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CF105
R-7-0558-4
Iss-3



TECHNICAL REPORT

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7/0358/4

SHEET NO. 1-5

AIRCRAFT

C-105

FRAME 697

PREPARED BY

DATE

G. MEYERS

OCT '56

CHECKED BY

DATE

TABLE OF MINIMUM MARGINS OF SAFETY

ITEM	DESCRIPTION	MODE OF FAILURE	MIN M.S.	PAGE
1.	FRAME ~ ELEMENTS #4 & 5	BENDING	+0.09	2-3
2.	VEE BRACE MAIN TUBE STRUTS	CRIPPLING	0.0	2-11
3.	VEE BRACE AT 1 ST LINE OF RIVETS	CRIPPLING	-0.03	2-14
4.	TUBE TO FITTING RIVET ATTACH	SHEAR	-0.01	2-15
5.	FITTING ~ TUBE ATTACH	COMPRESSION	0.0	2-16
6.	LUG END ~ TUBE TO FRAME	BEARING	0.0	2-18
7.	FRAME LUG	TENSION + SHEAR	+0.02	2-21
8.	BOLT ~ TUBE TO FRAME ATTACH	BENDING	-0.10	2-22
9.	LUG ~ STRUT TO WING ATTACH	SHEAR BEARING	+0.06	2-26
10.	RIVETS ~ ENG RAIL TO BEAM ATTACH	SHEAR	+0.06	2-30
11.	WEB ~ ENG. REM. BEAM	SHEAR	+0.09	2-43
12.	BRACKET ~ TRUSS END	BUCKLING	+0.08	2-46



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INTRODUCTION - SECTION I

THIS REPORT, BOOK IV, SUPERCEDES ALL PREVIOUS
WORK ON FRAME 697

THE CASE 11.3.6 (10 G ULT) IS CONSIDERED CRITICAL IN
THIS REPORT. HOWEVER ADDITIONAL CASES SUCH AS
ROLLING PULLOUT ARE TO BE INVESTIGATED AT A
LATER DATE.

IN THIS REPORT THE LOCAL AIR & DUCT PRESSURE EFFECTS
ARE CONSIDERED SMALL AND ARE NEGLECTED.



AVRO AIRCRAFT LIMITED
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TECHNICAL DEPARTMENT

REPORT NO. 7/0558/4

SHEET NO. 1-7

AIRCRAFT:

C-105

FRAME 697

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CALCULATION OF SECTION PROPERTIES

REF DWG NO 7-1058-1051 (SIDE) ISSUE 1
7-1058-1053 (BOTTOM) ISSUE 1

THE SECTION PROPERTIES OF 19 SELECTED SECTIONS ARE CALCULATED ON THE FOLLOWING PAGES BASED ON THE REF DWGS. AT ISSUE 1, FROM WHICH SECTION DEPTHS WERE SCALED WHEN DIMS. WERE NOT GIVEN.

AS NOTED PREVIOUSLY, THE FRAME IS "HOGGED-OUT" OF 75S-T6 PLATE. THE MIN. WEB THICKNESS IS LIMITED TO .10". THEREFORE THE WEBS ARE SUFFICIENTLY THICK TO BE CONSIDERED FULLY EFFECTIVE IN BENDING.

FOR GROSS SECTION PROPERTIES, WE HAVE INCLUDED EFFECTIVE SKIN = 1ST ON OUTBOARD SIDES OF 2 ROWS OF FLANGE RIVETS AND FULLY EFFECTIVE BETWEEN THE 1" SPACED ROWS

RIVET HOLES ARE NEGLECTED BECAUSE BEING SPACED AT 4D BECOME A LOCAL STRESS PROBLEM AND HAVE LITTLE EFFECT ON OVERALL FRAME STIFFNESS, A PROPERTY WE USE IN THE STRAIN ENERGY UNIT SOLUTIONS. AS REGARDS VALIDITY IN APPLYING THE RESULTING FRAME MOMENT DIAGRAM DERIVED BY STRAIN ENERGY TO A NET SECTION (HOLE AREA DEDUCTED ON TENSION SIDE) WE HAVE CONSIDERED THIS REASONABLE BECAUSE ON THE TENSION SIDE CAP, THE EFF. SKIN IS MUCH GREATER THAN THE 1ST USED IN CALC. THE STIFFNESS.

ALRO AIRCRAFT LIMITED
MILTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7/0558/4

SHEET NO. 1-9

AIRCRAFT

C-105

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SECTION PROPERTIES (CONTD)SECTION 2

(FOR SKETCH, SEE SECTION 1)

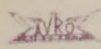
1 ELEMENT	2 WIDTH	3 HEIGHT	4 AREA	5 ARM	6 $A \times S$	7 $A \times S^2$	8 I_o
1	1.74	.20	.348	.10	.035	.004	—
2	.10	2.36	.236	1.36	.321	.436	.110
3	1.74	.14	.244	2.59	.631	1.635	—
4	2.91	.064	.186	2.71	.504	1.366	—
Σ			1.014		1.491	3.441	.110

$$I_o = \frac{.10 \times 2.36^3}{12} = .110 \text{ in}^4$$

$$\bar{x} = \frac{(6) / (4)}{1.014} = 1.491 / 1.014 = 1.47 \text{ in.}$$

$$I = (1) - (4) \times \bar{x}^2 + (8) = 3.441 - 1.014 \times 1.47^2 + .110 = 1.361 \text{ in}^4$$

$$h - \bar{x} = 2.74 - 1.47 = 1.27 \text{ in.}$$

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MALTON ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7/0558/4

SHEET NO. 1-13

AIRCRAFT

C-105

FRAME

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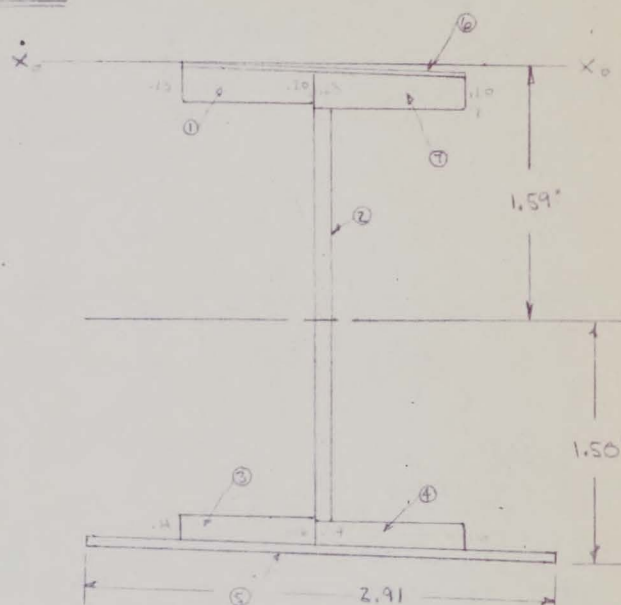
APRIL 1950

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DATE

SECTION PROPERTIES (CONTD)

SECTION 6



1	2	3	4	5	6	7	8
ELEMENT	WIDTH	HEIGHT	AREA	ARM	$A \times S$	$A \times S^2$	I_o
1	.82	.215	.176	.15	.0264	.00396	—
2	.10	2.57	.257	1.56	.401	.625	.141
3	.82	.15	.123	2.89	.355	1.027	—
4	.92	.15	.138	2.92	.402	1.176	—
5	2.91	.064	.186	3.02	.563	1.70	—
6	1.74	.025	.044	.04	.0017	.0001	—
7	.92	.215	.195	.17	.0336	.0057	—
Σ			1.122		1.7827	4.5378	.141

$$I_o = \frac{.10 \times 2.57^3}{12} = .141 \text{ in}^4$$

$$\bar{y} = \frac{(6)}{(4)} = 1.783 / 1.122 = 1.59 \text{ in.}$$

$$I = (7) - (4) \times \bar{y}^2 + (8) = 4.538 - 1.122 \times 1.59^2 + .141 = 1.839 \text{ in}^4$$



AVRO AIRCRAFT LIMITED
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TECHNICAL DEPARTMENT

AIRCRAFT

C-105

FRAME

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SHEET NO. 1-19

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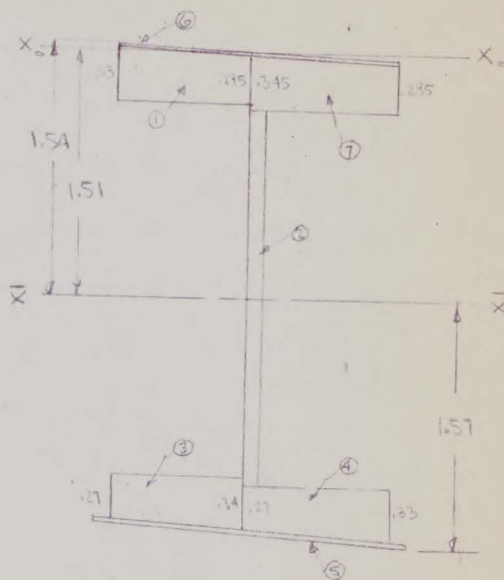
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SECTION PROPERTIES (CONTD)

SECTION 13



1	2	3	4	5	6	7	8
ELEMENT	WIDTH	HEIGHT	AREA	ARM	④ × ⑤	④ × ⑤ ²	I _o
1	.82	.312	.256	.15	.0384	.0058	—
2	.10	2.33	.233	1.53	.357	.546	.105
3	.82	.305	.250	2.80	.700	1.960	—
4	.92	.300	.276	2.86	.790	2.260	—
5	1.95	.032	.062	2.99	.188	.564	—
6	1.74	.025	.043	.012	.0004	—	—
7	.92	.320	.294	.20	.0588	.0118	—
Σ			1.415		2.1326	5.3476	.105

$$I_o = \frac{.10 \times 2.33^3}{12} = .105 \text{ IN}^4$$

$$\bar{y} = \frac{⑥}{④} = \frac{2.13}{1.415} = 1.51 \text{ IN}$$

$$I = ⑦ - ④ \times \bar{y}^2 + ⑧ = 5.348 - 1.415 \times 1.51^2 + .105 = \underline{\underline{2.233 \text{ IN}^4}}$$



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SHEET NO. 1-20

AIRCRAFT

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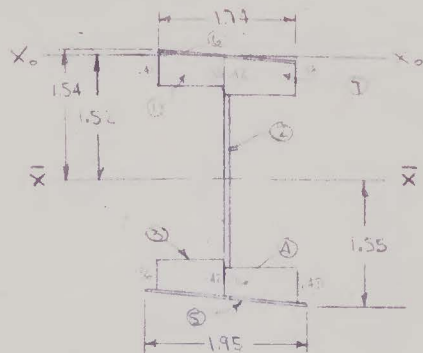
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SECTION PROPERTIES (CONT'D)

SECTION 14



1	2	3	4	5	6	7	8
ELEMENT	WIDTH	HEIGHT	AREA	ARM	$A \times S$	$A \times S^2$	I_o
1	.82	.345	.284	.20	.0648	.013	—
2	.10	2.17	.217	1.53	.332	.508	.085
3	.82	.39	.320	2.76	.883	2.440	—
4	.92	.315	.364	2.80	1.020	2.850	—
5	1.95	.032	.063	3.00	.181	.565	—
6	1.74	.025	.043	.012	.0004	—	—
7	.12	.40	.368	.24	.0888	.021	—
Σ			1.691		2.5775	6.397	.085

$$I_o = \frac{.10 \times 2.17^3}{12} = .085 \text{ in}^4$$

$$\bar{x} = \frac{(6)/(4)}{1.691} = 2.575/1.691 = 1.52 \text{ in.}$$

$$I = (7) - (4) \times \bar{x}^2 + (8) = 6.397 - 1.691 \times 1.52^2 + .085 = 2.562 \text{ in}^4$$



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AIRCRAFT

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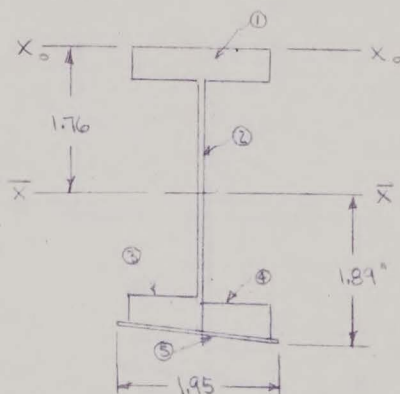
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SECTION PROPERTIES (CONTD)

SECTION 15



1	2	3	4	5	6	7	8
ELEMENT	WIDTH	HEIGHT	AREA	ARM	$A \times S$	$A \times S^2$	I_o
1	1.74	.39	.673	.195	.132	.0257	—
2	.10	2.64	.264	1.52	.401	.609	.153
3	1.92	.402	.369	3.23	1.192	3.850	—
4	.82	.412	.338	3.33	1.127	3.750	—
5	1.95	.032	.062	3.40	.211	.711	—
Σ			1.741		3.063	8.9457	.153

$$I_o = \frac{.10 \times 2.64^3}{12} = .153 \text{ in}^4$$

$$\bar{x} = \frac{(6)}{(3)} = 3.063 / 1.741 = 1.76 \text{ in}$$

$$I = (7) - (4) \times \bar{x}^2 + (5) = 8.946 - 1.741 \times 1.76^2 + .153 = 3.709 \text{ in}^4$$

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MALTON ONTARIO

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SHEET NO. 1-21

AIRCRAFT

C-105

FRAME

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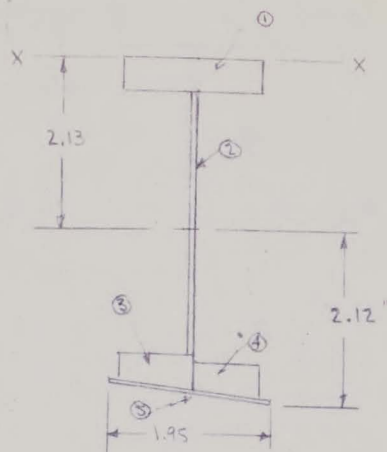
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SECTION PROPERTIES (CONTD)SECTION 16

1 ELEMENT	2 WIDTH	3 HEIGHT	4 AREA	5 ARM	6 $A \times S$	7 $A \times S^2$	8 I_p
1	1.74	.395	.687	.197	.135	.0266	—
2	.10	3.24	.324	2.03	.657	1.334	.284
3	.92	.40	.368	3.85	1.42	5.46	—
4	.82	.40	.328	3.96	1.30	5.15	—
5	1.95	.032	.062	4.12	.255	1.053	—
Σ			1.769		3.767	13.0236	.284

$$I_x = \frac{.10 \times 3.24^3}{12} = .284 \text{ in}^4$$

$$\bar{y} = \frac{6}{4} = 3.767 / 1.769 = 2.13 \text{ in}$$

$$I = 7 - 4 \times \bar{y}^2 + 5 = 13.02 - 1.769 \times 2.13^2 + .284 = 5.304 \text{ in}^4$$



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TECHNICAL DEPARTMENT

AIRCRAFT

C-105

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SHEET NO 1-23

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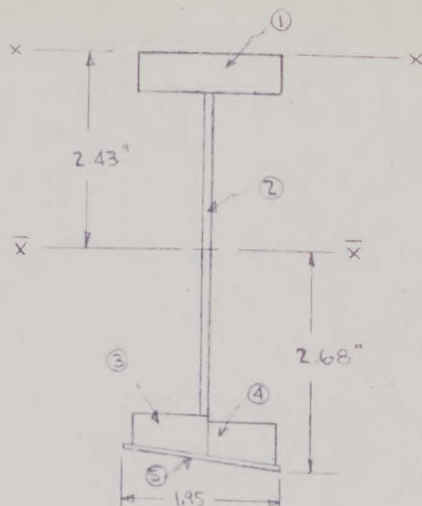
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SECTION PROPERTIES (CONTD)

SECTION 18



1	2	3	4	5	6	7	8
ELEMENT	WIDTH	HEIGHT	AREA	ARM	④ × ⑤	④ × ⑤ ²	I _o
1	1.74	.475	.826	.237	.196	.0464	—
2	.10	3.970	.397	2.47	.981	2.423	.522
3	.92	.452	.415	4.67	1.937	9.050	—
4	.82	.46	.377	4.24	1.618	6.940	—
5	1.99	.032	.062	4.18	.309	1.542	—
Σ			2.077		5.041	20.0014	.522

$$I_o = \frac{.10 \times 3.97^3}{12} = .522 \text{ in}^4$$

$$\bar{y} = \frac{⑥}{④} = 5.041 / 2.077 = 2.43 \text{ in.}$$

$$I = ⑦ - ④ \times \bar{y}^2 + ⑤ = 20 - 2.077 \times 2.43^2 + .522 = 8.25 \text{ in}^4$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO 7-CSSB/4

SHEET NO 1-26

AIRCRAFT:

C-105

FRAME 697

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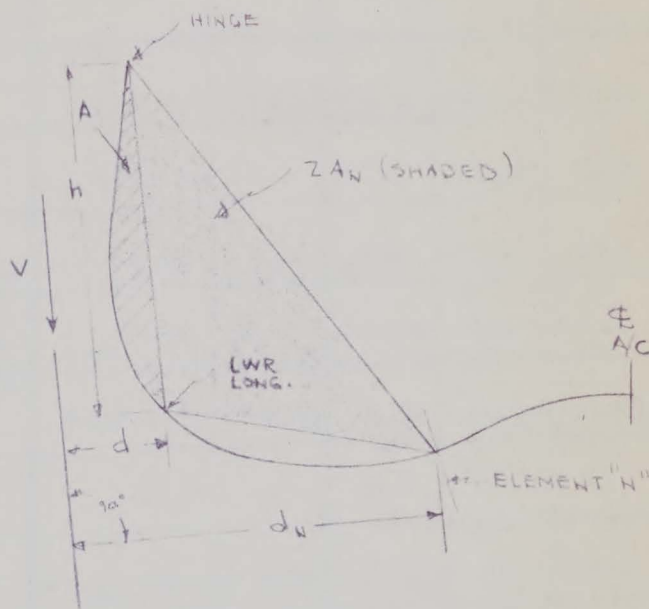
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DATE

CALC 2A BY METHOD III (REF PREV. PAGE)

AFTER DETERMINATION OF 2A, BY PLANIMETER, WE
CALCULATE 2A FOR ELEMENTS 7-19 INCL. BY FOLLOWING:



$$d = \frac{2A}{h}$$

TO FIND $2A_n$ FOR ANY ELEMENT

$$2A_n = \frac{d_n V}{f}$$

$$V = g h$$

$$\therefore 2A_n = d_n h$$

$$A = 141.32 \text{ in}^2 \text{ (BY PLANIMETER)}$$

$$2A = 282.64 \text{ in}^2$$

$$h = 45.44 \text{ in (SCALED)}$$

$$d = \frac{2A}{h} = \frac{282.64}{45.44} = \underline{\underline{6.22 \text{ in}}}$$

d IS LOCATED ON FULL-SIZE DWG & d, IS SCALED.

AVRO AIRCRAFT LIMITED
TECHNICAL DEPT. (AIRFRAME)

AIRCRAFT

C-105

WEIGHT

C. G POSITION

REPORT NO.

7/0558/4

SHEET

1-27

DATE _____

APRIL 1956

PREPARED BY -

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MALTON ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7/0558/4

SHEET NO. 1-28

AIRCRAFT:

C-105

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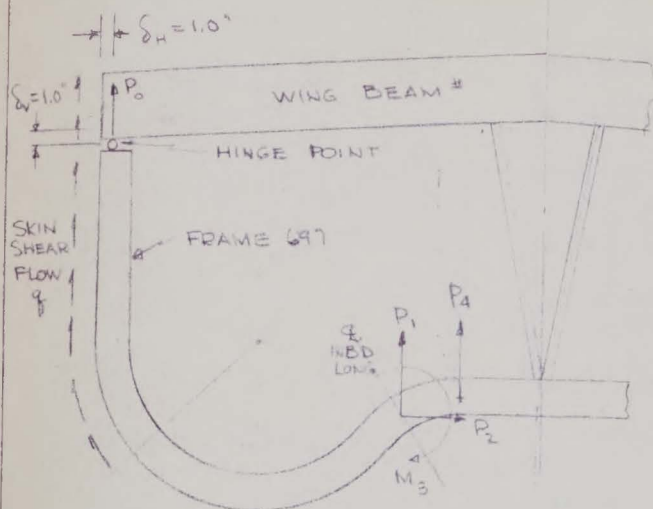
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UNIT ANALYSIS FOR FRAME 697



FRAME 697 RESISTS CONCENTRATED LOADS, MOMENTS & DEFLECTIONS AS SHOWN. THE INTERNAL MOMENT, SHEAR AND END LOAD WILL BE CALCULATED AT SELECTED STATIONS FOR EACH OF THE ABOVE "UNIT LOADS" SEPARATELY. THE TOTAL INTERNAL FRAME LOADS WILL THEN BE OBTAINED BY MULTIPLYING THE VALUES DUE TO A "UNIT LOAD" BY THE RATIO OF THE ACTUAL LOAD TO UNIT LOAD FOR EACH LOAD ACTING ON THE FRAME AND COMBINING THE RESULTS AT EACH SECTION.

P_0 - VERTICAL HINGE LOAD TRANSFERRED THRU PIN.

P_1 - VERTICAL } COMP. AT INBD LONGERON

P_2 - HORIZ. }

δ_v - VERTICAL }

δ_h - HORIZ }

INDUCED DEFLECTION AT PIN DUE TO WING BENDING.

M_3 - MOMENT INDUCED BY INBD LONGERON

P_4 - DOOR EDGE BEAM LOAD.



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

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REPORT NO. 1/0558/4

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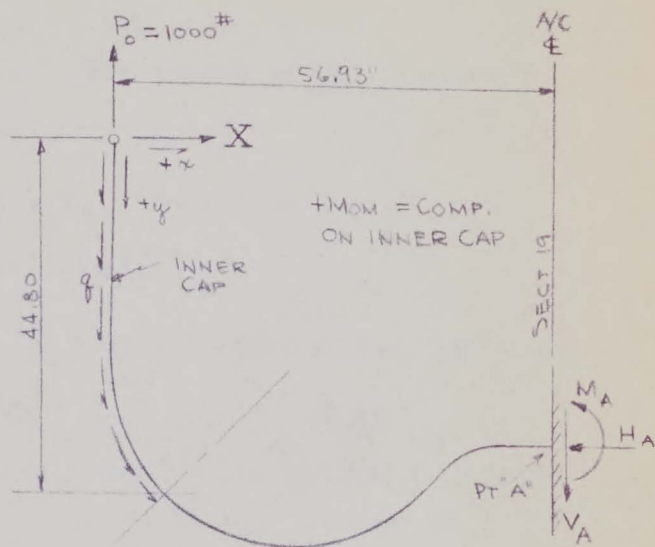
DATE

AIRCRAFT:

C-105

FRAME 697

UNIT ANALYSIS FOR LOAD $P_o = 1000 \#$



FOR THIS CASE WE HAVE 5 UNKNOWN (X, M_A , H_A , V_A & θ)
AND 3 EQUATIONS OF STATICS ($\Sigma H = 0$; $\Sigma V = 0$ & $\Sigma M = 0$)
∴ USE M_A & H_A AS THE REDUNDANTS AT PT "A" WHERE
BOTH SLOPE & HORIZONTAL DEFLECTION = 0. DUE TO
SYM. LOADING, WE HAVE:

$$\theta_A = 0 = \sum \frac{M m ds}{EI}$$

$$\delta_{A \text{ HORIZ}} = 0 = \sum \frac{M m ds}{EI}$$

AFTER CALC. M_A & H_A , THE INTERNAL MOM, SHEAR &
END LOAD IS DETERMINED BY EQUATIONS OF STATICS.



