

QCY
Avro
CF105
R-70583-12
ANALYST



TECHNICAL REPORT



AVRO AIRCRAFT LIMITED

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/5382/12

SHEET NO. 1-1

AIRCRAFT

SIDE

FIN

PREPARED BY

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INTRODUCTION.GENERAL STRUCTURE

THIS REPORT DEALS WITH THE HINGE FITTINGS AND THE ADJACENT STRUCTURE SUCH AS SPAR #1 AND THE SKIN NEAR THE FITTINGS. THE MAIN JOINT NEAR THE LOCATING HINGE IS ALSO ANALYSED HERE.

THE TRAILING EDGE OF THE FIN IS A BOX LIKE STRUCTURE BETWEEN SPAR #1 AND SPAR #2. THE FITTINGS ARE MOUNTED TO SPAR #1 AND THE SKIN. THE BOX CONTAINS AN INTERNAL CHORDWISE RIB ABOVE & BELOW EACH FITTING.

GENERAL METHOD OF ANALYSIS

THE FITTINGS ARE ANALYSED FOR THE MOST CRITICAL RUDDER LOADS WHICH COMES FROM THE 0.250 CP RUDDER CASE.

SPAR #1 IS ANALYSED FOR THE CRITICAL HINGE LOADS PLUS SHEAR FLOW. UNFORTUNATELY, A RIGOROUS ANALYSIS WHICH WOULD BALANCE ALL LOADS DOES NOT SEEM PRACTICAL. INSTEAD THE CRITICAL REGION OF SPAR #1 NEAR THE CONTROL CUTOUT WILL BE ANALYSED LOCALLY NEAR EACH FITTING. SHEAR FLOWS WILL BE TAKEN EITHER FROM 7/5382/10 OR BY ESTIMATION OF SHEAR FLOW WHERE THEY DO NOT SEEM FEASIBLE.

SPAR #1 SHEAR FLOW GIVEN IN 7/5382/10 ARE NOT REASONABLE IN SOME CASES. FOR EXAMPLE SOME OF THESE SHEAR FLOWS ARE LESS THAN 100 lb/in . HOWEVER, THE SHEAR ON SPAR #1 SHOULD BE APPROX 30% OF THE TOTAL SHEAR ON THE FIN FOR ANY PARTICULAR STATION AS SHOWN IN 7/5382/14 INT 4-18.



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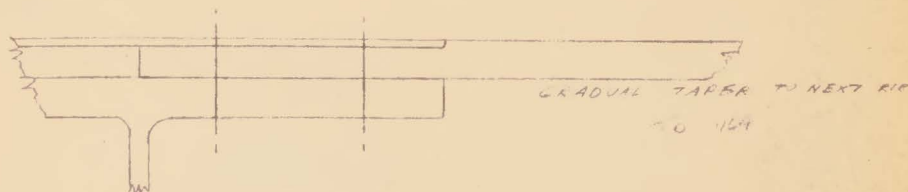
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L. Gardner

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T.E. BOTTOM JOINTBEARING IN STEEL SPLICE PLATE

ASSUMING THAT THE OUTER SPLICE PLATE CARRIES
A LOAD OF 2380^* AND THAT THE INNER
CAP REACTS THE REMAINDER.

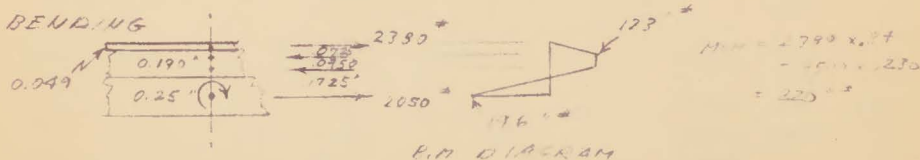
SINCE THIS IS A DOUBLE SHEAR JOINT THE
ALLOWABLE MAY GO UP TO THE FULL F_{bt}

$$\text{i.e. ALLOWABLE} = .25 \times 190,000 \times 0.057 \\ = 2780^*$$

M.S. OK

BOLTS $\neq$ DIA, $F_{tu} = 180,000$ (BOLT #16)

$$\text{SHEAR RATIO} = \frac{2450}{4650} = 0.527$$

BENDING

B.M. DIAGRAM

$$f_b = \frac{123 \times .125}{.000192} = 112,000 \text{ PSI} \quad \text{MODULUS OF RUPTURE} = 306,000$$

$$\text{BENDING RATIO} = \frac{112}{306} = 0.366$$



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Z.E. BOTTOM JOINT

BOLTS

$$M.S. = \frac{1}{\sqrt{R_0^2 + R_b^2}} - 1$$

$$= \frac{1}{\sqrt{.527^2 + .266^2}} - 1$$

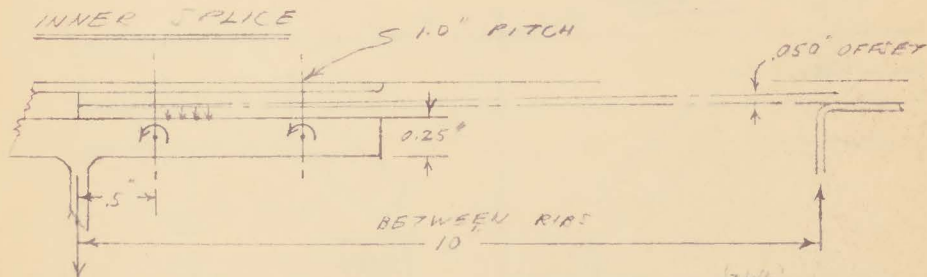
ULT. M.S. = 0.56

SKIN IN BEARING

LOAD = 4500 *

ALLOWABLE FOR $\frac{1}{4}$ SCREW BEARING IN .17 75S-76 = 5820 *
(F₆ 137ksi)

ULT. M.S. = 0.29



LOAD APPLIED TO RIB, LIMIT = $\frac{4500 \times 2 \times .03}{1.364 \times 10} = 33$

B.M. APPLIED TO INNER SPLICE BY RIB = $33 \times .5 = 16.5$

B.M. APPLIED BY BOLTS (SHT 5) = $\frac{220 \times 2}{1.364} = 322$

TOTAL B.M. = 338 (LIMIT)

$f_b = \frac{338 \times 6}{.25^2 \times 0.75 \times \frac{66}{76}} = 37,503$ PSI

NOTE: ANALYSIS IS
PESIMISTIC SINCE
THERE WILL BE
RESTRAINT FROM
SPARS.

REDISTRIBUTION FACTOR AT YIELD (AVRO MANUAL) = $\frac{66}{76}$

$f_b = \frac{4500 \times 2}{1.364 \times .87 \times .25} = 30,010$ PSI

NEGLECTS AMOUNT GIVEN TIMES STEEL STRIP
← CROSS GRAIN

$f_b \text{ calc} = 67,500$ PSI

$f_b = 62,000$ PSI

(LIMIT) M.S. =

ULT WILL NOT BE CRITICAL SINCE YIELDING WILL RELIEVE BENDING

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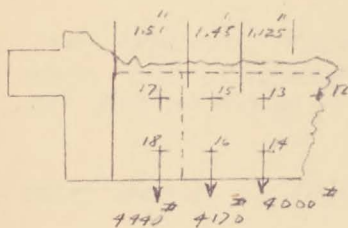
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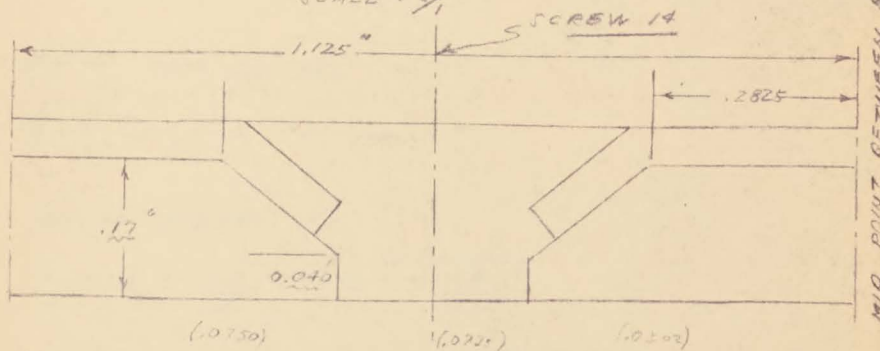
T.E. BOTTOM JOINT

SKIN NET SEC



CONSIDERING NET SEC FROM PT MID WAY BETWEEN
15 & 13 AND MIDWAY BETWEEN 12 & 13

SCALE: 5/1



$$\text{AREA} = 0.040 \times .875 + .565 \times .13 + .155 \times .13$$

$$= 0.1287 \text{ in}^2$$

$$F_c = \frac{4000 \times 2}{.1287} = 62,100 \text{ PSI}$$

$$F_s = \frac{1676}{.1287} = 13,000 \text{ PSI}$$

$$\text{BY MAX'S Q } F_{b \text{ MAX}} = \frac{62,100}{2} + \sqrt{13,000^2 + 31,050^2}$$

$$= 64,700 \text{ PSI}$$

MAT'L 705-T6 ALCLAD $F_{tu} = 72 \text{ KSI}$

* M.S. 11

* (NOTE BENDING OR STRESS CONC. MAY BE PRESENT)

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T.E. BOTTOM JOINT STA 42

STEEL SPLICE - IN TENSION

CONSIDERING TENSION AREA ADJACENT TO
BOLT 13 HALF WAY BETWEEN BOLTS
ON EACH SIDE

$$\text{NET AREA} = (1.125 - 0.25) 0.050 = .0437 \text{ in}^2$$

$$P \text{ TENSION} = 2380 \times 2 = 4760 \text{ lb}$$

$$P \text{ SHEAR} = \frac{1524 + 1676}{2} = 1600 \text{ lb (ASSUMING } \frac{1}{2} \text{ IN ST)}$$

$$f_t = 109,000 \text{ PSI}$$

$$f_s = 36,600 \text{ PSI}$$

WING MOHR'S C

$$\begin{aligned} f_{H \text{ MAX}} &= \frac{f_t}{2} + \sqrt{f_s^2 + \left(\frac{f_t}{2}\right)^2} \\ &= \frac{109,000}{2} \sqrt{36,600^2 + 50,450^2} \\ &= \underline{\underline{112,700 \text{ PSI}}} \end{aligned}$$

STEEL HT TO FCH = 150 KSI

$$\underline{\underline{MS = .33}}$$

A. V. ROE CANADA LIMITED
MALTON - ONTARIO
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AIRCRAFT:

C-145

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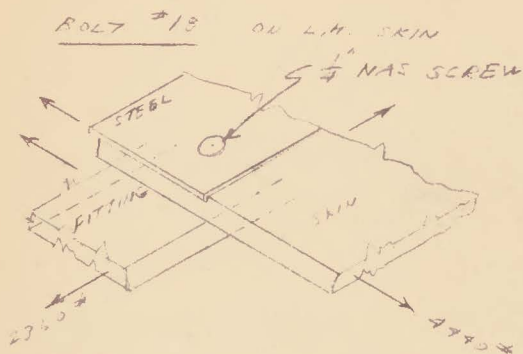
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T.E. BOTTOM JOINT



ASSUMING ABOUT $\frac{1}{2}$
OF 4440 # COMES
OFF ON SHEAR SURFACE
BETWEEN FITTING &
SKIN.

$\therefore$ LOAD ON SHEAR
SURFACE BETWEEN
FIT. & SKIN
 $= \sqrt{2260^2 + 2220^2}$
 $= 3240 \#$

SINGLE SHEAR ALLOWABLE = 4650 #

SHEAR RATIO = $\frac{3240}{4650} = 0.70$

ASSUMING SCREW BENDING LOAD OF: $\frac{4440}{15} \#$ VDL

$\therefore$ B.M. = $\frac{3240 \times .15}{2}$
 $\approx 243 \#$

$f_b = \frac{M C}{I} \approx \frac{243 \times .125}{.000192} = 158,000 \text{ PSI APPROX}$

$F_{t2} = 180 \text{ KSI}$ MODULUS OF RUPTURE = 306 KSI

BENDING RATIO = $\frac{158}{306} = .516$

M.S. = $\frac{1}{\sqrt{R_s^2 + R_b^2}} - 1 = \frac{1}{\sqrt{0.70^2 + 0.516^2}}$

M.S. ≈ 0.15



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TIE BOTTOM JOINT - STA. 42.05 (7-0183-132)

FITTING ATTACHMENT TO L.H. SKIN

SHAPE OF FITTING 1180132 (4 in. dia.)

LOADING 1180132

LOADING 1180132 = 1180 + 6700 = 15424.35.

16 8

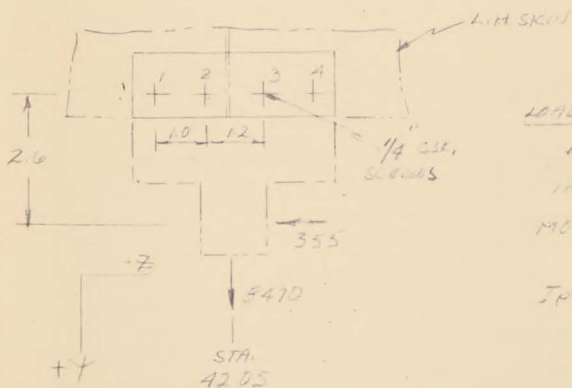
ALLOWED 1180132 3630"

MSI = 3630 - 1

1180

1180132

FITTING ATTACHMENT TO L.H. SKIN



LOADS OF L.H. SKIN ATTACHMENTS

DRAG LOAD = 8470" (REF. PG. 8)

INERTIA LOAD = 355" (REF. PG. 8)

MOMENT IN ATTACHMENTS = 2.6 x 355

= 921 in. lbs.

JA = 5.84

	Z	M/I	LOADING MOMENT Z M/I	P ₁ 8470/4	P ₂ 355/4	P ₄ TOTAL	REMARKS
1	-1.6	150	-240	2120	-89	1880	
2	-1.60		-30			2000	
3	1.60		30			2210	
4	1.6	150	240	2120	-89	2300	2300



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FIN T.E.,

BOTTOM JOINT.

