QCX
Avro
CF105
R-7-0558-4
Iss-3

AVRO AIRCRAFT

TECHNICAL REPORT

ANALYZED

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT: C-105

REPORT NO. 7-0558-4
ISSUE 3

FILE NO.

NO. OF SHEETS 1-1 OF 80 SEC I
50 SEC II

TITLE: ANALYSIS OF HEAVY FRAME STA 697

CONFIDENTIAL

Classification cancelled / Changed to UNCLASS
By authority of AVRS
Date 30 Sept 96
Signature
Unit / Rank / Appointment AVRSS

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PREPARED BY G. MEYERS DATE APRIL 1956

CHECKED BY DATE

SUPERVISED BY DATE

APPROVED BY DATE

ISSUE NO.	REVISION NO.	REVISED BY	APPROVED BY	DATE	REMARKS
3	118	G. MEYERS		12/10/56	SUPERCEDES ISSUES 1 & 2
					15865899

FORM 1316A

AVRO AIRCRAFT LIMITED
MALTON ONTARIO
TECHNICAL DEPARTMENT

REPORT No	7/0558/4
SHEET No	1-2

AIRCRAFT:		PREPARED BY	DATE
C-105	FRAME 697	G. MEYERS	APR '56
		CHECKED BY	DATE

INDEX

PAGE

SECTION I ~ LOADING CALCULATIONS

CONFIDENTIAL

FORM 1319 A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

REPORT NO 7/0558/4			
SHEET NO 1-3			
AIRCRAFT: C-105	FRAME 697	PREPARED BY G. MEYERS	DATE OCT '56
		CHECKED BY	DATE

INDEX | PAGE

SECTION II ~ DETAIL STRESSING

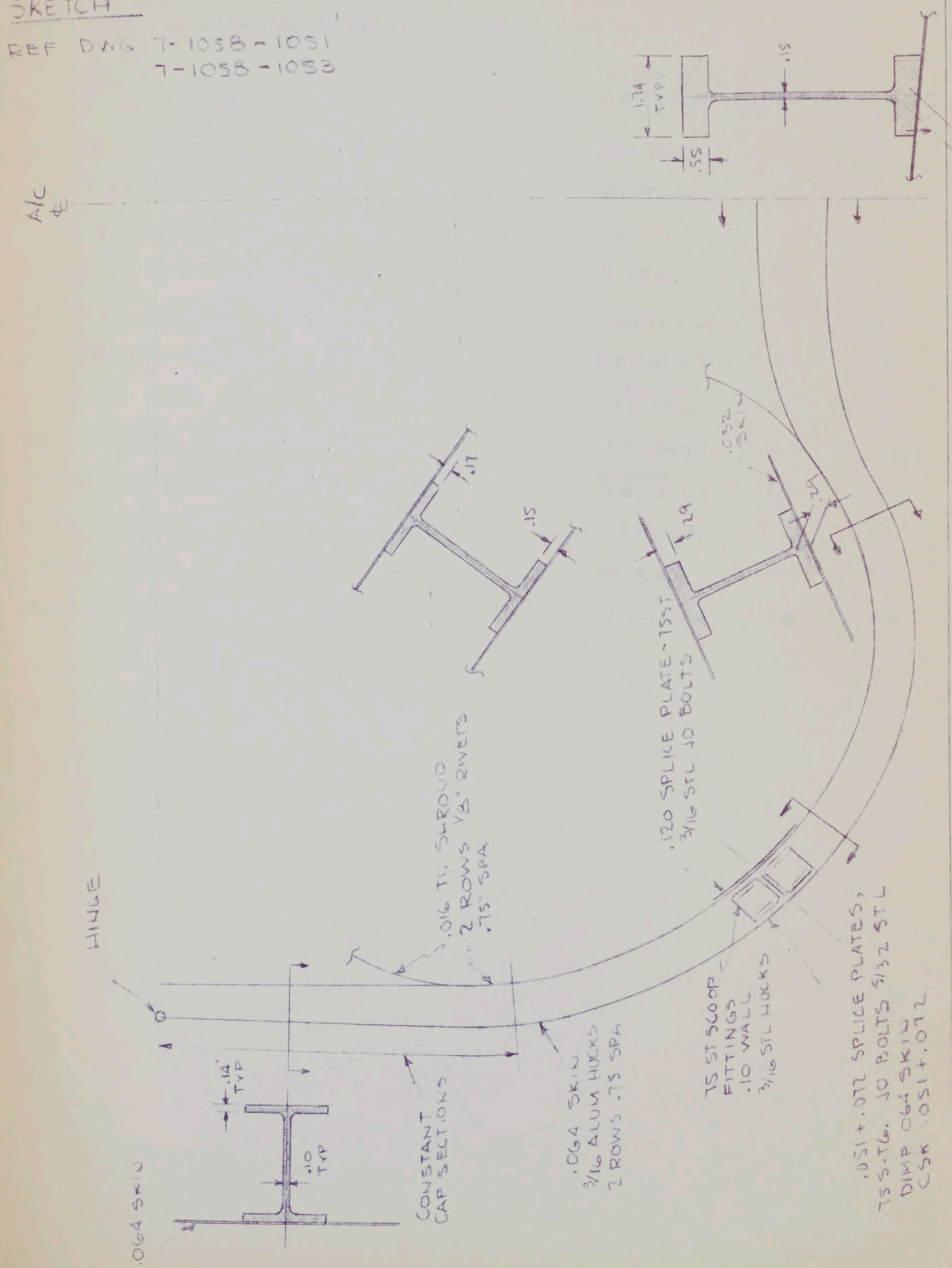
FM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

REPORT NO	7-0558-4	
SHEET NO	1-4	
AIRCRAFT: C-105	FRAME 697	
PREPARED BY	G. MEYERS	DATE AUG '56
CHECKED BY		DATE

SKETCH

REF DWG 7-1058-1051
7-1058-1053



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT		REPORT No 7/0358/4	
		SHEET No 1-5	
		PREPARED BY	DATE
C-105	FRAME 697	G. MEYERS	OCT '56
		CHECKED BY	DATE

TABLE OF MINIMUM MARGINS OF SAFETY

ITEM	DISCRIPTION	MODE OF FAILURE	MIN M.S.	PAGE
1,	FRAME ~ ELEMENTS #4 & #5	BENDING	+.09	2-3
2.	VEE BRACE MAIN TUBE STRUTS	CRIPPLING	0.0	2-11
3	VEE BRACE AT 1ST LINE OF RIVETS	CRIPPLING	-.03	2-14
4	TUBE TO FITTING RIVET ATTACH	SHEAR	-.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	+.02	2-21
8	BOLT ~ TUBE TO FRAME ATTACH	BENDING	-.10	2-22
9.	LUG ~ STRUT TO WING ATTACH	SHEAR BEARING	+.06	2-26
10	RIVETS ~ ENG RAIL TO BEAM ATTACH	SHEAR	+.06	2-30
11	WEB ~ ENG. REM. BEAM	SHEAR	+.09	2-43
12	BRACKET ~ TRUSS END	BUCKLING	+.08	2-46

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON ONTARIO
TECHNICAL DEPARTMENT

REPORT No.	7/0558/4
SHEET No.	1-6

AIRCRAFT:		PREPARED BY	DATE
C-105	FRAME 697	G. MEYERS	OCT '56
		CHECKED BY	DATE

INTRODUCTION ~ SECTION I

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

THE CASE 11.3 b (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
MALTON ONTARIO
TECHNICAL DEPARTMENT

REPORT NO. 7/0558/4	SHEET NO. 1-7	
AIRCRAFT: C-105	FRAME 697	
PREPARED BY: G. MEYERS	DATE: APR 56	
CHECKED BY:	DATE:	

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 = 15t 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 15t USED IN CALC THE STIFFNESS.

FORM 1319A

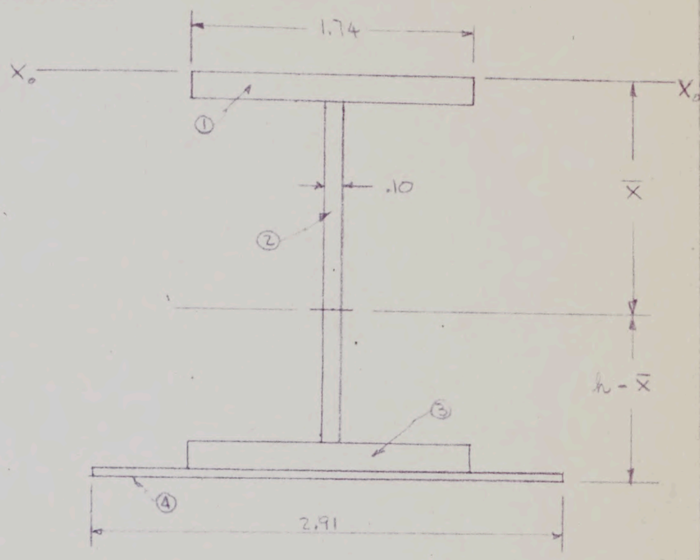
AVRO AIRCRAFT LIMITED
MALTON ONTARIO
TECHNICAL DEPARTMENT

REPORT NO	7/0558/4	
SHEET NO	1-8	
PREPARED BY		DATE
G. MEYERS		APRIL 1956
CHECKED BY		DATE

AIRCRAFT: C-105 — FRAME

SECTION PROPERTIES (CONT'D)

SECTION 1



1	2	3	4	5	6	7	8
ELEMENT	WIDTH	HEIGHT	AREA	ARM	④ × ⑤	④ × ⑤^2	I_o
1	1.74	.17	.296	.085	.025	.0021	—
2	.10	2.11	.211	1.23	.260	.320	.078
3	1.74	.17	.296	2.37	.702	1.662	—
4	2.91	.064	.186	2.48	.461	1.143	—
Σ			.989		1.448	3.1271	.078

$I_o = \dfrac{.10 \times \overline{2.11}^3}{12} = \underline{.078} \text{ IN}^4$

$\bar{x} = ⑥/④ = 1.448/.989 = \underline{1.46 \text{ IN}}$

$I = ⑦ - ④ \times \bar{x}^2 + ⑧ = 3.127 - .989 \times \overline{1.46}^2 + .078 = \underline{1.095} \text{ IN}^4$

$h - \bar{x} = 2.49 - 1.46 = \underline{1.03} \text{ IN.}$

AVRO AIRCRAFT LIMITED
MALTON ONTARIO
TECHNICAL DEPARTMENT

REPORT NO. 7/0553/4
SHEET NO. 1-9

AIRCRAFT		PREPARED BY	DATE
C-105	FRAME	G MEYERS	APRIL 1954
		CHECKED BY	DATE

SECTION PROPERTIES (CONT'D)

SECTION 2

(FOR SKETCH, SEE SECTION 1)

1	2	3	4	5	6	7	8
ELEMENT	WIDTH	HEIGHT	AREA	ARM	4 × 5	4×5^2	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

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

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

$I = (7) - (4) \times \bar{x}^2 + (8) = 3.441 - 1.014 \times 1.47^2 + .110 = 1.361 \text{ IN}^4$

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

AVRO AIRCRAFT LIMITED
MALTON ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT		REPORT NO. 7/0558/4	
		SHEET NO. 1-10	
		PREPARED BY	DATE
C-105	FRAME	G MEYERS	APRIL 1956
		CHECKED BY	DATE

SECTION PROPERTIES (CONT'D)

SECTION 3

(FOR SKETCH, SEE SECTION 1)

1	2	3	4	5	6	7	8
ELEMENT	WIDTH	HEIGHT	AREA	ARM	④ × ⑤	④ × ⑤²	I_o
1	1.74	.20	.348	.10	.0348	.0035	—
2	.10	2.57	.257	1.49	.383	.571	.141
3	1.74	.14	.244	2.85	.695	1.98	—
4	2.91	.064	.186	2.95	.548	1.62	—
Σ			1.035		1.6608	4.1745	.141

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

$\bar{x} = ⑥ / ④ = 1.661 / 1.035 = \underline{1.606\ IN.}$

$I = ⑦ - ④ \times \bar{x}^2 + ⑧ = 4.175 - 1.035 \times 1.606^2 + .141 = \underline{1.646}\ IN^4$

$h - \bar{x} = 2.97 - 1.606 = \underline{1.364\ IN.}$

4.175
4.316
1.646

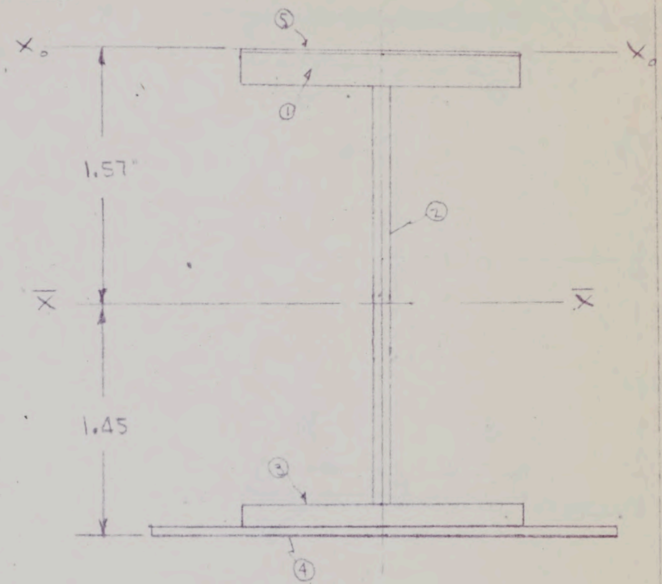
AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

REPORT NO 7/0558/4
SHEET NO 1-11

AIRCRAFT		PREPARED BY	DATE
C-105	FRAME	G MEYERS	APRIL 1956
		CHECKED BY	DATE

SECTION PROPERTIES (CONT'D)

SECTION 4



1 # ELEMENT	2 WIDTH	3 HEIGHT	4 AREA	5 ARM	6 ④ × ⑤	7 ④ × ⑤²	8 I_o
1	1.74	.20	.348	.125	.0435	.0054	—
2	.10	2.59	.259	1.53	.396	.606	.145
3	1.74	.14	.244	2.89	.705	2.040	—
4	2.91	.064	.186	2.99	.556	1.663	—
5	1.74	.025	.043	.012	.0005	—	—
Σ			1.080		1.7010	4.3144	.145

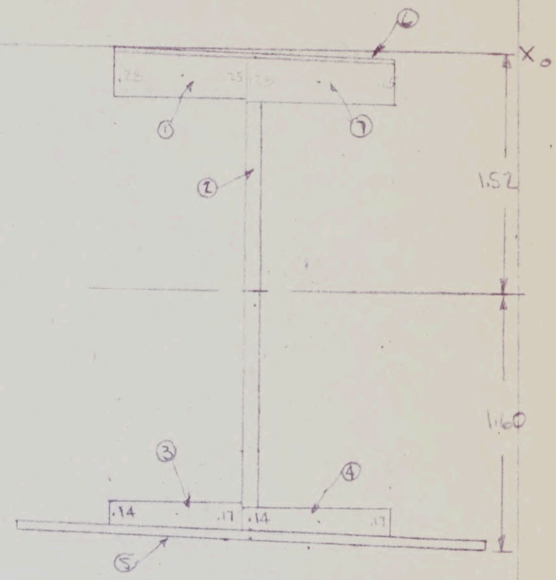
$I_o = \frac{.10 \times \overline{2.59}^3}{12} = .145 \text{ IN}^4$

$\bar{x} = ⑥/④ = 1.701/1.08 = 1.574 \text{ IN.}$

$I = ⑦ - ④ \times \bar{x}^2 + ⑧ = 4.314 - 1.08 \times \overline{1.574}^2 + .145 = 1.789 \text{ IN}^4$

SECTION PROPERTIES (CONT'D)

SECTION 5



1	2	3	4	5	6	7	8
ELEMENT	WIDTH	HEIGHT	AREA	ARM	(4) × (5)	(4) × (5)²	I_o
1	.82	.265	.217	.17	.037	.0063	—
2	.10	2.52	.252	1.60	.403	.645	.133
3	.82	.155	.127	2.90	.368	1.070	—
4	.92	.155	.143	2.93	.418	1.224	—
5	2.91	.064	.186	3.02	.561	1.695	—
6	1.74	.025	.044	.04	.0018	—	—
7	.92	.265	.244	.20	.0488	.0098	—
Σ			1.213		1.8376	4.6501	.133

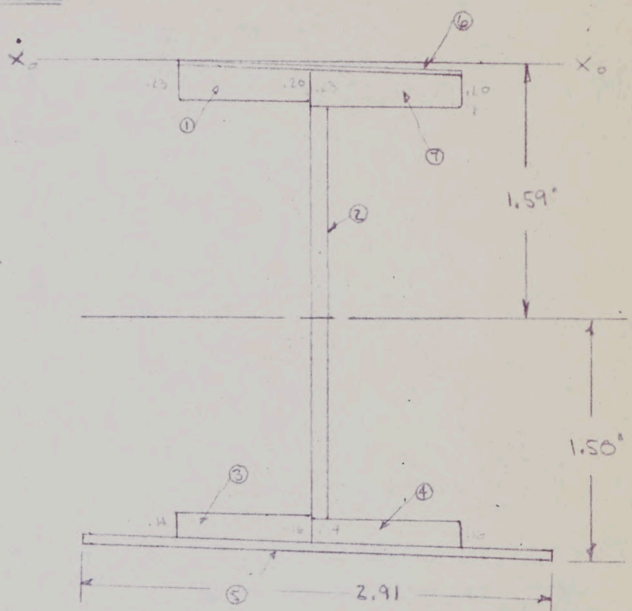
$I_o = \frac{.10 \times 2.52^3}{12} = .133 \text{ IN}^4$

$\bar{x} = (6)/(4) = 1.838/1.213 = 1.515 \text{ IN}$

$I = (7) - (4) \times \bar{x}^2 + (8) = 4.65 - 1.213 \times 1.515^2 + .133 = 1.997 \text{ IN}^4$

SECTION PROPERTIES (CONT'D)

SECTION 6



1 ELEMENT	2 WIDTH	3 HEIGHT	4 AREA	5 ARM	6 ④ × ⑤	7 ④ × ⑤²	8 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	.198	.17	.0336	.0057	—
Σ			1.122		1.7827	4.5378	.141

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

$$\bar{x} = ⑥/④ = 1.783/1.122 = \underline{1.59 \text{ IN.}}$$

$$I = ⑦ - ④ \times \bar{x}^2 + ⑧ = 4.538 - 1.122 \times \overline{1.59}^2 + .141 = \underline{1.839 \text{ IN}^4}$$

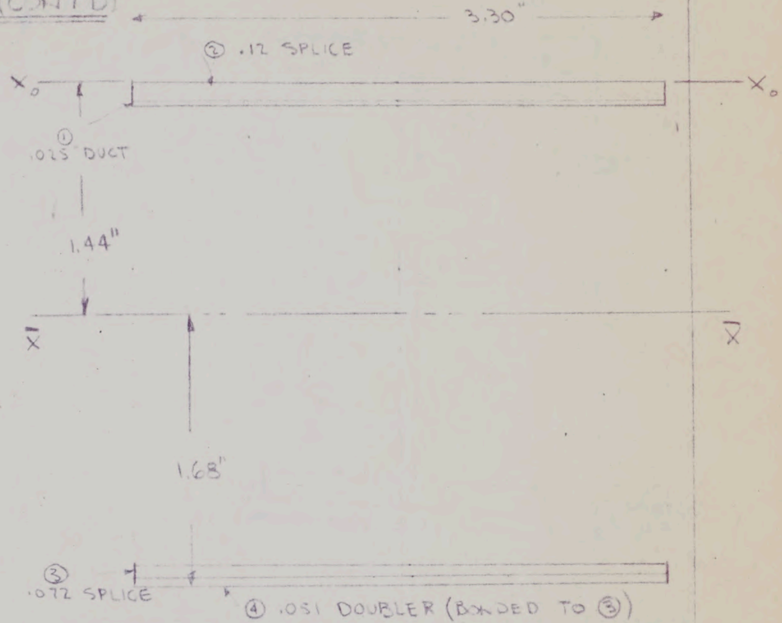
4.538
.141
4.679
-2.84
1.839

AVRO AIRCRAFT LIMITED
MALTON ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT		REPORT No 7/0558/4	
		SHEET No 1-14	
		PREPARED BY	DATE
C-105	FRAME	G MEYERS	APRIL 1956
		CHECKED BY	DATE

SECTION PROPERTIES (CONTD)

SECTION 7



1	2	3	4	5	6	7	8
ELEMENT	WIDTH	HEIGHT	AREA	ARM	④ × ⑤	④ × ⑤^2	I_o
1	3.30	.025	.082	.072	.0059	.0004	—
2	3.30	.120	.396	.06	.0238	.0014	—
3	3.30	.072	.238	3.03	.720	2.180	—
4	3.30	.051	.168	3.09	.5185	1.602	—
Σ			.884		1.2682	3.7538	—

$I_o = \frac{\quad}{12} = \_\_\_ \text{ IN}^4$

$\bar{x}$ = ⑥/④ = 1.268/.884 = 1.44 IN.

I = ⑦ − ④ × $\bar{x}^2$ + ⑧ = 3.784 − .884 × 1.59^2 = 1.547 IN^4

3.784
−2.237
1.547

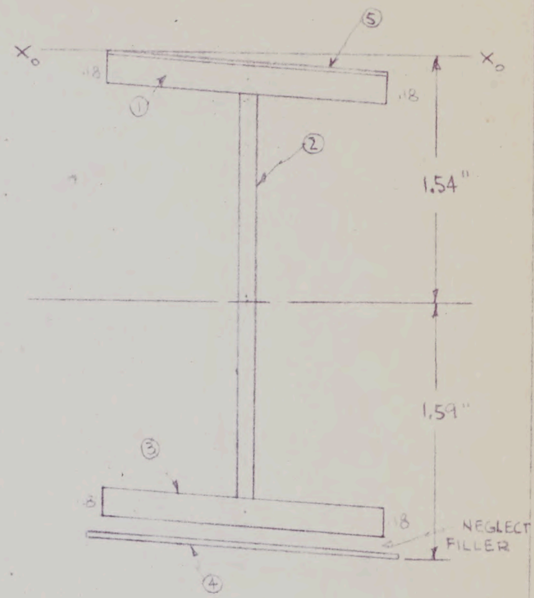
AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

REPORT NO 7/0558/4
SHEET NO 1-15

AIRCRAFT		PREPARED BY	DATE
C-105	FRAME	G MEYERS	APRIL 1958
		CHECKED BY	DATE

SECTION PROPERTIES (CONT'D)

SECTION 8



1	2	3	4	5	6	7	8
ELEMENT	WIDTH	HEIGHT	AREA	ARM	④ × ⑤	④ × ⑤²	I_0
1	1.74	.18	.313	.16	.0501	.0080	—
2	.10	2.50	.250	1.51	.377	.570	.130
3	1.74	.18	.313	2.85	.892	2.540	—
4	1.95	.032	.063	3.06	.193	.590	—
5	1.74	.025	.043	.07	.003	—	—
Σ			.982		1.5151	3.708	.130

$I_0 = \frac{.1 \times 2.50^3}{12} = .130 \text{ IN}^4$

$\bar{x} = ⑥ / ④ = 1.515 / .982 = 1.54 \text{ IN.}$

$I = ⑦ - ④ \times \bar{x}^2 + ⑧ = 3.708 - .982 \times 1.54^2 + .130 = 1.508 \text{ IN}^4$

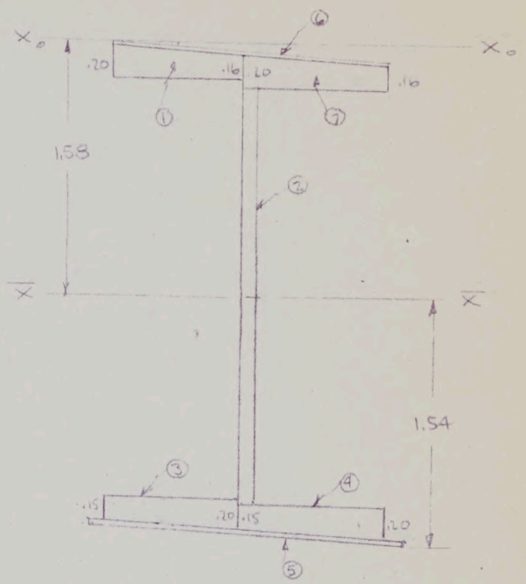
AVRO AIRCRAFT LIMITED
MALTON ONTARIO
TECHNICAL DEPARTMENT

REPORT NO 7/0558/4
SHEET NO 1-16

AIRCRAFT		PREPARED BY	DATE
C-105	FRAME	G MEYERS	APRIL 1956
		CHECKED BY	DATE

SECTION PROPERTIES (CONT'D)

SECTION 9 & 10



1	2	3	4	5	6	7	8
ELEMENT	WIDTH	HEIGHT	AREA	ARM	④ × ⑤	④ × ⑤²	I_o
1	.82	.18	.148	.14	.0207	.0029	—
2	.10	2.60	.260	1.58	.411	.649	.146
3	.82	.175	.144	2.92	.420	1.227	—
4	.92	.175	.161	2.97	.478	1.420	—
5	1.95	.032	.063	3.05	.192	.586	—
6	1.74	.025	.043	.07	.003	—	—
7	.92	.18	.166	.19	.0314	.006	—
Σ			.985		1.5561	3.8909	.146

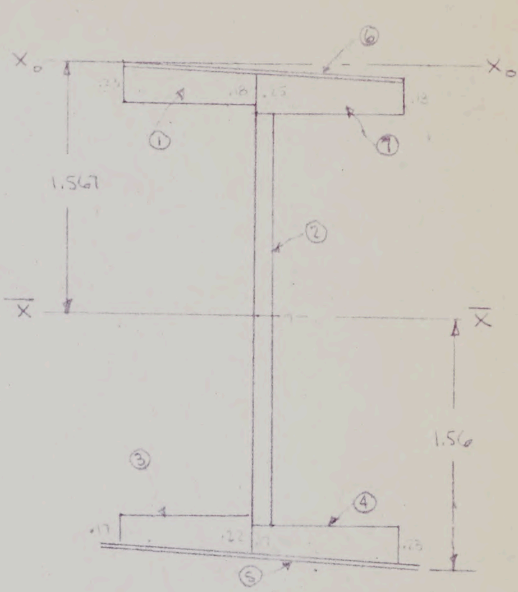
$$I_o = \frac{.1 \times \overline{2.60}^3}{12} = \underline{.146} \text{ IN}^4$$

$$\bar{x} = ⑥/④ = 1.556/.985 = \underline{1.58 \text{ IN.}}$$

$$I = ⑦ - ④ \times \bar{x}^2 + ⑧ = 3.891 - .985 \times \overline{1.58}^2 + .146 = \underline{1.577} \text{ IN}^4$$

SECTION PROPERTIES (CONT'D)

SECTION 11



1	2	3	4	5	6	7	8
ELEMENT	WIDTH	HEIGHT	AREA	ARM	(4) × (5)	(4) × (5)^2	I_o
1	.82	.205	.168	.14	.0235	.0033	—
2	.10	2.57	.257	1.60	.411	.658	.1415
3	.82	.195	.160	2.92	.467	1.365	—
4	.92	.200	.184	2.97	.546	1.630	—
5	1.95	.032	.063	3.06	.193	.590	—
6	1.74	.025	.043	.06	.0026	—	—
7	.92	.215	.198	.19	.0376	.0071	—
Σ			1.073		1.6807	4.2534	

$I_o = \frac{.10 \times \overline{2.57}^3}{12} = \underline{.1415}$ IN.^{4}

$\bar{x}$ = (6)/(4) = 1.681/1.073 = $\underline{1.567 \text{ IN}}$

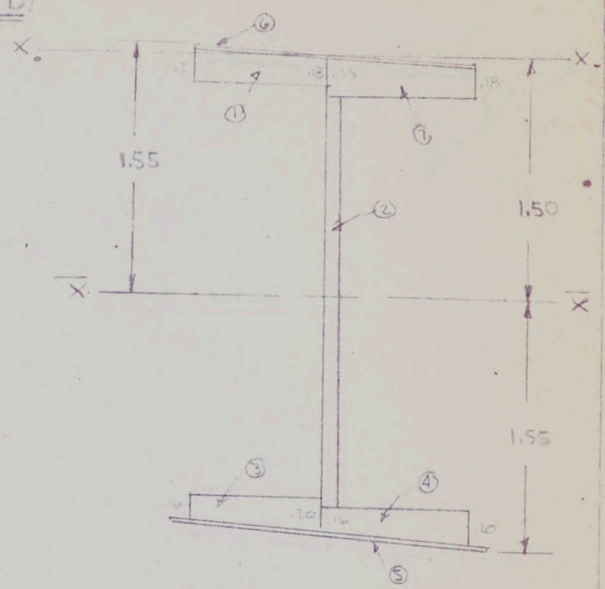
I = (7) − (4) × $\bar{x}^2$ + (8) = 4.253 − 1.073 × $\overline{1.567}^2$ + .142 = $\underline{1.760 \text{ IN.}^4}$

AVRO AIRCRAFT LIMITED
MALTON ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT C-105	FRAME	REPORT NO 7/0558/4	SHEET NO 1-18
		PREPARED BY G MEYERS	DATE APRIL 1956
		CHECKED BY	DATE

SECTION PROPERTIES (CONT'D)

SECTION 12



1 ELEMENT	2 WIDTH	3 HEIGHT	4 AREA	5 ARM	6 (4) × (5)	7 (4) × (5)^2	8 I_o
1	.82	.20	.164	.10	.0164	.0016	—
2	.10	2.59	.259	1.56	.404	.630	.145
3	.82	.18	.148	2.90	.428	1.240	—
4	.92	.18	.166	2.92	.485	1.415	—
5	1.95	.032	.063	3.02	.190	.574	—
6	1.74	.025	.043	.012	.0004	—	—
7	.92	.205	.189	.13	.0245	.0032	—
Σ			1.032		1.5483	3.8638	.145

$I_o = \frac{.10 \times \overline{2.59}^3}{12} = \underline{.145}$ IN^4

$\bar{x} = (6)/(4) = 1.548/1.032 = \underline{1.50}$ IN.

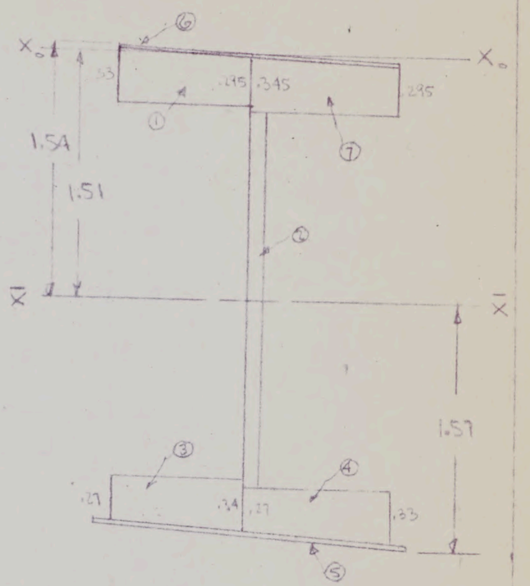
$I = (7) - (4) \times \bar{x}^2 + (8) = 3.864 - 1.032 \times \overline{1.50}^2 + .145 = \underline{\underline{1.685}}$ IN^4

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT		REPORT No. 7/0558/4	
		SHEET No. 1-19	
		PREPARED BY	DATE
C-105	FRAME	G MEYERS	APRIL 1956
		CHECKED BY	DATE

SECTION PROPERTIES (CONT'D)

SECTION 13



1	2	3	4	5	6	7	8
ELEMENT	WIDTH	HEIGHT	AREA	ARM	④ × ⑤	④ × ⑤²	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	.063	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

$I_o = \frac{.10 \times \overline{2.33}^3}{12} = \underline{.105}$ IN⁴.

$\bar{x} = ⑥ / ④ = 2.133/1.415 = \underline{1.51}$ IN.

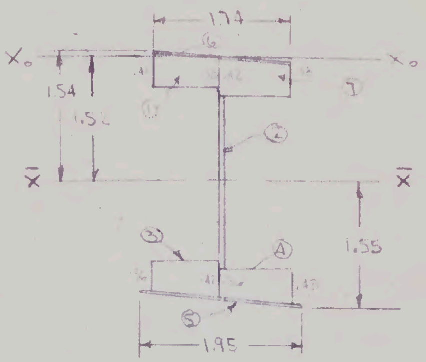
$I = ⑦ - ④ \times \bar{x}^2 + ⑧ = 5.348 - 1.415 \times \overline{1.51}^2 + .105 = \underline{\underline{2.233}}$ IN⁴

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT		REPORT No. 7/0558/4	SHEET No. 1-20
C-105	FRAME	PREPARED BY: G MEYERS	DATE: APRIL 1956
		CHECKED BY	DATE

SECTION PROPERTIES (CONT'D)

SECTION 14



1	2	3	4	5	6	7	8
ELEMENT	WIDTH	HEIGHT	AREA	ARM	4 × 5	4 × 5²	I_0
1	.82	.395	.324	.20	.0648	.013	—
2	.10	2.17	.217	1.53	.332	.508	.085
3	.82	.39	.320	2.76	.883	2.440	—
4	.92	.395	.364	2.80	1.020	2.850	—
5	1.95	.032	.063	3.00	.189	.565	—
6	1.74	.025	.043	.012	.0004	—	—
7	.92	.40	.368	.24	.0883	.021	—
Σ			1.699		2.5775	6.397	.085

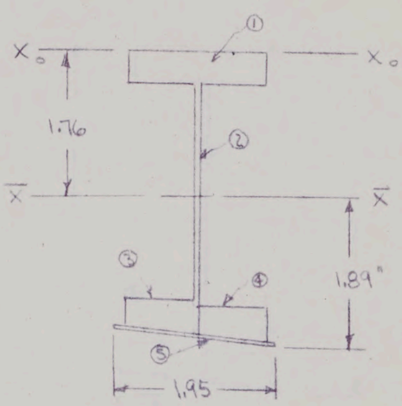
$I_0 = \frac{.10 \times \overline{2.17}^3}{12} = .085 \text{ in}^4$

$\bar{x} = (6)/(4) = 2.575/1.699 = 1.52 \text{ in.}$

$I = (7) - (4) \times \bar{x}^2 + (8) = 6.397 - 1.699 \times \overline{1.52}^2 + .085 = 2.562 \text{ in}^4$

SECTION PROPERTIES (CONT'D)

SECTION 15



1	2	3	4	5	6	7	8
ELEMENT	WIDTH	HEIGHT	AREA	ARM	④ × ⑤	④ × ⑤²	I_0
1	1.74	.39	.678	.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

$I_0 = \frac{.10 \times \overline{2.64}^3}{12} = \underline{.153} \text{ IN}^4$

$\bar{x} = ⑥/④ = 3.063/1.741 = \underline{1.76 \text{ IN}}$

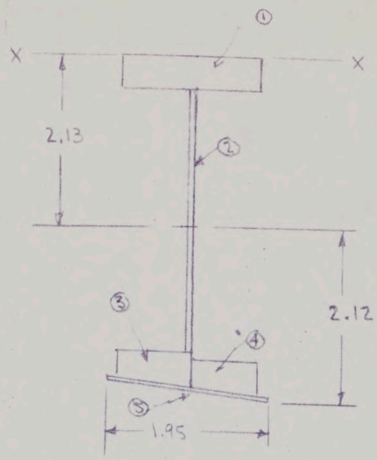
$I = ⑦ - ④ \times \bar{x}^2 + ⑧ = 8.946 - 1.741 \times \overline{1.76}^2 + .153 = \underline{3.709 \text{ IN}^4}$

AVRO AIRCRAFT LIMITED
MALTON ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT		REPORT No. 7/0558/4	
C-105	FRAME	SHEET No. 1-21	
		PREPARED BY: G MEYERS	DATE: APRIL 1956
		CHECKED BY	DATE

SECTION PROPERTIES (CONT'D)

SECTION 16



1 ELEMENT	2 WIDTH	3 HEIGHT	4 AREA	5 ARM	6 ④ × ⑤	7 ④ × ⑤²	8 I_o
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

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

$\bar{x} = ⑥/④ = 3.767/1.769 = \underline{2.13 \text{ in}}$

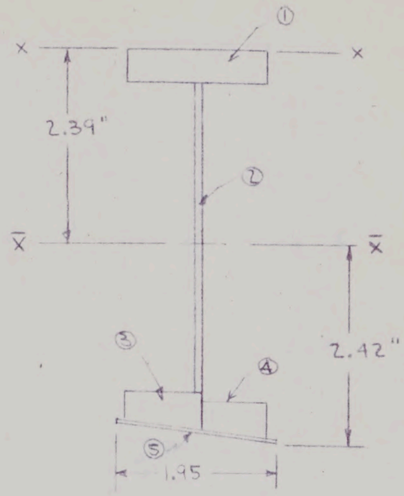
$I = ⑦ - ④ \times \bar{x}^2 + ⑧ = 13.02 - 1.769 \times \overline{2.13}^2 + .284 = \underline{5.304} \text{ IN}^4$

AVRO AIRCRAFT LIMITED
MALTON ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT		REPORT NO. 7/0558/4	
C-105	FRAME	SHEET NO. 1-22	
		PREPARED BY: G. MEYERS	DATE: APRIL 1956
		CHECKED BY	DATE

SECTION PROPERTIES (CONT'D)

SECTION 17



1 ELEMENT	2 WIDTH	3 HEIGHT	4 AREA	5 ARM	6 (4) × 5	7 (4) × 5²	8 I_o
1	1.74	.40	.695	.20	.139	.0278	—
2	.10	3.85	.385	2.32	.893	2.070	.475
3	.92	.385	.354	4.44	1.572	6.970	—
4	.82	.385	.316	4.55	1.440	6.540	—
5	1.95	.032	.062	4.71	.292	1.376	—
Σ			1.312		4.336	16.9838	.475

$I_o = \frac{.10 \times 3.85^3}{12} = .475 \text{ IN}^4$

$\bar{x} = (6)/(4) = 4.336/1.812 = 2.39 \text{ IN}$

$I = (7) - (4) \times \bar{x}^2 + (8) = 16.984 - 1.812 \times 2.39^2 + .475 = 7.099 \text{ IN}^4$

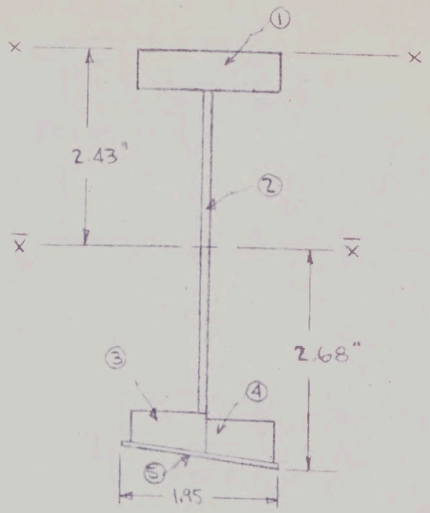
FORM 1314A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT		REPORT NO 7/0558/4	
C-105	FRAME	SHEET NO 1-23	
		PREPARED BY: G MEYERS	DATE: APRIL 1956
		CHECKED BY	DATE

SECTION PROPERTIES (CONT'D)

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	4.29	1.618	6.940	—
5	1.95	.032	.062	4.98	.309	1.542	—
Σ			2.077		5.041	20.0014	.522

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

$$\bar{x} = ⑥ / ④ = 5.041 / 2.077 = \underline{2.43 \text{ IN}}$$

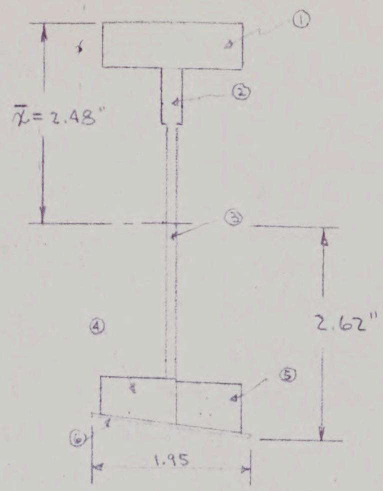
$$I = ⑦ - ④ \times \bar{x}^2 + ⑧ = 20 - 2.077 \times \overline{2.43}^2 + .522 = \underline{\underline{8.26}} \text{ IN}^4$$

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

REPORT NO. 7/0558/4 IV	SHEET NO. 1-24		
AIRCRAFT: C-105	FRAME 697	PREPARED BY: G. MEYERS	DATE: APR 56
		CHECKED BY:	DATE:

SECT. PROPERTIES (CONT'D)

SECTION 19 (4)



1 ELEMENT	2 WIDTH	3 HEIGHT	4 AREA	5 ARM	6 ④×⑤	7 ④×⑤²	8 I_o
1	1.74	.55	.957	.275	.263	.07	—
2	.25	.74	.185	.93	.172	.16	—
3	3.1	.15	.465	2.84	1.320	3.75	.372
4	.945	.525	.496	4.65	2.310	10.75	—
5	.795	.55	.438	4.73	2.080	9.82	—
6	1.95	.032	.062	4.98	.309	1.54	—
Σ			2.603		6.454	26.09	.372

$I_o = .15 \times \frac{3.1^3}{12} = .372 \text{ IN}^4$

$\bar{x} = 6.454/2.603 = 2.48"$

$I = 26.09 - 2.603(2.48)^2 + .372 = 10.432 \text{ IN}^4$

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

REPORT No.	1-0553/4
SHEET No.	1-25
PREPARED BY	G. MEYERS
DATE	OCT 1956
CHECKED BY	
DATE	
AIRCRAFT:	C-105
	FRAME 697

CALCULATION OF 2A

1. ELEM	2. METHOD	3. d_1 (SCALED)	4. h	5.	6. 2A (3) × (4)
1	I			8.39 × 1.0	8.39
2				14.64 × 1.24	18.15
3	I			20.97 × 1.33	27.89
4	II			$2\left(\frac{20.97 \times 1.53}{2} + 9.63\right)$	51.36
5				$2\left(\frac{20.97 \times 2.33}{2} + 28.07\right)$	104.98
6	II			$2\left(\frac{20.97 \times 3.42}{2} + 32.33 + 26.00\right)$	188.36
7	III	7.57	45.44		343.98
8		10.70			486.21
9		14.66			666.15
10		19.10			867.90
11		23.85			1083.74
12		28.81			1309.13
13		31.22			1418.64
14		33.71			1531.78
15		39.06			1774.89
16		42.04			1910.30
17		45.05			2047.07
18		49.93			2268.82
19	III	54.22	45.44		2495.56

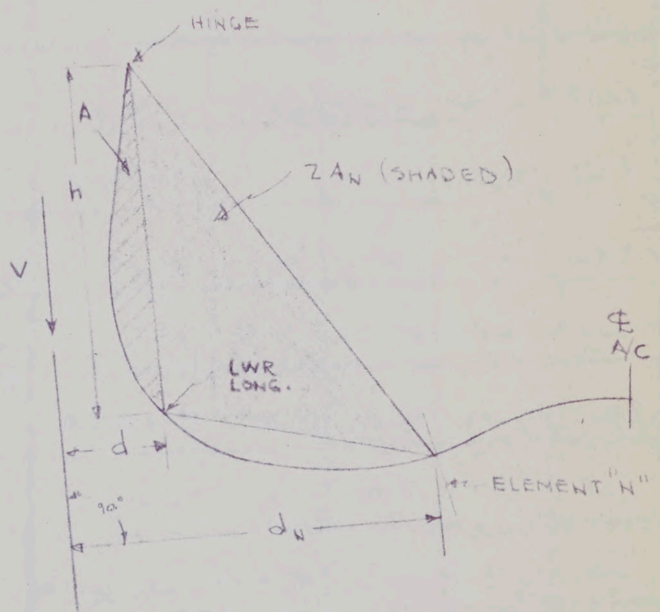
I BY MEASUREMENT: FOR TRIANGLE, 2A = S × h

II BY PLANIMETER + I

III SEE FOLLOWING PAGE.