AVRO AIRCRAFT LIMITED
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TECHNICAL DEPARTMENT

REPORT NO. 7/0558/4

SHEET NO. 1-30

AIRCRAFT:

C-105

FRAME 697

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UNIT ANALYSIS FOR LOAD $P_2 = 1000 \#$ (CONT'D)

TO OBTAIN X , q & V_A IN TERMS OF UNKNOWN H_A & M_A :

$$\sum \vec{H} = 0 : X + q(x_5) - H_A = 0$$

$$x_5 = 7.17' \text{ (REF SECT 7, P 1-27, LINE 9)}$$

$$\therefore X = H_A - 7.17 q$$

$$\downarrow \sum V = 0 : 44.80 q + V_A - 1000 = 0$$

$$\therefore V_A = 1000 - 44.80 q$$

$$\sum M_A = 0 : -1000(56.93) + 2Aq + M_A - 46.77 X = 0$$

$$-56,930 + 2445.56 q + M_A - 46.77 (H_A - 7.17 q)$$

$$-56,930 + 2495.56 q + M_A - 46.77 H_A + 335.341 q = 0$$

$$2830.901 q = -M_A + 46.77 H_A + 56,930$$

$$q = -353.244 \times 10^{-6} M_A + 16.521 \times 10^{-3} H_A + 20.11$$

$$X = H_A - 7.17 q = H_A - 7.17(-353.244 \times 10^{-6} M_A + 16.521 \times 10^{-3} H_A + 20.11)$$

$$X = H_A + 2532.759 \times 10^{-6} M_A - 118.456 \times 10^{-3} H_A - 144.189$$

$$X = 2.533 \times 10^{-3} M_A + .88154 H_A - 144.189$$

$$V_A = 1000 - 44.80 q$$

$$V_A = 1000 - 44.80(-353.244 \times 10^{-6} M_A + 16.521 \times 10^{-3} H_A + 20.11)$$

$$V_A = 1000 + 15.825 \times 10^{-3} M_A - 740.141 \times 10^{-3} H_A - 900.93$$

$$V_A = 15.825 \times 10^{-3} M_A - .740141 H_A + 99.07$$

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AVRO AIRCRAFT LIMITED

TECHNICAL DEPT. (AIRFRAME)

AIRCRAFT - C-105

WEIGHT

C. G. POSITION

REPORT NO. 7/0558/4

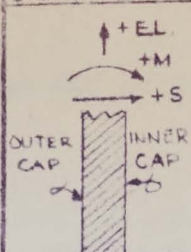
SHEET . . . 1-31

DATE . . . APRIL 1956

PREPARED BY - G. MEYERS

7	8	9	10	11	12	13	14	15	16	17	18	19
110.11	119.23	126.95	131.89	133.69	132.15	129.84	127.21	121.38	119.99	119.05	118.37	118.47
121.49	171.73	235.28	306.54	382.78	462.38	501.06	541.02	626.89	674.72	723.03	801.35	881.43
—	—	—	—	—	—	—	—	—	—	—	—	—
231.60	240.16	362.23	438.43	516.47	544.53	630.90	668.23	748.27	794.71	847.09	919.72	981.90
978.74	1021.27	1265.63	1453.83	1484.55	1772.89	767.24	673.58	1108.94	1442.65	349.46	548.55	484.95
38,320.5	41,494.1	44,182.8	45,901.8	46,527.7	45,182.9	45,187.7	44,270.9	42,243.4	41,758.5	41,432.5	41,194.4	41,229.6
5,682.9	8,022.7	11,005.5	14,525.6	17,904.5	21,628.1	23,437.4	25,306.5	29,323.0	31,560.1	33,819.6	37,483.2	41,229.1
—	—	—	—	—	—	—	—	—	—	—	—	—
32,637.6	33,461.4	33,171.9	31,563.2	28,623.2	24,361.8	21,750.3	18,964.4	12,920.4	10,198.4	7,612.9	3,711.2	.5

SIGN CONVENTION



ANALYSIS OF HEAVY FRAME

UNIT ANALYSIS FOR LOAD $P_0 = 1000 \text{ kg}$ (CONTD)

CALCULATION OF REDUNDANTS H_A & M_A

-1051 ①
(REF DWG 7-1058-1053 ①)

SECTION →	1	2	3	4	5	6	7	8	9	10
⑮ $\frac{\partial M}{\partial H_A} (\frac{\Delta S}{I})$	$\times 10^{-3}$	$\times 10^{-3}$	$\times 10^{-3}$	$\times 10^{-3}$						
⑮ LINE ⑮ $\times$ ⑥	55,620.6	58,153.8	68,928.0	75,849.5	83,112.4	102,694.5	137,926.5	174,449.5	115,921.5	104,600.0
⑮ DUE TO $Y =$										
⑮ (NONE)										
⑮ DUE TO $X =$										
⑮ -144.189 ② P.	-1,214.1	-2,112.4	-3,023.6	-3,903.2	-4,748.1	-5,542.6	-6,267.9	-6,877.0	-7,226.8	-7,500.0
⑮ DUE TO $q =$										
⑮ 20.11 (-2A)	-168.7	-365.0	-421.7	-1,032.8	-2,111.1	-3,787.9	-6,917.4	-9,777.7	-13,396.3	-17,450.0
⑮ DUE TO V_A										
⑮ +99.07 $\times$ 0	—	—	—	—	—	—	—	—	—	—
⑮ DUE TO $P_0 =$										
⑮ 1000 $\times$ η_{CG}	+480.0	+330.0	+150.0	+530.0	+1,970.0	+4,300.0	+8,330.0	+12,110.0	+16,120.0	+21,420.0
⑮ MOM DUE TO CONSTANTS										
⑮ Σ ⑮ ⑮ ⑮ ⑮ ⑮	-902.8	-2,147.4	-3,295.3	-3,576.0	-4,889.2	-5,830.5	-4,355.3	-4,454.7	-4,003.1	-3,540.0
⑮ $M_A (\frac{\partial M}{\partial M_A}) (\frac{\Delta S}{I})$										
⑮ = ⑮ $\times$ ⑮	.005	.009	.015	.026	.044	.070	.227	.297	.458	.637
⑮ $H_A (\frac{\partial M}{\partial H_A}) (\frac{\Delta S}{I})$										
⑮ = ⑮ $\times$ ⑮	1.351	2.531	4.340	6.811	10.014	16.831	31.944	34.173	41.990	45.800
⑮ $K (\frac{\partial M}{\partial M_A}) (\frac{\Delta S}{I})$										
⑮ = ⑮ $\times$ ⑮	-167.5	-430.8	-793.5	-1,064.2	-1,793.8	-2,751.3	-4,752.1	-4,549.5	-5,066.4	-5,140.0
⑮ $H_A (\frac{\partial M}{\partial H_A}) (\frac{\Delta S}{I})$										
⑮ ⑮ $\times$ ⑮	405.1	733.6	1,242.4	1,807.9	2,268.5	3,160.4	4,501.6	3,930.0	3,846.0	3,300.0
⑮ $K (\frac{\partial M}{\partial H_A}) (\frac{\Delta S}{I})$										
⑮ ⑮ $\times$ ⑮	50,214	124,879	227,138	282,464	406,353	516,005	669,615	523,202	464,045	370,600
⑮ Σ LINE ⑮ =	6.936									
⑮ EQ 1:										
⑮ 0 = 6.936 M_A + 333.241										
⑮ Σ LINE ⑮ =	333.241									
⑮ EQ 2:										
⑮ 0 = 333.241 M_A + 30,554.6										
⑮ Σ LINE ⑮ =	41,554.6									
⑮ EQ 1 $\times$ (-										
⑮ 333.241)										
⑮ 6.936										
⑮ 0 =										
⑮ 333.241 M_A - 16,010										
⑮ Σ LINE ⑮ =	30,554.6									
⑮ 0 =										
⑮ 14,554										
⑮ Σ LINE ⑮ =	4,207,547									
⑮ $H_A =$										
⑮ 151										



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C-105

FRAME 697

REPORT NO. 7/0558/4

SHEET NO. 1-33

PREPARED BY

DATE

G. MEYERS

APR 56

CHECKED BY

DATE

UNIT ANALYSIS FOR LOAD $P_0 = 1000 \#$ 4 (CONTD)

FROM PRECEEDING PAGE:

$$M_A = -1,308.8 \#$$

$$H_A = 151.94 \#$$

$$q = -353.24 \times 10^{-6} M_A + 16.52 \times 10^{-3} H_A + 20.11$$

$$q = -353.24 \times 10^{-6} (-1,308.8) + 16.52 \times 10^{-3} (151.94) + 20.11$$

$$q = +.4623 + 2.5100 + 20.11 = \underline{\underline{23.0823 \#}} \downarrow$$

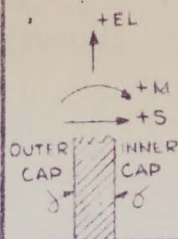
$$X = 2.533 \times 10^{-3} M_A + .88154 H_A - 144.189$$

$$X = .002533 (-1,308.8) + .88154 (151.94) - 144.189 = \underline{\underline{-13.56 \#}}$$

$$V_A = .015825 M_A - .740141 H_A + 99.07$$

$$V_A = .015825 (-1,308.8) - .740141 (151.94) + 99.07 = \underline{\underline{-34.10 \#}}$$

SIGN CONVENTION



ANALYSIS OF HEAVY FRAME 697

CALCULATION OF INTERNAL BENDING MOMENTS, SHEARS &
END LOADS DUE TO $P_0 = 1000 \#$

(FOR EQUATIONS SEE 710538/26 P. 1-7)

(FOR FRAME CONSTANTS SEE P. 1-27) (REF DWG 7-1058-1051/3)



AIRCRAFT

WEIGHT

C. G. P.

SECTION ->	1	2	3	4	5	6	7	8	9	10
(1) $+P_0(x) = +1000$ (1) P	+480	+330	+150	+530	+1,170	+4,300	+8,330	+12,110	+16,620	+21,420
(2) $+X(y) = -13.56$ (2) P	-114	-199	-284	-367	-447	-521	-581	-638	-680	-706
(3) $-2A\bar{y} = 23.0823$ (3) P	-194	-419	-644	-1,186	-2,423	-4,348	-7,140	-11,223	-15,376	-20,033
(4)										
(5)										
(6) INTERNAL B.M. $= \Sigma (1)(2)(3)$	+172	-288	-778	-1023	-900	-569	-799	+249	+564	+681
(7) $\sin \theta$	SEE (1) P. 1-27									
(8) $\cos \theta$	SEE (2) P. 1-27									
(9) $\bar{y}(y_s) = -23.082$ (10) P	-194	-338	-484	-629	-771	-903	-1034			
(10) $P_y = 1000$ (9)	+806	+662	+516	+371	+229	+97	-34			
(11) $\bar{y}(x_s) = -(-23.082)$ (9) P	-15	-21	-27	-20	-13	-72	+165			
(12) $P_x = +X + (11) = -13.56 + (11)$	-29	-35	-41	-34	-1	-58	-151			
(13) $P_y \cos \theta = (10) \times (8)$	+806	+662	+516	+366	+218	+84	-22	-21	-16	-9
(14) $-P_x \sin \theta = -(12) \times (7)$	-1	-1	+2	+5	0	-29	-113	-120	-134	-146
(15) END LOAD $= (13) + (14)$	+805	+661	+518	+371	+218	+55	-135	-141	-150	-155
(16) $P_y \sin \theta = (10) \times (7)$	-21	-17	+23	+58	+71	+48	-26	-27	-30	-33
(17) $P_x \cos \theta = (12) \times (8)$	-29	-35	-41	-34	-1	-50	-99	-92	-70	-35
(18) SHEAR $(16) + (17)$	-50	-52	-18	+24	+72	+98	+73	+65	+40	+2



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7/0558/4

SHEET NO. 1-35

AIRCRAFT:

C-105

FRAME 697

PREPARED BY

DATE

G. MEYERS

MAY 1956

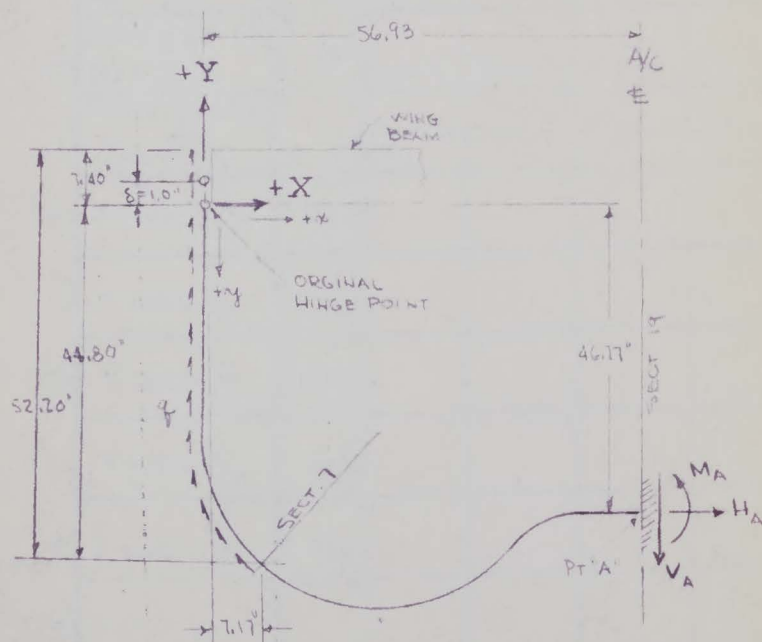
CHECKED BY

DATE

CALCULATION OF FRAME STIFFNESS (SPRING-RATE)

THE VERTICAL LOAD IN THE VEE BRACE STRUT REQUIRED TO DEFLECT THE FRAME 1" AT PT "A" (E OF A/C) WILL BE CALCULATED. THIS IS DONE BY THE METHOD OF "LEAST WORK" USING FINITE INTEGRATION AS SET OUT IN FRAMES 712 & 717, REPORT 7/0558/26, PI-4 TO 1-8. ONCE THE REACTIONS X & Y ARE DETERMINED, THE OTHER FRAME REACTIONS MAY BE OBTAINED BY APPLYING THE EQUATIONS OF STATICS.

AS SHOWN BELOW, THE SAME RESULTS MAY BE OBTAINED BY FIXING THE FRAME AT THE A/C E AND SETTING THE VERTICAL DEFLECTION AT THE HINGE PIN EQUAL TO 1.0" & THE HORIZONTAL DEFLECTION EQUAL TO ZERO. THIS FACILITATES THE CALCULATIONS IN THAT THE "FRAME CONSTANTS AT SELECTED SECTIONS" SHOWN ON PAGE 1-27 MAY BE USED.





ANALYSIS OF HEAVY FRAME 697
UNIT ANALYSIS FOR LOAD $\delta_v = 1.0'' \uparrow$
CALCULATION OF REDUNDANTS H_A & M_A

AIRCRAFT
WEIGHT
C. G. P.

SECTION →	1	2	3	4	5	6	7	8	9	10	
(1) $(\Delta S/I) \times$ ① P. x ② P.	3.665	1.521	.574	1.809	5.999	14.349	35.203	42.506	58.070	71.029	
(2) $(\Delta S/I) \times (2 A_g)$ ① x ⑤ P.	319	28	16	43	630	2703	12,109	20,667	38,683	61,646	8
(3) $(\Delta S/I) \times (X \cdot y)$ ① x ② P.	31X	22	12	49	198	552	1530	2,001	2,910	3,698	4
(4) $(\Delta S/I) \times y$ ② P. x ② P.	64.30	67.54	80.19	92.39	100.27	128.27	183.70	165.22	175.12	172.66	1
(5) $(\Delta S/I) \times (2 A_g)$ ④ x ⑤ P.	5399	1226	2,236	4,745	10,516	24,161	63,189	80,332	116,656	149,852	16
(6) $(\Delta S/I) \times (X \cdot y)$ ④ x ② P.	541X	989	1,682	2,501	3,302	4,931	7,985	7,777	8,177	8,990	8
(7) $(\Delta S/I) \times (Y \cdot z)$ ① x ① P.	1.8Y	.5	.1	1.0	11.8	61.7	293.2	514.7	965.1	1521.4	1
(8) Σ LINE (2)	782,802										
(9) Σ LINE (3)	31,336 X & 31,336Y										
(10) Σ LINE (5)	1,316,342										
(11) Σ LINE (6)	77,009 X										
(12) Σ LINE (7)	18,504.7 Y										
(13)											
(14)											
(15)											



SHEET . . . 1-36

DATE . . . MAY 12, 56

PREPARED BY - G. MEYERS

AIRCRAFT : C-105

WEIGHT . . . _____

C. G. POSITION - _____

[illegible]



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 70558/4

SHEET NO. 1-37

PREPARED BY

DATE

G. MEYERS

MAY 1956

CHECKED BY

DATE

AIRCRAFT:

C-105

FRAME 697

CALCULATION OF FRAME STIFFNESS

$$\uparrow \Sigma F_v = 0 : 52,20 \text{ g} - V_A = 0$$

$$Y = 7.40 \text{ g} \left\{ \begin{array}{l} \text{VERTICAL LOAD TRANSMITTED THRU HINGE} \\ \text{PIN} = \text{SHEAR LOAD IN STRUCTURE ABOVE PIN} \end{array} \right.$$

$$\begin{aligned} S_v &= +10 (10.3 \times 10^6) = 782,862 \text{ g} + 31,336 X + 18,504.7 Y \\ &= 782,862 \text{ g} + 31,336 X + 136,934.8 \text{ g} \\ 10.3 \times 10^6 &= 919,797 \text{ g} + 31,336 X \quad (1) \end{aligned}$$

$$\begin{aligned} S_H &= 0 = 1,316,342 \text{ g} + 77,009 X + 31,336 Y \\ &= 1,316,342 \text{ g} + 77,009 X + 231,886 \text{ g} \\ 0 &= 1,548,228 \text{ g} + 77,009 X \\ -2.53125 \times 10^7 &= -2,260,424 \text{ g} - 77,009 X \quad (2) \end{aligned}$$

$$\begin{aligned} -25,312,508 &= -712,196 \text{ g} \\ \text{g} &= +35.541 \text{ #/"} \end{aligned}$$

SUBSTITUTING IN EQ (2):

$$X = \frac{-1,548,228 \times 35.541}{77,009} = -714.534 \text{ #} \quad (4-)$$

$$Y = 7.40 \text{ g} = 7.40 \times 35.541 = 263 \text{ #} \uparrow$$

SUBSTITUTING IN EQ (1)

$$10,300,000 = 919,797 \times 35.541 + 31,336 (-714.534)$$

$$10,300,000 = 10,299,900 \text{ (CHECK)}$$

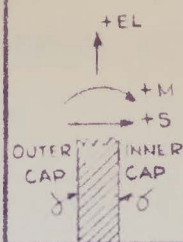
$$V_A = 52,20 \times 35.541 = 1855.24 \text{ #} \downarrow$$

$$\text{SPRING RATE} = 2 \times 1855.24 = 3710.48 \text{ #/"} \uparrow$$

$$M_A = 263 \times 56.93 + 35.541 \times 2495.56 - 714.534 \times 46.77 = 70248.5 \text{ #} \text{ g}$$

$$H_A = 714.534 + 35.541 \times 7.17 = 969.36 \text{ #} \rightarrow$$

FIG. C. 1.21 1-11



ANALYSIS OF HEAVY FRAME 697 CALCULATION OF INTERNAL BENDING MOMENTS, SHEARS & END LOADS DUE TO HINGE DEFLECTION $\delta = 1.0''$

(FOR EQUATIONS SEE 7/0558/26 P. 1-7)

(FOR FRAME CONSTANTS SEE P. 1-27) (REF DWG 7-1058-1051/3)

AIRCRAFT
WEIGHT
C. G.

SECTION	1	2	3	4	5	6	7	8	9	10
1 $+Y(x) = +263$ (1 P.	126	87	39	139	518	1,131	2,191	3,185	4,371	5,633
2 $+X(y) = -714.534$ (2 P.	-6,016	-10,468	-14,984	-19,342	-23,530	-27,467	-31,061	-33,633	-35,812	-37,206
3 $+Z A_z = 35.541$ (5 P.	293	645	991	1,825	3,731	6,645	12,225	17,280	23,676	30,846
4										
5										
6 INTERNAL B.M. $= \Sigma (1)(2)(3)(4)(5)$	-5,592	-9,736	-13,954	-17,378	-19,281	-19,641	-16,645	-13,168	-7,765	-727
7 $\sin \theta$	SEE (1) P.	1-27								
8 $\cos \theta$	SEE (8) P.	1-27								
9 $f(y_s) = 35.541$ (10 P.	299	521	745	968	1,187	1,391	1,592			
10 $P_y = Y + f(y_s) = 263 + (9)$	562	784	1,008	1,231	1,450	1,654	1,855			
11 $-f(x_s) = -35.541$ (9 P.	+22	+32	+42	+31	-20	-110	-255			
12 $P_x = X - f(x_s) = -715 + (11)$	-693	-683	-673	-684	-735	-825	-970			
13 $P_y \cos \theta = (10) \times (8)$	562	784	1,007	1,216	1,379	1,440	1,217	1,129	857	496
14 $-P_x \sin \theta = -(12) \times (7)$	-18	-18	+29	+107	+227	+406	+732	+770	+860	+935
15 END LOAD $= (13) + (14)$	+544	+766	+1,036	+1,323	+1,606	+1,846	+1,949	+1,899	+1,717	+1,431
16 $P_y \sin \theta = (10) \times (7)$	-15	-21	44	193	448	814	1,400	1,472	1,645	1,787
17 $P_x \cos \theta = (13) \times (8)$	-693	-683	-672	-676	-699	-718	-636	-591	-448	-259
18 SHEAR $= (16) + (17)$	-708	-704	-628	-483	-251	+96	+764	+881	+1,197	+1,528

FORM 1543
18



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C-105

FRAME 697

REPORT NO. 7/0558/4

SHEET NO. 1-29

PREPARED BY

DATE

G. MEYERS

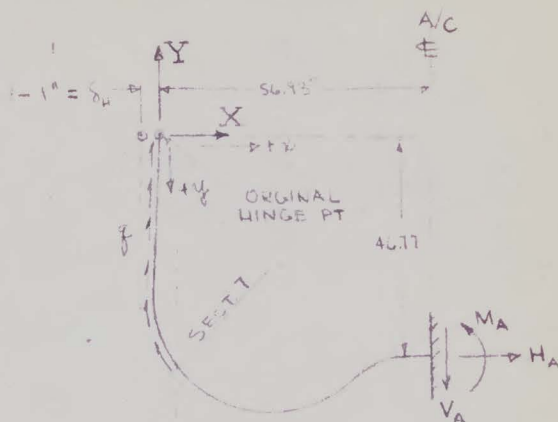
MAY 1956

CHECKED BY

DATE

UNIT SOLUTION FOR $\delta_H = -1.0'' \leftarrow$

EQUATIONS WILL BE IDENTICAL TO THOSE FOR UNIT SOLUTION $\delta_V = +1.0'' \uparrow$ (REF P. 35) EXCEPT FOR DEFLECTION SUBSTITUTION:



$$\delta_V = 0 = 182,862 \delta + 21,336 X + 18,504.7 Y$$

$$0 = 919,797 \delta + 31,336 X \quad (1)$$

$$\delta_H = -1.0'' \times 10.3 \times 10^6 = 1,316,342 \delta + 77,009 X + 21,336 Y$$

$$-0.3 \times 10^6 = 1,548,228 \delta + 77,009 X \quad (2)$$

$$0 = -2,260,424 \delta - 77,009 X \quad (1) = -1 \times \frac{77,009}{31,336}$$

$$-10.3 \times 10^6 = -712,196 \delta$$

$$\delta = +14.462'' \uparrow \quad Y = 7.4 \delta = +107.02'' \uparrow$$

SUB. IN EQ. (1):

$$X = \frac{-919,797(+14.462)}{31,336} = -424.5'' \leftarrow$$

$$V_A = 52.20 \delta = 754.92'' \downarrow$$



AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 70558/4

SHEET NO. 1-40

PREPARED BY

DATE

G. MEYERS

MAY 1956

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DATE

AIRCRAFT:

C-105

FRAME 697

UNIT SOLUTION FOR $S_{0H} = -1.0'' \leftarrow$ (CONT'D)

FROM PREVIOUS PAGE:

$$f = +14.462'' \uparrow$$

$$Y = +107.02'' \uparrow$$

$$X = -424.5'' \leftarrow$$

$$V_A = 754.92'' \downarrow$$

$$H_A = +424.5 + 14.462 \times 7.17'' = +528.2'' \rightarrow$$

$$\sum M_A = 0 = -M_A - 424.5 \times 46.77 + 14.462 \times 2,495.56 + 107.02 \times 56.93$$

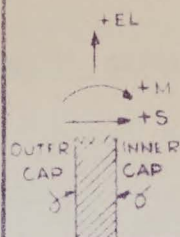
$$M_A = 22,329.6'' \curvearrowright$$

CHECK:

$$\sum F_H = -424.5 + 528.2 - 14.462 \times 7.17 = 0 \text{ (CHECK)}$$

$$\sum F_V = 14.462 \times 44.80 + 107.02 - 754.92 = 0 \text{ (CHECK)}$$

FIG. 1-19



ANALYSIS OF HEAVY FRAME 697

CALCULATION OF INTERNAL BENDING MOMENTS, SHEARS & END LOADS DUE TO HINGE DEFLECTION $S_H = 1.10$

(FOR EQUATIONS SEE 7-1058/26 P. 1-7)

(FOR FRAME CONSTANTS SEE P. 1-27) (REF DWG 7-1058-105/3)

AIRCRA
WEIG
C. G.

