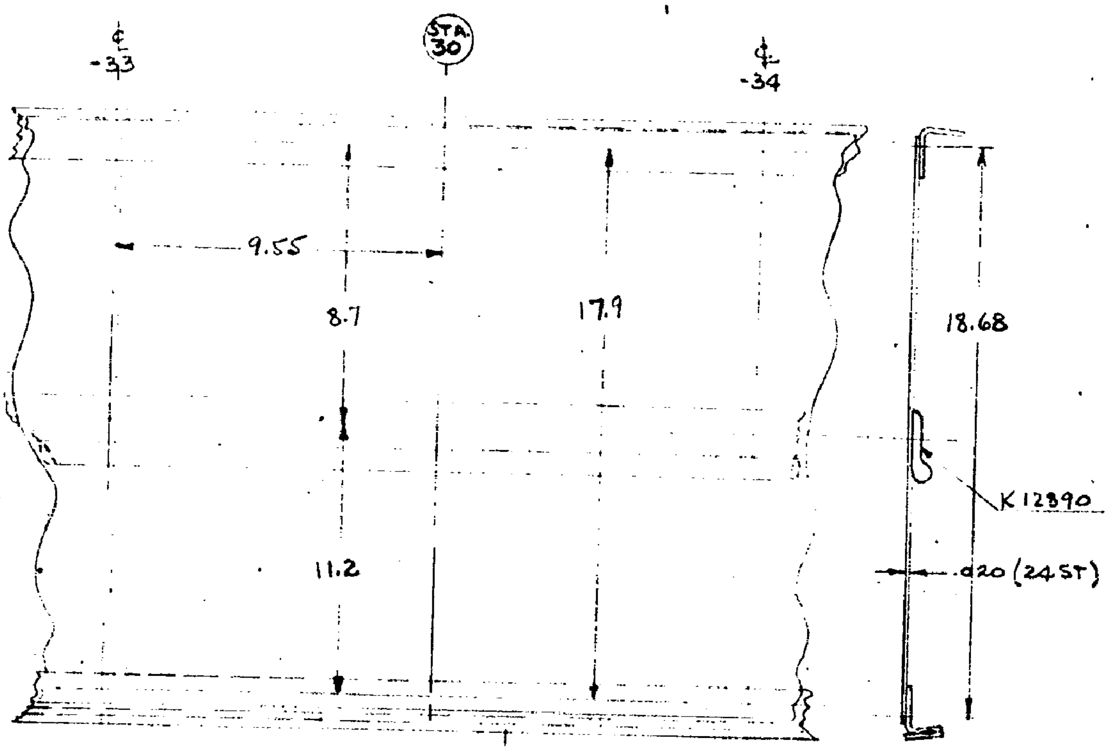
$$L_{D_{29}} = \frac{30 \times 16 + 66 \times 17}{102} + 17 = 33^{\#} \downarrow$$

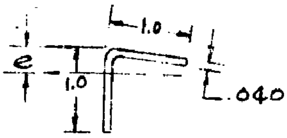
D.G.W. - I.L.A.A. 5,000' HIGH SPEED

$$L_{D_{29}} = \frac{30 \times 162 + 66 \times 177}{102} + 177 = 339^{\#} \downarrow$$

REF. SKETCH PAGE 111
& LOADS REF. PAGE 110

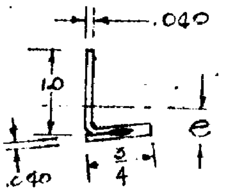
WING - AUXILIARY SPAR
(REF. DWG. 36W 1956)





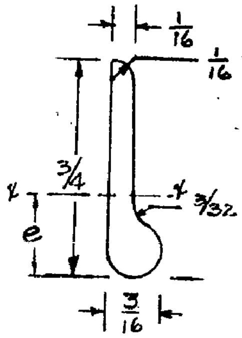
UPPER CAP

$A = .0759\ in.^2$
$I = .00766\ in^4$
$e = .274\ in.$
MAT. 24ST



LOWER CAP

$A = .0959\ in.^2$
$I = .00913\ in.^4$
$e = .249\ in.$
$F_a = 25,600$ psi
MAT. 24ST

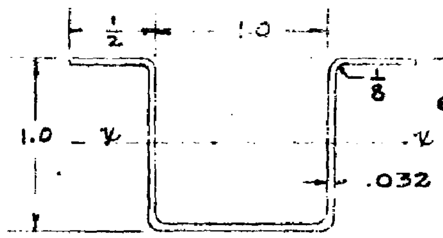


K12890 - 53ST EXT.