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THE LOADS APPLIED TO THE HINGE FITTING ARE SHOWN ON SHEET 2. THE FOLLOWING ASSUMPTIONS ARE MADE:-

1. THAT SHEAR ON SPAR 1 AND HINGE LOAD ARE ADDITIVE. WORK ON RUDDER DOES NOT SHOW THIS BUT IT IS CONSERVATIVE.

2. THAT CHORDWISE LOADS APPLIED BY HINGE TO BOLTS 1, 2, 26, 27, 31, 32, 36 & 37 (I.E. OUTB'D OF SPLICE) ARE CARRIED FORWARD IN SKIN AND THROUGH MAIN SKIN SPLICE (SHTS. 5.3 & 5.8).

3. THAT END LOAD FROM PTS. 3 & 4 OF T/E BOX (SHTS. 5-1 & 5-2) ARE CARRIED THROUGH FITTING.

4. THAT BOLTS 1, 2 & 26, 27, 31, 32, 36 & 37 TAKE LOAD INTO FITTING FROM OUTBOARD SKIN AS ASSUMED IN SPLICE CALCS. (SHTS 5-2; 5-3; 5-8).

$$\text{LOAD ON 1 \& 2} = \frac{68200}{22} \times \frac{1}{2}^* = 1550 \#.$$

* THIS ASSUMES HALF LOAD TAKEN ACROSS SPLICE BY STEEL PLATE.

$$\text{LOAD ON 26, 27, 31, 32, 36 \& 37} = \frac{75800}{26 \times 2}^* = 1457\#$$



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 Σ NO OF BOLTS ON INBOARD SIDE OF SPLICE

$$= \overset{3,4,5}{(3 \times 4.50)} + \overset{8,9,10}{(3 \times 3.84)} + \overset{13,14,15}{(3 \times 2.84)} + \overset{18,19,20}{(3 \times 1.66)} + \overset{23,24,25}{(3 \times .66)}$$

$$= 13.5 + 11.51 + 8.52 + 4.98 + 1.98 = 40.49$$

$$\therefore \bar{Y} \text{ OF BOLTS} = \frac{40.49}{24} = 1.686 \text{ I.E. } .564 \text{ BELOW } \frac{1}{2} \text{ OF WEB.}$$

$$\Sigma Y^2 \text{ OF BOLTS} = \overset{3,4,5}{(3 \times 2.814^2)} + \overset{28,29,30,33,34,35 \text{ etc}}{(9 \times 1.686^2)} + \overset{11,12,13,14,15,16,17}{(2 \times 1.54^2 + .88^2)}$$

$$+ \overset{11,12,13,14,15,16,17}{(2 \times 1.54^2 + .9^2)} + \overset{18,19,20,21,22,23,24}{(1 \times .026^2 + .88^2)} + \overset{25,26,27,28,29,30,31}{(1 \times .026^2 + .3^2)}$$

$$+ \overset{15,16,17,18,19,20,21,22,23,24}{(1 \times 1.54^2 + .88^2)} + \overset{13,14,15,16,17,18,19,20,21,22,23,24}{(1 \times 1.54^2 + .90^2)} + \overset{20,21,22,23,24,25,26,27,28,29,30,31}{(1 \times .026^2 + .88^2)}$$

$$+ \overset{18,19,20,21,22,23,24,25,26,27,28,29,30,31}{(1 \times .026^2 + .90^2)} + \overset{14,15,16,17,18,19,20,21,22,23,24,25,26,27,28,29,30,31}{1 \times 1.54^2} + \overset{19}{.026^2}$$

$$= 23.75 + 25.6 + 8.84 + 3.10 + 3.24 + 2.11 + 4.01$$

$$= 70.65$$

MOMENT ABOUT C.G. OF BOLTS IN THIS GROUP

$$= (8000 \times 2.6) + (11,180 \times 1.5) + (5200 \times 3.836)$$

$$+ (3100 \times 2.25 + .564) + (8742 \times 2.25 - .564)$$

$$= 20,800 + 16,770 + 19,950 + 8,720 + 14,730$$

$$= 80,970$$

$$\therefore \frac{\text{MOMENT}}{\Sigma Y^2} = \frac{80,970}{70.65} = 1,146.$$

MOMENT LOAD PER BOLT 3,4 & 5 = $1,146 \times 2.814$

$$= 3,225 \# \rightarrow$$

" " " 28,29,30 etc = $1,146 \times 1.686$

$$= 1,932 \# \leftarrow$$

" " " 8 = $1,146 \times 2.154 = 2,355 \# \rightarrow$

$$\begin{matrix} 8 \\ 10 \end{matrix} \left\{ \begin{matrix} 1,146 \times 0.90 = 1,032 \# \uparrow \\ 1,146 \times 0.90 = 1,032 \# \downarrow \end{matrix} \right.$$



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BOTTOM JOINT

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$$\text{DIRECT SHEAR LOAD } \downarrow \text{ PER BOLTS 8 \& 10} = \frac{19180}{12} \\ = 1600 \# \downarrow$$

$$\begin{aligned} \text{PER BOLTS 3, 4, 5; 8 \& 10; 28, 29, 30 \& c} &= \frac{8742 - 3100}{24} \\ &= 235 \# \leftarrow \end{aligned}$$

$$\begin{aligned} \text{CENTROID OF BOLTS 1, 2, 3, 4 \& 5 FROM BOLT 5} \\ &= \frac{3.98 + 2.98 + 1.78 + .88}{5} = \frac{9.62}{5} = 1.924 \text{ IN} \end{aligned}$$

$$\begin{aligned} \sum r^2 &= 2.056^2 + 1.056^2 + .144^2 + 1.044^2 + 1.924^2 \\ &= 4.23 + 1.12 + .02 + 1.09 + 3.70 = 10.16 \text{ IN}^2 \end{aligned}$$

$$\begin{aligned} \text{MOMENT ABOUT BOLT C.G} &= (335 \times 2.6) + 8470(2.38 - 1.924) \\ &= 871 + 3860 = 4731 \# \text{ IN} \end{aligned}$$

$$\begin{aligned} \therefore \text{LOAD ON BOLT 1} &= \delta P_1 = \frac{4731}{10.16} \times 2.056 = 957 \# \downarrow \\ \therefore \text{LOAD ON BOLT 2} &= \delta P_2 = \frac{4731}{10.16} \times 1.056 = 492 \# \downarrow \\ \therefore \text{LOAD ON BOLT 5} &= \frac{4731}{10.16} \times 1.924 = 898 \# \uparrow \end{aligned}$$

$$\begin{aligned} \text{DIRECT SHEAR LOAD } \downarrow \text{ PER BOLT } &= \frac{8470}{5} = 1694 \# \downarrow \\ \text{PER BOLT } &= \frac{335}{3} = 112 \# \leftarrow \end{aligned}$$

NOTE:- LOADS $P_1 = \delta P_1 + 1694 = 2651 \#$ & $P_2 = \delta P_2 + 1694 = 2186 \#$ ARE TAKEN CHORDWISE ACROSS L.H. SKIN SPLICE.



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BOTTOM JOINT.

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SUMMATION OF LOADS ON BOLTS

BOLT 5

RESULT. LOAD

$$= \sqrt{2878^2 + 796^2}$$

$$= \underline{2990 \#}$$

SINGLE SHEAR STRENGTH $\frac{1}{4}$ " NAS SCREW = 4650 #

$$M.S. = \frac{4650}{2990} - 1 = \underline{.55.}$$

BOLT 8

RESULT. LOAD

$$= \sqrt{2120^2 + 2632^2}$$

$$= \underline{3380 \#}$$

BOLT BEARS IN $\frac{1}{2}$ " WEB & $\frac{1}{2}$ " CAP OF SPAR 1 (I.E. $\frac{1}{2}$ " TOTAL) AND IN $\frac{1}{2}$ " STEEL FITTING.

$\therefore$ STRENGTH OF $\frac{1}{4}$ " NAS BOLT = 4650 #

$$M.S. = \frac{4650}{3380} - 1 = .38$$

BOLT 30

RESULT. LOAD

$$= \sqrt{705^2 + 2617^2}$$

$$= \underline{2710 \#}$$

COVERED ABOVE



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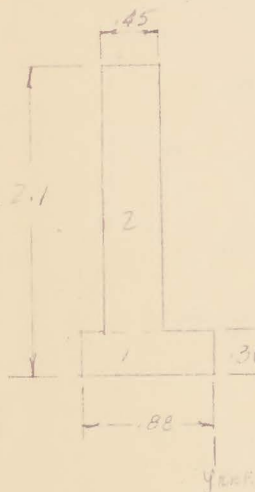
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RUDDER CONTROL HINGE #1 (7-0193-33)

STRESS ON SURFACE A-A



	AREA	Z-AXIS				Y-AXIS			
		Y	AY	AY ²	I ₀	Z	AZ	AZ ²	I ₀
1	.264	.150	.0326	.0044	-	.44	.116	.051	.017
2	.912	1.200	.9720	1.0800	.218	.515	.417	.215	.0136
Σ	1.074	1.350	1.0046	1.0844	.218	.955	.533	.266	.0304

$$I_z = 1.1724 + .218 - 10.116 \times .34 = .45$$

$$I_z/c = .45 / .34 = .98$$

$$I_y = .264 + .051 - 3.33 \times .50 = .031$$

$$I_y/c = .031 / .50 = .062$$

$$S_{OZ} = \frac{M_{ZL}}{I_z/c} = \frac{11,070}{.45} = 23,100 \text{ PSI}$$

$$S_{OY} = \frac{M_{YA}}{I_y/c} = \frac{2780}{.062} = 44,800 \text{ PSI}$$

IN CALCULATING TORSIONAL SHEAR STRESS, ASSUME
SECTION A-A TO BE RECTANGULAR IN SHAPE (24 x .33)
 $S = \frac{I}{\rho} (31.6 \frac{1}{2})$ (SEE FIGURE 33 MAIN JAW)

$$= \frac{1900}{24 \times (.33)^2} \left(31.6 \times \frac{.45}{2.1} \right)$$

$$= 15,100 \text{ PSI}$$

$$S_E = 11,000 / 1.074 = 10,300 \text{ PSI}$$

ALLOWABLE M_{ZL}

$$F_c = 70,000 \text{ PSI}$$

$$K = 24 \text{ in} / I_{OZ} = 2 \left(\frac{.75 \times .154 + .286 \times .32}{.45} \right) = 1.24$$

$$M_{ZL}(\text{allow}) = K F_c I_{OZ} = 1.24 \times 70,000 \times .45 = 41,400 \text{ IN-LBS}$$

ALLOWABLE M_{YA}

$$F_c = 70,000$$

$$K = 1.5$$

$$M_{YA}(\text{allow}) = K F_c I_{OY} = 1.5 \times 70,000 \times .062 = 6,500 \text{ IN-LBS}$$



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SHEET NO. 6-4

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RUDDER CONTROL HINGE #1

STRESS ON SEC A-A (CONT'D)

MARGIN OF SAFETY

$$R_{B2} = \frac{11,000}{41,000} = .27 \quad (1.249)$$

$$R_{B3} = \frac{2780}{6,500} = .43 \quad (1.393)$$

$$R_5 = \frac{10300}{70,000} = .15 \quad (1.1375)$$

$$R_8 = \frac{15,100}{40,000} = .38 \quad (1.786)$$

$$M.S. = \frac{1}{\left[\frac{(R_{B2} + R_{B3} + R_5)^2 + R_8^2}{1} \right]^{1/2}} - 1 = .09 \text{ M.S.}$$

ATTACHMENT TO R.H. SKIN

ATTACHMENT PER AUG 15 B/ 4-1/4 CTS. SCREWS.

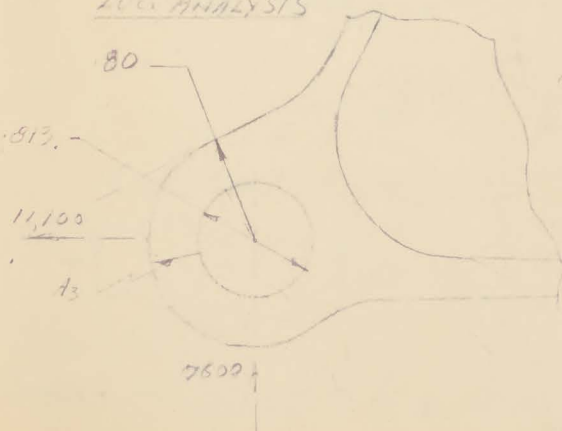
LOAD PER AUG = 11,100 + 4160 = 15,260 LBS.

LOAD PER SCREW = 15,260 / 4 = 3820 LBS.

ALLOWABLE SHEAR & STREN = 4650 = .22 M.S.