SECTION	1	2	3	4	5	6	7	8	9	10
1 +Y (v) = +107.02 (1) P	51	35	16	57	211	460	891	1,296	1,779	2,292
2 +X (u) = -424.5 (2) P	3,574	6,219	8,902	11,491	13,979	16,318	18,453	19,981	21,276	22,104
3 +Z A _g = +14.462 (5) P	121	262	403	743	1,518	2,724	4,175	7,032	9,634	12,552
4										
5										
6 INTERNAL B.M. = Σ (1, 2, 3, 4, 5)	3,402	5,922	8,483	10,691	12,250	13,134	12,587	11,653	9,863	7,260
7 SIN θ	SEE (1) P. 1-27									
8 COS θ	SEE (3) P. 1-27									
9 q (u _g) 14.462 (10) P	122	212	303	394	483	566	648			
10 P _y = Y + q (u _g) = 107 + (1)	229	319	410	501	590	673	755			
11 -q (x _g) -14.462 (9) P	+ 9	+ 13	+ 17	+ 13	- 8	- 45	- 104			
12 P _x = X - q (x _g) = -424.5 + (11)	- 416	- 412	- 408	- 412	- 433	- 470	- 529			
13 P _y COS θ = (10) × (8)	229	319	410	495	561	586	495	460	349	202
14 -P _x SIN θ = - (12) × (7)	- 11	- 11	18	64	134	231	399	420	469	510
15 END LOAD = (13) + (14)	218	308	428	559	695	817	894	880	818	712
16 P _y SIN θ = (10) × (7)	- 6	- 8	18	78	182	331	570	599	670	725
17 P _x COS θ = (12) × (8)	- 416	- 412	- 408	- 407	- 412	- 456	- 347	- 322	- 244	- 141
18 SHEAR (16) + (17)	- 422	- 420	- 426	- 329	- 230	- 125	+ 223	+ 277	+ 426	+ 587



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7/0555/4

SHEET NO. 1-42

AIRCRAFT:

C-105

FRAME 697

PREPARED BY

DATE

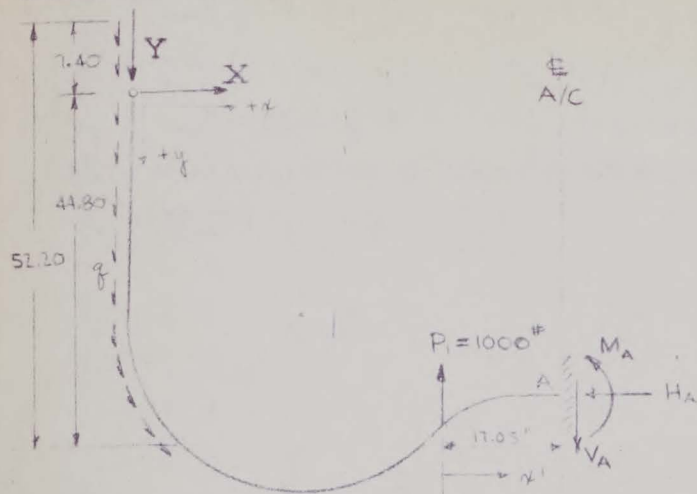
G. MEYERS

MAY 1956

CHECKED BY

DATE

UNIT ANALYSIS FOR $P_1 = 1000 \text{ lb}$



TO OBTAIN X, Y, θ & V_A IN TERMS OF H_A & M_A

$$\sum H = 0: X + \theta(7.4) - H_A = 0$$

$$\theta = 7.17$$

$$\therefore X = H_A - 7.17 \theta$$

$$\sum V = 0: -52.20 \theta + 1000 - V_A = 0$$

$$V_A = 1000 - 52.20 \theta \quad \& \quad Y = 7.40 \theta$$

$$\sum M_A = 0: Y(7.4) + 2A\theta + M_A = 17,050 + 46.77 X$$

$$56.93(7.4\theta) + 2495.56\theta + M_A = 17,050 + 46.77(H_A - 7.17\theta)$$

$$421.28\theta + 2495.56\theta + M_A = 17,050 + 46.77H_A - 335.34\theta$$

$$3,252.18\theta = 17,050 - M_A + 46.77H_A$$

$$\theta = -307.486 \times 10^{-6} M_A + 14.381 \times 10^{-3} H_A + 5.243$$

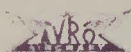
$$X = H_A - 7.17\theta = H_A - 7.17(-307.486 \times 10^{-6} M_A + 14.381 \times 10^{-3} H_A + 5.243)$$

$$X = 1.0H_A + 2.205 \times 10^{-3} M_A - .10311 H_A - 37.592$$

$$X = 2.205 \times 10^{-3} M_A + .89689 H_A - 37.592$$

4 (CONT'D)

MA



AVRO AIRCRAFT LIMITED

TECHNICAL DEPT. (AIRFRAME)

AIRCRAFT

C-105

WEIGHT

C. G. POSITION

REPORT NO 7/055B/4

SHEET 1-44

DATE MAY 1956

PREPARED BY G. MEYERS

7	8	9	10	11	12	13	14	15	16	17	18	19
								1.14	4.08	7.05	11.92	17.05
18.95	27.55	37.81	48.73	59.99	71.23	76.44	81.81	93.32	100.01	106.77	117.85	129.52
95.85	103.79	110.51	114.81	116.38	115.03	113.03	110.74	105.66	104.45	103.64	103.04	103.13
105.71	149.50	204.83	266.87	333.23	402.54	436.21	471.00	545.15	587.39	629.45	697.63	767.25
220.57	280.84	352.15	430.41	509.60	588.80	625.68	663.55	744.73	791.85	839.86	918.52	1000.00
932.13	985.15	1233.91	1427.24	1465.10	1755.80	701.39	668.86	1,103.69	441.06	348.54	493.25	485.00
886.41	1,288.73	1,768.68	2,279.41	2,800.27	3,331.93	3,575.68	3,826.83	4,365.31	4,673.13	4,944.24	5,512.50	6,058.43
38,983.8	42,216.6	44,952.1	46,701.1	47,337.9	46,790.8	45,974.6	45,041.8	42,979.0	42,485.7	42,153.8	41,911.7	41,947.5
4,946.8	6,992.2	9,579.9	12,481.3	15,585.3	18,826.6	20,401.5	22,028.5	25,524.7	27,472.0	29,438.9	32,627.9	35,898.6
33,154.5	33,935.9	33,602.5	1940.3	28,946.7	24,632.2	21,997.4	19,186.5	13,081.0	10,335.5	7,720.7	3,771.3	0.5



TECH

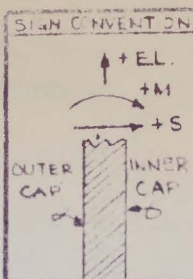
AIRCRAFT

WEIGHT

C. G. POSITION

ANALYSIS OF HEAVY FRAME 697
UNIT ANALYSIS FOR LOAD $P_1 = 1000 \text{ lb}$ (CONTD)
CALCULATION OF REDUNDANTS H_A & M_A

(REF DWG 1-1058 - 1051 ①)



SECTION →	1	2	3	4	5	6	7	8	9	10	11
⑮ $\frac{\partial M}{\partial H_A} (\frac{\Delta S}{I})$	$\times 10^{-3}$	$\times 10^{-3}$	$\times 10^{-3}$	$\times 10^{-3}$							
⑮ LINE ⑮ $\times 6$	56,353.7	59,207.6	70,326.0	80,150.2	84,697.6	104,481.8	140,110.9	119,114.3	117,410.6	105,914.0	83,220
⑮ DUE TO Y =											
⑮ 33.798 (-14)	18.6	12.8	5.8	20.6	16.4	166.8	323.2	469.8	644.8	831.1	1,023.0
⑮ DUE TO X =											
⑮ -37.592 14	316.5	550.7	788.3	1,017.6	1,237.9	1,445.0	1,634.1	1,769.4	1,884.1	1,957.4	1,984.1
⑮ DUE TO q =											
⑮ 5.243 (-2A)	44.0	95.2	146.2	269.3	550.4	987.6	1803.5	2,549.2	3,492.6	4,550.4	5,682
⑮ DUE TO V_A											
⑮ 726.315 (0)	—	—	—	—	—	—	—	—	—	—	—
⑮ DUE TO P_1											
⑮ 1000 lb	—	—	—	—	—	—	—	—	—	—	—
⑮ MOM DUE TO CONSTANTS											
⑮ Σ ⑮ ⑮ ⑮ ⑮ ⑮	379.1	658.7	940.3	1,307.5	1,864.7	2,599.4	3,760.8	4,789.4	6,021.5	7,338.9	8,689
⑮ $M_A (\frac{\partial M}{\partial M_A}) (\frac{\Delta S}{I})$											
⑮ = ⑮ $\times 12$	0038	10069	10116	10201	10364	10776	12056	12768	14358	16143	17460
⑮ $H_A (\frac{\partial M}{\partial H_A}) (\frac{\Delta S}{I})$											
⑮ = ⑮ $\times 12$	1.25	2.29	3.88	6.15	9.26	15.93	30.90	33.45	41.46	45.59	42.14
⑮ $K (\frac{\partial M}{\partial M_A}) (\frac{\Delta S}{I})$											
⑮ = ⑮ $\times 12$	64.4	117.3	198.3	342.2	621.0	1322.5	3,505.6	4,720.2	7,430.0	10,474.4	12,730
⑮ $H_A (\frac{\partial M}{\partial H_A}) (\frac{\Delta S}{I})$											
⑮ = ⑮ $\times 18$	415.9	760.4	1,293.3	1,882.2	2,355.9	3,271.3	4,645.3	4,042.2	3,945.4	3,382.9	2,408
⑮ $K (\frac{\partial M}{\partial H_A}) (\frac{\Delta S}{I})$											
⑮ = ⑮ $\times 18$	21,363	39,000	66,128	104,796	157,936	271,540	526,929	570,367	706,988	777,292	723,12
⑮ Σ LINE ⑮ =	6,754										
⑮ EQ 1: $0 = 6,754 M_A + 327.64 H_A - 95,497.1$											
⑮ Σ LINE ⑮ =	327.64										
⑮ EQ 2: $0 = 327.64 M_A + 31,470.3 H_A - 5,492,491$											
⑮ Σ LINE ⑮ =	95,497.1										
⑮ EQ 1' = $-1 \times \frac{327.64}{6,754} \cdot 0 = -327.64 M_A - 15,894.0 H_A + 4,632,612$											
⑮ Σ LINE ⑮ =	31,470.3										
⑮ EQ 2' = $0 = 0 + 15,576.3 H_A - 851,879$											
⑮ Σ LINE ⑮ =	5,492,491										
⑮ $H_A = +55,204 \text{ lb}$											

FORM 1543



AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C-103

FRAME 697

REPORT NO. 7,0352/4

SHEET NO. 1-46

PREPARED BY

DATE

G. MEYERS

MAY 1956

CHECKED BY

DATE

JOINT ANALYSIS FOR LOAD $P=1000 \# \uparrow$

FROM PREVIOUS PAGE: $H_A = +55.2 \# \leftarrow$

$M_A = 11,461.4 \# \# \downarrow$

$$\begin{aligned} \uparrow &= -.000307486 M_A + .014381 H_A + 5.243 \\ &= -35.14 + .714 + 5.243 = 2.513 \# \downarrow \end{aligned}$$

$$\begin{aligned} \nabla &= -.002275 M_A + .106419 H_A + 38.798 \\ &= -26.075 + 5.874 + 38.798 = +18.597 \# \downarrow \end{aligned}$$

$$\begin{aligned} V_A &= .016251 M_A - .75049 H_A + 726.315 \\ &= 183.967 - 41.438 + 726.315 = 868.844 \# \downarrow \end{aligned}$$

$$\begin{aligned} X &= .002205 M_A + .89681 H_A - 37.592 \\ &= 25.272 + 41.508 - 37.592 = 31.188 \# \rightarrow \end{aligned}$$

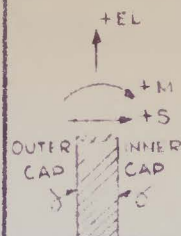
CHECK:

$$\begin{aligned} \uparrow M_A &= -2.513 \times 2495.56 + 17,051 - 18.597 \times 56.93 + 37.188 \times 46.77 \\ &= -6271.3 + 17,051 - 1058.7 + 1739.3 = 11,460.3 \text{ (CHECK)} \end{aligned}$$

$$\uparrow \Sigma F_v = 0 = -2.513 \times 44.80 - 18.597 + 1000 - 868.844 = 0 \text{ (CHECK)}$$

$$\rightarrow \Sigma F_H = 0 = +2.513 \times 7.17 - 55.2 + 37.188 = 0 \text{ (CHECK)}$$

SIGN CONVENTION



ANALYSIS OF HEAVY FRAME 697

CALCULATION OF INTERNAL BENDING MOMENTS, SHEARS & END LOADS DUE TO $P_1 = 1000 \text{ #}$

(FOR EQUATIONS SEE 7/0558/26 P1-7)

(FOR FRAME CONSTANTS SEE P 1-27) (REF DWG T-618-1091-2) (1058-1091-2)

AIRCRAFT

WEIGHT

C. G. POS

SECTION	1	2	3	4	5	6	7	8	9	10	
1 $-Y(w) = -18.597 \text{ (1) P}$	-1	-6	-2	-10	-37	-80	-155	-225	-309	-398	-4
2 $+X(y) = 37.188 \text{ (2) P}$	313	545	780	1007	1225	1430	1617	1780	1864	1936	19
3 $-2A\beta = -2.513 \text{ (5) P}$	-21	-46	-70	-129	-264	-473	-864	-1,222	-1,674	-2,181	-2
4 $+P_1(w) = 1000 \text{ (4) P}$											
5											
6 INTERNAL B.M. $= \Sigma (1, 2, 3, 4, 5)$	+283	+413	+707	+868	+924	+877	+598	+303	-119	-643	-12
7 $\sin \theta$	SEE (1) P		1-27								
8 $\cos \theta$	SEE (5) P		1-27								
9 $f(y_s) = -2.513 \text{ (1) P}$	-21	-37	-53	-68	-84	-98	-113	-128	-143	-158	-173
10 $P_y = Y + f(y_s) + P_1 = -11 + (-17) + 1000$	-40	-56	-72	-87	-103	-117	-132	-147	-162	-177	-192
11 $+f(x_s) = +2.513 \text{ (3) P}$	2	2	3	2	+1	+8	+18	+28	+38	+48	+58
12 $P_x = X + f(x_s) = 37 + (1)$	+35	+35	+34	+35	+38	+45	+55	+65	+75	+85	+95
13 $P_y \cos \theta = (10) \times (8)$	-40	-56	-72	-86	-98	-102	-87	-80	-61	-35	
14 $-P_x \sin \theta = -(12) \times (7)$	+1	+1	-1	-5	-12	-22	-42	-44	-49	-53	-
15 END LOAD $= (13) + (14)$	-39	-55	-73	-91	-110	-124	-129	-124	-110	-88	-
16 $P_y \sin \theta = (10) \times (1)$	+1	+2	-3	-14	-32	-58	-100	-105	-117	-127	-
17 $P_x \cos \theta = (12) \times (8)$	+35	+35	+34	+35	+36	+39	+36	+33	+25	5	
18 SHEAR $(16) + (17)$	+36	+37	+31	+21	+4	-19	-64	-72	-92	-112	-

* AT APPLICABLE SECTIONS

KORN 1540
105113

697
MENTS, SHEARS &



AVRO AIRCRAFT LIMITED
TECHNICAL DEPT. (AIRFRAME)

REPORT NO. 7/0558/4

SHEET 1-47

DATE MAY 1956

PREPARED BY G. MEYERS

AIRCRAFT C-105

WEIGHT

C. G. POSITION

DWG T-053-1051-1053 (8)

7	8	9	10	11	12	13	14	15	16	17	18	19
-155	-225	-309	-398	-490	-582	-625	-669	-763	-818	-873	-963	-1059
1,617	1,750	1,864	1,936	1,963	1,940	1,906	1,868	1,782	1,762	1,743	1,738	1,739
-864	-1,222	-1,674	-2,181	-2,723	-3,290	-3,565	-3,849	-4,460	-4,801	-5,144	-5,702	-6,271
								1,140	4,080	7,050	11,920	17,050
+598	+303	-119	-643	-1,250	-1,932	-2,284	-2,650	-2,301	+223	+2,781	+6,993	MA ² CHECK +11,459
-113												-113
-132							-132	+868				+868
+18												+18
+55												+55
-87	-80	-61	-35	0	+33	+48	+61	-225	-106	-61	0	0
-42	-44	-49	-53	-55	-53	-51	-49	-53	-55	-55	-55	-55
-129	-124	-110	-88	-55	-20	-3	+12	-278	-161	-116	-55	-55
-100	-105	-117	-127	-132	-128	-123	-117	+838	+862	+866	+868	+868
+36	+33	+25	5	0	-14	-20	-25	-14	-7	-4	0	0
-64	-72	-92	-112	-132	-142	-143	-142	+824	+855	+862	+868	+868



AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7/0558/4

SHEET NO. 1-48

AIRCRAFT:

C-105

FRAME 697

PREPARED BY

DATE

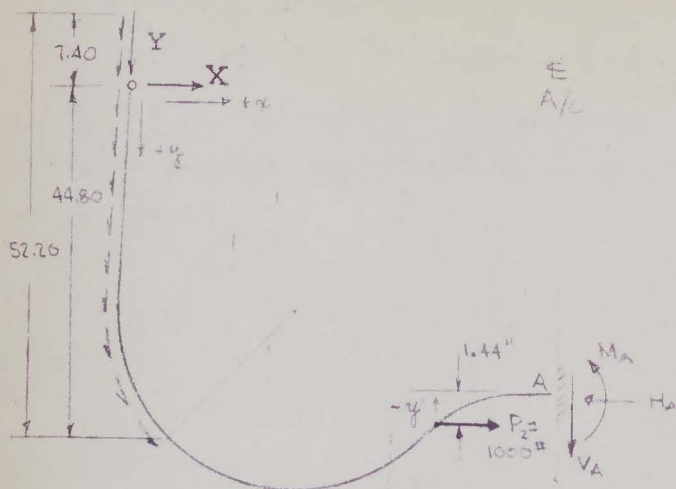
G. MEYERS

MAY 1956

CHECKED BY

DATE

UNIT ANALYSIS FOR $P_2 = 1000^{\#}$ →



TO OBTAIN X, Y, q & V_A IN TERMS OF M_A & H_A

$$\sum H = 0: X + q(x_2) - H_A + 1000 = 0$$

$$x_2 = 7.17$$

$$\therefore X = H_A - 7.17 q - 1000$$

$$\sum V = 0: -52.20 q - V_A = 0$$

$$V_A = -52.2 q \quad \& \quad Y = 7.40 q$$

$$\sum M_A = 0: Yx + 2.4q + M_A = -1000(1.44) + 46.77 X$$

$$56.93(7.4q) + 2495.56 q + M_A = -1,440 + 46.77(H_A - 7.17q - 1000)$$

$$421.28 q + 2495.56 q + M_A = -1,440 + 46.77 H_A - 335.34 q - 46,770$$

$$3,252.18 q = -48,210 - M_A + 46.77 H_A$$

$$q = -307.486 \times 10^{-6} M_A + 14.381 \times 10^{-3} H_A - 14.824$$

$$X = H_A - 7.17 q - 1000 = H_A - 7.17(-307.486 \times 10^{-6} M_A + 14.381 \times 10^{-3} H_A - 14.824) - 1000$$

$$X = 1.0 H_A + 2.205 \times 10^{-3} M_A - .10311 H_A + 106.288 - 1000$$

$$X = 2.205 \times 10^{-3} M_A + .89689 H_A - 893.712$$



AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7/0558/4

SHEET NO. 1-49

AIRCRAFT:

C-105

FRAME 637

PREPARED BY

DATE

G. MEYERS

MAY 1956

CHECKED BY

DATE

UNIT ANALYSIS FOR $P_2 = 1000 \# \rightarrow$ (CONT'D)

$$Y = 7.40 q_f = 7.40 (-307.486 \times 10^{-6} M_A + 14.381 \times 10^{-3} H_A - 14.824)$$

$$Y = -2.275 \times 10^{-3} M_A + 106.419 \times 10^{-3} H_A - 109.698$$

$$V_A = -52.20 q_f = -52.2 (-307.486 \times 10^{-6} M_A + 14.381 \times 10^{-3} H_A - 14.824)$$

$$V_A = 16.1051 \times 10^{-3} M_A - 750.69 H_A + 773.813$$

§ M A



AVRO AIRCRAFT LIMITED

TECHNICAL DEPT. (AIRFRAME)

AIRCRAFT

C-105

WEIGHT

C. G. POSITION

REPORT NO. 7/0558/4

SHEET - - 1-50

DATE . . . MAY 1956

PREPARED BY . G. MEYERS

[illegible]



AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C-105

FRAME 697

REPORT NO. 7/0558/4

SHEET NO. 1-51

PREPARED BY

DATE

G. MEYERS

MAY 1950

CHECKED BY

DATE

UNIT ANALYSIS FOR LOAD $P_2 = 1000\#$

FROM PREVIOUS PAGE: $H_A = +993.1\#$ ←

$M_A = -722.2\#$ ↓

$$q = -.000307486 M_A + .014381 H_A - 14.824$$

$$= +.222 + 14.282 - 14.824 = -.32 \#/\text{in} \uparrow$$

$$Y = -.002275 M_A + .106419 H_A - 109.698$$

$$= +1.643 + 105.685 - 109.698 = -2.37 \# \uparrow$$

$$V_A = .016051 M_A - .75069 H_A + 773.813$$

$$= -11.592 - 745.51 + 773.813 = +16.71 \# \downarrow$$

$$X = .002205 M_A + .89689 H_A - 893.712$$

$$= -1.592 + 890.701 - 893.712 = -4.60 \# \leftarrow$$

CHECK:

$$M_A = +.32 \times 2495.56 - 1440 + 2.37 \times 56.93 - 4.60 \times 46.77$$

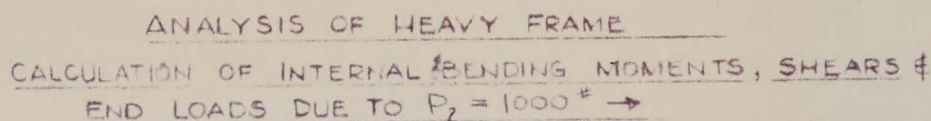
$$+ 798.58 - 1440 + 134.92 - 215.14 = -721.7 \text{ (CHECK)}$$

$$\sum F_V = 0 = +.32 \times 44.85 + 2.37 - 16.71 = 0 \text{ (CHECK)}$$

$$\sum F_H = 0 = -.32 \times 7.17 + 1000 - 4.60 - 993.1 = 0 \text{ (CHECK)}$$

HAY

JA
K



(FOR FRAME CONSTANTS SEE P. 1-27) (REF DWG 1-1058-1051 3)