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

$$2A_N = \frac{d_N V}{f}$$

$$V = f h$$

$$\therefore 2A_N = d_N h$$

$A = 141.32^{\square''}$ (BY PLANIMETER)

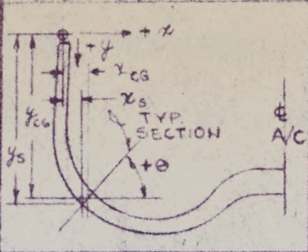
$2A = 282.64^{\square''}$

$h = 45.44''$ (SCALED)

$$d = \frac{2A}{h} = \frac{282.64}{45.40} = 6.22''$$

d IS LOCATED ON FULL-SIZE DWG & d_1 IS SCALED.

SIGN CONVENTION



HEAVY FRAME 697

SECTION PROPERTIES & CONSTANTS

(REF DWG 7-1058-1051 ①, -1053 ①)

AVRO

AIRCRA

WEIGH

C. G

SECTION →		1	2	3	4	5	6	7	8	9	10
① $x_{C.G.}$ OF SECTION		.48	.33	.15	.53	1.97	4.30	8.33	12.11	16.62	21.42
② y_{CG} OF SECTION		8.42	14.65	20.97	27.07	32.93	38.44	43.47	47.07	50.12	52.07
③ $\Delta S_{C.G.}$ OF SECTION		8.40	6.27	6.31	6.11	6.09	6.14	6.55	5.30	5.52	5.24
④ $\sum \Delta S_{C.G}$ OF SECTION		8.40	14.67	20.98	27.09	33.18	39.32	45.87	51.17	56.69	61.93
⑤ SWEPT AREA =2A		8.39	18.15	27.89	51.36	104.98	188.36	343.98	486.21	666.15	867.90
⑥ θ°		−1.5°	−1.5°	+2.5°	+9°	+18°	29.5°	49°	52.5°	62.5°	74.5°
⑦ SIN θ		−.0262	−.0262	+.0436	.1564	.3090	.4924	.7547	.7934	.8870	.9636
⑧ COS θ		.9997	.9997	.9991	.9877	.9511	.8704	.6561	.6088	.4618	.2672
⑨ x_S FROM HINGE TO OUTER SKIN	−.27	−.63	−.91	−1.17	−.87	+.55	+3.10	+7.17	11.15	15.92	21.03
⑩ y_S FROM HINGE TO OUTER SKIN	0	8.42	14.65	20.97	27.25	33.40	39.14	44.30	48.28	51.42	53.49
⑪ I (IN^4)		1.10	1.36	1.65	1.79	2.00	1.84	1.55	1.51	1.58	1.58
⑫ ΔS/I		7.636	4.610	3.824	3.413	3.045	3.337	4.226	3.510	3.494	3.316
⑬											
⑭											
⑮											

* FOR UNIT SOLUTIONS S_V, S_H & P_O USED I = 8.26 & ΔS/I = .591. ERROR

FORM 1543

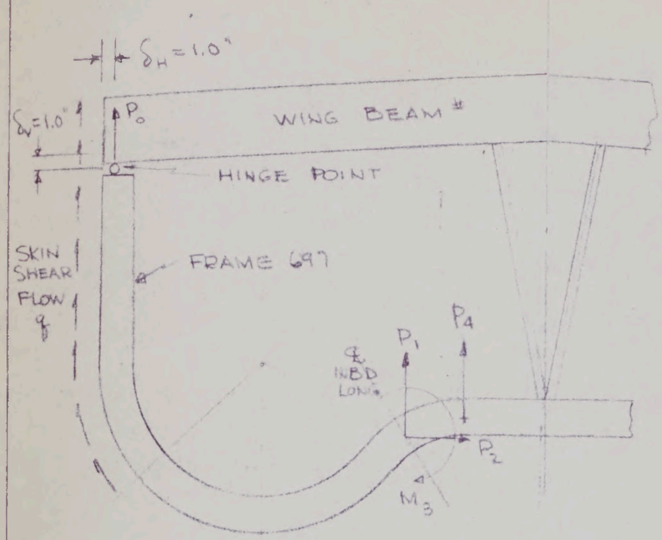
AVRO AIRCRAFT LIMITED

TECHNICAL DEPT. (AIRFRAME)

AIRCRAFT	C-105
WEIGHT	
C. G POSITION	
REPORT NO.	7/0558/4
SHEET	1-27
DATE	APRIL 1956
PREPARED BY	G. MEYERS

	10	11	12	13	14	15	16	17	18	19
2	21.42	26.37	31.31	33.60	35.96	41.07	43.96	46.93	51.80	56.93
2	52.07	52.78	52.17	51.26	50.22	47.92	47.37	47.00	46.73	46.77
2	5.24	5.06	5.04	2.50	2.58	5.50	2.95	2.95	4.88	5.06
9	61.93	66.99	72.03	74.53	77.11	82.61	85.56	88.51	93.39	98.45
.15	867.90	1083.74	1309.13	1418.64	1531.78	1774.89	1910.30	2047.07	2268.82	2495.56
5°	74.5°	90°	104.5°	111.5°	117.5°	105°	97°	94°	90°	90°
0	.9636	1.000	+.9682	+.9304	+.8870	+.9659	+.9926	+.9976	1.000	1.000
8	.2672	0	-.2504	-.3665	-.4618	-.2588	-.1219	-.0698	0	0
2	21.03	26.37	31.68	34.16	36.60	41.44	44.19	46.93	51.80	56.93
2	53.49	54.27	53.49	52.65	51.51	49.60	49.36	49.27	49.24	49.24
3	1.58	1.76	1.69	2.23	2.56	3.71	5.30	7.10	* 9.08	10.43
4	3.316	2.875	2.982	1.121	1.008	1.482	.557	.415	* .537	.485
11	ERROR NEGLIGIBLE.									

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.

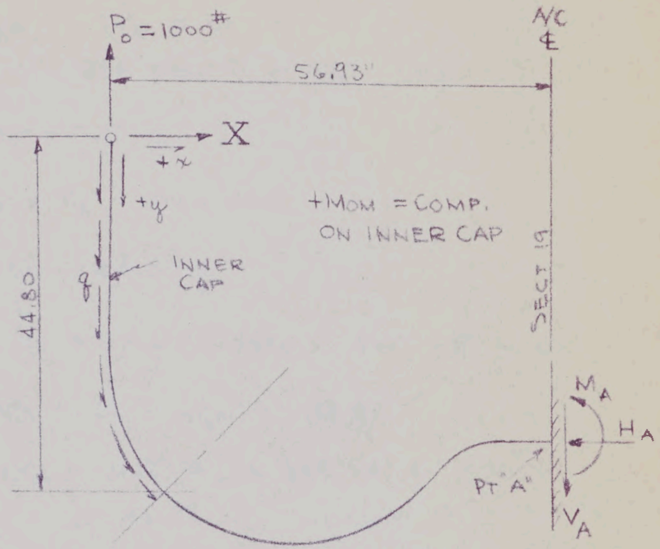
- P_0 - VERTICAL HINGE LOAD TRANSFERRED THRU PIN.
- P_1 - VERTICAL } COMP. AT INBD LONGERON
- P_2 - HORIZ. }
- δ_V - VERTICAL } INDUCED DEFLECTION AT PIN DUE TO WING BENDING.
- δ_H - HORIZ. }
- M_3 - MOMENT INDUCED BY INBD LONGERON
- P_4 - DOOR EDGE BEAM LOAD.

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

REPORT NO. 7/0558/4
SHEET NO. 1-29

AIRCRAFT:		PREPARED BY	DATE
C-105	FRAME 697	G. MEYERS	APR. 1956
		CHECKED BY	DATE

UNIT ANALYSIS FOR LOAD $P_o = 1000^{\#}$ ↑



FOR THIS CASE WE HAVE 5 UNKNOWNS (X, M_A, H_A, V_A & q) 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:

$$\theta_A = 0 = \Sigma \frac{Mm\,ds}{EI}$$

$$\delta_{A_{HORIZ}} = 0 = \Sigma \frac{Mm\,ds}{EI}$$

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

UNIT ANALYSIS FOR LOAD $P_a = 1000^{\#}\downarrow$ (CONT'D)

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

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

$x_s = 7.17"$ (REF SECT 7, P 1.27, LINE 9)

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

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

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

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

$-56{,}930 + 2495.56\,q + M_A - 46.77(H_A - 7.17\,q)$

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

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

$q = -353.244\times10^{-6} M_A + 16.521\times10^{-3} H_A + 20.11$

$X = H_A - 7.17\,q = H_A - 7.17(-353.244\times10^{-6} M_A + 16.521\times10^{-3} H_A + 20.11)$

$X = H_A + 2532.759\times10^{-6} M_A - 118.456\times10^{-3} H_A - 144.189$

$X = 2.533\times10^{-3} M_A + .88154\,H_A - 144.189$

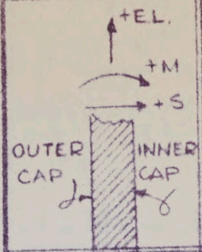
$V_A = 1000 - 44.80\,q$

$V_A = 1000 - 44.80(-353.244\times10^{-6} M_A + 16.521\times10^{-3} H_A + 20.11)$

$V_A = 1000 + 15.825\times10^{-3} M_A - 740.141\times10^{-3} H_A - 900.93$

$V_A = 15.825\times10^{-3} M_A - .740141\,H_A + 99.07$

SIGN CONVENTION



ANALYSIS OF HEAVY FRAME 697

UNIT ANALYSIS FOR LOAD $P_0 = 1000^{\#}$ (CONT'D)

CALCULATION OF REDUNDANTS H_A & M_A

(REF DWG 7-1058-1051 (1), 1053 (1))

	SECTION →	1	2	3	4	5	6	7	8	9
(1)	x_{CG}	(SEE LINE 1, P 1-27)								
(2)	y_{CG}	(SEE LINE 2, P 1-27)								
(3)	2A	(SEE LINE 5, P 1-27)								
(4)										
(5)										
(6)	$\frac{\Delta S}{I}$	(SEE LINE 12, P 1-27)								
(7)	COEFFICIENTS OF M_A: DUE TO Y	×10⁻³ (NONE)	×10⁻³	×10⁻³	×10⁻³					
(8)	DUE TO X: $2.533\times10^{-3}\,y_{CG} = 2.533\times10^{-3}$ (2)	×10⁻³ 21.33	×10⁻³ 37.11	×10⁻³ 53.12	×10⁻³ 68.57	83.41	97.37	110.11	119.23	126.95
(9)	DUE TO $q = -.3532\times10^{-3}(-2A)$	×10⁻³ 2.96	×10⁻³ 6.41	×10⁻³ 9.85	×10⁻³ 18.14	37.08	66.53	121.49	171.73	235.28
(10)	DUE TO $V_A = 15.825\times10^{-3}\times0$	—	—	—	—	—	—	—	—	—
(11)	MOM DUE TO M_A = Σ (7) (8) (9) (10)	×10⁻³ 24.29	×10⁻³ 43.52	×10⁻³ 62.97	×10⁻³ 86.71	120.49	163.30	231.60	290.96	362.23
(12)	$\partial M/\partial M_A \times (\Delta S/I)$ = LINE (11) × (6)	×10⁻³ 185.48	×10⁻³ 200.63	×10⁻³ 240.80	×10⁻³ 295.94	366.89	546.33	978.74	1021.27	1265.63
(13)	COEFFICIENTS OF H_A: DUE TO Y	×10⁻³ (NONE)	×10⁻³	×10⁻³	×10⁻³					
(14)	DUE TO X = 881.54×10^{-3} (2)	×10⁻³ 7,422.6	×10⁻³ 12,914.6	×10⁻³ 18,485.9	×10⁻³ 23,863.3	29,029.1	33,886.4	38,320.5	41,494.1	44,182.8
(15)	DUE TO $q = 16.521\times10^{-3}(-2A)$	×10⁻³ −138.6	×10⁻³ −299.9	×10⁻³ −460.8	×10⁻³ −848.5	−1734.4	−3,111.9	−5,682.9	−8,032.7	−11,005.5
(16)	DUE TO $V_A = -740.141\times10^{-3}\times0$	—	—	—	—	—	—	—	—	—
(17)	MOM. DUE TO H_A = Σ (13) (14) (15) (16)	×10⁻³ 7,284.0	×10⁻³ 12,614.7	×10⁻³ 18,025.1	×10⁻³ 23,014.8	27,294.7	30,774.5	32,637.6	33,461.4	33,177.3

FORM 1543

...17

...↑ (CONT'D)

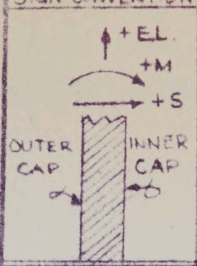
& M_A

AVRO AIRCRAFT LIMITED

TECHNICAL DEPT. (AIRFRAME)

REPORT NO.	7/0558/4
SHEET	1-31
DATE	APRIL 1956
AIRCRAFT	C-105
WEIGHT	
C. G. POSITION	
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	129.34	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	290.16	362.23	438.43	516.47	594.53	630.90	668.23	743.27	794.11	842.03	919.72	991.90
978.74	1021.27	1265.63	1453.83	1434.35	1112.39	707.24	673.58	1108.94	442.65	349.46	543.55	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
$\bar{5}$,682.9	$\bar{8}$,032.7	$\overline{11}$,005.5	$\overline{14}$,338.6	$\overline{17}$,904.5	$\overline{21}$,628.1	$\overline{23}$,437.4	$\overline{25}$,306.5	$\overline{29}$,323.0	$\overline{31}$,560.1	$\overline{33}$,819.6	$\overline{37}$,[illegible]	$\overline{41}$,229.1
—	—	—	—	—	—	—	—	—	—	—	—	—
32,637.6	33,461.4	33,177.3	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



ANALYSIS OF HEAVY FRAME

UNIT ANALYSIS FOR LOAD P_o = 1000# ↑ (CONT'D)

CALCULATION OF REDUNDANTS H_A & M_A

(REF DWG 7-1058-1053 ① -1051 ①)

		SECTION →	1	2	3	4	5	6	7	8	9	10
18		$\partial M/\partial H_A (\Delta S/I)$ LINE ⑰ × ⑥	× 10^{-3} 55,620.6	× 10^{-3} 58,153.8	× 10^{-3} 68,928.0	× 10^{-3} 73,549.5	83,112.4	102,694.5	137,926.5	117,449.5	115,921.5	104,6[illegible]
19	COEFFICIENTS OF CONSTANT	DUE TO Y =	(NONE)									
20		DUE TO X = -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	-6,787.0	-7,226.8	-7,50[illegible]
21		DUE TO q = 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	-17,45[illegible]
22		DUE TO V_A +99.07 × 0	—	—	—	—	—	—	—	—	—	—
23		DUE TO P_o = 1000 α_{cg}	+480.0	+330.0	+150.0	+530.0	+1970.0	+4,300.0	+8,330.0	+12,110.0	+16,620.0	+21,42[illegible]
24		MOM. DUE TO CONSTANTS Σ ⑲ ⑳ ㉑ ㉒ ㉓	-902.8	-2147.4	-3,295.3	-3596.0	-4889.2	-5,030.5	-4,355.3	-4454.7	-4003.1	-3,54[illegible]
25	$\partial U/\partial M_A$	$M_A (\frac{\partial M}{\partial M_A})(\frac{\Delta S}{I})$ = ⑪ × ⑫	.005	.009	.015	.026	.044	.090	.227	.297	.458	.63[illegible]
26		$H_A (\frac{\partial M}{\partial M_A})(\frac{\Delta S}{I})$ = ⑰ × ⑫	1.351	2.531	4.340	6.811	10.014	16.831	31.944	34.173	41.990	45.8[illegible]
27		$K (\frac{\partial M}{\partial M_A})(\frac{\Delta S}{I})$ = ㉔ × ⑫	-167.5	-430.8	-793.5	-1064.2	-1793.8	-2,751.3	-4,752.1	-4,549.5	-5,066.4	-5,14[illegible]
28	$\partial U/\partial H_A$	$H_A (\frac{\partial M}{\partial H_A})(\frac{\Delta S}{I})$ ⑰ × ⑱	405.1	733.6	1242.4	1,807.8	2,268.5	3,160.4	4,501.6	3,930.0	3,846.0	3,30[illegible]
29		$K (\frac{\partial M}{\partial H_A})(\frac{\Delta S}{I})$ ㉔ × ⑱	$\bar{5}0,214$	$\bar{1}24,879$	$\bar{2}27,138$	$\bar{2}82,464$	$\bar{4}06,353$	$\bar{5}16,605$	$\bar{6}69,615$	$\bar{5}23,202$	$\bar{4}64,045$	$\bar{3}70,6$[illegible]

30	Σ LINE ㉕ =	6.936	EQ 1:		0 = 6.936 M_A + 333.[illegible]
31	Σ LINE ㉖ =	333.241	EQ 2:		0 = 333.241 M_A + 30,551.[illegible]
32	Σ LINE ㉗ =	$\bar{4}1,554.8$	EQ. 1 × (− $\frac{333.241}{6.936}$) 48.045		0 = −333.241 M_A − 16,010.[illegible]
33	Σ LINE ㉘ =	30,554.6			0 = 14,554
34	Σ LINE ㉙ =	$\bar{4},207,847$			H_A = + 151.[illegible]

FORM 1543

'(CONT'D)

A & M_A

AVRO AIRCRAFT LIMITED

TECHNICAL DEPT. (AIRFRAME)

AIRCRAFT	C-105
WEIGHT	
C. G. POSITION	
REPORT NO.	7/0558/4
SHEET	1-32
DATE	APRIL 1956
PREPARED BY	G. MEYERS

7	8	9	10	11	12	13	14	15	16	17	18	19
137,926.5	117,449.5	115,921.5	104,663.6	82,291.7	72,646.9	24,382.1	19,116.1	19,148.0	5680.5	3159.4	2,193.3	.2
-6,267.9	-6787.0	-7,226.8	-7,507.9	-7,610.3	-7,522.3	-7,391.1	-7,241.1	-6,909.5	-6,830.2	-6,776.9	-6,738.0	-6,743.7
-6,917.4	-9,777.7	-13,396.3	$\overline{17,453.5}$	$\overline{21,794.0}$	$\overline{26,326.6}$	$\overline{28,528.9}$	$\overline{30,804.1}$	$\overline{35,693.0}$	$\overline{38,416.1}$	$\overline{41,166.6}$	$\overline{45,626.0}$	$\overline{50,185.7}$
—	—	—	—	—	—	—	—	—	—	—	—	—
+8,330.0	+12,110.0	+16,620.0	+21,420.0	+26,370.0	+31,310.0	+33,600.0	+35,960.0	+41,020.0	+43,960.0	+46,930.0	+51,800.0	+56,930.0
-4,355.3	-4454.7	-4003.1	-3,541.4	-3034.3	-2,538.9	-2,320.0	-2,085.2	-1,582.5	-1,286.3	-1,013.5	-564.0	+.6
.227	.297	.458	.637	.767	1.054	.446	.450	.830	.352	.294	.450	.485
31.944	34.173	41.990	45.888	42.501	43.191	15.383	12.774	14.328	4.514	2.660	2.017	0
-4,752.1	-4,549.5	-5,066.4	-5,148.6	-4505.5	-4501.2	-1640.8	-1,404.5	-1,754.9	-569.4	-354.2	-306.6	0
4,501.6	3,930.0	3,846.0	3,303.5	2,355.5	1,769.8	530.3	362.5	247.4	57.9	24.1	8.1	.1
$\overline{669,675}$	$\overline{523,202}$	$\overline{464,045}$	$\overline{370,656}$	$\overline{249,698}$	$\overline{184,443}$	$\overline{56,566}$	$\overline{39,861}$	$\overline{30,302}$	$\overline{7,307}$	$\overline{3,202}$	$\overline{1237}$	0

$0 = 6.936\,M_A + 333.241\,H_A - 41,554.8$

$0 = 333.241\,M_A + 30551.6\,H_A - 4,207,847$

$0 = -333.241\,M_A - 16,010.6\,H_A + 1,996,505$

$0 = 14,554\,H_A - 2,211,342$

$H_A = {}^{+}151.94^{\#}$ ←

SUB IN EQ 1:

5063.4

$0 = 6.936\,M_A + 333.241(151.94) - 41,554.8$

$M_A = \frac{-9077.8}{6.936} = \overline{1308.8}$ ″ #

CHECK SUB IN EQ #2:

$436146 + 4,642,466 \overset{?}{=} 4,207,847$

$4,206,320 = 4,207,847$ (CHECK)

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

REPORT No	7/0558/4	
SHEET No	1-33	
AIRCRAFT: C-105	FRAME 691	
PREPARED BY	G. MEYERS	DATE APR 56
CHECKED BY		DATE

UNIT ANALYSIS FOR LOAD $P_0 = 1000^{\#}$ ↓ (CONT'D)

FROM PRECEEDING PAGE:

$$M_A = -1{,}308.8 \, '^{\#}$$

$$H_A = 151.94^{\#} \leftarrow$$

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

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

$$q = +.4623 + 2.5100 + 20.11 = \underline{23.0823} \ ^{\#}/_{''} \downarrow$$

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

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

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

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

FORM 1319A

SIGN CONVENTION: +EL ↑; +M; +S →; OUTER CAP γ; INNER CAP γ

ANALYSIS OF HEAVY FRAME 697

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

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

(FOR FRAME CONSTANTS SEE P. 1-27) (REF DWG ~~7-0152~~ 7-1058-1051/3)

AVRO AIRCRA[FT]

AIRCRA[FT]

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	+1,970	+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	$-Z A z$ = 23.0823 ⑤ P.	-194	-419	-644	-1,186	-2,423	-4348	-7,[illegible]40	-11,223	-15,376	-20,033
4											
5											
6	INTERNAL B M = Σ ① ② ③	+172	-288	-778	-1023	-900	-569	-199	+249	+564	+681
7	SIN θ	SEE	⑦ P.	1-27							
8	COS θ	SEE	⑧ P.	1-27							
9	$q(y_s)$ -23.082 ⑩ P.	-194	-338	-484	-629	-771	-903	-1034 ←			
10	P_Y = 1000 + ⑨	+806	+662	+516	+371	+229	+97	-34 ←			
11	$q(x_s)$ -(-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 × ⑧	+806	+662	+516	+366	+218	+84	-22	-21	-16	-9
14	$-P_X \sin\theta$ = - ⑫ × 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 × ⑦	-21	-17	+23	+58	+71	+48	-26	-27	-30	-33
17	$P_x \cos\theta$ = ⑫ × 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

FORM 1543

...697

...MENTS, SHEARS &

DWG ~~7-0158~~ 7-1058-1051/3)

AVRO AIRCRAFT LIMITED

TECHNICAL DEPT. (AIRFRAME)

REPORT NO. . 7/0558/4

SHEET . . 1-34

DATE . .

AIRCRAFT . . C-105

WEIGHT . .

C. G. POSITION .

PREPARED BY .

7	8	9	10	11	12	13	14	15	16	17	18	19
+8,330	+12,110	+16,620	+21,420	+26,370	+31,310	+33,600	+35,960	+41,020	+43,960	+46,930	+51,800	+56,930
-581	-638	-680	-706	-716	-707	-695	-681	-650	-642	-637	-634	-634
-7,140	-11,223	-15,376	-20,033	-25,015	-30,218	-32,745	-35,357	-40,969	-44,094	-47,251	-52,370	-57603
-199	+249	+564	+681	+639	+385	+160	-78	-599	-776	-958	-1,204	M_A = -1,307 (CHECK)
-1034 ←											→	-1034
-34 ←											→	-34
+165 ←											→	+165
151 ←											→	+151
-22	-21	-16	-9	0	+9	+12	+16	+9	+4	+2	0	0
-113	120	-134	-146	-151	-146	-140	-134	-146	-150	-151	-151	-151
-135	-141	-150	-155	-151	-137	-128	-118	-137	-146	-149	-151	H_A = -151 (CHECK)
-26	-27	-30	-33	-34	-33	-32	-30	-33	-34	-34	-34	-34
99	9.2	70	35	0	-38	-55	-70	-39	-18	-11	0	0
+73	+65	+40	+2	-34	-71	-87	-100	-72	-52	-45	-34	V_A = -34 (CHECK)

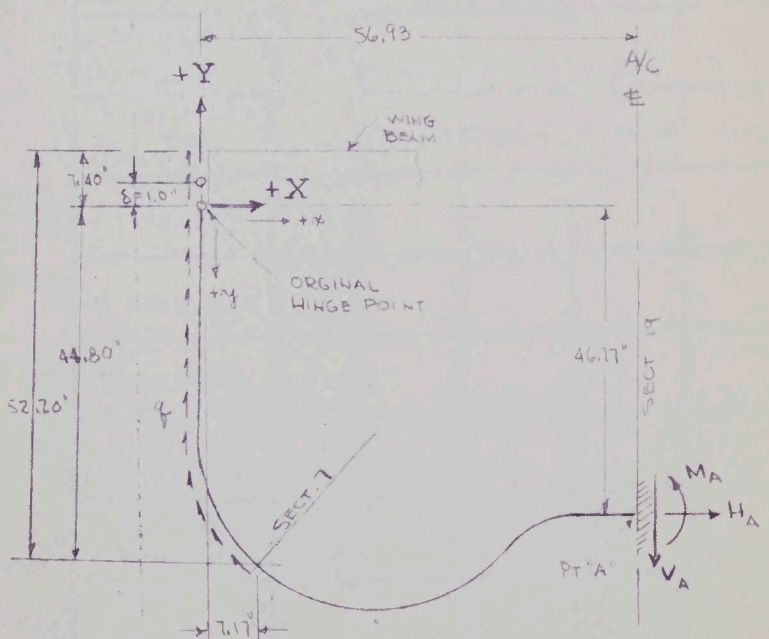
AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

REPORT No	7/0558/4	
SHEET No	1-35	
AIRCRAFT: C-105	FRAME 697	
PREPARED BY	G. MEYERS	DATE: 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" (℄ 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, P1-4 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 ℄ 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.



FORM 1319A

ANALYSIS OF HEAVY FRAME 697

UNIT ANALYSIS FOR LOAD $\delta_V = 1.0''$ ↑

CALCULATION OF REDUNDANTS H_A & M_A

AVRO AIRCRAFT

AIRCRAF

WEIGHT

C. G. PC

	SECTION →	1	2	3	4	5	6	7	8	9	10	
1	(ΔS/I) x ① P. × ⑫ P.	3.665	1.521	.574	1.809	5.999	14.349	35.203	42.506	58.070	71.029	7
2	(ΔS/I) x (2Aq) ① × ⑤ P.	31 q	28	16	93	630	2,703	12,109	20,667	38,683	61,646	8
3	(ΔS/I) x (X·y) ① × ② P.	31 X	22	12	49	198	552	1530	2,001	2,910	3,698	4
4	(ΔS/I) y ② P. × ⑫ P.	64.30	67.54	80.19	92.39	100.27	128.27	183.70	165.22	175.12	172.66	1
5	(ΔS/I) y (2Aq) ④ × ⑤ P.	539 q	1,226	2,236	4,745	10,576	24,161	63,189	80,332	116,656	149,852	16
6	(ΔS/I) y (X·y) ④ × ② P.	541 X	989	1,682	2,501	3,302	4,931	7,985	7,777	8,777	8,990	8
7	(ΔS/I) x (Y x) ① × ① P.	1.8 Y	.5	.1	1.0	11.8	61.7	293.2	514.7	965.1	1521.4	1
8	Σ LINE ②	782,862 q										
9	Σ LINE ③	31,336	X & 31,336 Y									
10	Σ LINE ⑤	1,316,342	q									
11	Σ LINE ⑥	77,009	X									
12	Σ LINE ⑦	18,504.7	Y									
13												
14												
15												

FORM 1543

AVRO AIRCRAFT LIMITED

TECHNICAL DEPT. (AIRFRAME)

AIRCRAFT - - C-105

WEIGHT - -

C. G. POSITION -

REPORT NO. - 7/0558/4

SHEET - - 1-36

DATE - - MAY 1956

PREPARED BY - G. MEYERS

9	10	11	12	13	14	15	16	17	18	19
58.070	71.029	75.814	93.366	37.666	36.248	60.792	24.486	19.476	30.614	27.611
38,683	61,646	82,163	122,228	53,434	55,524	107,899	46,776	39,869	69,458	68,905
2,910	3,698	4,001	4871	1,931	1,820	2,913	1,160	915	1,431	1,291
175.12	172.66	151.74	155.57	57.46	50.62	71.02	26.39	19.51	27.62	22.68
116,656	149,852	164,447	203,661	81,515	77,539	126,052	50,413	39,938	62,665	56,599
8,777	8,990	8,009	8,116	2,945	2,542	3,403	1,250	917	1,291	1,061
965.1	1521.4	1999.2	2,923.3	1,265.6	1,303.5	2,493.7	1,076.4	914.0	1585.8	1,571.9

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

REPORT NO. 7/0558/4
SHEET NO. 1-37

AIRCRAFT:		PREPARED BY	DATE
C-105	FRAME 697	G. MEYERS	MAY 1956
		CHECKED BY	DATE

CALCULATION OF FRAME STIFFNESS

$\uparrow \Sigma F_V = 0 : \quad 52.20 q - V_A = 0$

$Y = 7.40 q$ { VERTICAL LOAD TRANSMITTED THRU HINGE PIN = SHEAR LOAD IN STRUCTURE ABOVE PIN.

$\delta_V = +1.0 (10.3 \times 10^6) = 782,862 q + 31,336 X + 18,504.7 Y$

$= 782,862 q + 31,336 X + 136,934.8 q$

$10.3 \times 10^6 = 919,797 q + 31,336 X$ ①

$\delta_H = 0 = 1,316,342 q + 77,009 X + 31,336 Y$

$= 1,316,342 q + 77,009 X + 231,886 q$

$0 = 1,548,228 q + 77,009 X$ ②

$-2.53125 \times 10^7 = -2,260,424 q - 77,009 X$ ①' $= -① \times \frac{77,009}{31,336}$

$-25,312,508 = -712,196 q$

$q = +35.541 \ \#/'' \ \uparrow$

SUBSTITUTING IN EQ ②:

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

$Y = 7.40 q = 7.40 \times 35.541 = 263^{\#} \uparrow$

SUBSTITUTING IN EQ. ①

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

$10,300,000 \approx 10,299,900$ (CHECK)

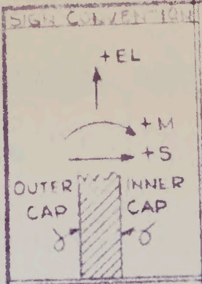
$V_A = 52.20 \times 35.541 = 1855.24^{\#} \downarrow$

SPRING RATE $= 2 \times 1855.24 = 3,710.48 \ \#/''$

$M_A = 263 \times 56.93 + 35.541 \times 2495.56 - 714.534 \times 46.77 = +70,248.5 \ ''\#$

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

FORM 1319A



ANALYSIS OF HEAVY FRAME 697

CALCULATION OF INTERNAL BENDING MOMENTS, SHEARS & END LOADS DUE TO HINGE DEFLECTION δ = 1.0" ¢

AVRO

AIRCRA

WEIGHT

C. G. F

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

(FOR FRAME CONSTANTS SEE P. 1-27) (REF DWG ~~7-0-63~~ 7-1058-1051/3)

	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	+ZAz = 35.541 (5) P.	298	645	991	1,825	3,731	6,695	12,225	17,280	23,676	30,846
4											
5											
6	INTERNAL B M = Σ (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 θ	SEE (7) P. 1-27									
8	COS θ	SEE (8) P. 1-27									
9	f(y_s) 35.541 (10) P.	299	521	745	968	1,187	1,391	1592	◄		
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 = X̄ - f(x_s) = -715 + (11)	-693	-683	-673	-684	-735	-825	-970	◄		
13	P_Y COS θ = (10) × (8)	562	784	1,007	1,216	1,379	1,440	1,217	1,129	857	496
14	$-P_x$ SIN θ = - (12) × (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 θ = (10) × (7)	-15	-21	44	193	448	814	1,400	1,472	1,645	1,787
17	P_x COS θ = (12) × (8)	-693	-683	-672	-676	-699	-718	-636	-591	-448	-259
18	SHEAR (16) + (17)	-708	-704	-628	-483	-251	+96	+764	+881	+1,19[illegible]	+1,528

FORM 1543

…S, SHEARS &
…δ = 1.0" &

…-1058-1051/3) ~~0163~~

AVRO AIRCRAFT LIMITED
TECHNICAL DEPT. (AIRFRAME)

AIRCRAFT	C-105
WEIGHT	
C. G. POSITION	

REPORT NO.	7/0558/4
SHEET	1-38
DATE	MAY 1956
PREPARED BY	G. MEYERS

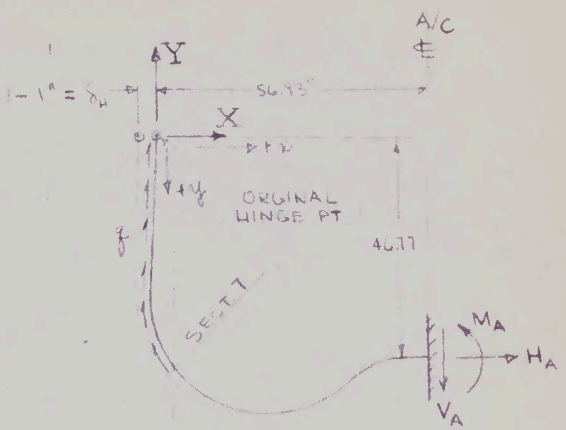
	8	9	10	11	12	13	14	15	16	17	18	19
	3,185	4,371	5,633	6,935	8,235	8,837	9,457	10,788	11,561	12,343	13,623	14,973
1	−33,633	−35,812	−37,206	−37,713	−37,277	−36,627	−35,884	−34,240	−33,847	−33,583	−33,426	−33,419
5	17,280	23,676	30,846	38,517	46,528	50,420	54,441	63,081	67,894	72,755	80,636	88,695
5	−13,168	−7,765	−727	+7,739	+17,486	+22,630	+28,014	+39,629	+45,608	+51,515	+60,833	M_A = +70,249 (CHECK)
2 ←												→ 1592
5 ←												→ 1855
5 ←												→ −255
0 ←												→ −970
7	1,129	857	496	0	−464	−680	−857	−480	−226	−129	0	0
2	+770	+860	+935	+970	+939	+902	+860	+934	+963	+968	+970	+970
9	+1,899	+1,717	+1,431	+970	+475	+222	+3	+454	+737	+839	+970	HA = +970 (CHECK)
0	1,472	1,645	1,787	1,855	1,796	1,726	1,645	1,792	1,841	1,851	1,855	+1855
6	−591	−448	−259	0	+243	+356	+448	+251	+118	+68	0	0
4	+881	+1,197	+1,528	+1,855	+2,039	+2,082	+2,093	+2,043	+1,959	+1,919	+1,855	VA = +1855 CHECK

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

		REPORT No. 7/0558/4	
		SHEET No. 1-39	
AIRCRAFT:		PREPARED BY	DATE
C-105	FRAME 697	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. 1-35) EXCEPT FOR DEFLECTION SUBSTITUTION:



$$\delta_V = 0 = 782{,}862\,z + 31{,}336\,X + 18{,}504.7\,Y$$

$$0 = 919{,}797\,z + 31{,}336\,X \qquad (1)$$

$$\delta_H = -1.0'' \times 10.3\times10^6 = 1{,}316{,}342\,z + 77{,}009\,X + 31{,}336\,Y$$

$$-10.3\times10^6 = 1{,}548{,}228\,z + 77{,}009\,X \qquad (2)$$

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

$$-10.3\times10^6 = -712{,}196\,z$$

$$z = +14.462^{\#} \uparrow \qquad Y = 7.4\,z = +107.02^{\#} \uparrow$$

SUB. IN EQ. (1):

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

$$V_A = 52.20\,z = 754.92^{\#} \downarrow$$

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT NO. 7/0558/4	
C-105	FRAME 697	SHEET NO. 1-40	
		PREPARED BY	DATE
		G. MEYERS	MAY 1956
		CHECKED BY	DATE

UNIT SOLUTION FOR $\delta_H = -1.0'' \leftarrow$ (CONT'D)

FROM PREVIOUS PAGE: $f = {}^{+}14.462 \,\#/in \uparrow$

$Y = {}^{+}107.02^{\#} \uparrow$

$X = -424.5^{\#} \leftarrow$

$V_A = 754.92^{\#} \downarrow$

$$H_A = +424.5 + 14.462 \times 7.17^{\#} = +528.2^{\#} \rightarrow$$

(103.7)

$$\overset{\curvearrowright}{\Sigma M_A} = 0 = -M_A - 424.5 \times 46.77 + 14.462 \times 2{,}495.56 + 107.02 \times 56.93$$

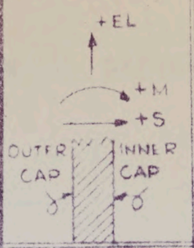
$$M_A = 22{,}329.6''^{\#}$$

CHECK:

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

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

SIGS C.1 ZEN 104



ANALYSIS OF HEAVY FRAME 697

CALCULATION OF INTERNAL BENDING MOMENTS, SHEARS & END LOADS DUE TO HINGE DEFLECTION $\delta_H = 1.0$

AVRO

AIRCRAFT
WEIGHT
C. G.