BEARING IN 22 SKIN CTS > 4650

AUG ANALYSIS



TENSILE LOAD 7600

AXIAL LOAD = 11,100



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AIRCRAFT:

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RUDDER CONTROL MINE #1LUG ANALYSIS (CONT'D)ALLOWABLE AXIAL LOADASSUME $t = .50$

$$a = .80 \quad a/d = .80 / .81 = .99$$

$$D = .81 \quad W/d = 1.6 / .81 = 1.98$$

$$W = 1.7 \quad D/E = .81 / .50 = 1.62$$

$$t = .50 \quad A_{br} = .81 \times .50 = .405$$

$$A_c = (.16 - .81) \times .50 = .335$$

$$K_{br} = .83$$

$$K_c = .70$$

$$P_{br} = .83 \times .405 \times 70,000 = 23,500 \text{ LBS.} \quad (25,200)$$

$$P_{cc} = .70 \times .335 \times 70,000 = 16,200 \text{ LBS.} \quad (17,500)$$

ALLOWABLE TRANSVERSE LOAD

$$A_{AV} = .50 \times (.80 - .81/2) = .137$$

$$A_{AV} = .137 = .457$$

$$A_{br} = .405$$

$$K_{LUG} = .45 \quad (\text{SEE CHART})$$

$$P_{LUG} = .45 \times .405 \times 70,000 = 12,750 \text{ LBS.}$$

MARGIN OF SAFETY

$$R_A = 11,100 / 19,300 = .575 \quad (.536)$$

$$R_{LR} = 7600 / 12,750 = .595 \quad (.570)$$

$$R_A + R_{LR} = 1$$

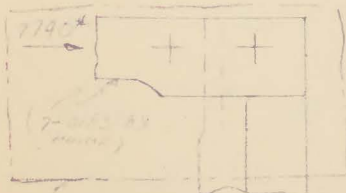
$$MS = \frac{1}{1.575 + 1.595} = .38$$

$$MS = \frac{1}{1.575 + 1.595} = .38$$

$$MS = .38$$

.1275

.02

ATTACHMENT TO L.H. SKIN

L.H. SKIN

4160

LEAD FROM MINE 416" (PG. 1)

END LEAD 7740" (P. 5)

$$RESISTANCE = \left[\frac{7740}{2} + \left(\frac{4160}{2} \right)^2 \right]^{1/2}$$

$$= 4400 \text{ LBS.}$$

$$MINIMUM 7740" SKIN W. 4400"$$

$$4400$$

.06175

(BEARING NOT CRITICAL)



AVRO AIRCRAFT LIMITED

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/1542/12

SHEET NO. 6-6

AIRCRAFT

2195

FIN

PREPARED BY

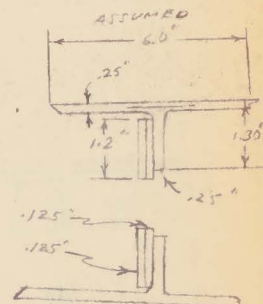
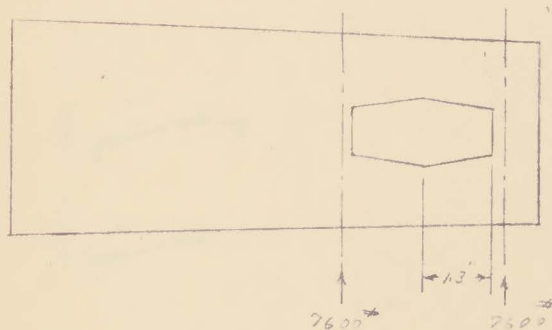
DATE

CHECKED BY

DATE

CONTROL * 1

* SEE NEXT SHEET

SHEAR ON SPAR * 1 $\approx$ 30% TOTAL FIN SHEAR

$$= 0.30 \times 31,000 \leftarrow (2/0.553/38 \text{ SHEET})$$

$$= 9300 \text{ lbs}$$

ASSUMING 60% OF UPPER LUG LOAD GOES ACROSS CUTOUT

$$\therefore \text{SHEAR LOAD} = 9300 + 7600 \times 0.60 = 13,850 \text{ lbs}$$

ASSUMING SHEAR IS DISTRIBUTED $\propto I$

$$\text{STRINGER } y = \frac{1.18 \times 0.25 \times 0.57}{1.18 \times 0.25 + 6 \times 0.25} = 0.10"$$

$$\text{STRINGER } I = \frac{1.18^3 \times 0.25}{12} = 0.135 \text{ in}^4$$

$$\text{DOUBLER + WEB } I = \frac{1.2^3 \times 0.25}{12} = 0.036 \text{ in}^4$$

$$\Sigma I = 0.282 \text{ in}^4$$

$$\therefore \text{SHEAR LOAD ON STRINGER} = 13,850 \times \frac{0.10}{0.282} = 5160 \text{ lbs}$$

$$B.M. = 5160 \times 1.3 = 6700 \text{ lb-in}$$

$$f_b = \frac{6700 \times 1.08}{0.105} = 69,000 \text{ PSI}$$

$$f_b \text{ DUE TO FIN BENDING } I_{\text{TOTAL}} = 180 \text{ in}^4 \text{ (STA 51)}$$

$$(7/0.553/38 \text{ SHEET } 1.20)$$

$$B.M. = 2000000 \text{ lb-in}$$

$$(\text{STRINGER}) f_b = \frac{M y}{I} = \frac{2 \times 10^6 \times 1.0}{180} = 11,100 \text{ PSI}$$

$$f_b \text{ TOTAL} \approx 80,000 \text{ PSI} \quad f_c = f_{fy} = 76 \text{ KSI (PLASTIC BENDING)}$$

* M.S. 705

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/05-93/

SHEET NO. 67

AIRCRAFT:

C105

FIN

PREPARED BY

DATE

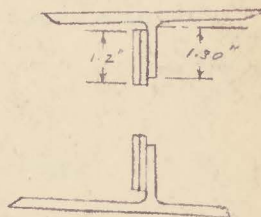
L. G. G. G.

AVG. 55

CHECKED BY

DATE

CONTROL # 1



ASSUMPTIONS:

- ① WEB ACTS LIKE A BEAM FIXED AT THE EDGE OF THE HOLE.
- ② THE STRINGER ACTS LIKE A BEAM FIXED AT THE ATTACHMENT.
- ③ S'S OF ALL BEAMS ARE EQUAL AND NO RESTRAINT BETWEEN BEAMS.

$$I \text{ OF STRINGER} = \frac{1.30^3 \times 0.12}{3} = 0.0880 \text{ in}^4$$

$$I \text{ OF WEB + D.} = \frac{1.2^3 \times 0.25}{12} = 0.0361 \text{ in}^4$$

$$\therefore \delta \text{ OF A CANTILEVER BEAM} = \frac{PL^3}{3IE}$$

$\therefore \delta$ 'S ARE EQUAL

$$\therefore P \propto \frac{I}{L^3}$$

$$\frac{1}{L^3} \text{ STRINGER} = \frac{0.0880}{2.2^3} = 0.0075$$

$$\frac{1}{L^3} \text{ WEB + D.} = \frac{0.0361}{1.3^3} = 0.0164$$

$$\Sigma \frac{1}{L^3} = 0.0239 \times 2 = 0.0478$$

$$\therefore \% \text{ LOAD CARRIED BY STRINGER, ONE SIDE} = \frac{0.0075 \times 100}{0.0478} = 15.7 \%$$

$$\therefore \% \text{ LOAD CARRIED BY WEB + D, ONE SIDE} = \frac{0.0164 \times 100}{0.0478} = 34.3 \%$$



AVRO AIRCRAFT LIMITED

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 5/2187/12

SHEET NO. 7-1

AIRCRAFT

C 105

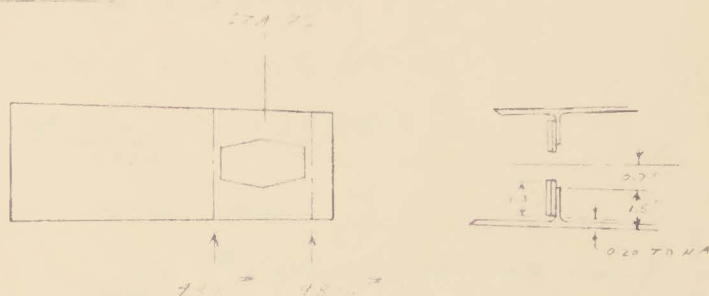
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DATE

CONTROL # 2SHEAR PLATE

SHEAR PLATE BASED ON NOMINAL OF 30%
OF TOTAL FIN SHEAR IN SPAR #1

TOTAL FIN SHEAR = 22,700 #

* SHEAR ON SPAR #1 = $22,700 \times .8 = 18,160$ #

ASSUMPTIONS:

- ① 60% OF LOAD ON UPPER LUG GOES THROUGH SPAR #1 AIRFOIL HOLE.
- ② NONE OF LOAD ON LOWER LUG CROSSES HOLE.

$$\begin{aligned} * \text{WEAR AIRFOIL CUTOUT} &= 6600 + 4800 \times .6 \\ &= 9480 \end{aligned}$$

ASSUMING SHEAR $\propto I$

AND ASSUMING EACH ELEMENT
BENDS ABOUT ITS OWN NA

$$I_{\text{STRIPPER}} = \frac{1.3^3 \times .1}{12} = 0.0034 \quad 33.87\% \text{ TOT}$$

$$I_{\text{WEB}} = \frac{1.7^3 \times .25}{12} = 0.0438$$

$$\Sigma I = 0.1172 \times 2 = .238 \text{ "4}$$

$$\text{LOAD CARRIED BY ONE STRIPPER} = .338 \times 9480 = 2920$$

* SEE NEXT SHEET

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0587/12

SHEET NO. 2-2

AIRCRAFT:

C105

FIN

PREPARED BY

DATE

A. Gooderson
CHECKED BY

JULY 55
DATE

CONTROL # 2

BENDING OF STRINGER

$$B.M. = 2920 \times 1.3 = 3800 \text{ ft} \cdot \text{lb}$$

$$f_b = \frac{3800 \times 1.3}{0.3734} = 67,400 \text{ PSI}$$

DIRECT f_b OF FIN

$$\text{FIN } I = 130 \text{ in}^4 \quad (7/0587/38 \text{ SHT 1-20})$$

$$\text{FIN B.M. AT STA 76} = 1,300,000 \text{ ft} \cdot \text{lb} \quad (REF 7/0587/38 \text{ SHT 3-14})$$

$$f_b = \frac{M_y}{I} = \frac{1,300,000 \times 1.7}{130} = 70,000 \text{ PSI}$$

$$\text{TOTAL } f_b = 67,000 + 7000 = 74,000 \text{ PSI}$$

$$f_c \approx f_{cy} \text{ APPROX}$$

$$f_{cy} = 24 \text{ KSI}$$

$$\text{INCLUDING REDISTRIBUTION FOR RECTANGULAR SECTION } f_{cy} = 26 \text{ KSI} \quad (\text{AVR. MANUAL})$$

$$* M.S. \approx 0.0$$

* THE WEB WAS STRESSED FOR A SHEAR OF 9480 # BUT LATER WORK INDICATES A SHEAR OF ABOUT 8800 # REF. 7/0587

NOTE MORE EXACT METHOD NEXT SET

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7/2582/

SHEET No. 7-2A

AIRCRAFT:

C105

FIN

PREPARED BY

DATE

6. J. J. J.

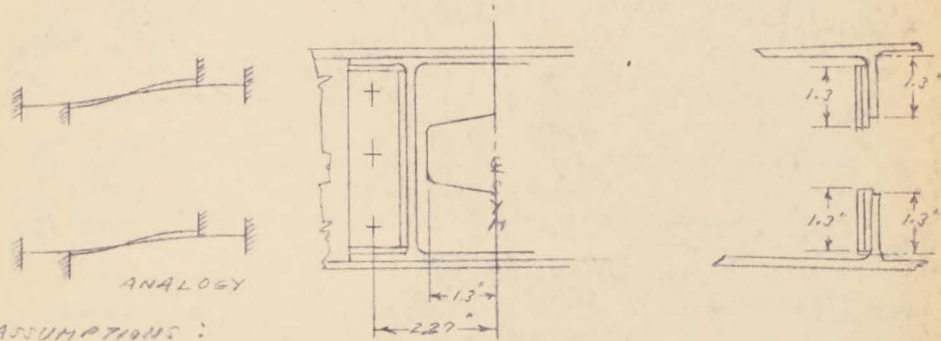
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DATE

CONTROL # 2

REGION NEAR CONTROL CUTOOUT



ASSUMPTIONS:

- ① SPAR WEB ACTS LIKE A BEAM FIXED AT THE HOLE EDGE
- ② MACHINED SKIN ACTS LIKE A BEAM FIXED AT ATTACHMENT
- ③ BEAMS BEND SEPARATELY & δ 'S ARE EQUAL.

$$I_{\text{STRINGER}} = \frac{1.3^3 \times 0.12}{3} = 0.0880$$

$$I_{\text{WEB + D.}} = \frac{1.3^3 \times 0.25}{12} = 0.0458$$

$$\text{FOR A CANTILEVER BEAM } \delta = \frac{PR^3}{3EI}$$

$\therefore \delta$ 'S ARE EQUAL

$$\therefore \text{LOAD} \propto \frac{1}{R^3}$$

$$\text{STRINGER } \frac{1}{R^3} = \frac{0.0880}{2.27^3} = 0.00752$$

$$(\text{WEB + D.}) \frac{1}{R^3} = \frac{0.0458}{1.3^3} = 0.0208$$

$$\Sigma \frac{1}{R^3} = 0.0283 \times 2 = 0.0566$$

% OF TOTAL LOAD

$$\text{LOAD ON STRINGER (ONE SIDE)} = 100 \times \frac{0.00752}{0.0566} = 13.3\%$$

$$\text{LOAD ON WEB + D. (ONE SIDE)} = 100 \times \frac{0.0208}{0.0566} = 36.7\%$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0583/12

SHEET NO. 7-28

AIRCRAFT:

C105

FIN

PREPARED BY

DATE

CHECKED BY

DATE

CONTROL # 2

LOAD

ASSUMPTIONS:

- ① 50% OF LOAD ON UPPER LUG GOES THROUGH SPAR #1 ACROSS HOLES
- ② 50% OF FIN SHEAR GOES DOWN SPAR #1 (2/0583/14 SEE 7-18)

$$\text{SHEAR ACROSS CUTOUT} = 22700 \times .70 + 9200 \times 0.60 = 9480 \pm$$

$$\text{LOAD ON WEB + COUPLER ON SIDE} = 36.7\%$$

(FROM PREVIOUS SET)

$$\text{LOAD ON D. & WEB} = 3.0 \times 9480 = 9480 \pm$$

$$f_b = \frac{9480 \times 1.3 \times 1.3}{0.458} = 128,000 \text{ PSI}$$

$$\text{ALLOWABLE } F_c = F_{cy} \times \text{FORM FACTOR} = 76 \text{ KSI}$$

NOTE: A. Young SEPT 28/55

$$f_b = 128,000 \text{ PSI}$$

TOTAL

$$F_{BU} = F_{TU} \times \text{FORM FACTOR} = 72000 \text{ CLAD } 75\% \times 1.5 = 108,000 \text{ PSI}$$

M.S. = 7.41

M.S. = -16



AVRO AIRCRAFT LIMITED

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0583/12

SHEET NO. 7-3

AIRCRAFT

C-105

PREPARED BY

DATE

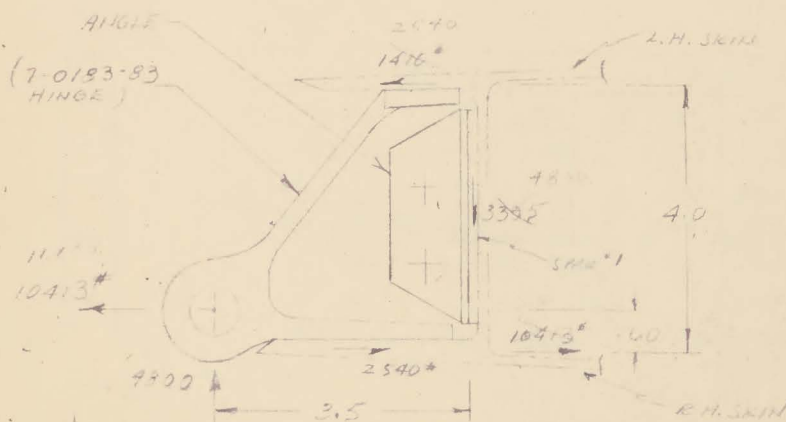
MCCABE

5-16-55

CHECKED BY

DATE

RUGBY CONTROL HINGE #2 (7-0193-83)