7-1058-1051/3

C. G. POSITION

*AT APPLICABLE SECTIONS



AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C-105

FRAME 617

REPORT NO. 7/0558/4

SHEET NO. 1-53

PREPARED BY

DATE

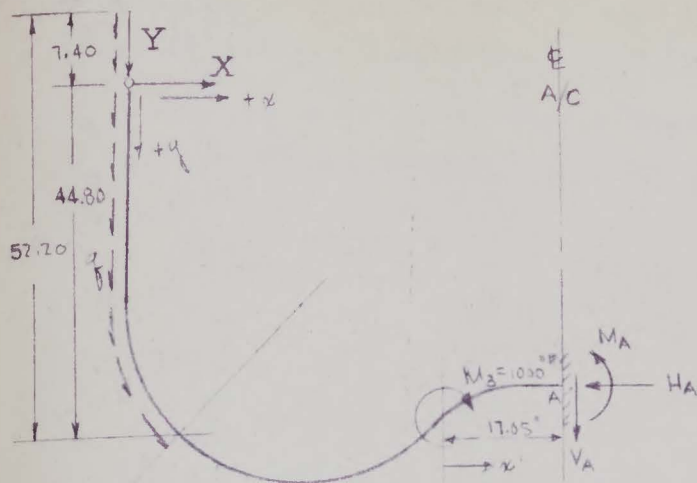
G. MEYERS

MAY 1956

CHECKED BY

DATE

UNIT ANALYSIS FOR $M_3 = 1000 \text{ lb-in}$



TO OBTAIN X , Y & V_A IN TERMS OF H_A & M_A

$$\sum H = 0: X + f(y_0) - H_A = 0$$

$$f_0 = 7.17 \text{ in}$$

$$\therefore X = H_A - 7.17 \text{ in}$$

$$\sum V = 0: -52.20 \text{ in} - V_A = 0$$

$$V_A = -52.20 \text{ in}$$

$$\text{and } Y = 7.40 \text{ in}$$

$$\sum M_A = 0: Yx + 2Ay + M_A = 1000 + 46.77 X$$

$$56.93(7.40 \text{ in}) + 2415.56 \text{ in} + M_A = 1000 + 46.77(H_A - 7.17 \text{ in})$$

$$421.28 \text{ in} + 2415.56 \text{ in} + M_A = 1000 + 46.77 H_A - 335.34 \text{ in}$$

$$3,252.18 \text{ in} = 1000 - M_A + 46.77 H_A$$

$$f = -307.486 \times 10^{-6} M_A + 14.381 \times 10^{-3} H_A + .3075$$

$$X = H_A - 7.17 \text{ in} = H_A - 7.17(-307.486 \times 10^{-6} M_A + 14.381 \times 10^{-3} H_A + .3075)$$

$$X = 1.0 H_A + 2.205 \times 10^{-3} M_A - .10311 H_A - 2.2043$$

$$X = 2.205 \times 10^{-3} M_A + .89689 H_A - 2.2043$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7/0558/4

SHEET NO. 1-54

AIRCRAFT:

C-105

FRAME 697

PREPARED BY

DATE

G. MEYERS

MAY 1956

CHECKED BY

DATE

UNIT ANALYSIS FOR $M_0 = 1000^* (\text{?})$ (CONT'D)

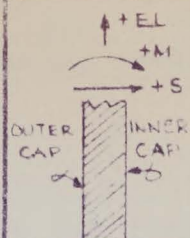
$$Y = 7.40 \text{ ?} = 7.40 (-302.486 \times 10^{-6} M_A + 14.381 \times 10^{-3} H_A + .3075)$$

$$Y = -2.275 \times 10^{-3} M_A + 106.419 \times 10^{-3} H_A + 2.2755$$

$$V_A = -52.20 \text{ ?} = -52.2 (-302.486 \times 10^{-6} M_A + 14.381 \times 10^{-3} H_A + .3075)$$

$$V_A = 16.051 \times 10^{-3} M_A - .7506 \text{ ? } H_A - 16.052$$

SIGN CONVENTION



ANALYSIS OF HEAVY FRAME

UNIT ANALYSIS FOR LOAD $M_3 = 1000^*$ (CONTD)

CALCULATION OF REDUNDANTS H_A & M_A

AVRO
AVR
TECHNIC

AIRCRAFT
WEIGHT
C. G. POSITION

(REF DWG 7-1058-1051/3)

SECTION →	1	2	3	4	5	6	7	8	9	10	11	
19												
19	DUE TO $Y = +2.2755 (-2)$											
20												
20	DUE TO $X = -2.2043$											
21												
21	DUE TO $q = .3015 (-2A)$											
22												
22	DUE TO $V_A = -16.052 (0)$											
23												
23	DUE TO $M_3 + 1000^*$											
24	MOM DUE TO CONSTANTS											
24												
25												
26												
27												
27	$K \left(\frac{\partial M}{\partial H_A} \right) \left(\frac{\Delta S}{I} \right) = (24 \times 12 P)$											
28												
29												
29	$K \left(\frac{\partial M}{\partial H_A} \right) \left(\frac{\Delta S}{I} \right) (24 \times 18)$											
30												
30	$\Sigma \text{LINE } (25) = 6.754$											
31												
31	$\Sigma \text{LINE } (26) = 327.64$											
32												
32	$\Sigma \text{LINE } (27) = 3882.63$											
33												
33	$\Sigma \text{LINE } (28) = 3,410.3$											
34												
34	$\Sigma \text{LINE } (29) = 297.218$											

REF P. 1-45

$$\text{EQ 1} = -1 \times \frac{-45,310.5}{6.754} : 0 = -327.64 M_A - 15,894.0 H_A + 188340$$

$$\text{EQ 1: } 0 = 6.754 M_A + 327.64 H_A - 3,882.63$$

$$\text{EQ 2: } 0 = 327.64 M_A + 31,470.3 H_A - 297,218$$

$$0 = 0 + 15,576.3 H_A - 108,950$$

$$H_A = + 6.995^{\#}$$

* AT APPLICABLE SECTIONS



AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C-105

FRAME 697

REPORT NO 7/0558/4

SHEET NO 1-56

PREPARED BY

DATE

G. MEYERS

MAY 1956

CHECKED BY

DATE

UNIT ANALYSIS FOR MOMENT $M_3 = 1000 \text{ lb} \cdot \text{ft}$

FROM PREVIOUS PAGE: $H_A = +6.995 \text{ lb} \leftarrow$
 $M_A = +235.53 \text{ lb} \cdot \text{ft}$

$$q = -0.000307436 M_A + 0.014331 H_A + 0.3075$$

$$= -0.0724 + 0.1006 + 0.3075 = +0.3357 \text{ lb/ft} \downarrow$$

$$Y = -0.002275 M_A + 0.06419 H_A + 2.2755$$

$$= -0.5358 + 0.444 + 2.2755 = +2.4841 \text{ lb} \downarrow$$

$$V_A = -52.20 q = -17.5235 \text{ lb} \uparrow$$

$$X = 0.002205 M_A + 0.89689 H_A - 2.2048$$

$$= 0.5193 + 6.2737 - 2.2048 = +4.5882 \text{ lb} \rightarrow$$

CHECK:

$$\sum M_A = -0.3357 \times 2,495.56 + 1,000 - 2.4841 \times 56.93 + 4.5882 \times 46.77$$

$$= +235.41 \text{ lb} \cdot \text{ft} \quad (\text{CHECK})$$

$$\sum F_V = 0 = -0.3357 \times 44.80 - 2.4841 + 17.5235 = 0 \quad (\text{CHECK})$$

$$\sum F_H = 0 = +0.3357 \times 7.17 - 6.995 + 4.5882 = 0 \quad (\text{CHECK})$$

CHECK
- 17 = V_A



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT

C-105

FRAME 697

REPORT NO 7/0558/4

SHEET NO 1-S8

PREPARED BY

G. MEYERS

CHECKED BY

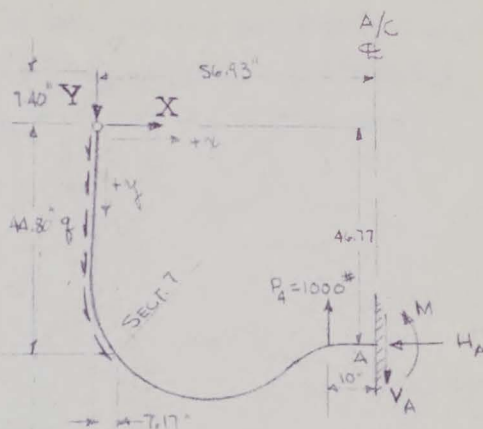
DATE

MAY 1950

DATE

UNIT SOLUTION FOR $P_4 = 1000\#$

P_4 IS APPLIED TO FRAME 697 AT BL 10 AND IS DUE TO FORE & AFT BEAM WHICH FRAMES #3 SERVICE DOOR (REF DWG 7-1058-3961)



TO OBTAIN X, Y, Z & V_A IN TERMS OF H_A & M_A

$$\sum H = 0: X + Z(\cos) - H_A = 0$$

$$\cos = 7.17^\circ$$

$$\therefore X = H_A - 7.17Z$$

$$\sum V = 0: -52.20Z + 1000 - V_A = 0$$

$$V_A = 1000 - 52.20Z \quad \& \quad Y = 7.40Z$$

$$\sum M_A = 0: Yx + 2AZ + M_A = 10,000 + 46.77X$$

$$56.93(7.40Z) + 2495.56Z + M_A = 10,000 + 46.77(H_A - 7.17Z)$$

$$421.28Z + 2495.56Z + M_A = 10,000 + 46.77H_A - 335.34Z$$

$$3,252.18Z = 10,000 - M_A + 46.77H_A$$

$$Z = -307.486 \times 10^{-6} M_A + 14.381 \times 10^{-3} H_A + 3.075$$

$$X = H_A - 7.17Z = H_A - 7.17(-307.486 \times 10^{-6} M_A + 14.381 \times 10^{-3} H_A + 3.075)$$

$$X = 1.0H_A + 2.205 \times 10^{-3} M_A - .10311 H_A - 22.048$$

$$X = 2.205 \times 10^{-3} M_A + .89689 H_A - 22.048$$



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REPORT NO. 7/0558/4

SHEET NO. 1-59

AIRCRAFT

C-105

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UNIT ANALYSIS FOR $P_4 = 1000 \text{ * } \ddagger$ (CONT'D)

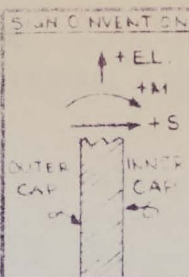
$$Y = 7.40 \ddagger = 7.40(-307.456 \times 10^{-6} M_A + 14.381 \times 10^{-3} H_A + 3.075)$$

$$Y = -2.275 \times 10^{-3} M_A + 106.419 \times 10^{-3} H_A + 22.755$$

$$V_A = 1000 - 52.20 \ddagger = 1000 - 52.2(-307.456 \times 10^{-6} M_A + 14.381 \times 10^{-3} H_A + 3.075)$$

$$V_A = 1000 + 16.051 \times 10^{-3} M_A - .75069 H_A - 160.515$$

$$V_A = 16.051 \times 10^{-3} M_A - .75069 H_A + 839.485$$



ANALYSIS OF HEAVY FRAME 697
UNIT ANALYSIS FOR LOAD $P_4 = 1000^{\text{lb}}$ (CONTD)
CALCULATION OF REDUNDANTS H_A & M_A

(REF. CWS 7-1058-1051)

TECH
AIRCRAFT
WEIGHT
C.G. POSITION

SECTION →	1	2	3	4	5	6	7	8	9	10	11
(18) X'											
(19) DUE TO $Y = 22.555(-Y)$	10.9	7.5	3.4	12.1	44.8	17.3	184.5	275.6	378.2	487.4	600.0
(20) DUE TO $X = -22.043(X)$	185.6	323.0	462.3	596.8	726.0	847.5	958.4	1027.9	1,105.0	1,148.0	1,163.7
(21) DUE TO $q = 3.075(-2A)$	25.8	55.3	85.8	157.9	322.8	579.2	1,057.7	1,495.1	2,048.4	2,668.8	3,332.1
(22) DUE TO $V_A = 831.485(0)$											
(23) DUE TO $P_4 = 1000 Y'$											
(24) Σ LINE 20-23	222.3	386.3	551.5	766.8	1,095.6	1,524.5	2,205.6	2,808.5	3,531.6	4,304.2	5,046.8
(25) $\frac{\partial U}{\partial M_A}$											
(26) $K \left(\frac{\partial M}{\partial M_A} \right) \left(\frac{\Delta S}{I} \right) = (24 \times 12)$	37.8	63.8	116.3	200.7	354.2	575.6	805.9	1,055.9	1,322.4	1,613.1	1,926.0
(27) $\frac{\partial U}{\partial H_A}$											
(28) $K \left(\frac{\partial M}{\partial H_A} \right) \left(\frac{\Delta S}{I} \right) = (24 \times 18)P$	12,527	22,872	38,785	61,459	92,625	151,273	204,029	234,733	244,647	255,875	264,100
(30) Σ LINE 25 = 6,754											
(31) Σ LINE 26 = 327,64											
(32) Σ LINE 27 = 60,254.8											
(33) Σ LINE 28 = 31,470.3											
(34) Σ LINE 29 = 3,265,172											

EQ 1:

$$0 = 6.754 M_A + 327.64 H_A - 60,254.8$$

EQ 2:

$$0 = 327.64 M_A + 31,470.3 H_A - 3,265,172$$

EQ 1' = $-1 \times \frac{327.64}{6.754}$: $0 = -327.64 M_A - 15,894.0 H_A + 2,922,990$

$$0 = 0 + 15,576.3 H_A - 342,187$$

$$H_A = +21.968^{\text{lb}}$$

HA 1 MA



HERO AIRCRAFT LIMITED

TECHNICAL DEPT AIRFRAME

AIRCRAFT

C-105

WEIGHT

C G POSITION

REPORT NO.

7/0558/A

SHEET

-60

DATE _____

MAY 1956

PREPARED BY

G. MEYER

[illegible]



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C-105

FRAME 697

REPORT NO. 7/0558/4

SHEET NO. 1-61

PREPARED BY

DATE

G. MEYERS

MAY 1956

CHECKED BY

DATE

UNIT ANALYSIS FOR LOAD $P_4 = 1000 \uparrow$

FROM PREVIOUS PAGE : $H_A = +21.968 \# \leftarrow$

$M_A = +7,855.7 \# \# \downarrow$

$$q = -0.000307486 \overset{+7,855.7}{M_A} + \overset{+21.968}{.014381} H_A + 3.075$$

$$= -2.416 + .316 + 3.075 = +.975 \#/\text{in} \downarrow$$

$$Y = 7.40 q = 7.40 \times .975 = +7.215 \# \downarrow$$

$$V_A = 1000 - \overset{50.695}{52.20} q = +949.105 \# \downarrow$$

$$X = H_A - 7.17 q = 21.968 - 7.17 \times .975 = +14.977 \# \rightarrow$$

CHECK:

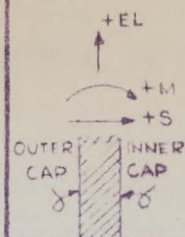
$$\overset{\curvearrowright}{M_A} = -.975 \times 2495.56 + 10,000 - 7.215 \times 56.93 + 14.977 \times 46.77$$

$$= -2433 + 10,000 - 410.75 + 700.4 = 7,856.6 \# \# \text{ (CHECK)}$$

$$\overset{\uparrow}{\sum F_V} = 0 = -\overset{50.695}{.975} \times 52.20 + 1000 - 949.105 = 0 \text{ (CHECK)}$$

$$\overset{\rightarrow}{\sum F_H} = 0 = \overset{6.99}{.975} \times 7.17 - 21.968 + 14.977 = 0 \text{ (CHECK)}$$

SIGN CONVENTION



ANALYSIS OF HEAVY FRAME 697

CALCULATION OF INTERNAL BENDING MOMENTS, SHEARS &
END LOADS DUE TO $P_4 = 1000 \text{ *}$

(FOR EQUATIONS SEE 7-10558/26 P. 1-7.)

(FOR FRAME CONSTANTS SEE P. 1-27) (REF DWG 7-10558-1051/3)

AVRO
AVR
TECHNIC

AIRCRAFT

WEIGHT

C. G. POSITION

SECTION	1	2	3	4	5	6	7	8	9	10	11
1 $-Y(x) =$ -7.215 (1) P.	3	2	1	4	14	31	60	87	120	155	190
2 $+X(y) =$ $+14.977 \text{ (2) P.}$	126	219	314	405	493	576	651	705	751	780	790
3 $-Z A_z$ $= -7.975 \text{ (5) P.}$	8	13	27	50	102	184	335	474	649	846	1057
4											
5 $+P_4 x$ $+1000 x$											
6 INTERNAL B.M. $= \Sigma (1)(2)(3)(4)(5)$	115	209	286	351	377	361	256	144	-18	-221	-457
7 $\sin \theta$	SEE (7) P. 1-27										
8 $\cos \theta$	SEE (8) P. 1-27										
9 $q(y_s)$ -7.975 (10) P.	8	14	20	27	33	38	44				
10 $P_y = Y + q(y_s) + P_1$ $= -7 + (9) + 1000$	15	21	27	34	40	45	51				
11 $+q(x_s)$ $+7.975 \text{ (9) P.}$	1	1	1	1	1	3	7				
12 $P_x = X + q(x_s)$ $= 15 + (11)$	14	14	14	14	16	18	22				
13 $P_y \cos \theta$ $= (10) \times (8)$	15	21	27	34	38	39	33	31	24	14	0
14 $-P_x \sin \theta$ $= -(12) \times (7)$	0	0	1	2	5	9	17	17	20	21	22
15 END LOAD $= (13) + (14)$	15	21	28	36	43	48	50	48	44	35	22
16 $P_y \sin \theta$ $= (10) \times (7)$	0	1	1	5	12	22	38	46	45	49	51
17 $P_x \cos \theta$ $= (12) \times (8)$	14	14	14	14	15	16	14	13	10	6	0
18 SHEAR $(16) + (17)$	14	15	13	9	3	-6	-24	-33	-35	-43	-51

* AT APPLICABLE SECTIONS

697
MENTS, SHEARS 4



AVRO AIRCRAFT LIMITED
TECHNICAL DEPT. (AIRFRAME)

REPORT NO. 7/0558/4
SHEET 1-62
DATE MAY 1956
PREPARED BY G. MEYERS

AIRCRAFT C-105
WEIGHT
C. G. POSITION

7-1058-1051/3
DWG 7-65

7	8	9	10	11	12	13	14	15	16	17	18	19
-60	-87	-120	-155	-190	-226	-242	-259	-296	-317	-339	-374	-411
651	705	751	780	796	781	768	752	718	709	704	700	700
335	474	649	846	1,057	1,276	1,383	1,443	1,731	1,863	1,996	2,212	2,433
											4,870	10,000
256	144	-18	-221	-457	-721	-857	-1,000	-1,309	-1,471	-1,631	+2984	M.A. CHECK +7856
-44												-44
-51										-51	+949	+949
+7												+7
+22												+22
-33	-31	-24	-14	0	+13	+19	+24	+13	+6	+4	0	0
-17	-17	-20	-21	-22	-21	-20	-20	-21	-22	-22	-22	-22
-50	-48	-44	-35	-22	-8	-1	+4	-8	-16	-18	-22	CHECK -22
-38	-46	-45	-49	-51	-49	-47	-45	-49	-51	-51	+949	+949
14	13	10	6	0	-6	-8	-10	-6	-3	-2	0	0
-24	-33	-35	-43	-51	-55	-55	-55	-55	-54	-53	+949	+949 CHECK



AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-4

SHEET NO. 1-63

PREPARED BY

DATE

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AUG '56

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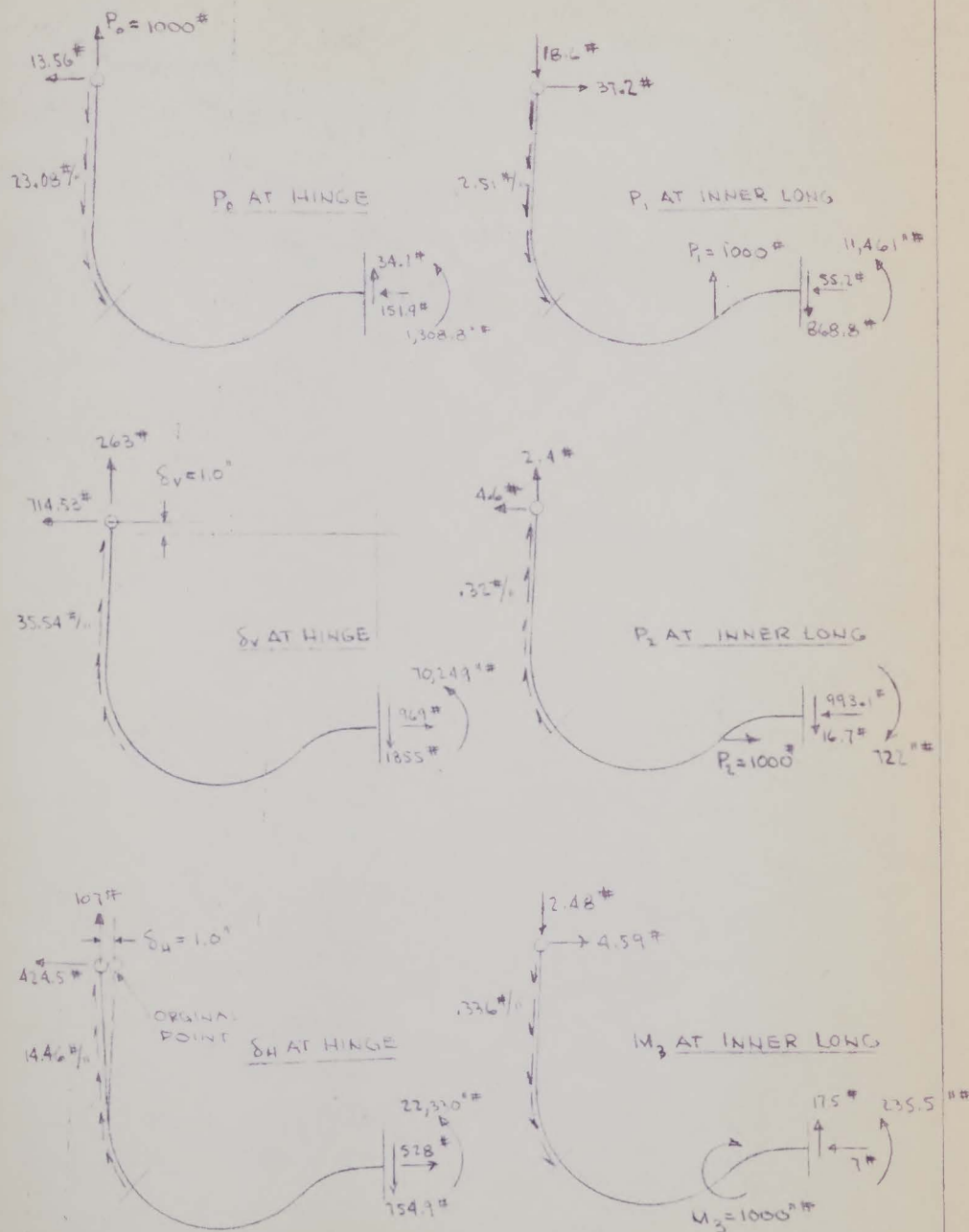
DATE

AIRCRAFT:

C-105

FRAME 697

SUMMARY - UNIT SOLUTIONS





AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7/0558/4

SHEET NO. 1-65

AIRCRAFT:

C-105

FRAME 697

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DATE

CASE 11.30 - HINGE LOAD

THE MAX LOAD TRANSFERRED THROUGH THE HINGE PIN IN A VERTICAL DIRECTION IS NOT WELL DEFINED AT TIME OF THIS ANALYSIS.

ON PREVIOUS ANALYSIS OF 697 (7/0558/4 ISSUE 1) THE VALUE $+25,000^{\#}$ (MAX) & $-16,000^{\#}$ (MIN) IS USED AND AGAIN USED HERE AS A CONSERVATIVE LOADING.