(FOR EQUATIONS SEE 7/0558/26 P1-7)
(FOR FRAME CONSTANTS SEE P 1-27) (REF DWG 7-1058-105/3)

	SECTION →	1	2	3	4	5	6	7	8	9	10
1	+Y (x) = +107.02 (1) P	51	35	16	57	211	460	891	1,296	1,779	2,292
2	+X (y) = −424.5 (2) P	$\overline{3574}$	$\overline{6,219}$	$\overline{8,902}$	$\overline{11,491}$	$\overline{13,779}$	$\overline{16,318}$	$\overline{18,453}$	$\overline{19,981}$	$\overline{21,276}$	$\overline{22,104}$
3	+2Aq = +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)	$\overline{3,402}$	$\overline{5,922}$	$\overline{8483}$	$\overline{10,691}$	$\overline{12,250}$	$\overline{13,134}$	$\overline{12,587}$	$\overline{11,653}$	$\overline{9,863}$	$\overline{7,260}$
7	SIN θ	SEE (7) P 1-27									
8	COS θ	SEE (8) P 1-27									
9	q (y_s) 14.462 (10) P.	122	212	303	394	483	566	648 ←			
10	P_Y = Y + q (y_s) = 107 + (9)	229	319	410	501	590	673	755 ←			
11	−q (x_s) −14.462 (9) P.	+ 9	+ 13	+ 17	+ 13	− 8	− 45	− 104 ←			
12	P_x = X − q (x_s) = −424.5 + (11)	$\overline{416}$	$\overline{412}$	$\overline{408}$	$\overline{412}$	$\overline{433}$	$\overline{470}$	$\overline{529}$ ←			
13	P_Y COS θ = (10) × (8)	229	319	410	495	561	586	495	460	349	202
14	$-P_x$ SIN θ = − (12) × (7)	$\overline{11}$	$\overline{11}$	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)	$\overline{6}$	$\overline{8}$	18	78	182	331	570	599	670	725
17	P_x COS θ = (12) × (8)	$\overline{416}$	$\overline{412}$	$\overline{408}$	$\overline{407}$	$\overline{412}$	$\overline{456}$	$\overline{347}$	$\overline{322}$	$\overline{244}$	$\overline{141}$
18	SHEAR (16) + (17)	−422	−420	−426	−329	−230	−125	+223	+277	+426	+587

FORM 1543

E 697

…OMENTS, SHEARS &

…ECTION $\delta_H = 1.0$ ←

AVRO

AVRO AIRCRAFT LIMITED

TECHNICAL DEPT. (AIRFRAME)

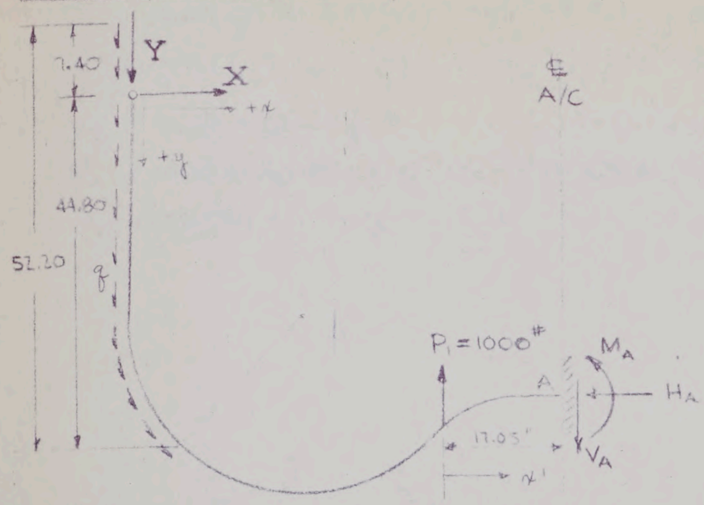
REPORT NO.	7/0558/4
SHEET	1-41
DATE	MAY 1956
AIRCRAFT	C-105
WEIGHT	
C. G. POSITION	
PREPARED BY	G. MEYERS

…F DWG ~~7-0151-~~ 7-1058-105 1/3

	7	8	9	10	11	12	13	14	15	16	17	18	19
)	891	1,296	1,779	2,292	2,822	3,351	3,596	3,848	4,390	4,705	5,022	5,544	6,093
8	18,453	−19,981	−21,276	−22,104	−22,465	−22,146	−21,760	−21,318	−20,342	−20,109	−19,952	−19,837	−19,854
+	4,975	7,032	9,634	12,552	15,673	18,933	20,516	22,153	25,668	27,628	29,605	32,812	36,091
4	−12,587	−11,653	−9,863	−7,260	−3,910	+138	+1,992	+4,683	+9,716	+12,224	+14,675	+18,519	M_A = (CHECK) 22,330
	648 ←											→	+648
	755 ←											→	+755
	−104 ←											→	−104
	−529 ←											→	−529
	495	460	349	202	0	−189	−277	−349	−195	−92	−53	0	0
	399	420	469	510	529	512	492	469	510	525	528	529	+529
7	894	880	818	712	529	323	215	120	315	433	475	529	CHECK +529 = H_A
\	570	599	670	728	529	731	702	670	729	749	753	755	+755
	−347	−322	−244	−141	0	132	194	244	137	65	37	0	0
	+223	+277	+426	+587	+529	+863	+896	+914	+866	+814	+790	+755	+755 = V_L CHECK

AVRO AIRCRAFT LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT**		REPORT No. 7/0558/4 SHEET No. 1-42	
		PREPARED BY	DATE
AIRCRAFT: C-105	FRAME 697	G. MEYERS	MAY 1956
		CHECKED BY	DATE

UNIT ANALYSIS FOR $P_1 = 1000^{\#}$ 4



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

$\Sigma H = 0: \quad X + q(x_s) - H_A = 0$

$x_s = 7.17"$

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

$\uparrow \Sigma V = 0: \; -52.20\,q + 1000 - V_A = 0$

$V_A = 1000 - 52.20\,q \quad \& \quad Y = 7.40\,q$

$\Sigma M_A = 0: \quad Y x + 2Aq + M_A = 17{,}050 + 46.77\,X$

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

$421.28\,q + 2415.56\,q + M_A = 17{,}050 + 46.77\,H_A - 335.34\,q$

$3{,}252.18\,q = 17{,}050 - M_A + 46.77\,H_A$

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

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

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

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

UNIT ANALYSIS FOR $P_1 = 1000^{\#}$ (CONT'D)

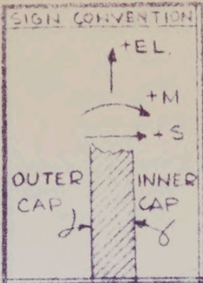
$$Y = 7.40\,f = 7.40(-307.486\times10^{-6}M_A + 14.381\times10^{-3}H_A + 5.243)$$

$$Y = -2.275\times10^{-3}M_A + 106.419\times10^{-3}H_A + 38.798$$

$$V_A = 1000 - 52.20\,f = 1000 - 52.2(-307.486\times10^{-6}M_A + 14.381\times10^{-3}H_A + 5.243)$$

$$V_A = 1000 + 16.051\times10^{-3}M_A - .75069\,H_A - 273.685$$

$$V_A = 16.051\times10^{-3}M_A - .75069\,H_A + 726.315$$



ANALYSIS OF HEAVY FRAME 697

UNIT ANALYSIS FOR LOAD P_1 = 1000# ↑ (CONT'D)

CALCULATION OF REDUNDANTS H_A & M_A

(REF DWG 7-1058 -1051 (8) / -1053 (1))

AVRO AI…
TECHN…

AIRCRAFT
WEIGHT
C. G. POSITION

	SECTION →	1	2	3	4	5	6	7	8	9	10	11
1	x_{CG}	(SEE LINE 1, P 1-27)										
2	y_{CG}	(SEE LINE 2, P 1-27)										
3	2A	(SEE LINE 5, P 1-27)										
4	χ'	—	—	—	—	—	—	—	—	—	—	—
5												
6	$\frac{\Delta S}{I}$	(SEE LINE 12, P 1-27)										
7	COEFFICIENTS OF M_A: DUE TO Y $-2.275\times10^{-3}(-x)$	1.09 $\times10^{-3}$	.75 $\times10^{-3}$	.34 $\times10^{-3}$	1.21 $\times10^{-3}$	4.48	9.78	18.95	27.55	37.81	48.73	59.99
8	DUE TO X $2.205\times10^{-3}y$	18.57 $\times10^{-3}$	32.30 $\times10^{-3}$	46.24 $\times10^{-3}$	59.69 $\times10^{-3}$	72.61	84.76	95.85	103.79	110.51	114.81	116.38
9	DUE TO q $-3.7486\times10^{-3}(-2A)$	2.59 $\times10^{-3}$	5.58 $\times10^{-3}$	8.58 $\times10^{-3}$	15.79 $\times10^{-3}$	32.28	57.92	105.77	149.50	204.83	266.87	333.23
10	DUE TO V_A $16.051\times10^{-3}(0)$	—	—	—	—	—	—	—	—	—	—	—
11	MOM DUE TO M_A = Σ (7) (8) (9) (10)	22.25 $\times10^{-3}$	38.63 $\times10^{-3}$	55.16 $\times10^{-3}$	76.69 $\times10^{-3}$	109.37	152.46	220.57	280.84	353.15	430.41	509.6[illegible]
12	$\partial M/\partial M_A \times (\Delta S/I)$ = LINE (11) × (6)	169.90 $\times10^{-3}$	178.08 $\times10^{-3}$	210.93 $\times10^{-3}$	261.74 $\times10^{-3}$	333.03	508.76	932.13	985.15	1233.91	1,427.24	1,465.1[illegible]
13	COEFFICIENTS OF H_A: DUE TO Y $106.419\times10^{-3}(-x)$	-51.08 $\times10^{-3}$	-35.12 $\times10^{-3}$	-15.96 $\times10^{-3}$	-56.40 $\times10^{-3}$	-209.65	-457.60	-886.47	-1,288.73	-1,768.68	-2,279.49	-2,806.2[illegible]
14	DUE TO X $896.89\times10^{-3}y$	7,551.8 $\times10^{-3}$	13,139.4 $\times10^{-3}$	18,807.8 $\times10^{-3}$	24,278.8 $\times10^{-3}$	29,534.6	34,476.5	38,987.8	42,216.6	44,952.1	46,701.1	47,337.9
15	DUE TO q $14.381\times10^{-3}(-2A)$	-120.7 $\times10^{-3}$	-261.0 $\times10^{-3}$	-401.1 $\times10^{-3}$	-738.6 $\times10^{-3}$	-1,509.7	-2,708.8	-4,946.8	-6,992.2	-9,579.9	-12,481.3	-15,585.[illegible]
16	DUE TO V_A $-.75069(0)$	—	—	—	—	—	—	—	—	—	—	—
17	MOM DUE TO H_A = Σ (13) (14) (15) (16)	7,380.0 $\times10^{-3}$	12,843.3 $\times10^{-3}$	18,390.7 $\times10^{-3}$	23,483.8 $\times10^{-3}$	27,815.3	31,310.1	33,154.5	33,935.7	33,603.5	[illegible]1,940.3	28,946.[illegible]

FORM 1543

...4 (CONT'D)

... M_A

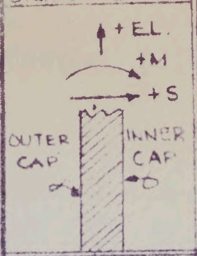
AVRO AVRO AIRCRAFT LIMITED
TECHNICAL DEPT. (AIRFRAME)

AIRCRAFT	C-105
WEIGHT	
C. G. POSITION	

REPORT NO.	7/0558/4
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
18.45	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
105.77	149.50	204.83	266.87	333.23	402.54	436.21	471.06	545.15	587.39	629.45	697.63	767.35
—	—	—	—	—	—	—	—	—	—	—	—	—
220.57	280.84	353.15	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	1,427.24	1,465.10	1,755.80	701.39	668.86	1,103.69	441.06	348.54	493.25	485.00
$\overline{886.47}$	$\overline{1,288.73}$	$\overline{1,768.68}$	$\overline{2,279.41}$	$\overline{2,806.27}$	$\overline{3,331.93}$	$\overline{3,575.68}$	$\overline{3,826.83}$	$\overline{4,365.31}$	$\overline{4,678.13}$	$\overline{4994.24}$	$\overline{5,512.50}$	$\overline{6,058.43}$
38,981.8	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
$\overline{4,946.8}$	$\overline{6,992.2}$	$\overline{9,579.9}$	$\overline{12,481.3}$	$\overline{15,585.3}$	$\overline{18,826.6}$	$\overline{20,401.5}$	$\overline{22,028.5}$	$\overline{25,524.7}$	$\overline{27,472.0}$	$\overline{29,438.9}$	$\overline{32,627.9}$	$\overline{35,358.6}$
—	—	—	—	—	—	—	—	—	—	—	—	—
33,154.5	33,935.1	33,603.5	31,940.3	28,946.3	24,632.2	21,997.4	19,186.5	13,081.0	10,335.5	7,720.7	3,771.3	0.5

SIGN CONVENTION



ANALYSIS OF HEAVY FRAME 697 I
UNIT ANALYSIS FOR LOAD P_1 = 1000# ↑ (CONT'D)
CALCULATION OF REDUNDANTS H_A & M_A

(REF DWG 7-1058, -1051 ①, -1053 ①)

AVRO A…
TECH…

AIRCRAFT -
WEIGHT -
C. G. POSITIO…

	SECTION →	1	2	3	4	5	6	7	8	9	10	11
18	$\partial M/\partial H_A(\Delta S/I)$ LINE ⑰ × ⑥	×10⁻³ 56,353.7	×10⁻³ 59,207.6	×10⁻³ 70,326.0	×10⁻³ 80,150.2	84,697.6	104,481.8	140,110.9	119,114.3	117,410.6	105,914.0	83,220…
19	COEFFICIENTS OF CONSTANT: DUE TO Y = 38.798 (−ν)	$\overline{18.6}$	$\overline{12.8}$	$\overline{5.8}$	$\overline{20.6}$	$\overline{76.4}$	$\overline{166.8}$	$\overline{323.2}$	$\overline{469.8}$	$\overline{644.8}$	$\overline{831.1}$	$\overline{1,023.1}$
20	DUE TO X = −37.592 y	$\overline{316.5}$	$\overline{550.7}$	$\overline{788.3}$	$\overline{1017.6}$	$\overline{1,237.9}$	$\overline{1,445.0}$	$\overline{1,634.1}$	$\overline{1,769.4}$	$\overline{1,884.1}$	$\overline{1,957.4}$	$\overline{1984.…}$
21	DUE TO q = 5.243 (−2A)	$\overline{44.0}$	$\overline{95.2}$	$\overline{146.2}$	$\overline{269.3}$	$\overline{550.4}$	$\overline{987.6}$	$\overline{1803.5}$	$\overline{2,549.2}$	$\overline{3,492.6}$	$\overline{4,550.4}$	$\overline{5,682.…}$
22	DUE TO V_A 726.315 (0)	—	—	—	—	—	—	—	—	—	—	—
23	DUE TO P_1 1000 x'	—	—	—	—	—	—	—	—	—	—	—
24	MOM. DUE TO CONSTANTS Σ ⑲ ⑳ ㉑ ㉒ ㉓	$\overline{379.1}$	$\overline{658.7}$	$\overline{940.3}$	$\overline{1,307.5}$	$\overline{1,864.7}$	$\overline{2,599.4}$	$\overline{3,760.8}$	$\overline{4,788.4}$	$\overline{6,021.5}$	$\overline{7,338.9}$	$\overline{8,689.…}$
25	∂U/∂M_A: $M_A(\frac{\partial M}{\partial M_A})(\frac{\Delta S}{I})$ = ⑪ × ⑫	.0038	.0069	.0116	.0201	.0364	.0776	.2056	.2768	.4358	.6143	.746…
26	$H_A(\frac{\partial M}{\partial M_A})(\frac{\Delta S}{I})$ = ⑰ × ⑫	1.25	2.29	3.88	6.15	9.26	15.93	30.90	33.45	41.46	45.59	42.4…
27	$K(\frac{\partial M}{\partial M_A})(\frac{\Delta S}{I})$ = ㉔ × ⑫	$\overline{64.4}$	$\overline{117.3}$	$\overline{198.3}$	$\overline{342.2}$	$\overline{621.0}$	$\overline{1322.5}$	$\overline{3,505.6}$	$\overline{4,720.2}$	$\overline{7430.0}$	$\overline{10,474.4}$	$\overline{12,730…}$
28	∂U/∂H_A: $H_A(\frac{\partial M}{\partial H_A})(\frac{\Delta S}{I})$ ⑰ × 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	2408.…
29	$K(\frac{\partial M}{\partial H_A})(\frac{\Delta S}{I})$ ㉔ × ⑱	$\overline{21,363}$	$\overline{39,000}$	$\overline{66,128}$	$\overline{104,796}$	$\overline{157,936}$	$\overline{271,590}$	$\overline{526,929}$	$\overline{570,367}$	$\overline{706988}$	$\overline{777,292}$	$\overline{723,12…}$
30	Σ LINE ㉕ =	6.754				EQ 1:	0 =	6.754 M_A +	327.64 H_A − 95,497.…			
31	Σ LINE ㉖ =	327.64				EQ. 2:	0 =	327.64 M_A + 31,470.3 H_A − 5,492,491				
32	Σ LINE ㉗ =	$\overline{95,497.1}$				EQ 1' = −1 × $\frac{327.64}{6.754}$:	0 =	−327.64 M_A − 15,894.0 H_A + 4,632,612…				
33	Σ LINE ㉘ =	31,470.3					0 =	0	+ 15,576.3 H_A − 859,879…			
34	Σ LINE ㉙ =	$\overline{5,492,491}$						H_A =	+ 55.204#			

FORM 1543

…97 #
…4 (CONT'D)
H_A & M_A

AVRO AIRCRAFT LIMITED
TECHNICAL DEPT. (AIRFRAME)

AIRCRAFT	C-105
WEIGHT	
C. G. POSITION	
REPORT NO.	7/0558/4
SHEET	1-45
DATE	MAY 1956
PREPARED BY	G. MEYERS

(6)	7	8	9	10	11	12	13	14	15	16	17	18	19
.8	140,110.9	119,114.3	117,410.6	105,914.0	83,220.6	73,453.2	24,659.1	19,340.0	19,397.9	5,576.9	3,204.1	2,025.2	0
3	$\overline{323.2}$	$\overline{469.8}$	$\overline{644.8}$	$\overline{831.1}$	$\overline{1,023.1}$	$\overline{1,214.8}$	$\overline{1,303.6}$	$\overline{1,395.2}$	$\overline{1,591.5}$	$\overline{1,705.6}$	$\overline{1,820.8}$	$\overline{2,009.7}$	$\overline{2208.8}$
.0	$\overline{1,634.1}$	$\overline{1,769.4}$	$\overline{1,884.1}$	$\overline{1,957.4}$	$\overline{1984.1}$	$\overline{1,961.2}$	$\overline{1,927.0}$	$\overline{1,887.9}$	$\overline{1,801.4}$	$\overline{1,780.7}$	$\overline{1,766.8}$	$\overline{1,756.7}$	$\overline{1,758.2}$
6	$\overline{1803.5}$	$\overline{2,549.2}$	$\overline{3,492.6}$	$\overline{4,550.4}$	$\overline{5,682.0}$	$\overline{6,863.8}$	$\overline{7,438.0}$	$\overline{8,031.1}$	$\overline{9,305.7}$	$\overline{10,015.7}$	$\overline{10,732.8}$	$\overline{11,895.4}$	$\overline{13,084.2}$
	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	1,140	4,080	7,050	11,920	17,050
.4	$\overline{3,760.8}$	$\overline{4,788.4}$	$\overline{6,021.5}$	$\overline{7,338.9}$	$\overline{8,689.2}$	$\overline{10,039.8}$	$\overline{10,668.6}$	$\overline{11,314.2}$	$\overline{11,558.6}$	$\overline{9,422.0}$	$\overline{7,270.4}$	$\overline{3,741.8}$	$\overline{1.2}$
6	.2056	.2768	.4358	.6143	.7466	1.0338	.4388	.4438	.8220	.3493	.2927	.4531	.4850
3	30.90	33.45	41.46	45.59	42.41	43.25	15.43	12.83	14.45	4.56	2.69	1.86	0
5	$\overline{3,505.6}$	$\overline{4,720.2}$	$\overline{7430.0}$	$\overline{10,474.4}$	$\overline{12,730.5}$	$\overline{17,627.9}$	$\overline{7,482.8}$	$\overline{7,567.6}$	$\overline{12,757.1}$	$\overline{4,155.7}$	$\overline{2,534.0}$	$\overline{1,845.6}$	0
3	4,645.3	4,042.2	3,945.4	3,382.9	2,408.9	1,809.3	542.4	371.1	253.9	57.6	24.7	7.6	0
10	$\overline{526,929}$	$\overline{570,367}$	$\overline{706,988}$	$\overline{777,292}$	$\overline{723,120}$	$\overline{737,455}$	$\overline{263,078}$	$\overline{218,817}$	$\overline{224,213}$	$\overline{52,546}$	$\overline{23,295}$	$\overline{7,578}$	0

$0 = 6.754\,M_A + 327.64\,H_A - 95,497.1$

$0 = 327.64\,M_A + 31,470.3\,H_A - 5,492,491$

$0 = -327.64\,M_A - 15,894.0\,H_A + 4,632,612$

$0 = 0 + 15,576.3\,H_A - 859,879$

$H_A = +55.204^{\#}$

SUBSTITUTING IN EQ 1:

$0 = 6.754\,M_A + 327.64(55.204) - 95,497.1$

$M_A = \dfrac{+18,087.0 + 95,497.1}{6.754} = +11,461.37''\#$

SUBSTITUTING IN EQ 2:

$+327.64(+11,461.37) + 31,470.3(55.204) \overset{?}{=} 5,492,491$

$+3,755,203 + 1,737,286 \overset{?}{=} 5,492,491$

(CHECK)

AVRO AIRCRAFT LIMITED MALTON · ONTARIO TECHNICAL DEPARTMENT		REPORT NO. 7/0558/4 SHEET NO. 1-46	
AIRCRAFT:		PREPARED BY	DATE
C-105	FRAME 697	G. MEYERS	MAY 1956
		CHECKED BY	DATE

UNIT ANALYSIS FOR LOAD $P_1 = 1000^{\#} \downarrow$

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

$M_A = 11{,}461.4''^{\#}$ ↻

$q = -.000307486\, M_A + .014381\, H_A + 5.243$

$= -3.524 + .794 + 5.243 = 2.513^{\#}/'' \downarrow$

$Y = -.002275\, M_A + .106419\, H_A + 38.798$

$= -26.075 + 5.874 + 38.798 = +18.597^{\#} \downarrow$

$V_A = .016051\, M_A - .75069\, H_A + 726.315$

$= 183.967 - 41.438 + 726.315 = 868.844^{\#} \downarrow$

$X = .002205\, M_A + .89681\, H_A - 37.592$

$= 25.272 + 49.508 - 37.592 = 37.188^{\#} \rightarrow$

CHECK :

$\overset{\frown}{M_A} = -2.513 \times 2495.56 + 17{,}051 - 18.597 \times 56.93 + 37.188 \times 46.77$

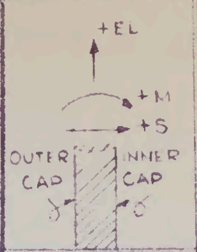
$-6271.3 + 17{,}051 - 1058.7 + 1739.3 = 11{,}460.3$ (CHECK)

$\uparrow \Sigma F_V \overset{?}{=} 0 = -2.513 \times 44.80 - 18.597 + 1000 - 868.844 = 0$ (CHECK)

$\overset{\rightarrow}{\Sigma F_H} \overset{?}{=} 0 = +2.513 \times 7.13 - 55.2 + 37.188 = 0$ (CHECK)

FORM 1319A

SIGN CONVENTION



ANALYSIS OF HEAVY FRAME 291

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

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

(FOR FRAME CONSTANTS SEE P 1-27) (REF DWG 7-~~0155~~ 1058 - 1051 R / 1053 L)

T

AIRCRAFT

WEIGHT

C. G. POS

	SECTION →	1	2	3	4	5	6	7	8	9	10	11
1	−Y(x) = −18.597 × ① P_1	−1	−6	−3	−10	−37	−80	−155	−225	−309	−398	−4[illegible]
2	+X(y) = 37.188 × ② P	313	545	780	1007	1225	1,430	1,617	1,750	1,864	1,936	1,9[illegible]
3	−2Az = −2.513 ⑤ P.	−21	−46	−70	−129	−264	−473	−864	−1,222	−1,674	−2,181	−2,[illegible]
4	$+P_1(x')$ 1000 × ④ P.	—	—	—	—	—	—	—	—	—	—	—
5												
6	INTERNAL B.M. = Σ ①②③④⑤	+283	+413	+707	+868	+924	+877	+598	+303	−119	−643	−1,2[illegible]
7	SIN θ	SEE ⑦ P. 1-27										
8	COS θ	SEE ⑧ P. 1-27										
9	$q(y_s)$ −2.513 ⑩ P.	−21	−37	−53	−68	−84	−98	−113	←			
10	$P_Y = Y + q(y_s) + P_1$ = −19 + ⑨ + 1000*	−40	−56	−72	−87	−103	−117	−132	←			
11	$+q(x_s)$ +2.513 ⑨ P.	−2	−2	−3	−2	+1	+8	+18	←			
12	$P_x = X + q(x_s)$ = 37 + ⑪	+35	+35	+34	+35	+38	+45	+55	←			
13	$P_Y \cos\theta$ = ⑩ × ⑧	−40	−56	−72	−86	−98	−102	−87	−80	−61	−35	
14	$-P_x \sin\theta$ = − ⑫ × 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 × ⑦	+1	+2	−3	−14	−32	−58	−100	−105	−117	−117	−
17	$P_x \cos\theta$ = ⑫ × 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

FORM 1540

697

…OMENTS, SHEARS &

…(DWG 7-~~0155~~ 1058 - 1051 ① - 1053 ③)

AVRO AIRCRAFT LIMITED
TECHNICAL DEPT. (AIRFRAME)

AIRCRAFT	C-105
WEIGHT	
C. G. POSITION	

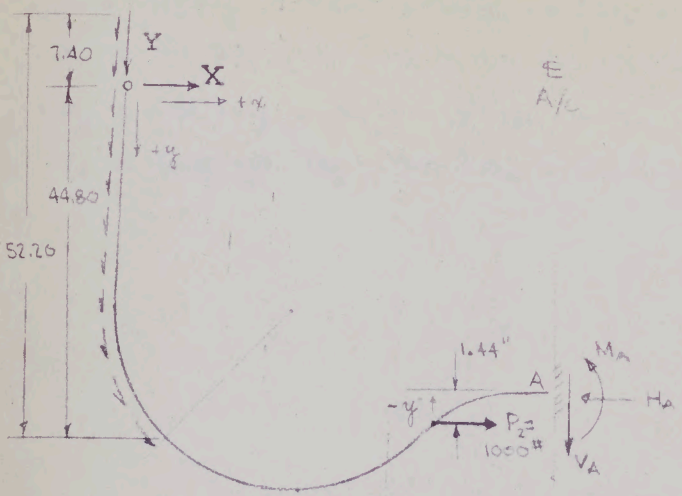
REPORT NO.	7/0558/4
SHEET	1-47
DATE	MAY 1956
PREPARED BY	G. MEYERS

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	1,748	1,738	1,739
−864	−1,222	−1,674	−2,181	−2,723	−3,290	−3,565	−3,849	−4,460	−4801	−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 = 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	−117	−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

AIRCRAFT:		REPORT NO. 7/0558/4
C-105	FRAME 697	SHEET NO. 1-48
		PREPARED BY: G. MEYERS — DATE: MAY 1956
		CHECKED BY: — DATE:

UNIT ANALYSIS FOR $P_2 = 1000^{\#} \rightarrow$



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

$\overrightarrow{\Sigma H} = 0: \quad X + q(x_s) - H_A + 1000 = 0$

$x_s = 7.17''$

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

$\uparrow \Sigma V = 0: \quad -52.20q - V_A = 0$

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

$\Sigma M_A = 0: \quad Yx + 2Aq + M_A = -1000(1.44) + 46.77X$

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

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

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

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

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

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

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

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

REPORT NO. 7/0558/4
SHEET NO. 1-49

AIRCRAFT:		PREPARED BY	DATE
C-105	FRAME 697	G. MEYERS	MAY 1956
		CHECKED BY	DATE

UNIT ANALYSIS FOR $P_z = 1000^{\#}$ → (CONT'D)

$$Y = 7.40\,q = 7.40(-307.486\times10^{-6}M_A + 14.381\times10^{-3}H_A - 14.824)$$

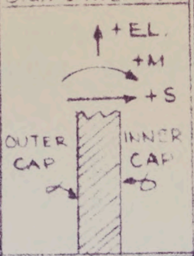
$$Y = -2.275\times10^{-3}M_A + 106.419\times10^{-3}H_A - 109.698$$

$$V_A = -52.20\,q = -52.2(-307.486\times10^{-6}M_A + 14.381\times10^{-3}H_A - 14.824)$$

$$V_A = 16.051\times10^{-3}M_A - .75069\,H_A + 773.813$$

FORM 1319A

SIGN CONVENTION



ANALYSIS OF HEAVY FRAME
UNIT ANALYSIS FOR LOAD P_2 = 1000# → (CONT'D)
CALCULATION OF REDUNDANTS H_A & M_A

(REF DWG 7-1058-1051(3))

AVRO AI[illegible] TECH[illegible]

AIRCRAFT -
WEIGHT -
C. G. POSITION

	SECTION →	1	2	3	4	5	6	7	8	9	10	11
18	y"											
19	COEFFICIENTS OF CONSTANT: DUE TO Y = -10[illegible].698 (-x)	52.6	36.2	16.4	58.1	216.1	471.7	913.8	1,328.4	1,823.2	2,349.7	2,892.[illegible]
20	DUE TO X = -8[illegible].712 y	$\overline{7,525.1}$	$\overline{13,093}$	$\overline{18,741}$	$\overline{24,193}$	$\overline{29,430}$	$\overline{34,354}$	$\overline{38,850}$	$\overline{42,067}$	$\overline{44,793}$	$\overline{46,536}$	$\overline{47,17[illegible]}$
21	DUE TO q = -14.824 (-2A)	124	269	413	761	1,556	2,792	5,099	7,208	9,875	12,866	16,065
22	DUE TO V_A 773.813 (0)	—	—	—	—	—	—	—	—	—	—	—
23	DUE TO P_2 1000 y"	—	—	—	—	—	—	—	—	—	—	—
24	MOM. DUE TO CONSTANTS Σ (19)(20)(21)(22)(23)	$\overline{7,348}$	$\overline{12,788}$	$\overline{18,312}$	$\overline{23,374}$	$\overline{27,658}$	$\overline{31,090}$	$\overline{32,837}$	$\overline{33,531}$	$\overline{33,095}$	$\overline{31,320}$	$\overline{28,212}$
25	$\partial U/\partial M_A$											
26												
27	$K\left(\frac{\partial M}{\partial M_A}\right)\left(\frac{\Delta S}{I}\right)$ = (24) × (12)	$\overline{1,748}$	$\overline{2,217}$	$\overline{3,363}$	$\overline{6,118}$	$\overline{9,211}$	$\overline{15,817}$	$\overline{30,608}$	$\overline{33,053}$	$\overline{40,836}$	$\overline{44,101}$	$\overline{41,33[illegible]}$
28	$\partial U/\partial H_A$											
29	$K\left(\frac{\partial M}{\partial H_A}\right)\left(\frac{\Delta S}{I}\right)$ (24) × (18) P	$\overline{414,082}$	$\overline{757,147}$	$\overline{1,287,810}$	$\overline{1,873,431}$	$\overline{2,342,566}$	$\overline{3,248,339}$	$\overline{4,600,822}$	$\overline{3,994,022}$	$\overline{3,885,704}$	$\overline{3,317,226}$	$\overline{2,347,8[illegible]}$

(30) Σ LINE (25) = 6.754

(31) Σ LINE (26) = 327.64

(32) Σ LINE (27) = $\overline{320,501}$

(33) Σ LINE (28) = 31,470.3

(34) Σ LINE (29) = $\overline{31,016,707}$

REF P. 1-45

EQ. 1: $0 = 6.754\,M_A + 327.64\,H_A - 320,501$

EQ. 2: $0 = 327.64\,M_A + 31,470.3\,H_A - 31,016,707$

EQ1' = $-1 \times \frac{327.64}{6.754}$: $0 = -327.64\,M_A - 15,894.0\,H_A + 15,54[illegible],66[illegible]$

$0 = 0 + 15,576.3\,H_A -$ [illegible]

H_A = +993.1 #

FORM 1543

(CONT'D)

... & 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

7	8	9	10	11	12	13	14	15	16	17	18	19
								-.31	-.87	-1.23	-1.50	-1.44
913.8	1,328.4	1,823.2	2,349.7	2,892.7	3,434.6	3,685.9	3,944.7	4,499.8	4,822.3	5,148.1	5,682.4	6,245.1
38,850	42,067	44,793	46,536	47,170	46,625	45,812	44,882	42,827	42,335	42,004	41,763	41,799
5,099	7,208	9,875	12,866	16,065	19,407	21,030	22,707	26,311	28,318	30,346	33,633	36,994
—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	310	870	1,230	1,500	1,440
32,837	33,531	33,095	31,320	28,212	23,783	21,096	18,230	12,326	10,065	7,740	3,948	0
30,608	33,053	40,836	44,101	41,333	41,758	14,797	12,193	13,604	4,439	2,698	1947	0
,600,822	3,994,022	3,385,704	3,317,226	2,347,820	1,746,937	520,208	352,568	239,099	56,131	24,800	7,995	0

$.754\ M_A + 327.64\ H_A - 320,501$

$27.64\ M_A + 31,470.3\ H_A - 31,016,707$

$27.64\ M_A - 15,894.0\ H_A + 15,547,664$

$0 \quad + 15,576.3\ H_A - [illegible],043$

$H_A = +993.1$ # ←

SUB. IN EQ 1:

$0 = 6.754\ M_A + 327.64(993.1) - 320,501$ (325,379)

$M_A = \dfrac{320,501 - 325,379}{6.754} = -722.2$ "#

SUB IN EQ 2:

$327.64(-722.2) + 15,894.0(993.1) \stackrel{?}{=} 15,547,664$ (15,784,[illegible])

$15,547,710 = $ " (CHECK)

UNIT ANALYSIS FOR LOAD $P_2 = 1000^{\#}$ →

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

$M_A = -722.2''^{\#}$ ↻

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

$= +.222 + 14.282 - 14.824 = \underline{-.32}\ ^{\#}/_{"}$ ↑

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

$= +1.643 + 105.685 - 109.698 = -\underline{2.37}\ ^{\#}$ ↑

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

$= -11.592 - 745.51 + 773.813 = \underline{+16.71}^{\#}$ ↓

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

$-1.592 + 890.701 - 893.712 = \underline{-4.60}^{\#}$ ←

CHECK:

$\curvearrowright M_A = +.32 \times 2{,}495.56 - 1440 + 2.37 \times 56.93 - 4.60 \times 46.77$

$+ 798.58 - 1{,}440 + 134.92 - 215.14 = \underline{-721.7}$ (CHECK)

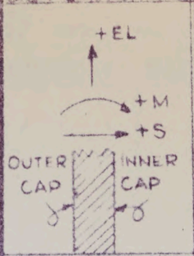
$\uparrow \Sigma F_V \overset{?}{=} 0 = +.32 \times 44.80 + 2.37 - 16.71 = \underline{0}$ (CHECK)

$\overset{\rightarrow}{\Sigma F_H} \overset{?}{=} 0 = -.32 \times 7.17 + 1000 - 4.60 - 993.1 = \underline{0}$ (CHECK)

ANALYSIS OF HEAVY FRAME

CALCULATION OF INTERNAL BENDING MOMENTS, SHEARS & END LOADS DUE TO $P_2 = 1000^{\#} \rightarrow$

SIGN CONVENTION



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

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

AVRO AIRCRAFT

AI…

TECHN…

AIRCRAFT -

WEIGHT -

C. G. POSITION

	SECTION →	1	2	3	4	5	6	7	8	9	10	11
1	$-Y(x) = +2.37$ (1) P.	1	1	0	1	5	10	20	29	39	51	62
2	$+X(y) = -4.60$ (2) P	−39	−67	−96	−125	−151	−177	−200	−217	−231	−240	−243
3	$-2Aq = +.32$ (5) P.	3	6	9	16	34	60	110	156	213	278	347
4												
5	$-P_z y''$ $-1000 y''$	—	—	—	—	—	—	—	—	—	—	—
6	INTERNAL B.M. =Σ(1)(2)(3)(4)(5)	−35	−60	−87	−108	−112	−107	−70	−32	+21	+89	+166
7	SIN θ	SEE (7) P. 1-27										
8	COS θ	SEE (8) P. 1-27										
9	$q(y_s)$ .32 (10) P.	+3	+5	+7	+9	+11	+13	+14	◄			
10	$P_y = Y + q(y_s)$ = 2 + (9)	+5	+7	+9	+11	+13	+15	+16	◄			
11	$-q(x_s)$ −.32 (9) P.	0	0	0	0	0	−1	−2	◄			
12	$P_x = X - q(x_s) + P_z$* = −5 + (11) + 1000	−5	−5	−5	−5	−5	−6	−6	◄			
13	$P_y \cos\theta$ = (10) × (8)	+5	+7	+9	+11	+12	+13	+10	+10	+7	+4	0
14	$-P_x \sin\theta$ = −(12) × (7)	0	0	0	+1	+2	+3	+5	+5	+5	+6	+6
15	END LOAD = 13 + 14	+5	+7	+9	+12	+14	+16	+15	+15	+12	+10	+6
16	$P_y \sin\theta$ = (10) × (7)	0	0	0	+2	+4	+7	+12	+13	+14	+15	+16
17	$P_x \cos\theta$ = (12) × (8)	−5	−5	−5	−5	−5	−5	−4	−4	−3	−2	0
18	SHEAR (16) + (17)	−5	−5	−5	−3	−1	+2	+8	+9	+11	+13	+16

*AT APPLICABLE SECTIONS

FORM 1543

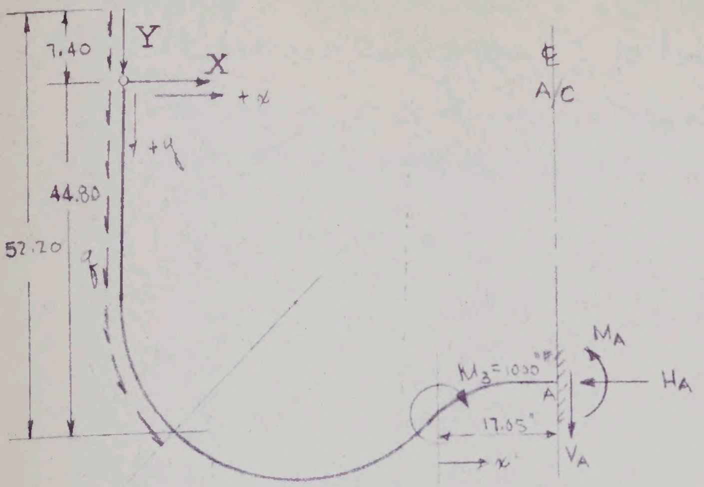
E MOMENTS, SHEARS & → F DWG ~~7-0158~~ 7-1058-1051/3	**AVRO AIRCRAFT LIMITED** TECHNICAL DEPT. (AIRFRAME) AIRCRAFT . . C-105 WEIGHT . . C. G. POSITION .
REPORT NO. . 7/0558/4 SHEET . . 1-52 DATE . . MAY 1956 PREPARED BY . G. MEYERS	

7	8	9	10	11	12	13	14	15	16	17	18	19
20	29	39	51	62	74	80	85	97	104	111	123	135
-200	-217	-231	-240	-243	-240	-236	-231	-220	-218	-216	-215	-215
110	156	213	278	347	419	454	490	568	611	655	726	799
—	—	—	—	—	—	—	—	-310	-8[illegible]0	-1,230	-1,500	-1,440
-70	-32	+21	+89	+166	+253	+298	+344	-135	-373	-680	-866	M_A = (CHECK) -721
+14	←										→	+14
+16	←										→	+16
-2	←										→	-2
-6	←					→	-6	+993	←		→	+993
+10	+10	+7	+4	0	-4	-6	-7	-4	-2	-1	0	0
+5	+5	+5	+6	+6	+6	+6	+5	-959	-986	-991	-993	-993
+15	+15	+12	+10	+6	+2	0	-2	-963	-990	-992	-993	CHECK -993 = M_A
+12	+13	+14	+15	+16	+15	+15	+14	+15	+16	+16	+16	+16
-4	-4	-3	-2	0	+2	+2	+3	+2	+1	0	0	0
+8	+9	+11	+13	+16	+17	+17	+17	+17	+17	+16	+16	+16 = V_A CHECK

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT: C-105	FRAME 697	REPORT NO. 7/0558/4	SHEET NO. 1-53
		PREPARED BY: G. MEYERS	DATE: MAY 1956
		CHECKED BY:	DATE:

UNIT ANALYSIS FOR $M_3 = 1000''^{\#}$



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

$$\overrightarrow{\Sigma H} = 0: \quad X + q(x_s) - H_A = 0$$

$$x_s = 7.17''$$

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

$$\uparrow \Sigma V = 0: \quad -52.20\,q - V_A = 0$$

$$V_A = -52.20\,q \qquad \& \quad Y = 7.40\,q$$

$$\overset{\curvearrowleft}{\Sigma M_A} = 0: \quad Y x + 2Aq + M_A = 1000 + 46.77\,X$$

$$56.93(7.4\,q) + 2495.56\,q + M_A = 1{,}000 + 46.77(H_A - 7.17\,q)$$

$$421.28\,q + 2495.56\,q + M_A = 1{,}000 + 46.77\,H_A - 335.34\,q$$

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

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

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

$$X = 1.0 H_A + 2.205 \times 10^{-3} M_A - .10311\,H_A - 2.2048$$

$$X = 2.205 \times 10^{-3} M_A + .89689\,H_A - 2.2048$$

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT No. 7/0558/4	
		SHEET No. 1-54	
		PREPARED BY	DATE
C-105	FRAME 697	G. MEYERS	MAY 1956
		CHECKED BY	DATE

UNIT ANALYSIS FOR $M_3 = 1000''^{\#}$ ↻ (CONT'D)

$Y = 7.40\,q = 7.40(-302.486\times10^{-6}M_A + 14.381\times10^{-3}H_A + .3075)$

$Y = -2.275\times10^{-3}M_A + 106.419\times10^{-3}H_A + 2.2755$

$V_A = -52.20\,q = -52.2(-307.486\times10^{-6}M_A + 14.381\times10^{-3}H_A + .3075)$

$V_A = 16.051\times10^{-3}M_A - .75069\,H_A - 16.052$

FORM 1318A

SIGN CONVENTION: ↑ +EL; +M; → +S; OUTER CAP α; INNER CAP ↩

ANALYSIS OF HEAVY FRAME

UNIT ANALYSIS FOR LOAD M_3 = 1000"# ↻ (CONTD)

CALCULATION OF REDUNDANTS H_A & M_A

(REF DWG 7-1058-1051/3)

AVRO — AVR… TECHNICA…

AIRCRAFT -
WEIGHT -
C. G. POSITION

	SECTION →	1	2	3	4	5	6	7	8	9	10	11	…
18													
19	COEFFICIENTS OF CONSTANT: DUE TO Y = +2.2755 (−α)	$\overline{1.09}$	$\overline{.75}$	$\overline{.34}$	$\overline{1.21}$	$\overline{4.48}$	$\overline{9.78}$	$\overline{18.95}$	$\overline{27.56}$	$\overline{37.86}$	$\overline{48.74}$	$\overline{60.00}$	
20	DUE TO X = −2.2043 ψ	$\overline{18.56}$	$\overline{32.30}$	$\overline{46.23}$	$\overline{59.68}$	$\overline{72.60}$	$\overline{84.75}$	$\overline{95.84}$	$\overline{103.78}$	$\overline{110.50}$	$\overline{114.80}$	$\overline{116.37}$	1…
21	DUE TO q = .3015 (−2A)	$\overline{2.58}$	$\overline{5.58}$	$\overline{8.53}$	$\overline{15.79}$	$\overline{32.28}$	$\overline{57.92}$	$\overline{105.77}$	$\overline{149.51}$	$\overline{204.84}$	$\overline{266.88}$	$\overline{333.25}$	4…
22	DUE TO V_A −16.052 (0)	—	—	—	—	—	—	—	—	—	—	—	—
23	DUE TO M_3 +1000*	—	—	—	—	—	—	—	—	—	—	—	—
24	MOM. DUE TO CONSTANTS Σ (19) (20) (21) (22) (23)	$\overline{22.23}$	$\overline{38.63}$	$\overline{55.5}$	$\overline{76.68}$	$\overline{107.36}$	$\overline{152.45}$	$\overline{220.56}$	280.35	$\overline{353.16}$	$\overline{430.42}$	$\overline{509.62}$	5…
25													
26	∂U/∂M_A												
27	$K(\frac{\partial M}{\partial M_A})(\frac{\Delta S}{I})$ = (24) × 12 P.	$\overline{3.78}$	$\overline{6.88}$	$\overline{11.63}$	$\overline{20.07}$	$\overline{36.42}$	$\overline{77.56}$	$\overline{205.59}$	$\overline{276.85}$	$\overline{435.77}$	$\overline{614.31}$	$\overline{746.64}$	1,…
28													
29	∂U/∂H_A: $K(\frac{\partial M}{\partial H_A})(\frac{\Delta S}{I})$ (24) × (18)	$\overline{1,252}$	$\overline{2,287}$	$\overline{3,878}$	$\overline{6,146}$	$\overline{9,263}$	$\overline{15,928}$	$\overline{30,903}$	$\overline{33,453}$	$\overline{41,465}$	$\overline{45,588}$	$\overline{42,411}$	4…

(30) Σ LINE (25) = 6.754
(31) Σ LINE (26) = 327.64 } REF P. 1-45
(32) Σ LINE (27) = $\overline{3882.63}$
(33) Σ LINE (28) = 31,410.3
(34) Σ LINE (29) = $\overline{297,298}$

EQ 1: 0 = 6.754 M_A + 327.64 H_A − 3,882.63

EQ 2: 0 = 327.64 M_A + 31,470.3 H_A − 297,298

EQ 1 = −1 × $\frac{327.64}{6.754}$ (−48.5105): 0 = −327.64 M_A − 15,894.0 H_A + 188,348

0 = 0 + 15,576.3 H_A − 108,950

H_A = + 6.995#

* AT APPLICABLE SECTIONS

FORM 1543

E
(CONT'D)
H_A & M_A

AVRO AIRCRAFT LIMITED
TECHNICAL DEPT. (AIRFRAME)

REPORT NO.	7/0558/4
SHEET	1-55
DATE	MAY 1956
AIRCRAFT	C-105
WEIGHT	
C. G. POSITION	
PREPARED BY	G. MEYERS

	7	8	9	10	11	12	13	14	15	16	17	18	19
.78	−18.95	−27.56	−37.82	−48.74	−60.00	−71.25	−76.46	−81.83	−93.34	−100.03	−106.79	−117.87	−129.54
.75	−95.84	−103.78	−110.50	−114.80	−116.37	−115.02	−113.02	−110.73	−105.65	−104.44	−103.63	−103.03	−103.12
92	−105.77	−149.51	−204.84	−266.88	−333.25	−402.56	−436.23	−471.02	−545.78	−587.42	−629.47	−697.66	−767.38
—	—	—	—	—	—	—	—	—	—	—	—	—	—
—	—	—	—	—	—	—	—	—	1000	1000	1000	1000	1000
45	−220.56	280.35	353.16	−430.42	−509.62	−588.83	−625.71	−663.58	+255.23	+208.11	+160.11	+81.44	0
6	−205.59	−276.85	−435.77	614.31	746.64	−1,033.87	−438.87	−443.84	+281.69	+91.79	+55.80	+40.17	0
28	−30,903	−33,453	41,465	45,588	−42,411	−43,251	−15,429	−12,834	+4,951	+1,161	+513	+165	0

$6.754 M_A + 327.64 H_A - 3,882.63$

$327.64 M_A + 31,470.3 H_A - 297,298$

$-327.64 M_A - 15,894.0 H_A + 188,348$

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

$H_A = +6.995$ #

SUBSTITUTING IN EQ. 1:

$0 = 6.754 M_A + 327.64(6.995) - 3,882.63$

$M_A = \frac{3,882.63 - 2,291.84}{6.754} = +235.53$ "# ↻

SUB IN EQ. 2:

$327.64(235.53) + 31,470.3(6.995) \overset{?}{=} 297,298$

$297,304 = $ " (CHECK)

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

		REPORT No. 7/0558/4	
		SHEET No. 1-56	
AIRCRAFT:		PREPARED BY	DATE
C-105	FRAME 697	G. MEYERS	MAY 1956
		CHECKED BY	DATE

UNIT ANALYSIS FOR MOMENT $M_3 = 1000''\#$

FROM PREVIOUS PAGE: $H_A = {}^{+}6.995\#$ ←
$M_A = {}^{+}235.53''\#$

$q = -.000307486\ M_A + .014381\ H_A + .3075$
$= -.0724 + .1006 + .3075 = +.3357\ \#/''$ ↓

$Y = -.002275\ M_A + .106419\ H_A + 2.2755$
$= -.5358 + .7444 + 2.2755 = +2.4841\#$ ↓

$V_A = -52.20\ q = -17.5235\#$ ↑

$X = .002205\ M_A + .89689\ H_A - 2.2048$
$= .5193 + 6.2737 - 2.2048 = +4.5882\#$ →

CHECK:

$M_A = -.3357 \times 2{,}495.56 + 1{,}000 - 2.4841 \times 56.93 + 4.5882 \times 46.77$
$= +235.41\#$ (CHECK)

$\uparrow \Sigma F_V \overset{?}{=} 0 = -.3357 \times 44.80 - 2.4841 + 17.5235 = 0$ (CHECK)

$\Sigma \vec{F}_H \overset{?}{=} 0 = +.3357 \times 7.17 - 6.995 + 4.5882 = 0$ (CHECK)

FORM 1319A

ANALYSIS OF HEAVY FRAME

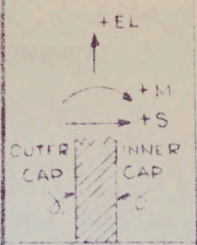
CALCULATION OF INTERNAL BENDING MOMENTS, SHEARS & END LOADS DUE TO $M_3 = 1000$ "# ↻

(FOR EQUATIONS SEE 1/0558.26 P1-7)

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

AVRO — TECHN…

AIRCRAFT · WEIGHT · C G POSITION



	SECTION →	1	2	3	4	5	6	7	8	9	10	11
1	−Y(x) = −2.4841 ① P.	−1.19	−.32	−.27	−1.32	−4.89	−10.68	−20.69	−30.08	−41.29	−53.21	−65.51
2	+X(y) = +4.5882 ② P	38.62	67.22	96.21	124.20	151.09	176.37	199.45	215.97	229.96	238.91	242.17
3	−2Az = −.3357 ⑤ P	−2.82	−2.09	−7.36	−17.24	−35.24	−63.23	−115.47	−163.22	−223.63	−291.35	−363.81
4												
5	+M_3* +1000											
6	INTERNAL B.M. = Σ ①②③④⑤	34.62	66.31	86.48	105.64	110.96	102.46	63.29	22.67	−34.96	−105.65	−187.15
7	SIN θ	SEE ⑦ P										
8	COS θ	SEE ⑧ P										
9	$q(y_s)$ −.3357 ⑩ P.	−3	−5	−7	−9	−11	−13	−15	◁			
10	$P_Y = Y + q(y_s)$ = −2 + ⑨	−5	−7	−9	−11	−13	−15	−17	◁			
11	$-(-q(x_s))$ +.3357 ⑨ P	0	0	0	0	0	+1	+2	◁			
12	$P_x = X - q(x_s)$ = 5 + ⑪	+5	+5	+5	+5	+5	+6	+7	◁			
13	P_Y COS θ = ⑩ × ⑧	−5	−7	−9	−11	−12	−13	−11	−10	−8	−5	0
14	$-P_x$ SIN θ = −⑫ × ⑦	0	0	0	−1	−2	−3	−5	−6	−6	−7	−7
15	END LOAD = ⑬ + ⑭	−5	−7	−9	−12	−14	−16	−16	−16	−14	−12	−7
16	P_Y SIN θ = ⑩ × ⑦	0	0	0	−2	−4	−7	−13	−13	−15	−16	−17
17	P_x COS θ = ⑫ × ⑧	+5	+5	+5	+5	+5	+5	+5	+4	+3	+2	0
18	SHEAR ⑯ + ⑰	+5	+5	+5	+3	+1	−2	−8	−9	−12	−14	−17

*AT APPLICABLE SECTIONS

FORM 1543

…MENTS, SHEARS &

7-1058-105/3

AVRO AIRCRAFT LIMITED
TECHNICAL DEPT (AIRFRAME)

AIRCRAFT	C-105
WEIGHT	
C G POSITION	
REPORT NO	7/0558/4
SHEET	1-57
DATE	MAY 1956
PREPARED BY	G. MEYERS

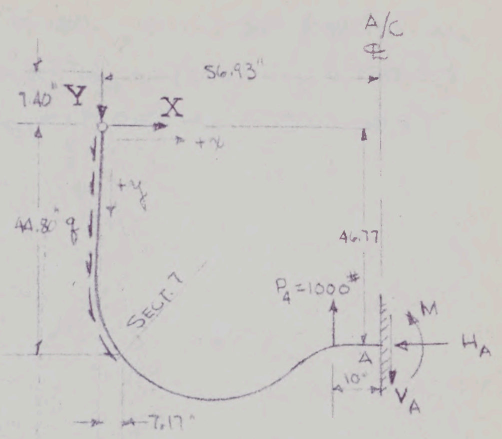
7	8	9	10	11	12	13	14	15	16	17	18	19
−20.69	−30.08	−41.29	−53.21	−65.51	−77.78	−83.47	−89.53	−101.90	−109.20	−116.58	−128.68	−141.42
199.45	215.97	229.96	238.91	242.17	229.37	235.19	230.42	219.87	217.34	215.65	214.41	+214.59
−115.47	−163.22	−223.63	−291.35	−363.81	−439.47	−476.24	−514.22	−595.83	−641.29	−687.20	−761.64	−837.76
								0 / 1000	1000	1000	1000	+1000
63.29	22.67	−34.96	−105.65	−187.15	−277.88	−324.52	−373.13	−477.86 / +522.14	+466.85	+411.87	+324.49	M_A = & CHECK +235.41
−15												−15
−17												−17
+2												+2
+7												+7
−11	−10	−8	−5	0	+4	+6	+8	+4	+2	+1	0	
−5	−6	−6	−7	−7	−7	−7	−6	−7	−7	−7	−7	−7
−16	−16	−14	−12	−7	−3	−1	+2	−3	−5	−6	−7	CHECK −7 = H
−13	−13	−15	−16	−17	−16	−16	−15	−16	−17	−17	−17	−17
+5	+4	+3	+2	0	−2	−3	−3	−2	−1	0	0	0
−8	−9	−12	−14	−17	−18	−19	−18	−18	−18	−17	−17	CHECK −17 = V

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT: C-105	FRAME 697	REPORT No 7/0558/4	SHEET No 1-58
		PREPARED BY: G. MEYERS	DATE: MAY 1956
		CHECKED BY:	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 7-1058-39461)



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

$$\overrightarrow{\Sigma H} = 0: \quad X + q(x_3) - H_A = 0$$

$$x_3 = 7.17''$$

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

$$\uparrow \Sigma V = 0: -52.20q + 1000 - V_A = 0$$

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

$$\Sigma M_A = 0: \quad Yx + 2Aq + M_A = 10{,}000 + 46.77X$$

$$56.93(7.4q) + 2495.56q + M_A = 10{,}000 + 46.77(H_A - 7.17q)$$

$$421.28q + 2495.56q + M_A = 10{,}000 + 46.77H_A - 335.34q$$

$$3{,}252.18q = 10{,}000 - M_A + 46.77H_A$$

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

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

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

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

UNIT ANALYSIS FOR $P_4 = 1000^{\#}$ (CONT'D)

$$Y = 7.40\,\xi = 7.40(-307.456\times10^{-6}M_A + 14.381\times10^{-3}H_A + 3.075)$$

$$Y = -2.275\times10^{-3}M_A + 106.419\times10^{-3}H_A + 22.755$$

$$V_A = 1000 - 52.20\,\xi = 1000 - 52.2(-307.456\times10^{-6}M_A + 14.381\times10^{-3}H_A + 3.075)$$

$$V_A = 1000 + 16.051\times10^{-3}M_A - .75069\,H_A - 160.515$$

$$V_A = 16.051\times10^{-3}M_A - .75069\,H_A + 839.485$$

SIGN CONVENTION: +EL, +M, +S, OUTER CAP σ, INNER CAP +σ

ANALYSIS OF HEAVY FRAME 697
UNIT ANALYSIS FOR LOAD P_4 = 1000# ↑ (CONT'D)
CALCULATION OF REDUNDANTS H_A & M_A

(REF DWG 7-1058-1051① / -1053②)

AVRO — TECH… — AIRCRAFT — WEIGHT — C G POSITION

	SECTION →	1	2	3	4	5	6	7	8	9	10	11
(18)	x'	—	—	—	—	—	—	—	—	—	—	—
(19)	COEFFICIENTS OF CONSTANT: DUE TO Y = 22.755 (−x)	10.9	7.5	3.4	12.1	44.8	97.3	184.5	275.6	378.2	487.4	600.[illegible]
(20)	DUE TO X = −22.048 y	185.6	323.0	462.3	596.8	726.0	847.5	958.4	1,037.8	1,105.2	1,148.0	1,163.[illegible]
(21)	DUE TO q = 3.075 (−2A)	25.8	55.8	85.8	157.9	322.8	579.2	1,057.7	1,495.1	2,048.4	2,668.8	3,332.[illegible]
(22)	DUE TO V_A 837.485 (0)	—	—	—	—	—	—	—	—	—	—	—
(23)	DUE TO P_{4A} 1000 x'	—	—	—	—	—	—	—	—	—	—	—
(24)	MOM. DUE TO CONSTANTS Σ (19) (20) (21) (22) (23)	222.3	386.3	551.5	766.8	1,09[illegible].6	1,524.5	2,205.6	2,808.5	3,531.6	4,304	50[illegible]
(25)	$\partial U/\partial M_A$											
(26)												
(27)	$K\left(\frac{\partial M}{\partial M_A}\right)\left(\frac{\Delta S}{I}\right)$ = (24) × (12)	37.8	63.8	116.3	200.7	364.2	775.6	2,055.9	2,768.5	4,322.4	6,143.1	7,46[illegible]
(28)	$\partial U/\partial H_A$											
(29)	$K\left(\frac{\partial M}{\partial H_A}\right)\left(\frac{\Delta S}{I}\right)$ (24) × (18)P.	12,527	22,872	38,785	61,459	92,625	151,[illegible]3	309,029	334,[illegible]3	414,647	455,875	424,10[illegible]

(30) Σ LINE (25) = 6.754

(31) Σ LINE (26) = 327.64

(32) Σ LINE (27) = $\overline{60,254.8}$

(33) Σ LINE (28) = 31,470.3

(34) Σ LINE (29) = $\overline{3,265,172}$

(Lines 30–33: REF P. 1-45)

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' = $-1 \times \frac{327.64}{6.754}$: $0 = -327.64\,M_A - 15,894.0\,H_A + 2,922,99$[illegible]

$0 = 0 + 15,576.3\,H_A - 342,18$[illegible]

$H_A = +21.968$ #

FORM 1543

...597

...1 (CONTD)

H_A & M_A

AVRO AIRCRAFT LIMITED

TECHNICAL DEPT AIRFRAME

AIRCRAFT	C-105
WEIGHT	
C G POSITION	
REPORT NO	7/0558/1
SHEET	-60
DATE	MAY 1956
PREPARED BY	G. MEYERS

	7	8	9	10	11	12	13	14	15	16	17	18	19
	—	—	—	—	—	—	—	—	—	—	—	4.87"	10.00"
0	$\overline{184.5}$	$\overline{275.6}$	$\overline{378.2}$	$\overline{487.4}$	$\overline{600.0}$	$\overline{712.5}$	$\overline{764.6}$	$\overline{818.3}$	$\overline{933.4}$	$\overline{1000.3}$	$\overline{1,067.9}$	$\overline{1,178.7}$	$\overline{1,295.4}$
	$\overline{958.4}$	$\overline{1,027.8}$	$\overline{1,105.7}$	$\overline{1,148.0}$	$\overline{1,163.7}$	$\overline{1,150.2}$	$\overline{1,130.2}$	$\overline{1,107.3}$	$\overline{1,056.5}$	$\overline{1,044.4}$	$\overline{1,036.3}$	$\overline{1,030.3}$	$\overline{1,031.8}$
	$\overline{1,057.7}$	$\overline{1,495.1}$	$\overline{2,048.4}$	$\overline{2,668.8}$	$\overline{3,332.5}$	$\overline{4,025.6}$	$\overline{4,362.3}$	$\overline{4,710.2}$	$\overline{5,457.8}$	$\overline{5,874.2}$	$\overline{6,294.7}$	$\overline{6,976.6}$	$\overline{7,673.8}$
	—	—	—	—	—	—	—	—	—	—	—	—	—
	—	—	—	—	—	—	—	—	—	—	—	4,870	10,000
5	$\overline{2,205.6}$	$\overline{2,808.5}$	$\overline{3,531.6}$	$\overline{4,304.2}$	$\overline{5,0[illegible].2}$	$\overline{5,888.3}$	$\overline{6,257.1}$	$\overline{6,635.3}$	$\overline{7,447.7}$	$\overline{7,918.9}$	$\overline{8,3[illegible].1}$	$\overline{4,315.6}$	$\overline{1.0}$
6	$\overline{2,055.9}$	$\overline{2,768.5}$	$\overline{4,322.4}$	$\overline{6,143.1}$	$\overline{7,466.4}$	$\overline{0,338.7}$	$\overline{4,388.7}$	$\overline{4,438.4}$	$\overline{8,220.0}$	$\overline{3,492.7}$	$\overline{2927.4}$	$\overline{2,128.7}$	$\overline{.5}$
3	$\overline{309,029}$	$\overline{334,333}$	$\overline{414,647}$	$\overline{455,375}$	$\overline{424,109}$	$\overline{432,514}$	$\overline{154,294}$	$\overline{128,336}$	$\overline{144,470}$	$\overline{44,163}$	$\overline{26,911}$	$\overline{8,140}$	0

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

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

$$0 = -327.64 M_A - 15,894.0 H_A + 2,922,990$$

$$0 = 0 + 15,576.3 H_A - 342,182$$

$$H_A = +21.968^{\#}$$

SUBSTITUTING IN EQ 1:

$$0 = 6.754 M_A + 327.64(21.968) - 60,254.8$$

$$M_A = \frac{+60,254.8 - 7,197.6}{6.754} = +7,855.7''^{\#}$$

SUBSTITUTING IN EQ 2:

$$327.64(7,855.7) + 31,470.3(21.968) \overset{?}{=} 3,265,172$$

+2,57[illegible] + 6[illegible]339

3,265,180 = 3,265,172

(CHECK)

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT No. 7/0558/4	
		SHEET No. 1-61	
		PREPARED BY	DATE
C-105	FRAME 697	G. MEYERS	MAY 1956
		CHECKED BY	DATE

UNIT ANALYSIS FOR LOAD $P_4 = 1000^{\#}\uparrow$

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

$M_A = +7,855.7''^{\#}$

$q = -.000307486\,M_A + .014381\,H_A + 3.075$

$= -2.416 + .316 + 3.075 = +.975^{\#/''} \downarrow$

$Y = 7.40\,q = 7.40 \times .975 = +7.215^{\#} \downarrow$

$V_A = 1000 - 52.20\,q = +949.105^{\#} \downarrow$

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

CHECK :

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

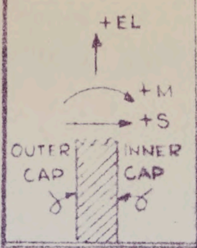
$-2433 + 10,000 - 410.75 + 700.4 = 7,856.6''^{\#}$ (CHECK)

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

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

FORM 1319 A

SIGN CONVENTION



ANALYSIS OF HEAVY FRAME 697

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

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

(FOR FRAME CONSTANTS SEE P. 1-27) (REF DWG ~~7-053~~ 7-1058-1051/3)

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	$+X(y) = +14.977$ ② P.	126	219	314	405	493	576	651	705	751	780	790
3	$-\Sigma Az = -.975$ ⑤ P.	-8	-13	-27	-50	-102	-184	-335	-474	-649	-846	-1,057
4												
5	$+P_4 x'$ $+1000 x'$	—	—	—	—	—	—	—	—	—	—	—
6	INTERNAL B.M. = Σ ①②③④⑤	115	209	286	351	377	361	256	144	-18	-221	-457
7	SIN θ	SEE ⑦ P. 1-27										
8	COS θ	SEE ⑧ P. 1-27										
9	$q(y_s)$ $-.975$ ⑩ P	-8	-14	-20	-27	-33	-38	-44				
10	$P_Y = Y + q(y_s) + P_1$ $= -1 + ⑨ + 1000^*$	-15	-21	-27	-34	-40	-45	-51				
11	$+q(x_s)$ $+ .975$ 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 × ⑧	-15	-21	-27	-34	-38	-39	-33	-31	-24	-14	0
14	$-P_X \sin\theta$ = − ⑫ × 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 × ⑦	0	+1	-1	-5	-12	-22	-38	-46	-45	-49	-51
17	$P_X \cos\theta$ = ⑬ × 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

FORM 1543

697

...OMENTS, SHEARS &

...T &

...F DWG ~~7-1053~~ 7-1058-1051/3

AVRO AIRCRAFT LIMITED

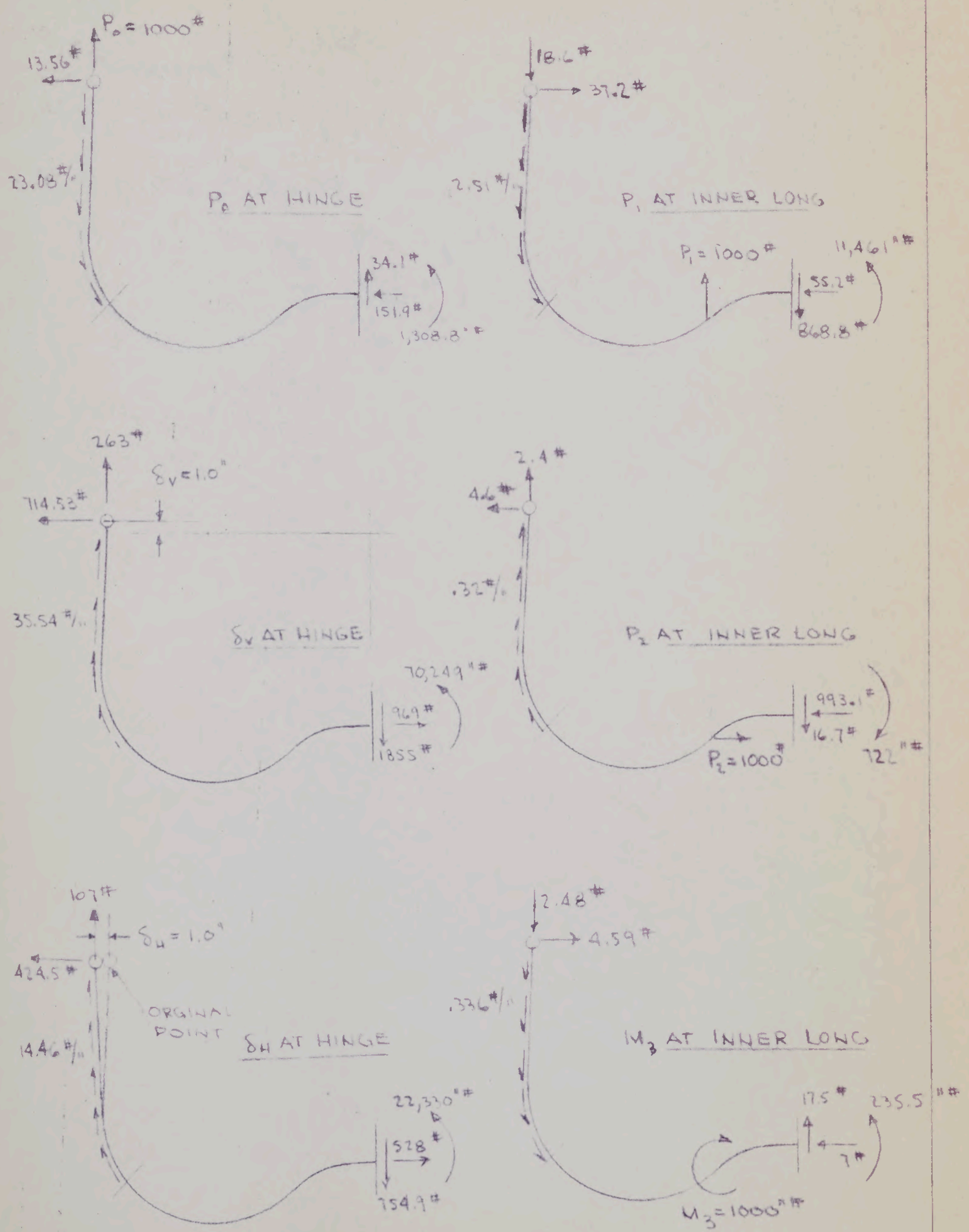
TECHNICAL DEPT. (AIRFRAME)

AIRCRAFT	C-105
WEIGHT	
C. G. POSITION	
REPORT NO.	7/0558/4
SHEET	1-62
DATE	MAY 1956
PREPARED BY	G. MEYERS

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	790	781	768	752	718	709	704	700	700
-335	-474	-649	-846	-1,057	-1,276	-1,383	-1,493	-1,731	-1,863	-1,996	-2,212	-2,433
—	—	—	—	—	—	—	—	—	—	—	4,870	10,000
256	144	-18	-221	-457	-721	-857	-1000	-1,309	-1,471	-1,631	+2984	MA = & 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

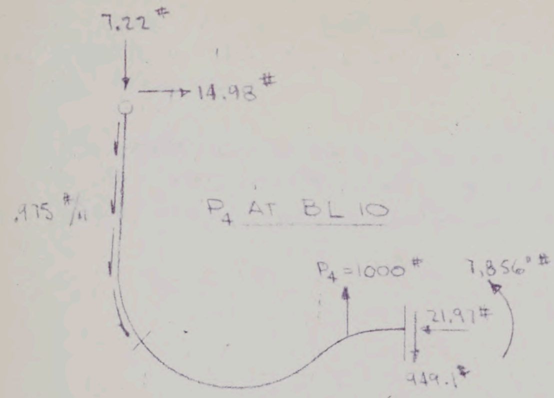
AVRO AIRCRAFT LIMITED MALTON — ONTARIO TECHNICAL DEPARTMENT		REPORT NO. 7-0558-4 SHEET NO. 1-63	
AIRCRAFT: C-105	FRAME 697	PREPARED BY G. MEYERS	DATE AUG '56
		CHECKED BY	DATE

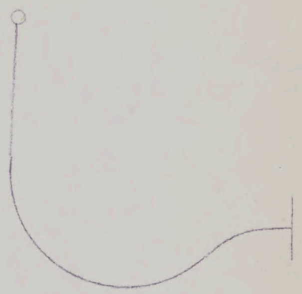
SUMMARY – UNIT SOLUTIONS



AIRCRAFT:		REPORT No. 7-0558-4 / SHEET No. 1-64	
C-105	FRAME 697	PREPARED BY	DATE
		G. MEYERS	AUG '56
		CHECKED BY	DATE

SUMMARY ~ UNIT SOLUTIONS (CONT'D)





AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

REPORT No. 7/0558/4			
SHEET No. 1-65			
AIRCRAFT: C-105	FRAME 697	PREPARED BY: G. MEYERS	DATE: MAY 1956
		CHECKED BY:	DATE:

CASE 11.3b - 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

$\delta_V = 1.74''$ ↑
$\delta_H = .30''$ ← (OUTB'D)
} REF RPT 7/0558/21

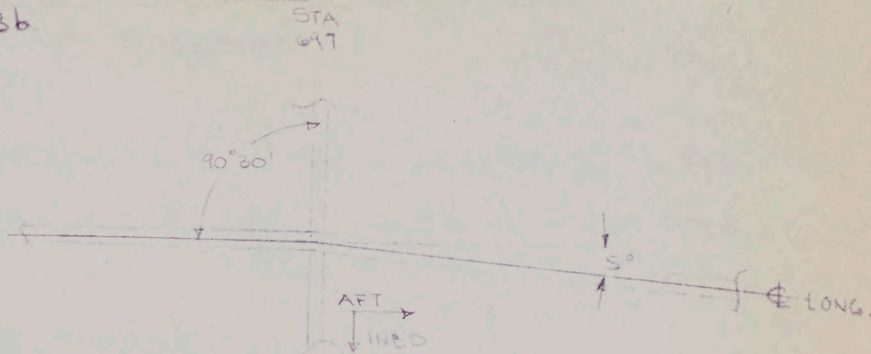
FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT No. 7/0558/4	
C-105	FRAME 697	SHEET No. 1-66	
		PREPARED BY	DATE
		G. MEYERS	AUG 56
		CHECKED BY	DATE

INNER LONG. KINK LOAD ~ P_2

CASE 11.36



PLAN VIEW LKG UP

L H SIDE ~ INBD LONG.

DIMS. SCALED FROM PRINT

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"

$\overrightarrow{\Sigma F_H} = 0 = 10{,}814 + P_1 \cos 5°$

$P_1 = -10{,}814 / .99619 = \underline{-10{,}870\#}$

94.4 .00873 852.9 .07846

$\uparrow \Sigma F_V = -P'' + 10{,}814 \sin 0°30' + 10{,}870 \sin 4°30'$

$P'' = 94.4 + 852.9 = \underline{947.3\#}$ ULT ACTING INBD. TO KEEP JOINT IN EQUILIBRIUM BUT OPPOSITE APPLIED (ACTING OUTBD) LOAD

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT: C-105	FRAME 697	REPORT No. 7-0558/4	SHEET No. 1-67
		PREPARED BY: G. MEYERS	DATE: SEPT 56
		CHECKED BY:	DATE:

INB'D LONGERON LOADS APPLIED TO FR 697

REF 1. REPORT 7/0558/81

CASE 11.3 b

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

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

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

(2337) (130)

SIGN CONV.
+M PRODUCES TEN IN SKIN SIDE

CALCULATE REACTION

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

(106)

R_{697} ACTS 30° FROM VERTICAL PLANE

RESOLVING INTO HORIZ & VERT. COMP:

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

$$P_1 = -R_{697} \cos 30° = 834 \times .866 = 722^{\#} (\downarrow)$$

ABOVE LOADS H' & P_1 ARE APPLIED TO FRAME

$$P_2 = H' + P'' = 417 + 947.3 = 1364^{\#} (\leftarrow)$$

(ACTING OUTB'D)

417: DUE TO BEAM REACTION

947.3: DUE TO LONG KINK LOAD P. __

OBSOLETE - SEE NEXT PAGE

ORM 1319A

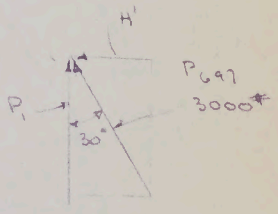
AVRO AIRCRAFT LIMITED
MALTON ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT		REPORT No 7-0558/4
C-105	FRAME 697	SHEET No 1-68
		PREPARED BY: G. MEYERS — DATE:
		CHECKED BY: — DATE:

INB'D LONG LOADS APPLIED TO FR 697 (CONT'D) CASE 11.3b

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 FIXETY HAS NOT BEEN ACCOMPLISHED AT THIS TIME, WE WILL ASSUME THAT REACTION, R_{697}, OF REF REPORT IS 3000# ULT.

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



RESOLVING INTO H & V COMPONENTS

3000 × .50

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

3000 × .866

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

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

H' (ABOVE) — DUE TO LONG KINK LOAD P

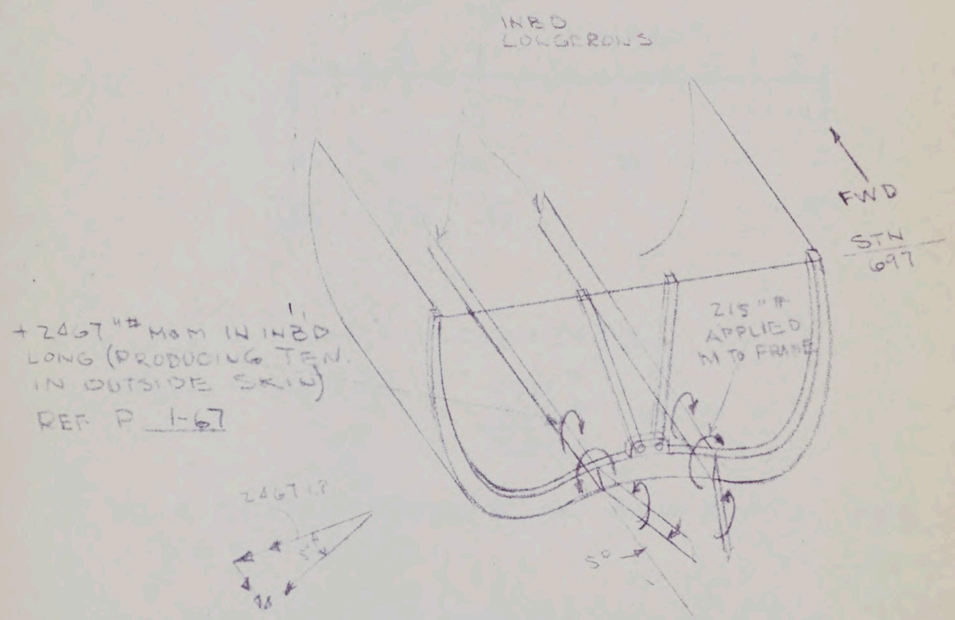
FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT No. 7/0558/4	
C-105	FRAME 697	SHEET No. 1-69	
		PREPARED BY	DATE
		G. MEYERS	AUG 1956
		CHECKED BY	DATE

M_3 ~ INDUCED MOM DUE TO LONG. KINK

CASE 11.36



$M_3 = M_{FRAME} = 2467 \sin 5° = \underline{\underline{215}}$ IN-LBS

.08716

REF PREV. PAGE

FORM 1319A

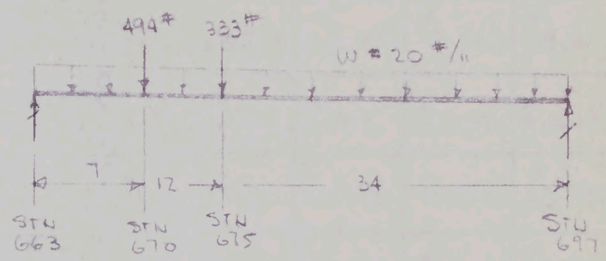
AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT		REPORT NO. 7/0558/4	
C-105	FRAME 697	SHEET NO. 1-70	
		PREPARED BY	DATE
		G. MEYERS	AUG. 1956
		CHECKED BY	DATE

DOOR BEAM BL 10 ~ P_4

COND 11.3.6

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



$\Sigma M_{663} = 0 = 7 \times 494 + 12 \times 333 - 34 R_{697}$

$R_{697} = 103 + 117 = 220^{\#}$

$340^{\#}$ ~ DUE TO w

$560^{\#}$

∴ $P_4 = 560^{\#}$ ULT ACTING ↓ ON FRAME 697 FOR $p = -1.36$ psi.