FROM 7/0583/10, VOL I, SH 19

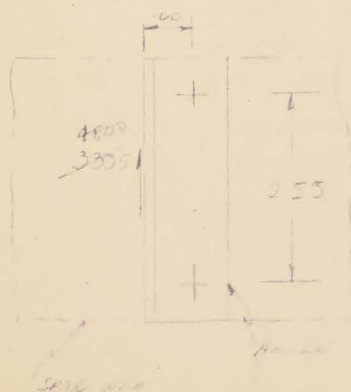
$$\text{HINGE SIDE LOAD} = 9600 / 2 = 4800 \text{ \# PER LUG}$$

$$\text{HINGE DRAG LOAD} = 20826 / 2 = 10413 \text{ \# PER LUG}$$

$$\text{L.H. SKIN REACTION} = 4800 \times 3.5 = 16800$$

$$= (16800 - 6650) / 4 = 2540 \text{ \#}$$

ANGLE ATTACHMENT TO SPAR #1 ULS



$$\text{SHEAR LOAD ON ANGLE} = 4800 \text{ \#}$$

LOAD ON ATTACHMENT FROM MOMENT

$$4800 \times 60 / 2.55 = 1130 \text{ LBS.}$$

LOAD PER ATTACHMENT FROM DRAG

$$4800 / 2 = 2400 \text{ LBS.}$$

$$\text{RESULTANT} = (1130^2 + 2400^2)^{1/2} = 2650 \text{ \#}$$

$$\text{ALLOW LOAD } 1/4 \text{ NAT} = 4650 \text{ \#}$$

$$\text{F.S.} = \frac{4650}{2650} = 1.75$$

T.S. 75



AVRO AIRCRAFT LIMITED

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 2/0582/12

SHEET NO. 2-6

AIRCRAFT:

C-105

PREPARED BY

DATE

McHABE

5-17-33

CHECKED BY

DATE

RUDDER CONTROL HINGE #2 (7-0183-03)

STRESS ON LUG A.H. (CON'T)

MARGIN OF SAFETY

$$R_{L2} = \frac{6620}{29400} = .22$$

29400

$$R_{L3} = \frac{1660}{5140} = .32$$

5140

$$R_L = \frac{13200}{66000} = .20$$

66,000

$$R_S = \frac{10170}{43000} = .23$$

43,000

$$M.S. = \frac{1}{[(R_{L2} + R_{L3} + R_L)^2 + R_S^2]^{1/2}} - 1$$

$$= \frac{1}{[(.22 + .32 + .20)^2 + .23^2]^{1/2}} - 1$$

M.S. .29

ATTACHMENT TO R.H. SKIN

ATTACHMENT PER LUG IS BY 4-1/4 CSK. SCREWS.

$$\text{LOAD PER LUG} = 2540 + 11100 = 13640 \text{ LBS.}$$

$$\text{LOAD PER SCREW} = 13640/4 = 3400 \text{ LBS.}$$

$$\text{ALLOW. LOAD } 1/4" \text{ HAS SCREW} = 4600 \text{ LBS.}$$

$$M.S. = \frac{4600}{3400} - 1 =$$

3400

M.S. .37

LUG ANALYSIS

$$\text{TRANSFERRED LOAD} = 4800$$

$$\text{PULL LOAD} = 11100$$

$$\text{ALLOWABLE LOAD (REF. HINGE #5 ANALYSIS, PAGES 10 & 20)}$$

$$P_{LU} = 14600^*$$

$$P_{LU} = 14200^{\pm}$$

$$R_L = 11100/14600 = .76$$

$$R_{L2} = 4800/14200 = .34$$

$$R_L^{1/2} + R_{L2}^{1/2} = 1$$

$$M.S. = \frac{1}{(.76 + .34)} - 1 =$$

M.S. .13

$$.76^{1/2} = .694$$

$$.34^{1/2} = .178$$



AVRO AIRCRAFT LIMITED

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 2/0585/12

SHEET NO. 7-7

AIRCRAFT:

C-105

PREPARED BY

DATE

McCABE

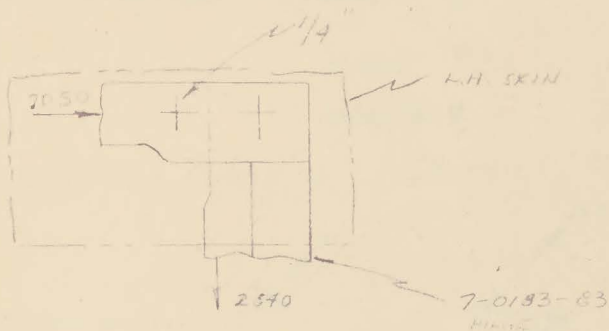
5-18-55

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DATE

RUDDER CONTROL HINGE #2 (7-0193-83)

HINGE ATTACHMENT TO L.H. SKIN.



LOAD FROM HINGE THROAT (Pg 6)

END LOAD = 7050* (Pg 3)

$$\text{RESULTANT} = \left[\left(\frac{2540}{2} \right)^2 + \left(\frac{7050}{2} \right)^2 \right]^{1/2}$$

$$= 3740 \text{ LB}$$

ALLOW. LOAD 19' 0" DIA. = 4050*

$$\text{M.S.} = \frac{4050 - 10}{3740}$$

M.S. .24



AVRO AIRCRAFT LIMITED

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO 7/0583/12

SHEET NO 8-1

AIRCRAFT

C105

FMA HINGE FITTINGS

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DATE

S. YOUNG

MAY 16/55

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RUDDER CONTROL HINGE #3

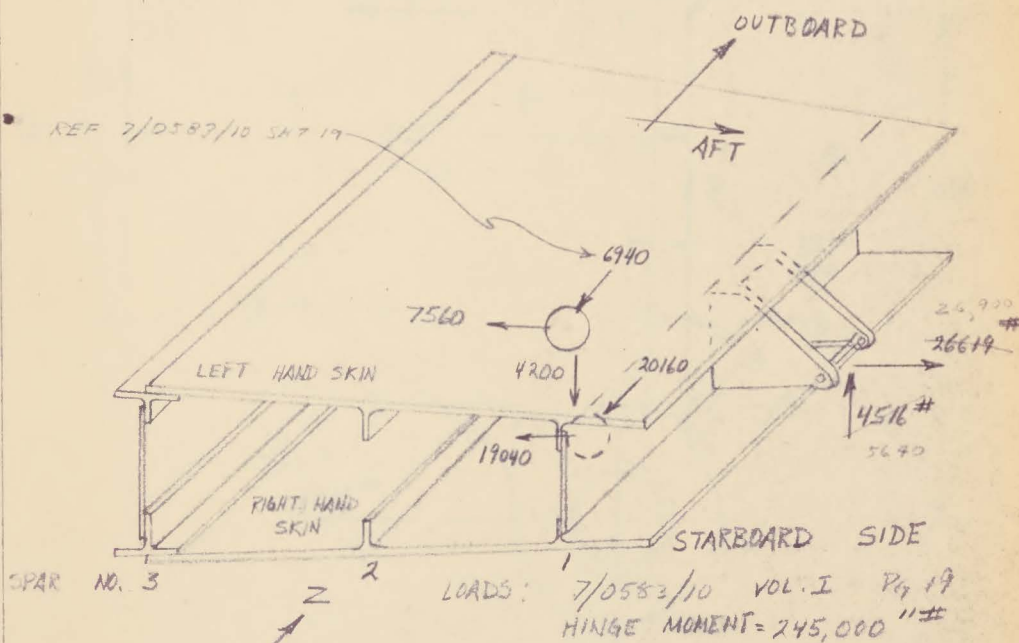
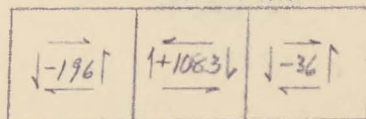
HINGE #3

7-0183-91

ASSEMBLY

7-0183-84

PRODUCTION - HINGE 3 (DETAIL) 7-1083-305

REAR SPAR
SHEAR FLOWS

STA 1820 1900 1917

BELCRANK HINGE

4158##



AVRO AIRCRAFT LIMITED

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/1583/12

SHEET NO. 8-2

AIRCRAFT

C105

FIN HINGE FITTINGS

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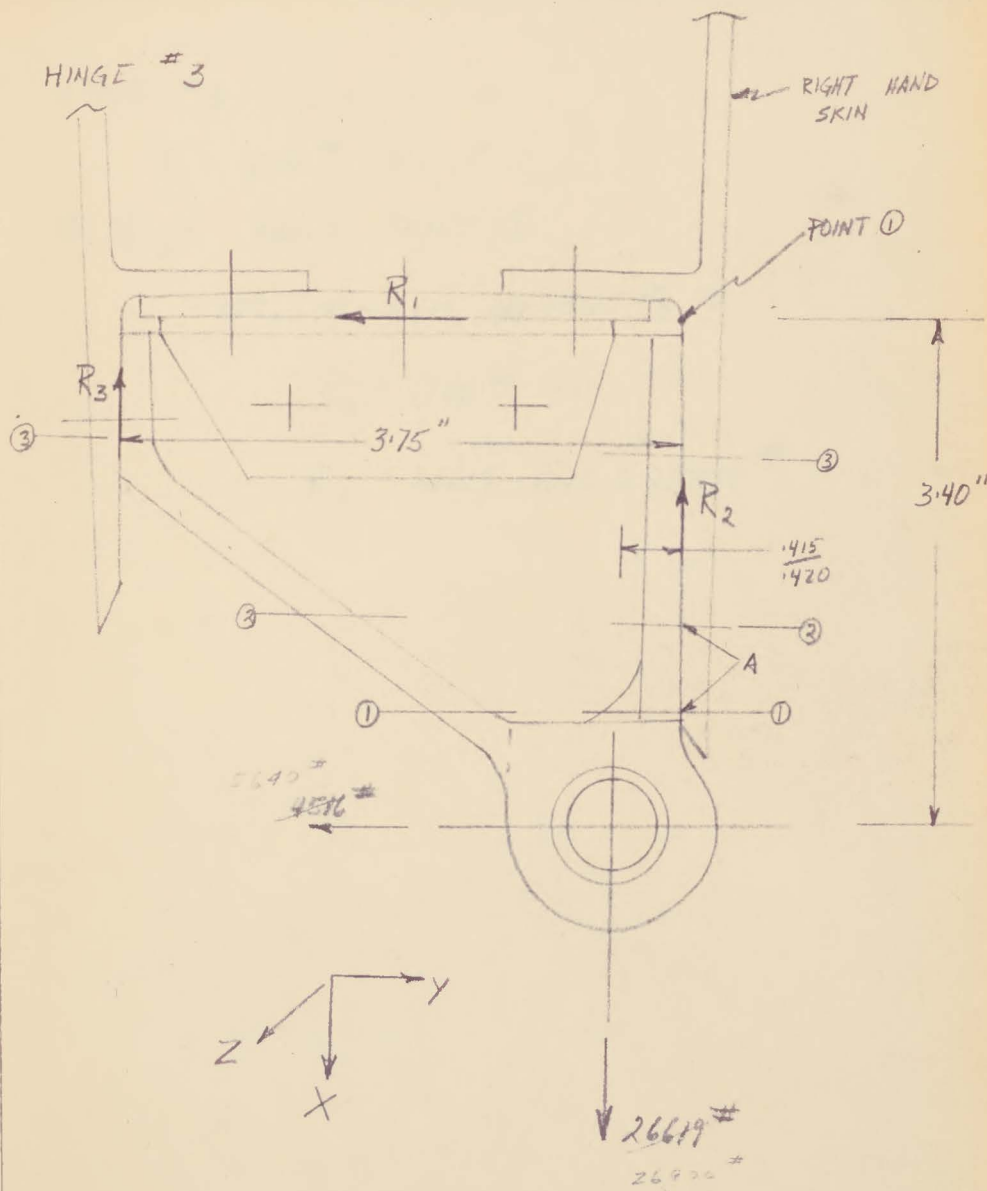
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TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0583/12

SHEET NO. 8-3

AIRCRAFT

C105

FIN HINGE FITTINGS

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DATE

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HINGE #3

$$R_1 = 4516 \# \quad 5640 \#$$

 $\Sigma M = 0$ ABOUT POINT ①

$$+4516 \times 3.40 - 26619 \times .417 + 3.75 R_3 = 0$$

24,700
5640

$$R_3 = 1140 \# \quad 2100 \#$$

$$R_2 = 26619 - 1140 = 25479 \#$$

24,700 - 2100 = 22,600



AVRO AIRCRAFT LIMITED

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO.

7/0583/12

SHEET NO.