$A = .0627\ in.^2$
$I_x = .00301\ in.^4$
$e = .298\ in.$

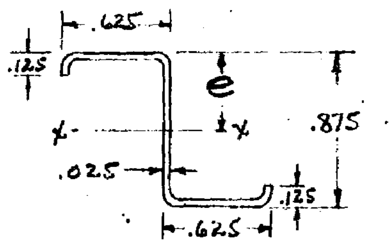
WING - AUXILIARY SPAR

STA. 30 STIFFENER
(36W1930-17)



A = .1162 IN.²
I_{xx} = .01733 IN.⁴
e = .5 IN.
MAT. 24ST 81

36W1956-33 & -34 STIFFENER



A = .0537 IN.²
I_{xx} = .00685 IN.⁴
e = .4375 IN.
MAT 24ST

I OF SPAR AT STA. 30

ELEMENT	A	Y	AY	$\bar{Y}$	$A\bar{Y}^2$	I_o
LOWER CAP	.0959	0	0	-8.25	6.53	.009
UPPER CAP	.0759	18.68	1.418	10.43	10.90	.008
TOTAL	[illegible]	8.25	1.418		17.43	.02

$I = 17.43 + .02 = 17.45$ IN.⁴

WING - AUXILIARY SPAR

STATION 30 - D.G.W. - L.A.A. - 5,000' (REF PAGE 111)

$M_{(MAX)} = 22,570$ IN. LBS.
$S = 627^{*}$
$h' = 18.68$ IN.
$A_{ft} = .0759$ IN.^{2} (UPPER CAP)
$I_{ft} = .00766$ IN.^{4}
$A_{fc} = .0959$ IN.^{2}
$I_{fc} = .00913$ IN.^{2}
$A_S = .0537$ IN.^{2}
$t = .020$ IN.

$h = 17.9$ IN.
$b = 9.55$ IN.
$d_S = 3/32 = .0938$ IN
$P_S = 1$ IN. O.C.
$A_{fR} = .0069$
$N = 8$
$A_{SER} = 2 \times .0069 = .0138$ IN.^{2}
$E_S = E_F = E_W = 10.3 \times 10^6$ p.s.i.

(REF. C.V.A.C. STRUCTURES BULLETIN A-1)

SHEARING STRESS IN THE WEB

$$\tau = \frac{S}{h't} = \frac{627}{18.68 \times .020} = 1,680 \text{ p.s.i.}$$

WAGNER ANGLE α

$$\lambda = bt E_w \left[\frac{b^3}{720 h E_f} \left(\frac{1}{I_{fc}} + \frac{1}{I_{ft}} \right) + \frac{1}{E_S A_S} \right]$$

$$= 9.55 \times .020 \times 10.3 \times 10^6 \left[\frac{(9.55)^3}{720 \times 17.9 \times 10.3 \times 10^6} \left(\frac{1}{.00913} + \frac{1}{.00766} \right) + \frac{1}{10.3 \times 10^6 \times .0537} \right]$$

$$= 1,968,000 (1.57 \times 10^{-6} + 1.808 \times 10^{-6}) = 6.64$$

PANEL SIZE 9.55×11.2 $\quad K_S = 7.35$

$$\tau_{cr} = 7.35 \times 10.3 \times 10^6 \left(\frac{.020}{9.55} \right)^2 = 319 \text{ p.s.i.}$$

$$r = \frac{\tau_{cr}}{25,000} = \frac{319}{25,000} = .0128$$

$\tan \alpha = .608$, $\alpha = 31.3°$, $\sec \alpha = 1.17$

$\sin \alpha = .5195$, $\cos \alpha = .8545$, $\cot \alpha = 1.645$

WING AUX. SPAR ~ STA. 30

WEB DESIGN:

FOR WEB STIFFENER RIVETS

$$C_R = 1 - \left(\frac{d_s}{P_s}\right) \sec\alpha + \frac{1}{4}\tan^2\alpha$$

$$= 1 - \left(\frac{.0936}{1} \times 1.17\right) + \frac{1}{4}(.608)^2 = .9826$$

$$\tau_{tu} = (R R_R C_R F_{tu}) \sin\alpha \cos\alpha$$

$R = .995$, $R_R = .805$ $F_{tu} = 61000\ \#/\square''$

$$\tau_{tu} = (.995 \times .805 \times .9826 \times 61000)(.5195 \times .8545) = 21260\ \#/\square''$$

$$\tau_{su} = .9\left(1 - d_s/P_s\right) \times F_{su}$$ $F_{su} = 37000\ \#/\square''$

$$= .9\left(1 - \frac{.09375}{1}\right) 37000 = 30200\ \#/\square''$$

$$M.S. = \frac{21260}{1680} - 1 = \underline{HIGH}$$

FLANGE RIVETS:

$$S_{fR} = 6t\sqrt{\left(\frac{\tau}{N + A_{SER}/A_{FR}}\right)^2 + \left(\frac{\tau\tan\alpha - \tau_{CR}}{N}\right)^2}$$

$$= 9.55 \times .02\sqrt{\left(\frac{1680}{8 + \frac{.0138}{.0064}}\right)^2 + \left(\frac{1680 \times .608 - 319}{8}\right)^2}$$

$= 36.2\ \#/\text{RIVET}$

RIVETS ARE CRITICAL IN BEARING ON .020 SHEET
ALLOW. BEARING = 192 #/RIVET

MARGIN HIGH

WING AUX. SPAR~STA. 30

WEB STIFFENERS:

$b = 9.55''$ $h = 17.9$
$t = .020''$ $S = 627^{\#}$

FROM NOMOGRAM, P. 7.434 OF C.V.A.C. #1:

$I_{REQ.} < .001 \text{ IN.}^4$
$I_{ACTUAL} = .00685 \text{ IN.}^4$ (REF. P. 114)

STIFFENER IS SATISFACTORY.