HOWEVER FOR CRITICAL FRAME STRESSES, USE $p = +1.74$ psi: BY RATIOING $P_4 = 560 \times \frac{+1.74}{-1.36} = -716^{\#}$ ↑

FORM 1319A

ANALYSIS OF HEAVY FRAME 697

CALCULATION OF BENDING MOMENT FOR

CASE 11.36 (10G)

		1	2	3	4	5	6	7	8	9	10
1.	M DUE TO $\delta_V = 1.74''$ ↑ = 1.74 ⑥ 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 $\delta_H = +.30''$ = .30 ⑥ 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# ↑ = 25 ⑥ P. 1-34	+4,300	-7,200	-19,450	-25,575	-22,500	-14,225	-4,975	+6,225	+14,100	+17,0
4.	M DUE TO P_0 = 16,000# ↓ = -16 ⑥ 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# ↑ = 2.600 ⑥ 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#(←) = -2.4473 ⑥ P. 1-52	+86	+147	+213	+264	+274	+262	+171	+78	-51	-21
7.	M DUE TO M_3 = -215"# ↺ = -.215 ⑥ P. 1-55	-7	-13	-19	-30	-24	-22	-14	-5	+8	+7
8.	M DUE TO P_4 = 716# (↑) = +.716 ⑥ P. 1-62	+82	+150	+205	+251	+270	+258	+183	+103	-13	-15
9.											
10.	REF ONLY	-9,854	-17,152	-24,588	-30,702	-34,302	-35,337	[illegible]	-25,444	-16,835	-5,4
11.											
12											
13											
14	Σ①+②+④+⑤+⑥ +⑦ +⑧ = Σ BM	-12,606	-12,544	-12,144	-14,335	-19,902	-26,233	-27,659	-29,4[illegible]	-23,859	-16,
15	Σ①+②+③+⑤+⑥ +⑦ + ⑧ = Σ BM	-5,554	-24,352	-44,038	-56,278	-56,802	-49,562	-35,818	-19,2[illegible]	2,735	+11,

FORM 1543

7

FOR

AVRO AIRCRAFT LIMITED

TECHNICAL DEPT. (AIRFRAME)

AIRCRAFT - - C-105

WEIGHT - -

C. G. POSITION -

REPORT NO. - 7/0558/4

SHEET - - 1-71

DATE - - OCT '56

PREPARED BY - G. MEYERS

	8	9	10	11	12	13	14	15	16	17	18	19
962	-22,912	-13,511	-1,248	+13,466	+30,426	+39,376	+48,744	+68,954	+79,358	+89,636	+105,849	+122,233
76	-3,496	-2,959	-2,178	-1,173	+41	+598	+1,405	+2,915	+3,667	+4,403	+5,556	+6,699
75	+6,225	+14,100	+17,025	+15,975	+9,625	+4,000	-1,950	-14,975	-19,400	-23,950	-30,100	-32,675
184	-3,984	-9,024	-10,896	-10,224	-6,160	-2,560	+1,248	+9,584	+12,416	+15,238	+19,264	+20,912
55	+788	-309	-1,672	-3,250	-5,023	-5,938	-6,890	-5,983	+580	+7,231	+18,182	+29,793
71	+78	-51	-218	-406	-619	-729	-842	-330	-913	-1664	-2,119	-1,765
14	-5	+8	+23	+40	+60	+70	+80	+103 / -112	-100	-89	-70	-51
3	+103	-13	-158	-327	-516	-614	-716	-937	-1053	-1168	+2,137	+5,625
843	-25,444	-16,835	-5,451	+8,350	+24,369	+32,763	+41,781	+64,722 / +64,507	+81,539	+98,344	+129,535	+162,534
,659	-29,478	-25,859	-16,347	-1,874	+18,209	+30,203	+43,029	+74,306 / +74,091	+93,955	+113,587	+148,799	+183,446
,818	-19,211	-2,735	+11,574	+24,325	+33,994	+36,763	+39,831	+49,747 / +49,532	+62,139	+74,399	+109,435	+129,854

ANALYSIS OF HEAVY FRAME 697
CALCULATION OF FRAME END LOADS FOR
CASE 11.3b (106)

AIRC
WEIG
C. G

	SECTION →	1	2	3	4	5	6	7	8	9	10
1.	E.L. DUE TO δ_v = +1.74 = 1.74 (15) P. 1-38	+947	+1,333	+1,805	+2,302	+2,794	+3,212	+3,391	+3,304	+2,988	+2,490
2.	E.L. DUE TO δ_H = +.30 = .30 (15) P. 1-41	+65	+92	+128	+168	+209	+245	+268	+264	+245	+213
3.	E.L. DUE TO P_a = 25000# ↑ = 25 (15) P. 1-34	+20,125	+16,525	+12,950	+9,275	+5,450	+1,375	−3,375	−3,525	−3,750	−3,875
4.	E.L. DUE TO P_b = 16000# ↓ = −16 (15) P. 1-34	−12,880	−10,576	−8,288	−5,936	−3,488	−880	+2,160	+2,256	+2,400	+2,43[illegible]
5.	E.L. DUE TO P_1 = 722# ↑ = .722 (15) P. 1-41	−28	−40	−53	−66	−79	−90	−93	−90	−79	−64
6.	E.L. DUE TO P_2 = 1364# (←) = −1.364 (15) P. 1-52	−7	−10	−12	−16	−19	−22	−20	−20	−16	−1[illegible]
7.	E.L. DUE TO M_3 = −215 "# ↺ = −.215 (15) P. 1-55	+1	+2	+2	+3	+3	+3	+3	+3	+3	+3
8	E.L. DUE TO P_4 = 560# ↓ = −.56 (15) P. 1-62	+8	+12	+16	+20	+24	+27	+28	+27	+25	+2[illegible]
9.											
10.		+986	+1,388	+1,886	+2,41[illegible]	2,883	+3,375	+3,670	+3,488	+3,160	+2,61[illegible]
11.											
12											
13.											
14	Σ ① + ② + ④ + ⑤ + ⑥ + ⑦ + ⑧ = Σ −E.L. MAX	−11,894	−9,187	−6,402	−3,525	−555	+2,495	+5,830	+5,744	+5,566	+5,128
15.	Σ ① + ② + ③ + ⑤ + ⑥ + ⑦ + ⑧ = Σ +E.L. MAX	+21,111	+17,914	+14,836	+11,686	+8,383	+4,750	+295	−37	−584	−1,22[illegible]

FORM 1543

697

ADS FOR

AVRO AIRCRAFT LIMITED

TECHNICAL DEPT. (AIRFRAME)

REPORT NO.	7/0558/4
SHEET	1-72
DATE	MAY 1956
PREPARED BY	G. MEYERS
AIRCRAFT	C-105
WEIGHT	
C. G. POSITION	

7	8	9	10	11	12	13	14	15	16	17	18	19
+3,391	+3,304	+2,988	+2,490	+1,688	+827	+386	+5	+790	+1,282	+1,460	+1,688	+1,688
+268	+264	+245	+213	+156	+97	+65	+36	+95	+130	+143	+159	+159
-3,375	-3,525	-3,750	-3,875	-3,775	-3,425	-3,200	-2,950	-3,425	-3,650	-3,725	-3,775	-3,775
+2,160	+2,256	+2,400	+2,480	+2,416	+2,192	+2,048	+1,888	+2,192	+2,336	+2,384	+2,416	+2,416
-93	-90	-79	-64	-40	-14	-2	+9	-201	-116	-84	-40	-40
-20	-20	-16	-14	-8	-3	0	+3	+1314	+1350	+1353	+1354	+1354
+3	+3	+3	+3	+2	+1	0	0	+1	+1	+1	+2	+2
+28	+27	+25	+20	+12	+4	+1	-2	+4	+9	+10	+12	+12
+3,670	+3,488	+3,160	+2,613	+1,810	+912	+450	+51	+2,003	+2,[illegible]56	+2,583	+3,115	+3,115
+5,830	+5,744	+5,566	+5,128	+4,226	+3,104	+2,498	+1,939	+4,195	+4,992	+5,267	+5,591	+5,591
+295	-37	-384	-1,227	-1,965	-2,513	-2,750	-2,899	-1,422	-994	-842	-600	-600

NOTE! NOT UP-TO-DATE

ANALYSIS OF HEAVY FRAME 697
CALCULATION OF FRAME SHEAR FOR CASE 11.3b (10G)

AIRCR[AFT]
WEIG[HT]
C. G.

	SECTION →	1	2	3	4	5	6	7	8	9	10
1.	V DUE TO $\delta_V = +1.74''$ = 1.74 (18) P. 1-38	-1,232	-1,225	-1,093	-840	-437	+167	+1,329	+1,523	+2,083	+2,659
2.	V DUE TO $\delta_H = +.30''$ = .30 (18) P. 1-41	-127	-126	-128	-99	-69	-38	-67	+83	+128	+176
3.	V DUE TO P_0 = 25,000# ↓ = 25 (18) P. 1-34	-1,250	-1,300	-450	-600	+1,800	+2,450	+1,825	+1,625	+1,000	+50
4.	V DUE TO P_0 = 16,000# ↓ = -16 (18) P. 1-34	+800	+832	+288	+384	-1,152	-1,568	-1,168	-1,040	-640	-32
5.	V DUE TO P_1 = 722# ↓ = .722 (18) P. 1-47	+26	+27	+22	+15	+3	-14	-46	-52	-66	-81
6.	V DUE TO P_2 = 1364# (←) = -1.364 (18) P. 1-52	+7	+7	+7	+4	+1	-3	-11	-12	-15	-18
7.	V DUE TO M_3 = -215"# (↺) = .215 (18) P. 1-55	+1	+1	+1	+1	0	0	+2	+2	+3	+3
8.	V DUE TO P_4 = 560# ↓ = -.56 (18) P. 1-62	-8	-8	-7	-5	-2	+3	+13	+18	+20	+24
9.											
10.											
11.											
12.											
13.											
14.	Σ ①+②+④+⑤+⑥+⑦+⑧ = Σ V_{MAX}	-533	-492	-954	-1308	-1,656	-1,453	+52	+537	+1,51	+273
15.	Σ ①+②+③+⑤+⑥+⑦+⑧ = Σ V_{MAX}	-2,583	-2,624	-1,692	-324	+1,296	+2,565	+3,045	+3,197	+3,15	[illegible]

FORM 1543

E 697

R FOR

AVRO AIRCRAFT LIMITED

TECHNICAL DEPT. (AIRFRAME)

AIRCRAFT	C-105
WEIGHT	
C. G. POSITION	
REPORT NO.	7/0558/4
SHEET	1-73
DATE	MAY 1956
PREPARED BY	G. MEYERS

	7	8	9	10	11	12	13	14	15	16	17	18	19
	+1,329	+1,523	+2,083	+2,659	+3,228	+3,548	+3,623	+3,642	+3,555	+3,409	+3,339	+3,228	+3,228
3	-67	+83	+128	+176	+159	+259	+269	+274	+260	+244	+237	+227	+227
50	+1,825	+1,625	+1,000	+50	-850	-1,775	-2,175	-2,500	-1,800	-1,300	-1,125	-850	-850
8	-1,168	-1,040	-640	-32	+544	+1,136	+1,392	+1,600	+1,152	+520	+720	+544	+544
4	-46	-52	-66	-81	-95	-103	-103	-103	+595	+617	+622	+627	+627
3	-11	-12	-15	+18	-22	-23	-23	-23	-23	-23	-22	-22	-22
0	+2	+2	+3	+3	+4	+4	+4	+4	+4	+4	+4	+4	+4
3	+13	+18	+20	+24	+29	+31	+31	+31	+3	+30	+30	-531	-531
	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	+3,801	+3,825	[illegible]	[illegible]	[illegible]	+3,533	[illegible]
											NOTE!	NOT	
											UP-TO-	DATE	
53	+52	+532	+1,51	+2731	+3,847	+4,852	+5,193	+5,425	+5,574	+4,801	+4,930	+4,077	+4,077
565	+3,045	+3,197	+3,15	+[illegible],813	+2,453	+1,941	+1,626	+1,325	+2,622	+2,981	+3,095	+2,683	+2,683

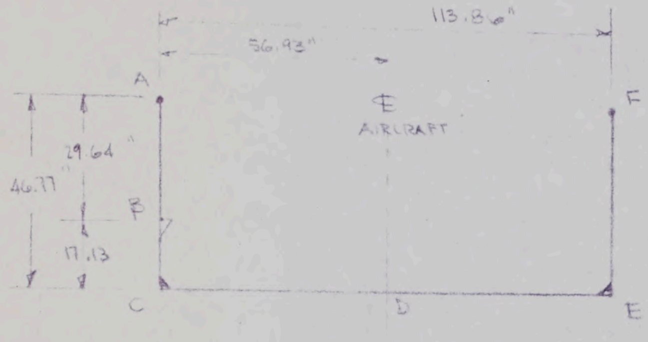
AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

REPORT No. 7/0558/4	SHEET No. 1-74
PREPARED BY: G. MEYERS	DATE: SEPT '56
CHECKED BY:	DATE:

AIRCRAFT: C-105 — FRAME 697

ENG. REMOVAL CASE

SIMPLIFIED FRAME



AVERAGING I's
USING PLOT OF ΣS VS. I — PLANIMETER READING (AREA) / LGTH

$I_{AV_{AC}} = (3.37/3.97) \times 2 = \underline{1.7}\ IN.^4$ (SCALE CORRECTION)

$I_{AV_{CE}} = (9.67/5.38) \times 2 = \underline{3.6}\ IN^4$

CALC. FIXED-END MOMENTS IN MEM AC.

$(FEM)_A = +\frac{Mb}{L}\left(3\frac{a}{L} - 1\right) = \frac{1000 \times 17.13}{46.77}\left(\frac{3 \times 29.64}{46.77} - 1\right) = \underline{329}''^{\#}$

FORMULAE, REF BRUHN

B — $M = 1000''^{\#}$ UNIT MOM.

$(FEM)_C = -\frac{Ma}{L}\left(\frac{3b}{L} - 1\right) = -\frac{1000 \times 29.64}{46.77}\left(\frac{3 \times 17.13}{46.77} - 1\right) = \underline{61.5}''^{\#}$

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

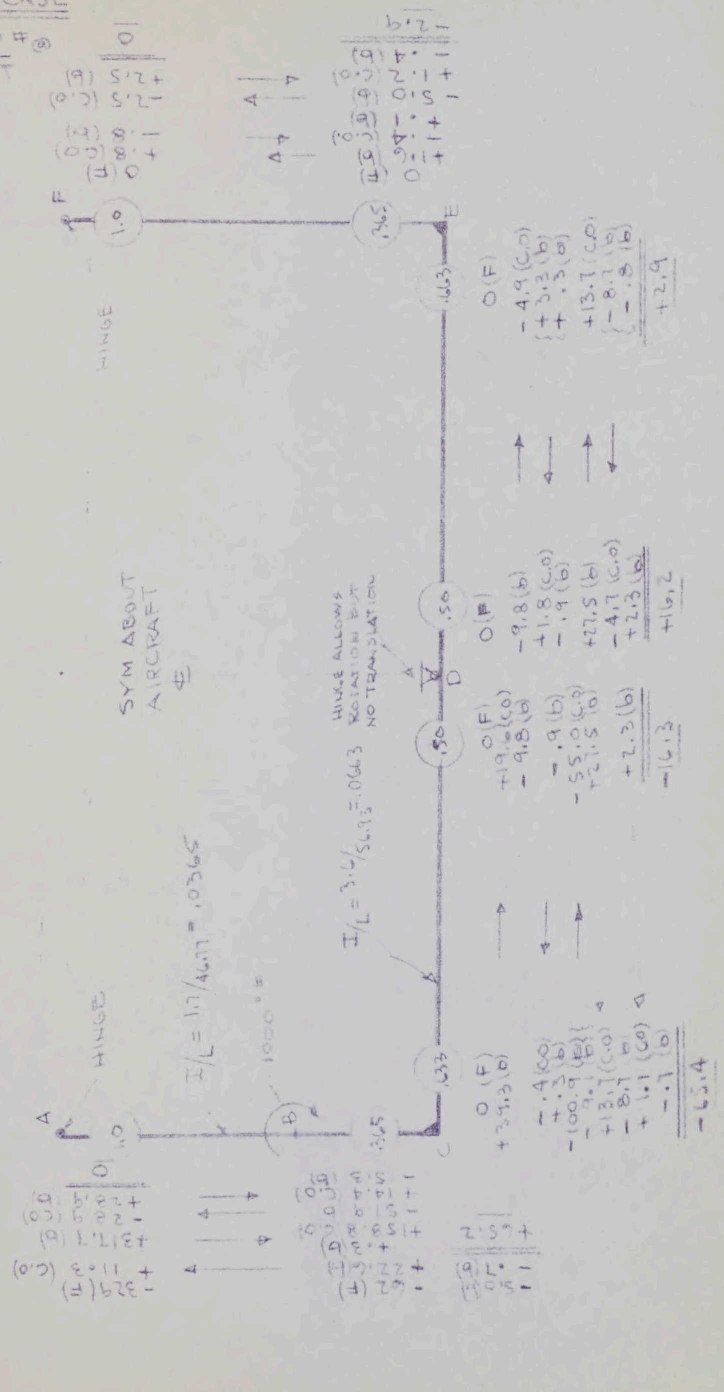
AIRCRAFT:		REPORT NO. 7/0558/4
C-105	FRAME 697	SHEET NO. 1-75

PREPARED BY	DATE
G. MEYERS	SEPT '56
CHECKED BY	DATE

ENG REMOVAL CASE

UNIT SOL. 1000"# @ OUTBD BRACKET

MOMENT DISTRIBUTION
FRAME 697 SIMPLIFIED AS SHOWN



NOTE: NO SIDESWAY PRESENT DUE TO ATTACHMENT TO VEE BRACE AT PT D

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT: C-105	FRAME 697	REPORT No. 7/0558/4 SHEET No. 1-76
		PREPARED BY: G. MEYERS — DATE: SEPT '56
		CHECKED BY: — DATE:

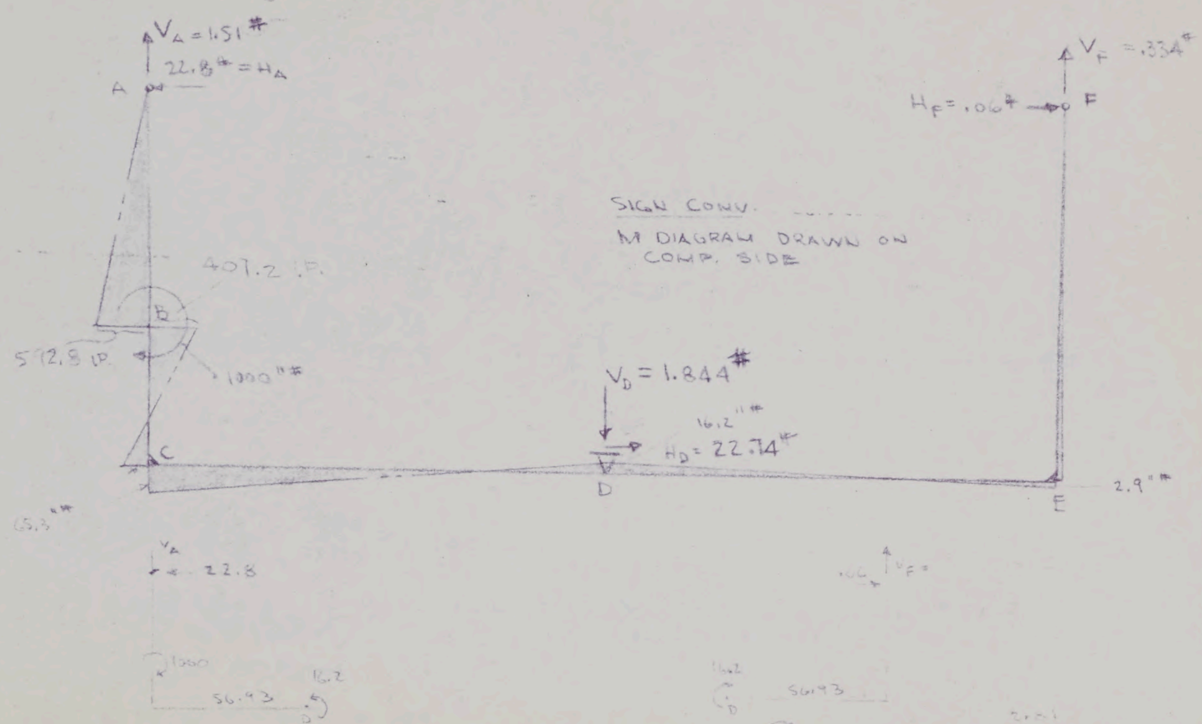
ENGINE REMOVAL CASE (CONT'D)

UNIT SOL. 1000"# @ ~ BM DIAG & SUPPORT REACTIONS

SOLVE FOR H_A

$\Sigma M_C = +65.3 + 1000 - 46.77 H_A = 0$

$H_A = \frac{1065.3}{46.77} = 22.8^{\#}$



$\Sigma M_D = 0 = -16.2 + 1000 - 56.93 \times V_A - 22.8 \times 46.77$

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

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

$V_F = \frac{19.01}{56.93} = .334^{\#}$

CHECK $\Sigma F_V = 0$ & $\Sigma F_H = 0$ BY INSPECTION

$\Sigma M_F = 1.51 \times 113.86 + 1000 - 1.844 \times 56.93 - 22.74 \times 46.77 \cong 0$ (CHECK)

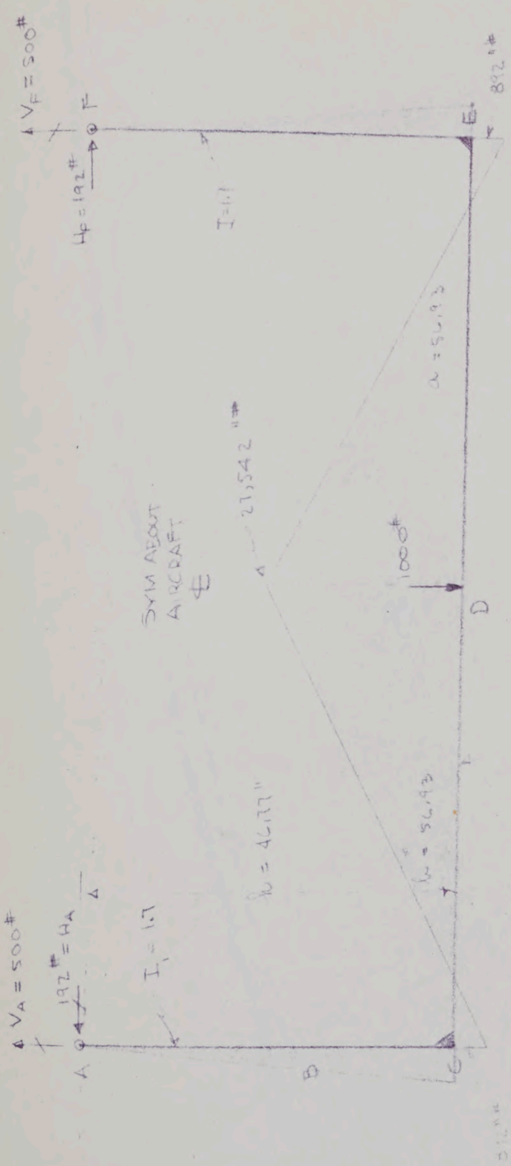
AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

REPORT No. 7/0558/4
SHEET No. 1-77

AIRCRAFT:		PREPARED BY	DATE
C-105	FRAME 697	G. MEYERS	SEPT 56
		CHECKED BY	DATE

ENGINE REMOVAL CASE (CONT'D)

UNIT SOLUTION 1000#↓ @ A/C ℄



$$K = \frac{I_2 h}{I_1 l} = \frac{3.6 \times 46.77}{1.7 \times 2 \times 56.93} = .87$$

$$H_A = \frac{3 Q a b}{2 l h (2K+3)} = \frac{3 \times -1000 \times 56.93^2}{2 \times 2 \times 56.93 \times 46.77 (2 \times .87 + 3)} = -192^{\#} (\leftarrow)$$

$$H_B = 192^{\#} (\rightarrow)$$

$$M_E \,\&\, M_C = 192 \times 46.77 = 898''^{\#}$$

$$M_D = -898 + 500 \times 56.93 = 27,542$$

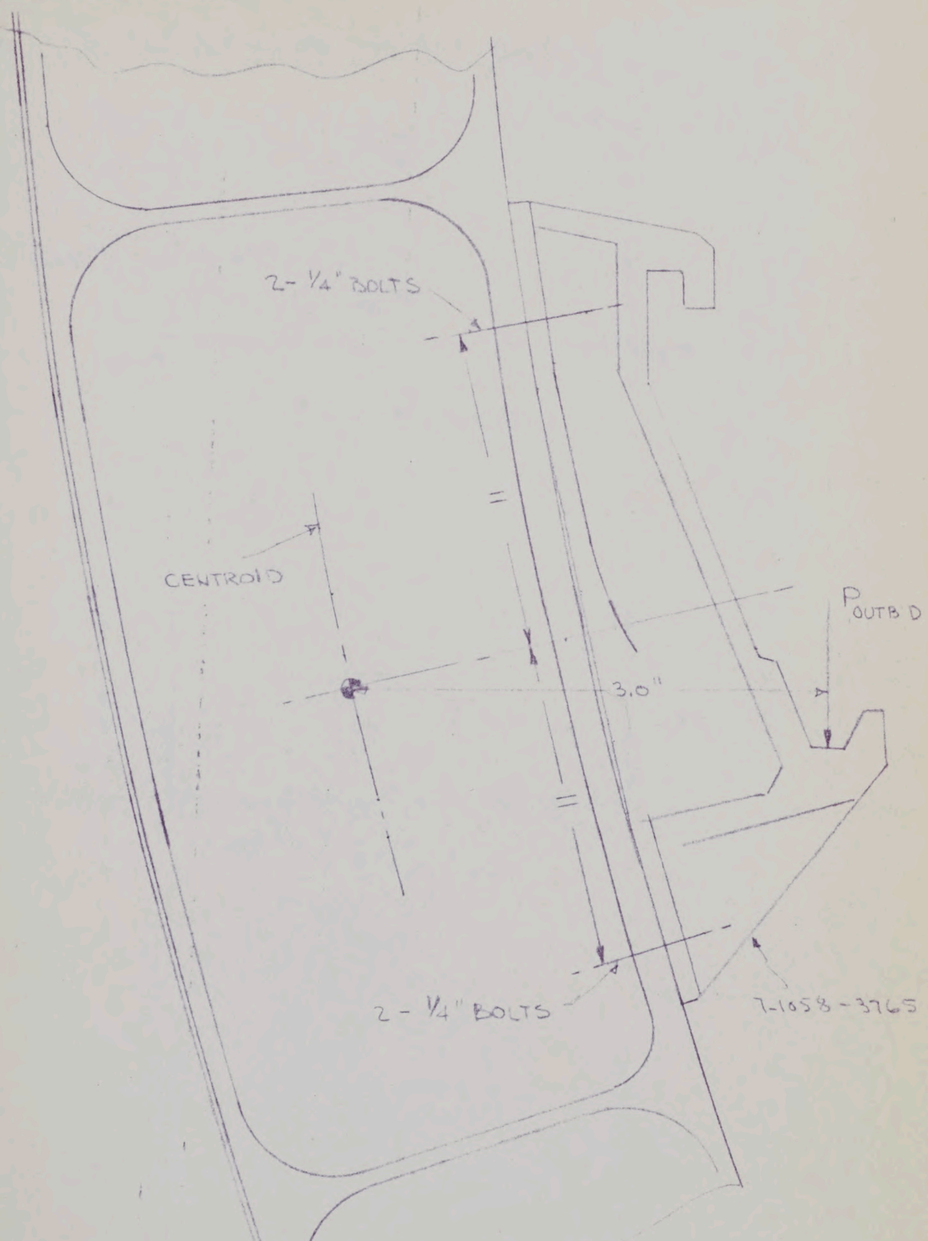
28,440
− 898
27,542

FORM 1319 A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT No. 7/0558/4	
		SHEET No. 1-78	
		PREPARED BY	DATE
C-105	FRAME 697	G. MEYERS	SEPT '56
		CHECKED BY	DATE

ENG. REMOVAL CASE (CONT'D)



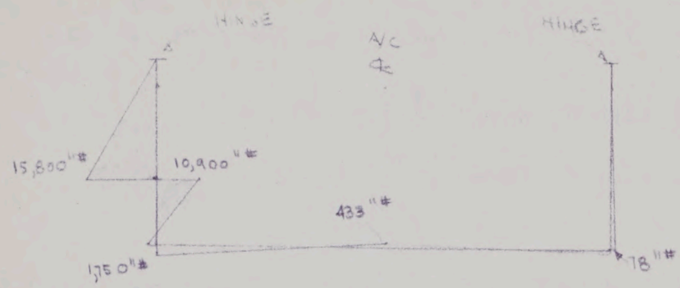
OUTB'D ENG. REM BKT
SIZE - FULL

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

REPORT No. 7/0558/4		SHEET No. 1-79
AIRCRAFT: C-105	FRAME 697	
PREPARED BY: G. MEYERS	DATE: DEC '56	
CHECKED BY:	DATE:	

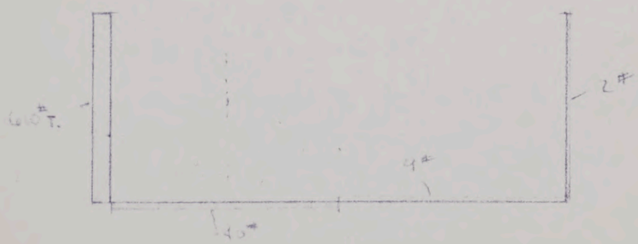
ENG. REMOVAL CASE (CONT'D)

CASE 1: 8102# ⊗ ACTING ON OUTB'D BKT.



MOM. DIAGRAM

END LOAD



SHEAR DIAG

⊗ REF. MEMO TO GOULD & METSON FROM HAYWARD DATED 22 DEC. 1955. SIDE LOAD OF 1284# NEGLECTED.

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

REPORT No	7/0558/4		
SHEET No	1-80		
AIRCRAFT: C-105	FRAME 697	PREPARED BY: G. MEYERS	DATE: SEPT '56
		CHECKED BY	DATE

ENGINE REMOVAL CASE (CONT'D)

CASE 2 ~ 8902# APPLIED TO INB'D BRACKET

CONSIDERING THE ENGINE LOAD OF 8902# TO BE DISTRIBUTED BY THE VEE BRACE TO THE WING BEAM STRUCTURE & FRAME 697 BY RATIO OF SPRING CONSTANTS OF EACH:

$$\delta_{FRAME} = 3710.5 \ \#/" \ (\text{REF P 1-37})$$

$$\delta_{WING\ STRUCT} = 57{,}000 \ \#/" \ (\text{REF P. MACKENZIE 9-26-56})$$

$$\overline{60{,}710.5 \ \#/"} \ \text{TOTAL}$$

$\therefore$ $100(3{,}710.5/60{,}710.5) = 6.1\%$ OF VEE BRACE LOAD IS CARRIED BY FRAME 697.

$$P = .061 \times 8902 = 544\# \downarrow \text{ ACTING @ } ℄ \text{ A/C}$$

MAX MOM DUE 544# ↓ :

$$M_{MAX} = .544 \times 27{,}542^{*} = \underline{15{,}000} \ "\#$$

* REF: UNIT SOLUTION FOR 1000# @ ℄ A/C.

CONCLUSION ~ ENG. REM. CASE

FROM THE ABOVE & BY INSPECTION, THESE CASES ARE DETERMINED TO BE NOT CRITICAL SINCE MAX BM'S ARE 15,800 "# WHILE FOR 10 G CASE, THE BM'S ARE AT LEAST 4 TIMES THIS FIGURE. SHEAR & END LOADS ARE EQUALLY AS NON CRITICAL FOR ENG. REMOVAL.

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT: C-105	FRAME 697	REPORT No. 7/0558/4	SHEET No. 2-1
		PREPARED BY: G. MEYERS	DATE: Oct 56
		CHECKED BY:	DATE:

SECTION II

DETAIL STRESSING OF FRAME 697

FORM 1319 A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

REPORT No. 7/0558/4
SHEET No. 2-2

AIRCRAFT:		PREPARED BY	DATE
C-105	FRAME 697	G. MEYERS	OCT 56
		CHECKED BY	DATE

STRESS LEVEL & MARGIN OF SAFETY

CASE 11.3 b

ELEMENT	CRITICAL MOMENT P1-71	CRITICAL FIBRE	C	I (1) P1-27	Mc/I	ALLOWABLE $F_{c\,YIELD}$ (2)	MARGIN OF SAFETY (3)
1	-12,606	OUTER	1.03	1.095	-11,850	-49,800	>+1.0
2	-24,352		1.27	1.361	-22,700		>+1.0
3	-44,038		1.364	1.646	-36,500		+.36
4	-56,278		1.45	1.789	-45,600		+.09
5	-56,802		1.60	1.997	-45,500		+.09
6	-49,562		1.50	1.839	-40,400		+.23
7	-35,818		1.68	1.547	-38,900		+.28
8	-29,428		1.59	1.508	-31,200		+.60
9	-25,859		1.54	1.577	-25,300		+.97
10	-16,347	OUTER	1.54	1.577	-16,050		>+1.0
11	+24,325	INNER	1.567	1.760	-21,650		>+1.0
12	+33,994		1.55	1.685	-31,200		+.60
13	+36,763		1.54	2.233	-25,400		+.96
14	+43,029		1.54	2.562	-25,800		+.93
15	+74,306		1.76	3.709	-35,300		+.41
16	+93,955		2.13	5.304	-37,700		+.32
17	+113,587		2.39	7.099	-38,200		+.30
18	+148,799		2.43	9.082	-40,000		+.24
19	+183,446	INNER	2.48	10.432	-43,100	-49,800	+.14

(1) GROSS SECTION PROPERTIES

(2) BASED ON 2 3/4" PLATE AT 330° FOR 50 HRS (RPT 7-0558/27 P. 2-2A)

(3) NEGLECTING PLASTIC BENDING : 10% CONSERV
NEGLECTING END LOADS (P/A) : 10% UNCONSERV.

FORM 1319A

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

REPORT No. 7/0558/4
SHEET No. 2-3

AIRCRAFT.		PREPARED BY	DATE
C105	FRAME 697		
		CHECKED BY	DATE

DETAIL STRESSING OF V-BRACE STRUCTURE

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT No. 7/0553/4	
		SHEET No. ~~1-123~~ 2-4	
AIRCRAFT	ANALYSIS OF HEAVY FRAME STA. 697	PREPARED BY	DATE
C-105		W. B. GROSSMAN	JULY 1955
		CHECKED BY	DATE

(ALL VALUES ULT.)

ANALYSIS OF CENTER "V-BRACE" STRUCTURE (REF DWG. 7-0558-224)

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

1.) UNBALANCED SIDE LOADS FROM THE FWD. AND AFT BAYS ARE TRANSMITTED TO FR. 697 AND ARE RESISTED BY THE "V-BRACE". THE MAX. LOAD HAS BEEN ESTIMATED AT P_0 = 10,540# (SIDE LOAD). THIS CAUSES AN END LOAD = ±35,140# IN EACH OF THE TUBES OF THE "V-BRACE".
~~(REF PGS. 1-119, 1-125)~~

2.) AN "OUT-OF-BALANCE" DUCT LOAD IS RESISTED BY THE UPPER LONGITUDINAL BEAM AS SHOWN IN THE SKETCH ON PG. 1-59, PT. "D". THIS UPPER LONGITUDINAL BEAM IS SUPPORTED BY THE "V BRACES" AT THE HEAVY FRAMES 644, 697 & 742 ONLY. THEREFORE, HALF OF THE LOAD IN EACH BAY WILL BE ASSUMED TRANSMITTED TO FR. 697.

$P_D = 5.75\,pd$ ~~(PG. 1-59)~~

$p = 10.2$ psi (ASSUMED CONSERVATIVE VALUE)

d = EFFECTIVE DUCT LENGTH = $\frac{1}{2}(697-644) + \frac{1}{2}(742-697) = 49''$

$\therefore P_D = 5.75(10.2)(49'') = 2870\#/\text{SIDE}$

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 ROLLER = 3300# (LIMIT) (REF CENTRE STRUT ANALYSIS STA. 644)

ENGINE HANDLING FACTOR = 3.0 (REF. AP 970 CH 723 PAR. 2.1)

$\therefore$ ENGINE RAIL LOAD = $P_J = 3.0 \times 3300\# = 9900\#$

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

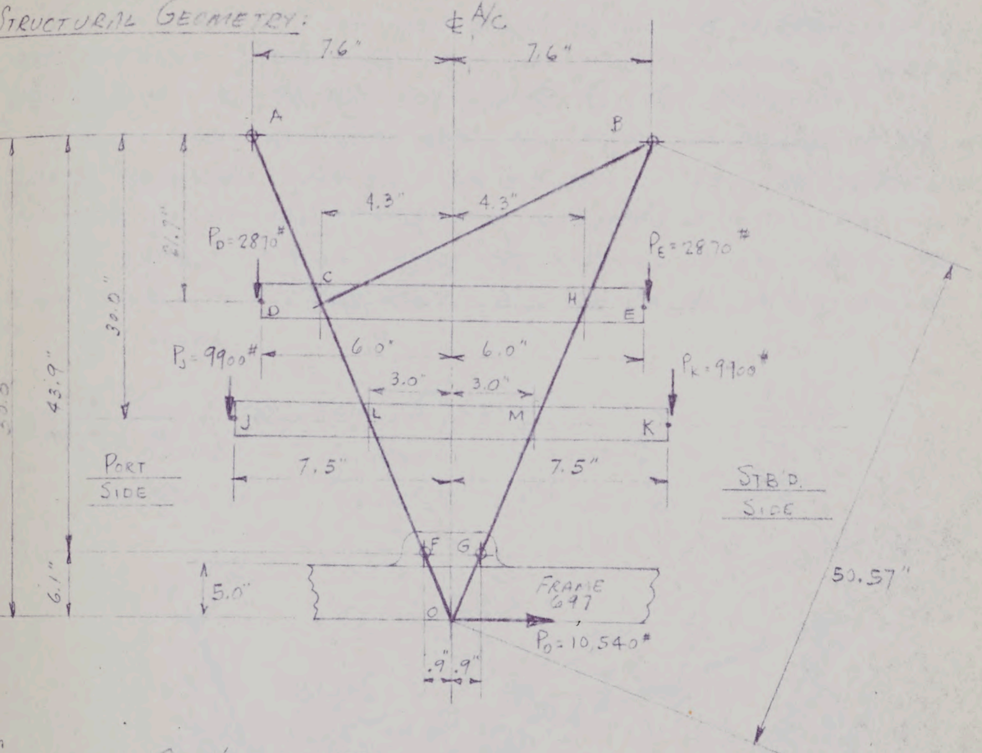
REPORT NO.	7/0558/4
SHEET NO.	~~1-184~~ 2-5

AIRCRAFT:		PREPARED BY	DATE
C-105	ANALYSIS OF HEAVY FRAME STA. 697	W. B. GROSSMAN	JULY 1955
		CHECKED BY	DATE

(ALL VALUES ULT.)

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

STRUCTURAL GEOMETRY:



COMBINATION OF LOADS: THE FOLLOWING COMBINATION OF LOADS WILL BE CONSIDERED.

COND. 1: FULL SIDE LOAD, $\pm P_O$, & BOTH DUCTS PRESSURIZED ($P_D\downarrow$ & $P_E\downarrow$)

COND. 2: FULL SIDE LOAD, $\pm P_O$ & ONLY PORT SIDE DUCT PRESSURIZED ($P_D\downarrow$, $P_E = 0$) [STARBOARD ENGINE OFF]

COND. 3: FULL SIDE LOAD, $\pm P_O$ & ONLY STB'D. SIDE DUCT PRESSURIZED ($P_E\downarrow$, $P_D = 0$) [PORT ENGINE OFF]

COND. 4: ENGINE INSTALLATION LOAD = $P_J\downarrow$ OR $P_K\downarrow$

FORM 1319A

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT NO. 7/0558/4	
		SHEET NO. ~~1-125~~ 2-6	
AIRCRAFT: C-105	ANALYSIS OF HEAVY FRAME STA. 697	PREPARED BY: W.B. GROSSMAN	DATE: JULY 1955
		CHECKED BY:	DATE:

(ALL VALUES ULT.)

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

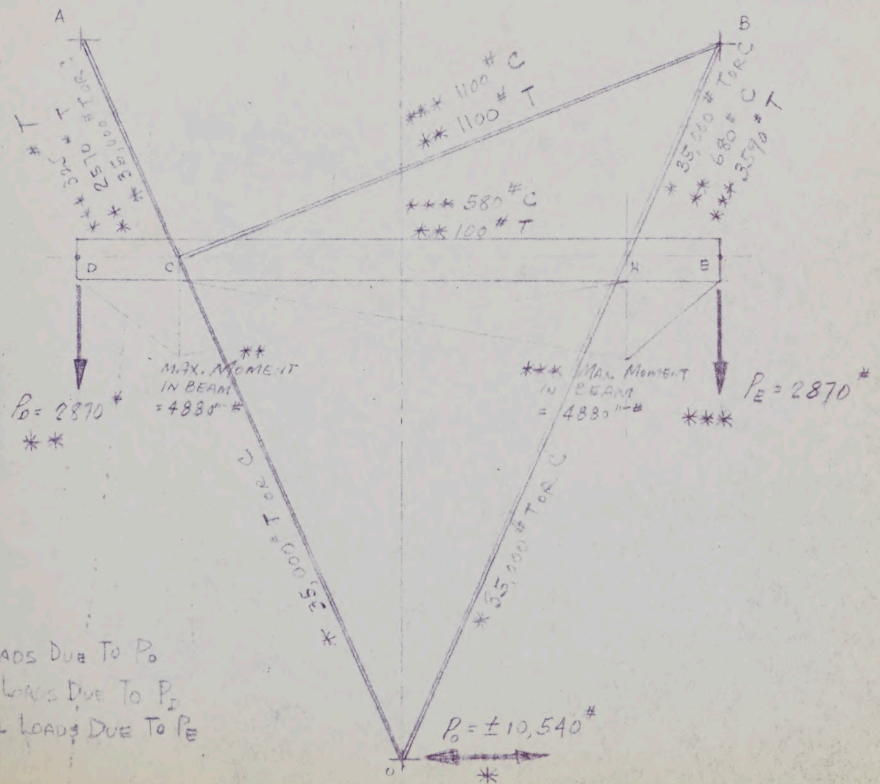
A SET OF UNIT ANALYSES WHICH GIVE THE INTERNAL LOADS IN THE "V-BRACE" STRUCTURE FOR VARIOUS UNIT EXTERNAL LOADS, WILL BE FOUND ON PGS. 93-96, "ANALYSIS OF FR. 644", 7/0558/19.