HINGE DEFLECTION

$$\delta_v = 1.74" \uparrow$$

$$\delta_H = .30" \leftarrow (\text{OUTB'D})$$

REF RPT 7/0558/21



AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7/0553/A

SHEET NO. 1-66

AIRCRAFT:

C-105

FRAME 697

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AUG 56

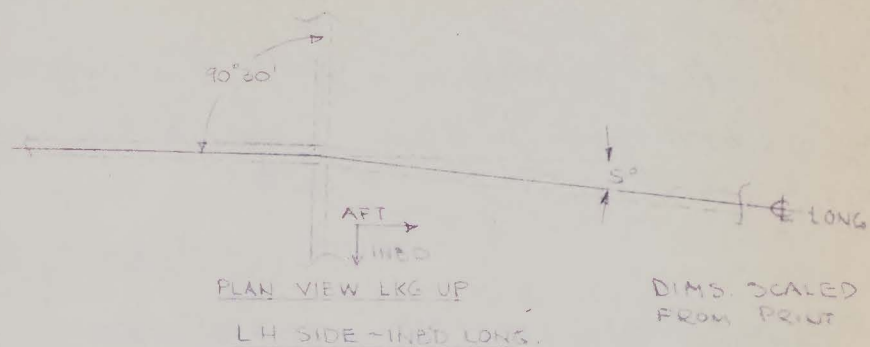
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INNER LONG KINK LOAD $\sim P_2$

CASE 11-36

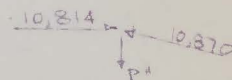
STA
697



REF MEMO 6 MAR 1956 BY C. DITCHFIELD

AXIAL LOAD = 10,814 # ULT

ASSUME THIS LOAD IS IMMEDIATELY FWD OF STA 697 &
SOLVE BY "METHOD OF JOINTS"



$$\sum F_H = 0 = 10,814 + P_1 \cos 5^\circ$$

$$P_1 = -10,814 / 0.99619 = -10,870 \#$$

$$\sum F_V = -P'' + 10,814 \sin 0^\circ 30' + 10,870 \sin 4^\circ 36'$$

$$P'' = 94.4 + 352.9 = 447.3 \# \text{ ULT ACTING INBD. TO}$$

KEEP JOINT IN EQUILIBRIUM, BUT OPPOSITE APPLIED
(ACTING OUTBD.) LOAD



AERO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT No. 7-0558/4

SHEET No. 1-67

AIRCRAFT:

C-105

FRAME 697

PREPARED BY

DATE

G. MEYERS

SEPT 56

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DATE

INBD LONGERON LOADS APPLIED TO FR 697

REF. REPORT 7/0558/81

CASE 11.3 b

FROM REF 1, P. 2.1.3 $W_1 = 214.9 \text{ #}$ $W_2 = 138.1 \text{ #}$ DLT

FROM REF 1, P. 2.15 $\begin{cases} M_{697} = 10.876 W_1 + .939 W_2 \\ R_{697} = 3.386 W_1 + .769 W_2 \end{cases}$

CALCULATE MOMENT

$$M_{697} = 10.876 (214.9) + .939 (138.1) = +2,467 \text{ #}$$

SIGN CONV.

+M PRODUCES TEN IN SKIN SIDE

CALCULATE REACTION

$$R_{697} = 3.386 (214.9) + .769 (138.1) = 834 \text{ #}$$

R_{697} ACTS 30° FROM VERTICAL PLANE

RESOLVING INTO HORIZ & VERT. COMP:

$$H' = -R_{697} \sin 30^\circ = 834 \times .5 = 417 \text{ #} \quad (\leftarrow)$$

$$P_1 = -R_{697} \cos 30^\circ = 834 \times .866 = 722 \text{ #} \quad (\uparrow)$$

ABOVE LOADS H' & P_1 ARE APPLIED TO FRAME

$$P_2 = H' + P_1 = 417 + 947.3 = 1364 \text{ #} \quad (\leftarrow)$$

(ACTING OUTBD)

DUE TO BEAM
REACTION

DUE TO LONG
KINK LOAD P_1



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

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REPORT NO. 7-0558/A

SHEET NO. 1-68

AIRCRAFT

C-105

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INB'D LONG LOADS APPLIED TO FR 697 (CONT'D)

CASE
11.36

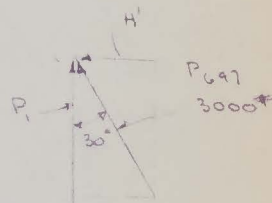
THE EXPECTED LOAD ON FRAME 697 DUE TO INNER LONG ARE MUCH HIGHER THAN THE 834# CALCULATED ON THE PREVIOUS PAGE DUE TO A MOMENT CARRY-OVER FROM FRAME 663, WHICH HAS BEEN ASSUMED FIXED (REF REPORT 7/0558/81 SHT 2.11). SINCE ANALYSIS OF INNER LONG WITH MORE REALISTIC FIXITY HAS NOT BEEN ACCOMPLISHED AT THIS TIME, WE WILL ASSUME THAT REACTION, R_{697} , OF REF REPORT IS 3000# DLT.

$$P_{697} = -R_{697}$$

RESOLVING INTO H & V COMPONENTS

$$H' = P_{697} \sin 30^\circ = 1500 \# (\leftarrow)$$

$$P_1 = P_{697} \cos 30^\circ = 2600 \# (\uparrow)$$



$$\therefore P_2 = 1500 \# (\leftarrow) + 947.3 \# (\leftarrow) = 2447.3 \# (\leftarrow)$$

H' (ABOVE)

DUE TO LONG KINK
LOAD P



AVRO AIRCRAFT LIMITED
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REPORT NO. 7/0558/4

SHEET NO. 1-69

AIRCRAFT:

C-105

FRAME 697

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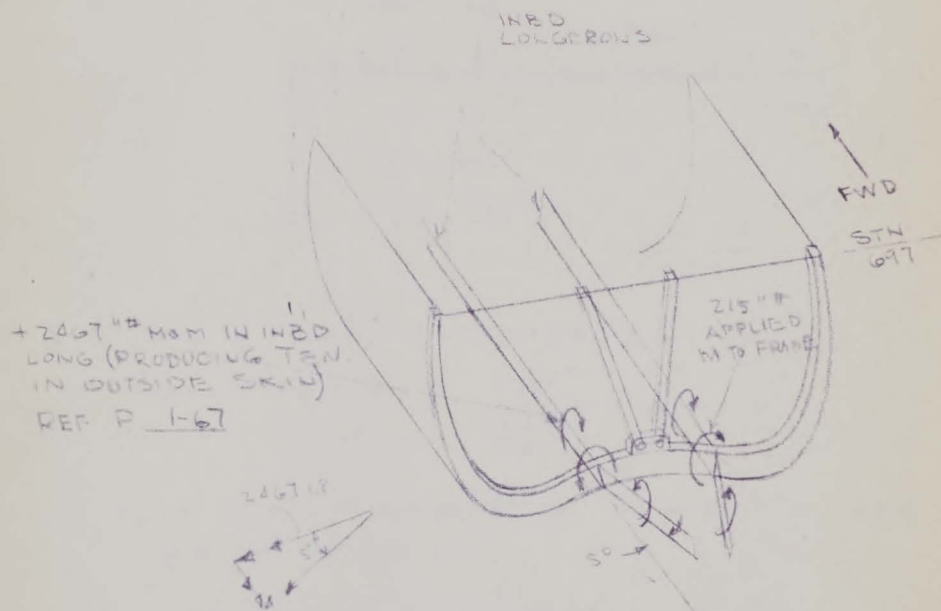
G. MEYERS

AUG 1956

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M_3 - INDUCED MOM DUE TO LONG. KINK
CASE 11.36



$$M_3 = M_{\text{FRAME}} = 2467 \sin 50^\circ = 215 \text{ 14-LBS}$$

REF PREV PAGE



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MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 710558/4

SHEET NO. 1-70

AIRCRAFT

C-105

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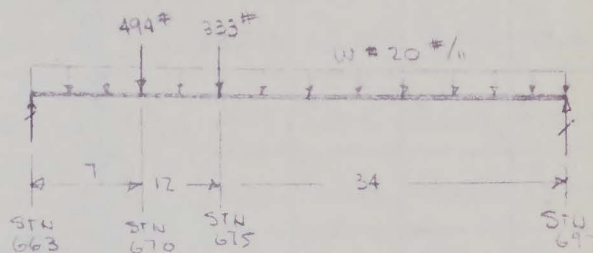
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DOOR BEAM BL 10 ~ P4

COND 11.3.6

REF. NOTES BY M. SEVICK (UNDATED)
ON INNER LONG ANALYSIS



$$\sum M_{697} = 0 = 7 \times 494 + 12 \times 333 - 34 R_{697}$$

$$R_{697} = 103 + 111 = 220 \#$$

$$\frac{340 \# \sim \text{DUE TO } W}{560 \#}$$

$\therefore P_4 = 560 \# \text{ U-T ACTING } \downarrow \text{ ON FRAME 697 FOR}$
 $p = -1.36 \text{ psi.}$

HOWEVER FOR CRITICAL FRAME STRESSES, USE $\gamma = +1.74$

PSI: BY RATIOING $P_4 = 560 \times \frac{+1.74}{-1.36} = \underline{\underline{-716 \# 4}}$

ANALYSIS OF HEAVY FRAME 697
CALCULATION OF BENDING MOMENT FOR
CASE 11.36 (106)

	1	2	3	4	5	6	7	8	9	10
1. M DUE TO $S_v = 1.74^*$ = 1.74 @ P. 1-38	9,730	16,941	24,280	30,238	33,549	34,175	28,962	22,912	13,511	1,2
2. M DUE TO $S_H = +.30^*$ = .30 @ P. 1-41	1,021	1,777	2,545	3,207	3,675	3,940	3,776	3,496	2,959	2,1
3. M DUE TO $P_0 = 25,000^* \downarrow$ = 25 @ P. 1-34	+4,300	7,200	19,450	25,575	22,500	14,225	4,975	6,225	+4,100	+17,0
4. M DUE TO $P_0 = 16,000^* \downarrow$ = -16 @ P. 1-34	-2,752	+4,608	+12,448	+16,368	+14,400	+9,104	+3,184	3,984	9,024	10,8
5. M DUE TO $P_1 = 2600^* \uparrow$ = 2.600 @ P. 1-47	+736	+1,282	+1,838	+2,257	+2,402	+2,280	+1,555	+788	309	1,67
6. M DUE TO $P_2 = 2447.3^* \leftarrow$ = -2.4473 @ P. 1-52	+86	+147	+213	+264	+274	+262	+171	+78	-51	-21
7. M DUE TO $M_3 = -215^* \uparrow$ = -2.15 @ P. 1-55	-7	-13	-19	-30	-24	-22	-14	-5	+8	+7
8. M DUE TO $P_4 = 716^* \uparrow$ = +.716 @ P. 1-62	+82	+150	+205	+251	+270	+258	+183	+103	-13	-15
9.										
10. REF ONLY	9,854	17,152	24,588	30,703	34,102	35,327	30,843	25,444	16,865	5,4
11.										
12.										
13.										
14. $\Sigma \textcircled{1} + \textcircled{2} + \textcircled{4} + \textcircled{5} + \textcircled{6}$ + $\textcircled{7} + \textcircled{8}$ = Σ BM	12,606	12,544	12,144	14,335	19,902	26,233	27,651	29,413	23,859	16,5
15. $\Sigma \textcircled{1} + \textcircled{2} + \textcircled{4} + \textcircled{5} + \textcircled{6}$ + $\textcircled{7} + \textcircled{8}$ = Σ BM	5,554	24,352	44,038	56,278	56,802	49,562	35,818	19,211	2,735	+11,

ANALYSIS OF HEAVY FRAME 697
CALCULATION OF FRAME END LOADS FOR
CASE 11.36 (10G)

SECTION →	1	2	3	4	5	6	7	8	9	10
1. EL. DUE TO $S_v = +174$ = 1.74 (5) P. 1-38	+947	+1,332	+1,805	+2,302	+2,794	+3,212	+3,391	+3,304	+2,988	+2,490
2. EL. DUE TO $S_v = +30$ = .30 (5) P. 1-41	+65	+92	+128	+168	+209	+245	+268	+264	+245	+213
3. EL. DUE TO $P_0 = 28000 \#$ = 25 (5) P. 1-34	+20,125	+16,525	+12,950	+9,275	+5,450	+1,375	-3,375	-3,525	-3,750	-3,875
4. EL. DUE TO $P_0 = 16000 \#$ = -16 (5) P. 1-34	-12,880	-10,576	-8,288	-5,936	-3,488	-880	+2,160	+2,256	+2,400	+2,480
5. EL. DUE TO $P_1 = 722 \#$ = .722 (5) P. 1-41	-28	-40	-53	-66	-79	-90	-93	-90	-79	-64
6. EL. DUE TO $P_2 = 1364 \#$ = -1.364 (5) P. 1-52	-7	-10	-12	-16	-19	-22	-20	-20	-16	-14
7. EL. DUE TO $M_3 = -215 \#$ = -.215 (5) P. 1-55	+1	+2	+2	+3	+3	+3	+3	+3	+3	+3
8. EL. DUE TO $P_4 = 560 \#$ = -.56 (5) P. 1-62	+8	+12	+16	+20	+24	+27	+28	+27	+25	+20
9.										
10.	+986	+1,389	+1,886	+2,417	+2,983	+3,315	+3,670	+3,480	+2,160	+2,611
11.										
12.										
13.										
14. $\Sigma 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 =$ $\Sigma -EL. MAX$	-11,894	-9,187	-6,402	-3,525	-555	+2,495	+5,830	+5,744	+5,566	+5,288
15. $\Sigma 1 + 2 + 3 + 4 + 5 + 6 + 7 + 8 =$ $\Sigma +EL. MAX$	+21,111	+17,914	+14,836	+11,686	+8,383	+4,750	+295	-37	-584	-722



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO 7/0558/A

SHEET NO 1-76

AIRCRAFT

C-105

FRAME 697

PREPARED BY

DATE

G. MEYERS

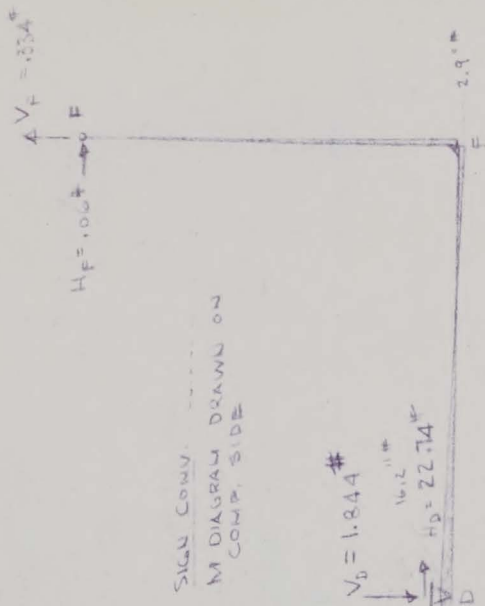
SEPT '56

CHECKED BY

DATE

ENGINE REMOVAL CASE (CONT'D)

UNIT SOL. 1000# - DM DIAG & SUPPORT REACTIONS



1000#

50.0#

$$\sum M_D = 0 = 16.2 + .06 \times 46.77 - 56.93 \times V_F$$

$$V_F = 19.01 = .334 \#$$

$$56.93$$

CHECK $\sum F_H = 0$ BY INSPECTION

$$\sum M_F = 1.51 \times 115.86 + 1000 - 1.844 \times 56.93 - 22.74 \times 46.77 \approx 0$$

(CHECK)

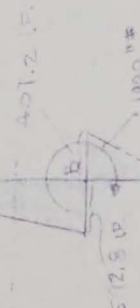
SOLVE FOR H_A

$$\sum M_C = +55.3 + 1000 - 46.77 H_A = 0$$

$$H_A = \frac{1055.3}{46.77} = 22.8 \#$$

$V_A = 1.51 \#$

$22.8 \# = H_A$



$V_A = 22.8$

$50.0 \#$

$$\sum M_D = 0 = -16.2 + 1000 - 56.93 \times V_A - 22.74 \times 46.77$$

$V_A = \frac{-86.2}{56.93} = -1.51 \#$



AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

REPORT NO 7/0558/4

SHEET NO 2-1

AIRCRAFT:

C-105

FRAME 697

PREPARED BY

DATE

G. MEYERS

OCT 56

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DATE

SECTION II

DETAIL STRESSING OF FRAME 697

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0558/4

SHEET NO. 2-3

AIRCRAFT:

C109

FRAME 697

PREPARED BY

DATE

CHECKED BY

DATE

DETAIL STRESSING OF V-BRACE
STRUCTURE

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-2554/4

SHEET No. 1-123 2-4

AIRCRAFT

C-105

ANALYSIS OF MAIN
FRAME STA. 617

PREPARED BY

W. B. GROSSMAN

DATE

JULY 1955

CHECKED BY

DATE

ANALYSIS OF CENTER "V-BRACE" STRUCTURE (ALL VALUES LBS) (REF DWS. 7-2554-224)

THE LOADS TO BE APPLIED TO THE CENTER "V-BRACE" STRUCTURE HAVE BEEN DETERMINED AS FOLLOWS:

- 1.) TRANSMITTED SIDE LOADS FROM THE FWD. AND AFT BAYS ARE TRANSMITTED TO FR. 617 AND ARE RESISTED BY THE "V-BRACE". THE MAX. LOAD HAS BEEN ESTIMATED AT $P_0 = 10.5 \text{ PSI}$ (SIDE LOAD). THIS CAUSES AN END LOAD $= \pm 35,000$ EACH OF THE TUBES OF THE "V-BRACE".
(REF PGS. 1-119, 1-125)

- 2.) AN "OUT-OF-BALANCE" DOWN LOAD IS RESISTED BY THE UPPER LONGITUDINAL BEAM AS SHOWN IN THE SKETCH ON PG. 1-53, PT. "D". THIS UPPER LONGITUDINAL BEAM IS SUPPORTED BY THE "V-BRACES" AT THE HEAVY FRAMES 644, 697 & 702 ONLY. THEREFORE, HALF OF THE LOAD IN EACH BAY WILL BE ASSUMED TRANSMITTED TO FR. 697.

$$P_0 = 3.75 \text{ psi (ASSUMED VALUE)}$$

$$P = 10.2 \text{ psi (ASSUMED CONSERVATIVE VALUE)}$$

$$d = \text{EFFECTIVE DOWN LENGTH} = \frac{1}{2}(617-644) + \frac{1}{2}(702-697) = 49"$$

$$\therefore P_0 = 5.75(10.2)(49) = 2970 \text{ LBS}$$

- 3.) IN ADDITION, THE LOAD ON THE ENGINE RAIL DURING ENGINE INSTALLATION OR REMOVAL MUST BE CONSIDERED. THIS LOAD IS ASSUMED APPLIED EITHER TO THE PORT OR STBD. SIDE AT ANY ONE TIME.

WEIGHT OF ENGINE ON ONE RAIL $= 3300 \text{ LBS}$ (REF CENTER STATION)
ENGINE HANDLING FACTOR $= 3.0$ (REF. AP 770 CH 722 PAR. 2.1)

$$\therefore \text{ENGINE RAIL LOAD} = P = 3.0 \times 3300 \text{ LBS} = 9900 \text{ LBS}$$

AIRCRAFT:

C-105

FRANK Stn. 697

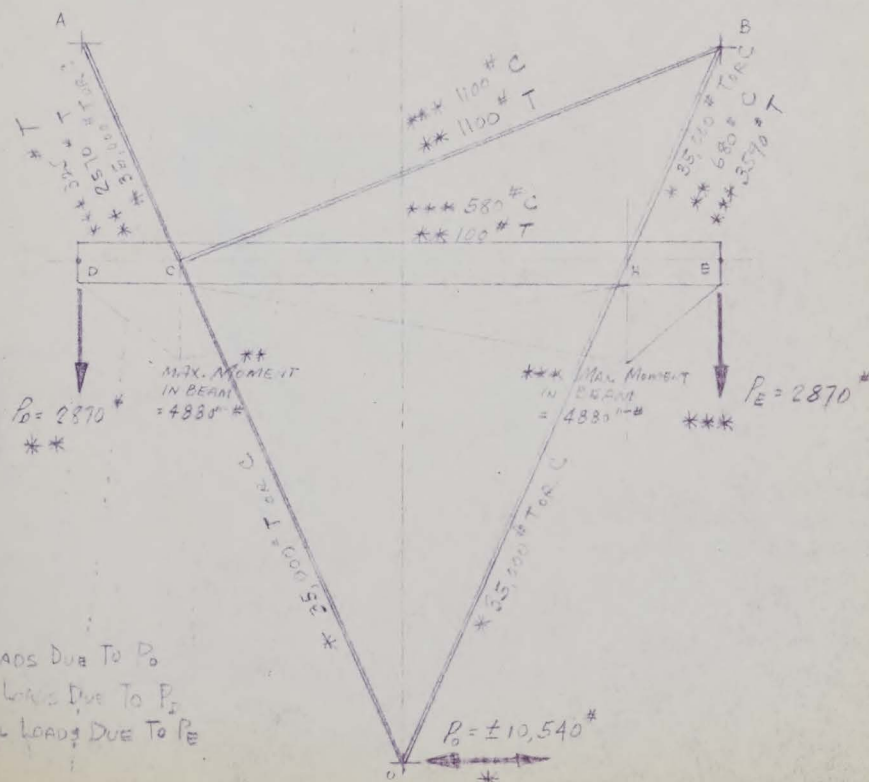
M. B. FREISMAN

CHECKED BY

DATE _____

(ALL VALVES LT.)

REF.
PG.
~~1074~~
L-2-5



- * INTERNAL LOADS DUE TO P_0
- ** INTERNAL LOADS DUE TO P_1
- *** INTERNAL LOADS DUE TO P_2

AIRCRAFT.

