

QCX
Avro
CF105
R-7-0558-12
Iss-2



TECHNICAL REPORT



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12 155.2.

SHEET NO. INDEX - 1

AIRCRAFT:

C105

TORSION BOX B.L. 18.5
'LOADING'

PREPARED BY

DATE

E.J. MANNING

MAR./56

CHECKED BY

DATE

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INTRODUCTION



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REPORT NO. 7-0558-12/2

SHEET NO. 2

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REFERENCES

REPORTS, ETC

- 1- 7-0558-32 DISTRIBUTION OF SHROUD TORQUE
- 2- 7-0558-13 PINNED PANEL & GEAR BOX SUPPORTS
- 3- AVRO STRESS MANUAL
- 4- STEINBRICK & GERARD AIRCRAFT STRUCTURAL MECHANICS
- 5- ROYAL AERONAUTICAL SOCIETY DATA SHEET VOL. II
- 6- STRUCTURAL PRINCIPLES AND DATA - G. DAWTY
- 7- 'FORMULAS FOR STRESS & STRAIN' - ROUSKE
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- 9- 'ANALYSIS & DESIGN OF AIRPLANE STRUCTURES' - BENDAT
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6 MAR 56

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2- SHEET NO. 2 (2)

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STRESSING CASES

THE FOLLOWING STRESSING CASES WERE CONSIDERED. THEY WERE OBTAINED FROM REF 2 SHTS 1-27 & 128 AND FROM REF 11. FOR EACH PARTICULAR CASE THE SEVEREST CASE ONLY FROM EITHER SOURCE WAS CONSIDERED.

CONDITION	P_s	P_b	P_i	g
1	1.36	+4.50	-2.10	10.0
2	+1.36	-5.50	-2.10	10.0
3	-1.74	+4.50	11.50	10.0
4	-1.74	-5.50	11.50	10.0
5	-0.68	3.47	24.85	0.45
6	-0.68	-1.36	24.85	3.45
7	-3.50	4.50	15.40	-4.27
8	-3.50	-1.36	15.40	-4.27
9	+1.0	3.47	24.85	-4.27
10	1.0	-1.36	24.85	-4.27
10A	1.0	4.50	-2.05	-4.27

 P_s = SIDE PRESS (LBS/INS²) P_b = BOTTOM PRESS (LBS/INS²) P_i = INTERNAL " " g = INERTIA FACTORSNOTE ALL ABOVE ARE GIVEN AS BEING ULTIMATE.

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SHEET NO. 4

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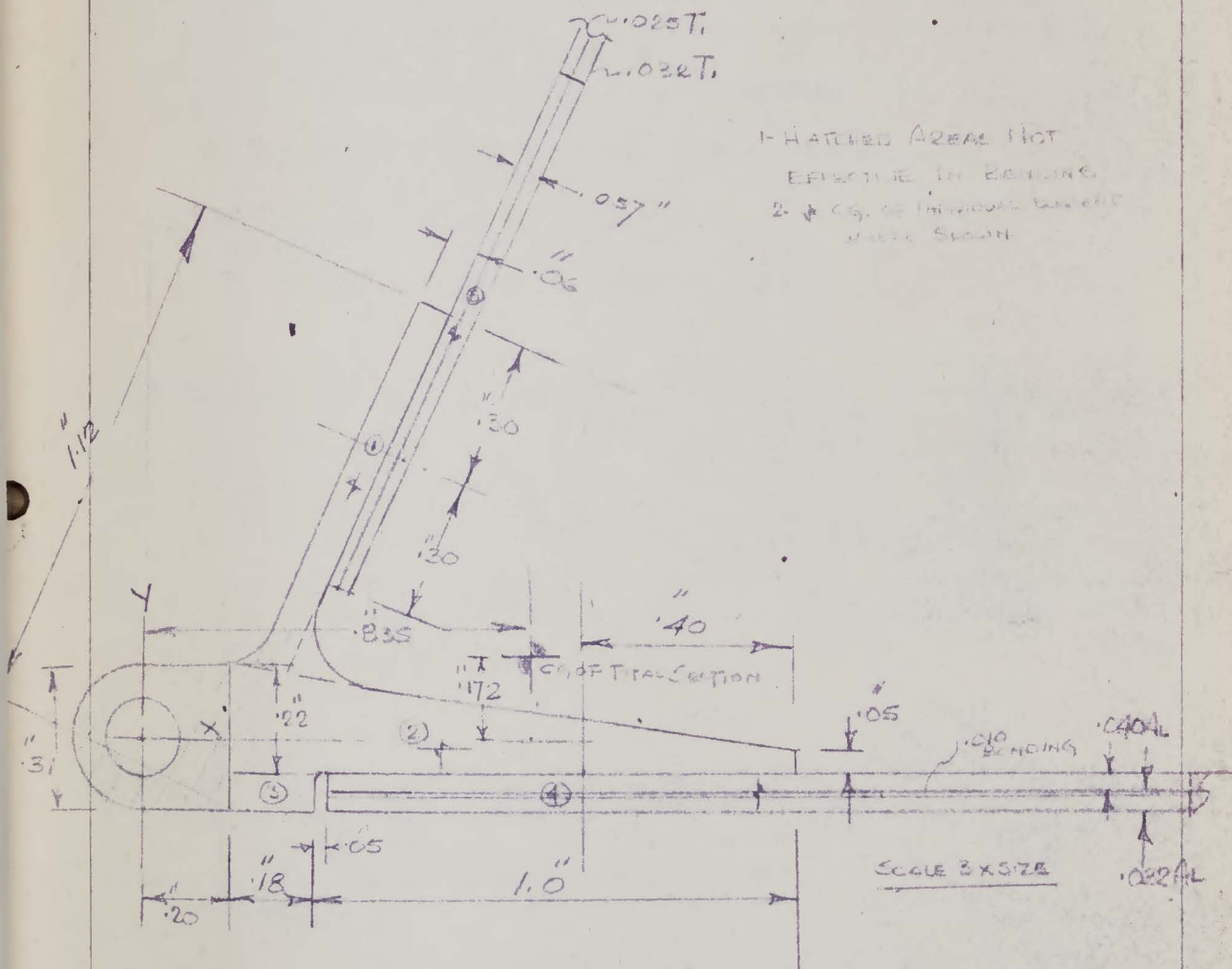
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TORSION BOX SECTION PROPERTIES

SECTION ①



1-Hatched Aztec Mot

EFFECTS OF ZINC

2. ∇ C.G. of triangle formed by the sides

$$E_A \text{ AT } 265^\circ \text{ F} = 9.55 \times 10^6 \text{ LBS/IN}^2$$

$$E_T \text{ At } 265^\circ\text{F} = 14.2 \times 10^6 \text{ lb/in}^2$$

COMPARATIVE T FOR T_1 IN AL WILL BE BASED $\sqrt{E}$

$$e. \quad t_{AL} = t_{TL} \left(\frac{E_{TL}}{E_{AL}} \right)^{1/2} = -t_{TL} \left(\frac{14.2}{9.55} \right)^{1/2} = t_{TL} \times 1.22$$

∴ COMPAREABLE TITANIUM THICKNESS IN ALUMINUM

$$T_{\text{ave}} = t_T \times 1.22$$



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TORSION BOX SECTION PROPERTIES SECTION (1) (CONT'D)

TAKING .30t AS BEING THE EFFECTIVE WIDTH OF SHEET TO BE USED IN BENDING WITH THE EXTRUSION, LE 15t EITHER SIDE OF A RIVET LINE.

∴ EFFECTIVE WIDTH OF TITANIUM CONSIDERED AS ALUMINUM

$$= .30 + 15 \times .057 = .30 + .855 = 1.155 \text{ INS}$$

EFFECTIVE WIDTH OF LOWER SHEETING

$$= .55 + .082 \times 15 = .55 + 1.23 = 1.78 \text{ INS}$$

ITEM	b	t _{av}	A	y	I _y	x	Ax
1	.80	.06	.0480	.61	.00230	.43	.02065
2	1.13	.135	.1525	-.013	.00208	.65	.1038
3	.18	.07	.0162	-.11	.00117	.29	.0047
4	1.73	.082	.1460	-.114	.01465	1.32	.1930
5	1.155	.0695	.0803	.85	.0683	.666	.0533
Σ			.4500	.1715	.0771	.935	.3755

NOTE THE .025 Ti DOUBLER EXTENDS FROM STA 591.65 TO 601.25 & FROM 630.05 TO 644.43. THE .025 DOUBLER HAS BEEN INCLUDED IN THE SECTION PROPERTIES THROUGHOUT THE TORSION BOX. ITS EFFECT ON THE OVERALL STIFFNESS OF TORSION BOX IS CONSIDERED TO BE NEGLIGIBLE.

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SHEET NO. 6

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TORSION BOX SECTION PROPERTIES (CONT'D):

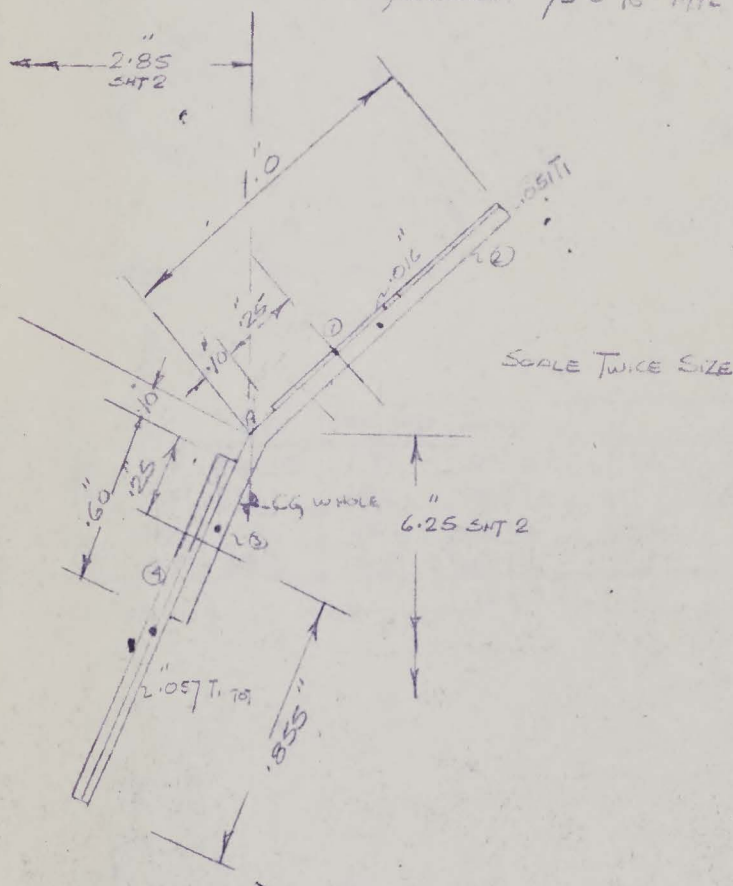
SECTION (2)

EFFECTIVE WIDTH 1st EITHER SIDE OF RIVER LINE

Effective width of 016 T₁ = $30 \times 0.16 = 4.8$

EFFECTIVE WIDTH OF .057T = .25 + .057 \times 15 = 1.105

ALL THICKNESSES TO BE MULTIPLIED $\times 1.22$ TO BRING THEM UP
TO EQUIVALENT 75-S TO 1976 REF SHT 4



ITEM	b	t	A	Factor	Factor 1000	y	Ay	x	Ax
1	.48	.016	.0718	1.22	.00337	6.42	.0608	3.10	.0291
2	1.0	.051	.0510	1.22	.0623	6.57	.408	3.24	.202
3	.60	.051	.0306	1.22	.0373	5.96	.222	2.76	.103
4	1.105	.057	.0630	1.22	.0767	5.65	.433	2.57	.177
E					.18567	6.06	1.238	2.86	.531



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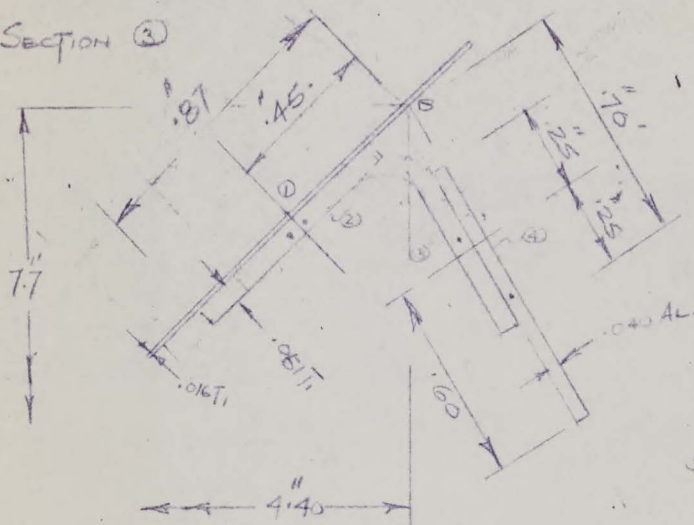
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TORSION BOX SECTION PROPERTIES (CONT'D)

SECTION ③



EFFECT WIDTH OF $T_1 = 30 \times .016 = 4.8$
 $AL = 2515 \times .040 = 1.850$

SCALE 2X SIZE

ITEM	D	t	AREA	PERIM	PERIM	PERIM	Y	Ay	X	Ax
1	.48	.016	.00778	1.22	.00237	7.37	.0630	4.04	.0378	
2	.70	.051	.0357	1.22	.04370	7.32	.3190	4.04	.1760	
3	.60	.051	.0306	1.22	.0375	7.32	.2720	4.58	.1625	
4	.85	.040	.0340	1.0	.0340	7.11	.2415	4.70	.1597	
Σ					.12437	7.28	.9025	4.37	.5430	



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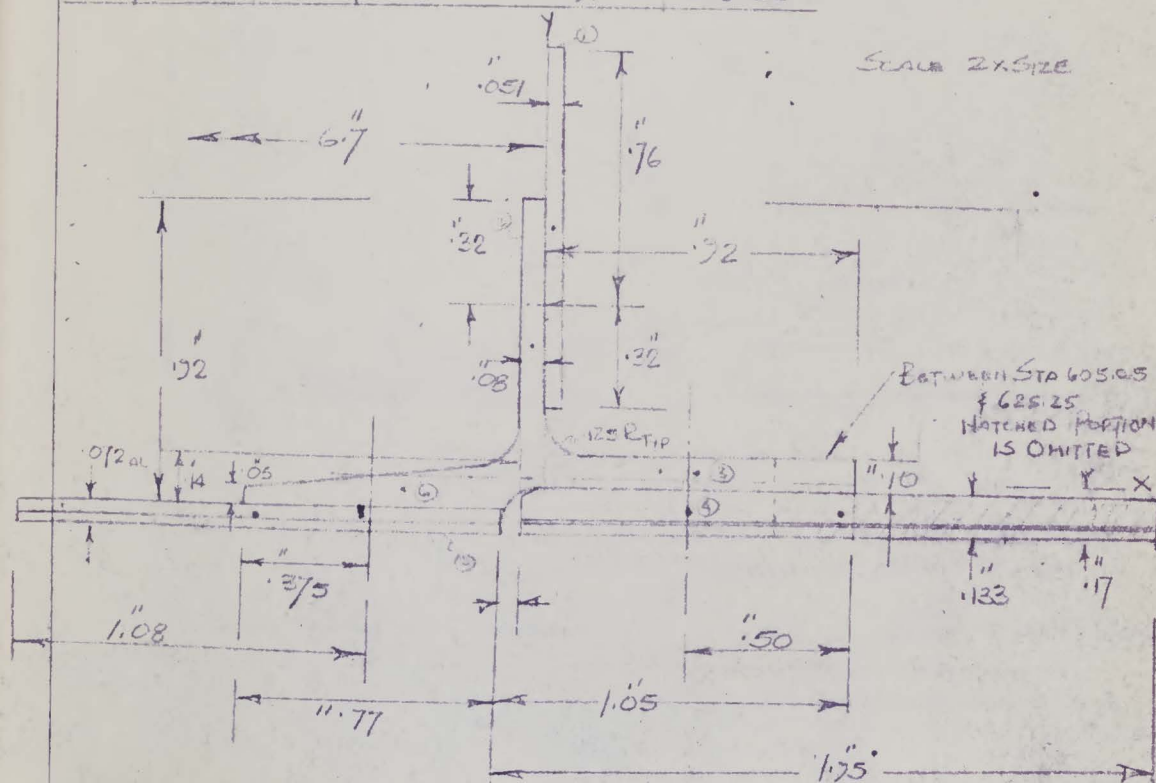
TORSION BOX SECTION PROPERTIES. (CONT'D)

SECTION 5 & 6

SECTION 5 AND 6 ARE SPLIT INTO 2 SECTIONS BECAUSE SECTION SIX VARIES AT DOORS #1 & 2 AND PINNED PANEL.

THE EDGE MEMBERS OF THE PINNED PANEL & DOORS ARE DISCONTINUOUS AT STA'S 5145, 606.05, 625.25 & 644.13. THE FOLLOWING SECTIONS CALCULATED ARE AT POINTS WHERE THE DOOR EDGE MEMBERS ARE TO BE CONSIDERED FULLY EFFECTIVE IN BENDING. THE TRANSITIONAL RANGE FOR ZERO TO FULLY EFFECTIVE SECTION WILL BE FOUND LATER ON BASED ON THE SHEAR CAPACITY OF THE ATTACHMENTS & THE ASSUMED FULLY EFFECTIVE EDGE MEMBER AREA.

SECTION 5 & 6 BETWEEN STA'S 591.65 & 605.05



NOTE: DOOR EDGE MEMBER DIM CHANGED TO 1.70 INSTEAD OF 1.90 AS SHOWN. CHANGE IS CONSIDERED NEGLIGIBLE



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SHEET No. 11

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Torsion Box Section Properties (Cont'd)

SECTION 546 BETWEEN STA'S 591.65 & 606.05

REF SMT 8

Item	b	t	A	y	Ay	x	Ax
1	1.08	.051	.0552	.75	.04130	6.725	.3710
2	.78	.08	.0623	.40	.02490	6.30	.3930
3	.52	.10	.0320	.02	.00184	7.15	.6570
4	1.50	1.33	.2530	.79	.2228	7.58	1.9200
5	1.475	.072	.1061	.134	.01420	5.83	.6150
6	.78	.025	.0740	.04	.00296	6.27	.4660
Σ			.6426	.0452	.02504	6.90	4.4260

SECTION BETWEEN 606.05 & 625.25 REF SMT 8

Item	b	t	A	y	Ay	x	Ax
1	1.08	.051	.0552	.75	.04130	6.725	.3710
2	.78	.08	.0623	.40	.02490	6.30	.3930
3	.68	.12	.068	.02	.00136	7.04	.4730
4	.75	.133	.0298	.09	.00318	7.075	.7070
5	1.475	.072	.1061	.134	.01420	5.83	.6150
6	.78	.025	.0740	.04	.00296	6.27	.4660
Σ			.4654	.089	.04142	6.52	3.0340

* 3.30 In. Group 1a Web Displacement in Outboard Rib

SECTION PROPERTIES OF 546 BETWEEN STA'S 625.25 & 644.43 REF SMT 8

Item	b	t	A	y	Ay	x	Ax
1	1.08	.051	.0550	.76	.04130	6.725	.270
2	.85	.08	.0680	.43	.02920	6.66	.452
3	.20	.125	.0945	.25	.00236	6.35	.600
4	.22	.10	.022	.04	.00363	7.17	.660
5	1.50	.167	.317	.072	.02283	7.53	2.410
6	1.555	.072	.1120	.14	.01570	5.8	.650
Σ			.7385	.0458	.03377	6.97	5.142



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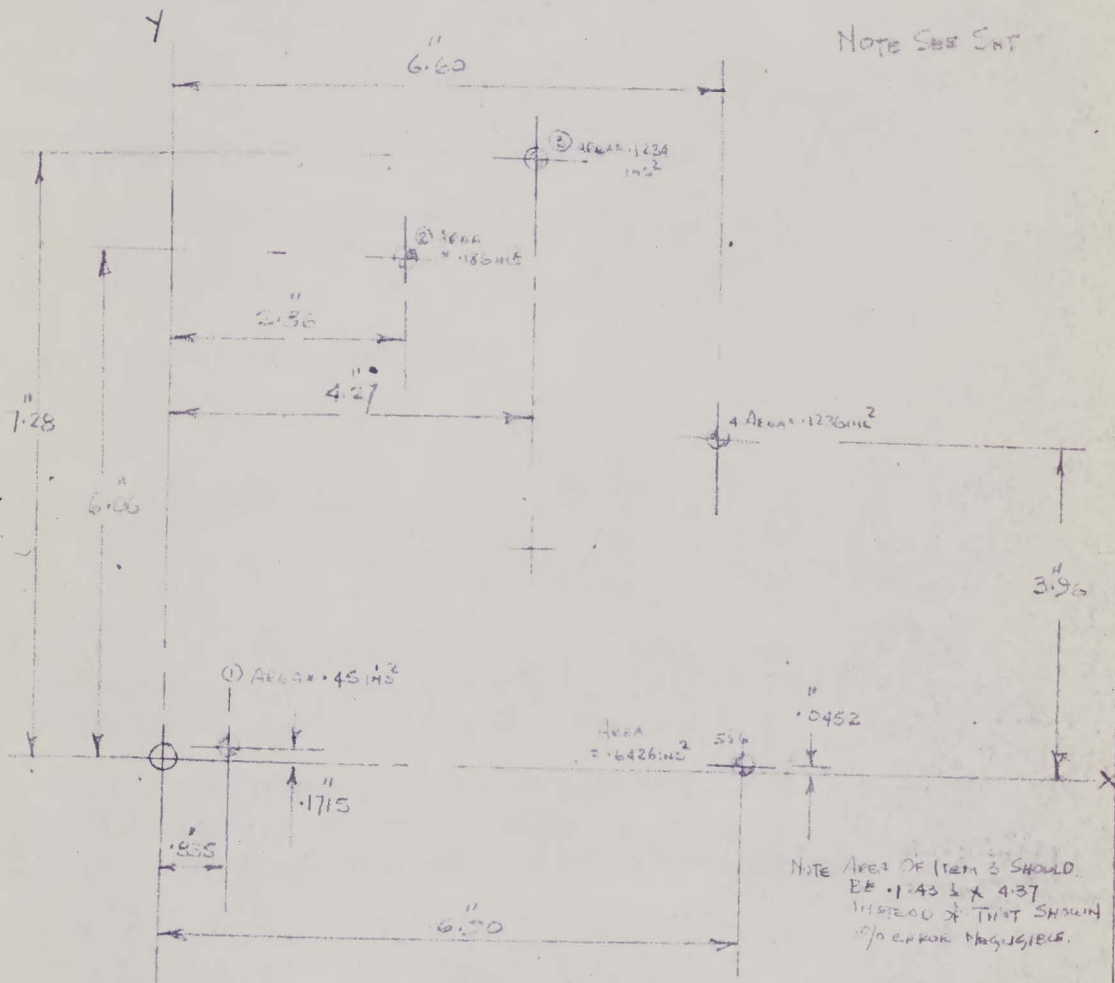
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TORSION BOX SECTION PROPERTIES FOR COMPLETE SECTION 574 5165 - 606.05



ITEM	A	y	Ay	ay ²	x	Ax	Ax ²	Axy
1	.4500	1.715	.0772	.0125	.135	.0760	.0140	.0643
2	.1860	6.06	.11250	6.8200	2.36	.5220	1.5220	3.210
3	.1234	7.28	.0900	6.55	4.27	.5270	2.250	3.840
4	.1236	3.96	.488	1.2350	6.60	.8140	5.3750	3.220
5	.0426	.0452	.0020	.00131	6.50	4.4300	29.006	.200
6	.15256	1.715	2.6122	15.3150	4.380	6.6720	39.5210	10.5243

$$I_{xNA} = 15.31556 - 1.715^2 \times 1.5256 = 15.31556 - 4.487 = 10.82856 \text{ IN}^4 \text{ SAY } 10.83 \text{ IN}^4$$

$$I_{yNA} = 39.5210 - 4.380^2 \times 1.5256 = 39.5210 - 29.20 = 10.3210 \text{ IN}^4 \text{ SAY } 10.22 \text{ IN}^4$$

$$I_{xyNA} = 10.5243 - 1.715 \times 4.380 \times 1.5256 = 10.5243 - 11.500 = -0.9756 \text{ IN}^4 \text{ SAY } -0.976 \text{ IN}^4$$



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TORSION FOR SECTION PROPERTIES FOR COMPLETE SECTION (CONT'D)

STA 59165 - 60005

$$\tan 2\theta = \frac{2 \times .976}{10.22 - 10.83} = \frac{1.952}{-.61} = 3.21$$

$$2\theta = 72.7^\circ \quad \theta = 36.35^\circ$$

$$\begin{aligned} I_{xp} &= 10.83 \cos^2 \theta + 10.22 \sin^2 \theta - 2 \times .976 \sin \theta \cos \theta \\ &= 10.83 \times .806^2 + 10.22 \times .593^2 - 2 \times .976 \times .806 \times .593 \\ &= 7.03 + 3.6 + .934 = 11.564 \text{ ins}^4 \end{aligned}$$

$$\begin{aligned} I_{yp} &= 10.83 \sin^2 \theta + 10.22 \cos^2 \theta - .934 \\ &= 3.31 + 6.65 - .934 = 9.026 \text{ ins}^4 \end{aligned}$$

SECTION PROPERTIES STA 60005 - 62525

ITEM	A	y	Ay	Ay ²	x	Ax	Ax ²	Axy
1-4	8350		2.592	15.3193		3.2490	5.461	10.5243
536	14654	.089	.0413	.0033	6.52	3.3300	19.753	.269
2	11344	1.954	2.6315	15.32193	3.52	5.2790	29.211	10.5933

$$I_{xNA} = 15.32193 - 1.954^2 \times 11344 = 15.32193 - 5.15 = 10.17193 \text{ ins}^4 \quad \text{SA} / 10.17 \text{ ins}^4$$

$$I_{yNA} = 9.026 - 3.92^2 \times 11344 = 9.026 - 20.70 = 9.511 \text{ ins}^4 \quad \text{SA} / 8.511 \text{ ins}^4$$

$$I_{xy} = 10.5933 - 1.348 \times 3.92 \times 11344 = 10.5933 - 10.32 = .2733 \text{ ins}^4$$



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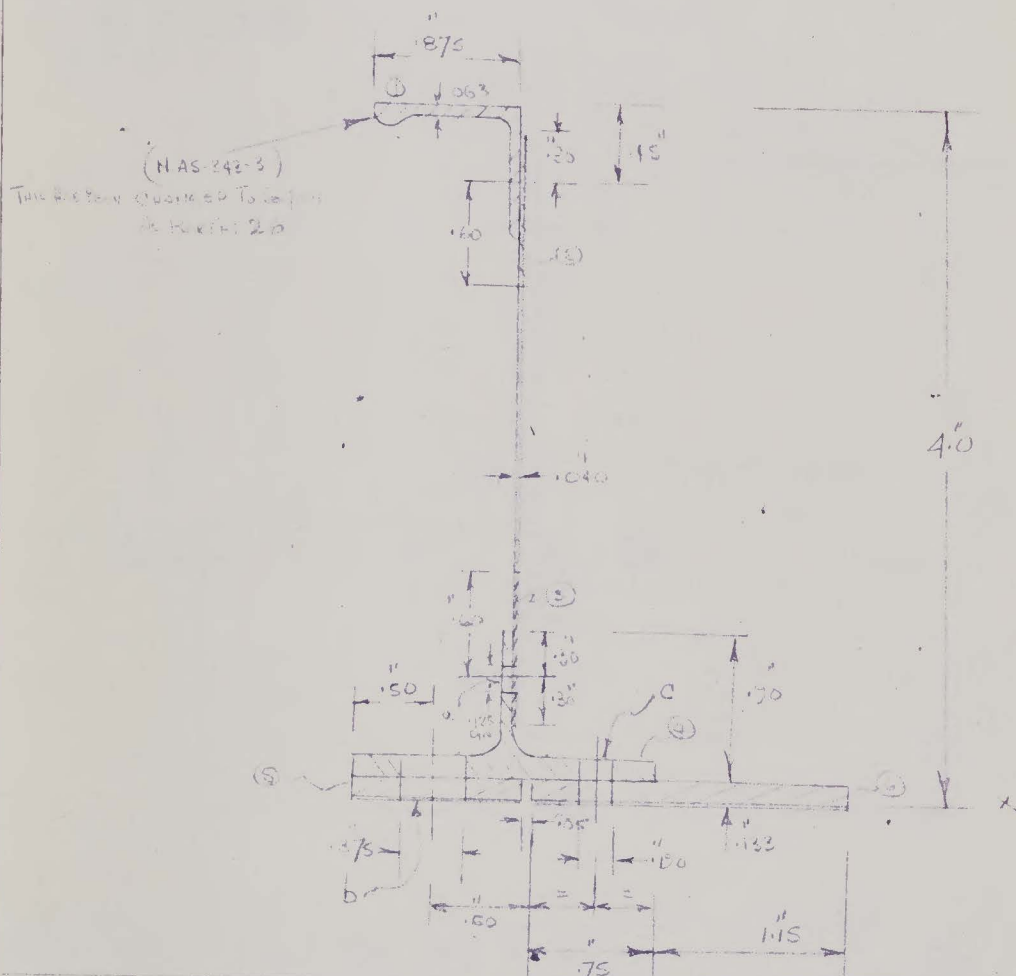
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TRANSVERSE Beam STA 66.05



Item	b	t	A	$\bar{y}$	$A\bar{y}$	$A\bar{y}^2$	I_{CG}
1	.1	.1232	.01232	3.300	.408	1.730	.0063
2	.22	.040	.00880	2.40	.2123	.4165	.00233
3	.30	.142	.04260	.883	.03768	.0331	.0023
4			.2237	2.133	.04761	.01312	.01023
5	.10	.123	.01230	.0665	.000817	.000537	NEG
6	.20	.133	.02660	.065	.001730	.001113	NEG
Less Hole a	.125	.10	.0125	.733	.00917	.00672	NEG
Less Hole b	.375	.258	.0967	.129	.01245	.01245	-
Less Hole c	.150	.224	.04260	.112	.00477	.00054	-
Σ			.6631	1.032	.68545	2.23355	.02129

$$I_{CG} = 2.23355 + .02129 - 1.032^2 \times .6631 = 2.25634 - .70700 = 1.54934 \text{ SAY } 1.55 \text{ IN}^4$$

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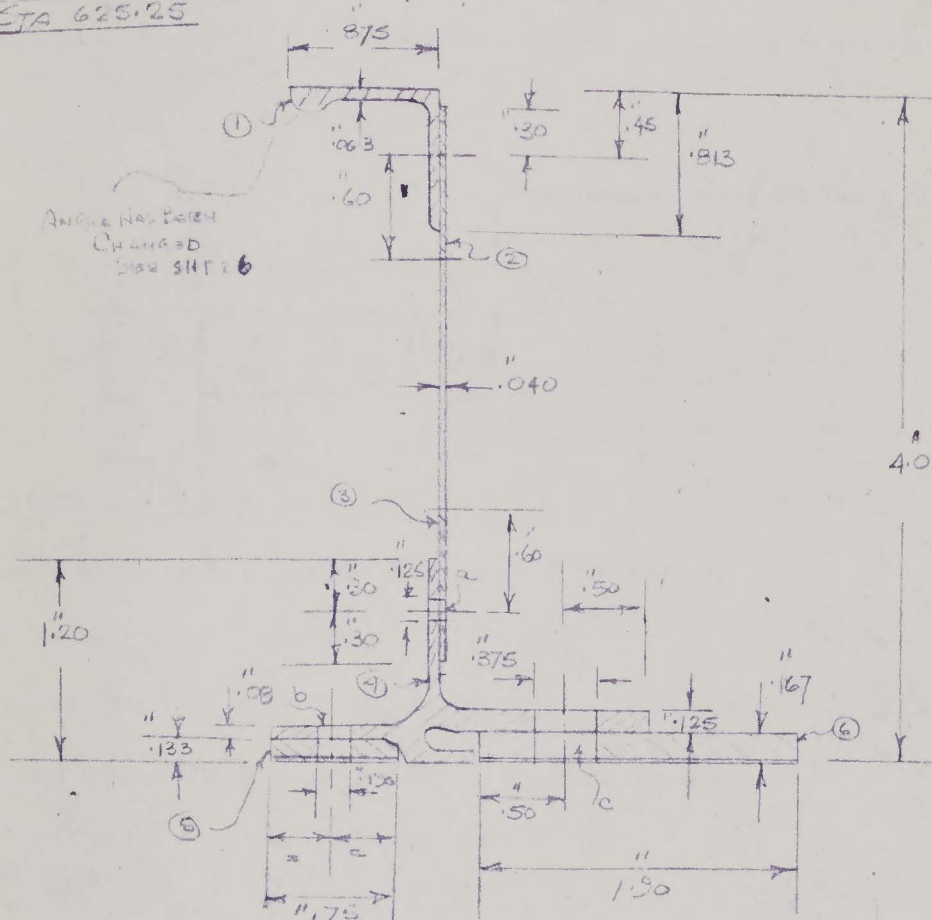
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TRANSVERSE BEAM SECTION PROPERTIES
AT STA 620.25



ITEMS	b	t	A	y	Ay	Ay ²	Ics
1			.1232	3.80	.4680	1.7800	.0063
2	.90	.64	.0360	3.40	.1223	.4163	.00233
3	.90	.64	.0360	1.05	.0378	.0397	.00223
4			.3210	.294	.0815	.0290	.01263
5	.75	.133	.0927	.0665	.00662	.00044	neg
6	1.00	.167	.3170	.0835	.02650	.00221	"
Less Hole a	.125	.10	.0125	.120	.01125	.01025	"
Less Hole b	.100	.213	.0405	.1063	.00432	.00046	"
" " c	.375	.292	.1093	.146	.016	.00234	neg
Σ			.7604	.926	.7115	2.2463	.03052

$$I_{CG} = 2.24650 + 0.3052 - 7604 \times 936^2 = 2.27702 - 645 = 1.612 \text{ IN}^4$$



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TORSION BOX

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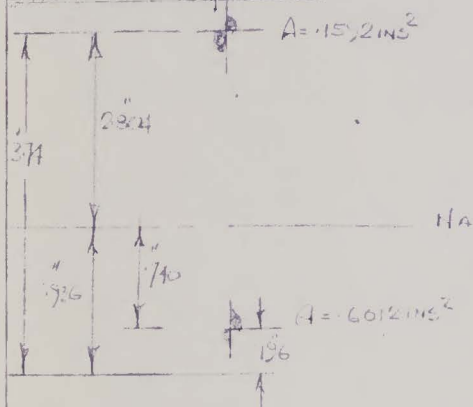
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CHECK LOADING ON MODIFIED TRANSVERSE Beam STA 625.25.
CHECK LOCAL BUCKLING



$$I = 1.612 \text{ IN}^4 \text{ SMT } 14$$

$$\text{Max Mom At Center} = (23738 + 7978) \text{ SMT } 17 = 31616 \text{ LBS IN}$$

$$\text{LOAD AT TOP CAP} = \frac{31616 \times 2.804 \times .1592}{1.612} = 8760 \text{ LBS COMP}$$

$$\text{LOAD AT BOTTOM CAP} = \frac{31616 \times 1.740 \times .6012}{1.612} = 8700 \text{ LBS TENS}$$

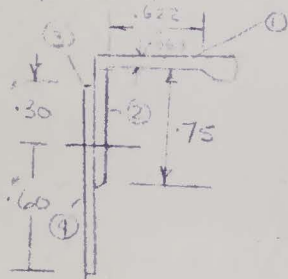
$$\text{MOMENT} = 8760 \times 2.804 + 8700 \times 1.740 = 24350 + 6450 = 30800 \text{ LBS IN} \text{ CHECK OK}$$

$$\text{COMP STRESS IN TOP CAP} = \frac{8760}{.1592} = 55000 \text{ LBS/IN}^2$$

USING REF S 01.01.08

FOR SKETCH OF SECTION & DIMENSIONS SEE SMT 20

TEMP CONCITION 245° FOR 50 HOURS Env Temp = 37°C at Root Temp





AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/2

SHEET NO. 24

AIRCRAFT:

C105

Torsion Box

PREPARED BY

A. F. G. H. C.

DATE

JAN/56

CHECKED BY

DATE

CHECK LOADING ON MODIFIED TRANSVERSE BEAMS

$$\text{FOR ITEM ① } f = 3.62 E_T (t/b)^2$$

$$t/b = .063/.622 = .103 \quad ; \quad (t/b)^2 = .103^2 = .0106$$

$$\text{Assuming } F_c = 77000 \quad \text{FROM AILES PAGE 87 } E_T = 2 \times 10^6$$

$$f = 3.62 E_T (t/b)^2 = 3.62 \times 2 \times 10^6 \times .0106 = 77000$$

$$F_{CY} \text{ FOR MTL AT } 265^\circ \text{ FOR 50 HRS} = 70000 \times .88 = 60500 \text{ LBS/IN}^2$$

$\therefore F_{CY}$ IS TO BE USED INSTEAD OF f

$$\text{ITEM ② } t/b = .063/.75 = .084 \quad ; \quad (t/b)^2 = .084^2 = .00706$$

$$\text{Assuming } f = 55000 \quad ; \quad E_T = 10.5 \times 10^6$$

$$f = .58 \times 10.5 \times 10^6 \times .00706 = 43000 \text{ LBS/IN}^2$$

$$E_T \text{ FOR } 43000 = 10.5 \times 10^6$$

$$\text{ITEM ③ } t/b = \frac{.040}{.30} = .133 \quad ; \quad (t/b)^2 = .01783$$

$$\text{Assuming } f = 43000$$

$$E_T = 9.5 \times 10^6 \quad \text{AILES PAGE 84}$$

$$f = 9.5 \times 10^6 \times .58 \times .01783 = 98200$$

$$\text{Assuming } f = 53000$$

$$E_T = 8 \times 10^6$$

$$f = 8 \times 10^6 \times .58 \times .01783 = 83200$$

$$\text{Assuming } f = 58000 \quad ; \quad E_T = 6 \times 10^6$$

$$f = .58 \times 6 \times 10^6 \times .01783 = 62000$$

$$\text{Using } f = 59000 \quad E_T = 5.7 \times 10^6$$

$$f = .58 \times 5.7 \times 10^6 \times .01783 = 59000 \text{ LBS/IN}^2$$

$$F_{CY} \text{ FOR MTL AT } 265^\circ \text{ FOR 50 HRS} = 58 \times 62000 = 54500 \text{ (LOWER BEAMS TO BE USED)}$$



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REPORT NO. 7-0558-12/2

SHEET NO. 25

AIRCRAFT:

C103

TORSION BOX

PREPARED BY

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CHECK LOADING ON MODIFIED TRANSVERSE BEAMS

LOCAL CREEPING

$$I \approx M \Phi \quad (t/b) = \frac{.040}{.60} = .0675 \quad ; (t/b)^2 = .00447$$

$$f = .58 E_c (t/b)^2$$

$$\text{Assume } f = 42000 \quad E_t = 9.5 \times 10^6$$

$$f = .58 \times 9.5 \times 10^6 (.00447) = 24600 \text{ LBS/IN}^2$$

$$f_{AD} = \frac{60500 \times .063 \times .622 + 42000 \times .75 \times .063 + 54500 \times .30 \times .020 + 24600 \times .60 \times .040}{.063 \times .622 + .75 \times .063 + .30 \times .040 + .60 \times .040}$$

$$\frac{2370 + 2020 + 490 + 591}{.0864 + .036} = \frac{5481}{.1224} = 45000$$

$$RF = \frac{45000}{55000} = .818$$

No Good

Assume Thicknesses To Go Up To .070 on Leg @ Only

(1) f previously 60500 SEE ENT 21.

$$(2) \quad t/b = \frac{.070}{.75} = .0935 \quad ; (t/b)^2 = .00875$$

$$\text{Assuming } f = 56000 \quad E_t = 10.5 \times 10^6$$

$$f = .58 \times 10.5 \times 10^6 \times .00875 = 53300$$

$$f_{AD} = \frac{2370 + 56000 \times .75 \times .070 + 490 + 591}{.0391 + .0515 + .036} = \frac{6221}{.126} = 49700$$

$$RF = \frac{49700}{55000} = .907$$

N.S.