ALTHOUGH THE STRUCTURAL GEOMETRY OF THE "V-BRACE" AT FR. 644 DIFFERS SLIGHTLY FROM THAT AT FR. 697, IT WILL BE SUFFICIENTLY ACCURATE TO USE THE ABOVE UNIT ANALYSES FOR FR. 697.

THE ACTUAL INTERNAL LOADS ARE OBTAINED BY MULTIPLYING THE VALUES SHOWN IN THE UNIT ANALYSIS BY THE RATIO OF THE ACTUAL APPLIED LOAD TO UNIT LOAD.

COND. 1: { FULL SIDE LOAD, $P_O = \pm 10{,}540^{\#}$
PORT DUCT PRESSURIZED, $P_D = 2870^{\#}$
STBD. DUCT PRESSURIZED, $P_E = 2870^{\#}$ }

[REF. PG. ~~1-174~~ 2-5]



* INTERNAL LOADS DUE TO P_O
** INTERNAL LOADS DUE TO P_D
*** INTERNAL LOADS DUE TO P_E

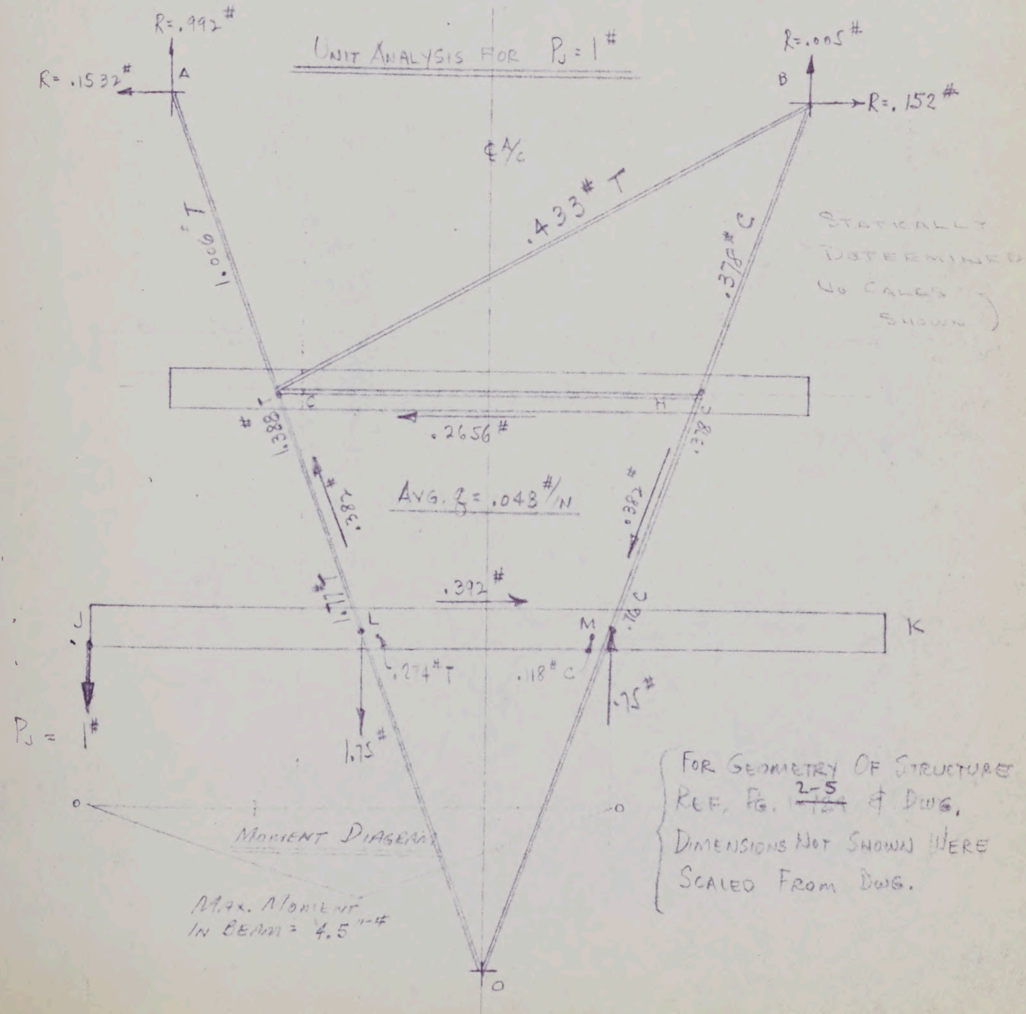
A. V. ROE CANADA LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7/0558/4
SHEET No. E126 2-7

AIRCRAFT:		PREPARED BY	DATE
C-105	Analysis Of Heavy Frame Sta. 697	W. B. Grossman	July 1955
		CHECKED BY	DATE

Analysis Of Center "V-Brace" Structure [Cont'd] (Ref. Dwg. 7-0458-224) (All Values Ult.)

For the case of the engine installation loads P_K & P_J (Pg. 2-5 / 1-174) the unit analyses in 7/0558/19, "Analysis Of Fr. 644", Pg. 96, cannot be used here. Frame 644 has a diagonal member in the panel L-M-H-C (Pg. 1-174), while Fr. 697 has a shear web in this panel. Therefore, the internal loads in the "V-Brace" structure, including the shears in the web, will be calculated on a unit basis, for $P_K = 1^{\#}$ & $P_J = 1^{\#}$. As before, the actual internal loads are obtained by proportion from the values shown below in the unit analysis.



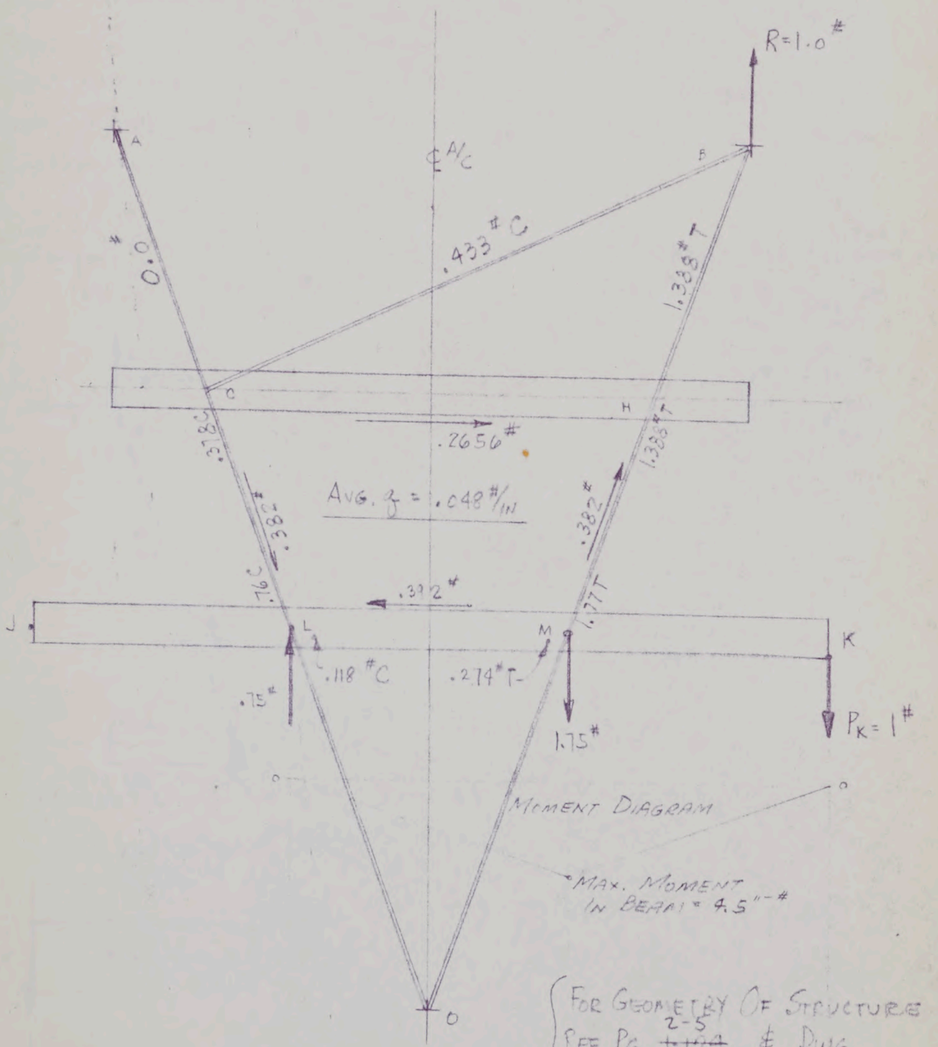
{ For Geometry Of Structure Ref. Pg. 2-5 / 1-174 & Dwg. Dimensions Not Shown Were Scaled From Dwg.

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

REPORT NO. 7/0558/4			
SHEET NO. ~~1-127~~ 2-8			
AIRCRAFT: C-105	ANALYSIS OF HEAVY FRAME STA. 697	PREPARED BY: W. B. GROSSMAN	DATE: JULY 1955
		CHECKED BY:	DATE:

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

UNIT ANALYSIS FOR $P_K = 1^{\#}$



FOR GEOMETRY OF STRUCTURE REF. PG. ~~1-124~~ 2-5 & DWG.
DIMENSIONS NOT SHOWN WERE SCALED FROM DWG.

FORM 4319A

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT No. 7/0558/4 SHEET No. ~~1-128~~ 2-9	
AIRCRAFT: C-105	ANALYSIS OF HEAVY FRAME STA. 697	PREPARED BY W. GROSSMAN	DATE JULY 1955
		CHECKED BY	DATE

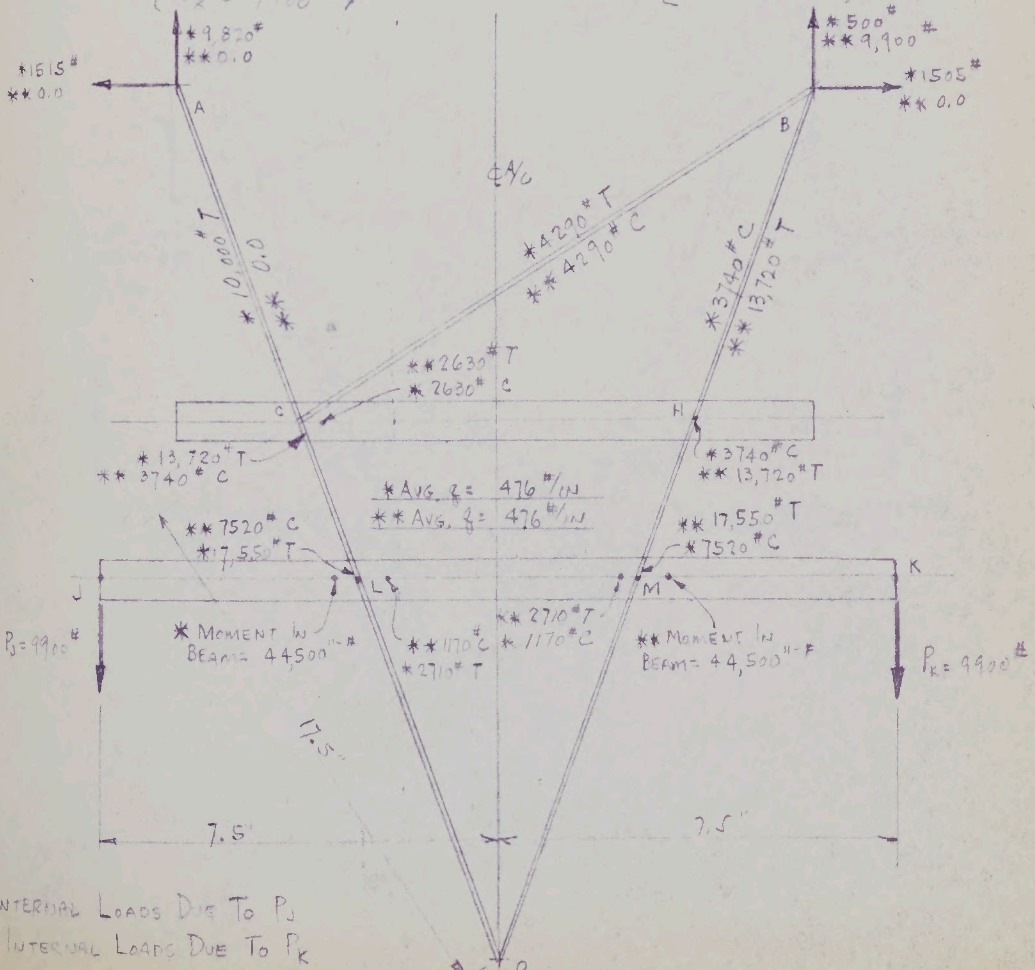
(ALL VALUES ULT.)

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

COND. 2 & 3 (REF. PG. 1-124) : THE INTERNAL LOADS IN THE "V-BRACE" STRUCTURE FOR THESE CONDITIONS MAY BE OBTAINED BY THE PROPER COMBINATION OF THE LOADS SHOWN IN THE SKETCH ON THE PRECEEDING PG. 1-125 FOR COND. 1. FOR COND. 2, $P_E = 0$. THEREFORE, THE INTERNAL LOADS DUE TO $P_E = 0$. FOR COND 3, $P_D = 0$. THEREFORE, THE INTERNAL LOADS DUE TO $P_D = 0$.

COND. 4 : ENGINE INSTALLATION LOADS
$P_J = 9900^{\#}$
$P_K = 9900^{\#}$

[FOR LOADS, REF. PGS. ~~1-123, 1-124~~ 2-4 & 2-5
FOR UNIT ANALYSES SEE PGS. ~~1-126, 1-127~~ 2-7, 2-8]



*INTERNAL LOADS DUE TO P_J
**INTERNAL LOADS DUE TO P_K

FORM 1319A

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

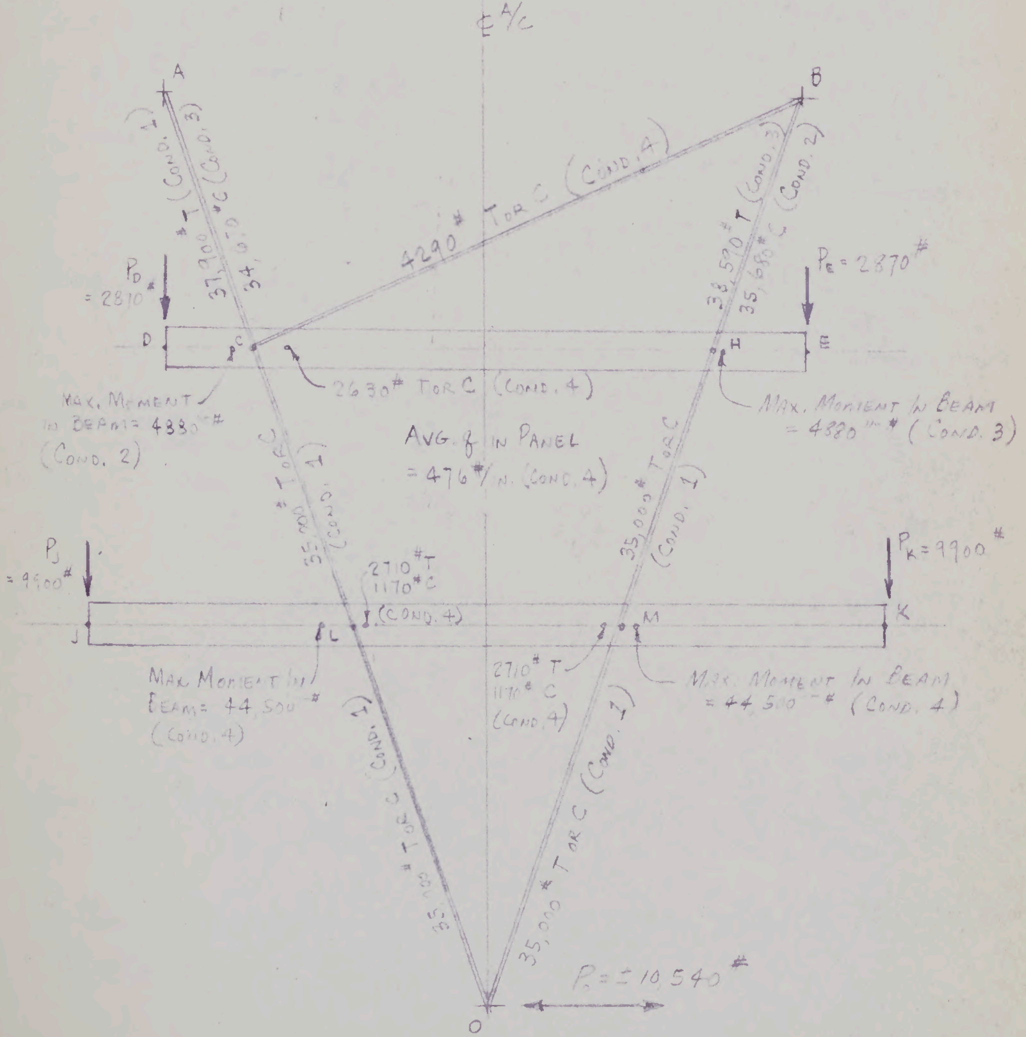
AIRCRAFT C-105	ANALYSIS OF HEAVY FRAME STA. 697	REPORT No. 7/0558/4	SHEET No. ~~1-127~~ 2-10
		PREPARED BY W. B. GROSSMAN	DATE JULY 1955
		CHECKED BY	DATE

(ALL VALUES ULT.)

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

SUMMARY OF CRITICAL INTERNAL LOADS & CONDITIONS:

[FOR INTERNAL LOADS, REF. PGS. ~~1-125~~ 2-6, ~~1-123~~ 2-9
FOR CONDITIONS, REF. PG. ~~1-94~~ 2-5]



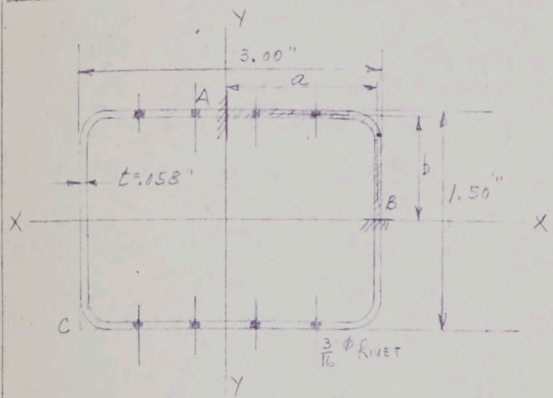
FORM 1319A

(ALL VALUES ULT.)

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

THE MAIN MEMBERS OF THE 'V-BRACE' CONSIST OF EXTRUDED RECTANGULAR TUBES, 4340 STEEL (MIL T-6736), H.T. TO 150,000 PSI.

FIRST TRIAL: TRY TUBE $t = .058''$



$A_G = 2(3.0+1.5)(.058)$ - AREA LOSS AT CORNERS

AREA LOST AT CORNERS DUE TO RADIUS (e.g. @ C) $= 2.5t^2$ {REF 7/0558/19 PG. 72

$A_G = 9(.058) - 4(2.5)(.058)^2$
$= .522 - .034 = \underline{.488\ \square''}$

FOR ABOVE TUBE:

$F_{TU} = 150$ ksi
$F_{TY} = F_{CY} = 135$ ksi
$F_{SU} = 90$ ksi
$F_{BRU} = 190$ ksi
} REF. ANC-5 PG. 24 ROOM TEMPERATURE

CHECK OF LOCAL INSTABILITY (CRIPPLING STRESS):

THE CRIPPLING STRESS WILL BE DETERMINED BY THE METHOD GIVEN IN JL AERO. SC., APRIL 1954 BY NEEDHAM. THIS IS BASED ON:

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

A GRAPH HAS BEEN PREPARED (SEE FOLLOWING PG. 1-131) WHICH GIVES F_{CC} AS A FUNCTION OF $\left(\frac{a+b}{2t}\right)$ FOR THE TUBE MAT'L. AS GIVEN ABOVE.

$a = 1.5 - \frac{.058}{2} = 1.471''$ $b = .750 - \frac{.058}{2} = .721$ $\frac{a+b}{2t} = 18.9$

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

FOR ELEVATED TEMPERATURES, WE WILL CONSERVATIVELY REDUCE THE ABOVE STRESS BY 10%. $\therefore F_{CC} = 90\%(81,200) = 73,000$ psi (ALLOW.) @ 260°F.

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

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

$M.S._1 = \frac{F_{CC}}{f_c} = \frac{73,000}{73,000} - 1 = 0.0$ **0.0**

[THIS WILL BE CONSIDERED AN ACCEPTABLE M.S. AT THE PRESENT TIME. THEREFORE, USE $t = .058''$]

FORM 1319A

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**	REPORT No. 7/0558/4	
	SHEET No. ~~1-132~~ 2-12	
AIRCRAFT: C-105 — ANALYSIS OF HEAVY FRAME STA. 697	PREPARED BY: W. B. GROSSMAN	DATE: JULY 1955
	CHECKED BY:	DATE:

ANALYSIS OF CENTER "V-BRACE" STRUCTURE [CONT'D.]

(ALL VALUES ULT.)
(REF. DWG. 7-0N8-274)

PRIMARY FAILURE OF TUBE (COLUMN ACTION):

1.) THE UNSUPPORTED LENGTH OF THE TUBE FOR FAILURE IN THE FORE & AFT DIRECTION (ABOUT AXIS Y-Y, PG ~~1-130~~ 2-11) WILL BE ASSUMED AS THE FULL DEPTH OF THE TUBE BETWEEN SPHERICAL BEARINGS. THE HORIZONTAL BEAMS (PG. ~~1-124~~ 2-10) ARE NEGLECTED AS SUPPORTING STRUCTURE FOR TUBE FAILURE IN THE ABOVE DIRECTION. [FOR TUBE CROSS-SECTION, SEE PG. ~~1-130~~ 2-11].

AREA LOST AT CORNER DUE TO RADIUS $= \frac{.034}{4} = .0085$ □"/CORNER [REF. PG. ~~1-130~~ 2-11]
$= .0043$ □"/HALF CORNER

$$\text{GROSS } I_{YY} = 2(1.50 \times .058 - .0085)(1.471)^2 + 2\left[\frac{3.00 \times .058 - .0085}{.058}\right]^3 \times \frac{.058}{12}$$
$$= .340 + .224 = .564 \text{ in}^4$$

GROSS AREA $= A_G = .488 \text{ in}^2$ (REF. PG. 1-130)

$$r = \sqrt{\frac{I}{A}} = \sqrt{\frac{.564}{.488}} = \sqrt{1.154} = 1.075 \text{ in.}$$

UNSUPPORTED LENGTH = 44.40" (SCALED FROM REF. DWG.)

$$\frac{L'}{r} = \frac{L}{\sqrt{c}(r)}$$ FOR PIN ENDED COLUMNS, $c = 1.0$ (ANC-5, PG. 13)

$$\frac{L'}{r} = \frac{44.4}{1.075} = 41.3"$$

F_c = ALLOW. COLUMN STRESS = 105,500 psi {REF. ANC-5, FIG. 2.23(c), PG. 29; H-T. = F_{TU} = 150,000 psi}

FOR ELEVATED TEMPERATURES WE WILL REDUCE THE ABOVE STRESS BY 10%. ∴ ALLOW. F_c = 90% (105,500) = 95,000 psi @ 260°F.

ASSUMING MAX. COMPRESSIVE LD. IN TUBE = 35,680# FOR FULL DEPTH (REF. PG. ~~1-129~~ 2-10)

ACTUAL $f_c = \frac{35,680^{\#}}{.488} = 73,000$ psi

$$MS = \frac{F_c \text{ (ALLOW.)}}{f_c \text{ (ACTUAL)}} = \frac{95,000}{73,000} - 1 = \underline{\underline{1.30}}$$ .30

FORM 1319A

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**	REPORT NO. 7/0358/4
	SHEET NO. ~~1-129~~ 2-13

AIRCRAFT:		PREPARED BY	DATE
C-105	ANALYSIS OF HEAVY FRAME STA. 677	W. S. GROSSMAN	JULY 1955
		CHECKED BY	DATE

(ALL VALUES ULT.)

ANALYSIS OF CENTRE V-BEAM STRUCTURE [CONT'D.] (REF. DWG. 7-0158-224)

PRIMARY FAILURE OF TUBE [COLUMN ACTION]:

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

AS BEFORE (PG. 1-132):

GROSS $I_{xx} = 2(3.00 \times .058 - .0085)(.721)^2 + 2\left[\frac{1.50(.058) - .0085}{.058}\right]^3 \times \frac{.058}{12}$

$= .181 + .024 = .205 \text{ in}^4$

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

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

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

F_c = ALLOW. COL. STRESS = 90% × 116,400 psi = 104,900 psi {REF. ANC-5, FIG. 2.23(c) PG. 29. F_{TU} = 150 KSI AT ELEVATED TEMP.}

ACTUAL f_c = 73,000 psi (PG. 1-132)

$MS = \frac{104,900}{73,000} - 1 = \underline{.435}$ .43

CHECK OF TENSILE STRESSES IN TUBE:

DEDUCTING FOR 8 - $\frac{3}{16}$ Ø RIVETS (DRILL DIAMETER = .191" - REF ANC-5 PG. 85)

GIVES: $A_{NET} = A_G - 8(.191)(.058) = .488 - .0887 = .3993 \square"$

[SEE FIRST LINE OF RIVETS ATTACHING TUBE TO SOCKET VIEWS "K-K" & "M-M", REF. DWG.]

MAX. TENSILE LOAD = 38,590# (SEE BH, PG. ~~1-129~~ 2-10)

ACTUAL $f_t = \frac{P}{A_n} = \frac{38,590\#}{.3993\square"} = 96,600$ psi

ALLOW F_{TU} = 90% × 150,000 = 135,000 psi @ 260°F (REF. PG. ~~1-130~~ 2-11)

$M.S. = \frac{135,000 \text{ psi}}{96,600 \text{ psi}} - 1 = \underline{.40}$ .40

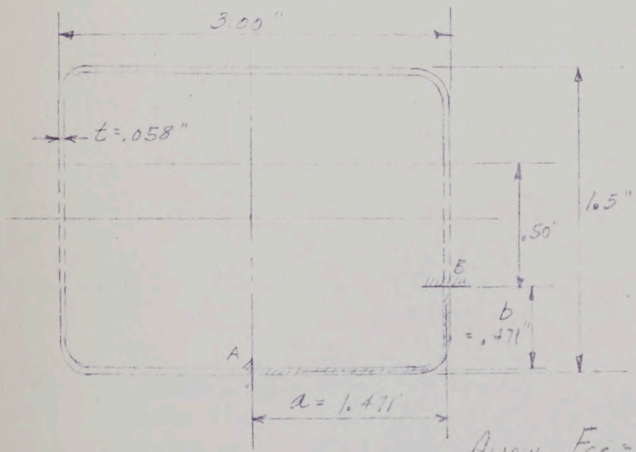
FORM 1319A

(ALL VALUES ULT.)

ANALYSIS OF CENTER "V-BRACE" STRUCTURE [CONT'D.] (REF. DWG. 7-1418-224)

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

AS SEEN FROM THE REF. DWG., THE TUBE IS ATTACHED TO THE SOCKET ON ONLY TWO (2) OF ITS FOUR (4) FACES (THE 3.0" WIDE FACES, PG. ~~1-130~~ 2-11). 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 (3.0" WIDE) BEFORE THE FIRST LINE OF RIVETS IS REACHED (THE LOAD PATH IS FROM THE TUBE TO THE SOCKET). THE CRIPPLING STRESS CALCULATION MADE ON PG. 2-11 WILL BE REVISED FOR THE SECTION SHOWN BELOW WHICH CONSIDERS ONLY A PART OF THE 1.5" WIDE FACE AS EFFECTIVE MATERIAL.



GROSS AREA = .488□" − 2(.5)(.058) (PG. ~~1-130~~ 2-11)

$A_G = .488 - .058$

$= .430\ \square''$

a = 1.471"
b = .471
t = .058"

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

ALLOW. $F_{CC} = 77,000 \times 1.16 \times 90\% = 80,500$ psi @ ELEVATED TEMP. (PG. ~~1-130~~ 2-11)

MAX. COMPRESSIVE LOAD IN TUBE = 35,680# (REF. BH PG. ~~1-129~~ 2-10)

ACTUAL $f_c = \frac{P}{A_G} = \frac{35,680}{.430} = 83,000$ psi

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

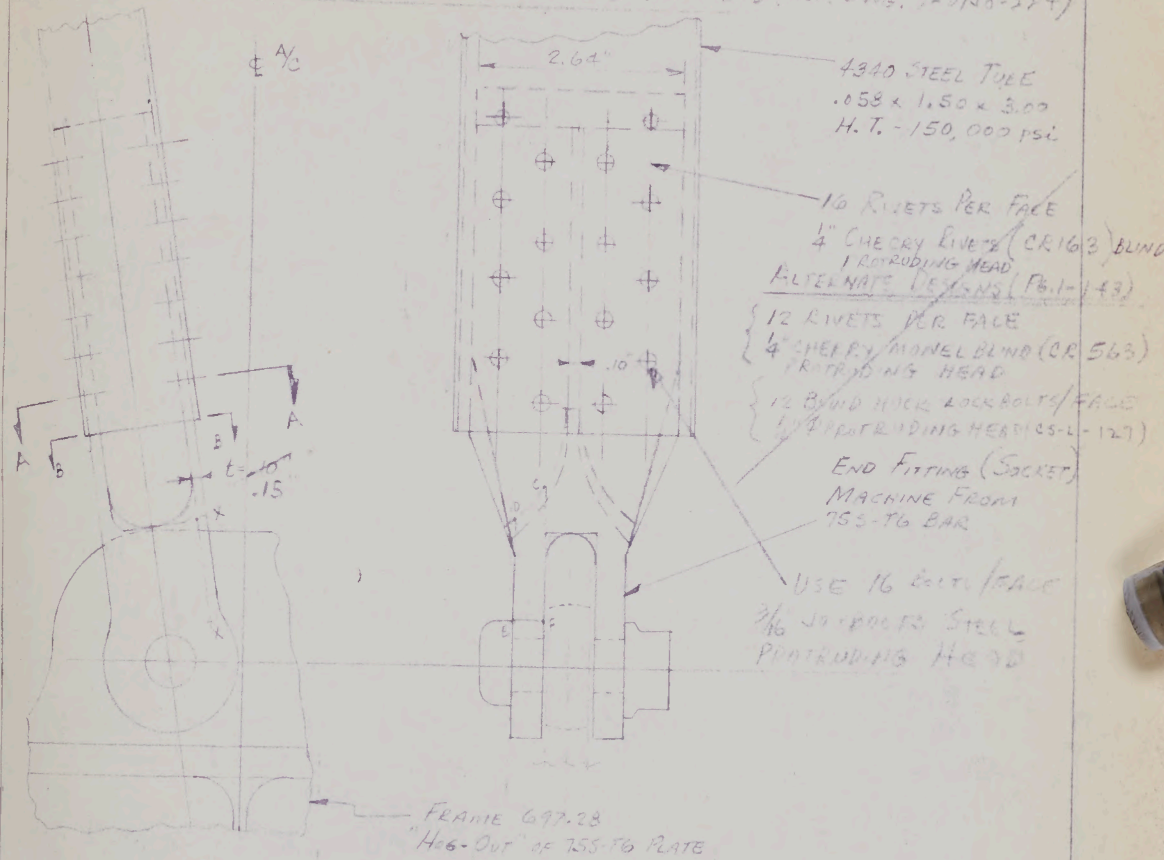
[IN VIEW OF THE ABOVE ASSUMPTIONS AND METHOD OF ANALYSIS, THE R.F. WILL BE CONSIDERED ACCEPTABLE.]

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

AIRCRAFT: C-105	Analysis Of Heavy Frame Sta. 697	REPORT NO. 7/0558/4	SHEET NO. ~~Z-135~~ 2-15
		PREPARED BY: W. B. Grossman	DATE: July 1955
		CHECKED BY	DATE

Analysis Of Center "V-Brace" Structure [Cont'd.] (Ref. Dwg. 7-0158-274)

(All Values Ult.)



Check Attachment Of Tube To Socket:

Try 1/4" Cherry Rivets (CR 163): Allow. Single Shear = 1660#/Riv. (ANC-5 Pg. 88)

Bearing in .10" Thick 75S-T6 Bar: F_{BRU} = 123 ksi (e/D = 2.0, ANC-5, Pg. 51).

Allow. F_{BR} = 2570 x 1.23 = 3160# (Ref. ANC-5, Pg. 85)

Bearing in .058" Thick 4340 Steel Tube: F_{BRU} = 190 ksi (H.T. 150 ksi, ANC-5 Pg. 24)

Allow. F_{BR} = 1490 x 1.90 = 2840# (Ref. ANC-5, Pg. 85)

∴ F_{ALLOW} = 1660#/Riv. (This checks with Table 3.6113(b), ANC-5 Pg. 89)

For Elevated Temperatures: F_{ALL} = .75 x 1660 = 1245#/Riv. (260° @ 300 Hrs., Pg. 1-89)

Actual Max. Tube Load = 38,590# (Ref. BH, Pg. 1-129)

Assuming 28 Rivets: Load/Riv. = $\frac{38,590}{28}$ = 1375 #/Riv. (Insufficient M.S. = $\frac{1245}{1375}$ - 1 = -.11)

Revise Design

Assuming 32 Rivets: Ld/Riv. = $\frac{38,590}{32}$ = 1205 #/Riv. M.S. = $\frac{1245}{1205}$ = +.031 -.01

Revise Design

See [illegible]

FORM 1319A

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

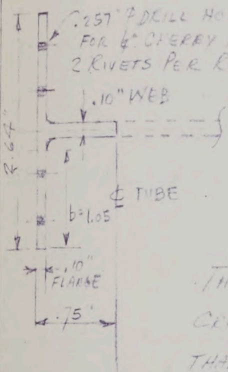
REPORT No. 7/0158/c
SHEET No. ~~1-136~~ 2-16

AIRCRAFT:		PREPARED BY	DATE
C-105	Analysis of Heavy Frame Sta. 697	W. B. Grossman	July 1955
		CHECKED BY	DATE

(All Values Ult.)

Analysis of Centre "V-Brace" Structure [Cont'd.] (Ref. Dwg 7-0158-224)

Check Socket at Section "A-A" (Pg. ~~1-135~~ 2-15): At section "A-A" the full tube load has been transferred to the socket. Assume that the socket face (2.64" wide) plus all of the web are effective in carrying the load:



Gross Area/Flange = $2.64(.1) + .65(.1) = .264 + .065 = .329 \square''$

Total $A_G = 2(.329) = .658 \square''$

Net Area/Flange = $.329 - 2(.257)(.1) = .329 - .052 = .277 \square''$

Total $A_N = .554 \square''$

Max. Compr. Load = 35,680# (Ref. BH, Pg. ~~1-129~~ 2-10)

$f_c = \frac{35680}{A_G = .658} = 54,250$ psi

The allow. compressive stress will be taken as the crippling stress on the outstanding flange, but not greater than F_{cy}. From Lockheed Stress Memo 45e, Fig. 31, Pg. 19:

For $b/t = \frac{1.05}{.10} = 10.5$ & one edge free: $F_{cc} = 22\,500$ psi

Allow. $F_{cc} = 75\%(22,500) = 16,900$ psi @ 260°F, ~~Pg. 1-87~~ (Obviously insufficient)

Revise the taper of the socket face (Pg. ~~1-135~~ 2-15) so as to reduce the outstanding flange at section A-A & increase flange thickness to .15" — Revise Design

(Scaling from Dwg.) Flange Width = 2.3"

$A_G = 2[2.3(.15) + (.65)(.1)] = 2[.345 + .065] = 2(.410) = .820 \square''$

$A_N = .820 \square'' - 4(.257)(.15) = .820 - .154 = .666 \square''$

(Scaling from Dwg.) $b = .90$ $b/t = \frac{.9}{.15} = 6.0$ $F_{cc} = 62,000$ [Lockheed Stress Memo 45e Fig. 31, Pg. 19]

Allow. $F_{cc} = 62\,000 \times 75\% = 46\,500$ psi (@ 260°F ~~Pg. 1-89~~)

Max. Compressive Ld. = ~~35 680~~ 37,... # (Above) $f_c = \frac{P}{A_G} = \frac{\sout{35,680}\ 37,700\#}{.820 \square''} = \sout{43,500}\ 46,...$ psi

(Compressive) M.S. = $\frac{46,500}{\sout{43,500}} = $ **0.0** — 0.0

Max. Tensile Ld. = 38,590# (Ref. BH, Pg. ~~1-129~~ 2-10)

$f_t = \frac{P}{A_N} = \frac{38,590\#}{.666 \square''} = 57,900$ psi

Allow. $F_{tu} = 57,800$ psi (~~Ref. Pg. 1-...~~)

(Tensile) M.S. = $\frac{57,800}{57,900} = $ **+.03** — +.03

Increase socket radii as shown in sketch Pg. ~~1-135~~ 2-15

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT NO. 7/0558/4 SHEET NO. 2-17	
AIRCRAFT: C-105	ANALYSIS OF HEAVY FRAME STA. 697	PREPARED BY: W. B. GROSSMAN	DATE: JULY 1955
		CHECKED BY:	DATE:

(ALL VALUES ULT.)

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

CHECK TRANSFER OF LOAD FROM SOCKET FLANGE TO LUG:

THE LOAD IN THE SOCKET FACE (2.64" WIDE) MUST BE TRANSFERRED TO THE LUG. THE TRANSFER OF THIS LOAD IS BY SHEAR ACROSS PLANE "X-X" (PG. 2-15) CAUSING A SHEARING STRESS ON CROSS-HATCHED AREA C-D-E-F.
THERE ARE FOUR (4) SUCH SHEAR PLANES TO BE CONSIDERED.

SHEAR AREA = 4 (.4)(1.4) = 2.24 □"

ASSUMING ALL OF MAX. LOAD TO BE TRANSFERRED ACROSS THIS SHEAR AREA:

MAX. TUBE LOAD = 38,590# (PG. 2-10) $f_s = \frac{38,590^{\#}}{2.240} = 17,200$ psi

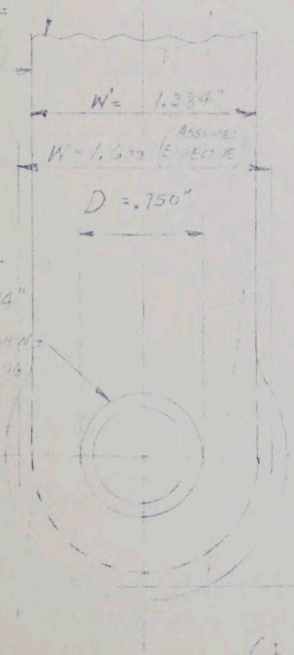
ALLOW F_{SU} = 35,300 psi (260° @ 300 HRS.)

$MS = \frac{35,300}{17,200} - 1 = \underline{1.05}$ 1.05

CHECK OF LUG: (@ BOTTOM CONTOUR) [ALL CALCULATIONS ARE REFERENCED TO "ANALYSIS OF LUGS" BY MELCON & HOBLIT, PRODUCT ENGINEERING, MAY 1950 & JUNE 1953]

TRY t=.40"

USE t=.48"



AN 10 BOLT
DIAM = 5/8 = .624"
INSERT 1/16" BUSHING
DRILL 3/4" IN LUG
DRILL = .750" Ø
PRESS FIT

$W/D = \frac{1.600}{.750} = 2.14$ $a/D = \frac{.80}{.750} = 1.07$ $D/t = \frac{.750}{.400} = 1.87$

$A_{BR} = Dt = .4(.750) = .300$ □"

$A_T = (W-D)t = (1.600 - .750).40 = .340$ □"

TENSION ACROSS NET SECTION:

$K_T = .965$ (FIG. 3, CURVE 2)

F_{TU} = 57.8 KSI (260° @ 300 HRS. PG. 1-89)

$P'_{TU} = K_T F_{TU} A_T = .965(57.8^{KSI})(.340□") = 19\,000^{\#}$

(FOR 2 LUGS) P'_{TU} = 38,000#

MAX. TUBE LOAD = 38,590# (PG. 2-10)

$MS = \frac{38.0}{38.5} - 1 = \underline{-.03}$ (ACCEPTABLE)

SEE NEXT PG. FOR NEW t=.48"

SHEAR BEARING FAILURE:

(FROM FIG. 4, USING CURVE D/t ≦ 2)

K_{BR} = 0.93

F_{TUX} = 57,800 psi (260° @ 300 HRS., PG. 1-8[illegible])

$P'_{BRU} = K_{BR} F_{TUX} A_{BR} = 0.93(57,800)(.300)$
= 16,150

(FOR 2 LUGS) P_{BRU} = 32 300#

MAX. TUBE LOAD = 38,590# (PG. 2-10)

$MS = \frac{32\,300}{38,590} - 1 = \underline{-.17}$ (INSUFFICIENT SEE NEXT PAGE 2-18)

FORM 1319A

(ALL VALUES ULT.)