COMPRESSION FLANGE:

$M_{MAX} = 22{,}570''^{\#}$
$h = 17.9''$ $h' = 18.68''$
$M/h = 1262^{\#}$

$S_{TU} = S - S_{CU} = 627 - 319 \times 18.68 \times .02$
$= 508^{\#}$

$\cot\alpha = 1.645$
FLANGE LOAD DUE TO TENSION FIELD EFFECT
$= S_{TU} \frac{\cot\alpha}{2} = 508 \times .823 = 418^{\#}$

$P_C = 1262 + 418 = 1680^{\#}$
$f_C = \frac{1680}{.0959} = 17500^{\#}/\square''$

$F_C = 25600^{\#}/\square''$ (C.V.A.C. #1)

$M.S. = \frac{25600}{17500} - 1 = \underline{+.46}$

SUMMARY OF CRITICAL MARGINS

		PAGE
WING BULKHEAD No. 29		
UPPER CHORD MEMBER	M.S. = .98	36
LOWER CHORD MEMBER	M.S. = 1.35	38
DIAGONAL MEMBER	M.S. = .42	39
WING TRAILING EDGE RIB STA No. 29		
UPPER CHORD MEMBER	M.S. = .33	49
LOWER CHORD MEMBER	M.S. = .09	51
DIAGONAL MEMBER	M.S. = .47	52
WING BULKHEAD STA. No 30		
CHORD MEMBER	M.S. LARGE	76
DIAGONAL MEMBER	M.S. = .19	76
RIVETS - TUBE TO FITTING	M.S. = .27	76
RIVETS - DIAGONAL TO CHORD MEMBER	M.S. = .32	76
WING TRAILING EDGE RIB STA No. 30 (YB-36)		
BEAM "bcmn"	M.S. LARGE	85
CANTILEVER BEAM	M.S. = 1.24	85
UPPER CHORD MEMBER	M.S. = .43	87
LOWER CHORD MEMBER	M.S. LARGE	88
DIAGONAL MEMBER	M.S. = .09	87
WING TRAILING EDGE RIB STA No 30 (B-36A)		
AUXILIARY SPAR STIFFENER	M.S. = .84	93
UPPER CHORD MEMBER	M.S. = .43	94
LOWER CHORD MEMBER	M.S. = .71	95
DIAGONAL MEMBER	M.S. = .09	94
WING NOSE RIB STA. 1013		
FLANGE	M.S. = .51	102
RIVET ATTACH. - RIB TO VERT. STFNR	M.S. LARGE	103
RIVET ATTACH. - RIB TO FRONT SPAR	M.S. LARGE	103
AUXILIARY SPAR		
WEB	M.S. LARGE	116
FLANGE RIVETS	M.S. LARGE	116
FLANGE	M.S. = .46	117

REEL – C

2126

A.T.I.

47159

TITLE: Stress Analysis of Outer Wing Bulkheads and Auxiliary Spar - Model YB-36 and B-36A	ATI- 47159
AUTHOR(S) : Lowrey, M.; Thomson, L. E.; Beard, N. W. and others	REVISION (None)
ORIG. AGENCY : Consolidated Vultee Aircraft Corp., Fort Worth Div., Texas	ORIG. AGENCY NO. FZS-36-142, Add A
PUBLISHED BY : USAF Contract W535-ac-22352 and Contract W33-038-ac-7	PUBLISHING AGENCY NO. (None)

DATE	DOC. CLASS.	COUNTRY	LANGUAGE	PAGES	ILLUSTRATIONS
April '47	Unclass.	U.S.	English	119	tables, diagrs, graphs

ABSTRACT:

This report contains an analysis of the following outer wing panel structures for the YB-36 and B-36A bombers: the critical aileron support inter-spar bulkhead and trailing edge rib; typical airload inter-spar bulkhead and trailing edge rib; typical airload nose rib; and the wing auxiliary spar. For the inter-spar bulkheads the crushing loads due to bending are computed by the method of C.V.A.C. No. 1 from the bending stresses of a previous report No. FZS-36-141. These loads are combined with the loads obtained from the pressure distribution curves as final loads for the bulkheads. Included are results of the analysis which are presented in various graphs and diagrams.

DISTRIBUTION: Copies of this report obtainable from Central Air Documents Office; Attn: MCIDXD

DIVISION: Structures (7) SECTION: Stress Analysis of Specific Aircraft (6) ATI SHEET NO.: R-7-6-17	SUBJECT HEADINGS: B-36 - Stress analysis (14884.605); B-36A (14885); YB-36 (99854.3); Wings - Stresses (99180) 147800

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