C-105

PREPARED BY

W. GROSSMAN

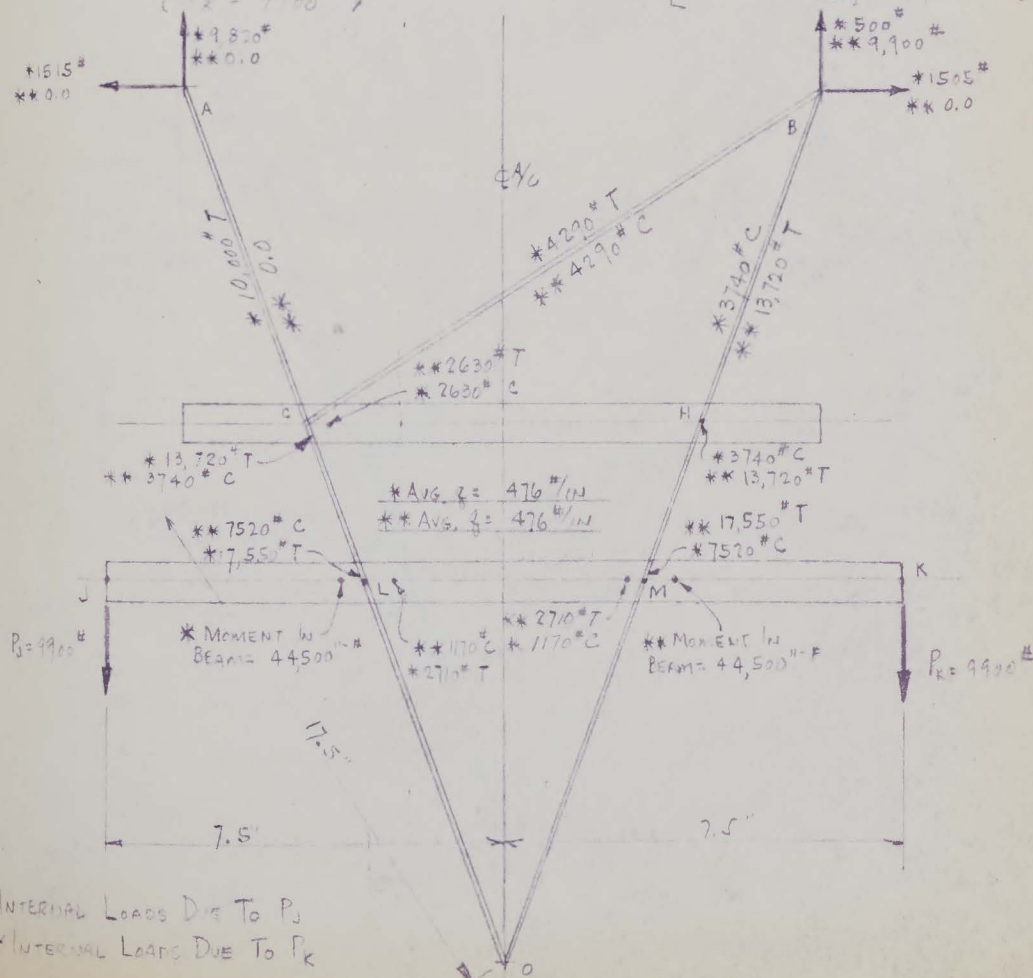
DATE _____

July 1955

CHECKED BY

DATE _____

2-4 & 2-5
FOR LOADS, REF. PGS. ~~1-123~~ 1-124
FOR UNIT ANALYSES, SEE
PGS. ~~1-124~~ 2-8
~~1-127~~



* INTERNAL LOADS DUE TO P_j
** INTERNAL LOADS DUE TO P_k

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7/6558/4

SHEET NO. 2-10

PREPARED BY

DATE

M. B. JOHNSON

JULY 1955

CHECKED BY

DATE

AIRCRAFT

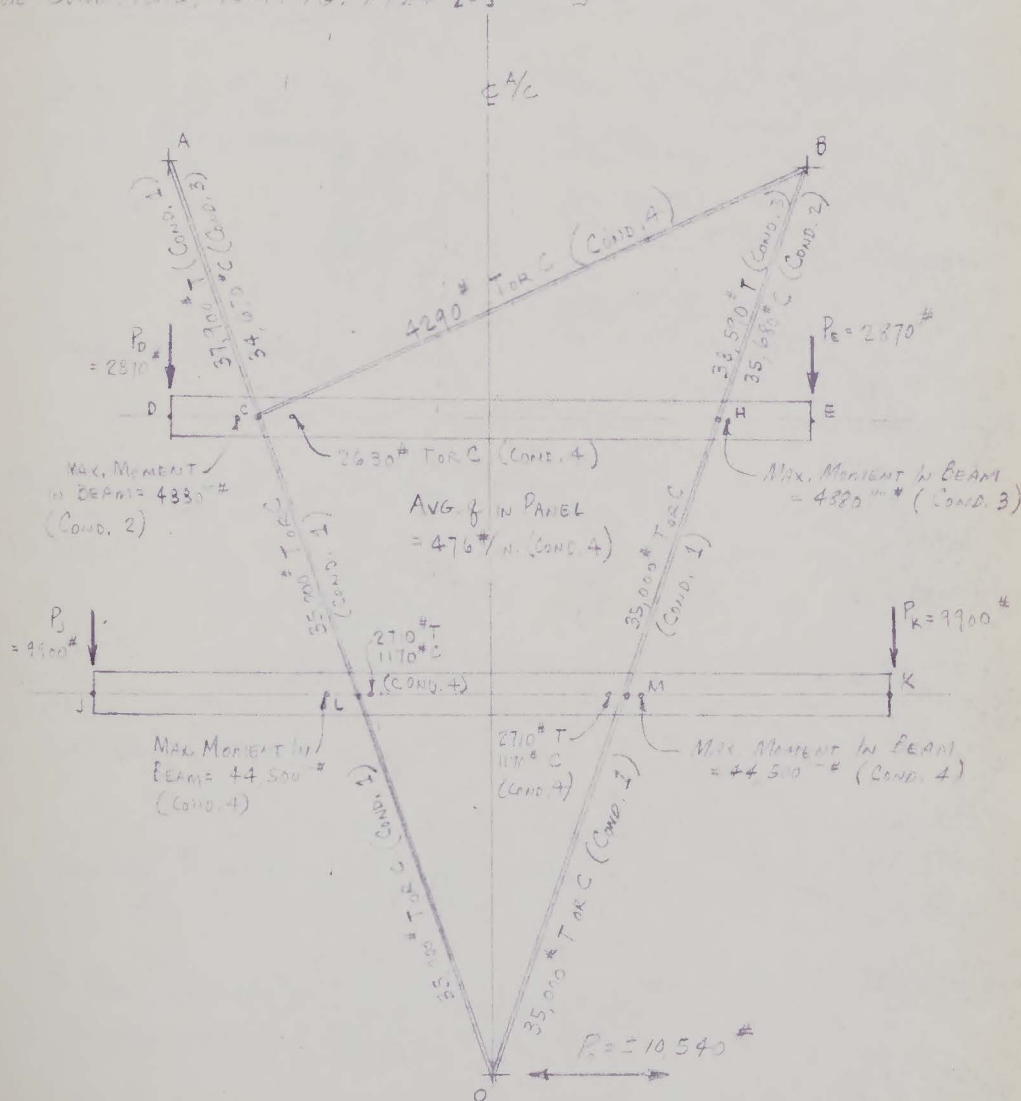
C-105

ANALYSIS OF HEAVY
ENGINE STA. 697

ANALYSIS OF CENTER "V-BRACE" STRUCTURE [CONT'D.] (ALL VALUES ULT.)
(REF. DWS. 7-ONE. 224)

SUMMARY OF CRITICAL INTERNAL LOADS & CONDITIONS:

[FOR INTERNAL LOADS, REF. PG. 1-125, 2-9
FOR CONDITIONS, REF. PG. 1-124, 2-5]



TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0558/4 35

SHEET NO. 7-130 2-11

AIRCRAFT

C-105

ANALYSIS OF HEAVY

FRAME STR. 677

PREPARED BY

DATE

W. P. GROSSMAN

JULY 1955

CHECKED BY

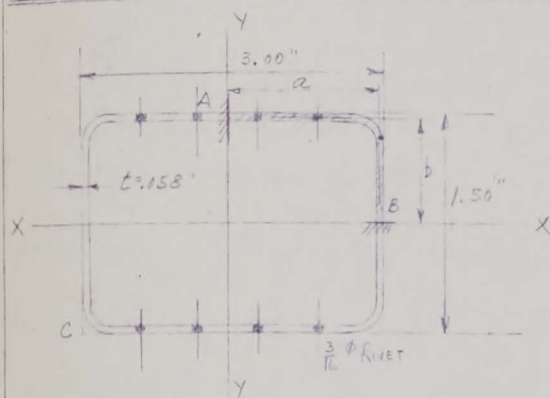
DATE

(ALL VALUES U.L.T.)

ANALYSIS OF CENTER "V-BRACE" STRUCTURE [CONT'D.] (REF. DWG. 7-0158-224)

THE MAIN MEMBERS OF THE "V-BRACE" CONSIST OF EXTENDED RECTANGULAR TUBES, 4340 STEEL (MIL T-6726), U.T. TO 150,000 PSI.

FIRST TRIAL: TRY TUBE $t = .058"$



$$A_g = 2(3.0 + 1.5)(.058) - \text{AREA LOSS AT CORNERS}$$

$$\text{AREA LOSS AT CORNERS DUE TO RADIUS (e.g. @ "C") = } 2.5t^2 \left\{ \begin{array}{l} \text{REF 7/0558/19} \\ \text{Pg. 72} \end{array} \right.$$

$$A_g = 9(.058) - 4(.25 \times .058)^2$$

$$= .522 - .034 = .488 \text{ in}^2$$

FOR ABOVE TUBE:

$$\begin{array}{l} F_{TU} = 150 \text{ KSI} \\ F_{TY} = F_{TX} = 135 \text{ KSI} \\ F_{SU} = 90 \text{ KSI} \\ F_{BU} = 110 \text{ KSI} \end{array} \left\{ \begin{array}{l} \text{REF. ANC-5} \\ \text{Pg. 24} \\ \text{ROOM TEMPERATURE} \end{array} \right.$$

CHECK OF LOCAL INSTABILITY (CRIPPLING STRESS):

THE CRIPPLING STRESS WILL BE DETERMINED BY THE METHOD GIVEN IN 10 AER. SEC., APRIL 12, 48, BY NEEDHAM. THIS IS BASED ON:

$$F_{CC} = \frac{C_0 \sqrt{E} F_{CY}}{\left(\frac{a+b}{2t}\right)^{0.75}}$$

A GRAPH HAS BEEN PREPARED (SEE FOLLOWING PGS. 1-131) WHICH GIVES F_{CC} AS A FUNCTION OF $\left(\frac{a+b}{2t}\right)$ FOR THE TUBE MATERIAL AS GIVEN ABOVE.

$$a = 1.5 - \frac{.058}{2} = 1.471 \quad b = .75 - \frac{.058}{2} = .721 \quad \frac{a+b}{2t} = 18.9$$

$$\therefore \text{ (FOR TYPE 3, FROM GRAPH PG. 1-131) } F_{CC} = 70,000 \text{ psi} \times 1.16 = 81,200 \text{ psi}$$

FOR ELEVATED TEMPERATURES, WE WILL CONSERVATIVELY REDUCE THE ABOVE STRESS BY 10%.

$$\therefore F_{CC} = 91\% (81,200) = 73,900 \text{ psi (ALLOW.) @ } 260^\circ\text{F.}$$

MAX. COMPRESSIVE LOAD IN TUBE = 35,680# (REF. BH, PG. 1-129)

$$\text{ACTUAL } f_c = \frac{P}{A_g} = \frac{35,680}{.488} = 73,000 \text{ psi}$$

$$MS_1 = \frac{F_{CC}}{f_c} = \frac{73,000}{73,000} - 1 = 0.0 \quad 0.0$$

THIS WILL BE CONSIDERED AN ACCEPTABLE MS. AT THE PRESENT TIME. THEREFORE, USE $t = .058"$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0-58/4

SHEET NO. ~~1-13~~ 2-13

AIRCRAFT:

C-105

ANALYSIS OF HEAVY

FRAM. SP. 611

PREPARED BY

W. S. GROSSMAN

DATE

JULY 1955

CHECKED BY

DATE

ANALYSIS OF CENTER V-BRACE BRACING [Cont'd.] (Ref. Eng. 7-058-224)

REINFORCEMENT OF TUBE [Column Action]:

- 2.) THE UNSUPPORTED LENGTH OF THE TUBE FOR FAILING IN THE LATERAL DIRECTION (ABOUT AXIS X-X, PG. 1-130) WILL BE ASSUMED = 22.0" WITH THE ENDS FIXED (SEE BH, PG. ~~1-129~~²⁻¹⁰). THE LONGITUDINAL BEAM IS ASSUMED AS A TUBE SUPPORTED AT PT. "H" FOR FAILURE IN THE LATERAL DIRECTION. (FOR TUBE CROSS-SECTION, SEE PG. ~~1-134~~²⁻¹¹).

As Before (PG. 1-127):

$$I_{eff} = 2(300 \times .05)(.72)^3 + 2 \left[\frac{.50(.05)^3 - .05^3}{.058} \right] = .181 + .024 = .205 \text{ in}^4$$

$$r = \sqrt{\frac{I_{eff}}{A}} = \sqrt{\frac{.205}{.488}} = .420 = .648"$$

UNSUPPORTED LENGTH = 22.0" (SCALED FROM REF. DIAG.)

$$\frac{L}{r} = \frac{22.0}{.648} = 33.9$$

F_c = Allow. Com. Stress = 70% x 164,000 psi = 114,800 psi { REF. ENG-5, FIG. 2.23(c) }
At Elevated Temp. F_c = 150,000 psi

Actual f_c = 73,000 psi (PG. 1-122)

$$M.S. = \frac{114,800}{73,000} - 1 = .435$$

.43

CHECK OF TENSILE STRESS IN TUBE:

PROVIDING FOR 3- ϕ CIRCLES (DRILL DIAMETER = .111" - REF. ENG-5 PG. 85)

$$A_{NET} = A_g - 3(.111)(.05) = .488 - .0847 = .3933 \text{ in}^2$$

SEE FIRST LINE OF CIRCLES ATTACHING TUBE TO SOCKET

VIEWS "K-K" & "M-M", REF. DIAG.

$$\text{MAX. TENSILE LOAD} = 37,500 \text{ lb} \quad \text{(SEE BH, PG. ~~1-129~~²⁻¹⁰)}$$

$$\text{Actual } f_t = \frac{P}{A_{NET}} = \frac{37,500}{.3933} = 95,300 \text{ psi}$$

Allow f_{tu} = 70% x 150,000 = 105,000 psi @ 260°F (Ref. PG. ~~1-134~~²⁻¹¹)

$$M.S. = \frac{105,000 \text{ psi}}{95,300 \text{ psi}} - 1 = .40$$

.40

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0558/4
SHEET NO. ~~1-12~~ 2-14

AIRCRAFT:

C-105

ANALYSIS OF HEAVY
FEMIC STA. 647

PREPARED BY

DATE

W.B. GROSSMAN

JULY 1955

CHECKED BY

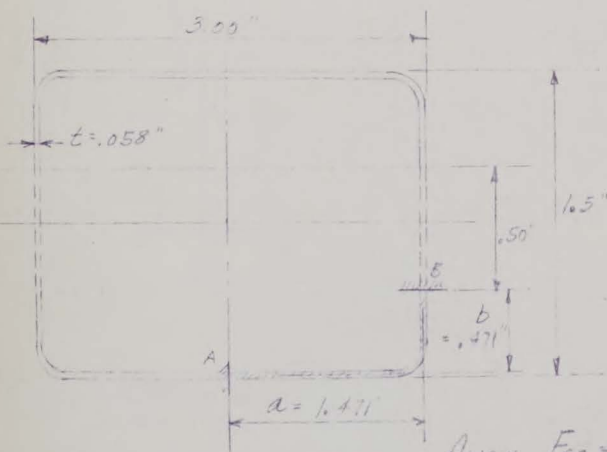
DATE

(ALL VALUES U.T.)

ANALYSIS OF CENTER "V-PRACE" STRUCTURE [CONT'D.] (REF. DIV. 7-NB-224)

CORROSION OF TUBE AT FIRST LINE OF RIVETS ATTACHING TUBE TO SOCKET:

AS SEEN FROM THE REF. DIVS., THE TUBE IS ATTACHED TO THE SOCKET ON ONLY TWO (2) OF ITS FOUR (4) FACES (THE 3.0" WIDE FACES, PG. ²⁻¹¹~~1-130~~). HENCE IT IS POSSIBLE THAT THE ENTIRE CROSS-SECTION IS NOT EFFECTIVE AT THE FIRST LINE OF RIVETS ATTACHING THE TUBE TO THE SOCKET. THIS WOULD OCCUR IF THE LOAD IN THE UNATTACHED FACES (1.5" WIDE) SHEARS OVER TO THE STIFFER, ATTACHED FACES (2.0" WIDE) BEFORE THE FIRST LINE OF RIVETS IS REACHED (THE LOAD THEN IS FROM THE TUBE TO THE SOCKET). THE CORROSION STRESS CALCULATION MADE ON PG. ²⁻¹¹~~1-130~~ WILL BE REVISED FOR THE SECTION SHOWN BELOW WHICH CONSIDERS ONLY A PART OF THE 1.5" WIDE FACE AS EFFECTIVE MATERIAL.



GROSS AREA = .4880" - 2(1.5" x .058")

$A_g = .488 - .174$

$= .314$

$a = 1.471$

$b = .471$

$t = .058$

$\frac{a+b}{2t} = \frac{1.942}{.116} = 16.75$

ALLOW. $F_{cc} = 77,000 \times 1.16 \times 90\% = 80,500 \text{ psi}$
@ ELEVATED TEMP.

MAX. COMPRESSIVE LOAD IN TUBE = 35,680# (REF. BH. PG. ²⁻¹⁰~~1-124~~)
ACTUAL $f_c = \frac{P}{A_g} = \frac{35,680}{.314} = 83,000 \text{ psi}$

$MS = \frac{F_{cc}}{f_c} = \frac{80,500}{83,000} - 1 = -.03$

[IN VIEW OF THE ABOVE ASSUMPTIONS AND METHOD OF ANALYSIS, THE R.F. WILL BE CONSIDERED ACCEPTABLE.]

L-135 2-18

AIRCRAFT:

C-105

PREPARED BY

DATE _____

JULY 1955

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DATE _____

$$M.S. = 1245 + .03F - .05$$

REVISE
DESIGN

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/2558/2

SHEET NO. 2-18

AIRCRAFT:

C-105

ANALYSIS OF HEAVY
ENGINE 514 697

PREPARED BY

DATE

CHECKED BY

DATE

ANALYSIS OF HEAVY V-ENGINE SERVICE (Continued) (Total Values Max.) (Ref. Draw 7-0158-224)

CHECK OF LOG: ENGINE DESIGN 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73 74 75 76 77 78 79 80 81 82 83 84 85 86 87 88 89 90 91 92 93 94 95 96 97 98 99 100

(Bottom Cover) $\frac{A}{D} = \frac{.50}{.750} = .67$ $\frac{D}{E} = \frac{.750}{.425} = 1.76$ $A_{R2} = .48(.750) = .360 \text{ in}^2$
 $K_{R2} = 0.93$ (From Fig. 4, U.S. Curve 1 = 82)
 $F_{R2} = 57,800 \text{ psi}$ ($\times 2 = 300,000$)
 $P_{R2} = 2 \times K_{R2} \times F_{R2} \times A_{R2} = 2(0.93) 57,800 (.360) = 39,300$
 $\text{Max. Tube Load} = 39,300 \text{ lb}$ ($\times 2 = 78,600$)
 $MS = \frac{39,300}{38,500} - 1 = .003$

LOG YIELD: $P_{L2} = P_{R2} = 39,300 \text{ lb}$ (Above)
 $\frac{P_{L2}}{A_{R2} \times F_{R2}} = \frac{39,300}{.48(.750) \times 57,800} = 0.93$
 $C = 1.10$ (From Fig. 5)
 $P_y = C \times F_{R2} \times P_{L2}$ $F_{R2} = 57,800 \text{ psi}$ $P_{L2} = 39,300 \text{ lb}$
 $P_y = 1.1 \left(\frac{.48}{.578} \right) (39,300) = 36,000 \text{ lb}$ (Yield)

CONVERT TO EQUIVALENT U.S. LOAD = $36,000 \times \left(\frac{.71 \times 10^6}{.71 \times 10^6} \right) = 40,000 \text{ lb}$
 $\text{Max. Tube Load} = 39,300 \text{ lb}$ ($\times 2 = 78,600$)
 $MS = \frac{40,000}{38,500} - 1 = .27$

PRESSURE YIELD: $A_{R2} = \text{Area On Pin On Engine} = .624(.42) = .260 \text{ in}^2$
 $F_{R2} = 90\% \times 100,000 \text{ psi} = 90,000 \text{ psi}$ (100% HT STEEL @ 260°F, PS 1177) (ANG-5)
 $P_{R2} = 1.65 F_{R2} A_{R2} = 1.65 90,000 (.260) = 100,000$
 $\text{Max. Tube Load} = 100,000 \text{ lb}$ ($\times 2 = 200,000$)
 $MS = \frac{100,000}{38,500} - 1 = 1.59$

PIN SHEAR: P_{R2} IS IN DOUBLE SHEAR (AN10 C 23 Bolt)
 $\text{Allowable Load} = 23,000 \text{ lb}$ Single Shear $\left\{ \begin{array}{l} P_{R2} \text{ Max. 5 T. 2 AN10 Bolt} \\ = 46,000 \text{ lb} \end{array} \right.$ Double Shear $\left\{ \begin{array}{l} P_{R2} 32 \end{array} \right.$
 $\text{Max. Tube Load} = 39,300 \text{ lb}$ ($\times 2 = 78,600$)
 $MS = \frac{46,000}{38,500} - 1 = .19$

TENSION AREA: $K = 1.5$ (From Curve 2) $A_T = (W \times t) = (.6 \times .48) = .288 \text{ in}^2$
 $F_{R2} = 57,800 \text{ psi}$ ($\times 2 = 300,000$)
 $P_{T2} = K \times F_{R2} \times A_T = 1.65 57,800 (.288) = 45,400 \text{ lb}$ (See Loss)
 $\text{Max. Tube Load} = 39,300 \text{ lb}$ ($\times 2 = 78,600$)
 $MS = \frac{45,400}{38,500} - 1 = .17$

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7/1559/4

SHEET NO. 137

2-19

PREPARED BY

DATE

W.B. GROSSMAN

JULY 1955

CHECKED BY

DATE

AIRCRAFT:

C-115

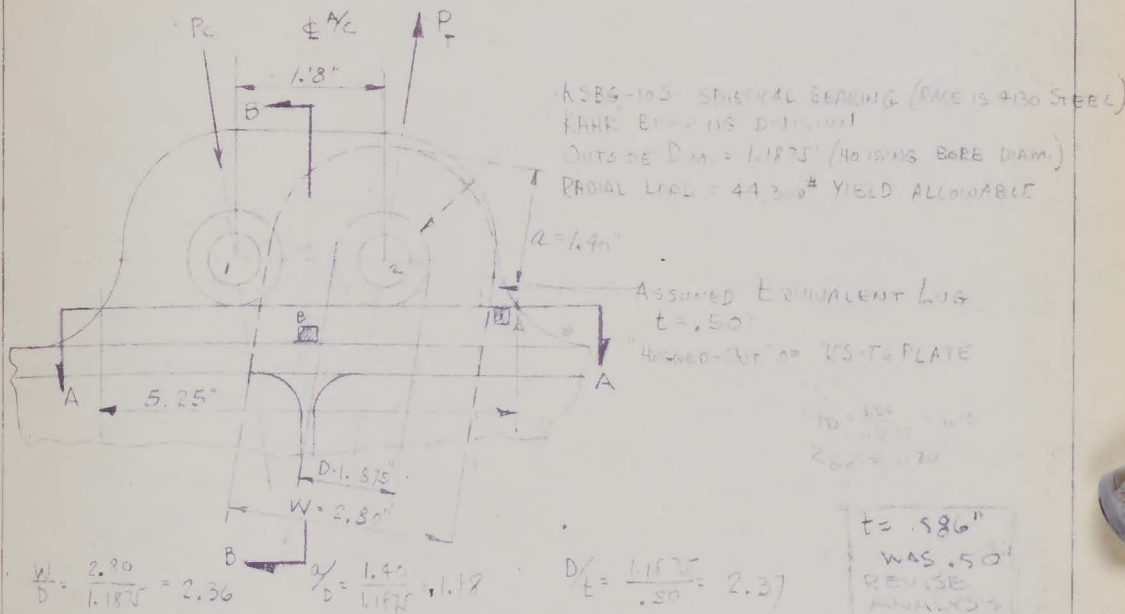
ANALYSIS OF HEAVY
LOADS STA. 697

(All Values U.S.)

ANALYSIS OF CENTER "V-PIECE" JOINTURE (Cont'd): (REF. DWS. 7-258-224)

[All Calculations are per "ANALYSIS OF LUGS"

CHECK OF FRAME LUG: Melton & Root, Product Engineering, May 12th June 23]



TENSION ACROSS NET SECTION: $K_T = .74$ (Fig. 3, Curve 2)

$F_{TU} = 57,850$ psi (160" 300 lbs. 16.1-17)

$P_{TU} = K_T F_{TU} \Delta_T = .74(57,850)(.806) = 43,800$ lbs

Max. Tube Load = 38,590 lbs (Pg. 2-10)

$M.S. = \frac{43,800}{38,590} - 1 = 1.135$

+1.13

SHEAR-BEARING FAILURE: $K_{BR} = 1.08$ (From Fig. 4, Using Curve for $P/D = 2.37$)

$F_{BR} = 57,850$ psi (160" 300 lbs. 16.1-17)

$P_{BR} = K_{BR} F_{BR} A_{PR} = 1.08(57,850)(.594) = 37,150$ lbs

Max. Tube Load = 38,590 lbs (Pg. 2-10)

$M.S. = \frac{37,150}{38,590} - 1 = 1.08$

+1.08

[THIS WILL BE CONSIDERED AS AN ACCEPTABLE VALUE]

SPHERICAL BEARING: THE MANUFACTURER'S RATING FOR THIS BEARING

IS GIVEN AS 44,300 lbs ALLOWABLE (PANE).

Max. Tube Load = 38,590 lbs (Pg. 2-10)

$M.S. = \frac{44,300}{38,590} - 1 = 1.10$

+1.10

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0558/23
SHEET NO. 1-14+ 2-21

AIRCRAFT

C-105

ANALYSIS OF HENTY
FRANK STA. 697

PREPARED BY

DATE

W.P. STOSCHMAN

JULY 1965

CHECKED BY

DATE

(ALL VALUES ULT.)