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

CHECK OF LUG: (@ BOTTOM CONTOUR) t = .46" | REVISED ... t = .40

$a/D = \frac{.??}{.750} = 1.17$ $D/t = \frac{.750}{.480} = 1.56$ $A_{BR} = .48(.750) = .360 \square''$

$K_{BR} = 0.93$ (FROM FIG. 4, USING CURVE a/D ...)

$F_{tux} = 57{,}800$ PSI (700° ... 300 HRS. ...)

(FOR 2 LUGS) $P_{BRU} = 2\, K_{BR}\, F_{tux}\, A_{BR} = 2(0.93)(57{,}800)(.360) = 38{,}800^{\#}$

MAX. TUBE LOAD = 38,590# (PG. 2-10) MS = $\frac{38{,}800}{38{,}590} - 1 = +.003$ | .00

LUG YIELD: $P'_{min} = P'_{BRU} = 38{,}800^{\#}$ (ABOVE)

(FOR 2 LUGS) $\frac{P'_{min}}{A_{BR} F_{tux}} = \frac{38{,}800}{2(.360)(57{,}800)} = 0.93$

C = 1.10 (FROM FIG. 5)

$P'_y = C \cdot \frac{F_{tyx}}{F_{tux}} \cdot P'_{min}$ $F_{tux} = 57{,}800$ PSI, $F_{tyx} = 48{,}900$ PSI {700° @ 300 HRS. ...}

$P_y = 1.1\left(\frac{48.9}{57.8}\right)(38{,}800) = 36{,}000^{\#}$ (YIELD)

CONVERTING TO EQUIVALENT ULT. LOAD = $36{,}000^{\#} \times \left(\frac{n = 10.?}{n = 7.??}\right) = 49{,}000^{\#}$

MAX. TUBE LOAD = 38,590# (PG. 2-10) MS = $\frac{49{,}000}{38{,}590} - 1 = .27$ | .27

BUSHING YIELD: A_{BRP} = AREA OF PIN ON BUSHING = .624(.48) = .300 □"

F_{cy} ON BUSHING = 90% ... PSI = 90,400 PSI (135 KSI HT STEEL @ 260°F, PG. 2-12, FIG. 5)

(FOR 2 LUGS) $P'_{bry} = 1.85\, F_{cy}\, A_{BRP} \cdot 2 = 1.85(90{,}400)(.300)(2) = 100{,}000^{\#}$

MAX. TUBE LOAD = 38,590# (PG. 2-10) MS = $\frac{100{,}000}{38{,}590} - 1 = +1.59$ | 1.59

PIN SHEAR: PIN IS IN DOUBLE SHEAR. (AN10C23 BOLT)

ALLOWABLE LOAD = 23,000# SINGLE SHEAR } REF. ANC-5 FOR AN10 BOLT
= 46,000# DOUBLE SHEAR } PG. 32

MAX. TUBE LOAD = 38,590# (PG. 2-10) MS = $\frac{46{,}000}{38{,}590} - 1 = .19$ | .19

TENSION ACROSS NET SECTION: $K_T = .965$ (FIG. 3 CURVE 2) $A_T = (W-D)t = (1.6-.75)(.48) = .407 \square''$

$F_{tu} = 57{,}800$ PSI (700° @ 300 HRS. ...)

$P_{tu} = K_T F_{tu} A_T = .965(57{,}800)(.407)(2) = 45{,}400^{\#}$ (FOR 2 LUGS)

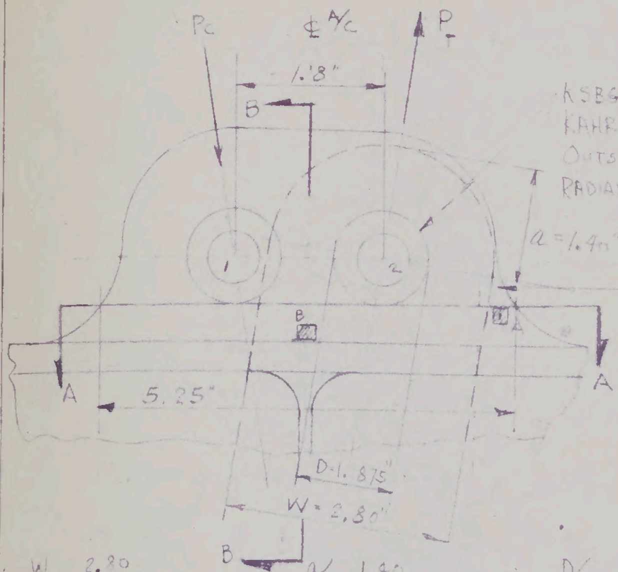
MAX. TUBE LOAD = 38,590# (PG. 2-10) MS = $\frac{45{,}400}{38{,}590} - 1 = .17$ | .17

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

AIRCRAFT: C-105	ANALYSIS OF HEAVY FRAME STA. 697	REPORT NO. 7/1558/4	SHEET NO. 2-19
		PREPARED BY: W. B. GROSSMAN	DATE: JULY 1955
		CHECKED BY	DATE

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

CHECK OF FRAME LUG: [ALL CALCULATIONS ARE REF. TO "ANALYSIS OF LUGS", MELCON & HOBLIT, PRODUCT ENGINEERING, MAY 1953 & JUNE 1953]



KSBG-10S SPHERICAL BEARING (RACE IS 4130 STEEL)
KAHR BEARING DIVISION
OUTSIDE DIA. = 1.1875" (HOUSING BORE DIAM.)
RADIAL LOAD = 44,300# YIELD ALLOWABLE

ASSUMED EQUIVALENT LUG
t = .50"
"HOGGED-OUT" OF 75S-T6 PLATE

t = .586"
WAS .50"
REVISE ANALYSIS

$\frac{W}{D} = \frac{2.80}{1.1875} = 2.36$ $\quad a/D = \frac{1.40}{1.1875} = 1.18$ $\quad D/t = \frac{1.1875}{.50} = 2.37$

$A_{BR} = Dt = 1.1875(.50) = .594\square''$

$A_T = (W-D)t = (2.80-1.1875)(.50) = .806\square''$

TENSION ACROSS NET SECTION: $K_T = .94$ (FIG. 3, CURVE 2)

$F_{TU} = 57,800$ PSI (360" @ 340 HRS., FIG. ~~1.4~~)

$P'_{TU} = K_T F_{TU} A_T = .94(57,800)(.806) = 43,800$#

MAX. TUBE LOAD = 38,590# (PG. ~~1.24~~ 2-10) $\quad$ M S = $\frac{43,800}{38,590}$ -1 = 1.135 $\quad$ +.13

SHEAR-BEARING FAILURE: $K_{BR} = 1.08$ (FROM FIG. 4, USING CURVE FOR $D/t = 2.37$)

$F_{TUX} = 57,850$ psi (360" @ 300 HRS., PG. ~~1.24~~) $\quad$ +.08

$P'_{BRU} = K_{BR} F_{TUX} A_{BR} = 1.08(57,850)(.594) = 37,100$#

MAX. TUBE LOAD = 38,590# (PG. ~~1.24~~ 2-10) $\quad$ M S = $\frac{37,100}{38,590}$ -1 = +.08

[THIS WILL BE CONSIDERED AS AN ACCEPTABLE VALUE]

LOAD IN SPHERICAL BEARING: THE MANUFACTURER'S RATING FOR THIS BEARING IS GIVEN AS 44,300# ALLOWABLE (ABOVE).

MAX. TUBE LOAD = 38,590# (PG. ~~1.24~~ 2-10) $\quad$ M S = $\frac{44,300}{38,590}$ -1 = +.10 $\quad$ +.10

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

REPORT No. 7/0558/C
SHEET No. ~~1-140~~ 2-20

AIRCRAFT: C-105

Analysis Of Heavy Frame Sta. 697

PREPARED BY	DATE
W. B. Grossmann	July 1955
CHECKED BY	DATE

(All Values Ult.)

Analysis Of Center "V-Brace" Structure (Cont'd.) (Ref. Dwg. 7-0258-224)

Check Of Frame Lug: (See Preceding Pg. 2-19 ~~1-139~~)

Lug Yield: $P'_{u_{MIN}} = 37,100^{\#} = P_{BRU}$ (Pg. 2-19 ~~1-139~~)

$$\frac{P'_{u_{MIN}}}{A_{BR}\ F_{TUX}} = \frac{37,100}{.594\,(57,500)} = 1.08 \quad ; \quad C = 1.10 \text{ (From Fig. 5)}$$

$F_{TUX} = 57,500$ psi $\quad F_{TYX} = 48,800$ psi (260° @ 300 hrs, Pg. ~~1-154~~)

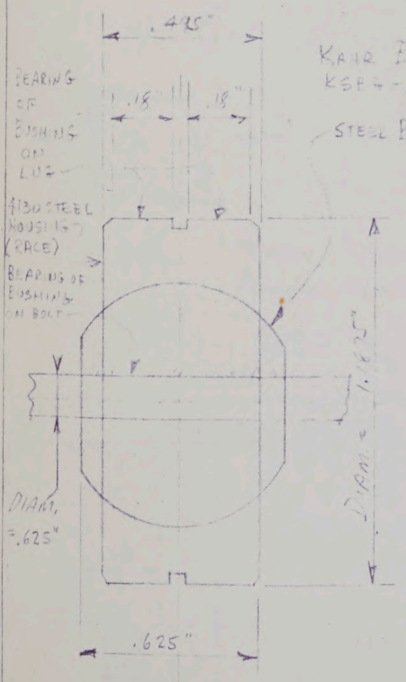
$$P'_y = C \cdot \frac{F_{TYX}}{F_{TUX}} \cdot P'_{u_{MIN}} = 1.10\left(\frac{48.8}{57.8}\right) 37,100 = 34,400 \text{ psi (Yield)}$$

Converting to Equivalent Ult Load $= 34,400 \times \left(\frac{n = 10.0}{n = 7.33}\right) = 47,000$ psi

Max. Tube Load $= 38,590^{\#}$ (Pg. 2-10 ~~1-129~~)

$$MS = \frac{47,000}{38,590} - 1 = +.215$$ +.21

Bushing Yield: Take A_{brb} as the smaller of the bearing areas of bushing on pin or bushing on lug. The central portion of the spherical bushing contains the bolt and is .625" wide. The outer portion of the bushing which is the race, is .495 wide & contains a notch. (Revise)



Kaar Bearing KSB4-10S

Steel Ball

$A_{BRB} = 1.875\,(.18" + .18") = .427\,\square"$ Bushing on Lug

$A_{BRB} = .625\,(.625) = .390\,\square"$ Bushing on Bolt

F_{CY} = Compress. Yield Stress of Bushing
Assuming 4130 Steel H.T. 125 ksi

$F_{CY} = 90\% \times 100,000$ psi $= 90,000$ psi @ 260°F. (Ref. Pg 2-12 ~~1-132~~ & ANC-5)

$$P'_{BRY} = 1.85\, F_{CY}\, A_{BRB} = 1.85\,(90,000)(.390) = 65,000^{\#}$$

Max. Tube Load $= 38,590^{\#}$ (Pg. 2-10 ~~1-129~~)

$$MS = \frac{65,000}{38,590} - 1 = +.68$$ +.68

FORM 1319A

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT NO. ~~7/0558/4~~ SHEET NO. ~~1-144~~ 2-21	
AIRCRAFT C-105	ANALYSIS OF HEAVY FRAME STA. 697	PREPARED BY W. E. GROSSMAN	DATE JULY 1955
		CHECKED BY	DATE

(ALL VALUES ULT.)

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

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 ON SECTION A-A. AT THE EXTREME FIBER (PT. 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. ~~1-124~~ 2-5)

HORIZONTAL COMP. OF P_C & P_T = $P_0 = \left[\frac{2(7.6)}{50.57}\right] 38{,}510^{\#} = 11{,}600^{\#}$ (REF PGS. ~~1-124~~ 2-5, ~~1-129~~ 2-10)

SHEAR AREA = $5.25(.50) = 2.625\ \square''$ (REF. PG. ~~1-139~~ 2-19)

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

MOMENT DUE TO VERT. COMPONENT OF P_C, P_T = $1.8'' \times \left(\frac{50}{50.57}\right) 38{,}510^{\#} = 68{,}700^{''\#}$ [REF. PG. ~~1-139~~ 2-19, ~~1-124~~ 2-5, ~~1-129~~ 2-10]

$f_t = \frac{6M}{bt^2} = \frac{6(68{,}700)}{.50(5.25)^2} = 29{,}900$ psi

PRINCIPAL SHEAR STRESS = $f_{S_{MAX}} = \sqrt{f_S^2 + (f_N/2)^2}$ (REF. ANC-5)

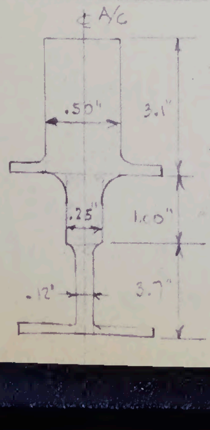
$f_{S_{MAX}} = \sqrt{(4420)^2 + \left(\frac{29{,}900}{2}\right)^2} = \sqrt{243{,}050{,}000} = 15{,}600$ psi

PRIN. TENSILE STRESS: $f_N = \frac{f_t}{2} + f_{S_{MAX}} = 14{,}950 + 15{,}600 = 30{,}550$ psi (REF. ANC-5)

ALLOW. F_{TU} = 57,800 psi
ALLOW. F_{SU} = 35,300 psi (260° @ 300 HRS. PG. ~~1-87~~)

$MS = \frac{1}{\frac{f_N}{F_{TU}} + \frac{f_{S_{MAX}}}{F_{SU}}} - 1 = \frac{1}{\frac{30{,}550}{57{,}800} + \frac{15{,}600}{35{,}300}} = \frac{1}{.528 + .442} = \frac{1}{.98} - 1 = +.02$ +.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 A/C ℄. THE SHEAR AREA IS TAKEN AS SHOWN IN THE SKETCH.



SHEAR AREA = $.50(3.1) + .25(1.00) + .12(3.7) = 1.55 + .25 + .445 = 2.245\ \square''$

VERT. COMPONENT OF P_C, P_T = $\left(\frac{50}{50.57}\right) 38{,}510^{\#} = 38{,}100^{\#}$ (PGS. ~~1-124~~ 2-5, ~~1-129~~ 2-10)

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

ALLOW. F_{SU} = 35,300 psi (260° @ 300 HRS, PG. ~~1-87~~)

$MS = \frac{35{,}300}{17{,}000} - 1 = +1.07$ +1.07

FORM 1319A

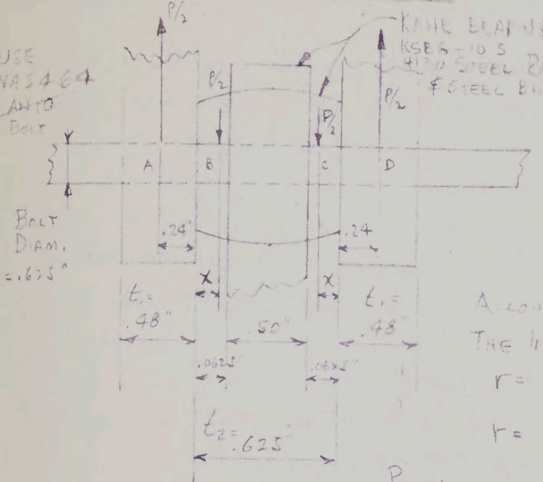
A. V. ROE CANADA LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT: C-105	ANALYSIS OF HEAVY FRAME STA. 617	REPORT NO. 7/0550/4	SHEET NO. ~~1-148~~ 2-22
		PREPARED BY: N. B. GROSSMAN	DATE: JULY 1955
		CHECKED BY:	DATE:

(ALL VALUES ULT)

ANALYSIS OF CENTER "V-BRACE" STRUCTURE [CONT'D]: (REF. DWG. 7-0156-224)

CHECK BENDING OF AN10 BOLT: [ALL CALCULATIONS ARE REFERENCED TO "ANALYSIS OF LUGS" MELCON & HOBLIT, PRODUCT ENG., JUNE 1953]



ASSUME THAT THE STEEL BALL IS SUFFICIENTLY RIGID FOR ITS WIDTH (.625") TO ACT AS A LUG.
∴ USE $t_2 = .625"$ INSTEAD OF .50".

FOR THE INNER LUG: $a = 1.40"$, $D = 1.1875"$ } PG. ~~1-139~~ 2-19

ACCOUNTING FOR THE EFFECT OF "PEAKING" ON THE INNER LUG ONLY:

$$r = \left[\frac{a}{D} - \frac{1}{2}\right]\frac{D}{t_2} = \left[\frac{1.40}{1.1875} - \frac{1}{2}\right]\frac{1.1875}{.625}$$

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

$$\frac{P_{MIN}}{A_{BR}\,F_{TUX}} = 1.08 \quad \text{(REF. PG. 1-140)}$$

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

$$x = \gamma\left(\frac{t_2}{4}\right) = .55\left(\frac{.625}{4}\right) = .086"$$

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

MAX. TUBE LOAD = 38,950# (PG. 1-129) : $P/2 = \frac{38,950}{2} = 19,475$#

BENDING MOMENT = $\frac{P}{2}(.24 + x) = 19,475\#(.24 + .086) = 19,475\#(.326") = 6350$"-#

$$f_b = \frac{Mc}{I} = \frac{M(D)}{(2).0491\,D^4} = \frac{6350}{.0982(.625)^3} = 264,000 \text{ psi}$$

F_B = BENDING MODULUS OF RUPTURE STRESS = K × F_{TU}

K = 1.46 (REF. ANC-5, PG. 30, D/t = 0 FOR A SOLID BOLT SHANK H.T. 125 KSI, AN10)

F_{TU} = 90% × 125,000 = 112,500 psi (@ 260°F, REF. ANC-5 & PG. 1-130)

F_B = 1.46 × 112,500 = 164,500 psi

$$M.S. = \frac{164,500}{264,000} - 1 = -.37$$ (INSUFFICIENT SEE BELOW)

TRY A 5/8" Ø BOLT OF HIGHER H.T. – NAS 464 – H.T. 160,000 psi (REF. ANC-5) REVISE DESIGN

K = 1.55 (REF. ANC-5, PG. 30, D/t = 0 FOR A SOLID BOLT SHANK H.T. 150 KSI)

AS ABOVE, F_{TU} = 96% × 160,000 = 154,000 psi (@ 260°F, REF. ANC-5 & PG. ~~1-130~~ 2-11)
4% RED DUE TO TEMP

F_B = 1.55 × 154,000 = 239,000 psi

$$M.S. = \frac{239,000}{264,000} - 1 = -.10$$ ACCEPTABLE

ASSUMING "X" = 0, & PROCEEDING AS ABOVE: f_b = 185,000 psi & M.S. = 239,000/... −1 = +.14

FORM 1319A

(ALL VALUES ULT.)

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

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

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

ANC-5, TABLE 2.611, PG. 36, GIVES ALLOWABLES FOR CR563 RIVETS IN 18-8($\frac{1}{2}$ HARD) CORROSION RESISTANT SHEET. THE DESIGN MECHANICAL PROPERTIES OF 18-8($\frac{1}{2}$ HARD) CORR. RESIS. SHEET ARE VERY SIMILAR TO THOSE FOR 4340 STEEL, HT 150 KSI (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 $\frac{1}{4}$ CR563 RIVETS IN .058" SHEET: ALLOW. = 2080# (INTERPOLATING IN ANC-5, PG. 36)
BEARING IN SOCKET, .15 THICK 75S-T6 BAR: F_{BRU} = 123 KSI (e/D = 2.0, ANC-5, PG. 51)
ALLOW. F_{BR} = 3860 × 1.23 = 4750# (REF. ANC 5, PG. 85)

FOR ELEVATED TEMPERATURES: RIVET ALLOW = 90% × 2080 = 1870# (REF. PG. 1-~~132~~ 2-12)
MAX. TUBE LOAD = 38,590# (REF. EH PG. ~~1-124~~) 2-10
ASSUMING 24 RIVETS: $LD./_{RIVET} = \frac{38,590}{24} = 1610^{\#}$ $M.S. = \frac{1870}{1610} - 1 = \underline{+.16}$

USING BLIND HUCK LOCKBOLTS, $\frac{1}{4}$"Ø (CS-L-127) PROTRUDING HEAD.

THE ABOVE LOCKBOLT IS MADE OF HEAT TREATED ALLOY STEEL & REQUIRES A DRILL HOLE = .261" DIAM. (REF. AVRO ENG. MANUAL, VOL. I, SECT. II, 6.3 & 6.9.3.). THE ULT. 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 3110# (REF. ANC-5, PG. 36). IN VIEW OF THE LACK OF DATA, IT WOULD BE CONSERVATIVE TO USE THE ALLOW. DEVELOPED ABOVE (FOR CR563 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 .250" FOR THE CR563 RIVET.]

∴ AS ABOVE, USE 24 RIVETS (12 PER FACE)
$\frac{1}{4}$"Ø BLIND HUCK LOCKBOLTS (CS-L-127)
PROTRUDING HEAD

MS = +.16

NOT USED REFER SHT. 1-151

FORM 1318A

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT NO. 7/0558/12	
		SHEET NO. ~~1-1##~~ 2-24	
AIRCRAFT: C-105	ANALYSIS OF HEAVY FRAME STA. 697	PREPARED BY	DATE
		W.B. GROSSMAN	JULY 1955
		CHECKED BY	DATE

(ALL VALUES ULT.)

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

CHECK OF LUG (@ UPPER WING ATTACHMENT FITTING):

REVISE 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 LOAD IN THE TUBE MUST BE TRANSMITTED THRU THE ONE LUG INSTEAD OF TWO (2) LUGS AS AT THE BOTTOM CONTOUR. (PG. ~~1-135~~ 2-15). IF THE FITTING IS MADE OF 75S-T6 STOCK, THE REQUIRED LUG BECOMES TOO LARGE (THE LUG THICKNESS IS FIXED AT .50" BY THE GAP AT THE WING YOKE FITTING, REF. DWG. 7-1062-1149).

IN THE ANALYSIS OF THE WING YOKE FITTING ITSELF (7/0562/8), THE LUG OF THE YOKE FITTING WAS CHECKED FOR A 40,000# TENSILE LOAD. THIS GAVE A RESERVE FACTOR OF R.F. = .95. (7/0562/8, PG. 1-5) HOWEVER, THE LOADS WERE INCREASED BY AN ARBITRARY FITTING FACTOR = 1.30. FOR A 40,000# COMPRESSIVE LOAD, THE YOKE FITTING LUG SHOWED A RF = 1.33 (@ 26° SEE VES. CURVE). IT IS FELT THAT THE YOKE FITTING LUG IS SATISFACTORY FOR THE MAX. TUBE LOADS INDICATED IN OUR REPORT, (35,500# TENSION, 35,680# COMPRESSION - PG. ~~1-132~~ 2-10).

IT HAS BEEN DECIDED TO USE A STEEL FITTING SIMILAR TO THE ONE IN THE STRUT FAIRING AT STA. 485.0 (DWG. 7-1054-392). 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 WELDING WILL BE DONE BY THE CLEVELAND PNEUMATIC TOOL CO. THIS COMPANY IS RECOMMENDING THE USE OF 4135 STEEL (MIL-S-6735) FOR TUBES WHICH ARE FLASH WELDED (MIL 6873 - FLASH WELD SPEC.). REVISE DESIGN

SEE PG. ~~1-144~~ 2-31

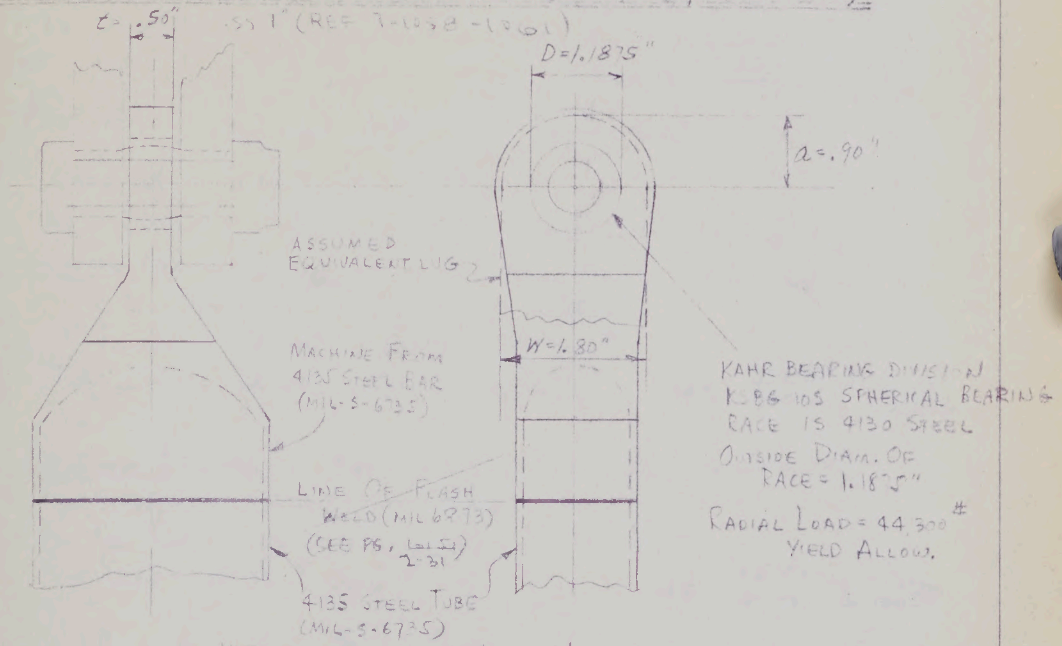
A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT: C-105	Analysis Of Heavy Frame Sta. 677	REPORT NO. 7/0558/4	SHEET NO. 2-25
		PREPARED BY: W. B. GROSSMAN	DATE: JULY 1955
		CHECKED BY	DATE

(All Values Ult.)

Analysis Of Center "V-Brace" Structure [Cont'd.]: (Ref. Dwg. 7-0558-224)

Check Of Steel Socket (@ Upper Wing Yoke Fitting, 7-1062-1949)



The allowables for the 4135 steel (H.T. 150,000 psi) will be arbitrarily reduced by 10% from the values in ANC-5 to account for the effects of elevated temperatures. (260°F. @ 3½ hrs.)

F_{TU} = 150,000 × 90% (96%) = 135,000 psi (144)
F_{TY} = F_{CY} = 135,000 × 90% = 121,500 psi
F_{SU} = 90,000 × 90% = 81,000 psi
F_{BRU} = 190,000 × 90% = 171,000 psi

} TN 2975; Ref. ANC-5 Pg. 24

FORM 1319A

(ALL VALUES ULT.)

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

CHECK OF STEEL SOCKET (@ UPPER WING Y-RIE FITTING, 7-1062-1949)

[ALL CALCULATIONS ARE REFERENCED TO "ANALYSIS OF LUGS" BY MELCON & HOBLIT, PRODUCT ENGINEERING MAY 1950 & JUNE 1953]

$W = 1.80''$ $a = .90''$ $D = 1.1875$ $t = .50''$ (REF. PG. 2-25 ~~1-145~~)

$\frac{W}{D} = \frac{1.80}{1.1875} = 1.52$ $\frac{a}{D} = \frac{.90}{1.1875} = .748$ $\frac{D}{t} = \frac{1.1875}{.50} = 2.38$

$A_{BR} = Dt = 1.1875(.50) = .594\ \square''$

$A_T = (W-D)t = (1.80 - 1.1875)(.50) = (.6125)(.50) = .306\ \square''$

TENSION ACROSS NET SECTION: $K_T = .98$ (FROM FIG. 3, CURVE 1)

$F_{TU} = 135{,}000$ psi (@ 260°F, PG. 2-25 ~~1-145~~)

$P'_{TU} = K_T F_{TU} A_T = .98(135{,}000)(.306) = 40{,}500^{\#}$

MAX. TUBE LOAD = ~~38,590~~ 40,090$^{\#}$ (REF. BH, PG. 2-10 ~~1-129~~) MS $\frac{43200}{40{,}090} - 1$ = +.07 — +.07

SHEAR-BEARING FAILURE: $K_{BR} = .50$ (FROM FIG. 4, FOR $2 < D/t < 3$)

$F_{TUX} = 135{,}000$ (@ 260°F, PG. 2-25 ~~1-145~~)

$P_{BRU} = K_{BR} A_{BR} F_{TUX} = .50(.594\square'')(135{,}000) = 40{,}000^{\#}$ (42,700)

MAX. TUBE LOAD = 38,590$^{\#}$ (REF. BH, PG. 1-129) MS $\frac{42{,}700}{40{,}090} - 1 = +.06$ — +.06

LUG YIELD: $P'_{U_{MIN}} = P'_{BRU} = 40{,}000^{\#}$: $\frac{P'_{U_{MIN}}}{A_{BR}(F_{TUX})} = K_{BR} = .50$

C = 1.10 (FROM FIG. 5)

$F_{TYX} = 121{,}500$ psi, $F_{TUX} = 135{,}000$ psi } 260°F, PG. 2-25 ~~1-145~~

$P'_Y = C \times \frac{F_{TYX}}{F_{TUX}} \cdot P'_{U_{MIN}} = 1.1\left(\frac{121{,}500}{135{,}000}\right)(40{,}000) = 39{,}600^{\#}$ YIELD

EQUIVALENT ULT. LOAD = $39{,}600^{\#} \times \left(\frac{n = 10.0}{n = 7.33}\right) = 54{,}000^{\#}$ NOT CRIT

MAX. TUBE LOAD = 38,590$^{\#}$ (REF. BH, PG ~~1-129~~ 2-10)

BUSHING YIELD: [SEE CHECK MADE ON PG. 2-20 ~~1-140~~] R.F. = 1.68

PIN SHEAR: USING AN NAS 464-10 BOLT (5/8" ⌀) IN DOUBLE SHEAR.

ALLOW. SINGLE SHEAR = 29,150$^{\#}$

ALLOW. DOUBLE SHEAR = 58,300$^{\#}$

MAX. TUBE LOAD = 38,590$^{\#}$ (REF. BH, PG. 2-10 ~~1-129~~) NOT CRIT

THICKNESS OF DOUBLE LUG AT BOTTOM FITTING: NO BUSHING IS REQ'D. ∴ D = .625" (PG. 1-137)

ROUGH PRELIMINARY CALCS. INDICATE t = .30"/LUG IS SATISFACTORY

(All Values Ult.)

Analysis Of Center "V-Brace" Structure [Cont'd.] (Ref. Dwg. 7-0158-224)

Check Of Local Instability & Tension Field Failure:

No mention is made in ANC-5 or Flash Weld Spec. MIL-W-6873 of any reduction in the allow. compressive stress due to the effects of flash welding. [The upset of the material on the inside of the tube at the flash weld adds to the compressive area at the "line of flash weld".] Therefore, the analysis on Pgs. ~~1-130~~ 2-11 to ~~1-134~~ 2-14 is still valid.

Check Of Tensile Stresses In Tube:

The rivets thru the tube & socket [illegible] exist. However, conservatively, we will deduct for 4 - 3/16" Ø rivets (Drill Diam. = .191", Ref. ANC-5, Pg. 85). These rivet holes occur on a cross-section where the cross-beams attach to the tube (Ref. $\overline{CH}$, $\overline{LM}$, Pg. ~~1-129~~ 2-10).

$A_{GROSS} = .488 \square''$ (Ref. Pg. 1-130)

$A_{NET} = .488 - 4(.191)(.058) = .488 - .044 = .444 \square''$

Max. Tube Load = 38,590# (Ref. $\overline{EH}$, Pg. ~~1-129~~ 2-10)

Actual $f_t = \frac{38,590}{.444} = 87,000$ psi

$F_{TU} = 135,000$ psi (210°F, Pg. ~~1-115~~ 2-25)

From ANC-5, Table 2.6123 (a), Pg. 38, & From MIL-W-6873, "Flash Weld"
Allow. Ult. Tensile Stress Of Welds = .8 F_{TU}
= .8(135,000) = 108,000 psi

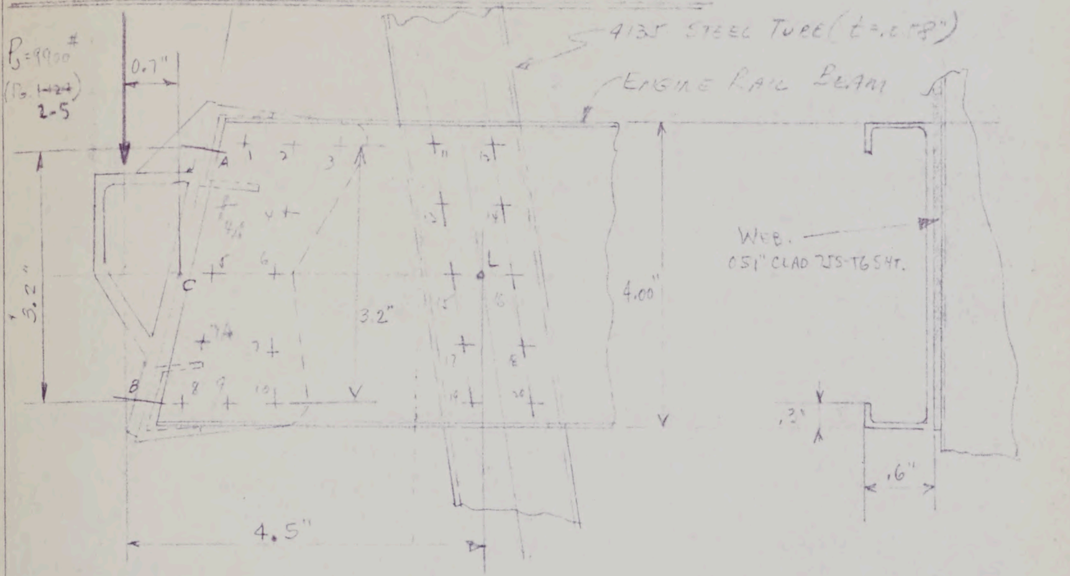
$$M.S. = \frac{108,000}{87,000} - 1 = +.24$$ +.24

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT No. 7/0158/4 SHEET No. ~~1-148~~ 2-28	
AIRCRAFT: C-105	Analysis Of Heavy Frame Sta. 697	PREPARED BY: W. B. Grossman	DATE: July 1955
		CHECKED BY:	DATE:

(All Values Ult.)

Analysis Of Center "V-Brace" Structure [Cont'd]: (Ref. Dwg. 7-0158-224)

Check Of Engine Beam & Attachments:



Check Of Bolts "A" & "B": Try 2 - AN4 Bolts Per Line

Moment Due To Ld. P_J About Pt. "B" = $.7 P_J = .7(9900^{\#}) = 6930$ in-#

Tension Ld. In Bolt = $\frac{M}{3.2 \times 2} = \frac{6930}{6.4} = 1080^{\#} = P_T$

Shear Ld./Bolt = $\frac{9900}{4} = 2470$ #/Bolt in Single Shear = P_S

AN4 Bolt (Ref. ANC-5, Pg. 32) Allow. Single Shear = 3680#   Allow. Tens. = 4080#

$$MS = \frac{1}{\frac{1080}{4080} + \frac{2470}{3680}} - 1 = \frac{1}{.264 + .671} = \frac{1}{.935} = \underline{+.07}$$ +.07

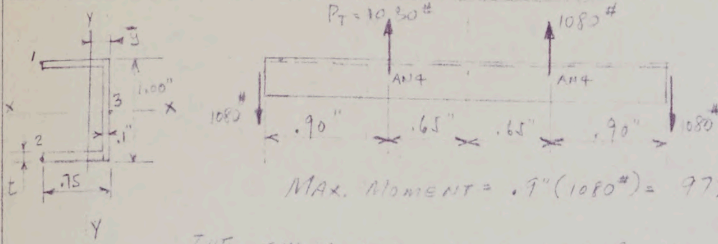
Thickness Of Fitting Should Be Sufficient To Develop The Full Shear Strength Of AN4 Bolt In Bearing. Fitting Is Made Of 75S-T6 Plate, 2 Thick (Ref. ANC-5, Pg. 49) F_{BRU} = 150,000 psi

Req'd. t To Develop 3680# In Brg = $\frac{3680^{\#}}{150{,}000 \text{ psi} (.25")} = .098"$ Use .10" = t

FORM 1319A

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

CHECK OF CHANNEL SECTIONS AT A & B (REF. PG. 1-145 & VIEWS "L-L" & "R-R" OF REF DWG.)



THE TENSION LDS. IN THE AN4 BOLTS CAUSE BENDING ABOUT THE Y-Y AXIS OF THE CHANNEL (PG. ~~1-148~~ 2-28)

MAX. MOMENT = .9"(1080#) = 972"-#

THE SHEAR LDS. IN THE AN4 BOLTS CAUSES BENDING ABOUT THE X-X AXIS OF THE CHANNEL. P_S = 2470#/BOLT. (PG. ~~1-48~~ 2-28)

AS ABOVE MAX. MOMENT = .9(2470) = 2220"-#

BENDING ABOUT AXIS X-X: ASSUMING FLANGE t = .064"

$I_{xx} = 2(.65)(.064)(.468)^2 + \frac{.1(1)^3}{12} = .0183 + .0083 = .0266 \text{ in}^4$

$f_b = \frac{Mc}{I_{xx}} = \frac{2220(.50)}{.0266} = 41,700 \text{ psi}$

BENDING ABOUT Y-Y AXIS: $\bar{y} = \frac{2(.064)(.65)(.425) + 1(.1)(.05)}{2(.064)(.65) + 1(.1)} = \frac{.0354 + .005}{.083 + .10} = \frac{.0404}{.183} = .22"$

$I_{yy} = .083(.425)^2 + .1(.05)^2 + \frac{2(.064)(.65)^3}{12} - .183(.22)^2$

$= .0150 + .0003 + .0029 - .0089 = .0093 \text{ in}^4$

$f_b = \frac{Mc}{I_{yy}} = \frac{972(.53)}{.0093} = 55,400 \text{ psi}$

ABOVE STRESSES DUE TO BENDING ABOUT X-X & Y-Y AXIS ARE TOO HIGH WHEN COMBINED ON CORNER "1" OR "2". ∴ TRY t = .10"

$I_{yy} = .0132$ $\bar{y} = .28"$
$I_{xx} = .0368$ $\bar{x} = .50$
} REF. REPUBLIC AV. CO. STRESS BULLETIN #4

$f_b = \frac{Mc}{I_{xx}} = \frac{2220(.5)}{.0368} = 30,000 \text{ psi}$
$f_b = \frac{Mc}{I_{yy}} = \frac{972(.47)}{.0132} = 34,600 \text{ psi}$
} TOTAL STRESS @ A CORNER = 64,600 psi

ALLOW. F_{cy} = 51,100 psi (2024 BAR HT3, PG. ~~1-67~~)

ASSUMING A MODULUS OF RUPTURE = 1.35 × F_{cy}
= 1.35 × 51,100 = 69,000 psi

$M.S. = \frac{69,000}{64,600} - 1 = +.07$ +.07

(ALL VALUES ULT.)

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

CHECK OF RIVETS 1, 2, 3 (PG. 1-148): MOMENT ON RIVETS 1 TO 10 = 6930"# (PG. ~~1-144~~ 2-28)

LD/RIV. = MOMENT / (3.2 × 6) = 6930 / (3.2 × 6) = 362# DUE TO MOMENT

LD/RIV = P / (2 × 10 RIVS) = 7950 / 20 = 415# DUE TO SHEAR

RESULTANT RIVET LD = $\sqrt{(415)^2 + (362)^2}$ = 614#

ALLOW. RIVET LOAD (AD5 FLAT. HD. IN .051 SHEET) = 536# × 1.16 = 594#/RIV.

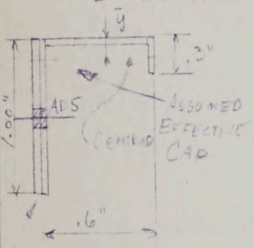
ADDING RIVETS "4A" & "7A" (PG. 1-148) — LD/RIV = 9960 / 24 = 415# (DUE TO SHEAR)

RESULTANT RIVET LOAD = $\sqrt{(415)^2 + (362)^2}$ = 560#/RIV.