8-4

AIRCRAFT

C 105

FIN HINGE FITTINGS

PREPARED BY

S. YOUNG

DATE

MAY 25/55

CHECKED BY

DATE

HINGE #3

FITTING ATTACHMENTS

ATTACH LOAD TO PORT SKIN = ²¹⁰⁰1140 #

ALLOW 4 - $\frac{3}{16}$ " SCREW (NAS 333) CSK .15 SKIN BASIC
 .20 AT FITTING
 = 4,3680 # PRODUCT ENG. MAY 1946

M.S. =

HIGH

ATTACH. LOAD TO STARBOARD SKIN = ²⁴⁵⁰⁰25479 #

ALLOW 8 - $\frac{1}{4}$ " NAS 334 SCREWS CSK .15 SKIN BASIC
 (REF PROD ENG MAY 46) .20 AT FITTING
 = 8 x 4650 = 37,200 #

M.S. = $\frac{37200}{24500} - 1$

.50

ATTACH. SHEAR LOAD = 5640 #

$$\text{MAX BOLT LOAD} = \frac{5640}{6} + \frac{\frac{5640}{2} \times .6}{2.25} = 940 + 755 = 1695 \#$$

ALLOW NAS464 P4A BOLT BRG WEB & DOUBLER

BRG = NOT CRITICAL

SHEAR = 4650 #

M.S. = $\frac{4650}{1695} - 1$

1.7

$$\text{BOLT LOAD ON FTG} = \left[\frac{5640^2}{4} + \left(\frac{5640 \times .21}{2 \times 1.50} \right)^2 \right]^{\frac{1}{2}} = \frac{1940 \#}{\text{M.S.}} = 91$$

$\frac{1}{4}$ 8-LT W. 119 ANGLE (125 KSI) =



AVRO AIRCRAFT LIMITED

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0583/12

SHEET NO. 9-5

AIRCRAFT

C105

FIN HINGE FITTINGS

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DATE

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MAY 16/55

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DATE

HINGE #3

CHECK LUG END BY ANALYSIS OF MELCON &
HOBLIT IN PRODUCT ENGINEERING, JUNE 1953

MATERIAL

755T AL. BAR

 $F_{TUL} = 78000$ $F_{TVL} = 70000$

QQ-A-277 T6

 $F_{TUT} = 66000$ $F_{TUT} = 58000$ $F_{CYLT} = 70000$ $F_{SU} = 43000$ AXIAL LOAD $P_a = 26,900 \frac{\#}{2} = 13,450 \frac{\#}{2}$ TRANSVERSE LOAD $P_{tr} = 5640 \frac{\#}{2} = 2820 \frac{\#}{2}$

AXIAL LOADING:

$$w/D = \frac{1.25}{.813} = 1.538$$

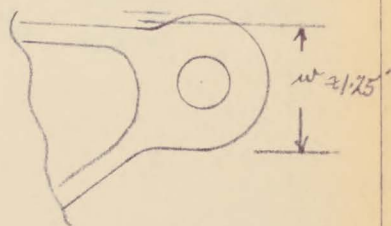
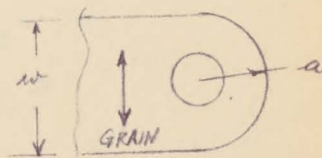
$$a/D = \frac{.70}{.813} = .86$$

$$D/t = \frac{.813}{.88} = .924$$

$$K_t = .87$$

$$A_t = (w - D)t = .437 \times .88$$

$$P'_{TV} = K_t A_t F_{TV} = .87 (.437 \times .88) 66000 = 22100 \frac{\#}{2}$$





AVRO AIRCRAFT LIMITED

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO.

7/0583/12

SHEET NO.

8-6

AIRCRAFT:

C105

FIN HINGE FITTINGS

PREPARED BY

S. YOUNG

DATE

MAY 24/55

CHECKED BY

DATE

HINGE #3

$$K_{BR} = .61$$

$$A_{br} = .813 \times .88 = .716 \text{ in}^2$$

$$P'_{br} = K_{br} A_{br} F_{TUX} = .61 \times .716 \times 66000 = 28,850 \text{ lb}$$

TO BE COMPATIBLE WITH THE OTHER
HINGE STRESSING & TO REDUCE OFFSETS, USE
AN EFFECTIVE LUG THICKNESS OF .55"

$$\text{WIDTH } w = 1.40$$

$$w/D = \frac{1.40}{.813} = 1.72$$

$$K_t = .75$$

$$A_t = (w - D)t = (1.40 - .813) \times .55 = .322 \text{ in}^2$$

$$P'_{TUX} = .75 \times .322 \times 66000 = 15,950 \text{ lb}$$

$$P_a = 13,310 \text{ lb}$$

$$R_a = \frac{13,310}{15,950} = .843$$

TRANSVERSE LOADING:

$$A_{A1} = \left(.70 - \frac{.813}{2} \right) \times .55 = .162 \text{ in}^2$$

$$A_{br} = Dt = .813 \times .55 = .447 \text{ in}^2$$

$$A_{A1}/A_{br} = .368$$

$$K_{tru} = .28 \quad (\text{CURVE (4) FIG. 18})$$

$$P'_{tru} = K_{tru} A_{br} F_{TUX} = .28 \times .447 \times 66000 = 7,960 \text{ lb}$$

$$P_{tr} = 2,258 \text{ lb}$$

$$R_{tr} = \frac{2,258}{7,960} = .354$$



AVRO AIRCRAFT LIMITED

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0583/12

SHEET NO. 3-7

AIRCRAFT

C.105

FIN HINGE FITTINGS

PREPARED BY

DATE

S. YOUNG

MAY 24/55

CHECKED BY

DATE

HINGE #3

$$M.S. = \frac{1}{(R_u^{16} + R_{tr}^{16})^{1/16}} - 1$$

$$= \frac{1}{(.843^{16} + .35^{16})^{1/16}} - 1 = 1 - 1 = 0$$



AVRO AIRCRAFT LIMITED

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO.

7/0583/12

SHEET NO.

8-8

AIRCRAFT

C105

FIN HINGE FITTINGS

PREPARED BY

S. YOUNG

DATE

MAY 24/55

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DATE

HINGE #3

SECTION 1-1 WITH LOADS REFERENCED
TO POINT 'A'

$$T_x = 13450 \text{ TENSION}$$

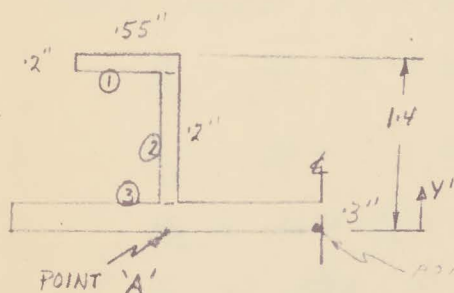
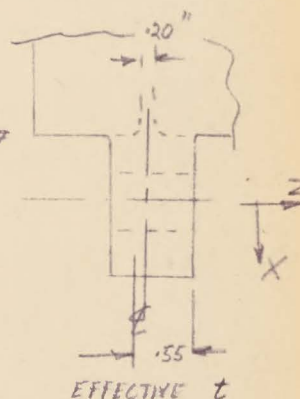
$$S_y = 2820 \text{ SHEAR}$$

$$M_z = 13450 \times .417 - 2820 \times .70 = 3630 \text{ " #}$$

$$\text{WEB OFFSET} = \frac{.55}{2} - \frac{.84}{2} = .165 \text{ "}$$

$$\text{MOMENT, } M_y = .165 \times 13450 = 2220 \text{ " #}$$

$$\text{TORSION, } M_x = .165 \times 2258 = 372 \text{ " #}$$

ASSUME 1" EFFECTIVE
OF ITEM ③

ITEM	A	Y'	AY'	AY' ²	I ₀	Y	AY
1	.11	.13	.143	.186		.1767	.084
2	.18	.17	.126	.088	.012	.267	.048
3	.130	.15	.045	.007		-.383	.132
Σ	.59	.533	.314	.281	.012		

$$I = 281 + .012 - .533 \times .59 = 125 \text{ IN}^4$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0583/12

SHEET NO. 8-11

AIRCRAFT:

C105

FIN HINGE FITTINGS

PREPARED BY

DATE

S. YOUNG

MAY 24/55

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HINGE #3

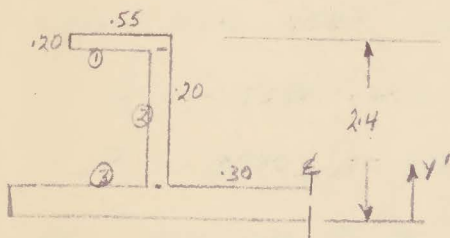
SECTION ②-②

$$T_x = 13310 \text{ #}$$

$$S_y = 2258 \text{ #}$$

ABOUT HEEL LINE 'A'

$$M_z = 13310 \times .417 - 2258 \times 1.35 = +2500 \text{ PSI}$$



ASSUME 1.5" OF ITEM ③
EFFECTIVE

ITEM	A	Y'	AY'	AY' ²	Y	AY
1	.11	.23	.253	.582	-1.475	-.162
2	.38	.12	.456	.547	-.375	-.142
3	.45	.15	.67	.010	.675	.304
Σ	.94	.825	.776	1.139		

$$I = 1.139 - .94 \times .825^2 = .499 \text{ IN}^4$$

ABOUT CENTROID,

$$M_z = +2500 - .825 \times 13310 = +2500 - 10980 = -8480 \text{ #}$$

$$f_{b10} = \frac{8480 \times 1.475}{.499} = -25050 \text{ PSI}$$

$$f_{b15} = \frac{8480 \times .675}{.499} = +11,450 \text{ PSI}$$

$$f_t = \frac{13310}{.94} = +14150 \text{ PSI}$$

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ANGE 3

SECTION (2) - (2)

$$f_{(3)} = 14150 + 11450 - 25600 \text{ PSI}$$

$$M.S. = \frac{66000}{25000} = 2.64$$

1.58

CHECK WEB COMP DUE TO SLOPE IN MEMBER ①

$$f = -25050 + 14150 = -10900 \text{ PSI}$$

$$P_1 = -10900 \times .11 = -1199 \quad \text{AT SECTION (2)-(2)}$$

AT SECTION ①-①

$$f_1 = -19200 + 22600 = +3400 \text{ Bt}$$

$$P_1 = 13400 \times .11 = + 374^{th}$$

CAP LOAD CHANGE OVER 45" BETWEEN SECTIONS

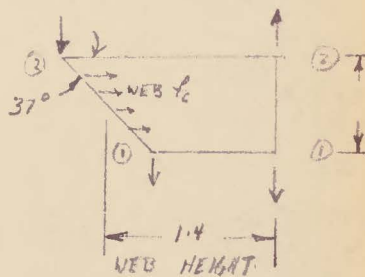
$$\Delta P = -1374 - (-1199) = 1573$$

$$\tan 37^\circ = \frac{\Delta P}{VIB P_c}$$

$$\text{WEB } P_c = \frac{1573}{1754} = 2085^{**}$$

PER INCH

$$\text{WEB } P_c = \frac{2085}{.45} = 4660 \text{ #/in}$$





AVRO AIRCRAFT LIMITED

TECHNICAL DEPARTMENT (Aircraft)

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SHEET NO.

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HINGE #3

SECTION ①-②

$$WEB \quad P_{CR} = \frac{C\pi^2 EI}{L^2}$$

TAKE $C=2$

$$L = 1.4''$$

$$E = 10 \times 10^6$$

$$PER \text{ INCH}, I = \frac{1'' \times .20^3}{12} = \frac{.008}{12}$$

$$P_{CR} = \frac{2\pi^2 \times 10^7 \times .008}{1.4^2 \times 12} = 66200 \text{ LB/IN}$$

$$f_{CR} = \frac{66200}{1'' \times 2''} = 331000 - \text{HIGH}$$

$$USE \quad F_{cy} = 70000 \text{ PSI}$$

$$P_{CR} = 70000 \times 1 \times 2 = 14000 \frac{\text{#}}{\text{IN}} \quad \text{WEB STRENGTH AMPLE}$$

$$C = \sqrt{\frac{1}{A}} = \sqrt{\frac{.008}{1.4 \times 2}} = \sqrt{.0032} = .0575$$

$$\frac{L}{C} = \frac{1.4}{.0575} = 24.4 \quad \text{Satisfactory.}$$

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MALTON, ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0583/12

SHEET NO. 8-14

AIRCRAFT:

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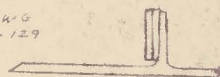
CONTROL # 3

NA ABOUT SAME FOR
AS FOR CONTROL #1

*NOTE: SHEAR ACROSS HOLE
WAS ESTIMATED TO BE 8290 #
AND M.S. IS QUOTED ON THIS
VALUE. LATER WORK 7/0583/12 HP-22
SHOWS THE SHEAR TO BE 3125 #

*NOTE: MORE EXACT METHOD
FOLLOWING IS

SAW DRG
7-0183-129



SHEAR ON SPAR #1 $\approx$ 33% TOTAL FIN SHEAR
(REF 7/0583/14 4-10)

TOTAL FIN SHEAR STA 90 = 22,000 # (7/0583/20 3-11)

SHEAR ON SPAR #1 $\approx$ 22,000 x .30 = 6600 # APPROX

SHEAR DUE TO UPPER HINGE LUG
ASSUMING 60% GOES THROUGH CUTOUT

SHEAR = 2820 x 0.60 = 1690 #

TOTAL SHEAR $\approx$ 8290 #

SHEAR IS CARRIED ACROSS HOLE BY BENDING OF
SPAR LEG, WEB & DOUBLER.
ASSUMING SHEAR $\propto$ I FOR EACH ELEMENT

$$I_{\text{SPAR LEG}} = \frac{1.1 \times 0.12^3}{3} = .0535 \text{ } ^4$$

$$I_{\text{WEB + DOUBLER}} = \frac{0.95 \times .25^3}{12} = .0179 \text{ } ^4$$

$$\Sigma I = .0714 \times 2 = .1428 \text{ } ^4$$

$$\therefore \text{SHEAR REACTED BY SPAR LEG} = 8290 \times \frac{.0535}{.1428} = 3100 \text{ } ^4$$

$$\therefore \text{B.M.} = 3100 \times 1.3 = 4030$$

$$f_b = \frac{4030 \times 1.1}{.0535} = 83,000 \text{ PSI} \quad F_c = F_y = 76 \text{ KSI PLASTIC}$$

* M.S. $\approx$ -.08

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0583/12

SHEET NO. 8-16

AIRCRAFT:

L108

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CONTROL # 3

SHEAR ON SPAR # 1

ASSUMPTIONS:

- ① 25% OF FIN SHEAR IS APPLIED TO SPAR # 1 (REF 7/0583/14 CH7 9-14)
 - ② 60% OF UPPER LUG LOAD CROSSES CUTOUT, (REF 7/0583/PB 3-14)
- LOAD ACROSS HOLE = $22,000 \times 0.70 + 2820 \times 0.60$
= 8290

PREVIOUS CH7

LOAD APPLIED TO WEB + D. = 32% OF 8290
= 2650

$$F_D = \frac{2650 \times 1.5 \times 0.95}{1.20129} = \underline{211,000 \text{ PSI}}$$

$$F_c = F_{ty} \times \text{FORM FACTOR} = \underline{76 \text{ KSI}} \quad (\text{AVRIL MANUAL})$$

$$\frac{76}{14.5} = 5.24$$

* LATER WORK (7/0583/10 547 178-78) SHOWS SHEAR TO BE 3125

NOTE: S. Young SEPT 28/65

$$f_B = 211,000 \text{ PSI}$$

$$F_{BU} = F_{TU} \times \text{FORM FACTOR}$$

$$= 72,000 \text{ CIAD } 75ST \times 1.5 = 108,000 \text{ PSI}$$

M.S. = -48



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REPORT NO. 7/0583/12

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AIRCRAFT

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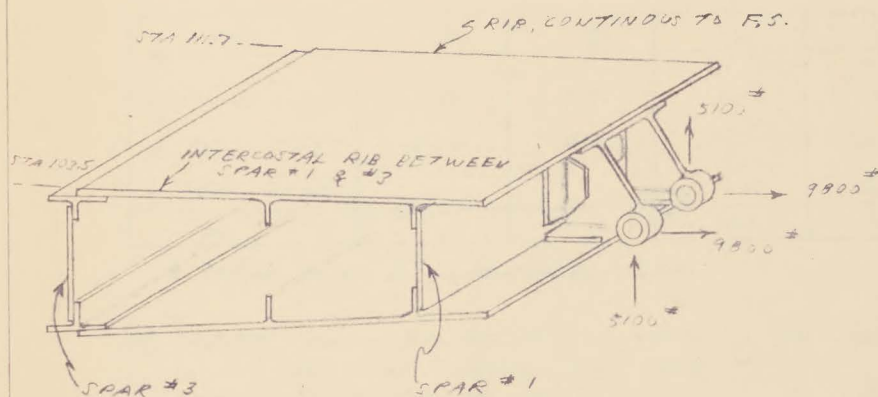
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J. Janderson

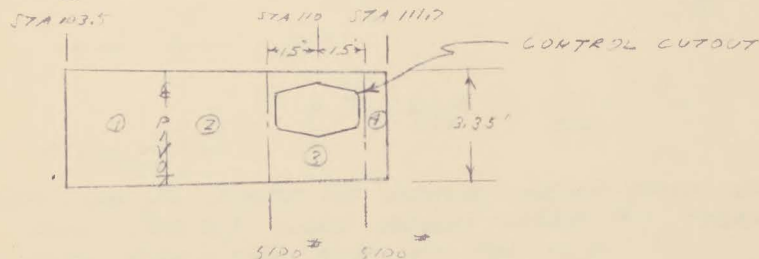
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CONTROL # 4SHEAR FLOW

THE CRITICAL SHEAR FROM SEVERAL SOURCES WILL BE USED.