ANALYSIS OF CENTER "V-BRACE" STRUCTURE [CONT'D.] (REF. DWG. 7-0558-224)

CHECK OF FRAME LUG: BENDING & SHEAR COMBINED LOADS (SECT. A-A)

AS SEEN ON THE SKETCH ON PG. 1-139, THE HORIZONTAL COMPONENTS OF LOADS P_C & P_T CREATE A SHEAR LOAD ON SECTION A-A. IN ADDITION, DUE TO THE FACT THAT THE VERT. COMPONENTS OF P_C & P_T ARE 1.8" APART, THE FRAME LUG IS SUBJECTED TO A MOMENT IN SECTION A-A. AT THE EXTREME FIBER (A-A) THE MATERIAL IS SUBJECTED TO A TENSILE STRESS DUE TO BENDING & A SHEAR STRESS. THE R.F. WILL BE CALCULATED BY COMPARING THE PRINCIPAL STRESSES (CREATED BY THE TENSION AND SHEAR) TO THE ULTIMATE ALLOWABLE STRESSES. (FOR GEOMETRY OF STRUCTURE, PG. 1-139)

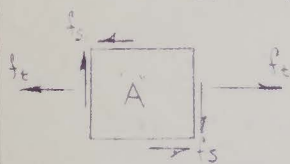
$$\text{HORIZONTAL COMP. OF } P_C \text{ \& } P_T = P_0 \cdot \left[\frac{2(16)}{50.57} \right] 38,510 = 11,600 \text{ \#} \quad (\text{REF PGs. 1-139, 1-140})$$

$$\text{SHEAR AREA} = 5.25(1.50) = 2.625 \text{ \#} \quad (\text{REF PG. 1-139})$$

$$f_s = \frac{P}{A} = \frac{11,600}{2.625} = 4,420 \text{ psi}$$

$$\text{MOMENT DUE TO VERT. COMPONENT OF } P_C, P_T = 1.8 \times \left(\frac{50}{50.57} \right) 38,510 = 68,700 \text{ \#-IN} \quad (\text{REF PG. 1-139})$$

$$f_t = \frac{6M}{bt^3} = \frac{6(68,700)}{5.0(5.25)^3} = 29,900 \text{ psi}$$



$$\text{PRINCIPAL SHEAR STRESS} = f_{s_{MAX}} = \sqrt{f_s^2 + \left(\frac{f_t}{2} \right)^2} \quad (\text{REF. ANGLE})$$

$$f_{s_{MAX}} = \sqrt{(4,420)^2 + \left(\frac{29,900}{2} \right)^2} = \sqrt{243,050,000} = 15,600 \text{ psi}$$

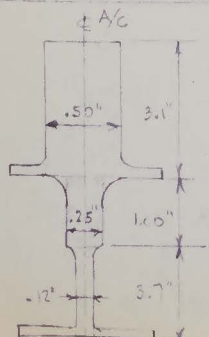
$$\text{PRIN. TENSILE STRESS} = f_N = \frac{f_t}{2} + f_{s_{MAX}} = 14,950 + 15,600 = 30,550 \text{ psi} \quad (\text{REF. ANGLE})$$

$$\text{ALLOW. } F_{TW} = 57,800 \text{ psi} \quad (260^\circ @ 300 \text{ HRS. PG. 1-141})$$

$$\text{ALLOW. } F_{SW} = 35,300 \text{ psi}$$

$$MS = \frac{1}{\frac{f_N}{F_{TW}} + \frac{f_{s_{MAX}}}{F_{SW}}} = \frac{1}{\frac{30,550}{57,800} + \frac{15,600}{35,300}} = \frac{1}{.528 + .442} = \frac{1}{.98} = 1.02$$

SHEAR ON VERTICAL SECTION B-B (PG. 1-139): THE VERTICAL COMPONENTS OF P_C & P_T CREATE A SHEAR LOAD ON SECTION B-B AT THE AG & THE SHEAR AREA IS TAKEN AS SHOWN IN THE SKETCH.



$$\text{SHEAR AREA} = .50(3.1) + .25(1.0) + .12(3.7) = 1.55 + .25 + .44 = 2.245 \text{ \#}$$

$$\text{VERT. COMPONENT OF } P_C, P_T = \left(\frac{50}{50.57} \right) 38,510 = 38,100 \text{ \#} \quad (\text{PGs. 1-139, 1-140})$$

$$f_s = \frac{P}{A} = \frac{38,100}{2.245} = 17,000 \text{ psi}$$

$$\text{ALLOW. } F_{SW} = 35,300 \text{ psi} \quad (260^\circ @ 300 \text{ HRS. PG. 1-141})$$

$$MS = \frac{35,300}{17,000} = 2.07$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0550/4
SHEET NO. 1742 2-22

AIRCRAFT:

C-105

ANALYSIS OF 4024
FINITE STR. 617

PREPARED BY

M.B. GROSSMAN

DATE

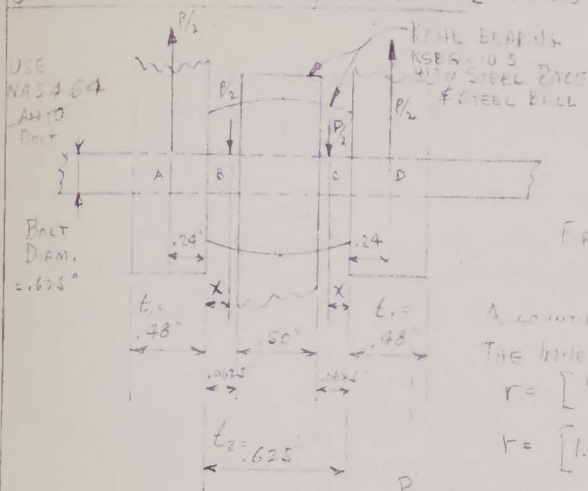
JULY 1955

CHECKED BY

DATE

ANALYSIS OF CENTER "V-BRACE" STRUTS [CND]: (REF. DWS. 7-1856-224)

CHECK BEARING OF AN10 BOLT: [ALL CALCULATIONS ARE REFERENCED TO ANALYSIS OF LUGS "MECHANICAL UNIT", FRONT ENG, JUNE 1953]



ASSUME THAT THE STEEL BALL IS SUFFICIENTLY RIGID FOR ITS WIDTH (.625") TO ACT AS A LUG. $\therefore$ USE $L_2 = .625"$ INSTEAD OF $.50"$.

FOR THE INNER LUG: $a = 1.40"$
 $D = 1.182"$

A CORRECTION FOR THE EFFECT OF "BEARING" ON THE INNER LUG ONLY:

$$r = \left[\frac{a}{D} - \frac{1}{2} \right] \frac{D}{L_2} = \left[\frac{1.40}{1.182} - \frac{1}{2} \right] \frac{1.182}{.625}$$

$$r = [1.18 - .50] 1.90 = .68(1.90) = 1.29$$

$$\frac{P_{MIN}}{A_{GR} F_{TUT}} = 1.08 \text{ (REF. PG. 1-142)}$$

(FROM FIG. 4): $\gamma = .55$

$$\kappa = \gamma \left(\frac{L_2}{a} \right) = .55 \left(\frac{.625}{1.4} \right) = .246$$

MAX. BENDING MOMENT CONSIDERING BOLT AS A BEAM SUPPORTED AT "A" & "D", AND LOADED AT PTS. "B" & "C".

$$\text{MAX. TUBE LOAD} = 38,150 \text{ (PG. 1-129)} : \frac{P_1}{2} = \frac{38,150}{2} = 19,475 \text{ \#}$$

$$\text{BENDING MOMENT} = \frac{P}{2} (.24 + \kappa) = 19,475 \text{ \#} (.24 + .246) = 19,475 \text{ \#} (.486) = 9450 \text{ \#-IN}$$

$$f_b = \frac{M}{I} = \frac{19,475 \text{ \#-IN}}{(2.549) D^4} = \frac{9450}{.1782(.625)^3} = 264,000 \text{ psi}$$

F_b = BENDING MOMENT OF RUPTURE STRESS = $K \times F_{TU}$

$K = 1.46$ (REF. ANC-S, PG. 30, $V_1 = 0$ FOR A SOLID BOLT SHANK H.T. 125 KSI; AN10)

$$F_{TU} = 10 \text{ \#} \times 125,000 = 1,250,000 \text{ (AT } 260^\circ \text{ F, REF. ANC-S \# PG. 1-130)}$$

$$F_b = 1.46 \times 1,250,000 = 1,825,000 \text{ psi}$$

$$MS = \frac{1,825,000}{264,000} - 1 = -1.37 \text{ (INSUFFICIENT)}$$

TRY A 5/8" P BOLT OF HIGHER H.T. - NAS 464 - H.T. 160,000 PSI (REF. ANC-S)

$K = 1.55$ (REF. ANC-S, PG. 30, $V_1 = 0$ FOR A SOLID BOLT SHANK H.T. 150 KSI)

$$\text{AS ABOVE, } F_{TU} = 16 \text{ \#} \times 160,000 = 2,560,000 \text{ (AT } 260^\circ \text{ F, REF. ANC-S \# PG. 1-130)}$$

$$F_b = 1.55 \times 2,560,000 = 3,968,000 \text{ psi}$$

$$MS = \frac{3,968,000}{264,000} - 1 = -1.10 \text{ ACCEPTABLE}$$

ADJUSTING "X" TO 0.4 PROCEEDING AS ABOVE: $F_{TU} = 125,000 \text{ psi}$ & $16 \text{ \#} = 2,000,000 \text{ psi}$ $-1 = +1.4$

REVISE DESIGN

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT

C-105

ANALYSIS OF HEAVY
FRAME STA. 697

REPORT NO.

7/0558/2

SHEET NO.

1-143 2-23

PREPARED BY

M.B. GROSSMAN

DATE

JULY 1955

CHECKED BY

DATE

ANALYSIS OF CENTER "V-BRACE" STRUCTURE [CONT'D.] (ALL VALUES U.T.)
(REF. DWG. 7-0558-224)

ALTERNATE ATTACHMENT OF TUBE TO SOCKET: (SEE P. 1-135)

USING CHERRY MONEL RIVETS (BLIND, PROTRUDING HEAD, CR 563)

ANC-5, TABLE 2.015, PG. 36, GIVES ALLOWABLES FOR CR 563 RIVETS IN 18-S (1/2 HARD) CORROSION RESISTANT SHEET. THE DESIGN MECHANICAL PROPERTIES OF 18-S (1/2 HARD) COR. RESIST. SHEET ARE VERY SIMILAR TO THOSE FOR 4340 STEEL, HT 105KSI (COMPARE VALUES TABLE 2.111(B) & 2.111(C), PGS. 24, 25 ANC-5). THEREFORE, WE ARE JUSTIFIED IN USING THE ABOVE VALUES TO OBTAIN RIVET ALLOWABLES FOR OUR TUBE.

FOR 1/4 CR 563 RIVETS IN .058" SHEET: ALLOW. = 2080[#] (INTERPOLATING IN ANC-5, PG. 36)
BEARING IN SOCKET, IS THICK 75-T6B40; FBR: 173 KSI (9/16-2.0, ANC-5, PG. 51)
ALLOW. FBR = 3660 x 1.35 = 4940[#] (REF. ANC-5, PG. 85)

FOR ELEVATED TEMPERATURES: RIVET ALLOW. = 70% x 2080 = 1456[#] (REF. PG. 1-132)
MAX. TUBE LOAD = 38,590[#] (REF. DR. 106, 1-132) 2-10

ASSUMING 24 RIVETS: $L_{S, RIVET} = \frac{38,590}{24} = 1610[#]$ MS. = $\frac{1456}{1610} = \underline{\underline{+.16}}$

USING BLIND HUCK LOCKBOLTS, 4" Ø (CS-L-127) PROTRUDING HEAD.

THE ABOVE LOCKBOLT IS MADE OF HEAT-TREATED ALLOY STEEL & REQUIRES A DRILL HOLE .261" DIA. (REF. AVRO ENG. MANUAL, VOL. 2, SECT II, 6.3 & 6.4.3). THE U.T. SINGLE SHEAR STRENGTH OF A STEEL PROTRUDING HEAD LOCKBOLT = 4650 (REF. ANC-5, PG. 92). THE SINGLE SHEAR STRENGTH OF THE ABOVE CHERRY MONEL RIVET IS 340[#] (REF. ANC-5, PG. 36). IN VIEW OF THE LACK OF DATA, IT WOULD BE CONSERVATIVE TO USE THE ALLOW. DEVELOPED ABOVE (FOR CR 563 IN .058" SHEET) FOR THE BLIND HUCK LOCKBOLTS BECAUSE BEARING IN THE .058" THICK TUBE IS THE CRITICAL FEATURE, [THE HUCK BLIND LOCKBOLT IS BETTER IN BEARING BECAUSE OF ITS .261" DRILL HOLE VERSUS .750" FOR THE CR 563 RIVET.]

AS ABOVE, USE 24 RIVETS (12 PER FACE)
4" Ø BLIND HUCK LOCKBOLTS (CS-L-127)
PROTRUDING HEAD

MS = +.16

1-143
2-23
PREPARED BY
M.B. GROSSMAN
DATE
JULY 1955
CHECKED BY
DATE

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-558/2

SHEET NO. 1-144 2-24

AIRCRAFT:

C-105

ANALYSIS OF HEAVY

FRAME STA. 697

PREPARED BY

DATE

W.B. GROSSEMAN

JULY 1955

CHECKED BY

DATE

(ALL VALUES IN IN.)

ANALYSIS OF CENTER "V-BRAKE" SOCKET [CONT'D.]: (REF. DWS. 7-058-224)

CHECK OF LUG (ON UPPER WING ATTACHMENT FITTING):

REVIEW DESIGN: USE STEEL FITTING FLASH WELDED TO TUBE.

THE PRESENT ARRANGEMENT OF END SOCKET AT THE UPPER WING ATTACHMENT FITTING IS UNSATISFACTORY. THE ENTIRE END LUG IN THE TUBE MUST BE TRAY. NOTED THAT THE LUG INSTEAD OF TWO (2) LUGS IS AT THE BOTTOM POSITION. (Pg. 1-15). IF THE FITTING IS MADE OF 75-76 STOCK, THE REQUIRED LUG BECOMES TOO LARGE (THE LUG THICKNESS IS FIXED AT .50" BY THE GAP AT THE WING YOKES FITTING, REF. DWS. 7-1062-1141).

IN THE ANALYSIS OF THE WING YOKES FITTING ITSELF (7-2562/8), THE LUG OF THE YOKES FITTING WAS CHECKED FOR A 40,000⁺ TENSILE LOAD. THIS GAVE A RESIDUE FACTOR OF 1.25. (7-2562/8, Pg. 1-5) HOWEVER, THE LOADS WERE INCREASED BY AN FACTOR FITTING FACTOR = 1.33. FOR A 40,000⁺ COMPRESSIVE LOAD, THE YOKES FITTING LUG CARRIED A REF = 1.33 (2,260⁺ TENSILE LOAD). IT IS FELT THAT THE YOKES FITTING LUG IS SATISFACTORY FOR THE MAX. TENSILE LOADS INCREASED IN OUR REPORT, (38,500⁺ TENSION, 35,400⁺ COMPRESSION - Pg. 2-10).

REVIEW DESIGN

IT HAS BEEN DECIDED TO USE A STEEL FITTING SIMILAR TO THE ONE IN THE START DRAWING AT STA. 4450 (DWS. 7-1054-342). THIS FITTING WILL BE FLASH WELDED AROUND THE PERIMETER TO THE TUBE. AFTER WELDING THE TUBE AND END FITTINGS (THE FITTING AT THE OTHER END OF THE TUBE WILL PROBABLY BE CHANGED TO CONFORM WITH THE UPPER FITTING) WILL BE HEAT-TREATED TO 150 KSI. THE FLASH WELD IS WILL BE DONE BY THE CLEVELAND BROWNE TOOL CO. THIS COMPANY IS RECOMMENDING THE USE OF 4130 STEEL (MIL-S-6765) FOR TUBES WHICH ARE FLASH WELDED (MIL 6873 - FLASH WELD SPEC.).

SEE PG. 1-144 2-31

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/558/4

SHEET NO. 1-191 2-25

AIRCRAFT:

C-105

ANALYSIS OF HEAVY

FRONT SEA 677

PREPARED BY

DATE

M. B. GROSSMAN

JULY 1955

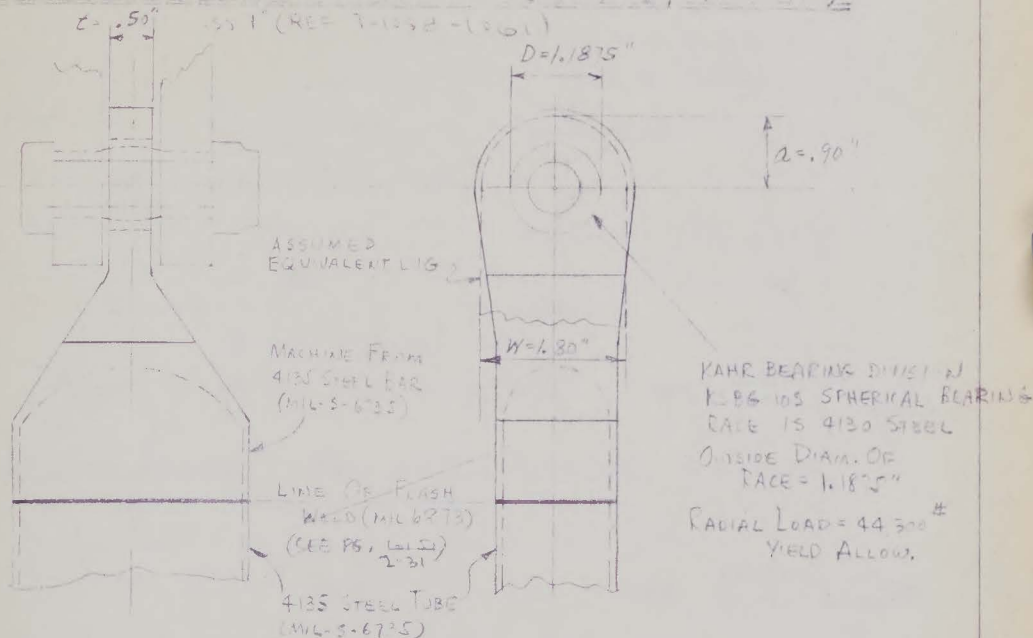
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DATE

(ALL VALUES U.T.)

ANALYSIS OF CENTER "V-BRACE" STRUCTURE [CONT'D.]; (REF. DWS. 7-058-224)

CHECK OF STEEL SECTOR (2) (HARD WELD: YORE FITTING, 7-1062-1940)



H.T. TO 150,000 PSI AFTER WELDING

THE ALLOWABLES FOR THE 4135 STEEL (H.T. 150,000 PSI) WILL BE ARBITRARILY REDUCED BY 10% FROM THE VALUES IN TABLE TO ACCOUNT FOR THE EFFECTS OF ELEVATED TEMPERATURES. (260°F. @ 300 HRS.)

$$\begin{aligned}
 F_{T1} &= 150,000 \times 90\% = 135,000 \text{ psi} \\
 F_{T2} &= F_{T1} \times 90\% = 121,500 \text{ psi} \\
 F_{S1} &= 90,000 \times 90\% = 81,000 \text{ psi} \\
 F_{S2} &= 190,000 \times 90\% = 171,000 \text{ psi}
 \end{aligned}$$

} IN 2475
 R. H. ALX-S. PS. 24

TECHNICAL DEPARTMENT (Aircraft)

REPORT No

7/550/4

SHEET No

1-147 2-27

AIRCRAFT

C-105

Analysis of Heat
Fracture Spec. 697

PREPARED BY

W. E. GOSSAULT

DATE

JULY 1955

CHECKED BY

DATE

Analysis of Center "V" Edge" Specimen [Cont'd.] (Ref. Ins. 7-058-224)

Check of Load Capacity & Fracture Cause Failure:

No mention is made in ANCS-5 or FLASH WELD SPEC. ANCS-W-6873 of any reduction in the allowable compressive stress due to the effects of flash welds. [The upset at the minimum in the inside of the tube at the flash weld adds to the compressive load at the "line of flash weld."] THEREFORE THE ANALYSIS ON Pgs. 1-140 TO 1-144 IS STILL VALID. 2-11 TO 2-14

Check of Tensile Stress in Tube:

THE DIAMETER THRU THE TUBES IS GIVEN AS 1.191 INCH. HOWEVER, CONSIDERABLY, WE WILL DEDUCT FOR 4-3/16" DIAM. (REF. DIAM. 1.191", REF. ANCS-3 PG. 25). THESE DIAMETERS WERE FOUND ON A CROSS-SECTION WHERE THE TUBES BEING ATTACHED TO THE TUBE (REF. CH. LM, PG. 1-144). 2-10

ASME - .488" (REF. PG. 1-13)

$$A_{net} = .488 - 4(1.191)(.044) = .488 - .444 = .444 \text{ in}^2$$

$$\text{MAX. TUBE LOAD} = 32,500 \text{ lb} \text{ (REF. PG. 1-144)} \text{ 2-10}$$

$$\text{Actual } \frac{P}{A} = \frac{32,500}{.444} = 87,000 \text{ psi}$$

$$F_{TU} = 125,000 \text{ psi (240°F, PG. 1-144)} \text{ 2-25}$$

From ANCS-5, Table 2 (PG. 1), PG. 36, & From ANCS-W-6873, "Flash Weld"

Allow. Net Tensile Stress = .8 F_{TU}

$$= .8(125,000) = 100,000 \text{ psi}$$

$$MS = \frac{100,000}{87,000} - 1 = +.24$$

+24



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7/0558/4

SHEET NO. 1-176 2-33

AIRCRAFT:

CF-105

FRAME 697

PREPARED BY

DATE

GM

4-56

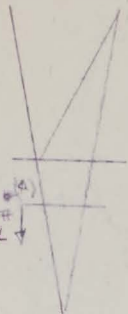
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ENGINE REMOVAL CASE

ULT DESIGN LOADS

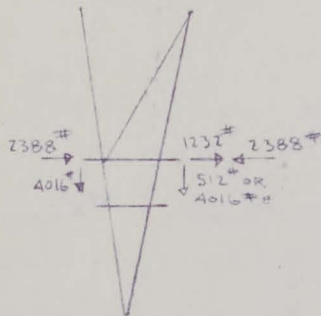
284#
→ -1325# (4)
← +8902#



VERT & SIDE LOAD CAN
BE COMBINED IN ANY
MANNER.

INB'D DUCT BEAM

REF 612-55 MEMO BY IDDON





AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

CP-105

FRAME 697

REPORT NO. 7/0558/4

SHEET NO. 1-178 2-35

PREPARED BY

DATE

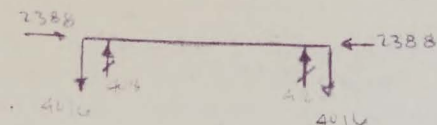
GM

APR 1956

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DATE

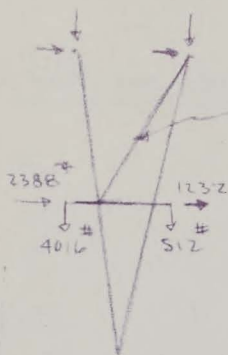
DUOT BEAM



CRIT IN BENDING
NOT CRIT AS BEAM
COLUMN BUCKLING
OF EXTREME DEPTH
CHECK GAINS AS COLUMN
IN PORTS AND DIRECTION



CRIT IN SHEAR
IN WEBS



DETERMINE IF
LOADING IS
CRITICAL IN STRUT

ENGINE REMOVAL BEAM





AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

CF-105

FRAME 697

REPORT NO. 7/0558/4

SHEET NO. 1-179 2-36

PREPARED BY

DATE

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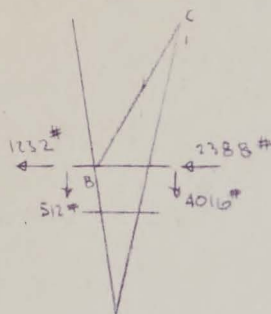
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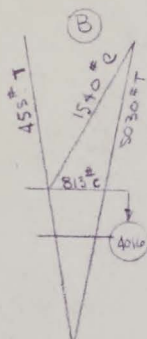
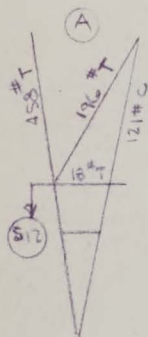
DATE

VEE BRACE

THE DIAGONAL STRUT MEM "BC" (P1-124) HAS BEEN SIZED ON BASIS OF 4290# (P1-124) HOWEVER, NEW DUCT LOADS WILL BE CONSIDERED BELOW TO FIND IF THEY ARE CRITICAL:



RATIO FROM P1-125 FOR VERT LOADS:



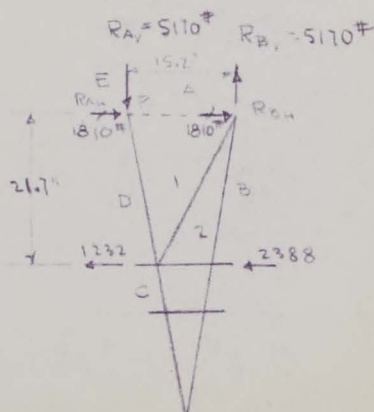
SOLVE FOR TRUSS DUE TO SIDE LOADS:

$$R_{AH} = R_{BH} = \frac{1232 + 2388}{2} = 1810\#$$

$$\sum M_B = 3620 \times 21.7 - 15.2 R_{AV}$$

$$\therefore R_{AV} = 5170\# \downarrow$$

$$\therefore R_{BV} = 5170\# \uparrow$$





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MALTON - ONTARIO

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AIRCRAFT:

CF-105

FRAME 697

REPORT NO.