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TECHNICAL DEPARTMENT

AIRCRAFT:

G105

TORSION BOX

REPORT NO. 7-0558-12/2

SHEET NO. 26

PREPARED BY

DATE

A. FERENC

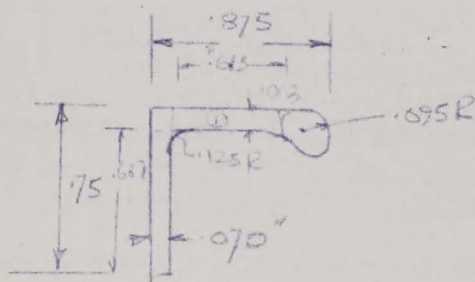
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DATE

CHECK LOADING ON MODIFIED TRANSVERSE BEAMS

CHANGE ANGLE TO SECTION AS SHOWN



f ITEM ① ③ & ④ AS BEFORE

$$\text{ITEM ② } t/b = 0.687 / 0.070 = 10.2 \quad (t/b)^2 = 0.104$$

f ASSUMED AT 60500 ; $E_T = 10 \times 10^6$

$$f = 1.58 \times 10^7 \times 0.104 = 60500$$

FCM FOR MTL = 60500 SHT 21

SHT 22

$$f_{AV} = \frac{60500 \times 0.613 \times 0.063 + 60500 \times (0.687 \times 0.070) + 490 + 591}{0.613 \times 0.063 + 0.687 \times 0.070 + 0.036 \text{ (SHT 21)}}$$

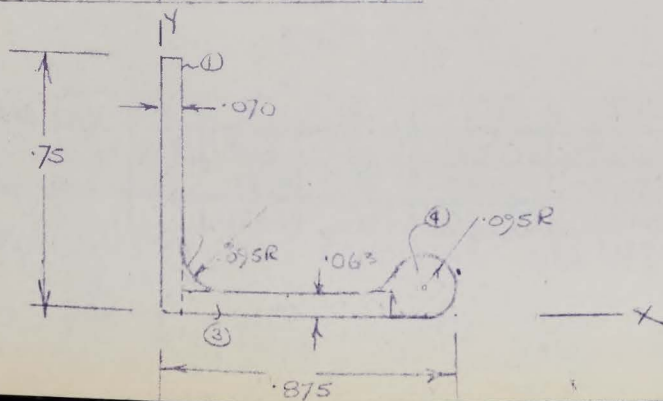
$$\frac{2340 + 2900 + 490 + 591}{0.0386 + 0.480 + 0.036} = \frac{6321}{1.226} = 50500$$

$$2F = 50500 \times 2 = 101000$$

7-0558-82
SEE PAGE 140

92

SECTION PROPERTIES OF NEW ANGLE



Horizontal Area Only
Included in Table

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-1262

SHEET NO

75

AIRCRAFT:

C105

Torsion Box

PREPARED BY

DATE _____

A. FEENE

Jan 130

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DATE _____

CHECK LOADING ON MODIFIED TRANSVERSE BEAMS
CHECK CAP AS COLUMN

$$\Delta \text{Enthalpy} = 657518760 = 7663495$$

$$F_{co} = 1.075 F_{cy} = 1.075 \times 54500 \text{ Sfr 21} = 58700$$

$$F_c = F_{c0} \left[1 - \frac{F_{c0} \times (L/p)^2}{4 \pi^2 E} \right]$$

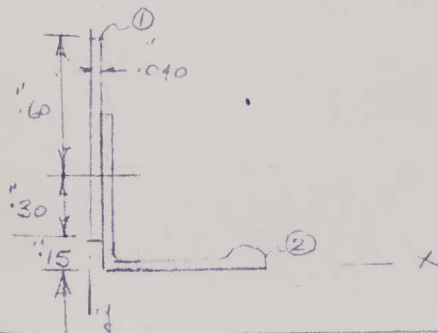
$$= 58700 \left[1 - \frac{52700 \times 40^2}{4\pi \times 10^9 \times 100} \right] \times 58700 \left[1 - 0.0001 \right] = 45300$$

$$\therefore \text{Avg Applied Stress} = \frac{7663}{.1512} = 42200$$

$$CF = \frac{45310}{48200} = .94$$

7-1553-82
SEA PAGE 140

CHECK TORSIONAL INSTABILITY



Item	p	t	A	A_1	A_1^2	I_{CG}	γ
1	20	0.90	0.036	0.0216	0.01295	0.00243	60
2			0.1201	0.0237	0.00467	0.0070	197
			0.1504	0.0453	0.01762	0.00943	29
Total	0.01624	0.00943	0.1504	0.0292	0.02705	0.0135	0.18731454

$$166 \cdot 017624 \cdot 00943 \cdot 15641292 = 02705 \cdot 01335 = 03701454$$



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/2

SHEET NO. 51

AIRCRAFT:

C105

TORQUE BOX

PREPARED BY

A. FERENC

CHECKED BY

DATE

JAN/56

DATE

TORSIONAL STIFFNESS OF TORQUE BOX

THE AVERAGE TORSIONAL STIFFNESS WILL BE CONSIDERED AS BEING A SECTION SHOWN ON SMT - 7 WITHOUT THE .025 T. DOUBLER.

$$K = \text{RAD/LEVIN/INS} = \frac{1}{4A^2} \int \frac{ds}{t\theta}$$

$$A_{avg} = \frac{6.5 \times 7.87 - 2.63 \times 6.42 - 1.45 \times 5.45 - 1.45 \times 1.55 - 2.30 \times 3.93}{2}$$

$$= 51.2 - 8.5 - 3.56 - 1.122 - 4.52 = 51.2 - 17.702 = 33.498 \text{ IN}^2$$

1	2	3	4	5	6	7
LIMITS	t	θ	$t\theta$ 3x4	ds	$\frac{ds}{t\theta}$ 54	$\int \frac{ds}{t\theta}$ 26.
1-2	.032	6.17×10^6	19.8×10^6	6.34	25.1×10^{-6}	
2-3	.067	6.17×10^6	413×10^6	8.12	5.12×10^{-6}	
3-4	.040	3.2×10^6	151×10^6	4.55	30.10×10^{-6}	
4-5	.051	3.2×10^6	197×10^6	3.34	12.8×10^{-6}	
5-1	.072	3.2×10^6	281×10^6	6.5	23.1×10^{-6}	
						113.23×10^{-6}

$$4A^2 = 4 \times 33.498^2 = 4480$$

$$K = \frac{113.23 \times 10^{-6}}{4480} = .02525 \times 10^{-6} \text{ RAD/LEVIN/INS}$$

IN REGION OF .025 T. DOUBLER

$$\int \frac{ds}{t\theta} = 113.23 + \frac{6.34}{.025 \times 6.17 \times 10^6} = (113.23 + 45.2) \times 10^{-6} = 158.43 \times 10^{-6}$$

$$K = \frac{158.43 \times 10^{-6}}{4480} = .0353 \times 10^{-6} \text{ RAD/LEVIN/INS}$$



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TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/2

SHEET NO. 33

AIRCRAFT:

C105

TORSION BOX

PREPARED BY

DATE

A. FERENC

JAN/56

CHECKED BY

DATE

AVERAGE FLEXURAL STIFFNESS OF TORSION BOX

THE TORSION BOX SECTION PROPERTIES GIVEN ON PAGES 12-16 ARE THE SECTION PROPERTIES AT THE TORSION BOX MAXIMUM SECTION. THAT IS WHEN THE JOCK EDGE MEMBER ITEM 6 SHT 2 IS CONSIDERED FULLY EFFECTIVE. THEREFORE MIN I WOULD OCCUR WHEN EDGE MEMBER HAS ZERO EFFECTIVENESS.

CG POSITIONS OF ITEMS 5 ONLY Ref SH 10

BETWEEN 591.65 & 606.05

Item	b	t	A	$\bar{y}$	$A\bar{y}$	x	Ax
1-6			.5426		.02504		4.4260
②			.2530		.0225		1.9200
~			.3856	.133	.05184	6.43	2.5060

$\sum Ax = 8.852$

FORMER TORSION BOX DESIGN

BETWEEN 606.05 & 625.25

Item	b	t	A	$\bar{y}$	$A\bar{y}$	x	Ax
1-6			.4654		.04192		3.0340
4			.0938		.00898		.7070
			.3656	.138	.05040	6.38	2.3270

$\sum Ax = 6.068$

FORMER TORSION BOX DESIGN

BETWEEN 625.25 & 644.43

Item	b	t	A	$\bar{y}$	$A\bar{y}$	x	Ax
1-6			.7385		.03377		5.142
5			.2170		.02285		2.410
			.4215	.1345	.05662	6.49	2.732



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MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO 7-0558-12/2

SHEET NO 34

AIRCRAFT

C105

TORSION BOX

PREPARED BY

DATE

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DATE

AVERAGE FLEXURAL STIFFNESS OF TORSION BOX CONT'D
MINIMUM SECTION PROPERTIES BETWEEN STA 606.05 & 606.05
REF FIG SHT 11 & ALSO SHT 12

ITEM	A	y	Ay	Ay ²	x	Ax	Ax ²	Axy
1-4	.853		2.3902	15.31625		2.2420	2.461	10.323
5	.3896	.123	.0518	100690	6.43	2.500	16.100	.334
Σ	1.2426	.203	2.4420	15.33515	3.40	4.742	25.561	10.657

$$I_{xNA} = 15.33515 - 2.03 \times 1.2426 \times 15.33515 = 15.33515 - 5.50 = 9.83515 \text{ SAY } 9.83 \text{ IN}^4$$

$$I_{yNA} = 25.561 - 1.2726 \times 2.4426 \times 15.33515 = 25.561 - 15.4 = 10.161 \text{ IN}^4$$

$$I_{xy} = 10.657 - 1.92 \times 2.461 \times 1.2426 = 10.657 - 2.946 = 7.711 \text{ IN}^4$$

MINIMUM SECTION PROPERTIES BETWEEN STA 606.05 & 625.25

ITEM	A	y	Ay	Ay ²	x	Ax	Ax ²	Axy
1-4	.853		2.3902	15.31625		2.2420	2.461	10.323
5	.3896	.135	.0525	100696	6.38	2.3300	16.002	.322
Σ	1.2426	.212	2.4405	15.33515	3.40	4.579	24.32	10.645

$$I_{xNA} = 15.33515 - 2.12 \times 1.2426 \times 15.33515 = 15.33515 - 5.620 = 9.71515 \text{ SAY } 9.71 \text{ IN}^4$$

$$I_{yNA} = 24.361 - 3.40 \times 1.2426 \times 15.33515 = 24.361 - 14.45 = 9.911 \text{ IN}^4$$

$$I_{xy} = 10.645 - 3.40 \times 2.461 \times 1.2426 = 10.645 - 2.93 = 7.715 \text{ IN}^4$$

MINIMUM SECTION PROPERTIES STA 625.25-644.45

ITEM	A	y	Ay	Ay ²	x	Ax	Ax ²	Axy
1-4	.8530		2.3902	15.31625		2.2420	2.461	10.323
5	.4215	.1395	.0587	100764	6.45	2.735	17.7800	.368
Σ	1.3045	.203	2.4405	15.33515	3.44	4.984	27.2431	10.691

$$I_{xNA} = 15.33515 - 2.03 \times 1.3045 \times 15.33515 = 15.33515 - 5.33 = 10.00515 \text{ SAY } 10.01 \text{ IN}^4$$

$$I_{yNA} = 27.2431 - 3.64 \times 1.4015 \times 15.33515 = 27.2431 - 17.65 = 9.5931 \text{ IN}^4$$

$$I_{xy} = 10.691 - 2.91 \times 2.461 \times 1.3045 = 10.691 - 9.4 = 1.291 \text{ IN}^4$$



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TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/2

SHEET NO. 35

AIRCRAFT:

C105

TORSION BOX

PREPARED BY

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AVERAGE FLEXURAL STIFFNESS OF TORQUE BOX CONT'D

TRANSITIONAL RANGE FROM ZERO EFFECTIVE TO FULLY EFFECTIVE
FOR DOOR EDGE MEMBER STA 591.65 - 606.05

DOOR EDGE MEMBER AREA = .2530 INS² SMT 11

FLY MIL = 64000 LBS/INS²

END LOAD CAPACITY = .2530 X 64000 = 16100 LBS

ASSUMING CAMLOCS WORKING IN SHEAR TO CAPACITY OF 1/4 AN EOLF
PITCH AT 1.40

SHEAR/INS = $\frac{3680}{1.4} = 2630$

DIST REQ'D = $\frac{16100}{2630} = 6.12$

ON SERVICE DOOR #2

CAMLOC PITCH = 1.54

S/INS = $\frac{2680}{1.54} = 1895$

DOOR EDGE MEMBER AREA = .312

DOOR LOAD = .312 X 64000 = 19950 LBS

DIST REQ'D = $\frac{19950}{1895} = 10.52$

DIST BETWEEN STA 644.95 - 625.25 = 19.20

∴ ASSUME FULLY EFFECTIVE AT CENTER ONLY.

AT PIN PANEL

DOOR EDGE MEMBER AREA = .0998

END LOAD = .0998 X 64000 = 6380 LBS

3/16 SCREWS AT APPROX 1.71 AN PITCH

S/INS = $\frac{2120}{1.71} = 1243$ LBS/INS

LENGTH REQ'D = $\frac{6380}{1243} = 5.13$ INS



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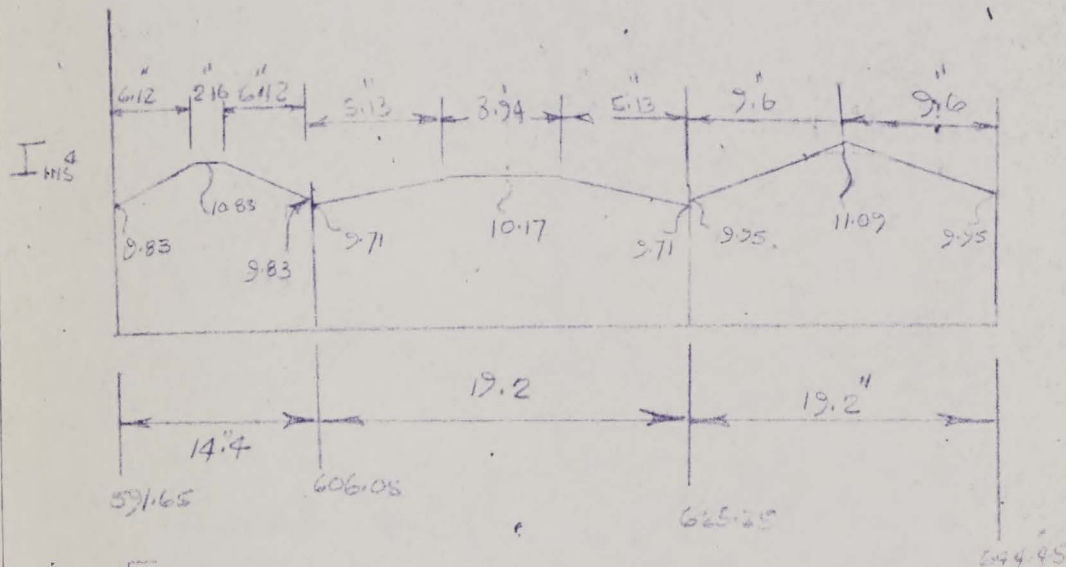
AIRCRAFT:

C105

TORSION BOX

AVERAGE FLEXURAL STIFFNESS OF TORQUE BOX (CONT'D)

ABOUT XX REF SHTS 12 13 16 33 34 35



$$A_v I = \left[\left(\frac{9.83 + 10.83}{2} \times 6.12 \right) + 2.16 \times 10.83 + 2 \left(\frac{11.09 + 9.35}{2} \times 9.16 \right) + 2 \left(\frac{9.71 + 10.17}{2} \times 5.13 \right) + 3.94 \times 10.17 \right] \div 52.8$$

$$= \frac{1262 + 23.4 + 202.5 + 101}{52.8} + 91.2 = \frac{548.8}{52.8} = 10.40 \frac{4}{142}$$



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AIRCRAFT:

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BRISON BOX AT
GEAR BOX CUT OUT

PREPARED BY

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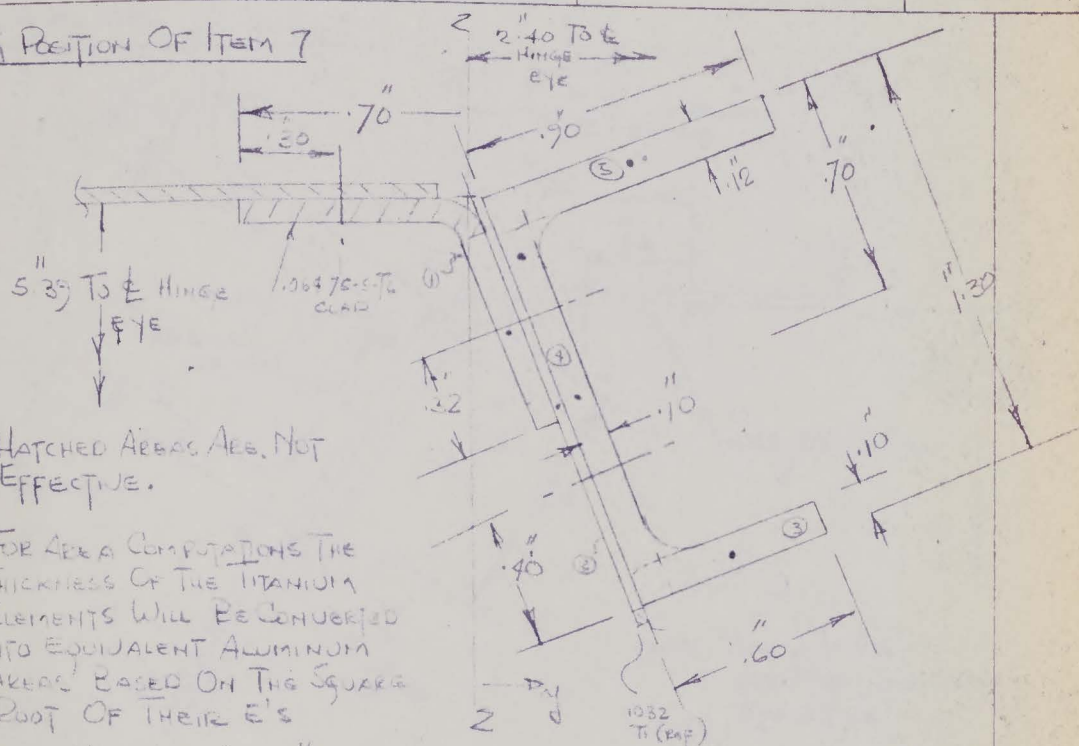
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DATE

AREA & CG POSITION OF ITEM 7



NOTE: (1) HATCHED AREAS ARE NOT EFFECTIVE.

(2) FOR AREA COMPUTATIONS THE THICKNESS OF THE TITANIUM ELEMENTS WILL BE CONVERTED INTO EQUIVALENT ALUMINUM AREAS BASED ON THE SQUARE ROOT OF THEIR E'S

$$\therefore \text{FOR T, AREA FACTOR} = \left(\frac{15.3 \times 10^6}{10.3 \times 10^6} \right)^{1/2} = 1.22$$

DETAIL 7 SCALE 2X SIZE

Item	b	t	A	AREA FACTOR	EQUIV. AREA	Z	Az	y	Any
1	.60	.064	.0384	1.0	.0384	4.29	.1920	2.28	.0875
2	.30	.032	.04165	1.22	.05075	4.78	.1990	2.13	.0885
3	.60	.10	.0600	1.0	.0600	4.33	.2600	1.60	.0960
4	.08	.10	.1080	1.0	.108	4.79	.5275	2.06	.2270
5	.90	.12	.108	1.0	.108	5.49	.5930	1.91	.2060
Σ					.36515	4.830	1.7615	1.93	.7050



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REPORT NO. 7-0558-12/2

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TORSION BOX AT GEAR
BOX CUT OUT

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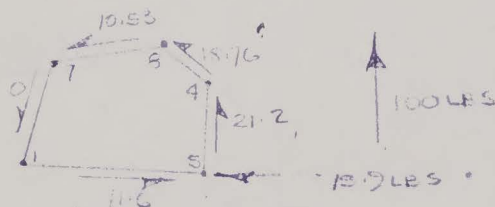
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SHEAR FLOWS DUE TO 100 LBS VERT. LOAD

ITEM	V	I	V/I	Z	A	Az	VZA I
1	100	8.43	11.85	-2.1785	.45	-.28	-11.6
4	↑	↑	↑	1.67	.1236	.206	2.44
5	↓	↓	↓	-2.212	.3656	-.810	-9.6
7	↓	↓	↓	2.48	.1352	.906	10.72
8	100	8.43	11.85	2.63	.2590	.695	8.23



CHECK BALANCE

$$\Sigma FV = 100 \text{ LBS} = 21.2 \times 3.82 + 18.76 \times 1.07 - 10.53 \times 2 - 11.6 \times 0.328$$

$$= 81 + 20.1 - 2.11 - 3.95 = 10.1 - 2.565 = 78.585$$

$$\Sigma FH = 11.6 \times 5.545 + 21.2 \times 2.2 - 18.76 \times 1.75 - 10.53 \times 4.155$$

$$= 64.3 + 4.67 - 3.3 - 44.7 = 68.97 - 53.07 = 15.9 \text{ LBS} \rightarrow$$

THEREFORE TO PREVENT THE SECTION FROM BENDING ABOUT THE PRINCIPLE AXIS A RESTRAINT OF 15.9 LBS MUST BE APPLIED TO THE BOX AT THE LOWER CORNER

SHEAR FLOW IN SYSTEM DUE TO BENDING WITHOUT TWIST

$$\oint \frac{Q}{I} ds = 0$$

ASSUMING GO IN SAME DIRECTION AS SHEAR FLOWS SHOWN ABOVE CUT ASSUMED JUST ABOVE ①

$$0 = \frac{5.545 \times 80}{.072 \times 3.5 \times 10^6} + \frac{11.6 \times 5.545}{.072 \times 3.5 \times 10^6} + \frac{90 \times 3.95}{.050 \times 3.5 \times 10^6} + \frac{21.2 \times 3.55}{.050 \times 3.5 \times 10^6} + \frac{90 \times 1.73}{.050 \times 3.5 \times 10^6} + \frac{18.76 \times 1.07}{.040 \times 3.5 \times 10^6}$$

$$+ \frac{90 \times 4.20}{.040 \times 3.5 \times 10^6} + \frac{10.53 \times 4.20}{.040 \times 3.5 \times 10^6} + \frac{90 \times 4.73}{.040 \times 3.5 \times 10^6}$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 1-0558-12/12

SHEET NO. 45

AIRCRAFT:

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TORSION BOX AT
GEAR BOX CUT OUT

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Apr/56

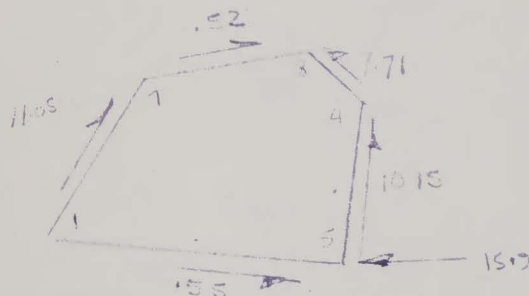
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SECTION AT E GEAR BOX CUT OUT SHEAR FLOWS FOR 100LB VERT LOAD

$$\begin{aligned}
 0 &= 19.75 \times 10^{-6} q_0 + 23.2 \times 10^{-6} q_0 + 19.6 \times 10^{-6} q_0 + 416 \times 10^{-6} q_0 + 7.525 \times 10^{-6} q_0 + 141 \times 10^{-6} q_0 \\
 &\quad + 26.3 \times 10^{-6} q_0 + 283 \times 10^{-6} q_0 + 241 \times 10^{-6} q_0 \\
 97.375 \times 10^{-6} q_0 &= 1079 \times 10^{-6} \\
 \therefore q_0 &= \frac{-1079 \times 10^{-6}}{97.375 \times 10^{-6}} = 11.05 \text{ LBS/INS}
 \end{aligned}$$

Net SHEAR FLOW



TAKING MOMENTS ABOUT 'O' REF SH 46

$$\begin{aligned}
 &10.15 \times 10.646 + 7.71 \times 3.85 - 15.5 \times 12.16 - 0.2 \times 10.681 - 11.05 \times 11.04 - 15.9 \times 2.118 \\
 &= 108 + 29.6 - 189.2 - 2.62 - 122.367 = 137.6 - 173.24 = -35.84 \text{ INCHES}
 \end{aligned}$$

$$\text{SHEAR CENTER} = \frac{-35.84}{100} = .3584 \text{ TO LEFT OF 'O'}.$$



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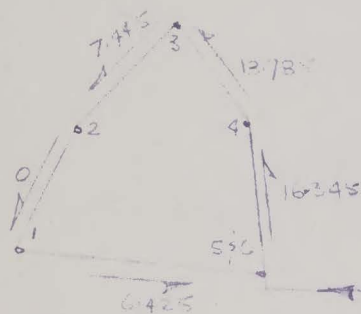
DATE

AIRCRAFT

TORSION BOX

C105

SHEAR CENTRE CALC FOR TORSION BOX 4 MAX I BETWEEN STA 59.65 & 60.05
SHEAR FLOWS FOR 100 LB VERT LOAD



CHECK BALANCE

$$\sum F_v = 100 = 16.345 \times 3.7885 + 13.735 \times 2.32 - 7.44 \times 1.72 - 6.425 \times 1.263$$

$$100 = 61.3 + 45.7 - 12.1 - 8.1 = 107.5 - 20.2 = 87.3 \text{ CHECK OK}$$

$$\sum F_H = 6.425 \times 6.065 - 16.345 \times 3.0 - 13.735 \times 2.32 - 7.445 \times 1.41$$

$$38.5 - 49.1 - 31.21 - 10.5 = 38.5 - 90.82 = 52.32 \text{ LBS}$$

THEREFORE TO PREVENT BENDING ABOUT PRINCIPLE AXIS A
RESTRAINT OF 202.3 LBS MUST BE APPLIED TO TORQUE BOX

SHEAR FLOWS IN SYSTEM FOR BENDING WITHOUT TWIST.

$$J = \sum \frac{y^2 L}{EI} + \sum \frac{y^2 b}{EI} = 0$$

ASSUMING q_0 IN SAME DIRECTIONS AS SHEAR FLOWS ABOVE.

$$0 = \frac{q_0 \times 6.065}{.072 \times 3.9 \times 10^{-6}} + \frac{6.425 \times 6.065}{.072 \times 3.9 \times 10^{-6}} + \frac{q_0 \times 3.7885}{.051 \times 3.9 \times 10^{-6}} + \frac{16.345 \times 3.7885}{.051 \times 3.9 \times 10^{-6}} + \frac{q_0 \times 4.065}{.040 \times 3.9 \times 10^{-6}} + \frac{13.735 \times 4.065}{.040 \times 3.9 \times 10^{-6}}$$

$$+ \frac{q_0 \times 1.065}{.067 \times 6.17 \times 10^{-6}} + \frac{1.445 \times 1.065}{.067 \times 6.17 \times 10^{-6}} + \frac{6.22 \times 1.065}{.057 \times 6.17 \times 10^{-6}}$$

$$0 = 21.6 \times 10^{-6} q_0 + 137.6 \times 10^{-6} q_0 + 13.75 \times 10^{-6} q_0 + 323 \times 10^{-6} q_0 + 26 \times 10^{-6} q_0 + 353 + 4 \times 10^{-6} q_0 + 333 \times 10^{-6} q_0$$

$$+ 17.75 \times 10^{-6} q_0$$

$$870.8 \times 10^{-6} q_0 = 852.15$$

$$q_0 = -95 \text{ LBS/IN}$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/2

SHEET NO. 51

AIRCRAFT:

C105

Torsion Box At Gear
Box Cut Out

PREPARED BY

A. FERENC

DATE

11/15/56

CHECKED BY

DATE

Shear Flows Due To 100 LB Vert Load
STA 615.65

$$q_{\text{cut above}} = 0 \quad A = 0 \quad q = \frac{V_z}{I_T} Z A$$

$$q_{\text{At 1}} = \frac{100}{10.17} \times .45 \left(\frac{1.7325}{1.554 - 1.715} \right) = 5.33 \times .45 \times 1.7325 = 7.88 \text{ LBS/IN}$$

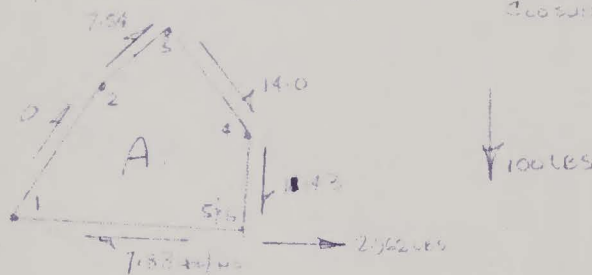
$$q_{\text{At 5/8}} = 7.88 + 5.33 \times .45 \left(\frac{1.554}{1.554 - 1.081} \right) = 7.88 + 3.155 = 16.43 \text{ LBS/IN}$$

$$q_{\text{At 4}} = 16.43 - 5.33 \times 1.224 \left(\frac{2.006}{2.56 - 1.054} \right) = 16.43 - 2.42 = 14.0 \text{ LBS/IN}$$

$$q_{\text{At 3}} = 14.0 - 5.33 \times 1.224 \left(\frac{5.32}{7.28 - 1.554} \right) = 14.0 - 6.46 = 7.54 \text{ LBS/IN}$$

$$q_{\text{At 2}} = 7.54 - 5.33 \times 1.224 \left(\frac{4.106}{6.76 - 1.554} \right) = 7.54 - 7.52 = .02 \text{ SHEAR BEZEL}$$

Close to zero, satisfactory



$$\Sigma F_V = 16.43 \times 3.871 + 14.0 \times 5.33 - 7.54 \times 9.32 - 7.88 \times 10.825$$

$$= 63.6 + 46.5 - 9.2 - 16.48$$

$$= 110.1 - 9.848 = 100.252 \text{ LBS}$$

$$\Sigma F_H = 7.88 \times 5.33 + 16.43 \times 10.3 - 14.0 \times 5.33 - 7.54 \times 14.1$$

$$= 44.8 + 121.2 - 32.6 + 10.65$$

$$46.12 - 43.15 = 2.962 \text{ LBS}$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0559-12/1

SHEET NO. 52

AIRCRAFT:

C105

TORISON BOX AT
GEAR FOR CUT OUT

PREPARED BY

A. FERRAC

DATE

Apr 56

CHECKED BY

DATE

LOCATION OF SHEAR CENTER

STAGE 66

SOLVING FOR REDUNDANT q_0

q_0 ASSUMED IN SAME DIRECTION AS SHEAR FLOW ON PAGE 12

SHEAR STRESS = $0 = \sum \tau_{xy} = \sum \frac{VQ}{It}$

$$0 = \frac{q_0 \times 5.69}{0.0713 \times 10^{-6}} + \frac{7.88 \times 5.69}{0.0713 \times 10^{-6}} + \frac{11.1 \times 3.875}{0.0501 \times 10^{-6}} + \frac{16.92 \times 3.875}{0.0501 \times 10^{-6}} + \frac{22 \times 4.06}{0.0401 \times 10^{-6}} + \frac{140.1 \times 4.06}{0.0401 \times 10^{-6}}$$

$$+ \frac{80 \times 1.565}{0.0716 \times 10^{-6}} + \frac{7.54 \times 1.565}{0.0716 \times 10^{-6}} + \frac{10 \times 6.23}{0.0716 \times 10^{-6}}$$

$$0 = 20.3 \times 10^{-6} q_0 + 160 \times 10^{-6} q_0 + 19.9 \times 10^{-6} q_0 + 1320 \times 10^{-6} q_0 + 26 \times 10^{-6} q_0 + 264 \times 10^{-6} q_0 + 7.15 \times 10^{-6} q_0$$

$$+ 54 \times 10^{-6} q_0 + 50 \times 10^{-6} q_0$$

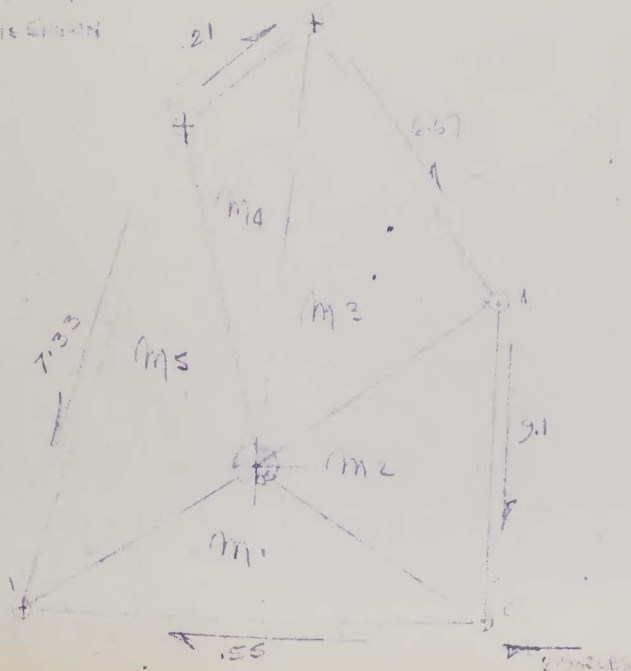
$$0 = 123.36 \times 10^{-6} q_0 + 900 \times 10^{-6} q_0$$

$$\therefore q_0 = -7.33 \text{ LBS/LIN}$$

AREA OF CELL

FOR LINS SEE CUT 50

NET FLOW IS SHOWN





AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0555-12/1

SHEET NO. 53

AIRCRAFT:

C105

TORSION BOX AT
GEAR BOX CUT OUT

PREPARED BY

DATE

A. FERENC

Apr/56

CHECKED BY

DATE

LOCATION OF SHEAR CENTER Sta 213.65

$$I_{y1} = 5685 \times 2.043 - 2.6 \times 2.05 = 11.62 - 6.77 = 10.943 \text{ INS}^2$$

$$I_{y2} = 3171 \times 2.68 - 2.006 \times 0.8 = 10.38 - 1.6 = 10.220 "$$

$$I_{y3} = 5326 \times 2.63 - 3.32 \times 0.35 = 14.27 - 1.61 = 12.660 "$$

$$I_{y4} = 5326 \times 1.41 - 1.22 \times 0.35 = 7.5 - 0.427 = 7.073 "$$

$$I_{y5} = 5685 \times 3.085 - 1.7329 \times 2.325 = 13.15 - 3.61 = 14.540$$

$$\Sigma I =$$

$$55.436 \text{ INS}^2$$

TAKING MOMENTS ABOUT CG

$$M = +.55 \times 10.943 - 2.962 \times 2.052 + 5.1 \times 10.220 + 6.67 \times 12.660 + 2.1 \times 7.073 - 7.23 \times 14.54$$

$$M = 6.025 - 6.08 + 52 + 84.5 + 14.85 - 106.5 = 72.13 \text{ LBS INS} \times$$

$$\text{SHEAR CENTER} = \frac{72.13}{100} = .7213 \text{ TO RIGHT OF CG.}$$



AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C105

PORTION Box AT
Gear Box CUT OUT

REPORT NO 7-0558-12/2

SHEET NO 54

PREPARED BY

DATE

A. FERENC

1 May 56

CHECKED BY

DATE

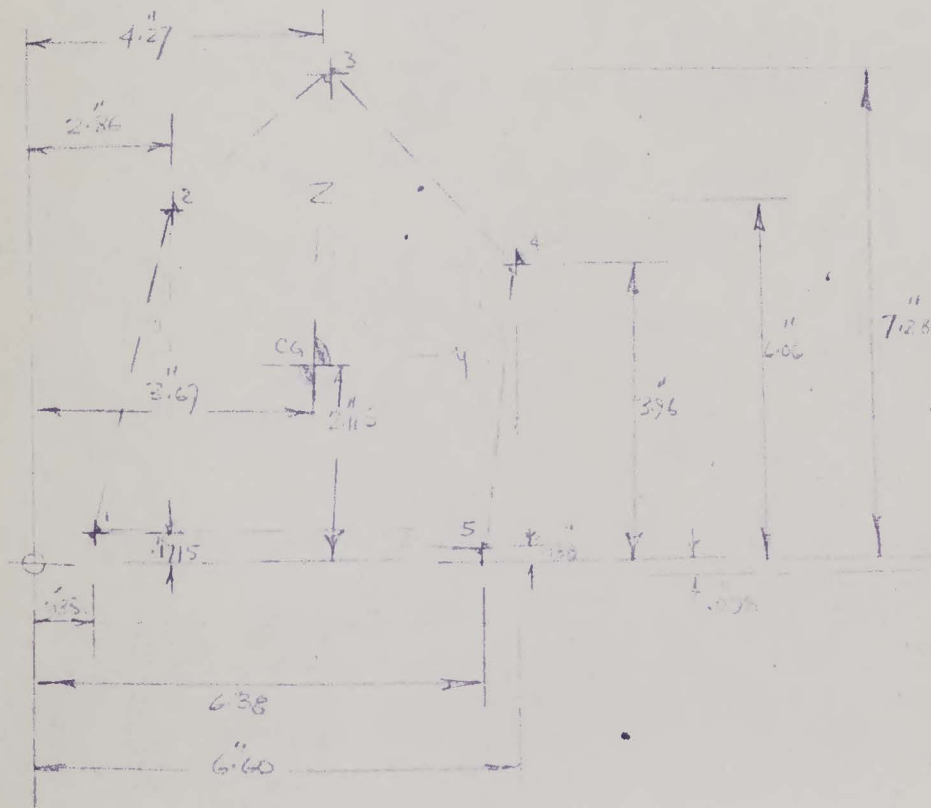
SECTION PROPERTIES AT STA 603.65 FWD

Item	A	Z	Az	Az ²	y	Ay	Ay ²	Axy	
1	.45	1.115	.0772	.01325	.835	.3760	.1410	10.43	REF b-1 ENT
2	.186	6.06	1.1250	6.8200	2.86	.5300	1.5220	3.210	REF b-1
3	1.234	7.28	.5000	6.8500	4.27	.5270	2.250	3.190	REF b-1
4	1.226	3.96	.488	1.2250	6.60	.8140	5.3750	3.720	REF b-1
5	3.056	1.38	.0504	.00696	6.38	2.3330	14.9000	.332	REF b-1
Σ	1.2186	2.115	2.6406	15.32521	3.67	4.582	24.361	10.656	

$$I_{\bar{y}} = 15.32521 - 2.115 \times 1.2436 = 15.32521 - 2.618 = 12.707 \text{ in}^4$$

$$I_{\bar{z}} = 24.361 - 3.67^2 \times 1.2486 = 24.361 - 16.52 = 7.841 \text{ in}^4$$

$$I_{\bar{x}} = 10.656 - 1.2486 \times 3.67 \times 2.115 = 10.656 - 9.691 = .965 \text{ in}^4$$





AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0458-12/2

SHEET NO. 57

AIRCRAFT:

C105

TORSION BOX AT GEAR
BOX CUT OUT

PREPARED BY

A. FERGUSON

DATE

Apr/56

CHECKED BY

DATE

SHEAR CENTER LOCATION STA 603.65 FWD

$$m_1 = 5.545 \times 1.977 - 2.71 \times 0.0335 = 10.96 - 0.09 = 10.870 \text{ in}^2$$

$$m_2 = 3.822 \times 2.93 - 1.845 \times 2.22 = 10.80 - 4.07 = 6.73 \text{ "}$$

$$m_3 = 5.165 \times 2.93 - 1.345 \times 6.0 = 15.10 - 8.07 = 7.03 \text{ "}$$

$$m_4 = 5.165 \times 1.41 - 1.22 \times 6.0 = 7.27 - 7.32 = -0.05 \text{ "}$$

$$m_5 = 3.8885 \times 2.835 - 1.2435 \times 2.025 = 10.99 - 2.51 = 8.48 \text{ "}$$

$$2A = 54.551 \text{ in}^2$$

TAKING MOMENTS ABOUT CG

$$M = 1.27 \times 10.87 + 10.04 \times 2.213 - 6.16 \times 10.383 - 3.82 \times 13.990 + 2.74 \times 6.533 + 10.25 \times 12.770$$

$$M = 13.8 + 22.2 - 64.8 - 53.4 + 17.9 + 130.2 = 55.9 \text{ LBS IN} \quad \uparrow$$

$$S.C. = \frac{55.9}{100} = .559 \text{ TO LEFT OF CG.}$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0358-12/R

SHEET NO. 58 (a)

AIRCRAFT:

C.105

TENSION BOX

PREPARED BY

DATE

J. B. YOUNG

MAY 26

CHECKED BY

DATE

TORQUE LOADING OF TENSION BOX

ASSUMPTIONS

- 1, THE BOX IS LOADED BY:
 - (a) INTERNAL PRESSURE
 - (b) BOTTOM PRESSURE
 - (c) SIDE "
 - (d) VERTICAL "j"
- 2, THE GEOMETRY (AND POSITION OF SHEAR CENTRE) IS ASSUMED TO BE UNIFORM ALONG THE LENGTH OF THE BOX; AS SHOWN IN SHEET 64.
- 3, ALL MOMENTS ARE TAKEN ABOUT THE SHEAR CENTRE.

NOTE

DUE TO ENGINE DOOR HOLE HOLES SPACED
SEE MODIFICATION SHEET (143)

RCRAFT 0195
U. W.