- ④ SHEAR FLOW FROM 7/0583/10 547 137 FOR PIVOT & NOMINAL SHEAR + HINGE SHEAR.

SHEAR DUE TO HINGE PROPORTIONED TO RIBS AS THOUGH SPAR #1 WAS CUT AT RIB TO BE CONSISTENT WITH REPORT 7/5583/10

$$q_0 = \frac{5100}{7.35} + \frac{6.0 \times 5100}{8.2 \times 3.35} = 2630 \text{ #/IN}$$

$$q_1 = \frac{6.0 \times 5100}{8.2 \times 7.35} = 1110 \text{ #/IN}$$



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TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/5582/12

SHEET NO. 9-2

AIRCRAFT

C105

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CONTROL # 4

① SHEAR FLOW FROM 7/5582/10 SHT 137 + HINGE LOAD

RAY	①	②	③	④
NOMINAL SHEAR	280	280	280	280
q FROM RIVET	-678	551	551	551
q FROM HINGE			-1110	-2673
Σ			* -279	-1799

* SHEAR FLOW IS UNREASONABLY LOW.

② SHEAR FLOW BASED ON NOMINAL q OF 30% OF TOTAL FIN SHEAR ON SPAR #1
(REF. 7/5582/19 9-18)TOTAL FIN SHEAR AT STA 110 = 18,200
(REF 7/5582/38 SHT 2-14) $\therefore$ SHEAR SPAR #1 $\approx 18,200 \times 0.30 = 5460$

SPAR h = 3.35"

$$\therefore q = \frac{5460}{3.35} = 1630 \text{ #/IN}$$

ASSUMPTIONS:

- (1) ASSUMING MORE OF HINGE SHEAR, FROM UPPER LUG, (60%) GOES DOWN SPAR #1 THAN FOR'D INTO FIN VIA RIB AT STA 11.7
- (2) NONE OF HINGE SHEAR FROM LOWER LUG GOES INTO UPPER RIB.
- (3) NONE OF RIVET LOADS GOES INTO UPPER RIB.

$$\therefore \text{SHEAR LOAD ACROSS HOLE} = 5460 \times 0.6 + 5100 = 8380$$

$$\therefore q = \frac{8380}{3.35} = 2500 \text{ #/IN}$$

* SEE NEXT PAGE



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TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/2587/12

SHEET NO. 9-4

AIRCRAFT

C105

FIN

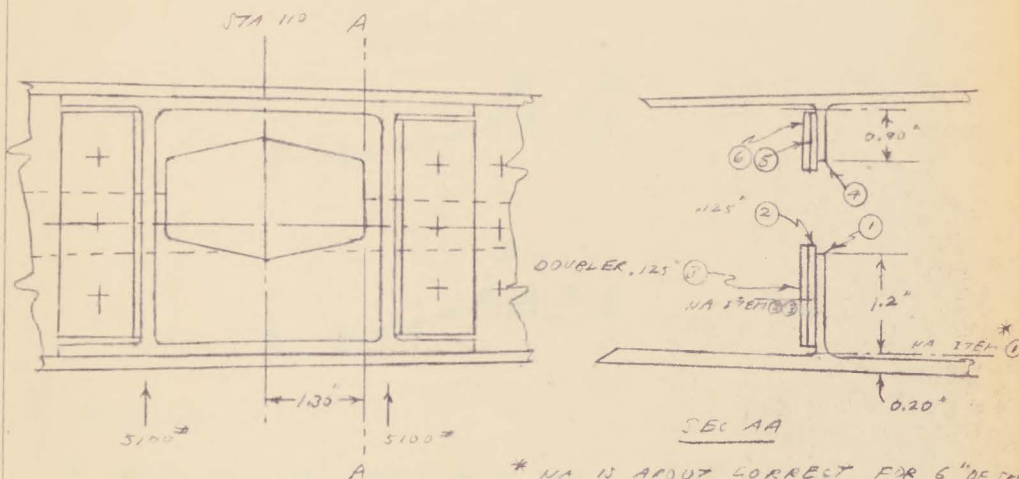
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CONTROL # 4



* NA IS ABOUT CORRECT FOR 6" OF FIN WITH $C = .15$

SHEAR LOAD TO BE TRANSMITTED ACROSS HOLE = 8780

ASSUMING SHEAR CARRIED BY ELEMENTS & I,
ASSUMING ELEMENTS BEND ABOUT THEIR OWN NEUT AXIS.

$$I \text{ ITEM } ① = \frac{1.2^3 \times 0.12}{3} = 0.0695 \text{ " }^4 \leftarrow 46.1\% \text{ OF TOTAL } I$$

$$I \text{ ITEM } ②③ = \frac{1.2^3 \times 0.25}{12} = 0.0362 \text{ " }^4$$

$$I \text{ ITEM } ④ = \frac{0.9^3 \times .12}{3} = 0.0293 \text{ " }^4$$

$$I \text{ ITEM } ⑤⑥ = \frac{.9^3 \times .25}{12} = 0.0152 \text{ " }^4$$

$$\Sigma I = 0.150 \text{ " }^4$$

$$I \text{ ITEM } ① \text{ REACTS } 46.1\% \text{ OF LOAD} = .464 \times 8780 = \underline{3890}$$

ASSUMING FIXED END AT SEC AA
AND FLEXURE POINT AT STA 110,

$$M_{110} = 1.7 \times 3890 = \underline{5050} \text{ " }^4$$

$$f_b = \frac{5050 \times 1.2}{0.0695} = 87400 \text{ PSI (NOTE FIN FB IS SMALL HERE)}$$

* SEE PREVIOUS SHEET

$$F_b \text{ \& } F_{cy} = 76,000 \text{ PSI (INCLUDING PLASTIC BENDING) * M.S. = } \underline{.13}$$

REVISION 1.0 11/17/12

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7/0553/1A

SHEET No. 9-4A

AIRCRAFT:

C195

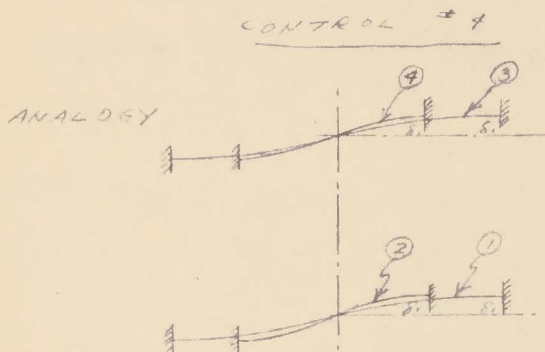
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ASSUMPTIONS:

- ① ALL BEAMS DEFLECT THE SAME AMOUNT
- ② ALL BEAMS BEND SEPARATELY,
- ③ WEB IS FIXED AT THE EDGE OF THE HOLE.
- ④ STRINGER IS FIXED AT FITTING ATTACHMENTS

- ∴ GEOMETRY IS SAME
- ∴ LOAD CAN BE PROPORTIONED BETWEEN ① & ③, AND ② & ④

$$\therefore \text{LOAD ON } ① \text{ \& } ② = \frac{I_①}{I_① + I_②} = \frac{0.0695}{0.0695 + 0.0293} \times 100 = 70.3\%$$

(OF TOTAL P)

EQUATING $\delta = \frac{PL^3}{3EI}$ TO DET'M LOAD ON EACH STRINGER

$$\frac{P_1 \times 2.27^3}{3E \times 0.0695} = \frac{P_2 \times 1.2^3}{3E \times 0.0293}$$

$$P_1 = \frac{60.7}{168} P_2$$

$$P_1 + P_2 = 2380 \times 0.703 = 1673 \text{ lbs}$$

$$P_1 = 1673 \times \frac{60.7}{229} = 447 \text{ lbs}$$

ITEM ① $F_0 = (1560 \times 2.27) \frac{1.2}{0.0695} = 61200 \text{ PSI}$



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TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0582/12

SHEET NO. 9-5

AIRCRAFT

C105

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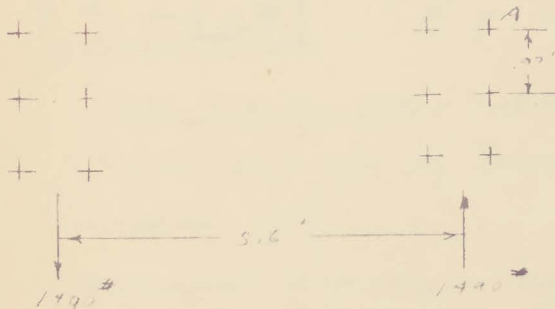
CONTROL # 4ATTACHMENTS TO DOUBLER.

LOADS DUE TO HINGE LOAD = 10,200 #

LOAD / RESULT = $\frac{10,200}{6} = 1700 \# \uparrow$ LOADS DUE TO SHEAR IN DOUBLERSHEAR REACTED BY DOUBLER = $\frac{I_{DOUBLER} \times \text{SHEAR}}{I_{TOTAL}}$

$$= \frac{.0181 + .0076 \times 8350}{.150}$$

$$= 1490 \#$$



ASSUMING $\frac{1}{2}$ MOM
COMES OFF ON
EACH SIDE.

$$\text{MOM / SIDE} = \frac{1490 \times 5.6}{2} = 4170 \#$$

$$\Sigma R^2 = .15^2 \times 6 + .97^2 \times 4 = 5.26 \#$$

$$P \leftarrow = \frac{4170 \times .97}{5.26} = 770 \#$$

$$P \uparrow \text{ DUE TO MOM} = .15 \times \frac{4170}{5.26} = 396 \#$$

$$P \uparrow \text{ " " " SHEAR} = \frac{1490}{1} = 248 \#$$

$$P \uparrow \text{ " " " HINGE LOAD} = \frac{10,200}{12} = 850 \#$$

$$P \text{ RESULT} = \sqrt{770^2 + 1490^2} = 1690 \#$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/2583/12

SHEET NO. 9-2

AIRCRAFT:

C105

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CONTROL # 1

CALC. OF BENDING STRESS AT STA 112

I TOTAL OF FIN = 72.6 "⁴ (REF 7/0553/38 SHT 1-12)

B.M. TOTAL = 620,000 "³ (REF. 7/0553/38 SHT 3-14)

DIST. OF FIN FROM NA = 2.0 "

$$\therefore f_b = \frac{620,000 \times 2}{72.6} = 17,100 \text{ PSI}$$

NEGLECTING CONCENTRATION DUE TO FIN TWIST

COMBINING f_s & f_b BY HOOKE'S σ

$$\begin{aligned} f_{s \max} &= \sqrt{\left(\frac{f_b}{2}\right)^2 + f_s^2} \\ &= \sqrt{8550^2 + 32,100^2} \\ &= \underline{\underline{43,000 \text{ PSI}}} \end{aligned}$$

$$F_{SD} \text{ 255-76} = 43,000 \text{ PSI}$$

$$* 17.5 \approx 0.09$$

* SHEAR LOAD USED WAS LARGER THAN HIDE
RECENT INFORMATION - SEE 4 PAGES PREVIOUS.