7/0558/4

SHEET NO.

1-181 2-38

PREPARED BY

DATE

G.M.

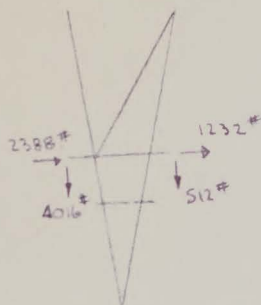
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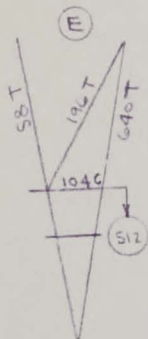
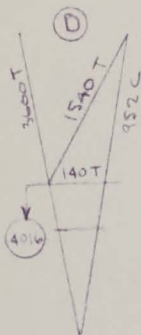
DATE

VEE BRACE

INVESTIGATE LOAD IN MEM "BC" UNDER REVERSED LOADING
(DUOT CASE)

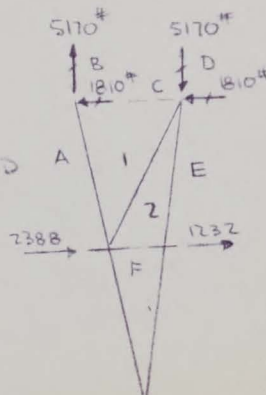


2-6
RATIO FROM P 1-125 FOR VERT LOADS:



SOLVE FOR TRUSS DUE TO SIDE LOADS:

REACTIONS SAME AS BEFORE EXCEPT REVERSED





AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

CF-105

FRAME 697

REPORT NO. 7/0538/4

SHEET NO. 4 1-182 2-39

PREPARED BY

DATE

GM

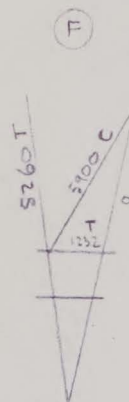
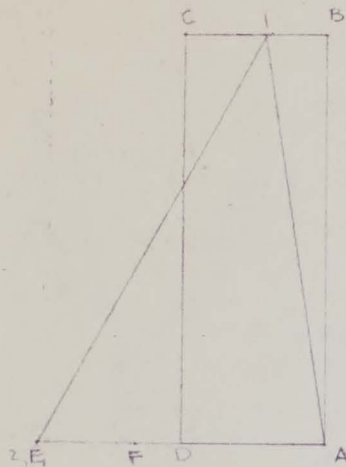
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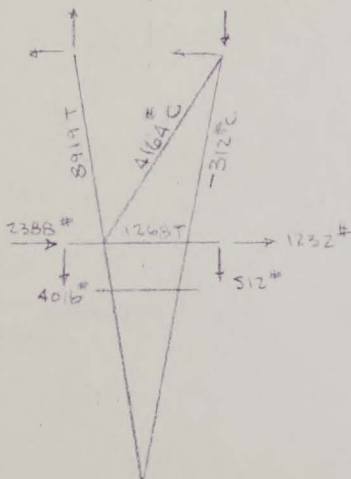
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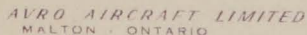
VEE BRACE - GRAPHICAL SOLUTION

SCALE 1" = 2000#



SUMMARY (D) + (E) + (F)





TECHNICAL DEPARTMENT

AIRCRAFT:

CF-105

FRAME 697

REPORT NO. 70558/4

SHEET NO 1-184 2-40

PREPARED BY

DATE _____

G. M

APR 1956

CHECKED BY

DATE _____

SUMMARY & CRITICAL DESIGN LOADS

RPT 7/0558/27

P. 2-39 P1-95

$$\oplus 8919^{\text{F}} \times .57 = 5090^{\text{F}} + 35000^{\text{F}} = 40,090^{\text{F}}$$

⊖ CASE — MW 2.12 $m = 0.19$

* THIS LOAD ACTUALLY REDUCES TO APPROX 3000# (DITCHFIELD APRIL 11, 1956) $\therefore$ TUBE END LOAD = $35,000 \times \frac{3000}{10,540} + 5010 = 15,040$ #. (WAS 40,000)
STRESSING CASE NOT CRITICAL IN STL TUBES, STIFFNESS IS DESIGN

CD TARIJA - DEC 1 - CANTON = AIZO - 11 1951



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

CF-105

FRAME 697

REPORT NO. 710558/4

SHEET NO. 2-42

PREPARED BY

DATE

G. MEYERS

MAR 1956

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DATE

"VEE" BRACE STRUCTURE

DUCT BEAM, ENGINE REMOVAL BEAM & .064 WEB ON VEE BRACE STRUCTURE FOR FRAME 697 WERE SIZED TO CONFORM TO DESIGN OF FRAME 644. SINCE DUCT BEAM LOADS AT 697 ARE ABOUT 50% OF 644 LOADS (REF MEMO BY IDDOU, 6 DEC 55) THE STRUCTURE WILL BE RE-EXAMINED WITH WEIGHT REDUCTION AS THE OBJECTIVE.

ENGINE REMOVAL BEAM "JLMK" P 2-41

CALC. REACTIONS:

$$\sum M_M = +6R_L - 11.54 \times 8902 = 0$$

$$\sum M_L = -8902 \times 5.54 + 6R_M$$

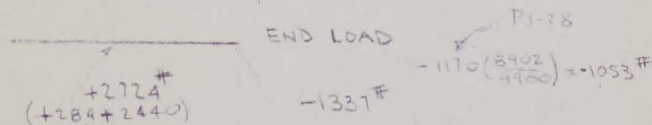
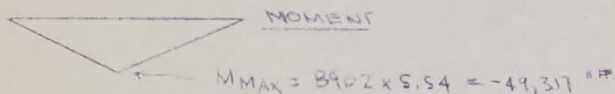
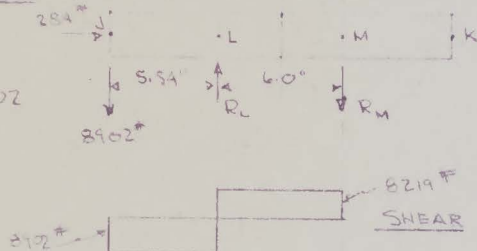
$$R_L = 11.54 \times 8902 / 6 = 17,121 \text{ \#}$$

$$R_M = \frac{8902 \times 5.54}{6} = 8,219.5 \text{ \#}$$

CHECK

$$\sum F_v = 0 = 17,121 - 8,219.5 - 8,902$$

(CHECK)



$$P. 1-28 \rightarrow 2710 \times \frac{8902}{4900} = 2440 \text{ \#}$$



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

CF-105

FRAME 697

REPORT NO. 7/0558/4

SHEET NO. 6 ~~1588~~ 2-43

PREPARED BY

DATE

G. MEYERS

MAR 1956

CHECKED BY

DATE

VEE BRACE ~ ENG REMOVAL BEAM

WEB ANALYSIS BETWEEN "L" & "M"

$$h = 2.2" \quad V = 8219\#$$

$$f = \frac{8219}{2 \times 2.2} = 1880\#/"$$

TRY .064" SPACING = $d = 2.2"$

$$f_{ALLOW} = 2050\#/" \quad (GLM FIG 501:05)$$

$$MS = \frac{2050}{1880} - 1 = +.09$$

CHECK CAPS AS BEAM-COLUMN

$$d = \left(\frac{50 I_{eff} h}{t} \right)^{.25} \quad (GLM SDM #501:324)$$

NOT REQ'D ~ REPLACING WEB SLOT WITH 2 $2\frac{1}{2}$ " DIA HOLES.



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

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AIRCRAFT:

CF-105

FRAME 697

REPORT NO. 7/0558/4

SHEET NO. 1-190 2-45

PREPARED BY

DATE

G. MEYERS

APRIL 1956

CHECKED BY

DATE

VEE BRACE STRUCTURE

SHEAR WEB "CLMH" P. 2-41

ANALYZE .064 PANEL WITH $3\frac{1}{2}$ " LIGHTENING HOLE BY NACA ARR #158. THIS ASSUMES NO TENSION FIELD IS FORMED.

ENGINE REMOVAL CRITICAL $P_1 = 8902\#$ (P1-126)

$$\therefore q = 8902 \times .048 = 428\#/\text{IN} \text{ FOR 2 WEB}$$

$P1-126 \quad q/\text{WEB} = 214\#/\text{IN}$

$$h/t = 4.97/.064 = 77.5$$

$$D/h = 3.50/4.97 = .704$$

WE HAVE ONLY 1 HOLE, WHILE REPORT ARR 158 GIVES ALLOWABLES ON BASIS OF HOLES SPACED FROM 1.5 TO 3D.

CONSERV. USE 1.5D SPACING CURVES & $D/h = 1.5$:

READ $q_{\text{ALLOW}} = 325\#/\text{IN}$ FOR 24ST SHT.

CONSERV. USE SAME FOR 75ST CLAD:

$$MS = \frac{325}{214} - 1 = +.51$$

WEB RIVETING

FROM INSPECTION THE CRITICAL LINE OF RIVETS IS AT PT "K" P. 2-41. $5-5/32$ RIVETS SPACED OVER 5" OR 1" O.C.

$$P/\text{RIVET} = 214\#/\text{IN}$$

$$5/32 \text{ RIVETS IN .064 } P_{\text{ALLOW}} = 896\#$$

$$MS = \frac{896}{214} - 1 = > 1$$



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MALTON, ONTARIO

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CF-105

FRAME 697

REPORT NO. 7/0558/4

SHEET NO. 1-192 2-4

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GM.

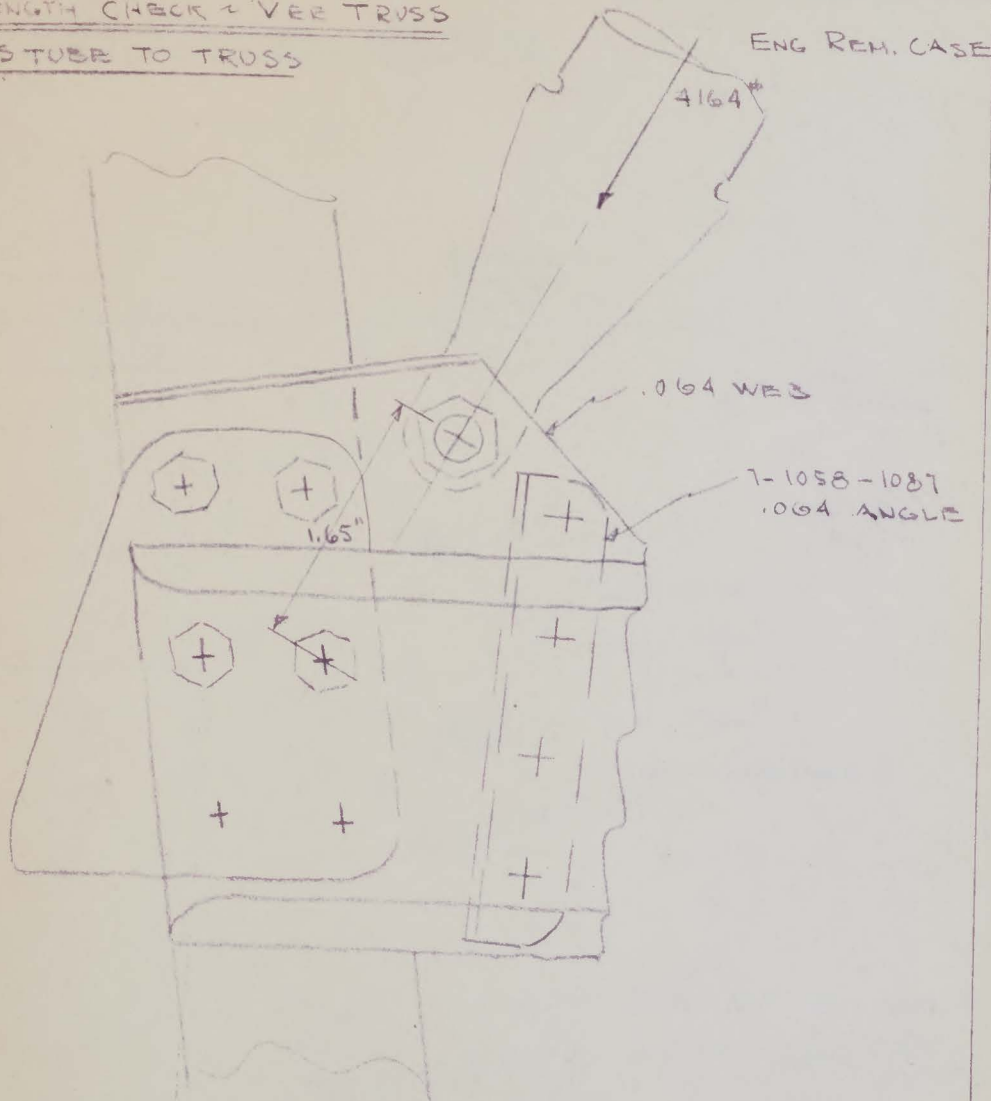
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STRENGTH CHECK - VEE TRUSS

CROSSTUBE TO TRUSS



CONSIDER .064 WEB CARRYING LOAD, & CHECK BY INTER-RIVET BUCKLING.

$$S/t = 1.65 / .064 = 25.8$$

FIR. = 44,500 PSI (LOCK. SM 68 P.4
FOR .064 CLAD 75S-T6)

CONSIDER 1" STRIP

$$P_{IR} = 2 \times .064 \times 44,500 = 5700 \text{ lb}$$

LONGER SIDE

$$MS = \frac{5700 \times .79}{4164} = 1.08$$

TEMP RED.

THE ABOVE ANALYSIS CONSIDERS NO STIF. STIF
OK, BUT SUPERFLOUS.



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REPORT NO. 710558/4

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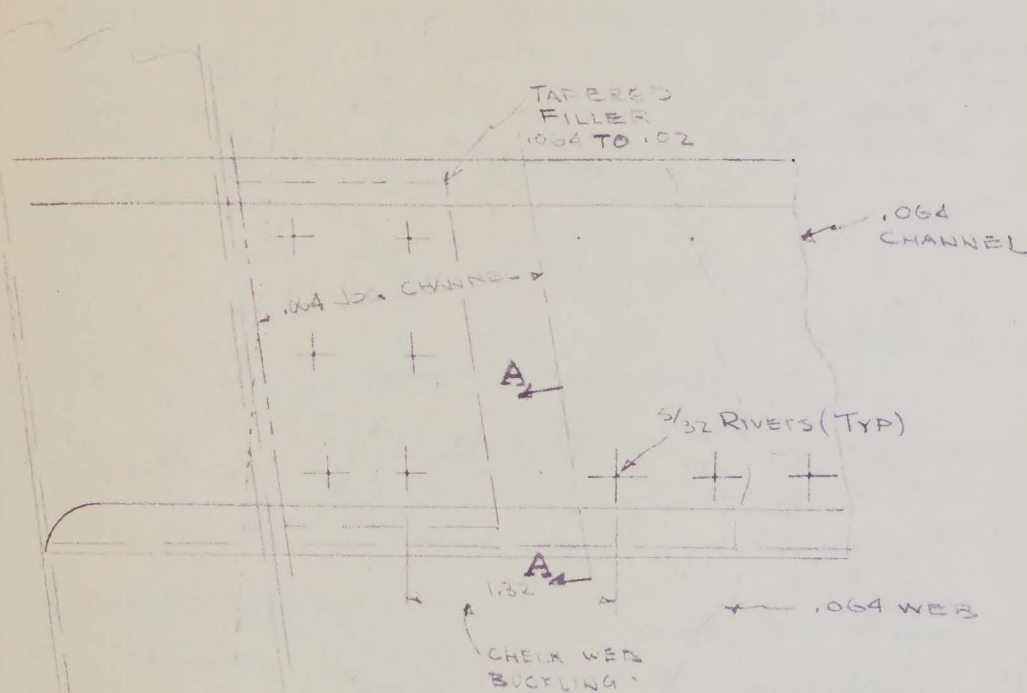
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VEE BRACE STRUCTURE - DUCT BEAM



$$M_{MAX} = 7240 \text{ IN-LBS} \quad (\text{REF DUCT LOAD MEMO})$$

$$M/L = 7240 / 2.2 \times 2 = -1650 \# \quad \text{END LOAD DUE TO BENDING}$$

REF DUCT LOAD 2 BEAMS
MEMO

$$-2388 / 2 = -1194 \# \quad \text{END LOAD DUE TO DIRECT LOAD}$$

ASSUME DIST. ON
2 LWR CAPS ONLY (CONSERV)

$$P_{TOTAL} = -1194 - 1650 = -2844 \#$$

$$\text{AREA LWR CAP} = .064 [1 + .875 + .25 + .55] = .171 \text{ IN}^2$$

(INCLUDING 1 .064 WEB)

$$P/A = -2844 / .171 = 16,600 \text{ PSI}$$

$$S/C = 1.32 / .064 = 20.6$$

$$FIR = 53,000 \text{ PSI} \quad (\text{REF LOCK SM 68 FOR .064 WEB IN INTERVIEW BUCKLING})$$

$$MS = \frac{53,000 - 16,600}{16,600} = 1$$



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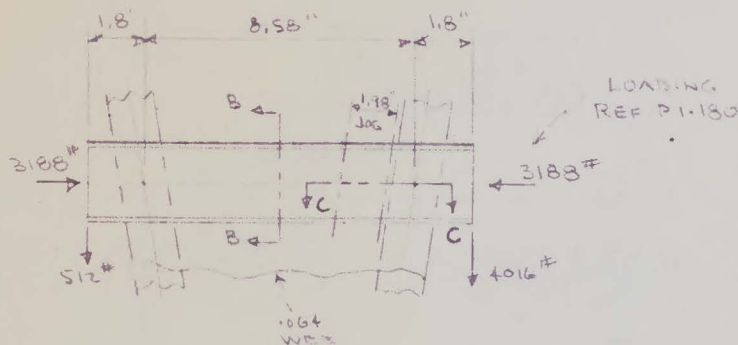
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DUCT SUPPORT BEAM JOGGLE ANALYSIS (REF 7-1058-1083 CHANNEL 7-1058-1055 ASSY)

BEAM IS JOGGLED .064" JUST INBOARD OF PT "C" P1-180. IN THE AREA OF THE JOGGLE, THE BEAM IS SUPPORTED BY A TAPERED FILLER. THE 3 ITEMS (CHANNEL, WEB & TAPERED FILLER) ARE RIVETED TOGETHER BY 5/32 RIVETS. BECAUSE OF THE HIGH AXIAL LOAD, CASE SHOWN ON P1-180 WILL BE CRITICAL. THE CHANNEL WILL BE CHECKED FOR CRIPPLING FAILURE AT INBD EDGE OF TAPERED FILLER. (SEE SECTION A-A P1-180). LOWER CAP OF CHANNEL IS IN COMP., CRITICAL.



$$M_{MAX} = \frac{4016 \times 1.8}{2} = 3640 \text{ IP}$$

2 CHANNELS



$$\text{END LOAD} = \frac{3188}{2} = 1594 \text{ #/CHANNEL}$$

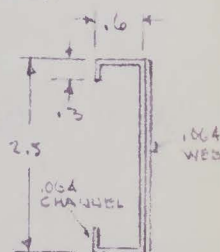
$$I_{B-B} = 2 \left[\frac{.5 \times .064 \times 1.218^3}{12} + \frac{.25 \times .064 \times 1.08^3}{12} \right] + \frac{2.44 \times .064^3}{12} + \frac{2.5 \times .064^3}{12} = .2928 \text{ IN}^4$$

CONSERV. CONSIDER MAX MOM. IS APPLIED TO SECT A-A PH94:

$$f_b = \frac{3620 \times 1.25}{.2928} = -15,460 \text{ PSI}$$

$$P/A = \frac{1594}{.064 \times 6.5} = -3,830 \text{ PSI}$$

$$\text{TOTAL STRESS IN CHANNEL AT JOG} = -19,290 \text{ PSI}$$



SECT B-B



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SHEET NO. 1-195 2-49

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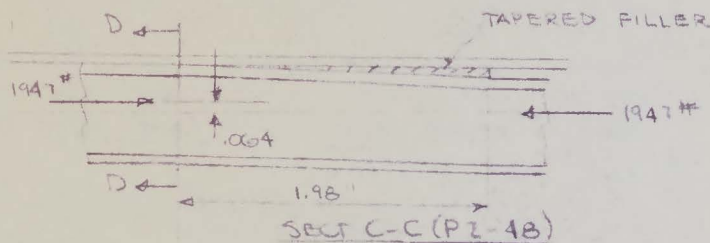
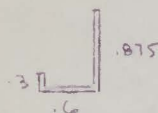
LOGGLE ANALYSIS (CONT'D)

TO CALC MOMENT CAUSED BY JOG, FIND LOAD IN CAP:

$$\text{CAP AREA} = .064(.25 + .50 + .825) = .101 \text{ IN}^2$$

$$\therefore \text{CAP END LOAD} = 19,290 \times .101 = 1947 \text{ \#}$$

P. 1-194

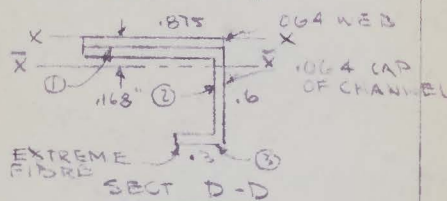


$$\therefore M_{\text{JOG}} = 1947 \times .064 = 125 \text{ IN-LBS}$$

M_{JOG} IS RESISTED BY CAP OF CHANNEL + .064 WEB

CHECK EXTREME FIBRE AT D-D

SECT PROP:



ITEM	W	h	A	Y	AY	Y-Y	(Y-Y) ²	A(Y-Y) ²
1	.875	.128	.112	.064	.00716	.104	.0108	.00121
2	.064	.408	.026	.322	.00838	.154	.0238	.00062
3	.30	.064	.019	.568	.0108	.400	.16	.00304
			.157		.02634			.00487 IN ⁴

$$\bar{Y} = \frac{.02634}{.157} = .168"$$

$$f_b = \frac{125 \times .168}{.00487} = -12,740 \text{ PSI AT EXTREME FIBRE}$$

$$\therefore \text{TOTAL STRESS} = -12,740 - 19,290 = -32,030 \text{ PSI}$$



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JOG ANALYSIS (CONT'D)

SECT D-D EXTREME FIBRE, PREVIOUS PAGE, WILL BE CRITICAL IN CRIPPLING. SINCE STRESS IS NOT UNIFORM ON SECT D-D, CONSERV. CONSIDER MAX STRESS OF -32,030 (PI-195) IS UNIFORM AND COMPARE WITH CRIPPLING ALLOWABLE: GLM FIG 403.18

ITEM (SEE PI-195)	b	t	t'	b/t	COND	AREA	F _{CRIP} 24ST	A x F _{CRIP}
1	.84	.118	.089	7.1	1 FIXED	.0995	45,000	4480
2	.54	.059	.059	9.2	2 "	.0318	70,000	2230
3	.27	.059	.059	4.6	1 "	.0159	66,000	1050
						.1472 IN ²		7760 #

$$\text{FOR 24ST } F_{CRIP} = \frac{7760}{.1472} = 52,700 \text{ PSI}$$

CONVERTING INTO 75 ST CLAD BY GLM FIG 403:19

$$F_{CRIP} = 72,000 \text{ PSI}$$

TEMP RED. = .79 FOR 265° @ 50 HRS REF 7/0558/27
P2-2

$$MS = \frac{.79 \times 72000}{32,030} - 1 = +.77$$

2 FOR COMPOSITE ELEMENTS USE $t_{\text{THICKER}} + \frac{1}{2} t_{\text{THINNER}}$

1 4% CLAD ON EA. SIDE OF .064 IS DEDUCTED