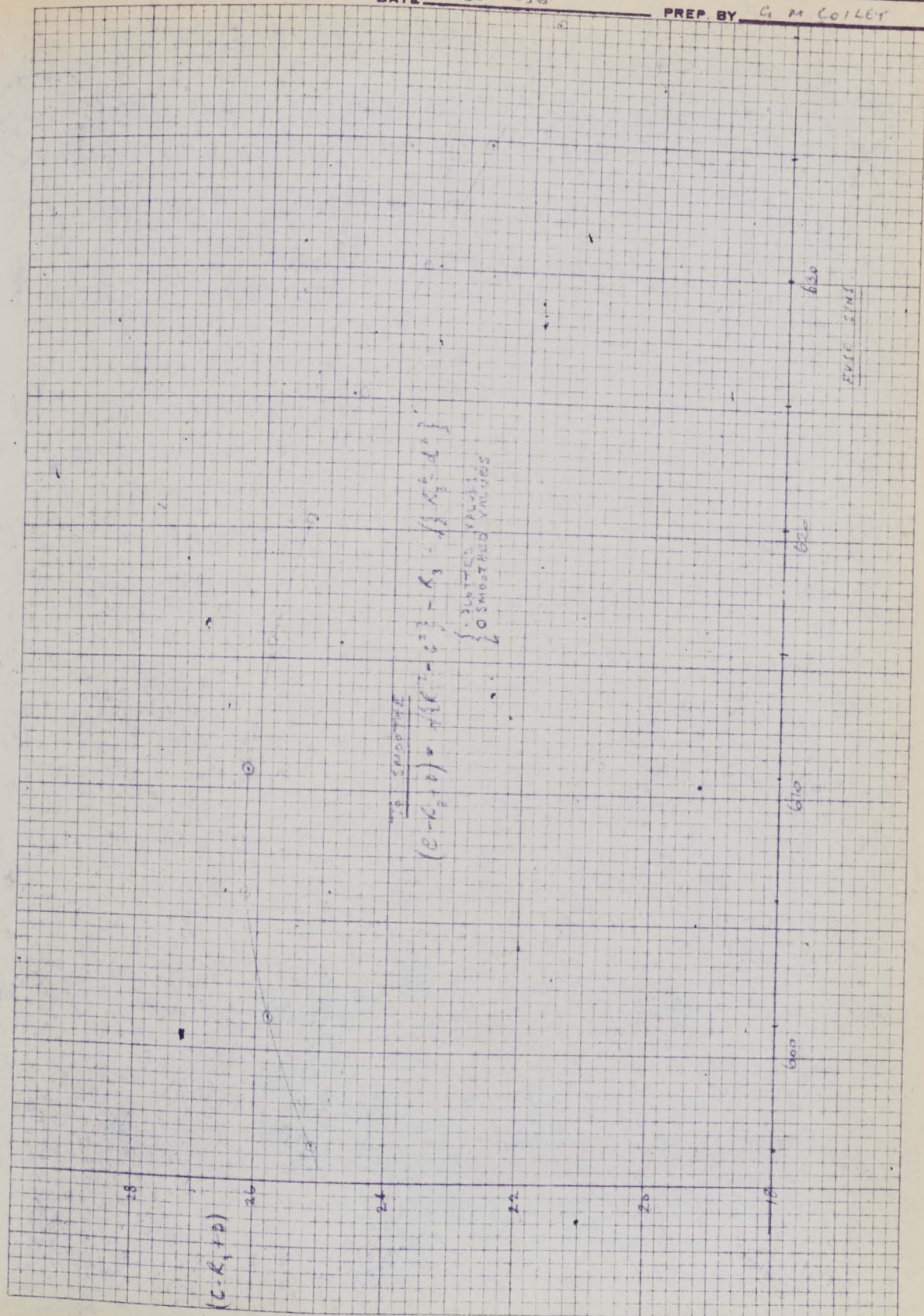
COMPONENT

SHEET No. 63

DATE 25-1-56

REPORT No. 7-0558-1212

PREP. BY G. M. COLLEY



TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-0558-12/2

SHEET No. 65

AIRCRAFT:

C105

Torsion Box

PREPARED BY

DATE

G.M. COILEY

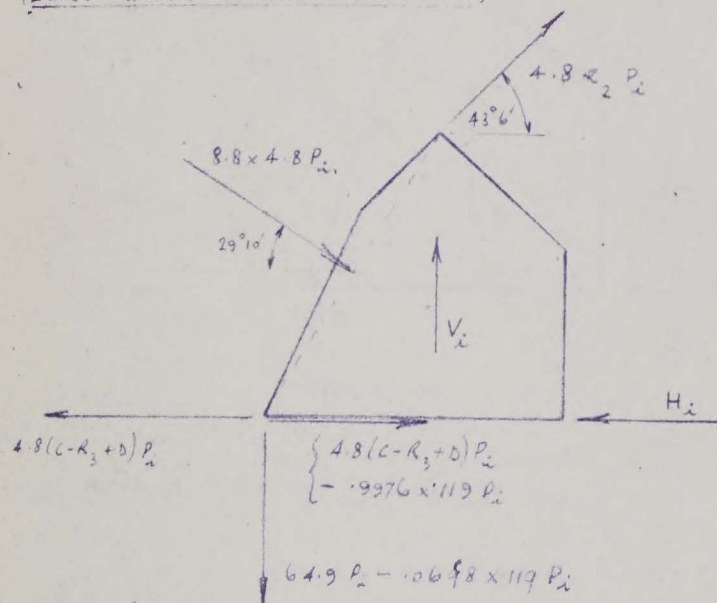
27-1-56

CHECKED BY

DATE

TORSION BOX LOADING

LOADING DUE TO INTERNAL DUCT PRESSURE P_i
(LOADS ARE FOR ONE BAY WIDTH = 4.8")



$$\begin{aligned} H_i &= + 8.8 \times 4.8 P_i \cos 29^\circ 10' + 4.8 R_2 P_i \cos 43^\circ 6' - 0.9976 \times 119 P_i \\ &= + 36.9 P_i + 3.505 R_2 P_i - 118.7 P_i \\ &= P_i (+ 3.505 R_2 - 81.8) \end{aligned}$$

$$\begin{aligned} V_i &= + 8.8 \times 4.8 P_i \sin 29^\circ 10' - 4.8 R_2 P_i \sin 43^\circ 6' + 64.9 P_i - 0.0698 \times 119 P_i \\ &= + 20.6 P_i - 3.28 R_2 P_i + 64.9 P_i - 8.31 P_i \\ &= P_i (77.2 - 3.28 R_2) \end{aligned}$$

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

REPORT NO. 7-0558-12/2

SHEET NO. 71

AIRCRAFT:

C105.

TORSION BOX

PREPARED BY

DATE

G. M. COLLEY

29-1-36

CHECKED BY

DATE

MAXIMUM TORQUE INPUT TO TORSION BOX FOR 4.8" BAY LENGTHS

STN.	596	601	606 E 620	610 E 625	615 E 620	639	634
23-38 K_2	603	629	710	710	710	710	710
23-38 $K_2 - 40.1$	563	589	670	670	670	670	670
214 K_1	10.8	13.5	15.2	16.4	16.9	10.8	13.5
214 $K_1 - 20$	-9.2	-6.5	-4.8	-3.6	-3.1	-9.2	-6.5

CONDITION G MAX TORSION

STN.	596	601	606 E 620	610 E 625	615 E 620	639	634
$P_1 + 14.85(23-38 K_2 - 40) + 14.030$		+14.630	+16.640	+16.640	+16.640	+6.640	+16.640
$P_2 - 136(214 K_1 - 20) + 3$		+ 9	+ 7	+ 5	+ 4	+ 13	+ 9
$P_3 - 0.688(214 K_1) + 14$		+ 14	+ 14	+ 14	+ 14	+ 14	+ 14
$M + 3.45(214 K_1) + 53$		+ 27	+ 7	- 4	- 14	+ 53	+ 27
TOTAL	+14,110	+14,680	+16,668	+16,655	+16,644	+16,720	+16,690

CONDITION 10 MAX TORSION

STN.	596	601	606 E 630	610 E 625	615 E 620	639	634
$P_1 - 2.05(23-38 K_2 - 40) - 1,159$		-1,210	-1,375	-1,375	-1,375	-1,375	-1,375
$P_2 + 2.50(214 K_1 - 20) - 41$		- 29	- 22	- 16	- 14	- 41	- 29
$P_3 + 1.00(214 K_1) - 21$		- 21	- 21	- 21	- 21	- 21	- 21
$M - 4.27(214 K_1) - 27$		- 14	- 4	+ 2	+ 7	- 27	- 14
TOTAL	-1,248	-1,274	-1,422	-1,410	-1,403	-1,464	-1,439

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-12/2

SHEET NO. 74

AIRCRAFT:

C106

Torsion Box

PREPARED BY

DATE

G. M. COILEY

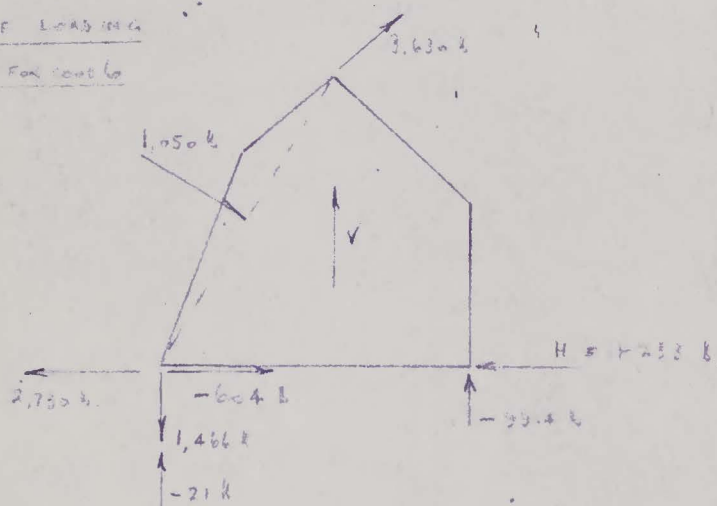
31-1-56

CHECKED BY

DATE

BALANCE OF LOADING

LOADS / BA- FOR 1000 lb



VERTICAL LOADS ARE BALANCED BY V , A SHEAR CARRIED IN THE TORQUE BOX AND REACTIONS AT THE HEAVY BEAMS. V ACTS THROUGH THE SHEAR CENTRE AND THEREFORE DOES NOT PRODUCE TORQUE.

HORIZONTAL LOADS ARE BALANCED BY H , THE SERVICE DOME LOAD. THIS WIND CONTRIBUTES TO THE BENDING OF THE BOX.

TO DETERMINE H .

$$\begin{aligned} H &= + 1.050 \cos 29^\circ 10' + 3.630 \cos 43^\circ 6' + 604 - 2,720 \\ &= + 917 + 2,950 - 2,126 \\ &= 233 \text{ lb. comp.} \end{aligned}$$

TAKING MOMENTS ABOUT THE SHEAR CENTRE

$$\begin{aligned} T &= 1.15 \times 1,050 + 3.19 \times 3,630 + 3.62 \times 917 - 3.07(1,466 + 21) \\ &\quad + 2.30(1,466 + 2,730 - 604) \\ &= 1,208 + 11,570 + 360 - 4,560 + 8,200 \\ &= 16,778 \text{ lb.-in.} \end{aligned}$$

$$\begin{aligned} \text{DIFF. FROM } &= \frac{16,778 - 16,720}{16,720} = \frac{58}{16,720} = 0.35\% \end{aligned}$$



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT No. 7-0558-12/2

SHEET No. 74(a)

AIRCRAFT:

C 105

TORSION BOX

PREPARED BY

DATE

J. H. YOUNG

23-5-56

CHECKED BY

DATE

MODIFICATION OF TORQUE DISTRIBUTION TO BOX

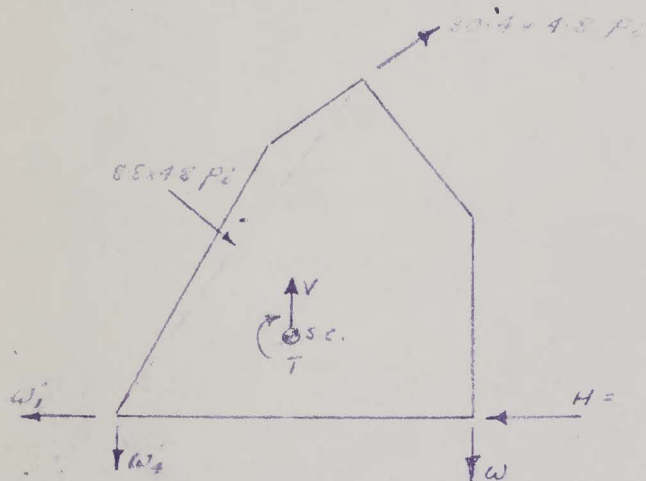
REASONS:-

(1) ENGINE DOOR NO. 1 IS NOW SLIT DOWN THE MIDDLE WITH LATCHES USED. IE NO CONTINUITY OF SKIN ON DOOR.

(2) HOOR TENSION BALANCE OF PRESSURE ON DOOR DUE TO CURVATURE IS NOW LOST. HENCE LOAD DISTRIBUTION TO TORSION BOX DIFFERENTLY MODIFIED.

PREVIOUS CASES ON PAGES

FROM 7-0558-30 TO 32 PAGE 26 CASE 6 LOADS ON BOX AS FOLLOWS:-



$$W_1 = 705 \times 4.8 \text{ lb} \\ = 3403 \text{ lb}$$

$$W_2 = 281 \times 4.8 + 3.35 \times 1.36 \times 4.8 \\ = 1361 \text{ lb}$$

$$W = 12.35 \times 4.8 \times 1.36 = 800 \text{ lb}$$

USING BEAM THEORY AS ON PAGE 14

RESOLVING HORIZONTAL

$$30.4 \times 4.8 \times 24.88 + 800 \times 13.6 + 8.8 \times 4.8 \times 24.88 \sin 23^\circ 10' \\ = 3403 = H$$

$$H = 165 \text{ lb}$$

TAKE MOMENTS ABOUT SC.



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0358-12/2

SHEET NO. 75

AIRCRAFT

C105

TORSION BOX

PREPARED BY

DATE

CHECKED BY

DATE

CALCULATION OF TORQUE DISTRIBUTION FOR SYMMETRIC CASE ONLY

FORMER STIFFNESS

As An Approximate Check On Ref 1, A. BENT WILL
BE CHOSEN SUCH THAT ITS GEOMETRY WILL GIVE APPROX
THE SAME BENDING MOMENT AROUND FRAME AS GIVEN
BY THE SHAPED FORMER.



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/2

SHEET NO. 77

AIRCRAFT:

C105

Torsion Box

PREPARED BY

A. FERENC

DATE

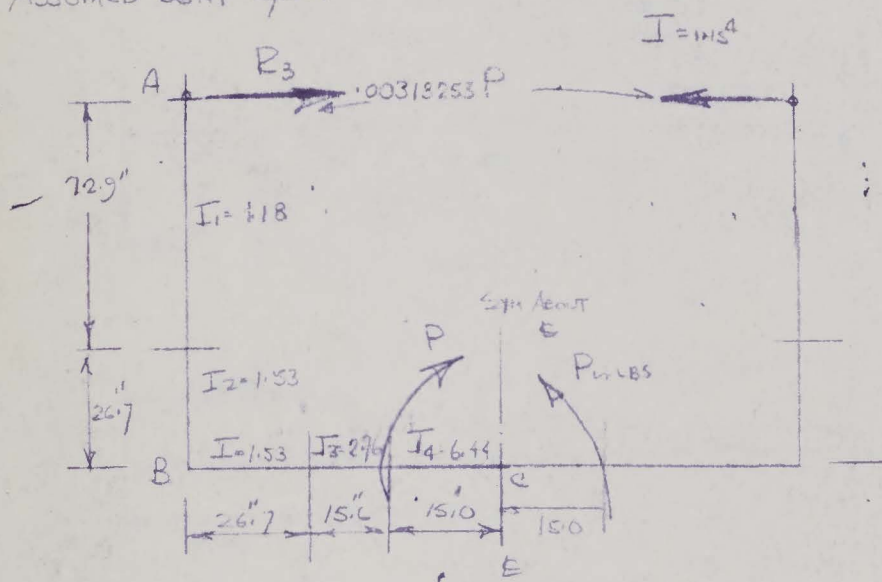
JAN/56

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DATE

CALCULATIONS OF TORQUE DISTRIBUTION FOR SYMMETRIC CASE ONLY

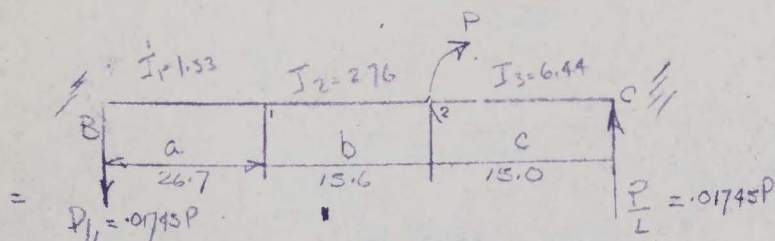
SINCE $Q_3 \neq Q_2$ ARE 0 REF 1 PAGE 5
MOMENT IS STRICTLY A FUNCTION OF HEIGHT.
 $\therefore$ ASSUMED BENT GEO.



IT IS NOW REQUIRED TO FIND A BEAM THAT HAS AN AVERAGE I THAT WILL GIVE THE SAME STIFFNESS AS BEAM BC AND BEAM A-B.

CONSIDERING B-C

$$M_1 = R_3 h = R_3 (22.9 + 26.7)$$





AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0358-12/2

SHEET NO. 79

AIRCRAFT

C105

Torsion Box

PREPARED BY

A. F. FERGUSON

DATE

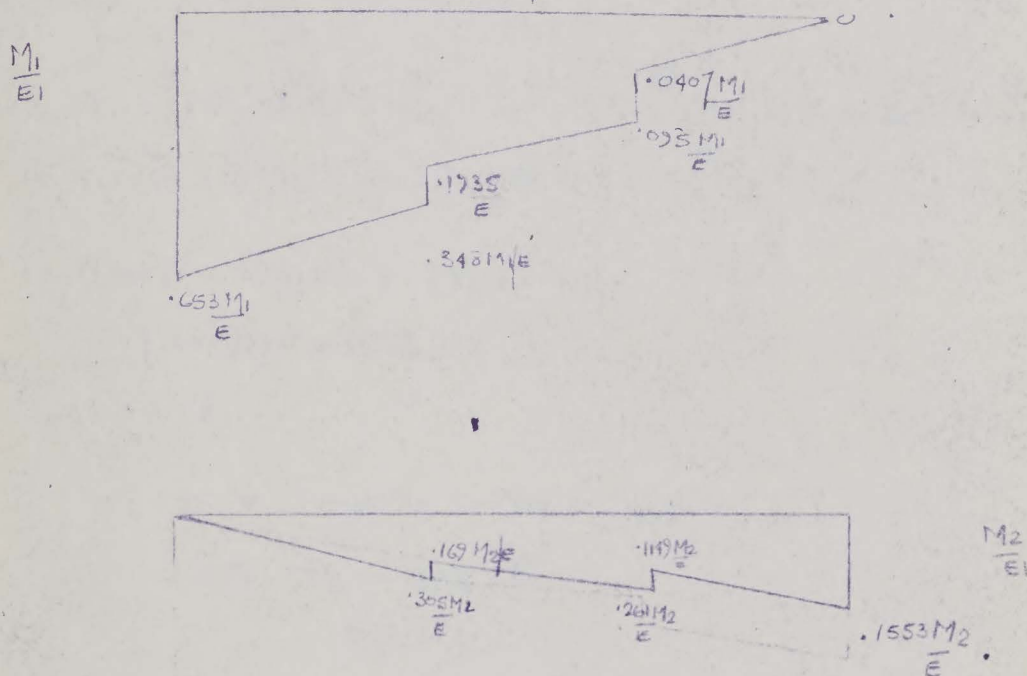
JAN 15/56

CHECKED BY

DATE

CALCULATION OF TORQUE DISTRIBUTION FOR SYMMETRIC CASE ONLY

AVI Beam B-C



① $\sum M/EI \text{ DIAGRAMS} = 0$ $E \text{ CONST}$

$$\frac{305 P \times 26.7}{2} + 2188 P \times 15.6 - 0.0407 P \times 15 + 5005 M_1 \times 26.7 + 1442 M_1 \times 15.6 + 0.0407 M_1 \times 15 \\ + 305 M_2 \times 26.7 + 215 M_2 \times 15.6 + 1251 M_2 \times 15 = 0$$

$$4.07 P + 3.41 P - 305 P + 13.35 M_1 + 2.25 M_1 + 305 M_1 + 4.075 M_2 + 3.355 M_2 + 2.034 M_2$$

$$7.175 P + 15.705 M_1 + 5.452 M_2 = 0$$

$$M_1 = -0.451 P - 0.595 M_2 \quad \text{--- (1)}$$

② $\sum \text{Mom. on } M/EI \text{ DIAGRAMS} = 0$

$$0 = \frac{305 P \times 26.7}{2} \times \frac{26.7}{3} + 1695 P \times 15.6 \left(\frac{26.7}{2} + \frac{15.6}{2} \right) + 0.0935 P \times 15.6 \left(\frac{26.7}{2} + \frac{15.6}{2} \right) - 0.0407 P \times 15 \left(\frac{15.6}{2} + \frac{26.7}{2} \right) \\ + 3.48 M_1 \times \frac{26.7^2}{2} + \frac{305 M_1 \times 26.7 \times 26.7}{3} + 0.0935 M_1 \times 15.6 \left(\frac{15.6}{2} + \frac{26.7}{2} \right) + 0.0407 M_1 \times 15.6 \left(\frac{15.6}{2} + \frac{26.7}{2} \right) \\ + 0.0407 M_1 \times 15 \left(\frac{15.6}{2} + \frac{26.7}{2} \right) + 305 M_2 \times \frac{26.7^2}{3} + 169 M_2 \times 15.6 \left(\frac{15.6}{2} + \frac{26.7}{2} \right)$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT

C105

TORSION BOX

REPORT NO. 7-0558-12/2

SHEET NO. 20

PREPARED BY

DATE

A. FERENC

JAN/56

CHECKED BY

DATE

CALCULATIONS OF TORQUE DISTRIBUTION FOR SYMMETRIC CASE ONLY.

AN I FOR BEAM B-C

$$\textcircled{1} + 0.02 M_2 \times \frac{15.6}{2} \left(\frac{15.6}{3} + 26.7 \right) + 0.149 M_2 \times \frac{15}{2} \left(\frac{15}{2} + 42.3 \right) + 0.04 M_2 \times \frac{15}{2} \left(\frac{15.6}{2} + 42.3 \right)$$

$$\textcircled{1} \quad 0 = 72.3 P + 91.25 P + 29.5 P - 144.4 P + 124 M_1 + 36.2 M_1 + 51 M_1 + 24.5 M_1 + 14.42 M_1$$

$$+ 72.5 M_2 + 171 M_2 + 26.6 M_2 + 36.1 M_2 + 15.9 M_2$$

$$177.61 P + 250.12 M_1 + 292.1 M_2 = 0$$

$$M_1 = -707 P - 1.162 M_2 \quad \text{--- } \textcircled{2}$$

SUBS. (2) IN (1)

$$-0.451 P - 0.575 M_2 = -707 P - 1.162 M_2$$

$$0.577 M_2 = -256 P$$

$$M_2 = -451 P$$

$$M_1 = -707 P - 1.162 P \times 451 = -707 P + 523 P = -184 P$$

Reactions Due To $M_2 = \frac{451 P}{57.3} = 0.00785 P$ $\uparrow$ $\downarrow$

Reactions Due To $M_1 = \frac{184 P}{57.3} = 0.00321 P$ $\downarrow$ $\uparrow$

Net $0.00464 P$ $\uparrow$ $\downarrow$



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TECHNICAL DEPARTMENT

REPORT NO. 7-0552-12, 2

SHEET NO. 81

AIRCRAFT:

C105

TORSION BOX

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DATE

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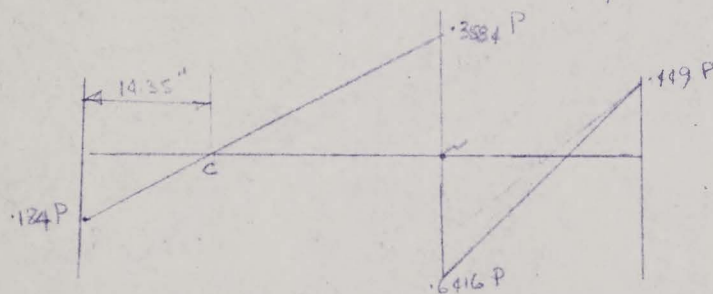
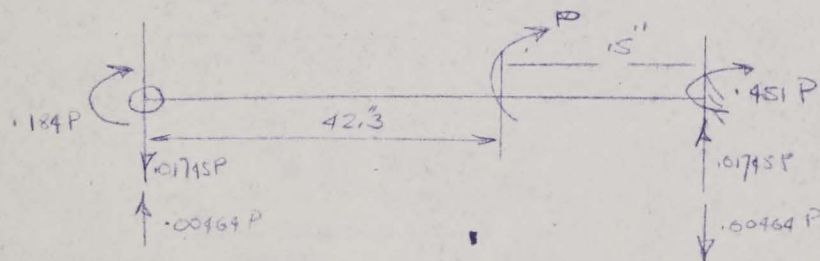
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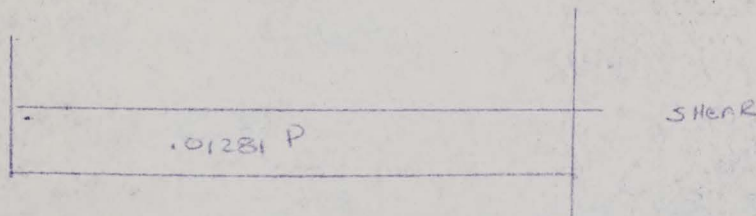
CALCULATION OF TORQUE DISTRIBUTION FOR SYMMETRIC CASE ONLY

AUT FOR BEAM B-C

BEAM LOADING



NET B.M.



SHEAR

TO FIND DEFLECTION AT POINT OF APPLICATION, AT C



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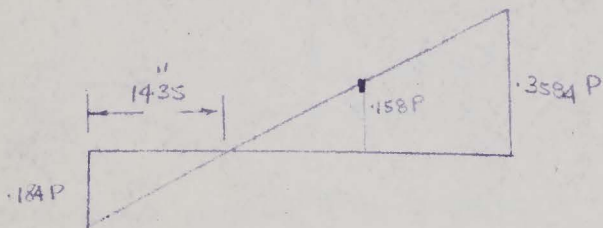
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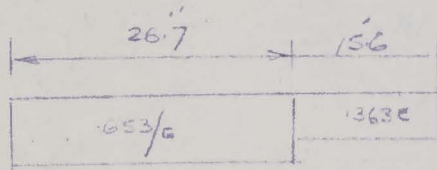
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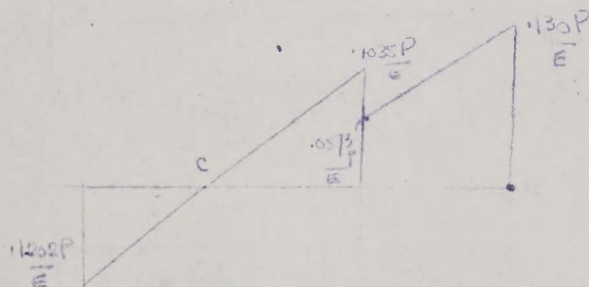
CALCULATIONS FOR TORQUE DISTRIBUTION SYMMETRIC CASE ONLY
AU I FOR BEAM E-C
DEFLECTION AT POINT C



Net
Mom DIAG.



$\frac{1}{EI}$ DIAGRAM



$\frac{M}{EI}$

$$J_c = -\frac{1202P}{E} \times \frac{14.35}{2} \times \frac{14.35}{3} = -8.25P$$

FROM REF 7 PAGE 109 CASE 37

$$y = -\frac{1}{6EI} (3M_1x^2 - R_1x^3)$$

$$R_1 = -\frac{6M_0(a-l)}{l^2} \quad ; \quad M_1 = -\frac{M_0}{l^2} (4a^2 - 3al - l^2)$$

$$M_0 = P$$

$$\frac{8.25P}{E} = -\frac{1}{6EI} \left\{ 3x - \frac{P}{57.3^2} (4 \times 57.3 \times 14.35 - 3 \times 14.35^2 - 57.3^2) 14.35^2 - \frac{6P}{57.3^3} (57.3 \times 14.35 - 14.35^2) 14.35^3 \right\}$$

$$-8.25P = -\frac{167}{I} (113P + 57.8P)$$

$$-8.25P = -28.7P$$

$$\therefore I = \frac{28.7}{4.125 \times 2} = 3.46 \text{ IN}^4$$



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C105

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CALCULATIONS FOR TORQUE DISTRIBUTION SYMMETRIC CASE ONLY

AV I FOR BEAM A-B

Σ MOMENTS OF M/EI DIAGRAMS ABOUT $B' = 0$

$$0 = 10.48 \frac{W}{E} \times \frac{22.9}{2} \times \frac{2}{3} \times 22.9 + 8.07 \frac{W}{E} \times \frac{26.7}{2} \left(22.9 + \frac{1}{3} \times 26.7 \right) - \frac{3925}{E} M \times \frac{22.9^2}{3}$$

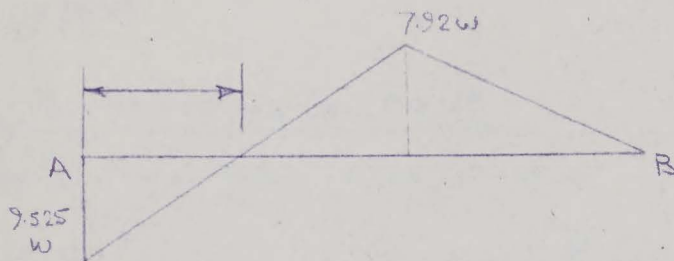
$$- \frac{3625}{E} M \times 26.7 \left(\frac{22.9}{2} + \frac{26.7}{2} \right) - \frac{3515}{E} M \times \frac{26.7}{2} \left(22.9 + \frac{2}{3} \times 26.7 \right)$$

$$= \frac{1835W}{E} + \frac{3430W}{E} - \frac{68.6M}{E} - \frac{2931M}{E} - \frac{191M}{E}$$

$$\frac{5265W}{E} = \frac{552.6M}{E} \quad \therefore M = 952.5W$$

$$\text{REACTION AT A} = .462W + \frac{9.525W}{49.6} = .462W + .1922W = .6544W$$

$$\text{REACTION AT B} = .3456W$$



Net Mom
Diagram

DEFLECTION UNDER LOAD W

$$= \frac{8.07W}{E} \times \frac{26.7}{2} \times \frac{1}{3} \times 26.7 - \frac{3025}{E} \times 9.525W \times \frac{26.7^2}{2} - \frac{3515}{E} \times 9.525W \times \frac{26.7}{2} \times \frac{2}{3} \times 26.7$$

$$= \frac{958W}{E} - \frac{1028W}{E} - \frac{795W}{E} = -\frac{873W}{E} \text{ IN'S}$$

FROM REF PAGE 105 CASE 22

$$y = \frac{1}{6EI} [R_1(x^3 - 3l^2x) + 3Wa^2x]$$

$$R_1 = \frac{1}{2}W \left(\frac{3a^2l - a^3}{l^3} \right)$$



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CALCULATIONS FOR TORQUE DISTRIBUTION SYMMETRIC CASE ONLY
AVERAGE I BEAM A-B

$$-875W = \frac{1}{6EI} \left[\frac{1}{2}W \left(\frac{3a^2l - a^3}{l^3} \right) (x^3 - 3lx^2) + 3Wa^2x \right]$$

At $x = b$

$$-875W = \frac{1}{EI} \left[.8W \left(\frac{3 \times 26.7^2 \times 49.6 - 26.7^3}{49.6^3} \right) (26.7^3 - 3 \times 49.6 \times 26.7^2) + 3W 26.7^2 \times 26.7 \right]$$

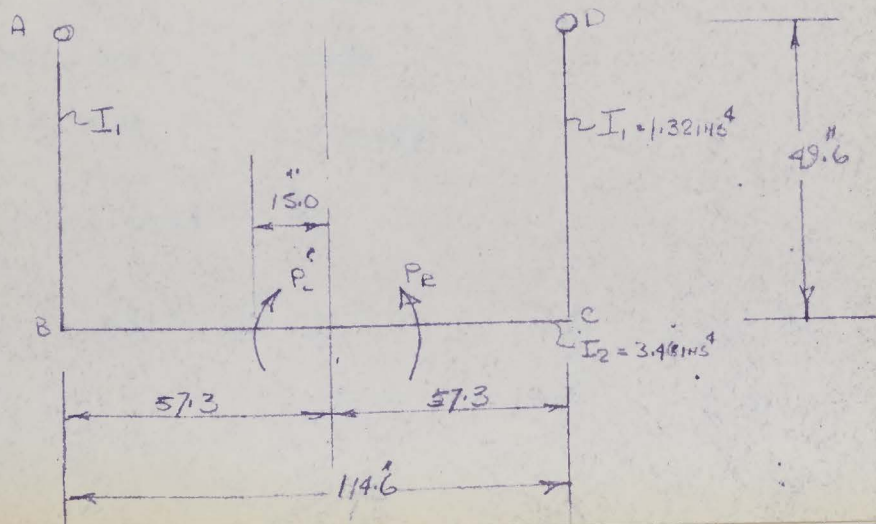
$$-875W = \frac{1}{EI} \left[.356W \times -157000 + 48900W \right]$$

$$-875W = \frac{1}{EI} \left[-55800 + 48900 \right] = \frac{1}{EI} \left[-6900 \right] = \frac{-1152W}{EI}$$

$$I = \frac{-1152W}{875W} = 1.32 \text{ INS}^4$$

SOLVING FOR REACTIONS ON BENT

SEE REF 8 PAGE 148 & REF 1 PAGE 5



TECHNICAL DEPARTMENT (Aircraft)

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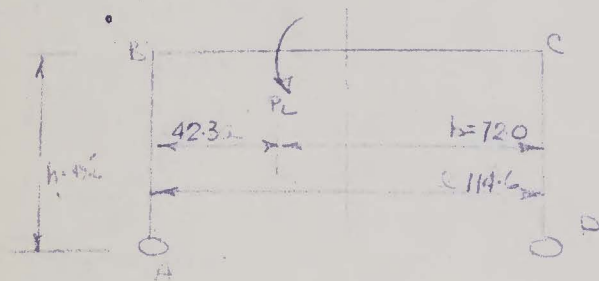
Jan 15/56

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CALCULATIONS FOR TORQUE DISTRIBUTION SYMMETRIC CASE ONLY.

CONSIDERING PL ONLY



$$\alpha = a/l = \frac{42.3}{114.6} = .370$$

$$\beta = b/l = \frac{72}{114.6} = .630$$

$$K = \frac{I_2}{I_1} \frac{h}{l} = \frac{3.46}{1.32} \times \frac{49.6}{114.6} = 1.135$$

Poisson's ratio

$$N = 2K + 3 = 2 \times 1.135 + 3 = 5.27$$

$$M_B = M_C = - \frac{2 \times P (.630 - .370)}{2 \times 5.27} = \frac{.78 P}{10.54} = .0738 P$$

$$M_1 = .0738 P - .370 P = -.4438 P$$

$$M_2 = .0738 P + .630 P = .75562 P$$

$$H_A = H_D = - \frac{.0738}{49.6} = -.00149 P$$

$$V_D = \frac{-P}{2 \times 57.3} = -.0087 P$$

$$V_A = -V_D = .0087 P$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO: 7-0558-12/2

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C105

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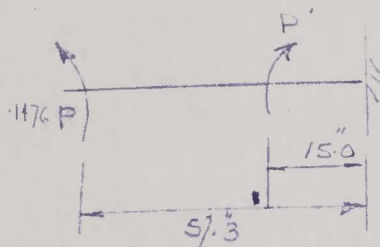
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CALCULATIONS FOR TORQUE DISTRIBUTION SYMMETRIC CASE ONLY.

STIFFNESS OF BEAM.



$$\theta = \frac{P L}{EI} - \frac{1176 L}{EI}$$

$$= 4.33 \times 10^{-7} - 2.44 \times 10^{-7}$$

$$\theta = 1.89 \times 10^{-7}$$

$$\text{STIFFNESS} = \frac{1}{1.89 \times 10^{-7}} = .529 \times 10^7 \text{ LB IN / RAD}$$

$$\text{FROM PAGE 20 REF 1 STIFFNESS} = 7.6104 \times 10^7$$

$$\text{FOR UNSUPPORTED BEAM PAGE 20 REF 1 STIFFNESS} = \frac{1}{2.35} = .429 \text{ LB IN / RAD.}$$

THE STIFFNESS OF THE BEAM SHOULD LIE SOMEWHERE BETWEEN THE MAX STIFFNESS OF THE FRAMES & MIN STIFFNESS OF FRAMES AS SHOWN ABOVE.

2 METHODS FOR DISTRIBUTING TORQUE WILL BE USED

- (1) CALCULATING STIFFNESS AS PREVIOUSLY SHOWN FOR HOW SECTION PROPERTIES.
- (2) EMPLOYING METHOD FOR OBTAINING HOW STIFFNESSES WHICH WILL BE SHOWN ON FOLLOWING SHEET AS FORWARDED BY V. WISE WITH J. STAMMINGS CONSENT.

- (1) WILL BE CORREL FOR THE TRANSVERSE MEMBERS
- (2) WILL BE CORREL FOR THE FRAMES.



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Calculation OF Torque Distribution Symmetric Case Only.

2 METHOD OF OBTAINING STIFFNESSES

$$\text{UNSTIFFENED BEAM } C_0 = \frac{2EI}{L_0} = \frac{2 \times 10^7 \times 6.44}{30} = 1.4253 \times 10^7 \text{ LBS INCH/RAD}$$

$$\beta_1 = 1.772 \text{ SRT } 20 \text{ ROP1}$$

$$\therefore \text{ AT } I = 6.44 \text{ IN}^4 \quad \beta = 1.772 \quad C = 1.772 \times 1.4253 = .761 \times 10^7 \text{ LBS INCH/INCH}$$

2 CURVES ARE APPROXIMATED OF β VS I IT WILL BE ASSUMED THAT $\beta = 1.0$ IN 1000 INS AND IN 1000 INS

$$I_1 \beta_1 = 6.44 \times 1.772 = 11.412$$

$$\frac{I_2 \beta_2}{11.412} \times .761 = C_2 = .0667 I_2 \beta_2 \times 10^7 \text{ LBS INCH/INCH}$$

WITH AN I_2 VALUE & TAKING MEAN VALUE BETWEEN THE TWO CURVES β IS FOUND

$\therefore C_2$ CAN BE FOUND



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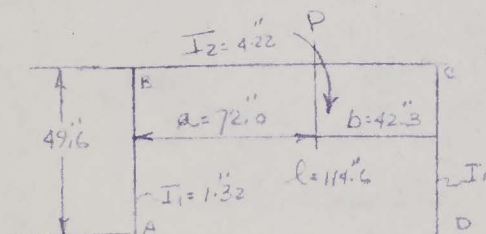
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CALCULATION OF TORQUE DISTRIBUTION SYMMETRIC CASE ONLY

SOLVING REINT REDUNDANTS FOR P_R



$$\alpha = \frac{72.0}{114.6} = .63$$

$$\beta = \frac{42.3}{114.6} = .37$$

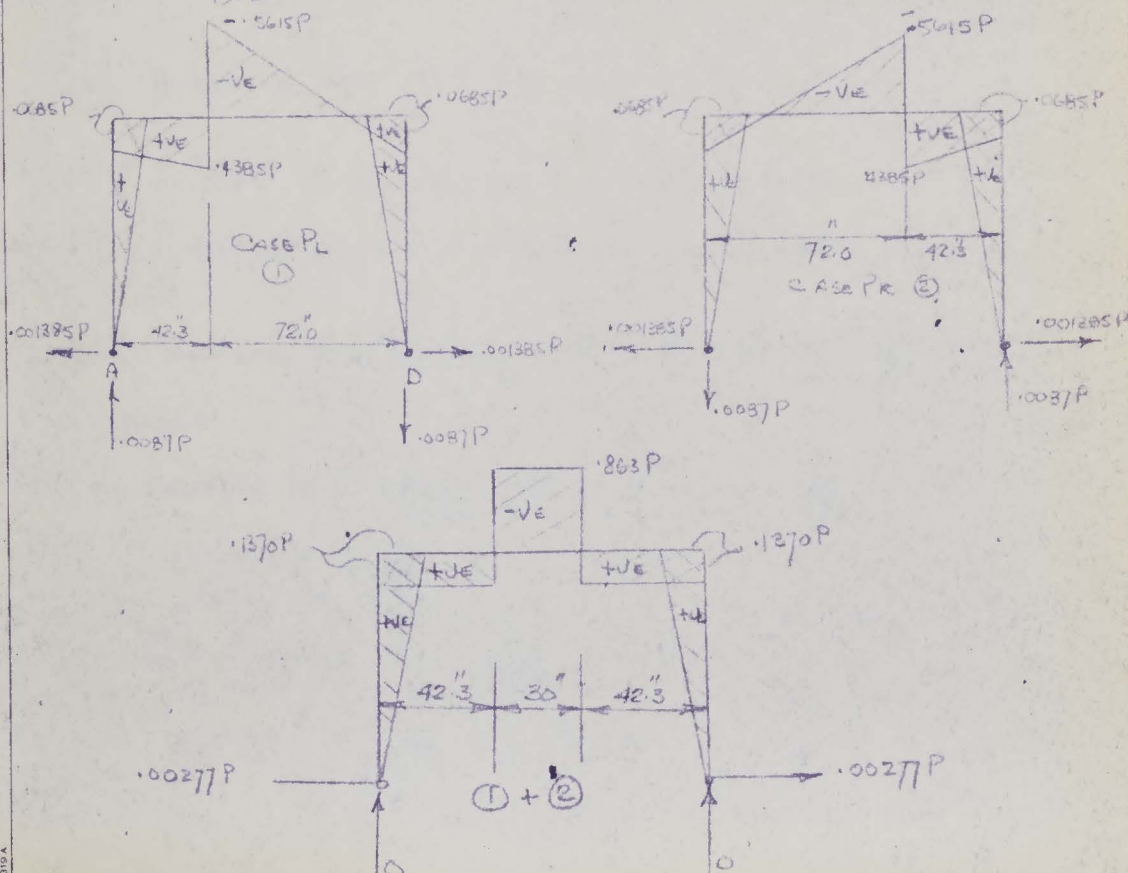
$$K = 1.38 \quad \left. \begin{array}{l} \\ \\ \end{array} \right\} \text{SKT}$$

$$M = 57.6$$

$$M_B = M_C = -\frac{3 \times P(.37 - .63)}{2 \times 57.6} = .0685P$$

$$M_1 = .0685P - .63P = -.5615P \quad ; \quad M_2 = .0685P + .37P = .4385P$$

$$H_A = H_D = -\frac{.0685P}{49.6} = -.001385P \quad ; \quad V_D = -\frac{P}{114.6} = +.0087P$$





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SHEET NO.

97

AIRCRAFT:

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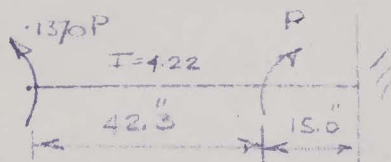
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CALCULATION OF TORQUE DISTRIBUTION SYMMETRIC CASE ONLY

STIFFNESS OF FRAME



$$\theta = \frac{Pa}{EI} - \frac{0.137PL}{EI} = \frac{P \times 15.0}{10^7 \times 4.22} - \frac{0.137P \times 57.3}{4.22 \times 10^7}$$

$$\theta = (3.57 \times 10^{-7} - 1.865 \times 10^{-7}) = 1.715 \times 10^{-7}$$

$$\text{STIFFNESS } \frac{1}{\theta} = 583 \times 10^7 \text{ LBS INCH/RAD} = K$$

Using Method 2 Ref SHT-52 & SHT-54

$$\text{At } I_2 = 8.95 = I_4 \text{ (Ref SHT-54)} \quad B_2 = 1.55$$

$$\therefore C_2 = 0.667 \times 1.55 \times 8.95 = 9.25 \times 10^7 \text{ LBS INCH/RAD}$$

$$\text{FOR AN INCREASE IN } I \text{ OF } \left(\frac{9.25}{6.199} = 1.39 \right) \quad K_{\text{INCREASES}} \left(\frac{9.25}{7.61} = 1.215 \right)$$

Using RENTS

$$\text{FOR AN INCREASE IN } I \text{ OF } \left(\frac{4.22}{3.46} = 1.22 \right) \quad K_{\text{INCREASES}} \frac{583}{529} = 1.102$$

RATIO OF INCREASE IN I
INCREASE IN K

$$\text{FOR METHOD 2} = \frac{1.39}{1.215} = 1.145$$

$$\text{FOR RENT} = \frac{1.22}{1.102} = 1.110$$



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CALCULATION OF TORQUE DISTRIBUTION SYMMETRIC CASE ONLY

AT THE MOMENT IT HAS BEEN DECIDED BY J. MANNING TO USE V. MASI'S METHOD OF OBTAINING BEAM STIFFNESSES. IT HAS ALSO BEEN DECIDED TO USE THE SAME STIFFNESS OF FRAME SPINGS AS OBTAINED IN REF 1 ALTHOUGH IT HAS CHANGED. THE CHANGE IS ASSUMED NEGLECTABLE. THE NEW STIFFNESS OF AFT FRAME HAS BEEN WORKED OUT ON PREVIOUS PAGE.