MS = 594 / 560 − 1 = +.06 — +.06

CHECK B.M. IN ENGINE RAIL BEAM AT PT. L (PG. ~~1-146~~ 2-28)

BENDING MOMENT = 44,500"# (PG. ~~1-124~~ 2-10, PT. L)



.051" CLAD 75S-T6 SHT. & EFFECTIVE PORTION OF .064" WEB

ȳ = .25" (ASSUMED)

MOMENT ARM = DISTANCE BETWEEN CAP C.G.'S = 4.00" − (.25)(2) = 3.50"

NET AREA OF CAP = (1.00 − .159)(.051 + .064) + .051(.498 + .300)
= .097 + .041 = .138 in²

ALLOW F_{tu} = 54 000 psi (260 @ 300 HRS PG. 1-89)

ACTUAL CAP LOAD = M / d = 44 500 / (3.5 × 2) = 6350#

ACTUAL f_t = 6350 / .138 = 46,000 psi

MS = 54000 / 46000 − 1 = +.17 — +.17

CHECK ATTACHMENT OF BEAM TO MAIN TIERS (RIVETS 11 TO 20, PG. ~~1-148~~ 2-28)

USE 5/32" CHERRY MONEL RIVETS PROTRUDING HEAD
(REF. 7/1558/19, PG. 109
ANALYSIS OF FR. 644)

FOR CHECK OF ALL REMAINING STRUCTURE SEE ANALYSIS IN 7/1558/19
AS LOADS IN OUR STRUCTURE EQUAL OR ARE LESS THAN THOSE FOR FRAME 644
WE WILL DUPLICATE ALL REMAINING STRUCTURE FOR OUR FRAME (REF 7-0158-213)

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT No. 7/0558/4 SHEET No. ~~1-151~~ 2-31	
AIRCRAFT: C-105	ANALYSIS OF HEAVY FRAME STA. 697	PREPARED BY: W. B. GROSSMAN	DATE: JULY 1955
		CHECKED BY:	DATE:

(ALL VALUES ULT.)

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

ALTERNATE ATTACHMENT OF TUBE TO SOCKET: (REF. PG. ~~1-138~~ 2-15 & ~~1-143~~ 2-23)

IT HAS BEEN DECIDED TO USE $\frac{3}{16}$" Ø JO BOLTS IN THIS ATTACHMENT.
THE SINGLE SHEAR STRENGTH = 2625 #/BOLT (REF. AVRO LIBRARY No. N-1-20-10E)

HOWEVER, BY THE SAME REASONING PRESENTED ON PG. ~~1-151~~ 2-31:

(A)

BOLT ALLOW. = 90% × 14 #... = 1260 #/BOLT. (REF. MK-5, PG. 36)
MAX. TUBE LOAD = 38,590# (REF. BH, PG. ~~1-124~~ 2-10)

ASSUMING 32 BOLTS: $L_D/_{BOLT} = \frac{38,590}{32} = 1205^{\#}$

$M.S. = \frac{1260}{1205} - 1 = +.043$ +.04

LATEST INFORMATION IS THAT THE UPPER FITTING WILL BE OF STEEL & THE LOWER FITTING WILL BE ALUMINUM, BUT THAT BOTH WILL BE ATTACHED TO THE TUBE BY JO-BOLTS AS SHOWN ABOVE.

THE ALUMINUM FITTING AT THE BOTTOM OF THE "V-BRACE" CAN REMAIN EXACTLY AS BEFORE (SEE PG. ~~1-135~~ 2-15).

THE STEEL FITTING AT THE TOP WILL BE SIMILAR TO THE BOTTOM FITTING EXCEPT FOR THE LUG PORTION WHICH WILL BE AS SHOWN ON PG. 1-146. THE WALL THICKNESS OF THIS TOP FITTING SHOULD BE AT LEAST .10".

(A) F_{BR_U} FOR MIL-T-6736 = 190000 PSI

$P_{BR_U} = 1.9 \times 1100 \times .75 = 1565$ LB

FROM THIS, USING F.. ABOVE (1260) FOR STAINLESS SHEET IS PROBABLY CONSERVATIVE.

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT: CF-105	FRAME 697	REPORT No. 7/0358/4	
		SHEET No. 1-175 2-32	
		PREPARED BY	DATE
		G.M.	APRIL 11, 1956
		CHECKED BY	DATE

VEE BRACE STRUCTURE

FOLLOWING PAGES SUPERCEDE OR SUPPLEMENT ALL WORK UP TO THIS TIME ON VEE BRACE STRUCTURE

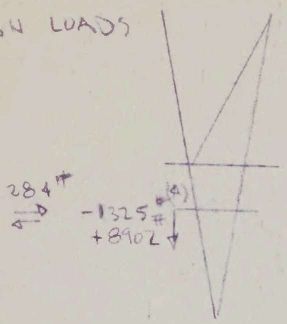
FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT: CF-105	FRAME 697	REPORT No. 7/0558/4	SHEET No. ~~1-176~~ 2-33
		PREPARED BY: GM	DATE: 4-56
		CHECKED BY:	DATE:

ENGINE REMOVAL CASE

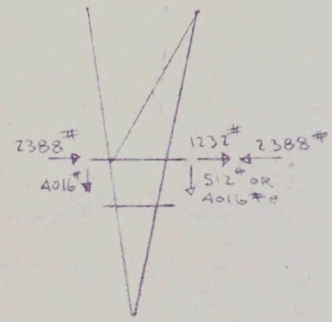
ULT DESIGN LOADS



VERT & SIDE LOAD CAN BE COMBINED IN ANY MANNER.

INB'D DUCT BEAM

REF 6-12-55 MEMO BY IDDON

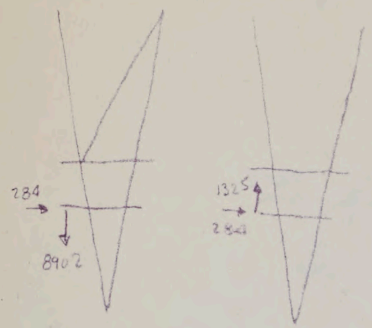


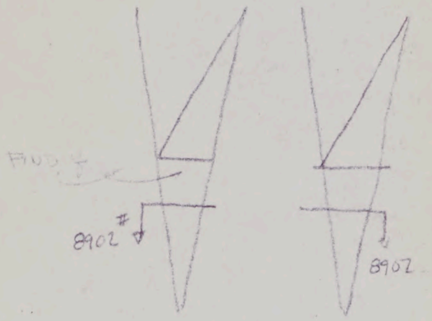
FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

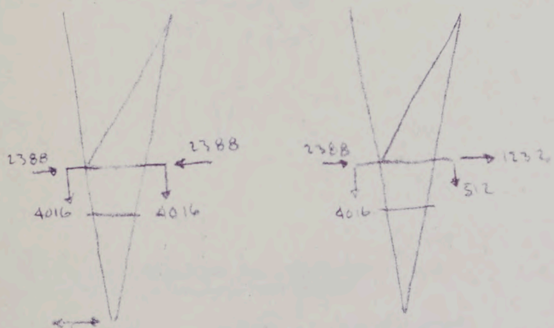
AIRCRAFT: CF-105	FRAME 697	REPORT No. 7/0558/4	
		SHEET No. ~~1-177~~ 2-34	
		PREPARED BY: GM	DATE: APR 1956
		CHECKED BY:	DATE:

INTERNAL "V" BRACE STRUCTURE ~ 697
ENGINE REMOVAL





CRIT CASES ∴ NEGLECT
SIDE LOAD & RATIO
8902/9900 LOADS ON P. 2-9



10,540# LOAD HAS NO
EFFECT ON INTERNAL
STRUCTURE ∴ NEGLECT

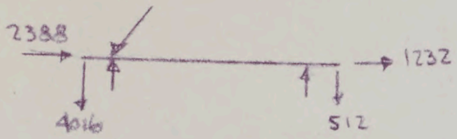
FORM 1316A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

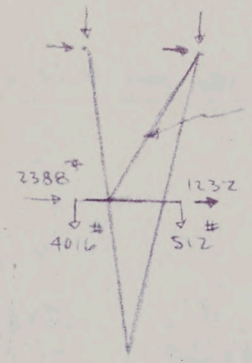
AIRCRAFT: CF-105	FRAME 697	REPORT No. 7/0558/4	
		SHEET No. ~~1-178~~ 2-35	
		PREPARED BY	DATE
		GM	APR 1956
		CHECKED BY	DATE

DUCT BEAM

CRIT IN BENDING
NOT CRIT AS BEAM COLUMN BECAUSE OF EXTREME DEPTH
CHECK CAPS AS COLUMN IN FORE & AFT DIRECTION



CRIT IN SHEAR IN WEBS



DETERMINE IF LOADING IS CRITICAL IN STRUT

ENGINE REMOVAL BEAM

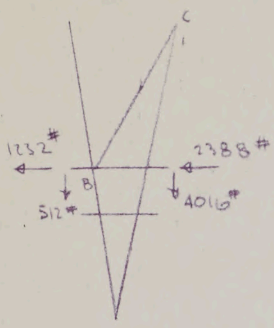
FORM 1310A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

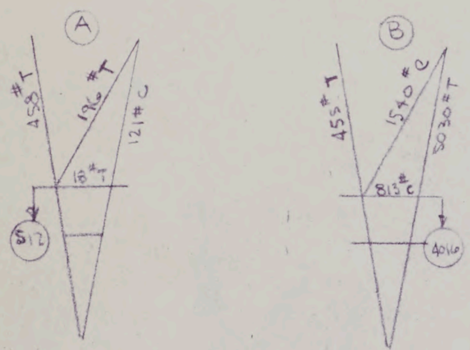
AIRCRAFT: CF-105	FRAME 697	REPORT No 7/0558/4	SHEET No ~~1-119~~ 2-36
		PREPARED BY: GM	DATE: 4-56
		CHECKED BY	DATE

VEE BRACE

THE DIAGONAL STRUT MEM "BC" (P1-124) HAS BEEN SIZED ON BASIS OF 4290# (P ~~1-129~~ 2-10) HOWEVER, NEW DUCT LOADS WILL BE CONSIDERED BELOW TO FIND IF THEY ARE CRITICAL:



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



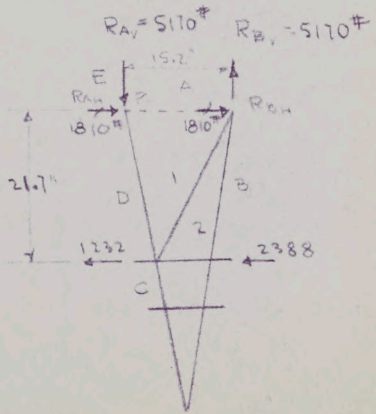
SOLVE FOR TRUSS DUE TO SIDE LOADS:

$$R_{A_H} = R_{B_H} = \frac{1232 + 2388}{2} = 1810^{\#}$$

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

$\therefore R_{A_V} = 5170^{\#} \downarrow$

$\& R_{B_V} = 5170^{\#} \uparrow$

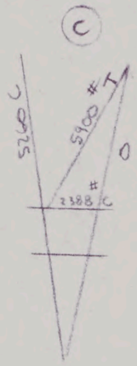


AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

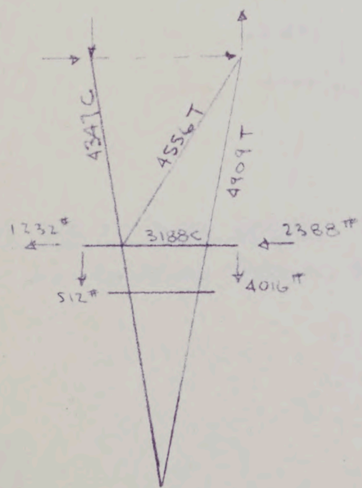
AIRCRAFT: CF-105	FRAME 697	REPORT No. 7/0558/4	
		SHEET No. 2. 1-180 2-37	
		PREPARED BY: GM	DATE: 4-56
		CHECKED BY	DATE

VEE BRACE - GRAPHICAL SOLUTION

SCALE 1" = 2000#



SUMMARY (A) + (B) + (C)



5900 T
196 T
6096 T

6096 T
1540 C
4556 T

813 C
2388 C
3201 C
-18 T
3183 C

458 T
455 T
913 T

5260 C
913
4347 C

5030 T
-121 C
4909 T

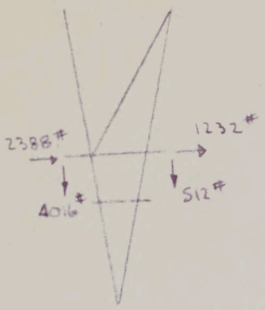
FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

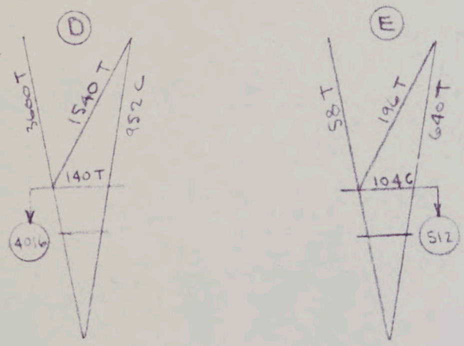
REPORT NO. 7/0558/4		SHEET NO. ~~1-181~~ 2-38	
AIRCRAFT: CF-105	FRAME 697	PREPARED BY: G.M	DATE: 4-56
		CHECKED BY:	DATE:

VEE BRACE

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

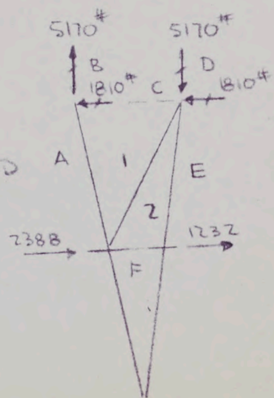


RATIO FROM P ~~1-125~~ 2-6 FOR VERT LOADS:



SOLVE FOR TRUSS DUE TO SIDE LOADS:

REACTIONS SAME AS BEFORE EXCEPT REVERSED

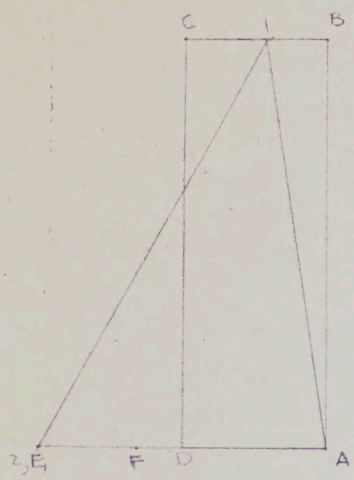


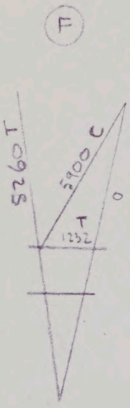
AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

AIRCRAFT:		REPORT NO. 7/0558/4	
		SHEET NO. ~~4~~ 1-182 2-39	
		PREPARED BY	DATE
CF-105	FRAME 697	GM	4-56
		CHECKED BY	DATE

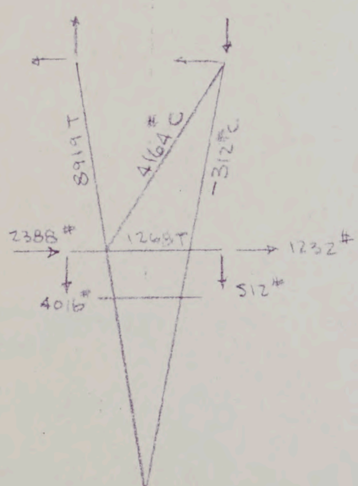
VEE BRACE - GRAPHICAL SOLUTION

SCALE 1" = 2000#





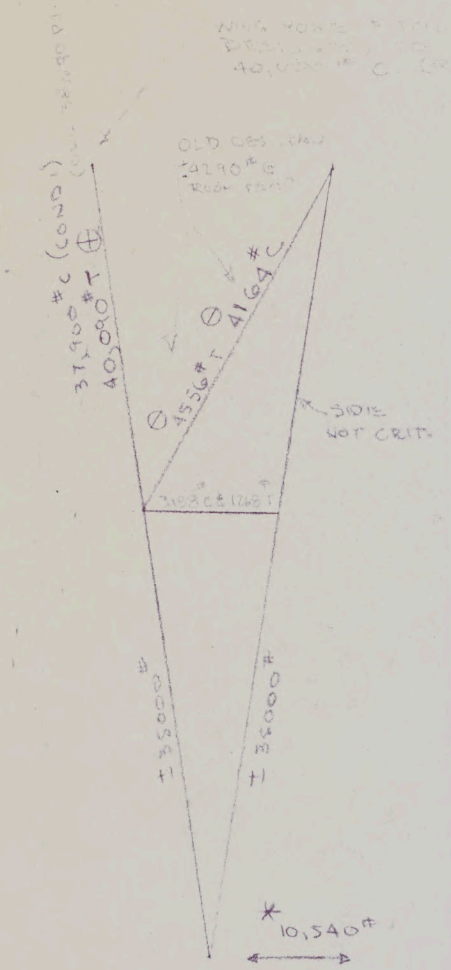
SUMMARY (D) + (E) + (F)



FORM 1319A

AVRO AIRCRAFT LIMITED MALTON · ONTARIO TECHNICAL DEPARTMENT		REPORT NO. 7/0558/4 SHEET NO. ~~1-184~~ 2-40	
AIRCRAFT: CF-105	FRAME 697	PREPARED BY: G.M	DATE: APR 1956
		CHECKED BY:	DATE:

SUMMARY – CRITICAL DESIGN LOADS



RPT 7/0558/27
P. 2-39 P1-95

⊕ 8919# T × .57 = 5090# T + 35000 T = 40,090# T

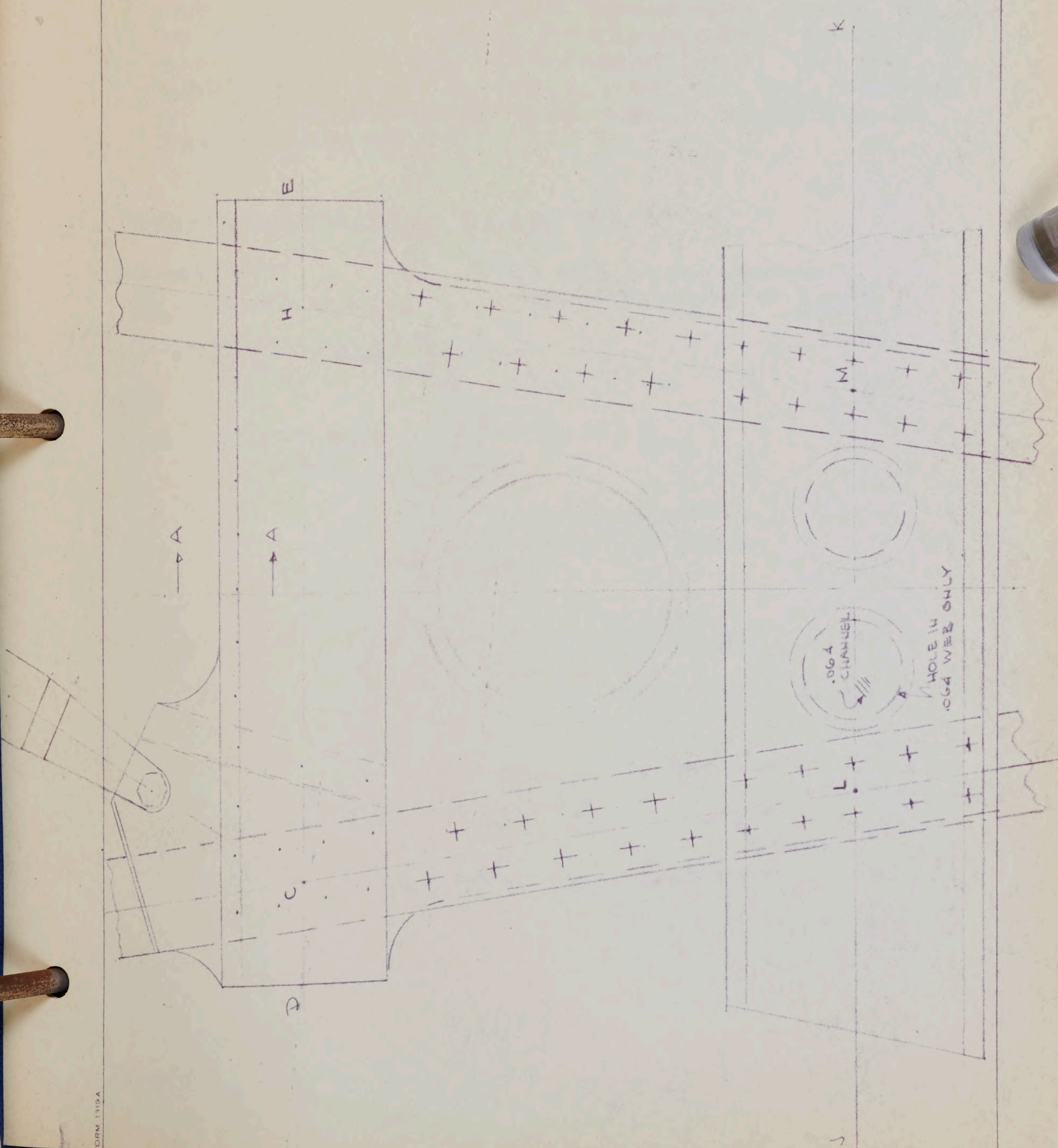
⊖ CASE ___ MN 2.12 n = 8.19

* THIS LOAD ACTUALLY REDUCES TO APPROX 3000# (DITCHFIELD APRIL 11, 1956) ∴ TUBE END LOAD = 35,000 × $\frac{3000}{10,540}$ + 5090 = 15,040#. (WAS 40,090) STRESSING CASE NOT CRITICAL IN STL TUBES, STIFFNESS IS DESIGN

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

REPORT No. 7/0558/4			
SHEET No. 2-41			
AIRCRAFT: CF-105	FRAME 697	PREPARED BY: G. MEYERS	DATE: APR. 1956
		CHECKED BY:	DATE:

VEE BRACE ANALYSIS



FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

REPORT NO. 7/0558/4
SHEET NO. ~~2~~ ~~1-187~~ 2-42

AIRCRAFT:		PREPARED BY	DATE
CF-105	FRAME 697	G. MEYERS	MAR 1956
		CHECKED BY	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 IDDON, 6 DEC 55) THE STRUCTURE WILL BE RE-EXAMINED WITH WEIGHT REDUCTION AS THE OBJECTIVE.

ENGINE REMOVAL BEAM "JLMK" P 2-41

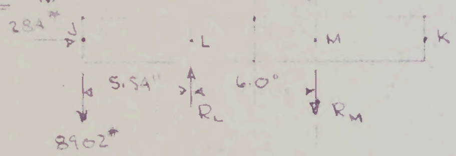
CALC. REACTIONS:

$\overset{\frown}{\Sigma M_L} = -8902 \times 5.54 + 6 R_M$

$\therefore R_M = \frac{8902 \times 5.54}{6} = \underline{8219.5}\ \#(\downarrow)$

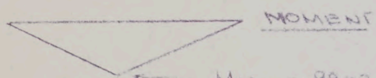
$\overset{\frown}{\Sigma M_M} = +6 R_L - 11.54 \times 8902 = 0$

$R_L = 11.54 \times 8902 / 6 = \underline{17{,}121}\ \#(\uparrow)$

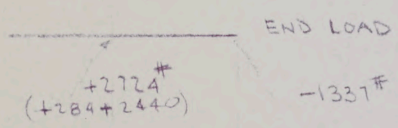


CHECK

$\Sigma F_V \uparrow = 0 = 17{,}121 - 8{,}219.5 - 8{,}902$
(CHECK)



$M_{MAX} = 8902 \times 5.54 = -49{,}317\ ''\#$



$-1170\left(\frac{8902}{9900}\right) = -1053\ \#$

P. 1-128 $\rightarrow 2710 \times \frac{8902}{9900} = 2440\ \#$

FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON : ONTARIO
TECHNICAL DEPARTMENT

REPORT No. 7/0558/4
SHEET No. ~~1/188~~ 2-43

AIRCRAFT:		PREPARED BY	DATE
CF-105	FRAME 697	G. MEYERS	MAR 1956
		CHECKED BY	DATE

"VEE" BRACE ~ ENG REMOVAL BEAM

WEB ANALYSIS BETWEEN "L" & "M"

$h = 2.2''$ $V = 8219^{\#}$

$q = \frac{8219}{2 \times 2.2} = \underline{1880}^{\#}/''$

TRY .064" SPACING = d = 2.2"

$q_{ALLOW} = 2050^{\#}/''$ (GLM FIG 501:05)

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

CHECK CAPS AS BEAM-COLUMN

$d = \left(\frac{50 I_{EFF} h}{t}\right)^{.25}$ (GLM SDM ~~#501.324~~)

NOT REQ'D ~ REPLACING WEB SLOT WITH 2 - 1½ DIA HOLES.

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT

REPORT No 7/0558/4
SHEET No 4 2-44

AIRCRAFT:		PREPARED BY	DATE
CF-105	FRAME 697	G. MEYERS	MAR 1956
		CHECKED BY	DATE

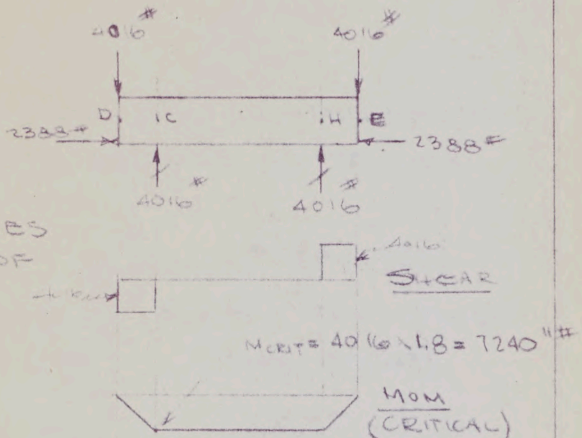
"VEE" BRACE (CONT'D)

DUCT BEAM "DCHE"

COND FOR $MOM._{MAX}$:

LWR (COMP) CAP IS CRIT AS COLUMN

THIS ANALYSIS ONLY INVESTIGATES BETWEEN PTS "C & H". OUTB'D OF THESE POINTS IS CHECKED BY J. MANNING'S GROUP.



LOADING COND FOR MAX SHEAR:

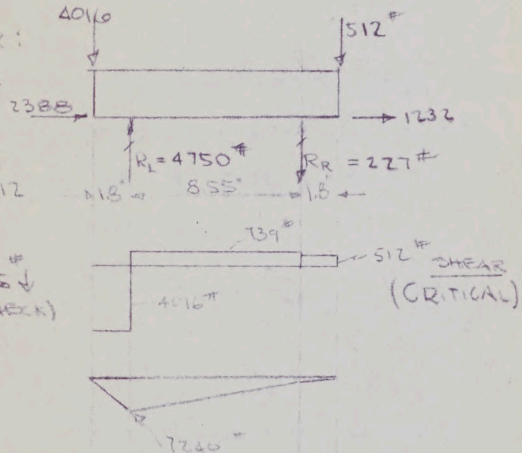
$\Sigma M_{R_L} = 0 = -4016 \times 1.8 + 8.55 R_R + 512 \times 10.35$

$R_R = +1940 / 8.55 = +227^{\#} \downarrow$

$\Sigma M_{R_R} = 0 = -4016 \times 10.35 + 8.55 R_L + 1.8 \times 512$

$R_L = 40679 / 8.55 = 4750^{\#} \uparrow$

$\Sigma F_V \uparrow = 4750 - 227 - 4016 - 512 = 5^{\#} \downarrow$ (CHECK)



AVRO AIRCRAFT LIMITED, MALTON - ONTARIO — TECHNICAL DEPARTMENT		REPORT NO. 7/0558/4	
		SHEET NO. 1-190 2-45	
AIRCRAFT:		PREPARED BY	DATE
CF-105	FRAME 697	G. MEYERS	APRIL 1956
		CHECKED BY	DATE

VEE BRACE STRUCTURE

SHEAR WEB "CLMH" P. 2-41

ANALYZE .064 PANEL WITH 3½" LIGHTENING HOLE BY NACA ARR #158. THIS ASSUMES NO TENSION FIELD IS FORMED.

ENGINE REMOVAL CRITICAL $P_3 = 8902^{\#}$ (P 1-126)

$\therefore q = 8902 \times .048 = 428^{\#}/_{''}$ FOR 2 WEB
(.048 from P 1-126)

$q/\text{WEB} = 214^{\#}/_{''}$

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

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

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 = .8 :

READ $q_{ALLOW} = 325^{\#}/_{''}$ FOR 24ST SHT

CONSERV USE SAME FOR 75 ST CLAD:

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

WEB RIVETING

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

$P/\text{RIVET} = 214^{\#}/_{''}$

5/32 RIVETS IN .064 $P_{ALLOW} = 596^{\#}$

$$MS = \frac{596}{214} - 1 = > 1$$

FORM 1319A

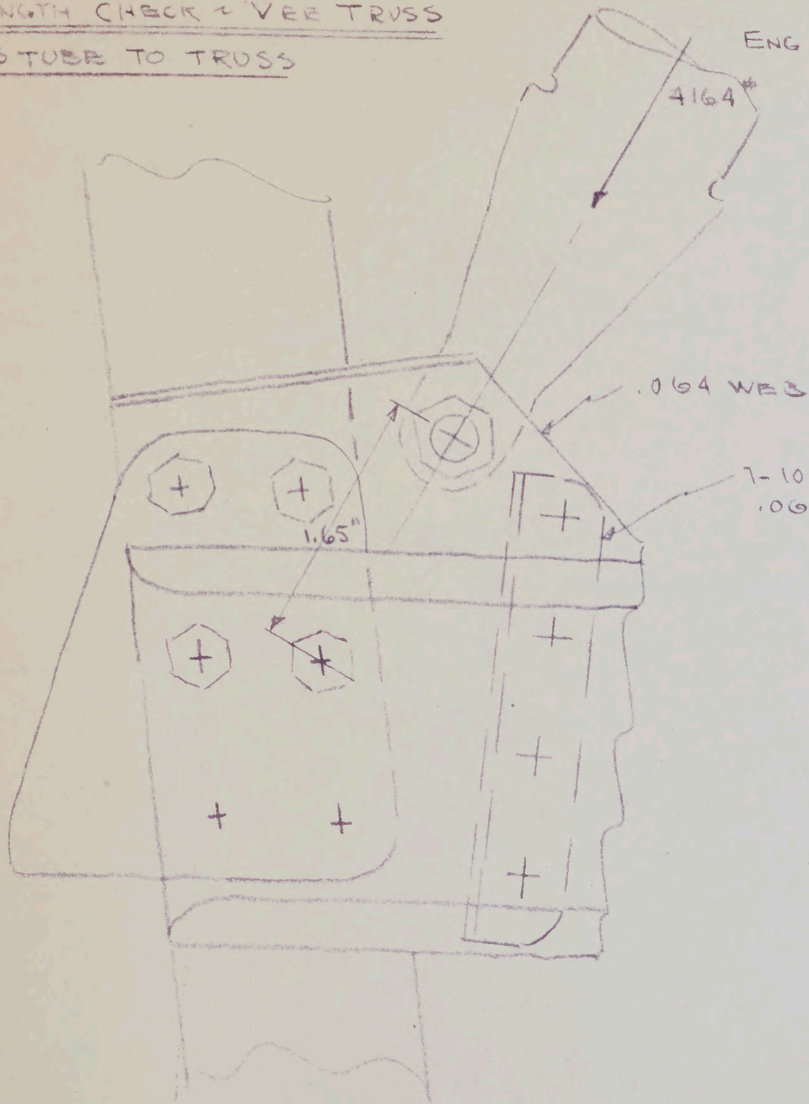
AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

REPORT No. 7/0558/4			
SHEET No. 1-192 2-46			
AIRCRAFT: CF-105	FRAME 697	PREPARED BY: GM.	DATE: APRIL 1956
		CHECKED BY	DATE

STRENGTH CHECK – VEE TRUSS

CROSS TUBE TO TRUSS

ENG REM. CASE



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

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

$F_{I.R.} = 44,500$ PSI (LOCK. SM 68 P.4 FOR .064 CLAD 75S-T6)

CONSIDER 1" STRIP

$\therefore P_{IR} = 2 \times .064 \times 44,500 = 5700^{\#}$ (1 ON EA SIDE)

TEMP RED.

$MS = \frac{5700 \times .79}{4164} - 1 = +.08$

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

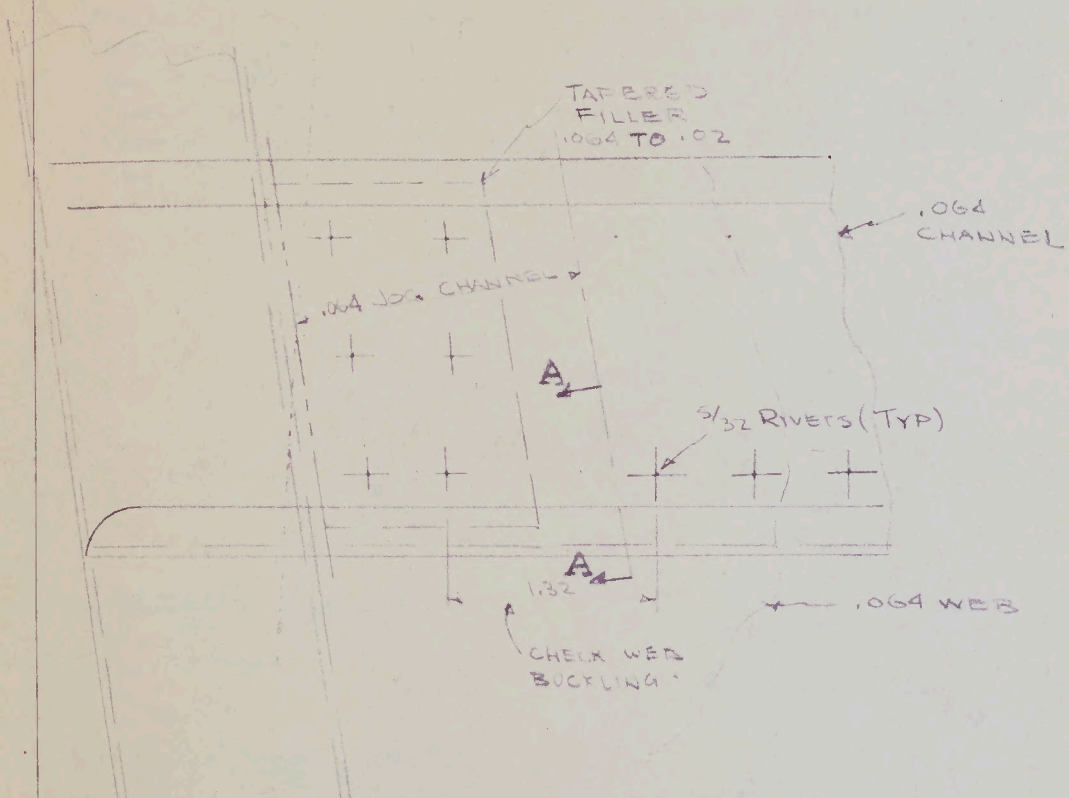
FORM 1319A

AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

REPORT No.	7/0558/4
SHEET No.	17193 2-47
PREPARED BY	DATE
G. MEYERS	APRIL 1956
CHECKED BY	DATE

AIRCRAFT: CF-105 | FRAME 697

VEE BRACE STRUCTURE – DUCT BEAM



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

$M/h = 7240/2.2 \times 2 = -1650$# END LOAD DUE TO BENDING.
(2 BRACES)

REF DUCT LOAD MEMO

$-2388/2 = -1194$# END LOAD DUE TO DIRECT LOAD

* ASSUME DIST. ON 2 LWR CAPS ONLY (CONSERV)

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

AREA LWR CAP (INCLUDING 1" .064 WEB) $= .064[1 + .875 + .25 + .55] = .171$ IN² (2.675)

$P/A = -2844/.171 = 16,600$ PSI

$s/t = 1.32/.064 = 20.6$

$F_{IR} = 53,000$ PSI (REF LOCK SH. 68 FOR .064 WEB IN INTERRIVET BUCKLING)

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

FORM 1319A

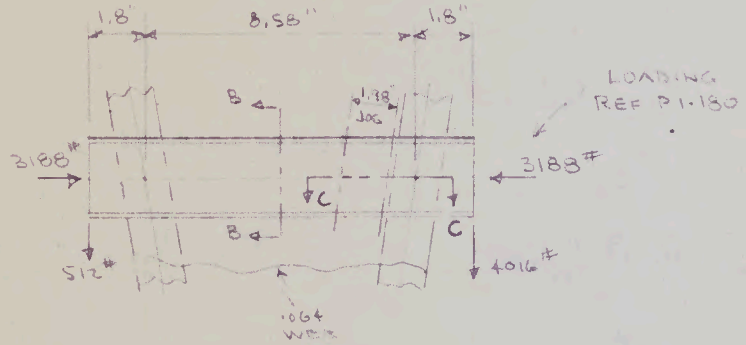
AVRO AIRCRAFT LIMITED
MALTON · ONTARIO
TECHNICAL DEPARTMENT

REPORT No. 7/0558/4	SHEET No. ~~1-194~~ 2-48
PREPARED BY: G. MEYERS	DATE: APRIL 1956
CHECKED BY:	DATE:

AIRCRAFT: CF-105 — FRAME 697

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

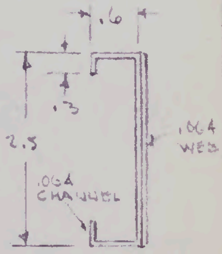
BEAM IS JOGGLED .064" JUST INBOARD OF PT "C" P 1-186. IN THE AREA OF THE JOGGLE, THE BEAM IS SUPPORTED BY A TAPERED FILLER. THE 3 ITEMS (CHANNEL, WEB & TAPERED FILLER ARE RIVETED TOGETHER BY 5/32 RIVETS. BECAUSE OF THE HIGH AXIAL LOAD, CASE ____ SHOWN ON P 1-~~180~~ 2-37 WILL BE CRITICAL. THE CHANNEL WILL BE CHECKED FOR CRIPPLING FAILURE AT INB'D EDGE OF TAPERED FILLER. (SEE SECTION A-A P ~~1-193~~ 2-47). LOWER CAP OF CHANNEL IS IN COMP. ∴ CRITICAL.



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

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

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



SECT B-B

CONSERV. CONSIDER MAX. MOM. IS APPLIED TO SECT A-A P1-194:

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

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

TOTAL STRESS IN CHANNEL AT JOG $\quad -19,290$ PSI

AVRO AIRCRAFT LIMITED
MALTON ONTARIO
TECHNICAL DEPARTMENT

REPORT No. 7/0558/4
SHEET No. 1-195 2-49

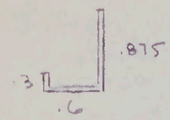
AIRCRAFT: CF-105 | FRAME 697

PREPARED BY | DATE
CHECKED BY | DATE

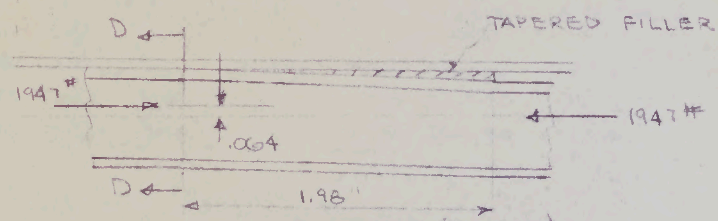
JOGGLE ANALYSIS (CONT'D)

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

CAP AREA = .064(.25 + .50 + .825) = .101 IN²



∴ CAP END LOAD = 19,290 × .101 = 1947#
P. 1-194



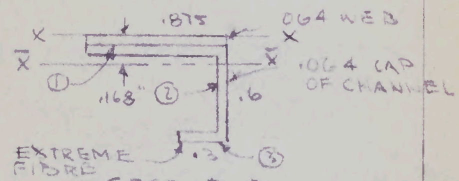
SECT C-C (P 2-48)

∴ M_{JOG} = 1947 × .064 = 125 IN-LBS

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

CHECK EXTREME FIBRE AT D-D

SECT PROP:



SECT D-D

ITEM	W	h	A	Y	AY	Y−$\bar{Y}$	(Y−$\bar{Y}$)²	A(Y−$\bar{Y}$)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 IN⁴

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

$$f_b = \frac{125(.664 - .168)}{.00487} = -12,740 \text{ PSI AT EXTREME FIBRE}$$

(.496)

∴ TOTAL STRESS = −12,740 − 19,290 = −32,030 PSI

FORM 1319A

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 (P1-195) IS UNIFORM AND COMPARE WITH CRIPPLING ALLOWABLE:

ITEM (SEE P1-195)	b	t ▷1	t' ▷2	b/t'	COND	AREA	F_{CRIP} 24ST (GLM FIG 403.18)	$A \times F_{CRIP}$
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 IN²		7760 #

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

CONVERTING INTO 75 ST CLAD BY GLM FIG 403:19

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

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

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

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

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