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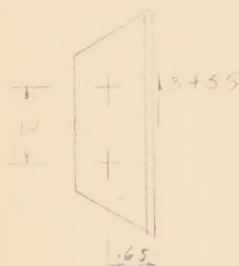
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RUBBER STRAP IN LINE #4 (7-0103-32)

HINGE ATTACHMENT TO HINGE



SHEAR LOAD ON HINGE = 5100 LBS

LOAD ON ATTACHMENT'S TRAP (TOP) =

$$.65 \times 5100 = 3310 \text{ LBS.}$$

1.0

LOAD ON ATTACHMENT FROM WHEAR LOAD =

$$5100 / 2 = 2550 \text{ LBS.}$$

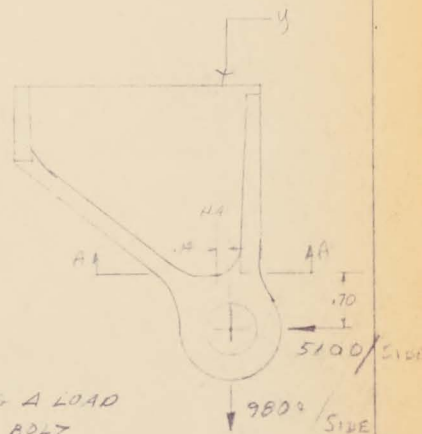
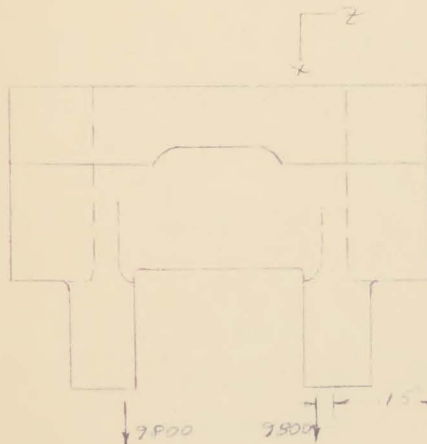
$$\text{RESULTANT} = (3310^2 + 2550^2)^{1/2}$$

$$= 4190 \text{ LBS.}$$

$$\text{ALLOW. LOAD } 1/4" \text{ BOLT (18000)} = 9650 \text{ LB}$$

$$\text{ALLOW. BEARING IN } 1/8" \text{ 75S-7L} = \frac{58670}{(125 \text{ ksi})} \text{ M.S.} = .11$$

STRESSES ON SEC. A-A

15 ← ASSUMING A LOAD
DIST. 04 BOLT

MOMENTS ON SEC. A-A

$$M_{EA} = .70 \times 5100 + .14 \times 9800$$

$$= 3570 + 1372 = 4942 \text{ IN. LBS.}$$

ASSUMING RUBBER IS ACCURATELY LOADED, THEN

$$M_{YA} = .15 \times 9800 = 1470 \text{ IN. LBS.}$$

$$M_{XA} = .15 \times 5100 = 765 \text{ IN. LBS.}$$

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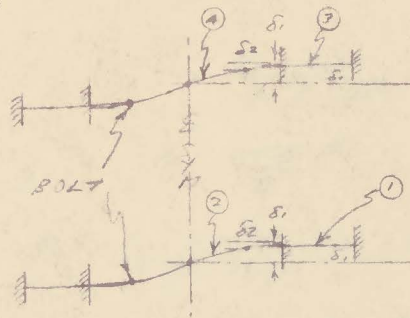
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CONTROL # 4

ANALOGY

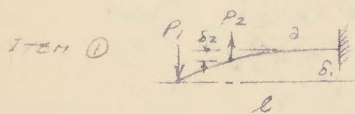


THE PROBLEM CAN BE SIMPLIFIED DUE TO THE FACT THAT THE GEOMETRY AND THE STIFFNESS OF THE WEB COMPARED TO THE STRINGER IS THE SAME ON EACH SIDE OF THE HOLE.

∴ LOAD ON ONE SIDE THE HOLE & STIFFNESS

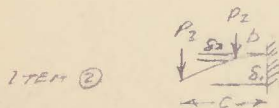
$$\begin{aligned} \% \text{ LOAD REACTED BY ITEM ① \& ②} &= \frac{I_0}{I_0 + I_3} \times 100 \\ &= \frac{0.0675}{0.0675 + 0.0273} \times 100 \\ &= 70.3\% \end{aligned}$$

PROPORTIONING LOAD BETWEEN ITEM ① & ②



$$\delta_1 = \frac{P_1 \times l^3}{3EI_1} - \frac{P_2 a^2 (3l - a)}{6EI_1} \dots (1)$$

$$\delta_2 = -\frac{P_2 \times a^3}{3EI_1} + \frac{P_1 a^2 (3l - a)}{6EI_1} \dots (2)$$



$$\delta_1 = \frac{P_2 \times c^3}{3EI_2} + \frac{P_3 b^2 (3c - b)}{6EI_2} \dots (3)$$

$$\delta_2 = \frac{P_2 \times b^3}{3EI_2} + \frac{P_3 c^2 (3c - b)}{6EI_2} \dots (4)$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. _____

SHEET No. 9-16

AIRCRAFT:

C105

FIN

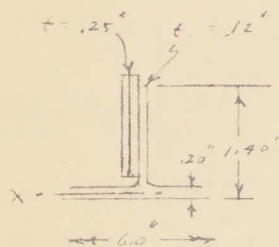
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INVESTIGATION OF BONDING DOUBLERS
TO SPAR # 1



CONTROL # 4

$$\bar{y} = \frac{1.4 \times .37 \times 0.7}{1.4 \times .37 + 6.0 \times .2} = 0.21$$

$$I_{LEG} = \frac{.37 \times 1.39^3}{7} = 0.157 \text{ in}^4$$

$$I_{FIN} = 6 \times .20 \times .21^2 = 0.057$$

$$I_{TOT} = 0.210 \text{ in}^4$$

WHEN SHEAR ACROSS HOLE = 8380

$$\text{THEN LOAD CARRIED ON THIS SIDE} = 8380 \times \frac{6.1^2}{1.1^2 + .8^2} = 6040$$

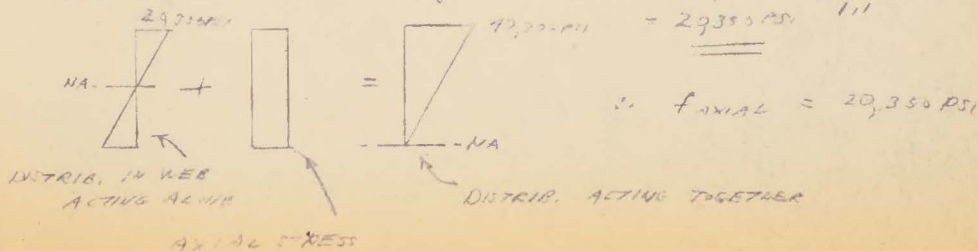
$$\therefore P.H. = 1.3 \times 5330 = 7850 \text{ lb}$$

THEN: ASSUMING IT ALL ACTS TOGETHER.

$$f_b = \frac{7850 \times 1.09}{0.210} = 90,700 \text{ PSI}$$

IF ITEMS ACT SEPARATELY AND CURVATURE IS THE SAME THEN f_b IN WEB = $90,700 \times \frac{0.55}{1.1}$

$$= 29,350 \text{ PSI}$$





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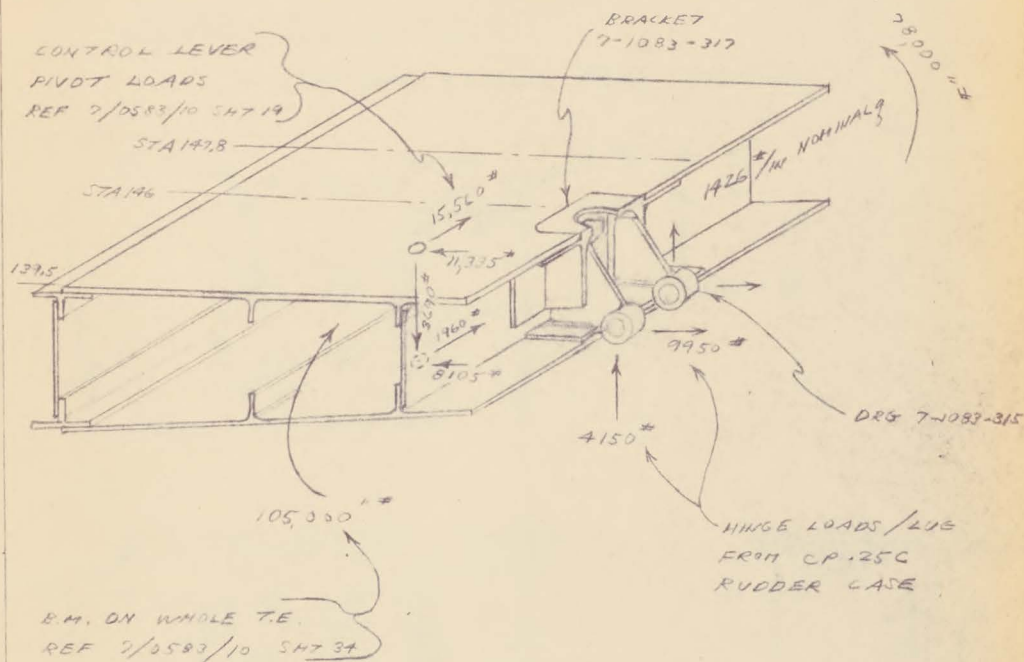
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CONTROL HINGE #5DISCUSSION

A RIGOROUS ANALYSIS WHICH WOULD BALANCE ALL LOADS DOES NOT SEEM PRACTICAL FOR SEVERAL REASONS. FIRSTLY, THE CRITICAL HINGE LOADS ARE FROM THE CP.250 RUDDER CASE, WHILE THE SHEARS ON THE FIN ARE FOR THE CP.50 CASE. SECONDLY, THE CONCEPT OF ISOLATING THE T.E. BOX MAY NOT YIELD EXACT RESULTS.



AVRO AIRCRAFT LIMITED

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/05 82/12

SHEET NO. 10-4

AIRCRAFT.

C105

FIN

PREPARED BY

DATE

CHECKED BY

DATE

CONTROL * 1BOLT LOADS FROM 3440 * WKT LOAD

ASSUMPTIONS: THE LOAD IS REACTED BY
BOLTS 2, 4, 9, AND 10. FITTING BENDING
RELIEVES LOAD IN BOLTS 1, AND 3.

LOAD IS ASSUMED $\propto$ AREA BR

BOLT	AREA BR	T. AREA	LOAD
2	0.312 x .1	31	1066
4	0.312 x .1	31	1066
9	0.19 x .1	19	654
10	0.19 x .1	19	654

ALL LOADS IN
CHORDWISE DIRECTION
POSITIVE "A"

BOLT LOADS DUE TO END LOADS

$$F_C \text{ IN FITTING THROUGH ITEM 11 547}$$

$$= \frac{\text{MOM } 700 \times 9 \times \frac{E}{L}}{I}$$

$$= \frac{27,000 \times 112 \times 9}{13.54}$$

$$= 27,000 \text{ PSI}$$

$$\therefore \text{LOAD} = 27,000 \times \text{AREA ITEM 11}$$

$$= 27,000 \times .204$$

$$= 5500 \text{ \#}$$

ASSUMPTIONS:

LOAD IS REACTED BY BOLTS 1, 2, 9, 10, 5, AND 6
IN $\propto$ THEIR DIAMETERS.

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0583/12

SHEET NO. 12-8

AIRCRAFT:

C105

FIN

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CONTROL #5

SPAR #1 (SHEAR FLOW)

WE HAVE REASON TO DOUBT THE SHEAR FLOWS GIVEN IN 7/0580/10 SINCE THEY ARE UNREASONABLY LOW IN SOME CASES.

ESTIMATED SHEAR FLOW IN SPAR #1 BASED ON 30% OF TOTAL FIN SHEAR (REF 7/0583/14 4-18)

TOTAL FIN SHEAR AT STA 146 = 15,200 #

∴ SHEAR ON SPAR #1 = $15,200 \times .30 = \underline{4550}$ #

ASSUMING 60% OF UPPER LUG LOAD GOES ACROSS FITTING.

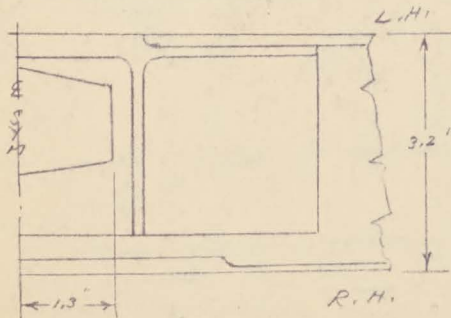
UPPER LUG LOAD = 4150 #

SHEAR DUE TO HINGE LOAD = $4150 \times .6 = \underline{2490}$ #

* ∴ TOTAL SHEAR = $4550 + 2490 = \underline{7040}$ #

* SEE NEXT PAGE

BENDING NEAR HOLE



SKIN DIM 7-0193-129

SHEAR IS TRANSFERRED ACROSS HOLE BY BENDING OF FITTING & MACHINED SKIN STRINGER.

ASSUMPTIONS:

① ALL SHEAR IS REACTED ON R.H. SIDE OF HOLE

② ELEMENTS ARE FIXED ADJACENT TO EDGE OF HOLE.

③ LOAD & STIFFNESS OF ELEMENTS

④ EACH ELEMENT BENDS ABOUT ITS OWN NA.

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REPORT NO. 7/0593/12

SHEET NO. 10-9

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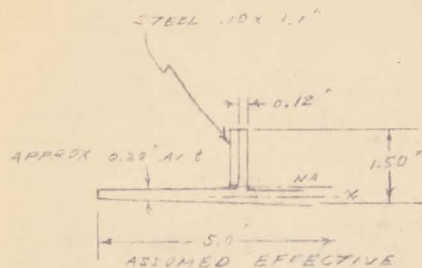
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6 Gaudin
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CONTROL #5



C.G.

$$y = \frac{1.4 \times .12 \times 0.7}{1.4 \times .12 + 5 \times .2} = 0.10"$$

$$I_{\text{MACHINED SKIN}} = \frac{1.3^3 \times 0.12}{3} + 0.10^2 \times 1.6 = 0.099 \text{ in}^4$$

$$I_{\text{STEEL BRACKET}} = \frac{1.1^3 \times .10 \times 3}{12} = 0.033 \text{ in}^4$$

$$I_{\text{TOT}} = 0.131 \text{ in}^4$$

$$B.M = 7040 \times 1.3 = 9190 \text{ in} \cdot \text{lb}$$

$$F_B \text{ MACHINED SKIN} = \frac{9190 \times 1.3}{.131} = 91000 \text{ PSI}$$

$$F_c = F_{cy} (\text{PLASTIC BENDING FOR REIT}) = 76 \text{ KSI}$$

AIRCRAFT MANUAL

* 17.5.2 - 16

* SHEAR USED IN ANALYSIS AND FOR M.S. WAS 7040 #

SHEAR FROM LATER INFORMATION INDICATES A SHEAR OF 4600 #
REF 7/0593/10 130-37

NOTE: S. Young SEPT. 28/55.

$$F_B = 91000 \text{ PSI}$$

$$F_{BU} = F_{TU} \times \text{FORM FACTOR} = 77010 \times 1.5 = 115,500 \text{ PSI}$$