TORSIONAL STIFFNESS OF TORQUE BOX

REF 1 PAGE 4

$$I_{AO} \text{ OF TORQUE BOX} = 10.40 \text{ IN}^4 \text{ SHT 37}$$

$$K = .03075 \times 10^{-6} \text{ RAD / LBS IN}^3 \text{ SHT 32}$$

$$\text{THEN } J' = \frac{I_{AO}}{9 K \Delta X} = \frac{1}{9 K} = \frac{1}{.03075 \times 10^{-6}}$$

$$B_{C, L+1} = \frac{9 J'}{\Delta X_{C, L+1}} = \frac{18}{.03075 \times 10^{-6}} = 3.25 \times 10^7 \text{ LBS IN}^3 / \text{RAD}$$

$$K_T = 3270 \text{ LBS IN}^3 / \text{IN} \quad \Delta X_{C, L+1}$$

$L, L+1$	$\Delta X_{C, L+1}$	$B_{C, L+1}$	L	ΔX_C	$K_T \Delta X_C$
0, 2	19.2	1,692,703	0	9.6	31,392
2, 4	14.4	2,256,945	2	16.8	54,936
4, 5	19.2	1,692,703	4	16.8	54,936
			5	9.6	31,392

$$C_0 = .76104 \times 10^7 \text{ REF 1 PAGE 20}$$

$$C_5 = .925 \times 10^7 \text{ REF SHT 31}$$

$$I_2' = 1.97 (\text{SHT 27}) + 2 \times (1.265 \text{ REF 2 SHT 572}) = 4.5 \text{ IN}^4$$

$$C_2' = \frac{2 \times 10^7 \times 4.5}{30} = .300000 \times 10^7$$

$$C_4 = \frac{2 \times 10^7 \times 2.04 (\text{SHT 23})}{30} = .136000 \times 10^7$$

065
100 SHT



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CALCULATION OF TORQUE DISTRIBUTION SYMMETRIC CASE ONLY

$$D_0 = 10^7 (0 + .76104 + .1692703) = .9303108 \times 10^7$$

$$D_2 = 10^7 (.1692703 + .300000 + .2256745) = .6949653 \times 10^7$$

$$D_4 = 10^7 (.2256745 + .136000 + .1692703) = .5309653 \times 10^7$$

$$D_5 = 10^7 (.1692703 + .925000 + 0) = 1.0942703 \times 10^7$$

$$(1) .0031392 = .9303108 \theta_0 - .1692703 \theta_2$$

$$(2) .0054936 = -.1692703 \theta_0 + .6949653 \theta_2 - .2256745 \theta_4$$

$$(3) .0054936 = -.2256745 \theta_2 + .5309653 \theta_4 - .1692703 \theta_5$$

$$(4) .0031392 = -.1692703 \theta_4 + 1.0942703 \theta_5$$

SOLVING FOR THESE 4 EQUATIONS ON FOLLOWING PAGE.

$$\theta_5 = .005774 \text{ RAD}$$

$$\theta_4 = .0187314 "$$

$$\theta_2 = .0155136 "$$

$$\theta_0 = .0061771$$

$$T_5 = .925 \times 10^7 \times .005774 = 53410$$

$$T_4 = .136 \times 10^7 \times .0187314 = 25543$$

$$T_2 = .300 \times 10^7 \times .0155136 = 46540$$

$$T_0 = .76104 \times 10^7 \times .0061771 = 47162$$

$$172655$$

% OF TOT.

$$30.95$$

$$14.79$$

$$26.96$$

$$27.32$$

$$100.00$$

0.35



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64 SHEET NO. 101

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CALCULATION OF TORQUE DISTRIBUTION SYMMETRIC CASE ONLY.

USING V. MASI'S METHOD OF DETERMINING STIFFNESSES OF HEAVY FRAMES + MODIFICATIONS TO TRANSVERSE BEAMS.

ALL CONSTANTS OF SHT 98 ARE THE SAME EXCEPT FOR $C_2' \neq C_4$

$$I_2' = (1.55 \text{ SHT} + 2 \times 1.265 \text{ Ref 2 SHT 572}) - 4.03 \text{ IN}^4$$

$$C_2' = \frac{2 \times 10^7 \times 4.08}{30} = .272 \times 10^7$$

$$C_4 = \frac{2 \times 10^7 \times 1.612 \text{ (SHT)}}{30} = .1073 \times 10^7$$

∴

$$D_0 = 10^7 (0 + .76104 + .1692708) = .930318 \times 10^7$$

$$D_2 = 10^7 (.1692708 + .272000 + .2256945) = .6669653 \times 10^7$$

$$D_4 = 10^7 (.2256945 + .107500 + .1692708) = .5023653 \times 10^7$$

$$D_5 = 10^7 (.1692708 + .225000 + 0) = 1.0942708 \times 10^7$$

$$(1) .0031392 = .930318 \theta_0 - .1692708 \theta_2$$

$$(2) .0054936 = -.1692708 \theta_0 + .6669653 \theta_2 - .2256945 \theta_4$$

$$(3) .0054936 = -.2256945 \theta_2 + .5023653 \theta_4 - .1692708 \theta_5$$

$$(4) .0031392 = -.1692708 \theta_4 + 1.0942708 \theta_5$$

SOLVING FOR THESE EQUATIONS ON FOLLOWING PAGE

$$\theta_5 = .0060439 \text{ RAD}$$

$$\theta_4 = .0205265 \text{ "}$$

$$\theta_2' = .0168155 \text{ "}$$

$$\theta_0 = .0064340 \text{ "}$$

$$\therefore T_5 = .925 \times 10^7 \times .0060439 = 55906 \text{ LBS IN} \quad 32.38 \%$$

$$T_4 = .1075 \times 10^7 \times .0205265 = 22067 \text{ "} \quad 12.78 \%$$

$$T_2 = .272 \times 10^7 \times .0168155 = 45738 \text{ "} \quad 26.49 \%$$

$$T_0 = .76104 \times .0064340 = 48965 \text{ "} \quad 28.35 \%$$

$$172676$$

$$100.00 \%$$



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REPORT No. 7-0558-12/2

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CALCULATION OF TORQUE DISTRIBUTION SYMMETRIC CASE ONLY
SOLVING FOR θ 'S

EQUATION	COEFFICIENT OF θ_0	COEFF. OF θ_2	COEFF OF θ_4	COEFF OF θ_5	R.H.S	SAL COEFF
1	.9303108	-.1692708			.0031392	.7641792
2	-.1692708	.6667653	-.2256945		.0054936	.2774936
3		-.2256945	.5023653	-.1692708	.0054936	.1128936
4			-.1692708	1.0942708	.0031392	.9281592
1	1.000000	.1819508			.0033744	.8214236
2	1.000000	3.9402265	1.3333339		.0324545	1.6393471
1-2=5		3.7582757	1.3333339		.0358289	2.4607707
5		1.000000	.3547728		.0095333	.6547606
3		1.000000	2.2238641	.7499997	.0243408	.5002054
5-3=6			1.8710913	.7499997	.0338741	1.1549660
6			1.000000	.4008354	.0181039	.6172686
4			1.000000	6.4646164	.0185454	5.483108
6-4=7				6.063781	.0366493	6.1004304
7				1.000000	.0060439	1.0060439

$$\therefore \theta_5 = .0060439$$

$$\theta_4 = .0205265$$

$$\theta_2 = .0168155$$

$$\theta_0 = .0064340$$

CHECK

$$(1) .0059856 - .0028463 = 31393 \text{ OK}$$

$$(2) -.0010891 + .0112153 - .0046327 = 54935 \text{ OK}$$

$$(3) -.0037952 + .0103118 - .0010231 = 54935 \text{ OK}$$

$$(4) = -.0034745 + .0066136 = 31391 \text{ OK}$$



AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/2

SHEET NO. 103

AIRCRAFT:

C105

TORSION BOX

PREPARED BY

A. FERENC

DATE

JAN 1956

CHECKED BY

DATE

CALCULATION OF TORQUE DISTRIBUTION SYMMETRIC CASE ONLY USING STIFFNES ASSUMING FRAME + RIGHT ANGLED BENT

B_{LH} SAME AS ON PAGE 102

K_L AXIAL SAME AS ON PAGE 102

$$C_0 = .529 \times 10^7 \text{ SHT}$$

$$C_2' = .272 \times 10^7 \text{ SHT}$$

$$C_4 = .1075 \times 10^7 \text{ SHT}$$

$$C_5 = .583 \times 10^7 \text{ SHT}$$

$$D_0 = 10^7 (0 + .529 + .1692708) = .6982708 \times 10^7$$

$$D_2 = 10^7 (.1692708 + .272000 + .2256945) = .6669653 \times 10^7$$

$$D_3 = 10^7 (.2256945 + .1075000 + .1692708) = .5023653 \times 10^7$$

$$D_4 = 10^7 (.1692708 + .58300 + 0) = .7522708 \times 10^7$$

$$(1) .0031392 = .6982708 \theta_0 - .1692708 \theta_2'$$

$$(2) .0054936 = -.1692708 \theta_0 + .6669653 \theta_2' - .2256945 \theta_4$$

$$(3) .0054936 = -.2256945 \theta_2' + .5023653 \theta_4 - .1692708 \theta_4$$

$$(4) .0031392 = -.1692708 \theta_4 + .7522708 \theta_4$$

SOLVING FOR THESE EQUATIONS ON FOLLOWING PAGE

$$\theta_5 = .0091417 \text{ RAD}$$

$$\theta_4 = .0220820 \text{ "}$$

$$\theta_2' = .0179545 \text{ "}$$

$$\theta_0 = .0033481 \text{ "}$$

$$T_5 = .583 \times 10^7 \times .0091417 = 53296 \text{ LBS IN}$$

$$T_4 = .1075 \times 10^7 \times .022082 = 23738 \text{ " "}$$

$$T_2' = .272 \times 10^7 \times .0179545 = 48836$$

$$T_0 = .529 \times 10^7 \times .0033481 = 46806$$

172676

% of Tor

30.86 %

13.75 %

28.28 %

27.11 %

100.00 %



AVRO AIRCRAFT LIMITED
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SHEET NO. 104

AIRCRAFT:

C105

TORSION BOX

PREPARED BY:

A. FERENC

DATE

JAN 30

CHECKED BY

DATE

CALCULATION OF TORQUE DISTRIBUTION SYMMETRIC CASE ONLY SOLVING FOR SLOPES

EQUATION	COEFFICIENT θ_0	COEFF θ_2'	COEFF θ_4	COEFF θ_5	R.H.S	Σ ALL COEFF
1	.6982708	-.1692708			.0031392	.5321392
2	-.1692708	+.6667653	.2256745		.0054936	.2774936
3		.2256745	.5023653	.7692708	.0054936	.1128936
4			-.1692708	.7522708	.0031392	.5861392
1	1.000000	.2424143			.0044957	.7620814
2	1.000000	.39402265	1.3333339		.0321545	1.6373471
1-2=5		3.6978122	1.3333339		.0367502	2.4014285
5		1.000000	.3605737		.0099924	.6494187
3		1.000000	.22253641	.7499997	.0243408	.5002054
5-3=6			1.8652904	.7499997	.0343332	1.1496241
6			1.000000	.4020820	.0184063	.6163244
4			1.000000	4.4441852	.0185454	3.4627307
6-4=7				4.0421032	.0369517	4.0790551
7				1.000000	.0091417	1.0091417
$\theta_5 = .0091417$ $\theta_4 = .0220820$ $\theta_2' = .0179545$ $\theta_0 = .0088481$						

CHECK

- (1) .0061784 - .0030392 = .0031392 OK
- (2) -.0014977 + .0119750 - .0049838 = .0054935 OK
- (3) -.0040522 + .0110932 - .0015474 = .0054936 OK
- (4) -.0037378 + .0068770 = .0031392 OK



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/2

SHEET NO. 105

AIRCRAFT:

C105

TORSION BOX

PREPARED BY

DATE

A. FERENC

Jan 15/56

CHECKED BY

DATE

SUMMARY OF TORQUE DISTRIBUTION SYMMETRIC CASE

① FROM REPORT 7-0558-32 SHT 31 (i.e. ORIGINAL CASE BASED ON OLD I's)

		% OF TOTAL	
T ₅	= 61074 LBS IN	35.4	
T ₄	= 16079 LBS IN	9.3	
T ₂ '	= 39530 LBS IN	23.1	ORS
T ₀	= 55579 LBS IN	32.2	

② USING MACI'S METHOD FOR OBTAINING FRAME STIFFNESSES & NEW I's FOR FRAMES. MODIFIED TRANSVERSE BEAMS NOT USED. i.e. TWO COMP. CAPS & ATTACHMENT HOLES NOT REMOVED FROM TENSION CAP REF SHTS 24, 16 & 18

		%	
T ₅	= 53410 LBS IN	30.93	
T ₄	= 25543 "	14.79	
T ₂ '	= 46540 "	26.96	ORS.
T ₀	= 47162 "	27.32	

③ USING MACI'S METHOD FOR OBTAINING FRAME STIFFNESSES & MODIFIED TRANSVERSE BEAMS. SEE SHT 31 & NEW I's FOR FRAMES.

		%	
T ₅	= 55906 LBS IN	32.38	
T ₄	= 22067 "	12.78	
T ₂ '	= 45738 "	26.49	
T ₀	= 48965 "	28.35	

④ ASSUMING FRAME IS A RIGHT ANGLE BENT WITH LATEST FRAME I's & MODIFIED TRANSVERSE BEAM I's.

		%	
T ₅	= 53296 LBS IN	30.86	
T ₄	= 23738 "	13.75	
T ₂ '	= 48836 "	28.28	
T ₀	= 46086 "	27.11	

THE FIRST TWO ARE OBSOLETE BUT SHOWN HERE FOR COMPARISON ONLY. MACI'S METHOD ③ IS CRITICAL FOR FRAMES. ④ IS CRITICAL FOR TRANSVERSE BEAMS

SEE SHT 106 FOR SKETCH



AVRO AIRCRAFT LIMITED
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TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/2

SHEET NO. 107

AIRCRAFT:

C103

INNER LONGERON

PREPARED BY

DATE

A. FERENC

MAR 56

CHECKED BY

DATE

UNIT SHEARS & B.M.'S

THE FOLLOWING PAGES 143-146 GIVE THE SHEAR
AND B.M.S FOR:

UNIT + $V_E g$

" + $V_E P_L$

" + $V_E P_S$

" + $V_E P_b$



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MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/2

SHEET NO. 107A

AIRCRAFT:

C.105

INNER LONGERON

PREPARED BY

DATE

J B YOUNG

MAY 56

CHECKED BY

DATE

INNER LONGERON STN 501-663 AS BEAM

ASSUMPTIONS

FOR TORSION BOX AND INNER LONGERON TO STN 663 ACTING AS A BEAM IT WAS DECIDED TO BUILD BEAM IN AT STN 663. AS PRELIMINARY SKETCHING AND PANEL DESIGN NOT COMPLETE ON INNER LONGERON STN 663-697 AT THIS STAGE, THIS FIXING MOMENT WOULD THEN BE TAKEN ON STR. STN 663-697.

REF A.V.O. 1 GOULD TO J. MANNING 19 FEB 1956.

LONGERON BEAM DESIGN NOW COMPLETE. HENCE AT LATER DATE THESE B.M. DIAGRAMS WILL BE SUPERSEDED I.E. BEAM COLUMN ANALYSIS WILL BE DONE FOR BEAM LENGTH STN 501-742.

- ① BEAM FULLY FIXED AT STN 663-65
- ② " PIN JOINTED " " 591-65
- ③ ALL SUPPORTS RIGID AND LEVEL.



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TECHNICAL DEPARTMENT

AIRCRAFT:

C105

INNER
LONGERON

REPORT NO. 7-0538-12/2

SHEET NO. 110

PREPARED BY

DATE

R. J. LADDON

27 Feb '56

CHECKED BY

DATE

$$R_A = 350 / 52.78 = 6.65 \text{ lb}$$

$$R_C = 107 / 19.20 = 5.60 \text{ lb}$$

$$R_B = 6.65 + 5.60 = 12.25 \text{ lb}$$

CONSIDER UNIT G.

$$S_1 = 4.85$$

$$F_L = 12000$$

$$S_2 = 3.32$$

$$F_R = 136$$

$$-25.864$$

$$T_B = \frac{27.36}{-8.25}$$

$$= -3.32 \text{ lb in.}$$

$$T_C = \frac{1}{2} \left\{ \frac{136}{3.32} + 884 \right\}$$

$$= +422 \text{ lb in.}$$

$$R_A = \frac{+884}{52.78} = +16.8 \text{ lb}$$

$$R_C = \frac{+884}{19.20} = +46 \text{ lb}$$

$$R_B = \frac{+884}{16.8} = +52.6 \text{ lb}$$

$$R_D = 1306 / 19.20 = 68.2 \text{ lb}$$

$$R_C = 16.8 + 68.2 = 85.0 \text{ lb}$$

CRAFT
I. W.

C.105

COMPONENT INNER

SHEET No. III

REPORT No. 7-0558-12/2

DATE 27 FEB 56

PREP. BY K. J. OODEN

SFE IN AIR WING
(VERTICAL)

+VE

UP

DOWN

DOWN

775016 INS

789016 INS

TOP TENS

TOP
COMP

DEEP
TENS

57165 57495 60125 60605 60785 61265 62045 62525 63005 63485 63965 64445 64925 65405

FORM 1746

6-59-65

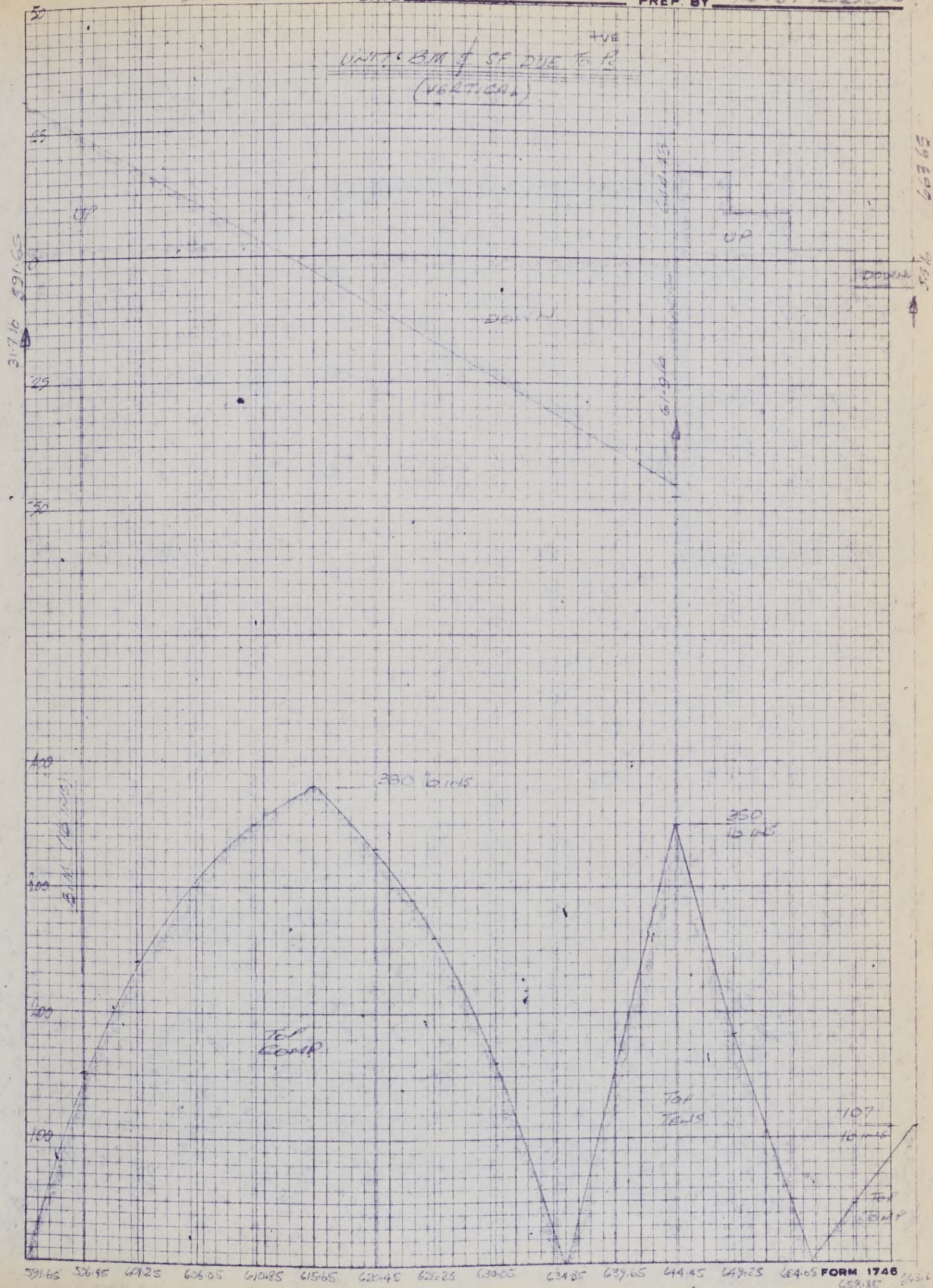
STATIONS

RAFT
W.

C.105. COMPONENT INNER
LONGERON

SHEET No. 113
DATE 27 FEB '56

REPORT No.
PREP BY K.J. IODON





AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-17/2

SHEET NO. 114 (2)

AIRCRAFT:

C 105

TORSION BOX

PREPARED BY

DATE

J. B. YOUNG

MAY 56

CHECKED BY

DATE

SHEAR PANELS

ASSUMPTIONS

- 1, AXIAL LOAD APPLIED AT STN 591 IS DIFFUSED OVER ONE BAY
- 2, AXIAL LOAD AND B.M. APPLIED AT STN 644 IS DIFFUSED OVER TWO BAYS.
- 3, DIFFUSION LOADS DUE TO B.M. AND A.L. AT THE CUT-OUT (603-610) AFFECTS PANELS FROM STNS 596 - 603 FWD AND 610 - 615 AFT OF CUT-OUT.
- 4, ALL SHEAR FLOWS ARE ASSUMED CONSTANT OVER PANEL LENGTHS.
- 5, SHEAR FLOW DUE TO TORQUE IS GIVEN BY BATHO THEORY
- 6, " " " " VERTICAL SHEAR WAS FOUND BY ASSUMING THAT THE BOX BENDS ABOUT AN AXIS PARALLEL TO THE BOTTOM SKIN.

METHOD OF ANALYSIS

FOR EACH SHEAR PANEL THE TOTAL SHEAR FLOW WAS FOUND FOR UNIT CASES, I.E.:-

$$P_L = 10 \text{ lb/in}^2$$

$$P_B = 10 \text{ " "}$$

$$P_S = 10 \text{ " "}$$

$$\tau = 10 \text{ g}$$

ACTUAL VALUES OF PRESSURES AND INERTIA WERE THEN SUBSTITUTED FOR DESIGN CASES ON PAGES 162 + 164.



AVRO AIRCRAFT LIMITED
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TECHNICAL DEPARTMENT

REPORT NO. 70558-12/2

SHEET NO. 115

AIRCRAFT:

C105

TORSION BOX

PREPARED BY

DATE

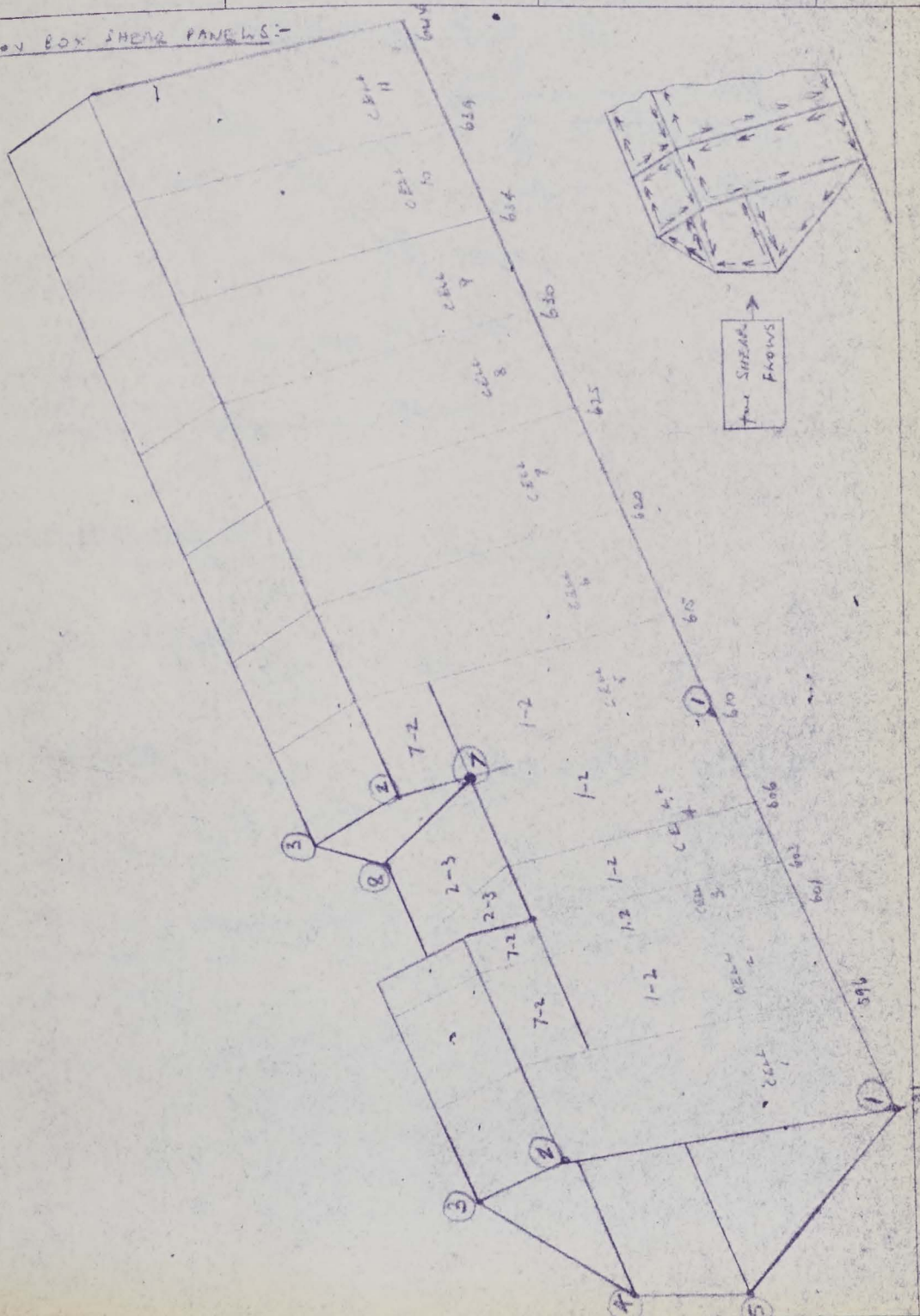
G. M. CORLEY

6-7-66

CHECKED BY

DATE

TORSION BOX SHEAR PANELS:-





AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C105

Torsion Box

REPORT NO. 7-0558-12/2

SHEET NO. 116

PREPARED BY

DATE

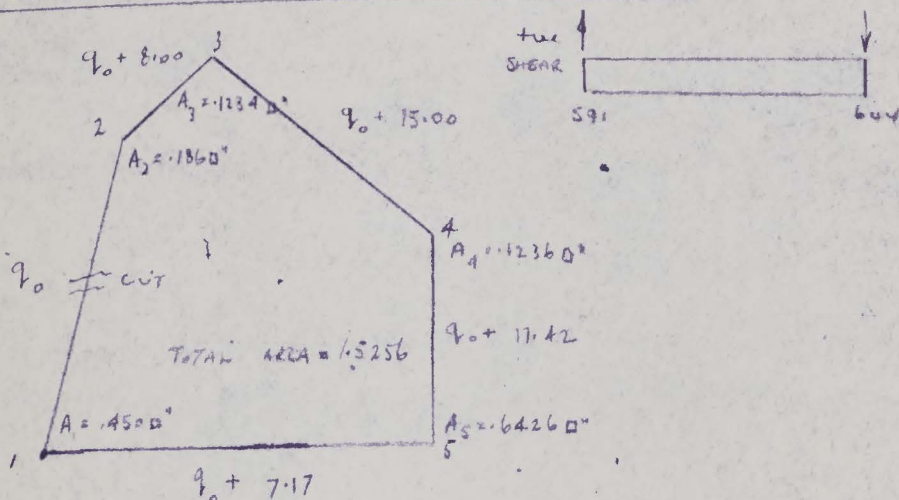
A. M. COILEY

2-4-56

CHECKED BY

DATE

SHEAR FLOWS FOR VERT SHEAR $z = 100$ K. AT STN 591



TAKING MOMENTS ABOUT 1-5

$$= 6.25 \times .186 + 7.7 \times .1234 + 3.77 \times .1236$$

$$= 1.163 + 0.950 + 0.465$$

$$= 2.578 \text{ in}^3$$

$$\bar{x} = \frac{2.578}{1.5256} = 1.69$$

I ABOUT NA

$$= (.450 + .6426) 1.69^2 + .186 \times 4.56^2 + .1234 \times 5.01^2 + .1236 \times 2.08^2$$

$$= 3.12 + 3.86 + 3.09 + 0.53$$

$$= 10.60 \text{ in}^4$$

APPLY 100 K VERTICAL SHEAR

ACTING OVER 1.0 INCH

$$B.M. = 100 \text{ in}$$

$$\text{SHEAR FLOW TO 1.} = \frac{100 \times 1.69}{10.6} \times .45 = -7.18 \text{ k/in}$$

$$2. = \frac{100 \times 4.56}{10.6} \times .186 = 8.00 \text{ k/in}$$

$$3. = \frac{100 \times 5.01}{10.6} \times .1234 = 7.00 \text{ k/in}$$

$$4. = \frac{100 \times 2.08}{10.6} \times .1236 = 2.42 \text{ k/in}$$

$$5. = \frac{100 \times 6.44}{10.6} \times .6426 = 10.25 \text{ k/in}$$



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SHEET NO. 118

AIRCRAFT:

C/S

Torsion Box

PREPARED BY

DATE

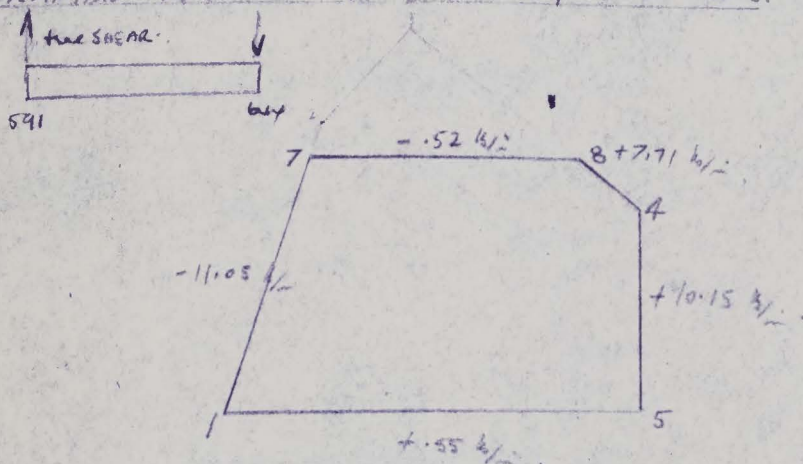
R. A. COLLEY

6-4-56

CHECKED BY

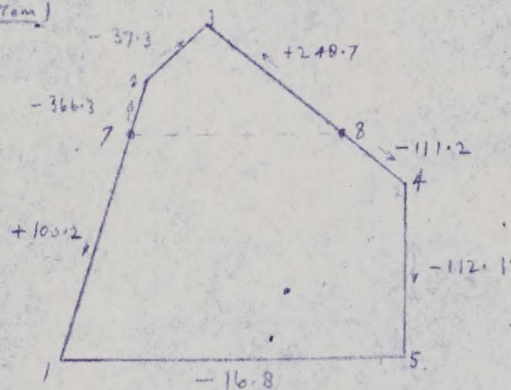
DATE

SHEAR FLOWS FOR VERT SHEAR 2 -100 LBS AT CUT OUT STNS 606-610 BAY 4
INFORMATION FROM CALC BY A. FERRELL; CUT OUT CALC.



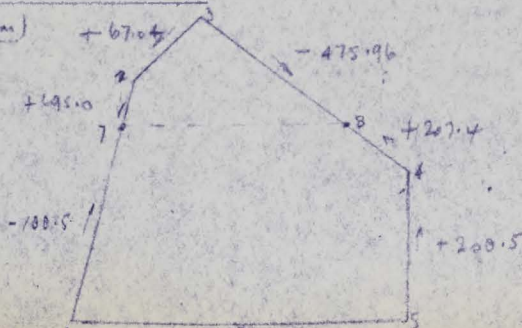
SHEAR FLOWS IN TUBES FOR DIFFUSION OF LOAD AT CUT OUT DUE TO VERT BM
INFORMATION FROM A. FERRELL.

FOR BM 2-31, 461 LBS APPLIED AT 603
(Corner Bottom)



3/4 FOR STNS 596-603
BAYS 2 & 3

FOR BM 2-39, 883 LBS APPLIED AT 610
(Comp Bottom)



3/4 FOR STNS 610-615
BAY 5



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SHEET NO. 119

AIRCRAFT:

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PREPARED BY

DATE

G. M. COILEY

6-4-16

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DATE

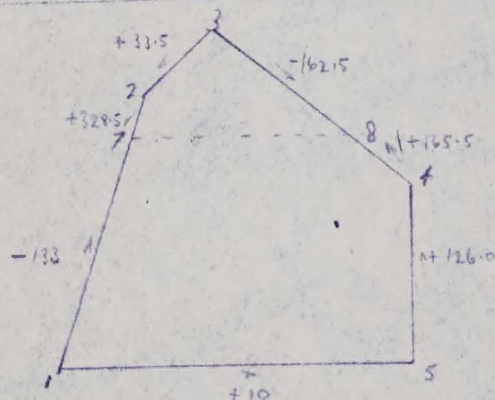
SHEAR FLOWS IN PANELS FOR DIFFUSION OF LOAD AT CUT OUT DUE TO AXIAL LOAD
INFORMATION FROM A PERENC

FOR A CONSTANT AXIAL LOAD = 14,250 K Comp.

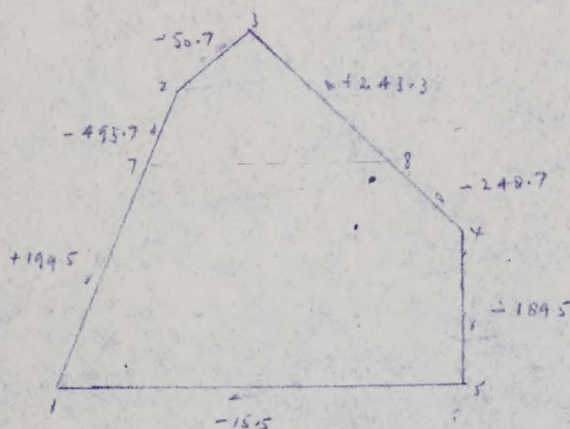
5/11 FOR

STNS 596-603

BAYS 2 & 3



5/11 FOR STNS 604-612 BAYS





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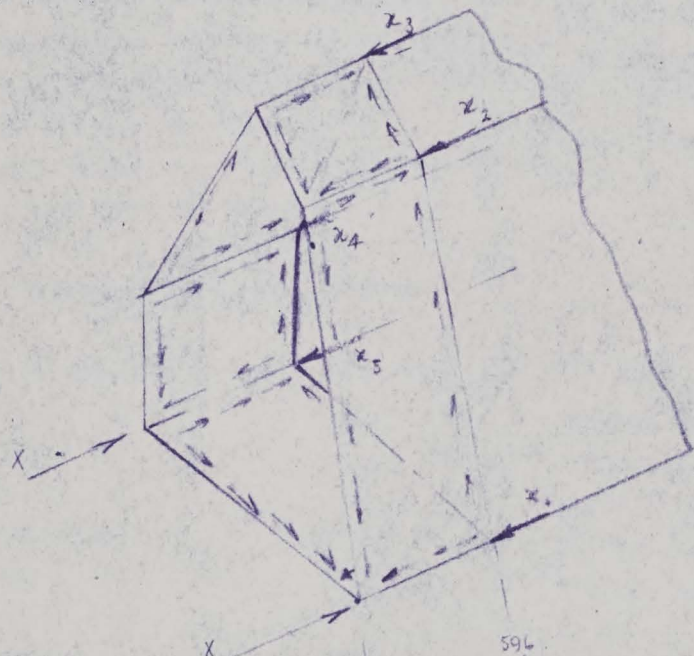
R. M. COLLET

27-3-56

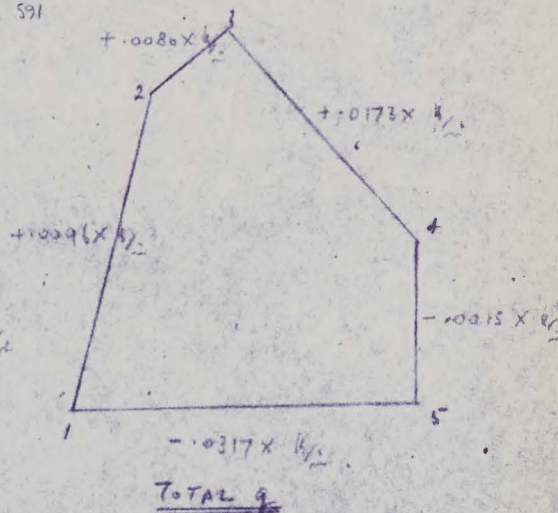
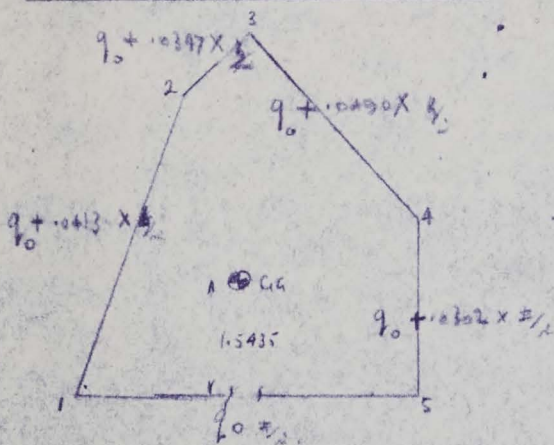
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DISTRIBUTION OF AXIAL LOAD, STN 591 (AXIAL LOAD = 2X)



SHEAR FLOWS IN PANELS IN TERMS OF X





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G.M. COLLEY

4-4-56

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DATE

THE SHEAR FLOW IN PANELS WITH PANEL 1-5 CUT

$$\begin{aligned}
 1-2 \quad q' &= .2085X - x_1' = .2085X - .1672X = +.0413X \\
 2-3 \quad q' &= .2085X - x_1' - x_2' = +.0413X - .0016X = +.0397X \\
 3-4 \quad q' &= .2085X - x_1' - x_2' - x_3' = +.0397X + .0093X = +.0490X \\
 4-5 \quad q' &= .2085X - x_1' - x_2' - x_3' - x_4' = +.0490X - .0188X = +.0302X \\
 5-1 \quad q' &= .2085X - x_1' - x_2' - x_3' - x_4' - x_5' + .2085X = +.0302X - .2386X + .2085X \\
 &= +.0001 \text{ (SHEAR FLOW)}
 \end{aligned}$$

REF PERRY PAGE 450

WEB	AS	EFFECTIVE +	AS E	q'	q' AS E	q
1-2	6.9	.1085	81.2	+.0413X	+3.360X	+.0096X
2-3	2.1	.177	27.3	+.0397X	+1.1083X	+.0080X
3-4	4.5	.1040	112.5	+.0490X	+5.510X	+.0173X
4-5	3.9	.1051	76.5	+.0302X	+2.310X	-.0013X
5-1	6.5	.1072	90.3	0	0	-.0317X
	23.9		387.8		+12.263X	

FOR NO TWISTING.

$$q_0 \sum \frac{AS}{b} + \sum q' \frac{AS}{b} = 0 \quad q_0 + q' = q$$

$$q_0 = \frac{-12.263X}{387.8} = -.0317X$$



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2-4-56

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DIFFUSION OF LOAD AT STN 644.42

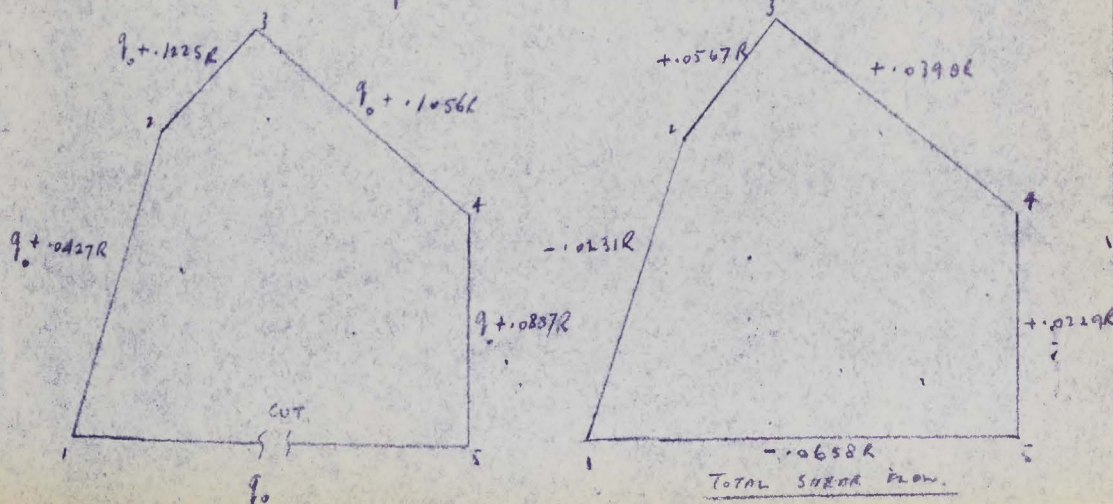
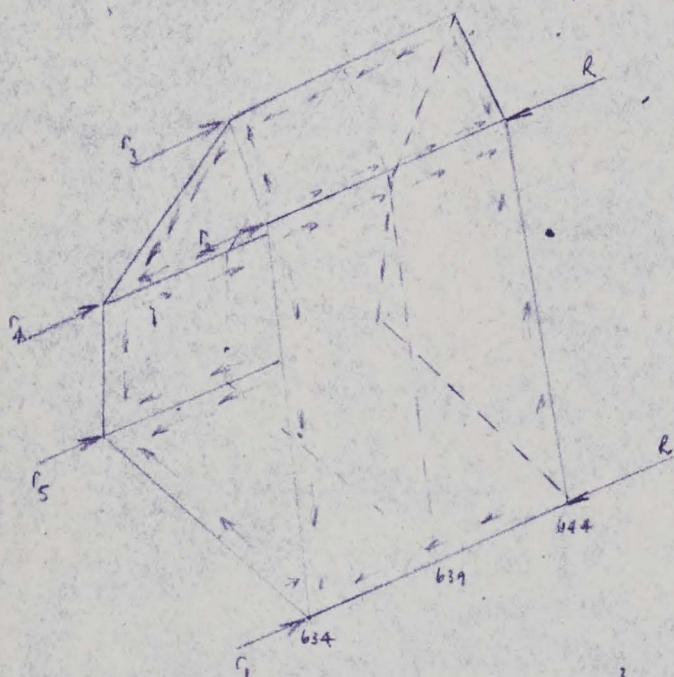
THERE ARE TWO LOADINGS TO BE DIFFUSED AT THIS END OF THE TORSION BOX

1. AXIAL LOAD

2. BENDING LOAD, DUE TO FIXING MOMENT FROM IN BOARD BEAM.

1. AXIAL LOAD (2R)

DIFFUSION WILL BE ASSUMED TO TAKE PLACE EVENLY OVER TWO BAYS





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G. M. WILEY

3-4-56

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NOTE ON DIFFUSION OF AXIAL LOAD AT STN 644.43.

WHEN THE BM DIAGRAM FOR THE COMPLETE TORSION BOX WAS PRODUCED THE FOLLOWING ASSUMPTIONS WERE MADE:

1. WITH AXIAL LOAD APPLIED THE VERTICAL CENTROIDS OF AREA OF TORSION BOX AND BEAM WERE SUCH THAT THEY PRODUCED NO VERTICAL BENDING OF THE TORSION BOX.

2. DUE TO THE RESTRAINT FROM THE BOUNDING BOXES, THERE WAS NO SIDE BENDING OF THE TORSION BOX.

FOR COMPATABILITY THESE ASSUMPTIONS WILL BE USED IN THE ANALYSIS OF DIFFUSION AT STN 644.43.

FOR AN AXIAL LOAD = 2 R

$$A_1 = .4500$$

$$A_2 = .1860$$

$$A_3 = .1234$$

$$A_4 = .1236$$

$$A_5 = .16420$$

$$\Sigma A = 1.15256$$

$$r_1 = +.530 R$$

$$r_2 = +.1234 R$$

$$r_3 = +.162 R$$

$$r_4 = +.162 R$$

$$r_5 = +.843 R$$

LOAD IN TO MEMBERS OVER TWO BAYS IS 2.6

$$r_1 = .0615 R$$

$$r_2 = .0244 R$$

$$r_3 = .0169 R$$

$$r_4 = .0169 R$$

$$r_5 = .0878 R$$



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Tolson Cox

PREPARED BY

DATE

G.M. COILEY

3-4-56

CHECKED BY

DATE

THEN SHEAR FLOWS IN PANELS DUE TO R & r LONGING WITH PANEL 1-5 CUT

PANEL

$$1-2 \quad .1042R - r_1' = +.1042R - .0618R = +.0427R$$

$$2-3 \quad .1042R - r_1' - r_2' + .1042R = +.0427R - .0244R + .1042R = +.1225R$$

$$3-4 \quad .1042R - r_1' - r_2' + .1042R - r_3' = +.1225R - .0169R = +.1056R$$

$$4-5 \quad .1042R - r_1' - r_2' + .1042R - r_3' - r_4' = +.1056R - .0169R = +.0887R$$

$$5-1 \quad .1042R - r_1' - r_2' + .1042R - r_3' - r_4' - r_5' = +.0887R - .0878R = .0009R \text{ ERROR VERIFIED}$$

FOR ZERO TWIST

REF PERRY PAGE 450

$$\oint_0 \sum \frac{\Delta s}{t} + \sum q' \frac{\Delta s}{t} = 0$$

WHERE q_0 IS THE UNKNOWN SHEAR FLOW TO MAKE TWIST ZERO

WEB	Δs	EFFECTIVE t	$\frac{\Delta s}{t}$	q'	$q' \frac{\Delta s}{t}$	q
1-2	6.9	.086	81.2	+.0427R	+3.47R	-.0231R
2-3	2.1	.077	27.3	+.1225R	+5.35R	+.0567R
3-4	4.5	.040	112.5	+.1056R	+11.87R	+.0398R
4-5	3.9	.051	76.5	+.0887R	+6.79R	+.0129R
5-1	6.5	.072	90.3	0	0	-.0658R
TOTALS	23.9		387.8		+25.48R	

$$387.8 q_0 = +25.48R$$

$$q_0 = -.0658R$$



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TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/2

SHEET NO. 127

AIRCRAFT:

C105

Torsion box

PREPARED BY

DATE

G. M. COLLEY

4-4-56

CHECKED BY

DATE

FROM CALCS FOR DIFFUSION OF BENDING LOADS AT STN 591

FOR A MOMENT $\approx 100k$ APPLIED

LOAD IN MEMBERS AT STN 634

SIN FOR MOMENT = $6.25P$ OVER 2 BAYS

$$p_1 = +7.17 k$$

$$p_1'' = +.0467 P k/l$$

$$p_2 = -8.00 k$$

$$p_2'' = -.0522 P k/l$$

$$p_3 = -7.00 k$$

$$p_3'' = -.0456 P k/l$$

$$p_4 = -2.42 k$$

$$p_4'' = -.0157 P k/l$$

$$p_5 = +10.25 k$$

$$p_5'' = +.0668 P k/l$$

THEN SHEAR FLOWS IN PANELS WITH PANEL 1-5 CUT

PANEL

$$1-2 \quad q' = +.1042P - p_1'' = +.1042P - .0467P = +.0575P$$

$$2-3 \quad q' = +.1042P - p_1'' - p_2'' = .1042P - .0467P - .0522P = +.0053P$$

$$3-4 \quad q' = +.1042P - p_1'' - p_2'' - p_3'' = .1042P - .0467P - .0522P - .0456P = +.0051P$$

$$4-5 \quad q' = +.1042P - p_1'' - p_2'' - p_3'' - p_4'' = .1042P - .0467P - .0522P - .0456P - .0157P = +.0051P$$

$$5-6 \quad q' = +.1042P - p_1'' - p_2'' - p_3'' - p_4'' - p_5'' = .1042P - .0467P - .0522P - .0456P - .0157P - .0668P = 0$$

WEB	ΔS	EFFECTIVE t	$\frac{\Delta S}{t}$	q'	$q' \frac{\Delta S}{t}$	q'
1-2	6.9	.085	81.2	+0.0575 P	+4.67 P	+0.0147 P
2-3	2.1	.077	27.3	+0.0053 P	+0.13 P	-0.0373 P
3-4	4.5	.040	112.5	+0.0051 P	+5.74 P	+0.0083 P
4-5	3.9	.051	76.5	+0.0051 P	+6.03 P	+0.0240 P
5-6	6.5	.072	90.3	0	0	-0.0428 P
			387.8		+16.59 P	

$$q' \sum \frac{\Delta S}{t} + \sum q' \frac{\Delta S}{t} = 0$$

15.67

$$q' = \frac{-16.59P}{387.8} = -.0428 P k/l$$

-.0428

Error 5.6%

Not corrected



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/2

SHEET NO. 128

AIRCRAFT:

C105

Torsion Box

PREPARED BY

DATE

G. M. COLLET

29-3-56

CHECKED BY

DATE

TORQUE DISTRIBUTION FOR TOTAL APPLIED TORQUE = 1000.8 lb-in.

REF 7-0558-12 SH 69.
(ISSUE 2)

TORQUE REACTIONS

STN 591	27.11%	$T_0 = 271.1 \text{ lb-in}$
STNS 606, 610, 615	28.28%	$T_2 = 282.8 \text{ lb-in}$
STN 625	13.75%	$T_4 = 137.5 \text{ lb-in}$
STN 644	30.86%	$T_8 = 308.6 \text{ lb-in}$

TORQUE APPLIED PER 4.8 LAY = $\frac{1000}{4.8} = 208.3 \text{ lb-in}$

REACTION AT STN 606 = $\frac{282.8 \times 1.646}{4.176} = 111.4$

REACTION AT STNS 610 & 615 = $\frac{282.8 \times 1.265}{4.176} = 85.8$

TORQUE DISTRIBUTION FOR 1000 lb-in TOTAL APPLIED TORQUE:

FUSELAGE	591	596	601	606	610	615	620	625	630	634	639	644
LOADING												
FRAME & BEAM REACTIONS	-271.1	0	0	-111.4	-85.8	-85.8	0	-137.5	0	0	0	-308.6
TORQUE INPUT	+45.5	+90.9	+139.1	-5.42	+139.1	+90.9	+90.9	+90.9	+90.9	+90.9	+90.9	+45.5
INPUT TOTAL	-225.6	+90.9	+139.1	-116.8	+53.3	+5.1	+90.9	-46.6	+90.9	+90.9	+90.9	-263.1
CELL	1	2	3	4	5	6	7	8	9	10	11	
LOADING												
TORQUE	-225.6	-134.7	+4.4	-112.4	-59.1	-54.0	+36.9	-9.7	+81.2	+172.1	+263.0	0.0
STN												
TORQUE	-4.09	-2.45	+0.09	-2.23	-1.08	-0.982	+0.671	-0.176	+1.48	+3.18	+4.78	
SDO												

$2A = 48 + 1A = 48 +$

$\rightarrow 2A \text{ for Cell 3} = 55 \text{ error negligible}$

CUT OUT IN TORSION BOX

DUE TO THE CUT-OUT BETWEEN STNS 603 & 610, THE DUCT LOAD DUE TO P_1 WHICH WOULD NORMALLY BE TAKEN BY STN 606 IS SHARED EQUALLY BETWEEN STNS 601 & 610

THE EFFECT OF THIS MODIFICATION TO THE LOADING WILL NOT EFFECT THE P_0, P_1, P_2 DISTRIBUTION TO WARRANT SEPARATE ANALYSIS.

INPUT AT STN 606 = $\frac{+90.9 (670 - 710)}{670} = -5.42 \text{ lb-in}$

INPUT AT STN 601 & 610 = $\frac{+90.9 + 45.5 + 2.7}{2} = +139.1 \text{ lb-in}$



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AIRCRAFT:

C105

Tension box

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DATE

C. A. COLLEY

5-4-56

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BM DUE TO VERTICAL SHEAR FOR VARIOUS LOADINGS

the BM. TENSION AT BOTTOM.

$P_L = 10 \text{ k/m}$	STN	BM
(REF. INNER LONG. LOADING	603	-7,000 k-in
PAGE 9)	610	-10,000 k-in
	644	+11,000 k-in
		$P = \frac{11,000}{6.25} = -1,760 \text{ k.}$

$P_B = 10 \text{ k/m}$	STN	BM
(REF. INNER LONG. LOADING	603	-61,000 k-in
PAGE 8)	610	-76,000 k-in
	644	+78,900 k-in
		$P = \frac{78,900}{6.25} = -12,600 \text{ k.}$

$P_S = 10 \text{ k/m}$	STN	BM
(REF. INNER LONG. LOADING	603	+2,800 k-in
SHEET 10)	610	+3,500 k-in
	644	-3,500 k-in
		$P = +\frac{3,500}{6.25} = +560 \text{ k.}$

$\eta = 10 \text{ g}$	STN	BM
(REF. INNER LONG. LOADING	603	+8,600 k-in
SHEET 11)	610	+13,700 k-in
	644	-8,840 k-in
		$P = +\frac{8,840}{6.25} = +1,420 \text{ k.}$

BM DUE TO VERTICAL LOAD FOR VARIOUS LOADINGS

the shear V

	CR44										
LOADING	1	2	3	4	5	6	7	8	9	10	11
$P_L = 10 \text{ k/m}$	-650	-580	-460	-270	-50	+160	+380	+550	+760	+1,080	+1,270
$P_B = 10 \text{ k/m}$	-6,420	-4,880	-3,280	-1,650	-60	+1,490	+2,780	+4,430	+6,330	+7,540	+9,430
$P_S = 10 \text{ k/m}$	+283	+213	+144	+75	+6	-63	-132	-201	-270	-340	-409
$\eta = 10 \text{ g}$	+716	+716	+716	+716	-38	-780	-780	-780	-780	-780	-780



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AIRCRAFT:

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DATE

G. M. COLLEY

5-9-16

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DATE

AXIAL LOAD APPLIED TO BOX FOR VARIOUS LOADINGS

$P_1 = 10.0 \text{ lb.}$ AXIAL LOAD = 0
 $P_2 = 10.0 \text{ lb.}$ " " " "
 $P_3 = 10.00 \text{ lb.}$ " " " "

$\eta = 10g$ (REF PRELIMINARY LOADS ON INNER LONGERON
 - G. BITEFIELD, 6 MARCH 56.)

STN 591 { 17,181 L.C. (X = +8,590 L)

644 { 15,740 S.C. (R = +7,870 L)

STN 603 AND 610 17,181 L.C. AND 15,740 S.C.

B.M. DUE TO AXIAL LOAD

REF. LONG ANALYSIS INNER LONGERON PAGE 26.

$\eta = 10g$

TENSION IN BOTTOM.

STN.	591	596	601	606	610	615	629	644
B.M.	-	-	-	-	-	-	+	+
L.	43,400	38,000	33,000	27,150	21,000	16,800	9,300	14,600

DIFFUSION OF MOMENT AT STN 591

THE MOMENT USED IS LESS THAN THE VALUE

SHOWN IN THE TABLE BECAUSE INPUT WAS DETERMINED ACCURATELY FOR THIS STATION 16.

AXIAL LOAD X DISTANCE FROM N.A. VALUE USED = $3.38X = 29,100 \text{ L.}$ FOR $\eta = 10g$
 WHERE $X = +8,590 \text{ L.}$

DIFFUSION OF MOMENT AT STN 644

MOMENT GIVEN IN TABLE ABOVE IS USED

ie -14,600 L. Too Low.

$\therefore P = -14,600 \text{ L.} = -2,340 \text{ L.}$

SF DUE TO AXIAL LOAD

SF = +1,095 L.

the spread.

6000

S/F IN PANEL, EXCEPT PANEL 4

1-2 = +109 L.

4-5 = -81 L.

2-3 = +22 L.

5-1 = +31 L.

3-4 = -54 L.



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1/16 IN PANELS 1-2 DUE TO $P_5 = 10.4$

APPLIED LOAD	CELL										
	1	2	3	4	5	6	7	8	9	10	11
		(1-7)	(1-7)	(1-7)	(1-7)						
TORQUE	- 10	- 6	0	- 5	- 3	- 2	+ 1	0	+ 3	+ 7	+ 11
VERT ^b SHEAR	+ 28	+ 21	+ 14	+ 8	+ 1	- 6	- 13	- 20	- 27	- 34	- 41
BM DUE TO " "	—	- 9	- 9	—	+ 21	—	—	—	—	+ 8	+ 8
AXIAL LOAD	—	—	—	—	—	—	—	—	—	—	—
SF DUE TO " "	—	—	—	—	—	—	—	—	—	—	—
BM " " " "	—	—	—	—	—	—	—	—	—	—	—
TOTAL	+ 14	+ 6	+ 5	+ 3	+ 19	- 8	- 12	- 20	- 24	- 19	- 22
PANEL 1	7-2	7-2		7-2							
TORQUE	- 6	0		- 3							
VERT ^b SF	+ 21	+ 14		+ 1							
VERT ^b BM	+ 33	+ 33		- 74							
TOTAL	+ 48	+ 47		- 76							

1/16 IN PANELS 1-2 DUE TO $Q = 10.9$

APPLIED LOAD	CELL										
	1	2	3	4	5	6	7	8	9	10	11
		(1-7)	(1-7)	(1-7)	(1-7)						
TORQUE	- 3	- 2	0	- 2	- 1	- 1	0	0	+ 1	+ 2	+ 3
VERT ^b LOAD	+ 72	+ 72	+ 72	+ 79	- 4	- 78	- 78	- 78	- 78	- 78	- 78
BM DUE TO " "	—	- 27	- 27	—	+ 65	—	—	—	—	+ 21	+ 21
AXIAL LOAD	+ 83	- 158	- 158	—	+ 237	—	—	—	—	- 182	- 182
SF DUE TO " "	+ 109	+ 109	+ 109	+ 121	+ 109	+ 109	+ 109	+ 109	+ 109	+ 109	+ 109
BM " " " "	—	+ 96	+ 96	—	- 104	—	—	—	—	- 34	- 34
TOTAL	+ 261	+ 110	+ 92	+ 198	+ 292	+ 30	+ 31	+ 31	+ 32	- 160	- 161
PANEL 1	7-2	7-2		7-2							
TORQUE	- 2	0		- 1							
VERT ^b SF	+ 72	+ 72		- 4							
" BM	+ 100	+ 100		- 239							
AXIAL LOAD	+ 404	+ 404		- 586							
SF DUE TO " "	+ 109	+ 109		+ 109							
BM " " " "	- 350	- 350		+ 384							
TOTAL	+ 333	+ 335		- 337							

* INCLUDED IN AXIAL LOAD.



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6-6-56

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7-3
02
S_{IN} IN PANELS 2-3 DUE TO P₂ = 106 lb

CELL

APPLIED LOAD	1	2	3	4 (7-8)	5	6	7	8	9	10	11
TORQUE	-302	-181	+7	-164	-80	-72	+49	-13	+109	+281	+352
VERT SHEAR	-13	-12	+10	-4	-1	+3	+8	+11	+15	+22	+25
B.M. DUE TO " "	—	-8	-8	—	+17	—	—	—	—	+66	+66
AXIAL LOAD	—	—	—	—	—	—	—	—	—	—	—
S.F. DUE TO " "	—	—	—	—	—	—	—	—	—	—	—
B.M. DUE TO " "	—	—	—	—	—	—	—	—	—	—	—
TOTAL	-315	-201	-11	-165	-64	-69	+57	-2	+124	+319	+443

S_{IN} IN PANELS 2-3 DUE TO P₂ = 106 lb

CELL

APPLIED LOAD	1	2	3	4 (7-8)	5	6	7	8	9	10	11
TORQUE	-2	-1	0	-1	0	0	0	0	+1	+1	+2
VERT SHEAR	-128	-98	-66	-9	-1	+30	+56	+89	+127	+159	+190
B.M. DUE TO " "	—	-71	-71	—	+128	—	—	—	—	+470	+470
AXIAL LOAD	—	—	—	—	—	—	—	—	—	—	—
S.F. DUE TO " "	—	—	—	—	—	—	—	—	—	—	—
B.M. DUE TO " "	—	—	—	—	—	—	—	—	—	—	—
TOTAL	-130	-170	-137	-10	+127	+30	+56	+89	+128	+630	+662



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S_{IN} IN PANELS 2-3 DUE TO $P_5 = 10 \frac{1}{2}$

CELL

APPLIED LOAD	1	2	3	4 (7-8)	5	6	7	8	9	10	11
TORQUE	-10	-6	0	-5	-3	-2	+1	0	+3	+1	+11
VERT SHEAR	+6	+4	+3	+1	+0	-1	-3	-4	-5	-7	-8
BM DUE TO " "	—	+3	+3	—	-6	—	—	—	—	-21	-21
AXIAL LOAD	—	—	—	—	—	—	—	—	—	—	—
S.F. DUE TO " "	—	—	—	—	—	—	—	—	—	—	—
BM " " " "	—	—	—	—	—	—	—	—	—	—	—
TOTAL	-4	+1	+6	-4	-9	-3	-2	-4	-2	-21	-18

S_{IN} IN PANELS 2-3 DUE TO $P_7 = 10 \frac{1}{2}$

APPLIED LOAD	1	2	3	4 (7-8)	5	6	7	8	9	10	11
TORQUE	+3	-2	0	-2	-1	-1	0	0	+1	+2	+3
VERT SHEAR	+14	+14	+14	+4	-1	-16	-16	-16	-16	-16	-16
BM DUE TO " "	—	+10	+10	—	-23	—	—	—	—	-53	-53
AXIAL LOAD	+70	+40	+40	—	-60	—	—	—	—	+447	+447
S.F. DUE TO " "	+22	+22	+22	+6	+24	+22	+22	+22	+22	+22	+22
BM DUE " " "	+	-36	-36	—	+37	—	—	—	—	+87	+87
TOTAL	+103	+48	+50	+8	-26	+5	+6	+6	+7	+189	+490



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5/16 IN IN PANEL 3-4 DUE TO $P_r = 10 \frac{1}{2}$

CELL

APPLIED LOAD	1	2	3	4	5	6	7	8	9	10	11
		(8-4)	(8-4)	(8-4)	(8-4)						
TORQUE	-10	-6	0	-5	-3	-2	+1	0	+3	+7	+11
VERT SHEAR	-14	-11	-7	-5	-0	+3	+7	+10	+14	+17	+21
B.M. DUE TO " "	—	+10	+10	-23	-23	—	—	—	—	+5	+5
AXIAL LOAD	—	—	—	—	—	—	—	—	—	—	—
S.F. DUE TO " "	—	—	—	—	—	—	—	—	—	—	—
B.M. " " " "	—	—	—	—	—	—	—	—	—	—	—
TOTAL	-24	-7	+3	-33	-26	+1	+8	+10	+17	+29	+37
PANEL		3-8	3-8	3-8	3-8						
TORQUE		-6	0		-3						
VERT SHEAR		-11	-7		0						
" B.M.		-22	-22		+42						
TOTAL		-39	-29		+39						

5/16 IN PANELS 3-4 DUE TO $P_r = 10 \frac{1}{2}$

CELL

APPLIED LOAD	1	2	3	4	5	6	7	8	9	10	11
		(8-4)	(8-4)	(8-4)	(8-4)						
TORQUE	-3	-2	0	-2	-1	-1	0	0	+1	+2	+3
VERT SHEAR	-36	-36	-36	-52	+2	+39	+39	+39	+39	+39	+39
B.M. DUE TO " "	—	+28	+28	—	-71	—	—	—	—	+12	+12
AXIAL LOAD	+150	+197	+197	—	-295	—	—	—	—	+313	+313
S.F. DUE TO " "	-54	-54	-54	-85	-54	-54	-54	-54	-54	-54	-54
B.M. " " " "	*	-106	-106	—	+114	—	—	—	—	-20	-20
TOTAL	+57	+29	+29	-139	-305	-16	-15	-15	-14	+292	+293
PANEL		3-8	3-8	3-8	3-8						
TORQUE		-2	0		-1						
VERT S.F.		-56	-36		+2						
VERT B.M.		-68	-68		+63						
AXIAL LOAD		-195	-195		+294						
S.F. DUE TO " "		-54	-54		-54						
B.M. " " " "		+240	+240		-263						
TOTAL		-115	-113		+141						



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S/in IN PANELS 4-5 DUE TO $P_2 = 10,000$

CELL

APPLIED LOADS	1	2	3	4	5	6	7	8	9	10	11
TORQUE	-302	-181	+7	-164	-80	-72	+49	-13	+109	+231	+352
VERT SHEAR	+48	+43	+34	+20	+4	-12	-28	-41	-56	-80	-94
B.M. DUE TO " "	—	-25	-25	—	+52	—	—	—	—	-42	-42
AXIAL LOAD	—	—	—	—	—	—	—	—	—	—	—
S.F. DUE TO " "	—	—	—	—	—	—	—	—	—	—	—
B.M. " " " "	—	—	—	—	—	—	—	—	—	—	—
TOTAL	-254	-163	+16	-164	-24	-84	+21	-54	+53	+109	+216

S/in IN PANELS 4-5 DUE TO $P_2 = 10,000$

CELL

APPLIED LOADS	1	2	3	4	5	6	7	8	9	10	11
TORQUE	-2	-1	0	-1	0	0	0	0	+1	+1	+2
VERT SHEAR	+476	+362	+244	+167	+4	-111	-206	-329	-468	-589	-705
B.M. DUE TO " "	—	-212	-212	—	+398	—	—	—	—	-302	-302
AXIAL LOAD	—	—	—	—	—	—	—	—	—	—	—
S.F. DUE TO " "	—	—	—	—	—	—	—	—	—	—	—
B.M. " " " "	—	—	—	—	—	—	—	—	—	—	—
TOTAL	+474	+149	+32	+166	+402	-111	-206	-329	-468	-890	-1005



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$\frac{3}{16}$ IN PANEL 4-5 DUE TO $P_2 = 10 \text{ lb/in}^2$

CELL

APPLIED LOAD	1	2	3	4	5	6	7	8	9	10	11
TORQUE	-10	-6	0	-5	-3	-2	+1	0	+3	+7	+11
VERT SHEAR	-20	-16	-11	-8	-5	+5	+10	+15	+20	+25	+30
B.M. DUE TO " "	—	+10	+10	—	-23	—	—	—	—	+13	+13
AXIAL LOAD	—	—	—	—	—	—	—	—	—	—	—
S.F. DUE TO " "	—	—	—	—	—	—	—	—	—	—	—
B.M. DUE TO " "	—	—	—	—	—	—	—	—	—	—	—
TOTAL	-30	-12	-1	-13	-26	+3	+11	+15	+23	+45	+54

$\frac{5}{16}$ IN PANEL 4-5 DUE TO $P_2 = 109$

CELL

APPLIED LOAD	1	2	3	4	5	6	7	8	9	10	11
TORQUE	-3	-2	0	-2	-1	-1	0	0	+1	+2	+3
VERT SHEAR	-53	-53	-53	-73	+3	+58	+68	+58	+58	+58	+58
B.M. DUE TO " "	—	+30	+30	—	-71	—	—	—	—	+34	+34
AXIAL LOAD	-13	+150	+150	—	-225	—	—	—	—	+180	+180
S.F. DUE TO " "	-81	-81	-81	-111	-81	-81	-81	-81	-81	-81	-81
B.M. DUE TO " "	*	-107	-107	—	+115	—	—	—	—	-56	-56
TOTAL	-150	-63	-61	-186	-266	-24	-23	-23	-22	+137	+138



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/2

SHEET NO. 141

AIRCRAFT:

C105

Torsion Case

PREPARED BY

DATE

G. M. Coleby

6-4-56

CHECKED BY

DATE

5/16 IN PANEL 5-1 DUE TO $P_5 = 10 \text{ kg}$

CELL

APPLIED LOAD	1	2	3	4	5	6	7	8	9	10	11
TORQUE	-10	-6	0	-5	-3	-2	+4	0	+3	+7	+11
VERT ⁺ LOAD	+8	+6	+4	0	+0	-2	-4	-6	-8	-10	-12
BM DUE TO " "	—	+2	+2	—	-3	—	—	—	—	+24	+22
AXIAL LOAD	—	—	—	—	—	—	—	—	—	—	—
S.F. DUE TO " "	—	—	—	—	—	—	—	—	—	—	—
BM " " " "	—	—	—	—	—	—	—	—	—	—	—
TOTAL	-2	+2	+6	-5	-6	-4	-3	-6	-5	+21	+23

5/16 IN PANELS 5-1 DUE TO $3 \times 10 \text{ kg}$

CELL

APPLIED LOAD	1	2	3	4	5	6	7	8	9	10	11
TORQUE	-3	-2	0	-2	-1	-1	0	0	+1	+2	+3
VERT ⁺ LOAD	+20	+20	+20	-39	-1	-22	-22	-22	-22	-22	-22
BM DUE TO " "	—	+4	+4	—	-10	—	—	—	—	-61	-61
AXIAL LOAD	-276	+12	+12	—	-19	—	—	—	—	-518	-518
S.F. DUE TO " "	+31	+31	+31	-6	+31	+31	+31	+31	+31	+31	+31
BM " " " "	—	-16	-16	—	+17	—	—	—	—	+100	+100
TOTAL	-228	+49	+51	-47	+17	+8	+9	+9	+10	-468	-467



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C101

Top Slew, Low

REPORT NO. 7-0558-12/R

SHEET NO. 142

PREPARED BY

DATE

G.M. COLLET

6-4-56

CHECKED BY

DATE

SUMMARY OF SHEAR FLOWS IN PANELS (lb/in) DUE TO P_1, P_2, P_3 & q

PANELS 1-2 -

CELL

CELL	1	2	3	4	5	6	7	8	9	10	11
$P_1 = 10 \text{ lb/in}$	-367	-217	-17	-194	-132	-56	+87	+42	+185	+313	+453
$P_2 = 10 \text{ lb/in}$	-644	-248	-137	-184	-366	+149	+278	+443	+634	+610	+766
$P_3 = 10 \text{ lb/in}$	+14	+6	+5	+3	+19	-8	-12	-20	-24	-19	-22
$q = 10 \text{ g}$	+261	+110	+92	+193	+242	+30	+31	+31	+32	-160	-161

PANELS 2-3 -

	1	2	3	4	5	6	7	8	9	10	11
$P_1 = 10 \text{ lb/in}$	-315	-205	-11	-145	-64	-69	+57	-2	+124	+319	+443
$P_2 = 10 \text{ lb/in}$	-130	-170	-137	-10	+127	+30	+56	+89	+128	+630	+662
$P_3 = 10 \text{ lb/in}$	-4	+1	+6	-4	-9	-3	-2	-4	-1	-21	-18
$q = 10 \text{ g}$	+103	+48	+50	+8	-26	+5	+6	+6	+7	+487	+489

PANELS 3-4 -

	1	2	3	4	5	6	7	8	9	10	11
$P_1 = 10 \text{ lb/in}$	-269	-177	+5	-143	-25	-80	+30	-41	+11	+162	+274
$P_2 = 10 \text{ lb/in}$	+319	+31	-48	+126	+399	-75	-139	-221	-315	-501	-577
$P_3 = 10 \text{ lb/in}$	-24	-7	+3	-33	-26	+1	+8	+10	+17	+24	+37
$q = 10 \text{ g}$	+57	+29	+29	-139	-305	-16	-15	-15	-14	+292	+292

PANELS 4-5 -

	1	2	3	4	5	6	7	8	9	10	11
$P_1 = 10 \text{ lb/in}$	-254	-163	+10	-144	-24	-84	+21	-54	+53	+109	+216
$P_2 = 10 \text{ lb/in}$	+474	+149	+32	+166	+402	-111	-206	-329	-468	-890	-1005
$P_3 = 10 \text{ lb/in}$	-30	-12	-1	-13	-26	+3	+11	+15	+23	+45	+54
$q = 10 \text{ g}$	-150	-63	-61	-180	-266	-24	-23	-23	-22	+137	+138

PANELS 5-1

	1	2	3	4	5	6	7	8	9	10	11
$P_1 = 10 \text{ lb/in}$	-320	-201	-11	-163	-73	-67	+60	+3	+131	+337	+463
$P_2 = 10 \text{ lb/in}$	-184	-171	-125	+8	+56	+42	+79	+125	+181	+766	+811
$P_3 = 10 \text{ lb/in}$	-2	+2	+6	-5	-6	-4	-3	-6	-5	+21	+23
$q = 10 \text{ g}$	-228	+49	+51	-47	+17	+8	+9	+9	+10	-468	-467

PANEL 7-2 -

	2	3	5
$P_1 = 10 \text{ lb/in}$	-321	-121	+90
$P_2 = 10 \text{ lb/in}$	-1188	-1027	+1324
$P_3 = 10 \text{ lb/in}$	+48	+47	-76
$q = 10 \text{ g}$	+173	+120	+227

PANEL 3-8 -

	2	3	5
$P_1 = 10 \text{ lb/in}$	-97	+85	-196
$P_2 = 10 \text{ lb/in}$	+717	+638	-704
$P_3 = 10 \text{ lb/in}$	-39	-29	+30
$q = 10 \text{ g}$	-115	-113	+141

SHEAR & B.M.'S ULT FOR PARTICULAR VALUES OF BOTTOM PRESSURE (P_b) AT VARIOUS STA'S

A. V. I

SHEAR - VE WHEN ACTING DOWN } PARALLEL TO E OF A/C
B.M - VE TENSION TOP

AIRCRAFT

WEIGHT

C. G. P

STA	1	2	3	4	5	6	7	8	9	10
	SHEAR DUE TO UNIT H ₀ P _b	SHEAR DUE TO VARIOUS MULTIPLES OF P _b REF SHT 2				B.M. DUE TO UNIT H ₀ P _b	B.M.'S DUE TO VARIOUS MULTIPLES OF P _b REF SHT 2			
	4.50	5.50	3.47	1.36		4.50	5.50	3.47	1.36	
	4.50	5.50	3.47	1.36		4.50	5.50	3.47	1.36	
591.65	718	3231	3249	2451	576	0	0	0	0	0
596.45	565	2543	3108	1961	768	3000	13500	16500	10410	4080
601.25	410	1845	2255	1423	558	5200	23400	28600	18244	7072
606.05	245	1103	1348	850	333	6800	30600	37400	23556	9248
610.85	85	378	468	295	116	7600	34200	41800	26372	10336
615.65	72	324	396	250	98	7750	34875	42625	26893	10540
620.45	225	1013	1238	781	306	7000	31500	38500	24250	9520
625.25	330	1485	1815	1145	449	4900	22050	26950	17005	6664
630.05	550	2475	3025	1909	748	3100	13950	17050	10757	4216
634.85	715	3218	3933	2481	972	0	0	0	0	0
639.65	872	3924	4796	3026	1186	4000	18000	22000	13870	5440
644.45	1025	4613	5638	3557	1354	7890	35505	43395	27338	10730
649.25	785	3533	4318	2724	1068	4150	18675	22825	14441	5644
654.05	600	2700	3300	2082	816	1300	5850	7150	4511	1768
658.85	500	2250	2750	1735	680	1100	4950	6050	3811	1496
663.65	318	1431	1749	1103	432	2630	11835	14465	9126	3577
	0	0	0	0	0	2630	11835	14465	9126	3577
	Ref SHT 8	4.50 X (1)	5.50 X (1)	3.47 X (1)	1.36 X (1)	Ref SHT 8	4.50 X (1)	5.50 X (1)	3.47 X (1)	1.36 X (1)

A. V. ROE CANADA LIMITED

MALTON, ONTARIO

TECHNICAL DEPT. (AIRFRAME)

AIRCRAFT

C105

WEIGHT

VARIOUS

C. G. POSITION

VARIOUS

REPORT NO.

7-0558-12/2

SHEET

144

DATE

MARCH 56

PREPARED BY

A. FERENC

9	10	11	12	13	14	15	16	17	18	19
B.M. Due to Various MULTIPLES OF PL (Ref Spt 2)										
2.10	11.50	24.85	1540	-2.05						
597	8270	7050	4370	582						
1201	6578	14214	8809	1173						
1722	9330	20377	12628	1681						
2100	11500	24350	15400	2050						
2041	11178	24154	14969	1993						
1843	10120	21868	13552	1804						
1512	8280	17352	11088	1476						
991	5428	11729	7269	968						
168	920	1988	1232	164						
987	5405	11680	7238	964						
2310	12650	27355	16940	2255						
1197	6555	14165	8778	1169						
105	575	1243	770	103						
147	805	1740	1078	144						
395	2162	4672	2895	335.4						
2100 (3)	11500 (3)	24350 (3)	15400 (3)	2050 (3)						

SHEAR & B.M.'S ULT FOR PARTICULAR VALUES OF SIDE PRESSURE (P_s) AT VARIOUS STATIONS

A. V. RO

TE

AIRCRAFT

WEIGHT

C. G. POSI

FOR SIGN CONVENTION SEE SHT 143

STA	1	2	3	4	5	6	7	8	9	10	11
↓	SHEAR DUE TO UNIT +VE P _s	SHEAR DUE TO VARIOUS MULTIPLES OF P _s (REF. SHT 2)						B.M. DUE TO UNIT +VE P _s	B.M. DUE TO VARIOUS OF P _s (REF. SHT 2)		
	LBS.	LBS.	LBS.	LBS.	LBS.	LBS.		LBS INCH	LBS INCH	LBS INCH	LBS
591.65	0	0	0	0	0	0		0	0	0	0
596.45	31.7	43.1	55.2	21.6	111	31.7		150	204	261	10
601.25	24.79	33.7	43.1	16.9	86.8	24.79		240	326	418	16
606.05	17.82	24.2	31.0	12.1	62.4	17.82		300	408	522	20
610.85	10.97	14.9	19.1	7.46	38.4	10.97		350	476	609	23
615.65	4.06	5.52	7.06	2.76	14.2	4.06		380	517	661	25
620.45	2.85	3.87	4.96	1.94	9.97	2.85		330	449	574	22
625.25	9.76	13.3	16.9	6.64	34.2	9.76		260	354	452	17
630.05	16.67	22.7	29.0	11.3	58.3	16.67		160	218	278	10
634.85	23.58	32.1	41.0	16.0	82.5	23.58		20	27.2	34.8	13
639.65	30.49	41.5	53.1	20.7	107	30.49		155	211	270	10
644.45	37.40	50.9	65.1	25.4	131	37.40		350	476	609	23
649.25	44.4	60.4	77.3	30.2	155	44.4		182	248	317	12
654.05	17.5	23.8	30.5	11.9	61.3	17.5		50	68	87	34
658.85	9.28	12.6	16.1	6.3	32.5	9.28		48	65.3	83.5	33
663.65	2.13	2.90	3.71	1.45	7.46	2.13		107	146	186	72
	5.5	7.48	9.57	3.74	19.3	5.5					
	0	0	0	0	0	0					
	REF SHT 10	1.36 X (1)	1.74 X (1)	0.68 X (1)	3.50 X (1)	1.0 X (1)		REF SHT 10	1.36 X (1)	1.74 X (2)	0.68 X (1)

STIA 3

A. V. ROE CANADA LIMITED

MALTON, ONTARIO
TECHNICAL DEPT. (AIRFRAME)

REPORT NO. 7-0558-12/2

SHEET 146

DATE MAR. 156

PREPARED BY A. FERENC

AIRCRAFT C105
WEIGHT VARIOUS
C. G. POSITION VARIOUS

9	10	11	12	13	14	15	16	17	18	19
427										
1430										
2882										
4357										
5850										
5867										
3756										
1772										
192										
1388										
2605										
3775										
2349										
918										
534										
1302										
427 (6)										

SHEAR & B.M.'S ULT FOR PARTICULAR VALUES OF INERTIA

AT VARIOUS STATIONS

FOR SIGN CONVENTION SEE SHT 143

A. V. ROE

M
TECH

AIRCRAFT

WEIGHT

C. G. POSITION

STA	1	2	3	4	5	6	7	8	9	10	11
↑	SHEAR DUE TO UNIT +VE g	SHEAR DUE TO VARIOUS MULTIPLS OF g (REF SHT 2)				P.M. DUE TO UNIT +VE g	B.M. DUE TO VARIOUS MULTS OF g (REF SHT 2)				
	LBS	LBS	LBS	LBS		LB INCH	LB INCH	LB INCH	LB INCH		
591.65	0	71.6	605	306		0	0	0	0		
596.45	71.6	716	605	306		335	3350	2831	1430		
601.25	71.6	716	605	306		675	6750	5704	2882		
606.05	71.6	716	605	306		1025	10250	8661	4357		
610.85	71.6 3.8	716 380	605 32.1	306 16.2		1370	13700	11577	5850		
615.65	3.8 78	380 780	32.1 659	16.2 333		1360	13600	11492	5867		
620.45	78	780	659	333		875	8750	7394	3736		
625.25	78	780	659	333		415	4150	3507	1772		
630.05	78	780	659	333		45	450	380	192		
634.85	78	780	659	333		225	2250	2746	1388		
639.65	78	780	659	333		610	6100	5155	2605		
644.45	78 72	780 720	659 608	333 307		884	8840	7470	3715		
649.25	72 69.54	720 695.4	608 588	307 297		550	5500	4648	2349		
654.05	69.54 67.11	695.4 671.1	588 567	297 281		215	2150	1817	918		
658.85	67.11 64.7	671.1 647	567 547	281 276		125	1250	1056	534		
663.65	64.7 0	647 0	547 0	276 0		422	4220	3567	1802		
	REF SHT 11	10.0 X (1)	8.45 X (1)	4.27 X (1)		REF SHT 11	10.0 X (6)	8.45 X (6)	4.27 X (6)		

NET ULT. SHEARS (LBS.) & B.M.'s (LBS-INS) FOR

SYMMETRIC CASES 1 & 2

FOR SIGN CONVENTION REF SHEET 143

A. V. R

AIRCRAFT

WEIGHT

C. G. POS

		1	2	3	4	5	6	7	8	9	10		
STA'S		591.65	596.45	601.25	606.05	610.85	615.65	620.45	625.25	630.05	634.85	639.65	
SHEAR'S	P _s	0	43.1	33.7	24.2	14.9	5.52	3.87	13.3	22.7	32.1	41.5	50.9
	P _b	0	3231	2543	1845	1103	378	324	1013	1485	2475	3218	3961
	P _c	0	142	130	113	80.9	33.6	10.5	56.7	103	123	192	261
	g	0	716	716	716	716	716	716	716	716	716	716	716
	NET	0	2329.9	1663.3	991.8	291.2	577.12	271.63	163	579.3	1524.9	2204.5	2889.1
B.M.'S	P _s	0	204	326	408	476	517	449	254	218	272	218	184
	P _b	0	13500	22400	30600	34200	34875	31500	22050	12950	0	18400	21800
	P _c	0	591	1201	1722	2100	2041	1848	1512	991	168	991	184
	g	0	3350	6750	10250	13700	13600	8750	4150	450	3250	6750	10250
	NET	0	9349	15123	18220	17924	18717	20453	16034	13121	3054.8	10250	21800
SHEAR'S	P _s	0	43.1	33.7	24.2	14.9	5.52	3.87	13.3	22.7	32.1	41.5	50.9
	P _b	0	3949	3108	2255	1348	468	336	1228	1815	3035	3533	4151
	P _c	0	142	130	113	80.9	33.6	10.5	56.7	103	123	192	261
	g	0	716	716	716	716	716	716	716	716	716	716	716
	NET	0	4850.1	3987.7	3108.2	2159.8	1223.12	443.27	2088	2720.7	3945.1	4946.5	5889.1
B.M.'S	P _s	0	204	326	408	476	517	449	254	218	272	218	184
	P _b	0	16500	23600	37400	41300	42625	38500	26950	17050	0	21800	21800
	P _c	0	591	1201	1722	2100	2041	1848	1512	991	168	991	184
	g	0	3350	6750	10250	13700	13600	8750	4150	450	3250	6750	10250
	NET	0	20651	36377	49780	58076	58783	49547	32966	17809	3054.8	21800	21800

NET ULT SHEAR (LBS) & B.M (LBS INS) FOR SYMMETRIC

CASES 576

FOR SIGN CONVENTION SEE GHT 143

A. V. R

AIRCRAFT

WEIGHT

C. G. PO

		1	2	3	4	5	6	7	8	9	10	
STA'S		531.65	596.45	601.25	606.05	610.85	615.65	620.45	625.25	630.05	634.35	63
SHEARS	P _s	0	21.6	16.9	12.1	7.46	2.76	1.94	6.64	11.3	16.0	20.7
	P _b	0	2491	1961	1423	850	295	250	781	1145	1909	2431
	P _i	0	1630	1541	1342	557	398	124	671	1213	1516	2274
	g	0	605	605	605	605	605	605	659	659	659	659
	NET	0	3587.6	2913.9	2172.1	1209.46	90.76	721.86	343.84	283.06	799.64	1715.3
SHEARS	P _s	0	102	163	204	238	258	224	177	109	13.6	10
	P _b	0	10410	18044	23556	26372	26023	24290	17003	10797	0	13
	P _i	0	7050	14214	20377	24850	24154	21868	17892	11729	1988	11
	g	0	2831	5704	8661	11577	11492	7394	3507	330	2746	51
	NET	0	14731	26717	35516	39883	39813	38988	31565	22975	4747.6	20
SHEARS	P _s	0	21.6	16.9	12.1	7.46	2.76	1.94	6.64	11.3	16.0	20.7
	P _b	0	276	768	558	333	116	58	306	449	748	972
	P _i	0	1630	1541	1342	557	398	124	671	1218	1516	2274
	g	0	605	605	605	605	605	605	659	659	659	659
	NET	0	120.6	184.9	191.1	26.46	320.24	316.36	416	631.06	287.36	121.3
SHEARS	P _s	0	102	163	204	238	258	224	177	109	13.6	10
	P _b	0	4080	7072	9248	10336	10540	9520	6664	4246	0	54
	P _i	0	7050	14214	20377	24850	24154	21868	17892	11759	1988	11
	g	0	2831	5704	8661	11577	11492	7394	3507	330	2746	51
	NET	0	241	1601	2672	3175	2380	5178	7898	8002	4747.6	110

A. V. ROE CANADA LIMITED

MALTON, ONTARIO

TECHNICAL DEPT. (AIRFRAME)

AIRCRAFT

C105

WEIGHT

VARIOUS

C. G. POSITION

VARIOUS

REPORT NO. 7-0558-12/2

SHEET 150

DATE MAR/56

PREPARED BY A. FERENC

	9	10	11	12	13	14	15	16	17	18	19
25	630.05	634.35	639.65	644.45	649.25	654.05	658.85	663.65			
3	82.5	107	121	155	61.3	32.5	7.46	19.3	0	COL5	SHT14
5	2475	3218	3324	4613	533	2700	2250	1431	0	COL2	SHT12
5	939	1409	1771	2133	2433	1417	2233	1201	847	231	697
3	333	333	333	333	307	297	297	281	276	0	COL4
1.3	3829.5	5067	6159	7234	6334.3	5319.3	4220.5	2334.6	1322.7	0	
50	12350	0	18000	35505	13675	5850	4950	11835	0	COL12	SHT14
38	700	1222	7238	16940	8778	770	1078	2895	0	COL7	SHT12
2	132	1388	2605	3775	2249	918	534	1202	0	COL12	SHT13
20	21937	86	28286	57445	30439	7713	6730	16907	0	COL9	SHT15
2	82.5	107	121	155	61.3	32.5	7.46	19.3	0	COL5	SHT14
5	741	572	1136	1337	1063	816	680	432	0	COL5	SHT12
5	939	1409	1771	2133	2433	1417	2233	1201	847	231	697
3	333	333	333	333	307	297	297	281	276	0	COL4
1.3	606.5	877.0	1049	1227	1733.3	711.3	741.5	461.46	616.54	540.3	0
4	4210	0	5440	70730	5644	1768	1436	3577	0	COL12	SHT14
38	7212	1222	7238	16940	8778	770	1078	2895	0	COL10	SHT12
2	132	1388	2605	3775	2249	919	534	1202	0	COL13	SHT13
66	34.1	86	4946	11210	6120	96	284	1495	0	COL9	SHT15

REF SHT 3
CASE 7
P₃=350, P₆=450, P₁=1540, g=4.27

REF SHT 8
CASE 8
P₃=350, P₆=136, P₁=1540, g=4.27

NET ULT SHEAR (LBS) & B.M (LBS IN) FOR SYMMETRIC CASES 728

A. V. RO

AIRCRAFT

WEIGHT

C. G. POS

FOR SIGN CONVENTION REF SMT 143

		1	2	3	4	5	6	7	8	9	10	11
STA'S		591.65	596.45	601.25	606.05	610.85	615.65	620.45	625.25	630.05	634.85	639.65
SHEAR	P _s	0	36.8	62.4	38.4	14.2	9.97	34.2	58.3	83.3	107	130
	P _b	0	3231	2543	1845	1103	378	324	1013	1485	2475	3218
	P _c	0	1941	955	832	593	246	77	416	755	939	1409
	g	0	306	306	306	306	306	333	333	333	333	333
	NET	0	4687	3890.8	3045.4	2040.4	944.2	427.17	1796.2	2631.3	3819.5	5067
Σ'S	P _s	0	525	840	1050	1225	1330	1155	910	590	70	54
	P _b	0	13500	22400	30600	34200	34875	31500	22050	12350	0	180
	P _c	0	4370	8809	12628	15400	14969	13552	11088	7247	1232	72
	g	0	1430	2882	4317	5850	5807	3736	1772	192	1388	26
	NET	0	17825	35931	48655	56675	56981	49943	35820	21527	86	288
SHEAR	P _s	0	36.3	62.4	38.4	14.2	9.97	34.2	58.3	83.3	107	130
	P _b	0	516	768	558	333	116	78	306	449	741	113
	P _c	0	1941	955	832	593	246	77	416	755	939	1409
	g	0	306	306	306	306	306	333	333	333	333	333
	NET	0	482	579.8	642.4	604.4	450.2	5.17	477.2	697.3	606.5	877.0
B.M'S	P _s	0	525	840	1050	1225	1330	1155	910	590	70	54
	P _b	0	4080	7072	7248	10336	10540	9520	6664	4216	0	50
	P _c	0	4370	8809	12628	15400	14969	13552	11088	7247	1232	72
	g	0	1430	2882	4317	5850	5807	3736	1772	192	1388	26
	NET	0	2145	5459	8807	12139	11566	8923	7106	3411	86	49

NET ULT SHEAR (LBS) & B.M (LBS IN) FOR SYMMETRIC

CASES 9 & 10

FOR SIGN CONVENTION REF SMT 143

A. V. R

AIRCRAFT

WEIGHT

C. G. POS

		1	2	3	4	5	6	7	8	9	10	
STA'S		591.65	596.45	601.25	606.05	610.85	615.65	620.45	625.25	630.05	634.85	639.65
V	Ps	317	2479	1782	1097	406	285	576	1667	2358	3049	3740
	Pb	2991	1961	1423	850	295	250	781	1145	1909	2481	3201
	Pc	1630	1541	1342	957	598	124	671	1218	1516	2274	2811
	g	306	306	306	306	306	306	333	333	333	333	333
V	NET	4445.3	3783.21	3053.18	2102.03	944.4	672.4	357.35	1775.24	2679.33	3734.42	5057.51
B	Ps	0	150	240	300	350	380	330	260	160	20	15
	Pb	0	10410	13044	2356	26372	26893	24290	17003	1057	0	13
	Pc	0	7050	14214	20377	24850	24154	21868	17892	11729	1938	110
	g	0	1430	2882	4377	5850	5307	3736	1772	192	1388	26
B	NET	0	18740	34900	48050	56722	56474	47564	36407	22334	580	280
V	Ps	317	2479	1782	1097	406	285	576	1667	2358	3049	3740
	Pb	976	768	558	233	116	58	306	445	768	972	118
	Pc	1630	1541	1342	957	598	124	671	1218	1516	2274	2811
	g	306	306	306	306	306	306	333	333	333	333	333
V	NET	378.3	1054.2	1072.18	919.03	583.4	261.74	39.35	688.24	1085.33	1071.42	1604.51
B	Ps	0	150	240	300	350	380	330	260	160	20	15
	Pb	0	4080	7072	9248	10236	10540	9520	6664	4246	0	54
	Pc	0	7050	14214	20377	24850	24154	21868	17892	11729	1938	110
	g	0	1430	2882	4377	5850	5807	3736	1772	192	1388	26
B	NET	0	4250	9784	15206	20014	19041	15754	12740	7161	580	86

SUMMARY OF SHEARS & B.M.'S ULT FOR CASES 1-10A

INCLUSIVE & DOES NOT INCLUDE EFFECT OF END LOAD

FOR SIGN CONVENTION REF SAT 143

A. V. F.

AIRCRAFT

WEIGHT

C. G. P.

STA →	1	2	3	4	5	6	7	8	9	10	
	591.65	596.45	601.25	606.05	610.85	615.65	620.45	625.25	630.05	634.85	639.65
CASE 1	0	1163.3	551.8	291.2	371.15	211.63	163	579.3	1524.9	2204.5	2
CASE 2	0	3587.7	2108.2	2459.8	1223.12	413.21	2088	2720.7	3565.1	446.5	5
CASE 3	0	2582.1	1781	842.1	146.24	241.96	560.9	1298	2438	3543.1	45
CASE 4	0	3067.9	2319	1601.9	352.24	211.59	1690.1	2002	3062	2607.9	4
CASE 5	0	2713.9	2172.1	1209.46	3076	242.84	755.64	1715.3	2782	4116.7	52
CASE 6	0	189.9	151.1	26.96	320.24	4.16	287.36	121.3	125	663.7	10
CASE 7	0	3890.8	3045.4	2040.4	944.2	421.17	1736.2	2631.3	3822.5	5067	6
CASE 8	0	579.8	642.4	601.4	450.2	311.57	477.2	697.3	606.5	877	7
CASE 9	0	3783.21	3253.18	2102.03	544.24	241.32	1775.24	2677.33	3734.42	5037.51	8
CASE 10	0	1054.2	1072.48	519.03	582.24	39.35	689.24	1085.33	1077.42	1604.51	1
CASE 10A	0	2697.21	2022.13	1319.13	647.14	327.05	1280.04	1701.32	2659.4	3332.01	3
CASE 1	0	5349	15123	18220	17924	13717	20453	16034	12191	3054.8	1
CASE 2	0	20651	26877	49780	53076	8783	49547	32966	17309	3054.8	2
CASE 3	0	13681	23646	30302	32609	33114	33444	26632	20106	4204	1
CASE 4	0	16319	28354	37698	43351	44386	36556	22268	10894	4204.8	2
CASE 5	0	14731	26717	35516	39883	39813	38788	31565	22175	4747.6	2
CASE 6	0	241	1601	2672	3175	2380	3178	7898	8002	4747.6	2
CASE 7	0	17825	35531	42655	56675	56981	49943	35820	21387	86	2
CASE 8	0	2145	5459	8807	12139	11566	8923	7106	3421	86	2
CASE 9	0	18740	34200	48050	56722	56474	49564	36407	22434	580	2
CASE 10	0	4250	5784	15206	20014	19041	15754	12740	7161	580	2
CASE 10A	0	14198	24369	32496	37650	33209	33102	22086	12630	1572	2

A. V. ROE CANADA LIMITED

MALTON, ONTARIO

TECHNICAL DEPT. (AIRFRAME)

AIRCRAFT . . . C105
WEIGHT . . . VARIOUS
C. G. POSITION . . . VARIOUS

REPORT NO. . . 7-0558-12/2

SHEET . . . 153

DATE . . . MAR/56

PREPARED BY . . . A. FERENC

9	10	11	12	13	14	15	16	17	18	19
630.05	624.35	629.65	644.45	649.25	654.05	658.85	663.65			
1524.9	2204.5	2851.1	3431.6	4151.2	4861.8	5582.4	6303.0	7023.6	7744.2	REF SHT 16
3365.1	4446.5	5368.9	6164.4	6959.8	7755.3	8550.7	9346.2	10141.6	10937.1	REF SHT 16
2438	3543.1	4532.1	5503.3	6464.5	7415.7	8366.9	9318.1	10269.3	11220.5	REF SHT 17
3062	4071.9	4871.9	5591.9	6311.9	7031.9	7751.9	8471.9	9191.9	9911.9	REF SHT 17
2782	4116.7	5250.4	6310.2	7281.3	8152.4	9023.5	9894.6	10765.7	11636.8	REF SHT 18
125	663.7	1038.4	1418.2	1798.0	2177.8	2557.6	2937.4	3317.2	3697.0	REF SHT 18
3829.5	5067	6159	7224	8289	9354	10419	11484	12549	13614	REF SHT 19
606.5	877	1049	1221	1393	1565	1737	1909	2081	2253	REF SHT 19
3734.42	5057.51	6172.6	7287.7	8402.8	9517.9	10633.0	11748.1	12863.2	13978.3	REF SHT 20
1077.42	1604.51	1767.6	2336.6	2905.7	3474.7	4043.8	4612.9	5181.9	5751.0	REF SHT 20
2639.4	3332.4	3985.6	4678.6	5371.6	6064.6	6757.6	7450.6	8143.6	8836.6	REF SHT 21
12191	3054.8	10702	23379	11730	35	3487.7	7074			REF SHT 16
17209	3054.8	29298	55021	29770	547	7512.3	19226			REF SHT 16
20106	4204	17575	3224	20047	430	4588.5	9563			REF SHT 17
10894	4204.8	22425	38376	21453	863	6411.5	16337			REF SHT 17
22075	4747.6	20810	47501	24042	387	7534	10303.7			REF SHT 18
8002	4747.6	1160	9393	3957	23	779	2399.3			REF SHT 18
21337	86	28386	57445	30439	771	1730	16207			REF SHT 19
3421	86	4946	11210	6120	9	284	1495			REF SHT 19
22134	580	123010	58158	30733	60	6043	15493			REF SHT 20
7161	580	3690	20050	10638	34	730	2790			REF SHT 20
12630	1572	19486	36675	19673	661	5292	13144.6			REF SHT 21



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/2

SHEET NO. 154

AIRCRAFT:

C105

INNER LONGERON

PREPARED BY

DATE

A. FERENC

CHECKED BY

DATE

UP TO PAGE 153 NO CONSIDERATION WAS GIVEN FOR END LOADS DUE TO INERTIA & MOMENTS DUE TO END LOADS.

THE FOLLOWING WORK WILL CONSIDER THESE LOADS AND MOMENTS AND ADD THEIR RESULTS TO THE PREVIOUS WORK.

$$\text{FROM REF 10 I OF INNER LONGERON} = 67.97 \times \frac{6.25^2}{6.80^2} = 5.770$$

STA 644.45 - 663.65

$$\text{FROM REF 10 PAGE 161 DIST TO HA FROM STATION } 6.25 \times 3.63 = 2.34$$

6.80

BETWEEN STA'S 644.45 & 663.65

I OF INNER LONGERON AVERAGES BETWEEN STA 551.65 & 663.65 FROM PAGE 36 = 10.40 IN⁴

THE END LOADS FOR THE SYMMETRIC CASES ARE OBTAINED FROM REF 6.

IN A DISCUSSION WITH K. IDOLAN IT WAS AGREED THAT THE FOLLOWING ASSUMPTIONS BE USED.

- a) ^{COMP.} AVERAGE END LOAD FOR BENDING PURPOSES IS 13000 LBS FOR 109 SYMMETRIC CASE
- b) HA IS TO BE ASSUMED CONSTANT AT 3.34 FROM RTM SKIN.
- c) FROM THE PRELIMINARY WORK DONE IN REF 10 PAGES 113 TO 115 THE SECONDARY B.M.'S DUE TO THE EFFECT OF END LOAD ARE CONSIDERED TO BE NEGLIGIBLE.

FOR A GENERAL SOLUTION OF THE REDUNDANTS BY USE OF CLARKE'S EQUATION SEE REF 10 PAGES 109-111.

TO BE ADDED TO SHEET FOR COMPLETE UNIT TWO SYMMETRIC PICTURE.

Down

UP

4240

4000

3000

2000

TOP TENS

TOP
COM

730

TOP TEN

A. V. ROE CANADA LIMITED

MALTON, ONTARIO

TECHNICAL DEPT. (AIRFRAME)

AIRCRAFT . . . C105

WEIGHT . . . VARIOUS

C. G. POSITION . . . VARIOUS

REPORT NO. . . 7-0558-12/2

SHEET . . . 157

DATE . . . MAR/56

PREPARED BY . . . A. FERENC

	9	10	11	12	13	14	15	16	17	18	19
25	630.05	624.35	639.65	644.45	649.25	654.05	658.85	663.65			
		1095	1095	1095	1095	1095	1095	1095			
		1095	1095	1095	1095	1095	1095	1095			
		9253	9253	9253	9253	9253	9253	9253			
		467.6	467.6	467.6	467.6	467.6	467.6	467.6			
0	100	410	930	1460	900	350	180	720	Ref	SHT 25	
0	1000	4100	2500	1400	9000	3500	1000	7200	Ref	SHT 2	
3	845	2465	7859	12337	7605	2958	1521	6169	"	"	
6	427	1751	3571	6234	3343	1495	769	3117	"	"	

SUMMARY OF SHEARS & B.M.'S ULT FOR SYMMETRIC CASES 1-10A INCLUSIVE

SHT 153 + ADDITIONS APPROPRIATE SHT 157

SIGN CONVENTION AS PER SHT 143

A. V. RO

TEC

AIRCRAFT

WEIGHT

C. G. POSIT

STA	1	2	3	4	5	6	7	8	9	10	11
	591.65	596.45	601.25	606.05	610.85	615.65	620.45	625.25	630.05	634.85	639.6
CASE 1	1254.9	568.3	103.2	803.8	472.12	1316.52	1258	1674.3	2634.4	3299.5	3546
" 2	5451	5082.7	4203.2	3254.8	2218.12	1446.63	593	1625.7	2870	3851.5	4773
" 3	2252.2	1488.1	686	245.9	1541.74	1443.40	1655.9	2393	3533	4658.1	5627
" 4	9927.8	4162.9	3414	2696.9	2081.33	1234.49	595.1	907	1967	2512.9	3072
" 5	2667.3	1988.6	1246.8	284.16	834.54	1269.14	1764.74	2640.6	3707.3	5042	6175
" 6	8041	740.4	734.2	898.84	1245.64	921.14	637.94	1046.6	1050	1589	1963
" 7	51566	4358.5	3513	2508	1111.8	1201.6	276.37	1328.6	2163.7	3361	4599.4
" 8	997.6	1047.4	1110	1072	978.5	516	15.3	9.6	229.7	138	409.4
" 9	4912.9	4250.8	3520.78	2559.9	1461.82	80.25	236.55	137.64	2211.7	3266.2	4587.5
" 10	1445.9	1521.8	1539.78	1386.63	1051.54	189.34	428	111.45	220.64	617.73	609.1
" 10A	3834.3	3164.21	2481.73	1786.9	1114.74	140.55	170.25	813.24	1233.72	2191.8	2364.91
CASE 1	43400	47212	48123	45570	39924	35517	32253	22534	14121	1045.2	2000
" 2	43400	17349	3877	23430	36076	41983	37747	26466	1630	1045.2	1992
" 3	43400	51681	56646	57652	54609	49314	45244	33132	21106	104	2687
" 4	43400	21681	4646	10348	21391	27539	24756	15868	9874	104	1312
" 5	38673	46847	54602	53627	58473	54009	48959	37058	2382	1282.6	2836
" 6	38673	32358	2486	25783	21765	16576	15149	13391	8847	1282.6	2019
" 7	18531	35579	21840	36977	47281	49807	44904	33044	21160	1665	2441
" 8	18531	14081	2442	2871	2745	4392	3884	4330	2924	1665	97
" 9	18531	1514	20809	36372	47328	49300	44525	33631	21707	2351	2403
" 10	18531	11976	4307	3523	10620	11867	10715	9964	6174	2331	471
" 10A	18531	2428	10773	21318	28256	31135	28063	19301	12809	179	1551



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/2

SHEET NO.

162

AIRCRAFT:

C105

Torsion Box

PREPARED BY

G. M. COILEY

DATE

9-4-56

CHECKED BY

DATE

MAX DESIGN SHEAR FLOW IN PANELS FOR DESIGN CONDITIONS

MAX S/W IN PANELS 1-2:-

CELL	1	2	3	4	5	6	7	8	9	10	11
CONDITION	9	9	2	9	9	8	5	7	5	9	3
P_1 $B_{1/2}$	+24.85	+24.85	-2.05	+24.85	+24.85	+15.4	+24.85	+15.4	+24.85	+24.85	+24.85
P_2 $B_{1/2}$	+3.47	+3.47	-5.5	+3.47	+3.47	-5.5	+3.47	+4.50	+3.47	+3.47	+3.47
P_3 $B_{1/2}$	-1.68	-1.68	+1.0	-1.68	-1.68	+1.35	-1.68	+3.50	-1.68	-1.68	-1.68
η γ	-4.25	-4.25	+10.45	-4.25	-4.25	-4.16	+8.45	+9.45	+8.45	-4.25	-4.25
S/W DUE TO P_1	-910	-538	+3	-480	-328	-86	+217	+65	+459	+776	+1123
" " P_2	-223	-103	+75	-64	-127	-82	+96	+199	+220	+212	+266
" " P_3	-1	0	+1	0	-1	-1	+1	+7	+2	+1	+2
" " η	-111	-48	+96	-84	-124	-12	+26	+28	+27	+63	+68
TOTAL S/W	-1245	-689	+75	-628	-580	-181	+340	+291	+708	+1057	+1459

MAX S/W IN PANELS 2-3:-

CELL	1	2	3	4	5	6	7	8	9	10	11
CONDITION	9	9	2	9	6	10	5	8	5	5	5
P_1 $B_{1/2}$	+24.85	+24.85	-2.05	+24.85	+24.85	+24.85	+24.85	+15.40	+24.85	+24.85	+24.85
P_2 $B_{1/2}$	+3.47	+3.47	-5.50	+3.47	-1.36	-1.36	+3.47	-5.5	+3.47	+3.47	+3.47
P_3 $B_{1/2}$	+1.00	-1.68	+1.00	+1.00	+1.00	+1.00	-1.68	+1.36	-1.68	-1.68	-1.68
η γ	-4.25	-4.25	+10.45	-4.25	+8.45	-4.25	+8.45	-4.16	+8.45	+8.45	+8.45
S/W DUE TO P_1	-783	-500	+2	-410	-159	-171	+142	-3	+308	+792	+1,100
" " P_2	-45	-59	+75	-3	-16	-4	+19	-49	+44	+219	+230
" " P_3	0	0	0	0	-1	0	0	0	0	+1	+1
" " η	-44	-20	+52	-3	-22	-2	+5		+6	+413	+413
TOTAL S/W	-872	-579	+129	-416	-198	-177	+166	-52	+358	+1,425	+1,744



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/2

SHEET NO. 163

AIRCRAFT:

C105

Torsion Box

PREPARED BY

DATE

G. M. COLLEY

10-4-56

CHECKED BY

DATE

MAX S/W IN PANELS 3-4

CELL	1	2	3	4	5	6	7	8	9	10	11
CONDITION	9	9	8	6	8	5	8	5	8	8	6
P_L b/d	+24.85	+24.85	+15.40	+24.85	+15.40	+24.85	+15.40	+24.85	+15.40	+15.40	+24.85
P_B b/d	-1.36	-1.36	-5.50	-1.36	-5.50	+3.47	-5.50	+3.47	-5.50	-5.50	-1.36
P_S b/d	+1.00	+1.00	+1.36	+1.00	+1.36	-.68	+1.36	-.68	+1.36	+1.36	+1.00
q g	-4.25	-4.25	+9.45	+8.45	+9.45	+9.45	-4.16	+8.45	-4.16	+9.45	+8.45
S/W DUE TO P_L	-668	-439	+8	-356	-38	-199	+46	-102	+109	+250	+680
" " " P_B	-43	-4	+26	-17	+219	-26	+76	-77	+173	+276	+79
" " " P_S	-2	-1	0	-2	-3	0	+1	-1	+2	+4	+4
" " " q	-24	-12	+27	-117	-298	-14	+6	-13	+6	+276	+246
TOTAL S/W	-737	-456	+61	-492	-558	-239	+129	-193	+290	+806	+1009

MAX S/W IN PANELS 4-5

CELL	1	2	3	4	5	6	7	8	9	10	11
CONDITION	6	6	9	6	8	5	8	5	8	8	8
P_L b/d	+24.85	+24.85	+24.85	+24.85	+15.40	+24.85	+15.40	+24.85	+15.40	+15.40	+15.40
P_B b/d	-1.36	-1.36	+3.47	-1.36	-5.50	+3.47	-5.50	+3.47	-5.50	-5.50	-5.50
P_S b/d	+1.00	+1.00	-.68	1.00	+1.36	-.68	+1.36	-.68	+1.36	+1.36	+1.36
q g	+8.45	+8.45	-4.25	+8.45	+9.45	+8.45	-4.16	+8.45	-4.16	+9.45	+9.45
S/W DUE TO P_L	-631	-405	+40	-358	-36	-209	+32	-134	+82	+168	+332
" " " P_B	-65	-20	+11	-23	-220	-38	+111	-114	+257	+489	+553
" " " P_S	-3	-1	0	-1	-3	0	+1	-1	+3	+6	+7
" " " q	-127	-53	+26	-156	-251	-20	+10	-19	+9	+129	+130
TOTAL S/W	-826	-479	+77	-538	-510	-267	+154	-268	+351	+792	+1022

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-12/2

SHEET NO. 166

AIRCRAFT:

C105

TORSION BOX WITH 3'D
BEAM JOINT AT SUB-113

PREPARED BY

DATE

C. A. GILLEY

14-12-55

CHECKED BY

DATE

LOADS IN TORSION BOX MEMBERS (P_1, P_2, P_3, P_4, P_5)

THESE ARE ASSUMED TO BE AS GIVEN BY ENGINEER'S BENDING THEORY

THAN $P_2 + P_3 + P_4 = P_1 + P_5$

SHEAR FLOWS IN PANELS:-

ASSUME THERE IS NO SHEAR IN PANEL 4-5

PANEL 3-4

$$q_{3-4} = \frac{P_4}{l}$$

PANEL 2-3

$$q_{2-3} = \frac{P_3 + P_4}{l}$$

PANEL 1-5

$$q_{1-5} = \frac{P_1}{l}$$

PANEL 1-2

$$q_{1-2} = \frac{P - P_2 - P_3 - P_4}{l} = \frac{P - P_1 - P_5}{l}$$

$$\text{OR } q_{1-2} = \frac{2P \tan \theta}{l_A} = \frac{2P(l_F - l_A)}{2l_A l} = \frac{P(l_F - l_A)}{l_A l}$$



SHEAR FLOWS q_m ARE PUT INTO END DIAGRAMS. THE EQUAL AND OPPOSITE MOMENTS PRODUCED WILL BE REACTED BY THE HEAVY FRAME AT 644-43 AND 6400 BEAM AT 6400-27, AND THEY WILL ALSO BALANCE THROUGH THE TORSION BOX ITSELF, ACCORDING TO THE STIFFNESS OF THE MEMBERS CONCERNED.

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-12/2

SHEET NO.

167

AIRCRAFT:

C105

TORQUE BOX TO INBD BEAM

JOINT AT STN 644.43

PREPARED BY

DATE

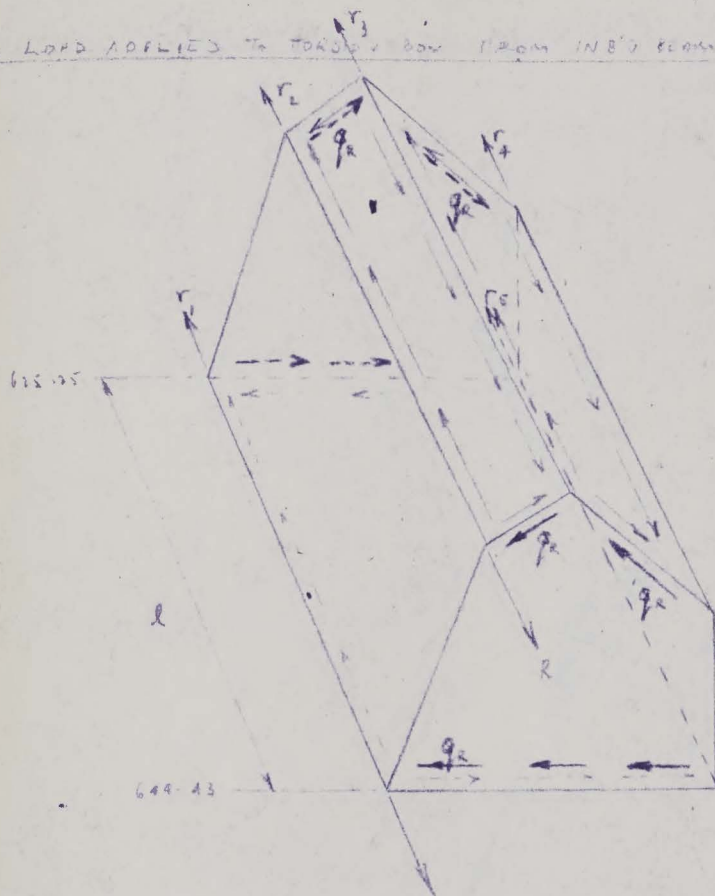
G. M. COLEY

15-12-57

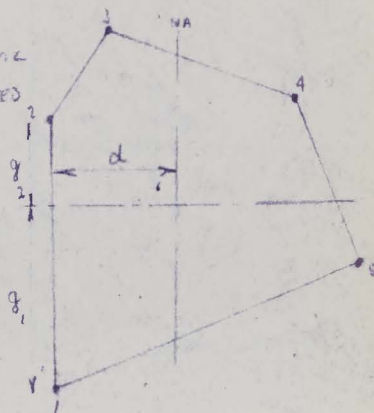
CHECKED BY

DATE

END LOAD APPLIED TO TORQUE BOX FROM INBD BEAM.



R_1, R_2, R_3, R_4, R_5 ARE ASSUMED TO
BE GIVEN BY ENGINEERS BENDING THEORY.
THE SHEAR FLOWS q_i ARE PUT INTO THE
END DIAPHRAGMS AND PRODUCE A HORIZONTAL
LOAD = $2Rd$ WHICH MUST BE REACTED
BY THE FRAME AND BEAM AT STNS 644.43
& 625.25 RESP AND A VERTICAL LOAD
= $\frac{R(q_1 - q_2)}{2}$ WHICH IS REACTED IN THE SAME
MANNER.



TECHNICAL DEPARTMENT (Aircraft)

REPORT No. P-0558-12/2

SHEET No. 168

AIRCRAFT:

C105

TORQUE BOX TO INBD
BEAM JOINT AT 67N
644-43

PREPARED BY

DATE

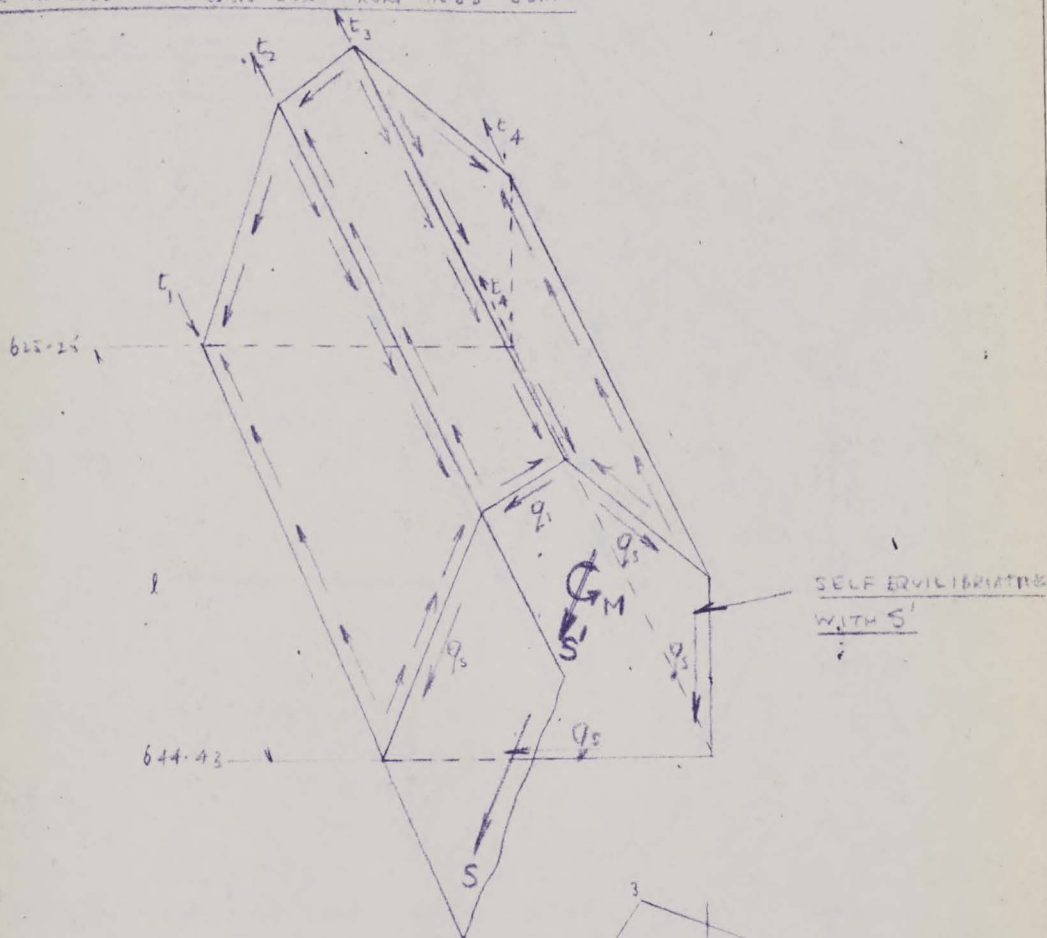
G. M. COILEY

15-11-51

CHECKED BY

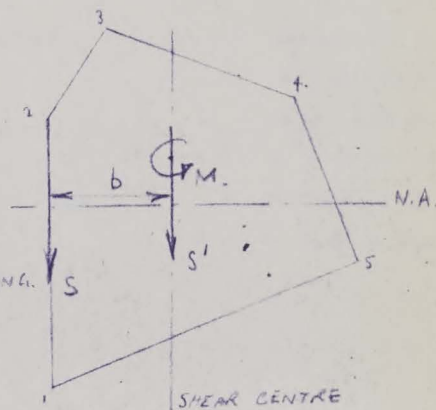
DATE

SHEAR APPLIED TO TORSION BOX FROM INBD BEAM



E_1, E_2, E_3, E_4 & E_5 ARE ASSUMED TO BE GIVEN BY ENGINEERING BENDING THEORY FOR A SHEAR S' APPLIED AT THE SHEAR CENTER.

THE SHEARS S_2 APPLIED TO THE END DIAPHRAGMS ARE SELF EQUILIBRATING. WITH S' THE MOMENT $M = S'b$ WILL BE REACTED BY THE FRAME AT STN 644-43 OR TAKEN THROUGH THE TORSION BOX ACCORDING TO THEIR RELATIVE STIFFNESSES.



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

REPORT NO. 7-0558-12/2

SHEET NO. 174

AIRCRAFT:

C105

TORQUE BOX TO INB'D
BEAM JOINT AT STN 644.43

PREPARED BY

DATE

G. M. LORRY

20.12.47

CHECKED BY

DATE

LOADING OF TORSION BOX DUE TO APPLICATION OF $S' = -7,626 \text{ k}$ & $W = -243.5 \text{ k}$

MOMENT AT STN 628.25 DUE TO S' & W :

$$= -7,626 \times 19.8 = -150,995$$

$$\frac{243.5 \times 19.8^2}{2} = +44,300$$

$$\text{TOTAL} = -101,500 \text{ k-in.}$$

BY PREPARING THE PURE MOMENT CASE BY $\frac{-101,500}{19.8} = -5,126 \text{ k}$

$$E_1 = -11,940 \text{ k}$$

$$E_2 = +5,300 \text{ k}$$

$$E_3 = +6,260 \text{ k}$$

$$E_4 = +3,470 \text{ k}$$

$$E_5 = -3,450 \text{ k}$$

SHEAR FLOWS IN TORSION BOX ADJACENT TO STN 644.43

CONSIDER A PORTION OF BOX 1 IN LONG.

SHEAR ON SECTION = $-7,626 \text{ k}$

MOMENT PRODUCED = $-7,626 \text{ k-in.}$

SHEAR FLOW TO MEMBER 1 = $+285 \text{ k/in.}$

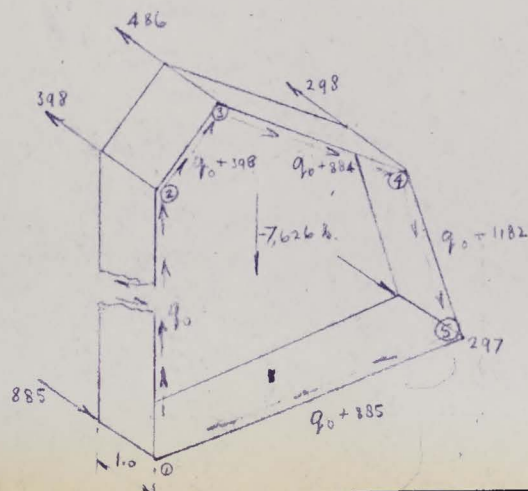
2 = -398 k/in.

3 = -486 k/in.

4 = -298 k/in.

5 = $+297 \text{ k/in.}$

AT STN 644.43



A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-12/2

SHEET NO. 177

AIRCRAFT:

C105

TORQUE BOX TO IN 36.

SEAM JOINT AT STN 644.43

PREPARED BY

DATE

G.M. COILEY

21-4-55

CHECKED BY

DATE

TOTAL AXIAL LOAD IN TENSION BOX MEMBERS AT STN 625.25

TENSION t_m

LOADING APPLIED.	ITEM.	1	2	3	4	5
$M_B = 66,347 \text{ k}$		+ 7,800	- 3,460	- 4,220	- 2,590	+ 2,590
$2R = -8,320 \text{ k}$		- 2,380	- 1,365	- 1,113	- 1,463	- 2,012
$S' \& W = -7,626 \text{ k} \& -243.5 \text{ k}_{min}$		- 11,740	+ 5,300	+ 6,460	+ 3,470	- 3,920
$T \& Z$		0	0	0	0	0
$T = 1463$		- 6,520	+ 475	+ 1127	- 83	- 3,395
AREA OF MEMBER (in^2)		8434	2157	1840	1240	8327
STRESS (lb/in^2)		16,400	2,110	6,120	344	10,200

SHEAR FLOWS AT STN 625.25



	PANEL	1-2	2-3	3-4	4-5	5-1
LOADING APPLIED						
$M_B = 66,347 \text{ k}$		-19.0	-356.0	-135.0	0	-135.0
$2R = -8,320 \text{ k}$		+12.0	-134.2	-76.3	0	+105.0
$S \& W \text{ GIVE } -2,726 \text{ k}$ SHEAR		+389.0	+235.0	+46.5	-68.9	+46.4
$T \& Z \text{ GIVE } +2,400 \text{ k}$ TORQUE		-35.1	-35.1	-35.1	-35.1	-35.1
TOTAL		+346.9	-240.3	-169.9	-104.0	-19.0

SHEAR FLOWS AT STN 644.43



	PANEL	1-2	2-3	3-4	4-5	5-1
LOADING APPLIED						
$M_B = 66,347 \text{ k}$		-19.0	-356.0	-135.0	0	-135.0
$2R = -8,320 \text{ k}$		+12.0	-134.2	-76.3	0	+105.0
$S' \& W \text{ GIVE } -7,626 \text{ k SHEAR}$		+1004.0	+606.0	+120.0	-178	+119.0
$T \& Z \text{ GIVE } 61,100 \text{ k TORQUE}$		+894.0	+894.0	+894.0	+894.0	+894.0
TOTALS		+1871.0	+1009.8	+802.7	+716.0	+983.0
SHEAR FLOWS USED BY J. NEEDHAM		1601	1151	626	459	1138

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558 12/2

SHEET NO. 180

AIRCRAFT:

C105

TORQUE BOX TO FORMER

JOINT AS SHW 591-65

PREPARED BY

DATE

G. M. COLLIER

15-11-55

CHECKED BY

DATE

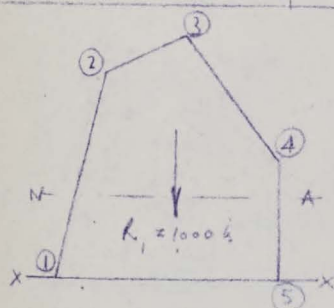
CONDITION 6

$$\begin{aligned}
 138 \text{ lb} &= 138 \times 24.85 = 3430 \downarrow \\
 636.8 \text{ lb} &= 636.8 \times -5.1 = 325 \uparrow \\
 10575 \text{ in} &= 10575 \times -8.19 = 0 \\
 69.3 \text{ in} \times 10.2 &= 69.3 \times 8.19 \times 9312 = 538 \uparrow \\
 70.7 \text{ in} &= 70.7 \times 8.19 = 579 \uparrow \\
 229 \text{ lb} &= 229 \times 0 = 0 \\
 R_1 &= 1968 \downarrow
 \end{aligned}$$

CONDITION 4

$$\begin{aligned}
 138 \text{ lb} &= 138 \times 10.20 = 1410 \downarrow \\
 636.8 \text{ lb} &= 636.8 \times -5.5 = 3500 \uparrow \\
 10575 \text{ in} &= 10575 \times 10 = 0 \\
 69.3 \text{ in} \times 10.2 &= 69.3 \times 10 \times 9312 = 683 \uparrow \\
 70.7 \text{ in} &= 70.7 \times 10 = 707 \uparrow \\
 229 \text{ lb} &= 229 \times -1.0 = 0 \\
 R_1 &= 3480 \uparrow
 \end{aligned}$$

SHEAR IN PANELS FOR $R_1 = 1000 \text{ lb}$



(INTERPOLATION FROM TORQUE BOX REPORT BY N. LOMBROZO SHEET NO 112)

$$\begin{aligned}
 \text{LOAD TO } ① &= \frac{1000 \times -2.70 \times 2700}{7.944} = -92.0 \text{ lb/in (COMP)} \\
 \text{" " } ② &= \frac{1000 \times +4.70 \times 1058}{7.944} = +62.5 \text{ lb/in (TEN)} \\
 \text{" " } ③ &= \frac{1000 \times +6.50 \times 180}{7.944} = +90.5 \text{ lb/in (TEN)} \\
 \text{" " } ④ &= \frac{1000 \times +1.15 \times 4100}{7.944} = +16.0 \text{ lb/in (TEN)} \\
 &\quad (\text{SEE NEXT PAGE})
 \end{aligned}$$



AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C.105

TORSION BOX
CUT-OUT.

REPORT NO. 7-0558-12/2

SHEET NO. 184.01

PREPARED BY

DATE

K.J. IDDOH

1 MAR '56

CHECKED BY

DATE

SECTION 'A' (GENERAL)

A.1 DISCUSSION.

THE TORSION BOX HAS BEEN LOCALLY REDUCED IN HEIGHT IN ORDER TO CLEAR THE GEAR BOX DRIVE SHAFT AND ITS SEAL. IT IS THEREFORE REQUIRED TO CHECK THIS DIMINISHED SECTION AND THE DIFFUSION OF LOADS INTO THE ADJACENT STRUCTURE.

A.2 METHOD OF ANALYSIS.

FROM THE BENDING MOMENTS AND SECTION CONSTANTS AND END LOADS THE CAP LOADS AT $\frac{1}{2}$ OF CUT-OUT AND AT UNDISTURBED SECTIONS TO EITHER SIDE ARE CALCULATED. THE DIFFERENCE OF THESE LOADS MUST THEN BE SHEARED AROUND THE OUTER PANELS OF THE TORSION BOX TO FORM A BALANCE. THE PICK-UP OF LOAD INTO THE END LOAD MEMBERS WILL LOAD THE ATTACHMENTS.

TORSION LOADING CHANGES BETWEEN THE UNDISTURBED AND CUT SECTIONS WILL BE BALANCED ON THE DIAPHRAGMS BOUNDING THE CUT-OUT.

THE TOTAL SHEARS IN THE PANELS WILL BE EXAMINED AND CHECKED FOR TENSION FIELD EFFECTS IF BUCKLED.

SKIN ATTACHMENTS ARE ALREADY COVERED IN A SEPARATE REPORT.

A.3 LIST OF ASSUMPTIONS.

1. THAT ALL DIFFUSION TAKES PLACE BETWEEN STATIONS 596.45 AND 603.65 AND BETWEEN 610.85 AND 615.65
2. THAT DIFFUSION SHEAR FLOWS ARE UNIFORM ACROSS THEIR RESPECTIVE PANELS
3. THAT THE ANGLES AND WEB FORMING, THE TOP OF THE CUT-OUT ARE MADE CONTINUOUS ACROSS THE DIAPHRAGMS ADJACENT TO THE CUT-OUT.
4. THE MOMENTS OF INERTIA ARE CONSTANT BETWEEN STA 596.45-603.65, 603.65-610.85 AND 610.85-615.65. FOR ENDLOAD & MOMENT DIFFUSION.
- 5- THE TORSION BOX IS RESTRAINED BY THE SKIN FROM BENDING IN ANY OTHER PLANE THAN THAT NORMAL TO THE SKIN.



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C105

TORSION BOX AT GEAR
BOX CUT OUT

REPORT NO. 7-0558-12/1

SHEET NO. 185

PREPARED BY

A. Forenc

DATE

Apr 19

CHECKED BY

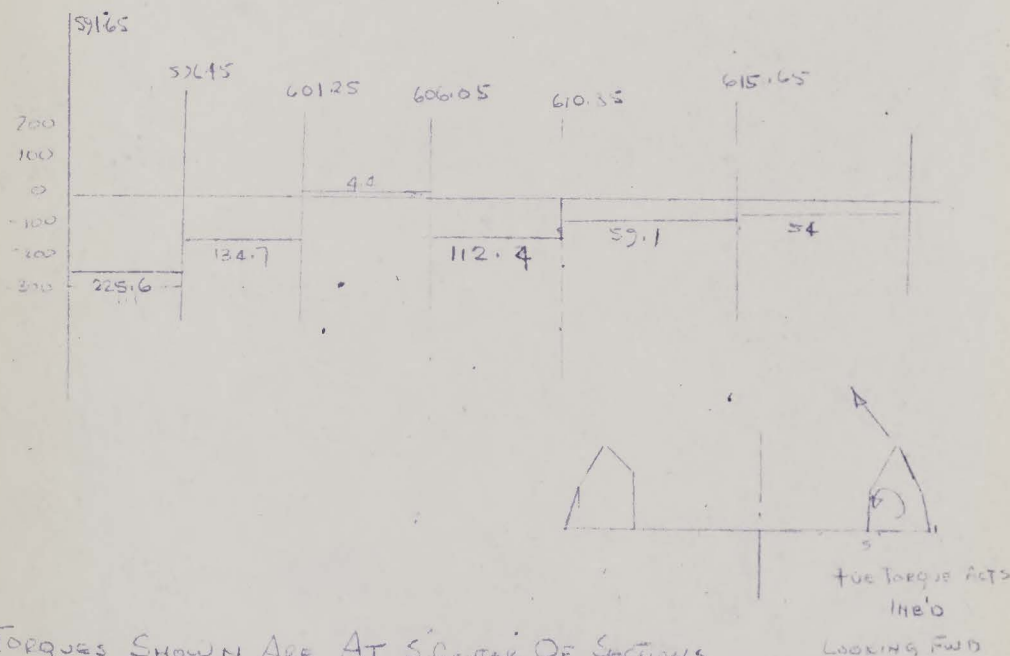
DATE

UPON EXAMINATION OF THIS REPORT IT HAS BEEN FOUND THAT TWO CASES ARE CRITICAL THEY ARE CASE 2 & CASE 5.

CONSIDERING CASE 5 TORQUE LOADING

FROM THIS REPORT IT CAN BE SEEN THAT THE TORQUE IS AFFECTED MAINLY BY THE INTERNAL PRESSURE. THE TORQUE DUE TO P_0 & P_1 ARE NEGLIGIBLE.

FROM REF THE FOLLOWING TORQUE DIAGRAM WAS OBTAINED FOR A TOTAL APPLIED TORQUE OF 1000 LB IN.



CASE 5 FOR CONVENIENCE WILL BE BROKEN UP INTO 3 PARTS

- TORQUE
- VERT SHEARS & ASSOCIATED B.M.'S
- END LOAD & " "



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/2

SHEET NO. 186

AIRCRAFT:

C105

TORSION BOX
AT GEAR BOX CUT OUT

PREPARED BY

DATE

A. FERENC

Mar/56

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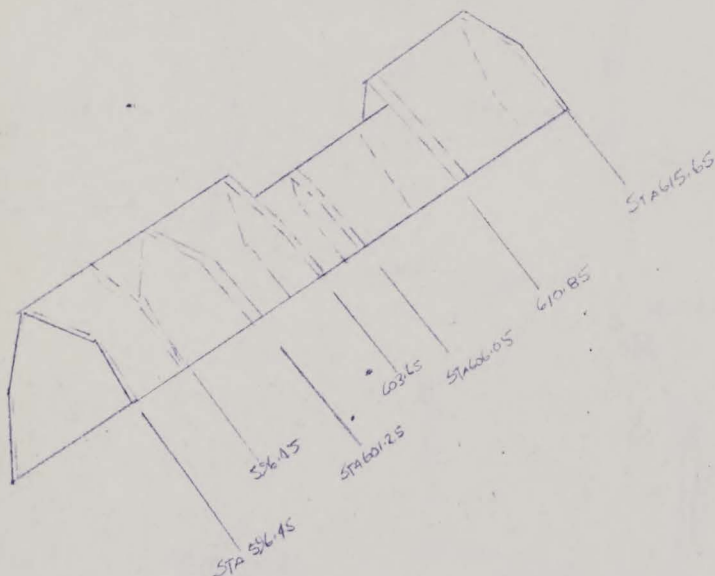
DATE

CASE 6 TORQUE ONLY

MAX TORQUE APPLIED/RAY DUE TO PL = 16,640 LBS/INS

FOR 52.8" TOTAL APPLIED TORQUE = $\frac{52.8}{4.8} \times 16,640 = 183,000$ LBS/INS

FACTOR TO BE APPLIED TO TORQUE DIAGRAM OF PAGE 20 = $\frac{183,000}{1000} = 183$



CONSIDERING PORTION IN AREA OF CUT OUT ONLY

TORQUE AT STA 603.65 AFT = $\frac{4.4 \times 183}{48.377} = 16.62$ LBS/INS

AT STA 606.05 FWD = 16.62 LBS/INS

AT STA 606.05 AFT = $\frac{112.4 \times 183}{48.377} = 425$ LBS/INS

AT STA 610.85 FWD = 425 LBS/INS



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/2

SHEET NO. 188

AIRCRAFT

C105

TORSION BOX AT
GEAR BOX CUT OUT

PREPARED BY

A. FERENC

DATE

APR/56

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DATE

PORTION IN AREA OF CUT OUT

CASES VERT SHEARS & ASSOCIATED B.M'S OUT

SHEARS B.M. AT STA 603.65

SHEAR AT STA 601.25 = 2172.1 LBS

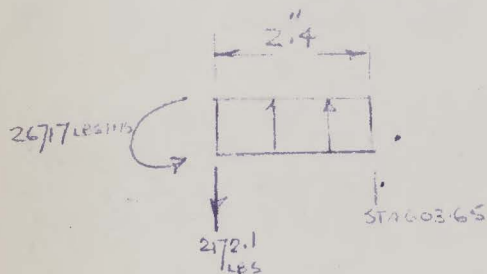
SHEAR AT STA 606.05 = -1207.46 LBS

$\Delta V = 962.65$

Ref Page 103

ΔV Assumed To Come On As A.U.D.L. BETWEEN THESE TWO STA'S

$\therefore$ SHEAR AT STA 603.65 = $2172.1 + 603.65 - 601.25 \times 962.65 = 2172.1 + 931.25 \times 962.65$
 $603.65 - 601.25$



MOMENT AT STA 601.25 = 26717 LBS IN

MOMENT AT STA 603.65 = $26717 + 2172.1 \times 2.4 - \frac{962.65 \times 2.4^2}{2}$

= $26717 + 5220 + 576 = 31461$ LBS IN'S THIS TOP

END LOADS STA 603.65 AFT

Item	Area	$\bar{Z}$	$A\bar{Z}$	M	I	$\frac{M}{I}$	$\frac{M}{I} A\bar{Z}$	$\frac{M}{I} A\bar{Z}^2$	η	M_2
				LB IN'S			LB'S			LB IN'S
1	.45	2.1785	.98	31461	8.43	3730	3660	7960	2.885	10550
4	.1236	1.61	.799	A	A	A	742	1195	2.83	-2135
5	.3656	2.212	.810	A	A	A	3020	6300	2.66	8050
7	.3652	2.48	.506	A	A	A	3380	8380	1.79	6050
3	.2550	-2.68	-.695	31461	8.43	3730	2590	6990	2.405	-6230
Σ							+320600	30855		-4815
								OK		LB IN'S

The Unbalanced Moment Of 4815 LB IN'S Is Received By SKIN



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT No. 7-0558-12/2

SHEET No. 189

AIRCRAFT:

C195

TORSION BOX AT GEAR
BOX CUT OUT

PREPARED BY

DATE

A. FERENC

142/56

CHECKED BY

DATE

PORTION IN AREA OF CUT OUT

CASE 5 VERT SHEARS & ASSOCIATED B.M.'S ULT

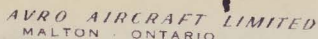
B.M. AT STA 606.05 = -35516 LBS IN. Ref. Page 153

" " STA 610.85 = -37883 " "

THE END LOADS OF PAGE 154 WILL BE RATIO'D UP TO AGREE WITH THE ABOVE B.M.'S SINCE THE SECTION IS CONSTANT.

THE UNIT SHEAR FLOWS OF PAGE 45 WILL BE RATIO'D UP TO THE CORRESPONDING SHEAR AT THE STATION. AND THE SHEAR FLOWS THUS OBTAINED ARE ASSUMED TO VARY LINEARLY BETWEEN STA'S.

THE BOOM END LOADS AND PANEL SHEARS FOR CASE 5 FOR VERT SHEAR & ASSOCIATED B.M. IN THE AREA OF THE CUT OUT IS SHOWN ON THE FOLLOWING PAGE.



REPORT NO. 7-0558-1212

SHEET No 190

AIRCRAFT:

C105

TORSION BOX AT
GEAR BOX CUT OUT

PREPARED BY

DATE _____

A. FERENC

App 156

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DATE _____

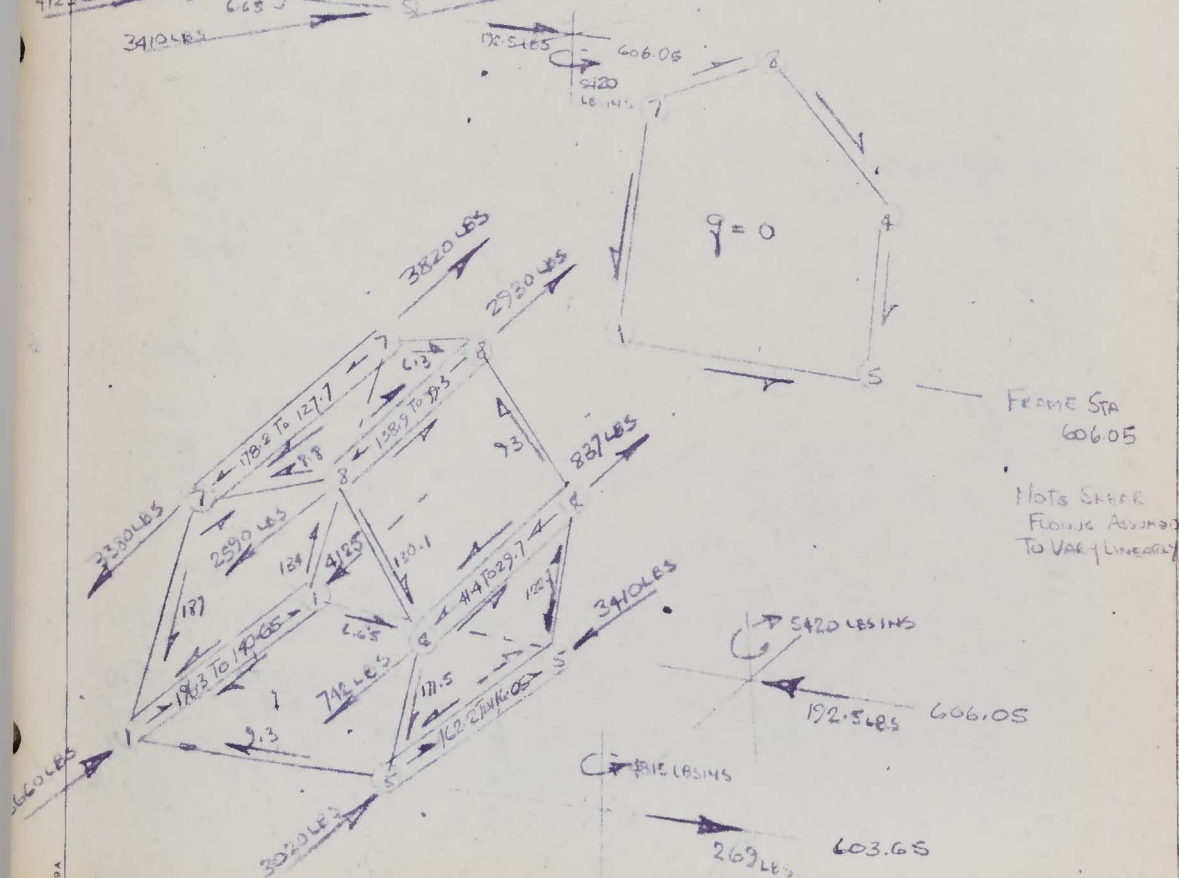
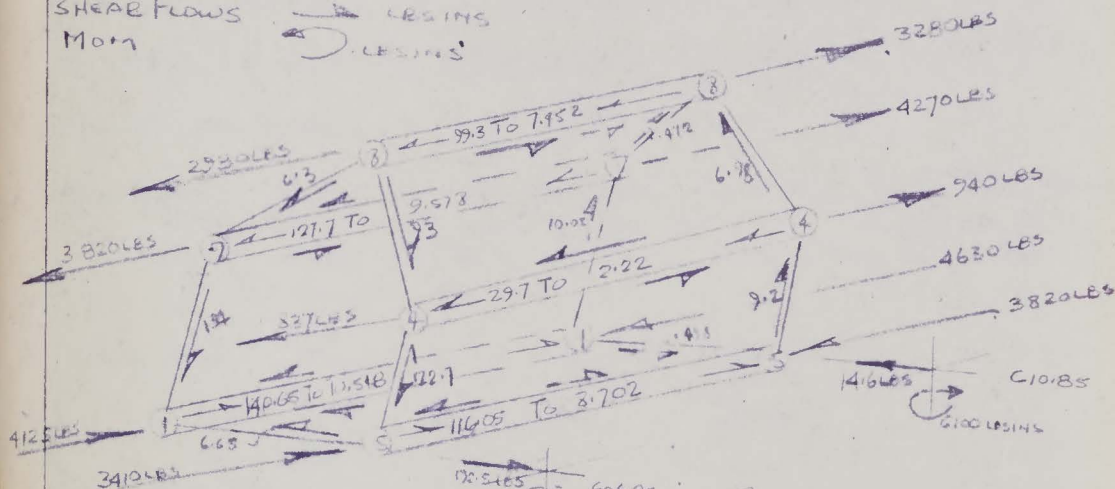
PORTION IN AREA OF CUT OUT - ROOM END LOADS & PANEL SHEARS
CASE 5 VERT SHEARS & ASSOCIATED B.M.'S CUT

END LOADS $\rightarrow$ LBS

SHEAR FLOWS $\rightarrow$ CRACKING

Mon

LESSONS



FRAME STA
606.05

Mots SHOCK
Flowing Assumed
To Vary Linearly



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C105

TORSION BOX AT
GEAR BOX CUT OUT

REPORT NO. 7-0558-12/2

SHEET NO.

191

PREPARED BY

DATE

A. FERENC

MAR/56

CHECKED BY

DATE

LOADS ON SECTION STA 603.65 TO 610.85
DUE TO END LOADS AND ASSOCIATED B.M.'S CASE 5

LOADS AT STA 603.65 SEE REF INNER LONGERON

$$B.M. = 27885 + 925.3 \times 24 = 27885 + 22200 = 25665 \text{ LBS INCH}$$

$$SHEAR = 925.3 \text{ LBS}$$

END LOAD

ALTHOUGH THE END LOAD ASSOCIATED WITH THE ABOVE
B.M. WAS 1200 LBS/G REF B-3. THE ACTUAL END
LOAD AT THIS STA WILL BE USED WITH THE
ABOVE VALUE.

$$10G \text{ CASE END LOAD AT STA } 591 = 17131 \text{ LBS}$$

$$G \text{ AT } 591 = 15790"$$

$$\Delta P =$$

$$\Delta x = 53$$

$$1441 \text{ LBS}$$

$$\Delta P = 27.2 \text{ LBS/INCH}$$

$$\Delta x$$

$$\therefore \text{END LOAD AT STA } 603.65 = 17181 - (603.65 - 591) \times 27.2 = 16337 \text{ LBS COMP}$$

$$\text{AT } 8.45 G = 1845 \times 16337 = 4250 \text{ LBS}$$

LOADS AT STA 606.05

$$B.M. = -23111 \text{ LBS INCH}$$

$$SHEAR = 926.3 \text{ LBS}$$

$$\text{END LOAD AT } 10 G = 16641 + 2.4 \times 27.2 = 1670 \text{ LBS COMP}$$

$$\text{AT } 8.45 G = 1400 \text{ LBS COMP}$$

LOADS AT STA 610.85

$$B.M. = -18550$$

$$SHEAR = 925.3$$

$$\text{END LOAD AT } 10 G = 16337 - 7.2 \times 27.2 = 16641 \text{ LBS COMP}$$

$$\text{AT } 8.45 G = 13900 \text{ LBS COMP}$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/2

SHEET NO. 192

AIRCRAFT:

C105

TORSION BOX AT
GEAR BOX CUT OUT

PREPARED BY

A. FERENC

DATE

MAR/56

CHECKED BY

DATE

LOADS ON SECTION STA 603.65 AFT.

END LOADS IN BOOM DUE TO DIRECT END LOAD + ASSOCIATED B.M. CASE 5ULT

B.M. = -25665 LBS INS, DIRECT END LOAD 14250

THE END LOADS FOR A B.M. OF 31461 LBS INS IS GIVEN ON
PAGE 188 THEREFORE FOR A B.M. OF 31461 LBS INS THE END
LOADS OF PAGE 188 WILL BE RATIOED BY $\left(\frac{25665}{31461} = .815\right)$

THE DIRECT END LOAD IS DISTRIBUTED IN PROPORTION TO AREAS

$$\text{AS } \frac{A}{\Sigma A}$$

ITEM	END LOAD DUE TO B.M.	DIRECT END LOAD	NET END LOAD
1	-2990	-4100	-7090
4	605	-1128	-523
5	-2460	-3340	-5800
7	2760	-3330	-570
8	2110	-2360	-250

THE SHEAR FLOWS OF PAGE 6 WILL BE RATIOED UP

IN THE RATIO OF $925.3/100$

THE BOOM END LOADS AND PANEL SHEARS ARE
SHOWN ON FOLLOWING PAGE

NOTE:

THE CHANGE IN END LOAD IS NEGLIGIBLE DUE TO DIRECT END LOAD
IS NEGLIGIBLE, A CONSTANT END LOAD OF 14250 LBS IS ASSUMED
APPLIED



REPORT NO. 7-0558-12/2

SHEET No. 193

AIRCRAFT

C/05

TORSION BOX AT
GEAR BOX CUT OUT

PREPARED BY

DATE _____

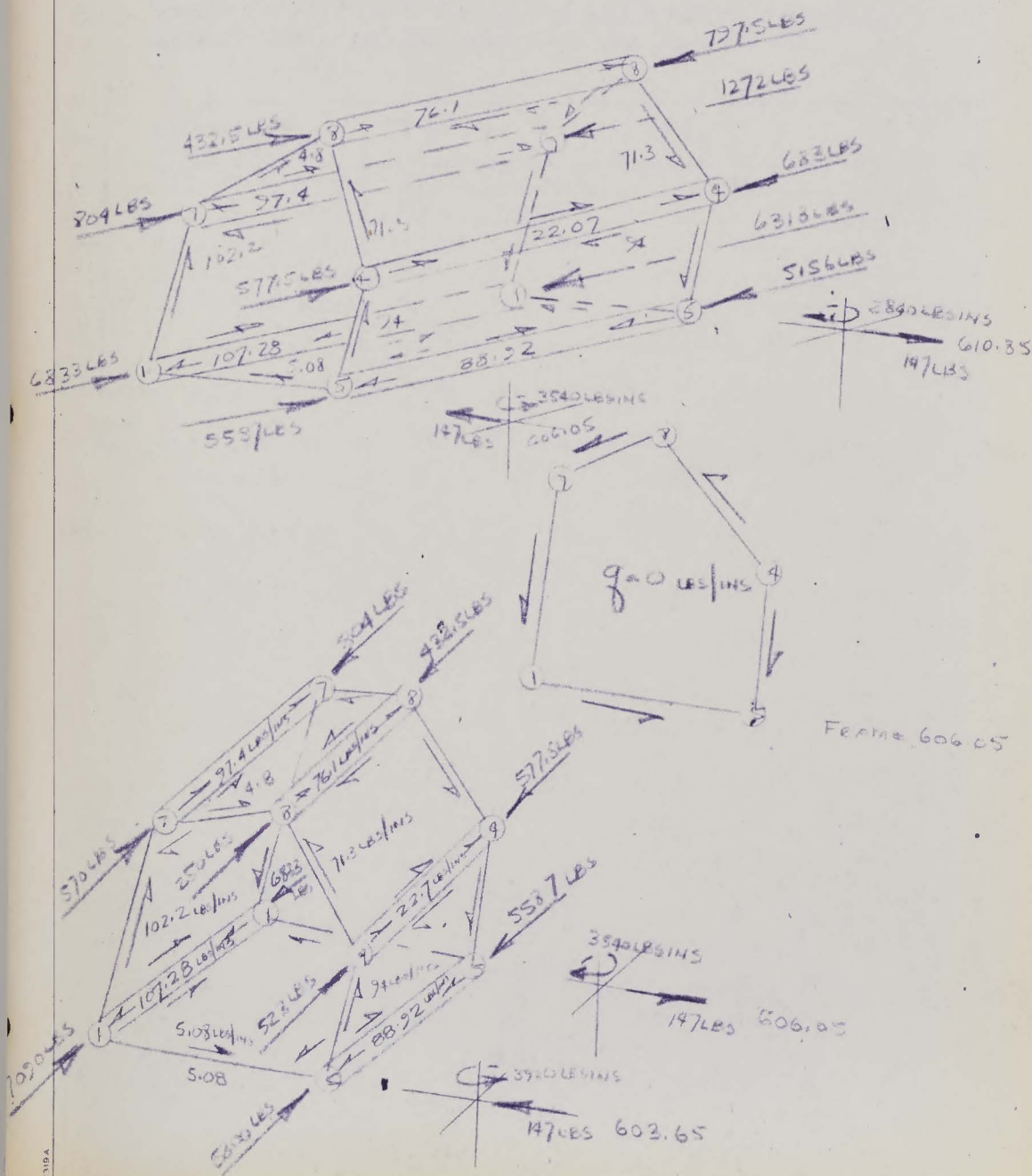
A. FERGUSON

APR 56

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Sketch of Boom End Loads and Panel Shears - Case 5-ULT
Due to Direct End Load & Shears and EM's Associated with End Load





AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/2

SHEET NO. 194

AIRCRAFT:

C105

TORSION BOX AT
GEAR-BOX CUT OUT

PREPARED BY

DATE

A. FERENC

APR/56

CHECKED BY

DATE

ROOM END LOADS AND PANEL SHEARS CASE S-ULT
DUE TO DIRECT END LOAD AND ITS ASSOCIATED SHEARS & RM'S
CHECK BALANCE AT 610.35 FWD

END LOAD = $777.5 + 1272.5 + 683 + 631.8 + 515.6 = 14227$
SHOULD BE 14250 Ref SHT 192 CHECK OK

Item	END LOAD SHT 28	Z SHT 23	M _y	V SHT 23	M _z
1	631.8	2.1725	-1.720	2.305	-13200
4	683	-1.61	1100	2.88	1370
5	515.6	2.412	-11370	2.66	13800
7	1272	-2.43	2160	1.73	-2260
8	777.5	-2.66	2130	2.405	1915
Σ			-13700		-2735

M_y = -12590 SHT 191 CHECK OK

M_z = 2890 CUBINS SHT 193 CHECK OK.



REPORT NO. 7-05558-1212

SHEET No. 195

AIRCRAFT:

0105

TORSION BOX AT
GEAR BOX CUT OUT

PREPARED BY

DATE _____

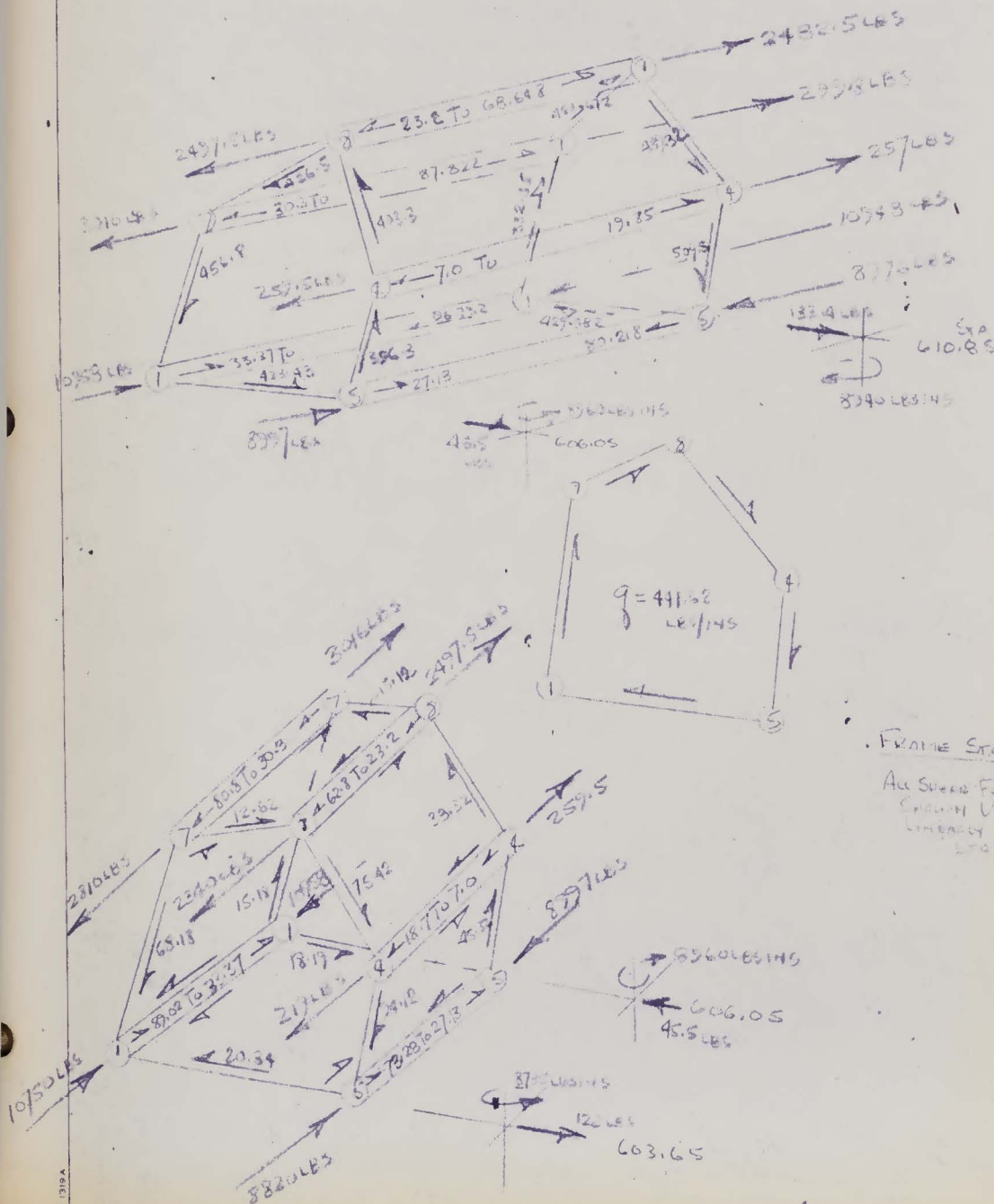
A. FERENC

Apr 156

CHECKED BY

DATE _____

SKETCH SHOWING NET PANEL SHEARS & ROOM END LOADS U/LT
FOR CASE 5 COMPLETE
REF SHTS 187, 190, 193



FRANK STAGGOS

All Sweet Flowers
Grown Val
Linn
Linn



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/2

SHEET NO. 196

AIRCRAFT:

C105

TORSION BOX AT
GEAR BOX CUT OUT

PREPARED BY

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DATE

REDISTRIBUTION OF END LOAD

CASE 5 U/L - DUE TO U/LT SHEARS & ASSOCIATED E/M ONLY
BETWEEN STA 603.65 & 596.45 ONLY.

THE DIFFERENCE IN THE ROOM END LOADS AT STA 603.65
DUE TO CHANGE IN SECTION AT STA 603.65 IS ASSUMED
TO BE DISSIPATED BETWEEN STA 603.65 AND 596.45.
THE SECTION PROPERTIES FOR THIS PURPOSE WILL BE
ASSUMED CONSTANT BETWEEN STA 603.65 FWD & 596.45,
WITH THE SECTION AT STA 603.65 FWD ASSUMED BEING
CONSTANT.

END LOADS AT STA 603.65 FWD FOR SECTION PROPERTIES SEE SHEET 5A.

$I = 9.74 \text{ in}^4$

Item	Area	$\bar{z}$	$A\bar{z}$	I	M/I	$\frac{M A \bar{z}}{I}$	$\frac{M A \bar{z}}{I}$	$\bar{y}$	$\frac{M \bar{z}}{I}$
1	.45	1.235	.556	2.461	2220	-2320	5450	2.825	2000
2	.156	3.545	.553	A	A	2370	3350	.81	-1320
3	.1234	5.163	-.638	Y	Y	2060	10620	.60	1225
4	.1236	1.645	-.208	Y	Y	736	1357	2.93	2155
5	.3656	1.977	+.723	2.1461	3230	-2335	4620	2.71	-6230
Σ							313.97		3140

THE END LOADS AT STA 603.65 AFT. IS GIVEN ON PAGE 193



AVRO AIRCRAFT LIMITED
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TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/R

SHEET NO. 198

AIRCRAFT:

C105

TORSION BOX AT
GEAR BOX CUT OUT

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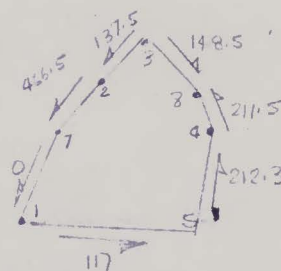
DATE

CASE S-VLT

DISTRIBUTION OF BODILY ENLOADS FROM R.M. ASSOCIATED WITH VLT CHECKS

STA 596.45 - 603.65

ITEM	ENLOAD STA 596.45	ENLOAD STA 603.65	ΔP	ΔX	$\frac{\Delta P}{\Delta X}$	$q = \sum \frac{\Delta P}{\Delta X}$
1	2820	+3660	340	7.20	117	0
5	-2335	+3020	685		95.3	117
4	736	-742	-6		-7.835	212.3
8	0	-2590	-2590		-360	211.465
3	2060	0	2060		+286	-148.535
2	2370	0	2370		329	137.465
7	0	-3380	-3380	7.20	-468	466.465
						0



$$\begin{aligned} \sum FV &= 212.3 \times 3.822 + 211.5 \times 1.07 - 148.5 \times 2.25 - 137.5 \times 1.22 - 466.5 \times 1.23 - 117 \times 0.355 \\ &= 812 + 226 - 334 - 168 - 573 - 39.2 \\ &= 1038 - 1078.92 \end{aligned}$$

SHOULD BE ZERO CHECK OK.

$$\begin{aligned} \sum FH &= 117 \times 5.545 + 212.3 \times 2.2 + 148.5 \times 3.55 - 211.5 \times 4.75 - 137.5 \times 1.91 - 466.5 \times 1.53 \\ &= 648 + 467 + 276 - 1003 - 194 - 433 = 243.4 \text{ LBS} \rightarrow \end{aligned}$$

$$FH \text{ SHOULD EQUAL } \frac{\Delta I_2}{L} = \frac{4115 - 3170}{7.2} = \frac{1645}{7.2} = 228 \text{ LBS}$$

THIS IS CONSIDERED SATISFACTORY



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MALTON - ONTARIO

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AIRCRAFT:

C105

TORSION BOX AT
GEAR BOX CUT OUT

REPORT NO. 7-0558-12/2

SHEET NO. 199

PREPARED BY

DATE

A. FERGUSON

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CASE 5 ULT- VERT SHEARS & B.M.'S ONLY.

DISTRIBUTION OF BMD LOADS IN BOOM STAS 596.45 TO 603.65

$$m_1 = 5.545 \times 3.822 - 2.095 \times 0.235 = 21.2 - 0.70 = 20.5 \text{ INS}^2$$

$$m_2 = 3.822 \times 2.33 - 0 \times 2.11 = 8.9 \text{ INS}^2$$

$$m_3 = 2.33 \times 1.07 - 0 \times 1.855 = 2.5 \text{ INS}^2$$

$$m_4 = 3.32 \times 1.855 - 0 \times 1.07 = 6.15 \text{ INS}^2$$

$$m_5 = 3.32 \times 1.41 - 0 \times 2.10 = 4.67 \text{ INS}^2$$

$$m_6 = 2.10 \times 2.34 - 0.87 \times 1.41 = 4.92 - 1.23 = 3.69 \text{ INS}^2$$

$$m_7 = 5.885 \times 3.435 - 3.785 \times 1.095 = 20.1 - 4.15 = 15.95 \text{ INS}^2$$

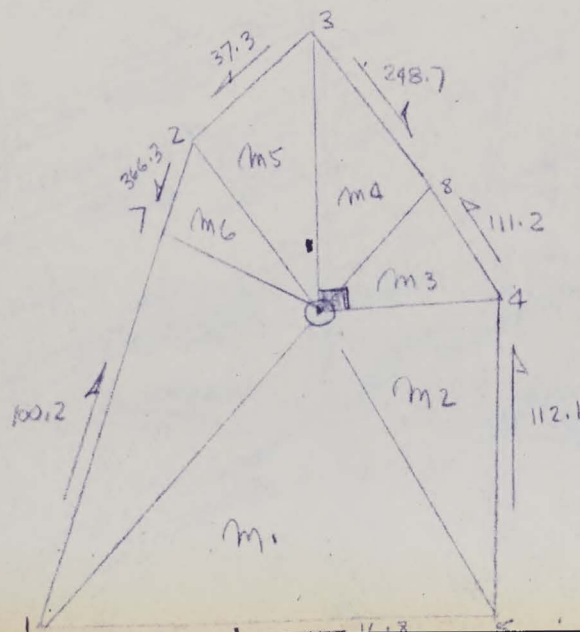
$$2A = 2m = 62.36 \text{ INS}^2$$

TAKING MOMENTS ABOUT O

$$M = 11.7 \times 20.5 + 21.23 \times 8.9 + 2.5 \times 21.5 - 198.5 \times 6.15 + 137.5 \times 4.67 + 466.5 \times 3.69$$

$$= 2400 + 1890 + 529 - 912 + 642 + 1715 = 6264 \text{ LBS INS}^2$$

$$q_0 = \frac{6264}{62.36} = 100.2 \text{ LBS/INS}$$



FOR DIM'S SEE
SHT 196

NET FLOWS
SHOWN



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/2

SHEET NO. 201

AIRCRAFT:

C105

TORSION BOX AT
GEAR BOX CUT OUT

PREPARED BY

A. FEEHNC

DATE

Apr/56

CHECKED BY

DATE

REDISTRIBUTION OF BOOM END LOADS CASE 5 ULT
DUE TO VERT SHEARS & ASSOCIATED B.M ONLY
BETWEEN STA 60.85 & 615.65.

THE BOOM END LOADS ARE ASSUMED DISSIPATED OVER
ONE BAY. THE SECTION AT STA 610.85 AFT IS ASSUMED
TO EXTEND TO 615.65.

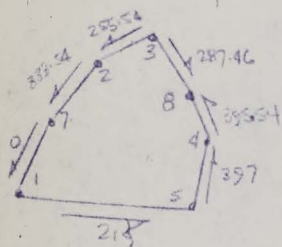
END LOADS AT STA 610.85

B.17 = -39883 IN LBS REF SHT 180

SINCE THE SECTION PROPERTIES AT 603.65 FWD AND 610.85 AFT
ARE THE SAME, THE END LOADS OF SHT 196 WILL BE RATIO
UP ON THE BASIS OF $\left(\frac{29883}{31461} = 1.268\right)$

THE END LOADS AT STA 610.85 FWD ARE OBTAINED FROM SHT 190

Item	END LOAD STA 610.85	END LOAD STA 615.65	ΔP	ΔX	$\frac{\Delta P}{\Delta X}$	$\sum \frac{\Delta P}{\Delta X}$
1	4630	3580	1050	4.8	219	0
5	-3820	2965	355	↑	178	219
4	+940	-933	7		1.46	-397
8	3280	0	3280		683	395.54
3	0	-2610	-2610		-543	287.46
2	0	-3010	-3010	↓	-628	-255.54
7	4270	0	4270		890	883.54
						0 Flow is Considered



CHECK BALANCE

$$\sum F_V = 397 \times 2.822 + 395.54 \times 1.07 - 287.46 \times 2.25 - 255.54 \times 1.22 - 883.54 \times 1.23 - 219 \times 0.935$$

$$= 1520 + 423 - 646 - 312 - 1085 - 7.35 = 1943 - 2050.35$$

CONSIDERED TO BE SATISFACTORY

$$\sum F_H = 219 \times 5.545 + 397 \times 2.2 + 287.46 \times 1.855 - 395.54 \times 4.75 - 255.54 \times 1.91 - 883.54 \times 1.23$$

$$= 1215 + 87.3 + 533 - 188 - 360 - 811 = 476.3 \text{ LBS}$$



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MALTON - ONTARIO

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AIRCRAFT:

C105

TORSION BOX AT
GEAR BOX CUT OUT

REPORT NO. 7-0559-12/2

SHEET NO. 202

PREPARED BY

DATE

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Apr/56

CHECKED BY

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REDISTRIBUTION OF BOOM END LOADS CASE 5 UPT.
DUE TO WEAT SHEARS & ASSOCIATED B.M.'S ONLY.
STA. 610.35 TO 615.65

SOLVING FOR q_0

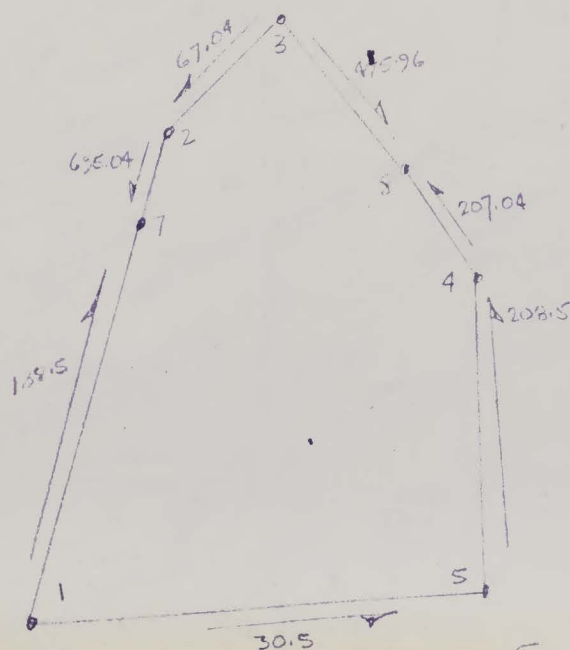
FORGED END SAT 199 TAKING MOMENTS ABOUT 'O' USING BASIC
DIAGRAM OF SAT 201

$$M = 219 \times 20.5 + 357 \times 8.9 + 395.54 \times 2.5 - 287.46 \times 6.15 + 255.46 \times 4.67 + 583.59 \times 3.69$$

$$= 4500 + 3530 + 990 - 1765 + 1190 + 3260 = 11705 \text{ LBS IN.}$$

$$q_0 = \frac{11705}{62.36} = 188.5 \text{ LBS IN.}$$

NET SHEAR FLOWS



Panel End Loads & Panel SHEARS ARE SHOWN ON FOLLOWING PAGE



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/2

SHEET NO. 204

AIRCRAFT:

C105

TORSION BOX AT GEAR
BOX CUT OUT

PREPARED BY

A. FERENC

DATE

APR/56

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REDISTRIBUTION OF ROOM END LOADS CASE 5ULT DUE TO DIRECT END LOAD ONLY.

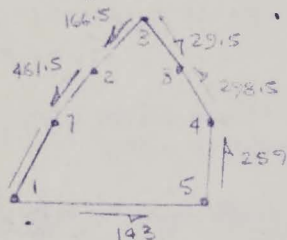
STA 603.65 TO 596.45.

DIRECT END LOAD AT STA 610.85 & 603.65 = 14250 LBS See Note
PAGE 192

THE END LOADS AT STA 603.65 AFT ARE GIVEN ON PAGE 192.
THE DIRECT END LOADS AT STA 603.65 FWD ARE FOUND IN THE
SAME MANNER REF TO SECTION PROPERTIES PAGE 54

	END LOAD STA 596.45	END LOAD STA 603.65	ΔP	ΔX	$\frac{\Delta P}{\Delta X}$	$Q = \sum \frac{\Delta P}{\Delta X}$
1	5130	4100	1030	7.2	-143	0
5	4175	-3340	835	↑	-116	-143
4	-1412	-1128	-284		-39.5	-259
8	0	-2360	2360		328	-298.5
3	-1410	0	-1410		-196	29.5
2	-2125	0	-2125	↓	-295	-166.5
7	0	-3330	3330	7.2	468	-461.5

0 CLOSURE
CONSIDERED
SAT. STA. 1004.



$$\sum FV = 259 \times 3.822 + 298.5 \times 1.07 - 29.5 \times 2.25 - 166.5 \times 1.22 - 461.5 \times 1.23 - 143 \times 0.335$$

$$= 990 + 319 - 66.5 - 203 - 568 - 47.8 = 1305 - 942.28 = 466.72 \text{ LBS } \uparrow$$

$$\sum FH = 143 \times 5.545 + 259 \times 2.2 + 29.5 \times 1.855 - 298.5 \times 1.475 - 166.5 \times 1.41 - 461.5 \times 1.23$$

$$= 793 + 570 + 54.3 - 440.5 - 235 - 423 = 904.8 - 804.5 = 100.3 \text{ LBS } \rightarrow$$



AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C105

TORSION BOX AT
GEAR BOX CUT OUT

REPORT NO. 7-0558-12/2

SHEET NO.

205

PREPARED BY

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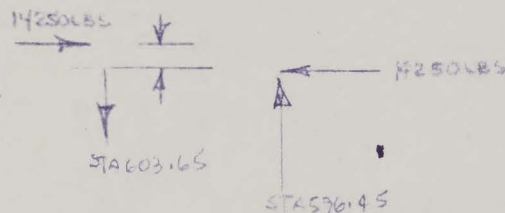
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DATE

REDISTRIBUTION OF BOOM END LOADS CASE 5 ULT
DUE TO DIRECT END LOAD ONLY
STA 596.95 TO 603.65

CHECK BALANCE

FROM PAGES 133, 54 THE RELATIVE VERT POSITIONS OF CG ARE OBTAINED
 $2.35 - 2.115 = .235$



THEREFORE MOMENT IS INDUCED OF $14250 \times .235 = 3350 \text{ LBS IN}$
THE UNBALANCED VERT LOAD = 466.72 LBS
THE UNBALANCED MOMENT IS REACTED BY SHEARS AS SHOWN
MOMENT FROM COUPLE = $7.2 \times 466.72 = 3350 \text{ LBS IN}$ CHECK OK.

THE OFFSET IN POSITIONS OF CG IN HORIZONTAL = $3.72 - 3.67 = .05$
MOMENT = $.05 \times 14250 = 712.5 \text{ LBS IN}$

THE SIDE MOMENT IS REACTED IN SAME MANNER AS THE VERT MOMENT.

UNBALANCED HORIZ LOAD = 100.3 LBS

MOM = $7.2 \times 100.3 = 722 \text{ LBS IN}$ CHECK SATISFACTORY.

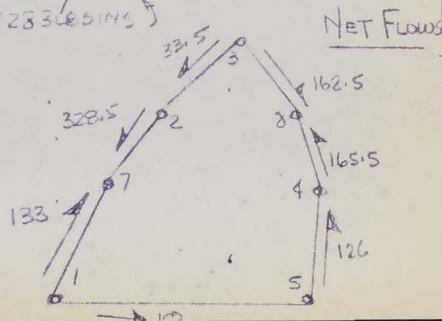
SOLVING FOR g_0 Ref Areas Page 199 & Flaps Page 204

$$M = 142 \times 20.5 + 253 \times 8.9 + 293.5 \times 2.5 - 29.5 \times 6.15 + 166.5 \times 4.67 + 161.5 \times 3.69$$

$$M = 2930 + 2210 + 747 - 181 + 777 + 1700 = 8283 \text{ LBS IN}$$

$$g_0 = \frac{8283}{62.36} = 133 \text{ LBS IN}$$

THE BOOM END LOADS AND PANEL SHEARS ARE SHOWN ON FOLLOWING PAGE





AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 1-0558-12/2

SHEET NO. 207

AIRCRAFT:

C105

Torsion Box At Gear
Box Cut Out

PREPARED BY

A. FERENC

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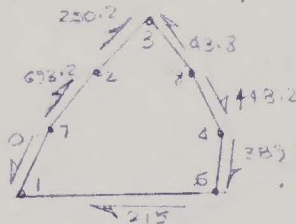
DATE

BOOM END LOAD REDISTRIBUTION CASE 507
BETWEEN STA 610.85 & 615.65
DUE TO DIRECT END LOAD ONLY

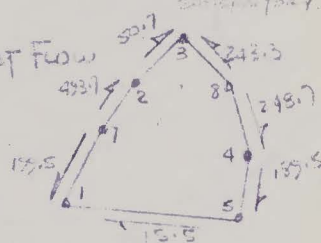
SINCE THE SECTIONS AT STA 610.85 ARE THE SAME AT STA 610.85
AND ALSO THE END LOAD REMAINS THE SAME, THE LOAD IN EACH
BOOM IS THE SAME AS THAT ON PAGE 204

ITEM	END LOAD STA 610.85	END LOAD STA 615.65	ΔP	Δx	$\frac{\Delta P}{\Delta x}$	$q = \sum \frac{\Delta P}{\Delta x}$
1	4160	-5130	1030	4.8	215	0
5	-3340	-4175	835		174	215
4	-1128	-1412	284		59.2	389
8	-2360	0	-2360		-492	448.2
3	0	-1410	1410		294	-43.8
2	0	-2215	2125		443	250.2
7	-3330	0	-3330	4.3	-695	693.2

BASIC
FLOW



Net Flow



$$\sum F_v = 389 \times 3.872 + 448.2 \times 1.107 - 43.8 \times 2.25 - 250.2 \times 1.22 - 693.2 \times 1.23 - 215 \times 0.235 \\ = 1485 + 480 - 98.8 - 305 - 853 - 7.2 = 1965 - 1264 = 701 \text{ LBS } \uparrow$$

$$\sum F_H = 215 \times 5.546 + 389 \times 2.0 + 43.8 \times 1.855 - 448.2 \times 1.475 - 250.2 \times 1.41 - 693.2 \times 0.23 \\ = 1190 + 85.7 + 81.5 - 215 - 352 - 693 = 1357.2 - 1210 = 147.2 \text{ LBS } \leftarrow$$

By inspection OF SHTS 204-205 It can be seen THAT THE VALUES
ON THOSE SHTS NEED TO BE MULTIPLIED BY $\frac{7.2}{4.8}$ TO OBTAIN THE
ABOVE VALUES.

$$\therefore q_0 = \frac{7.2}{4.8} \times 133 = 199.5 \text{ LBS/IN } \leftarrow$$

BOOM END LOADS AND PANEL SHEARS ARE SHOWN ON FOLLOWING PAGE



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

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AIRCRAFT:

C105

TORSION BOX AT
GEAR BOX CUT OUT

REPORT NO. 7-0558-12/2

SHEET NO. 208

PREPARED BY

DATE

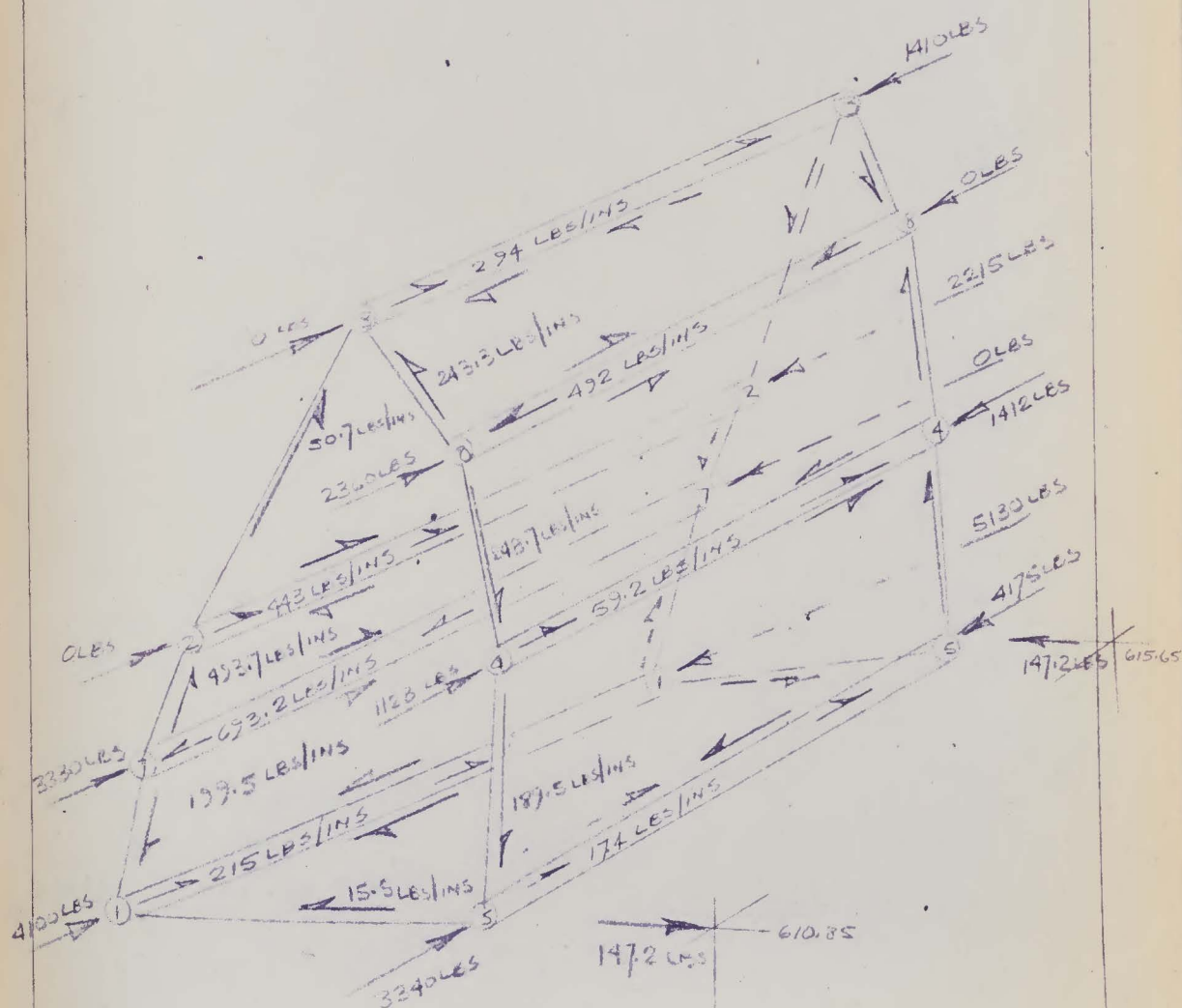
J. F. FERRER

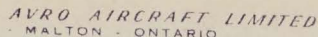
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SKETCH OF BOOM END LOAD REDISTRIBUTION CASES-ULT
DUE TO DIRECT END LOAD ONLY
STA 610.85 TO 615.65





TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/2

SHEET No 210

AIRCRAFT:

Q105

TORSION BOX AT
GEAR BOX CUT OUT

PREPARED BY

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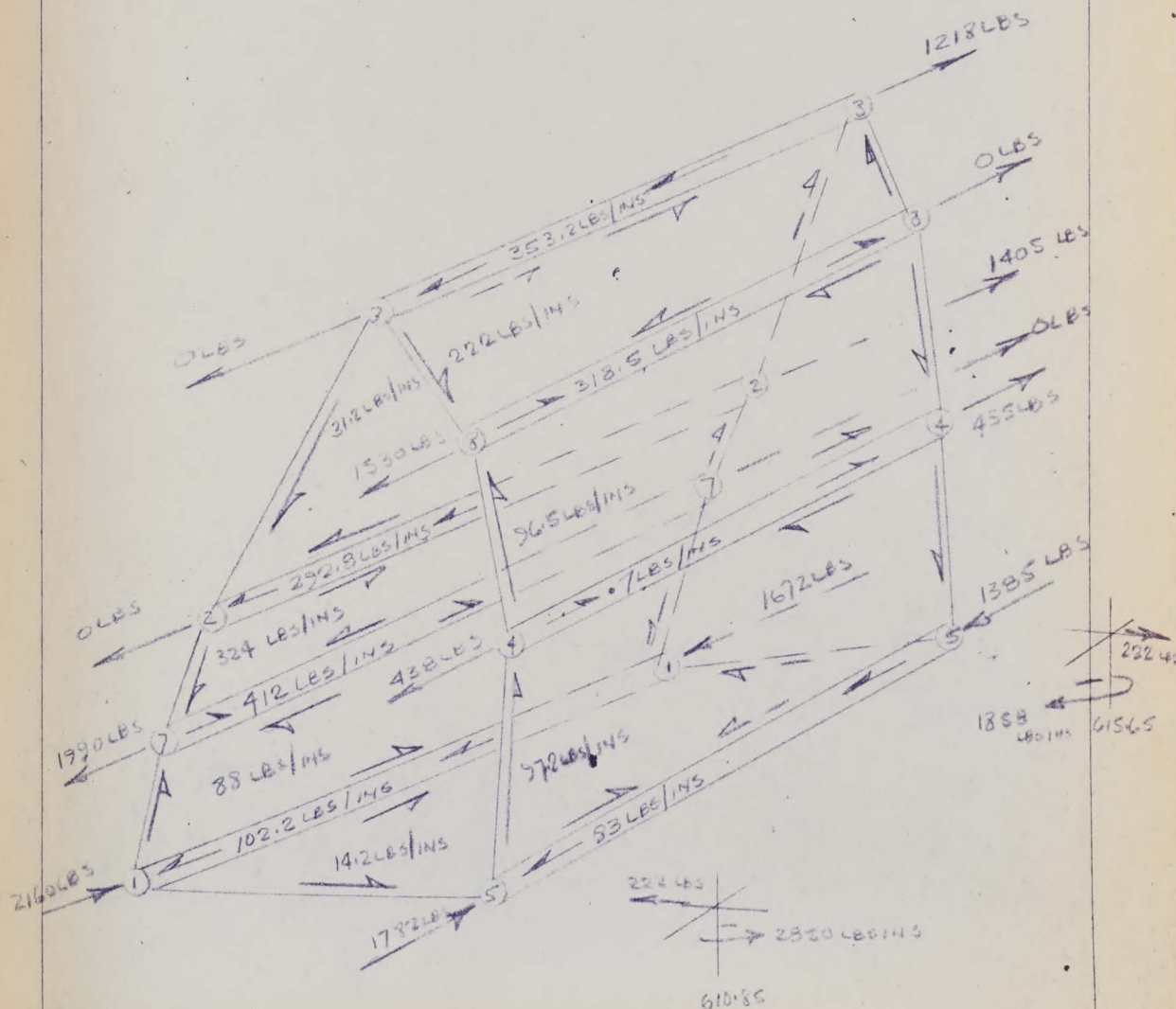
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DATE _____

Sketch of Room End Load Redistribution Case 5 ult.
Due To B.M's Associated With End Load Only.
Between STA 610.85 & 615.65

B.17 = -18590 REF SHT 191

B.M = -18590 Ref SHT 191
The Ketch of SHT 38 will be Ratio'd By $\left(\frac{18590}{39882 (\text{SHT } 36)} = .467 \right)$





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REPORT NO. 7-0558-12/2

SHEET NO. 211

AIRCRAFT:

C105

Torsion Box A-Gear
Box Cut Out

PREPARED BY

DATE

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APR 56

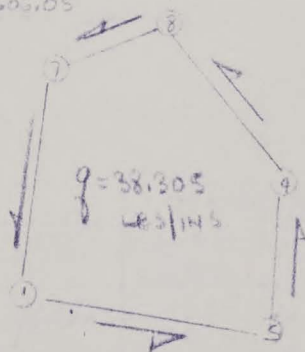
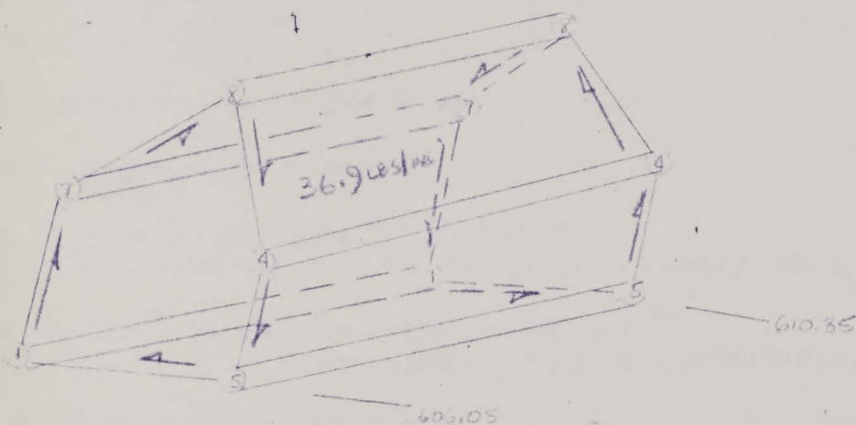
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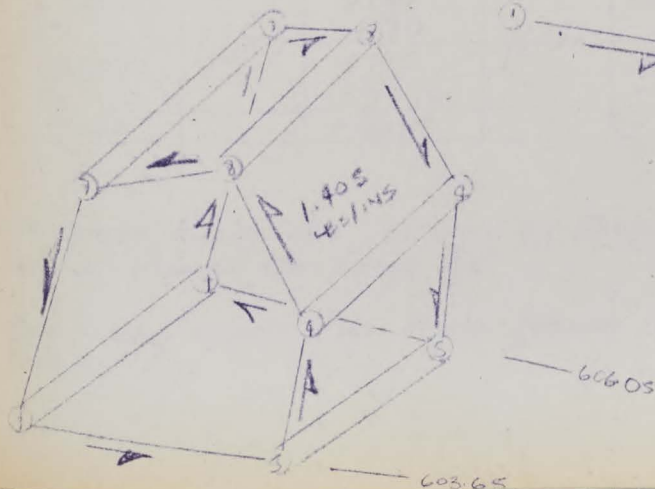
CONSIDERING CASE 2 BETWEEN STA 603.65 & 610.85
TORQUE DISTRIBUTION ONLY

SINCE TORQUE IS PRIMARILY A FUNCTION OF THE INTERNAL PRESSURE REF SHT 185
THE TORQUE DIAGRAM OF SHT 187 WILL BE RATIO'D BY $\frac{-2.10}{24.85} = -.0845$

THIS IS SHOWN BELOW.



FRAME STA 606.05





AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-12/2

SHEET NO. 212

AIRCRAFT:

C105

TORSION BOX AT
GEAR BOX CUT OUT

PREPARED BY:

A. FERENC

DATE

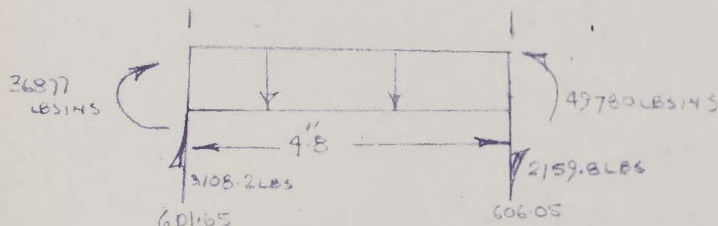
Apr/56

CHECKED BY

DATE

B.M.'S AT STA 603.65, 610.85 & 606.05
DUE TO VERT SHEARS ONLY.

See Ref ST 153



$$\Delta V = 3108.2 - 2159.8 = 948.4 \text{ LBS}$$

$$U.D.L = \frac{948.4}{4.8} = 197.5 \text{ LBS/IN}$$

CHECK BALANCE ON MOMENTS AT STA 606.05

$$36877 + 2108.2 \times 4.8 - 948.4 \times 2.4 = 51797 - 2280 = 49517 \text{ CHECK SATISFACTORY}$$

$$\text{SHEAR AT STA } 603.65 = 3108.2 - 474.2 = 2634 \text{ LBS}$$

$$\text{B.M. " " " " } = 36877 \times 197.5 \times \frac{2.4^2}{2} + 3108.2 \times 2.4 = 43785 \text{ LBS/IN} \text{ COMPOUND}$$

$$\text{B.M. AT STA } 610.85 = 58076 \text{ LBS/IN} \text{ SEE REF ST 153, SHEAR } = 1223.12 \text{ LBS}$$

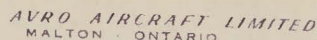
END LOADS AT VARIOUS STATIONS

THESE ARE FOUND BY FACTORING THE END LOADS ON PAGE 154

Item	STA 603.65 FWD		STA 606.05		STA 610.85	
	ENDLOAD	MZ	ENDLOAD	MZ	ENDLOAD	MZ
1	5020		5780		6760	
4	-1030	6650	-1170	7600	-1370	8800
5	4200		4770		5575	
7	-4700		-5330		-6240	
8	-3600		-4085		-4780	

THE SHEAR FLOWS ARE OBTAINED BY FACTORING THE UNIT SHEAR FLOWS OF PAGE 45

BOOM END LOADS AND PANEL SHEARS ARE SHOWN ON FOLLOWING PAGE.



TECHNICAL DEPARTMENT

SHEET No. 215

AIRCRAFT:

2105

TORSION BOX AT
GEAR BOX CUT OUT

PREPARED BY

DATE _____

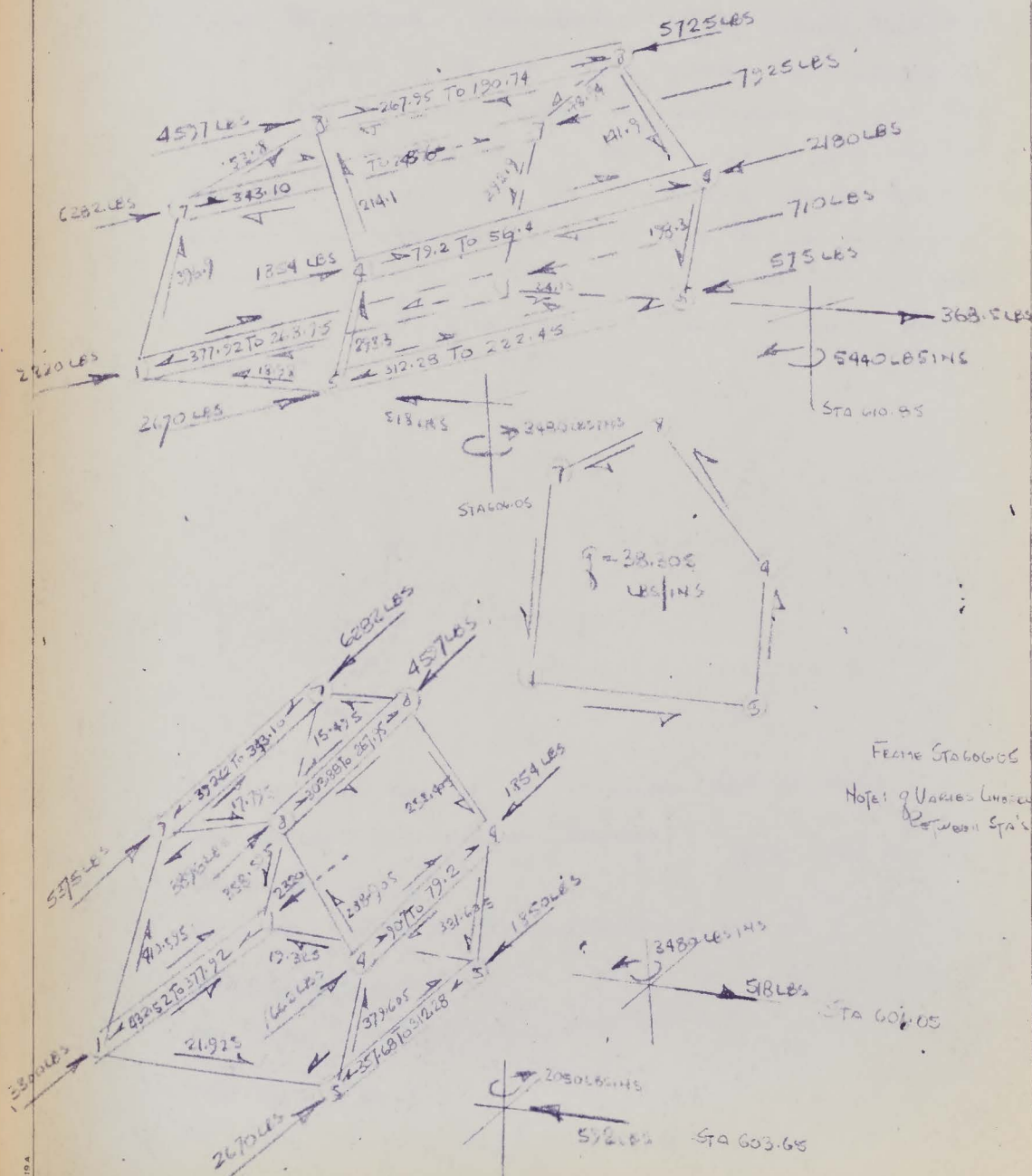
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SKETCH OF NET BOOM END LOADS & PANEL SHEARS
CASE 2 COMPLETE BETWEEN STA'S 601.65 FWD & 610.85 AFT
REF SHTS. 46, 98 & 99



TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-12/2

SHEET NO. 216

AIRCRAFT:

C105

TORQUE BOX

PREPARED BY

DATE

G.L. SLADICK

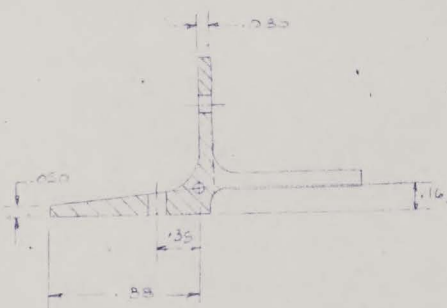
FEB. 1936

CHECKED BY

DATE

TORQUE BOX JOINTS - STAS 606.05 AND 625.25

SINCE THE DESIGN REQUIREMENTS FOR SERVICE DOORS # 1 AND # 2 AND THE PUNED PANEL DIFFER THE REQUIRED TORQUE BOX EXTRUSION (BONE LANDING) CONSISTS OF THREE SEPARATE SECTIONS. EACH SECTION IS SPACED BY TWO BATH TUB FITTINGS AT THE TRANSVERSE BEAM STAS 606.05 AND 625.25. BOTH JOINTS ARE TO BE DESIGNED TO CARRY AN END LOAD (TENSION OR COMPRESSION) EQUIVALENT TO THE TENSILE STRENGTH OF THE X-HATCHED AREA SHOWN BELOW. (REF J. MAINWING)



LET A_T THE AREA OF THE X-HATCHED SECTION ABOVE THEN CONSIDER THE FOLLOWING SECTIONS:

REF SHY 11

STAS 531.65 - 606.05

$$A_T = \text{AREA ITEMS (2) + (4)} = .0623 + .0740 = .1363 \text{ in}^2$$

STAS 606.05 - 625.25

$$A_T = \text{AREA ITEMS (2) + (4)} = .1363 \text{ in}^2$$

STAS 625.25 - 641.43

$$A_T = \text{AREA OF ITEMS (2) + (4)} = .0680 + .0345 = .1025 \text{ in}^2$$

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

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TORQUE BOX JOINTS 656.05 AND 625.75

USE SMALLER AREA - AT 1363 IN² (SEE J. MANNING)

DEDUCT 2 1/2 DIA RIVET HOLES

RIVET HOLE DEPTH - $SEN\ 3.03 \times .050 + .53122 \times .11$

$= .050 + .066 = .116$

RIVET HOLE DEPTH - $WED\ SIDE \times .080$

RIVET HOLE AREA - $(.116 + .08) \times .125 \times .125 = .0243\ IN^2$

NET AREA - $.1363 - .0243 = .112\ IN^2$

MATERIAL ALLOWANCES

THE 1/8 TORQUE BOX EXTENSION IS MADE FROM 75 STS. MAT'L
FROM ALC-5

FTW - LONGITUDINAL - 80-83,000 PSI

- TRANSVERSE - 70-74,000

FTY - LONGITUDINAL - 72-75,000

- TRANSVERSE - 61-65,000

MIN. PROPERTIES - FTW - 70,000

FTY - 60,000

$FTY \times \frac{.1363}{.1125} < FTW$ SO THAT FTW GOVERNS

DESIGN END LOAD USING MIN. MAT'L PROPERTIES - $70,000 \times .112$

= 7826 LBS SAY 7825 LBS

NOTE - ONLY THE TENSION LOAD CASE NEED BE CONSIDERED

SINCE THE COMPRESSION CASE WILL PRODUCE LOWER

INDUCED MOMENTS ON THE ATTACHMENTS.

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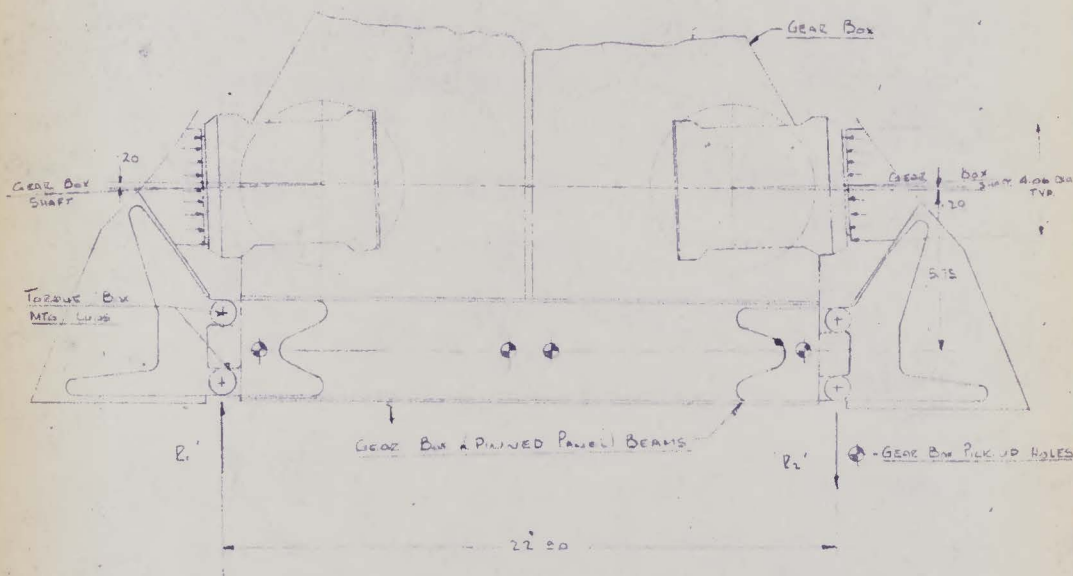
Jan. 1964

CHECKED BY

DATE

GEAR BOX DIAGRAMS E AND F

LOADING DUE TO SHROUD PRESSURE



BOTH SHROUDS ARE CUT AWAY AND FITTED WITH DECKS TO ACCOMMODATE THE GEAR BOX DECK. SINCE THE ENDS OF THE GEAR BOXES ARE EXPOSED TO THE SHROUD PRESSURE AND BECAUSE THE GEAR BOX SHAFTS FAIL TO LINE UP (1.40 VERTICAL OFFSET) AN UNBALANCED MOMENT IS INDUCED IN THE FRONT AND REAR PINNED PANEL BEAM. THIS UNBALANCED MOMENT MAY BE KEPT BY FORCES R_1' AND R_2' AT THE GEAR BOX MOUNTING LUG PICKUPS.

TWO LOADING CASES ARE TO BE CONSIDERED

- (1) SHROUD PRESSURE = 25 P.S.I. (BOTH SIDES)
- (2) SHROUD PRESSURE DIFFERENTIAL = 4.1 P.S.I.

REF. J. MANNING

ASSUME PRESSURE ON ONE SIDE = 25 P.S.I.

AND " " " " OPPOSITE " " = 20.9 "

NOTE - TOP TIE ON GEAR BOXES WILL BE NEGLECTED (CONSERVATIVE)

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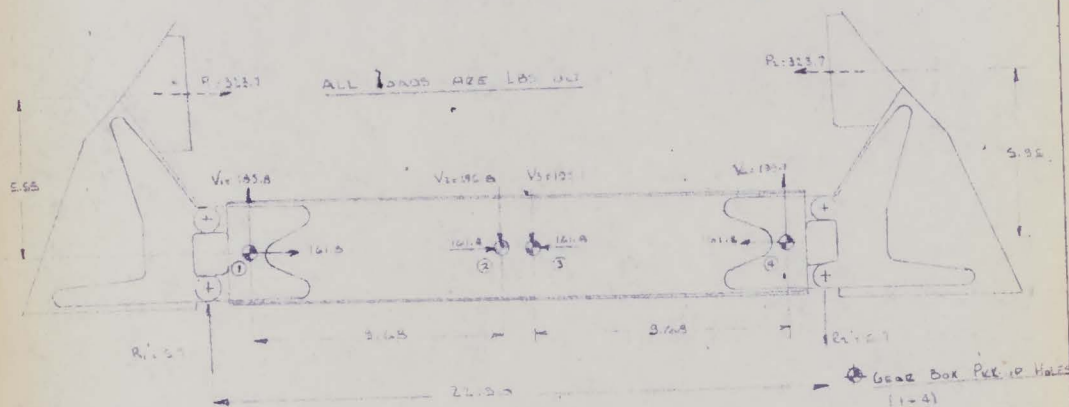
JAN. 1956

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DATE

GEAR BOX DIAPHRAGMS E AND F

LOADING DUE TO SHROUD PRESSURE CONT'



CONSIDER CASE (1)

LET P_1 AND P_2 = END LOAD ON GEAR BOXES DUE TO SHROUD PRESSURE

M_1 & M_2 = INDUCED GEAR BOX BEAM MOMENTS DUE TO P_1 AND P_2

M_0 = UNBALANCED " " " MOMENT = $M_2 - M_1$

V_1 AND V_2 = VERTICAL SHROUD LOADS AT GEAR BOX PICKUP PINS (1) AND (2) DUE TO M_1

V_3 AND V_4 = " " " " " " " " (3) " (4) " " M_2

R_1' AND R_2' = REACTIONS AT TORQUE BOX MTG. LUGS DUE TO M_0

THEN WITH REF. TO THE ABOVE DIAGRAM

EXPOSED AREA OF GEAR BOX = $\pi/4 (4.06)^2 = 2.55 \text{ in}^2$ (CONSERVATIVE AS THE GEAR BOX SHAFT AREA SHOULD BE DEDUCTED)

SHROUD PRESSURE 25 P.S.I.

$P_1, P_2 = 12.95 \times 25 = 323.7 \text{ LBS.}$

$M_1 = 323.7 \times 5.55 = 1732 \text{ IN. LBS.}$

$M_2 = 323.7 \times 5.55 = 1928 \text{ " "}$

$M_0 = 1928 - 1732 = 196 \text{ " "}$

$V_1, V_2 = M_1 / 3.68 = 1732 / 3.68 = 469.8 \text{ LBS.}$

$V_3, V_4 = M_2 / 3.68 = 1928 / 3.68 = 523.1 \text{ "}$

$R_1', R_2' = M_0 / 22.20 = 196 / 22.20 = 8.8 \text{ "}$

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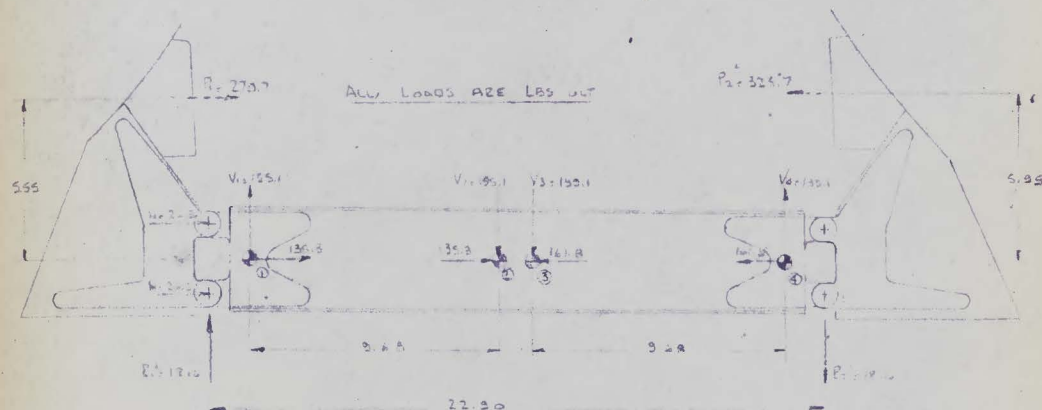
JAN 1950

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Gear Box Diagrams E and F

LOADING DUE TO SHEAR PRESSURE CONT



CONSIDER CASE (2)

SHEAR PRESSURES: 25 PSI AND 20 PSI

EXPOSED AREA OF GEAR BOX = 12.56 in²

$$P_2 = 12.56 \times 25 = 313.7 \text{ LBS}$$

$$P_1 = 12.56 \times 20 = 251.2 \text{ LBS}$$

THEN LET H = THE HORIZONTAL REACTIONS AT THE TORQUE BOX

$$\text{MAINTAINING LOAD} = (P_2 - P_1) / 2$$

$$H = (313.7 - 251.2) / 2 = 31.25 \text{ LBS}$$

$$M_1 = 251.2 \times 5.95 = 1502 \text{ IN LBS}$$

$$M_2 = 313.7 \times 5.95 = 1876 \text{ IN LBS}$$

$$M_0 = 1876 - 1502 = 374 \text{ IN LBS}$$

$$V_1 = V_2 = M_1 / 3.68 = 1502 / 3.68 = 408.1 \text{ LBS}$$

$$V_3 = V_4 = M_2 / 3.68 = 1876 / 3.68 = 510.1 \text{ LBS}$$

$$R_1 = R_2 = M_0 / 22.50 = 374 / 22.50 = 16.6 \text{ LBS}$$

SNAP-LOCK BINDER, 1½ inch capacity

NO. 4872-W

MANUFACTURED IN CANADA BY
THE CHAS. CHAPMAN CO. LIMITED
London - Canada