MS=

26



AVRO AIRCRAFT LIMITED

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 2/2587/12

SHEET NO. 10-11

AIRCRAFT

C105

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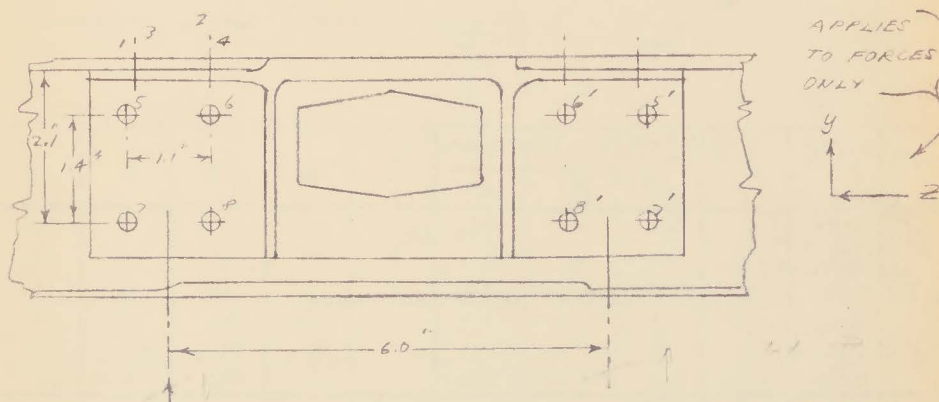
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CONTROL #5BOLT LOADS DUE TO SHEAR

SHEAR = 3450 #

APPLIES
TO FORCES
ONLY2. LOAD CARRIED BY FITTING & I OF FITTING
AND MACHINED SKIN $I_{SKIN} = 0.008 \text{ in}^4$ $I_{FITTING} = 0.003 \text{ in}^4$

$$\% \text{ LOAD IN FITTING} = \frac{0.003}{0.008 + 0.003} \times 100 = 29.8\%$$

$$\text{LOAD} = 0.298 \times 3450 \text{ lbs} = 1030 \text{ #}$$
ASSUMING $\frac{1}{2}$ MOM REACTED ON EACH SIDE
$$\therefore \text{MOM} = \frac{6.0}{2} \times 1030 = 3090 \text{ # in}$$

 ASSUMING SHEAR REACTED BY BOLTS 5, 6, 7, 8
 AND MOM BY BOLTS 5, 6, 7, 8, 1, AND 2

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

REPORT NO. 7/0133/12

SHEET NO. 10 - 12

AIRCRAFT:

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CONTROL 5

C.G.

$$y = \frac{0.20 \times 2 \times 2.1 \times 2}{6} = 0.93" \text{ FROM L.H. SKIN}$$

$$\text{DIRECT LOAD EACH} = \frac{-2100}{4} = -525$$

	y	z	y ²	z ²	M/I	LOADS FROM 120		DIRECT LOAD P _y	Σ P _y	Σ P _z	P _{RES}
						P _x	P _y				
1	.93	-	.87	-	1090	1010	-	-	-	1010	
2	.93	-	.87	-		1010	-	-	-	1010	
5	.23	-.53	.05	.28	↓	250	-600	525	-75	250	
6	.23	+.53	.05	.28		250	+600		1125	250	
7	-1.12	-.53	1.27	.28		-1230	-600	↓	-75	-1230	
8	-1.12	+.53	1.27	.28		-1230	+600	525	1125	-1230	
1'					1090	1010	-	-525	-525	1010	
2'						1010	-		-525	1010	
5'						250	600	↓	75	250	
6'					↓	250	-600		-1125	250	
7'						-1230	600		75	-1230	
8'						-1230	-600	-525	-1125	-1230	

4.58 1.21

$$I = 5.79$$

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT

C-105

REPORT NO. 2/0583/12

SHEET NO. 10-15

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$$Q_{P10} + Q_{P90} = 19,900 / 2 = 9950 \text{ lbs.}$$

BETWEEN
SHEAR FACES

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0503/12

SHEET No 10-16

AIRCRAFT

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DATE _____

MCCABE

CHECKED BY

DATE _____

MOMENT ON ATTACHMENTS: $1.16 \times 4150 - 1.37 \times 3440$

$$= 4820 - 4720 = 100 \text{ m.ABS}$$

T	y	x	M	10905 + 1007 (-10905 -1007)		Py = 4150	Px = 3440	Py (10104)	Px (10104)	RE2002
				Py	Px					
1	.52	-.50	48	27	25	-1040	-860	-1016	-835	
2	.52	.50	↓	27	25	↑	↑	-1064	-835	
3	-.52	-.50	↓	27	-25	↓	↓	-1016	885	
4	-.52	.50	48	-27	-25	-1040	-860	-1064	885	1780

19.5 2650 - 1

1380

BOLT TO SKIN - 1 DIA

$$\text{LOAD} = \frac{7950 + 2440}{2} = 3350 \text{ EACH}$$

MS. 92

 $\frac{1}{4} \text{ BRG } 155 = 3850$

$\frac{1}{4}$ BRG 124 = 4550

ALLOW SHEAR = 9650

$$\text{ALLOW (AVG)} = 4200$$
$$M.F. = .25$$



AVRO AIRCRAFT, LIMITED

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/05-82/12

SHEET NO. 12-17

AIRCRAFT

C-105

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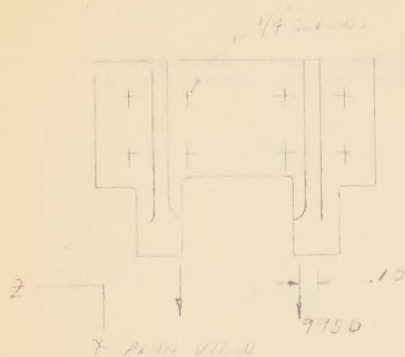
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CROSS SECTION HINGE #5 (70193-22)

STRESS ON SEC. A-A (REF. PG. 16)



MOMENTS ON SEC. A-A

FROM VIEW ON PG. 16,

$$M_{2A} = .34 \times 9950 + .70 \times 4015$$

$$= 3380 + 2800 = 6280 \text{ IN. LBS.}$$

LOADING AT PLAN VIEW, ASSUME

LUG TO BE ECCENTRICALLY LOADED, THEN

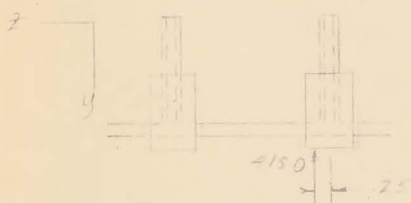
$$M_{yA} = .10 \times 9950 = 995 \text{ IN. LBS.}$$

LOADING AT END VIEW,

$$M_{xA} = .25 \times 4150 = 1040 \text{ IN. LBS.}$$

END LOAD = 9950 LBS. (24300N)

$$St = 9950 / .745 = 13300 \text{ PSI.}$$



END VIEW

SECTION PROPERTIES (SEC. A-A, PG. 16)

	AREA	Z-AXIS				Y-AXIS	
		y	Ay	Ay ²	I _c		I _c
1	.525	1.01	.53	.551	.108	0	.0056
2	.220	.123	.027	.003	.01	0	.0192
3	.745	1.76	.523	.334	.187		.0138

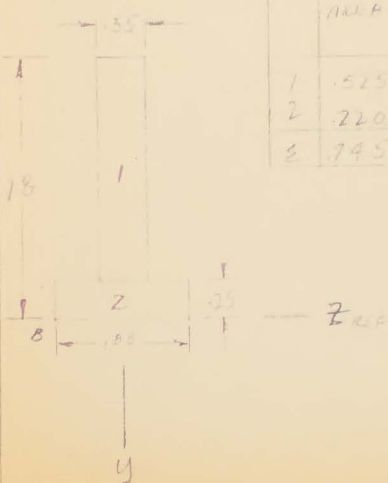
$$I_z = .108 + .334 + .176 + .523$$

$$= .623 + .429 = .234$$

$$I_y = .0138$$

$$I_z/c = .234 / .76 = .308$$

$$I_y/c = .0138 / .44 = .045$$



SEC. A-A

AIRCRAFT

C-105

PREPARED BY

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DATE _____

HINGE SIDE LOAD = 3230 LBS.

HINGE DRAG LOAD = 440 LBS.

$$\text{K.H. SMITH REACTION} = \frac{3230 \times 2.44}{2.28} + \frac{1.86 \times 490}{2.28}$$

$$= 5229 \text{ LBS}$$

$$L.H. SKIN RELATION = 4870 + 440 \times \frac{.42}{2.28} = 4951.85$$

$$\text{LOAD ON ATTACHMENTS FROM LINEAR} = \frac{5229}{2} = 2615 \text{ \#}$$

$$R_{\text{SULFATE}} = (2615^2 + (77 + 354)^2)^{\frac{1}{2}} = \underline{\underline{2670}}$$

$$\text{ALLOWABLE SHEAR \# BOLT (FOM 2100 ksi)} = 4650^*$$

ALLOWABLE BEARING IN 11" 755-76 FITTING = 3750 M.S. = 0.40

ALLOWABLE PEARLING IN SKIN .16 COR = 4600* (PENG MAY 92)

ATTACHMENT TO L. H. SKIN.

LOAD PER BOLT = 495 #

$\frac{5}{16}$ " NAS SCREW W/ .14 = 6000 # (BEARING BEARING 100 .19 C/A = 6000#)

(CONTINUED NEXT PAGE)

M.S.

• 21



AVRO AIRCRAFT LIMITED

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/3523/12

SHEET NO. 11-2

AIRCRAFT:

C-105

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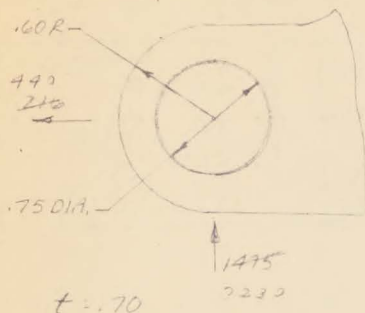
DATE

M. C. B. F.

5-25-55

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DATE

RUDDER HINGE - LOWERLUG

TRANSVERSE LOAD 1475 #

AXIAL LOAD = 216 #

MARGIN AXIAL LOAD

$$d = .60$$

$$D = .75$$

$$W = 1.20$$

$$t = .70$$

$$d/D = .60/.75 = .80$$

$$W/D = 1.2/.75 = 1.6$$

$$D/t = .75/.70 = 1.07$$

$$A_{br} = .75 \times .70 = .525 \text{ IN}^2$$

$$A_t = (1.2 - .75) \times .70 = .315$$

$$K_t = .84$$

$$K_{br} = .54$$

$$P_{br} = .54 \times .525 \times 70,000 = 19,800 \text{ LBS.}$$

$$P_{t} = .84 \times .315 \times 70,000 = 18,500 \text{ LBS.}$$

ALLOWABLE TRANSVERSE LOAD

$$A_{AV} = .70 \times 225 = .157$$

$$A_{AV} = .157 \times .30$$

$$A_{br} = .525$$

$$K_{br} = .12$$

$$P_{br} = .12 \times .525 \times 70,000 = 4410 \text{ LBS.}$$

MARGIN OF SAFETY

AXIAL LOAD NEGLECTABLE

$$M.S. = \frac{4410}{3230} - 1 =$$

(METHOD IS PESSIMISTIC)

$$M.S. > .36$$

ATTACHMENT TO SPAR WEB (CONT FROM PREVIOUS SAT)

$$\text{LOAD} = 3230 \text{ #}$$

$$\text{ALLOWABLE SHEAR } \frac{1}{4} \text{ BOLT} = 4650 \text{ #}$$

$$\text{ALLOWABLE BEARING IN } 0.11 \text{ FITTING } 755 \times 76 = 3760 \text{ #} \quad M.S. = 0.17$$

F.A.M. = 127 KSI



AVRO AIRCRAFT LIMITED

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 2/3182/12

SHEET NO. 12-1

AIRCRAFT:

C105

SIDE 1 WEB

STA 42 OUTBOARD

PREPARED BY

DATE

S. YOUNG

MAY 3/55

CHECKED BY

DATE

LOADING

FROM 7/0582/12 VII 137

CONTROL	HINGE	WEB γ
1		2542
2		1430
3		1023
4		1022
5		2022

MAX WEB $\gamma = 2542\%$ AT CONTROL #1

FROM 7/0582/12 VII I 137

CONTROL	HINGE	WEB γ
1		1350
2		1070
3		1000
4		1005
5		1150

MAX WEB $\gamma = 1550\%$ AT STA 24 (REF)
1450% AT CONTROL #5



AVRO AIRCRAFT LIMITED
TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/5547/12

SHEET NO. 68

AIRCRAFT

C105

FIN

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CONTROL #1

SHEAR LOAD ACROSS HOLE

(SEE 7/5547/H 4-15)

ASSUMING SHEAR = 33% TOTAL FIN SHEAR
+ 60% OF UPPER LUG LOAD

$$\begin{aligned} &= 0.33 \times 34,000 + 0.60 \times 7,600 \\ &= 9,890 + 4,560 \\ &= 13,950 \end{aligned}$$

* THE M.S. WILL BE QUOTED ON THE ABOVE LOAD
HOWEVER, LATER WORK (7/5583/10 INT 138-32)
INDICATES A SHEAR OF 2250 PSI

DOUBLER AND WFS ON ONE SIDE CARRY 34.3%
OF TOTAL LOAD.

$$LOAD = .343 \times 13,950 = 4780$$

$$F_s = \frac{4780 \times 1.3 \times 0.6}{0.036} = 127,000 \text{ PSI}$$

(DUE TO SHEAR)

$$\begin{aligned} \text{TO ONE TO FIN BENDING} &= \frac{2 \times 10^6 \times 2.1}{10^3} \text{ PSI} \\ &= 21,000 \text{ PSI} \end{aligned}$$

$$F_{TOT} = 127,000 \text{ PSI}$$

$$F_s = F_{YU} \times \text{YIELD FORM FACTOR} = 76 \text{ KSI}$$

NOTE 1. Young SEPT 28/55

$$F_{B \text{ TOTAL}} = 127,000 \text{ PSI}$$

$$F_{BU} = F_{YU} \times \text{FORM FACTOR} = 72000 \text{ CAL 755T. 1.5} = 108000 \text{ PSI}$$

M.S. =

M.S. = 40

-15

A. V. RO

TE

AIRCRAFT

WEIGHT

C. G. POSIT

SUMMARY OF BOLT LOADS & M.S.

* SEE 3 PAGES PREVIOUS

BOLT	1	2	3	4	5	6	7	8	9	10	11
	DUE TO FITTING			DUE TO END LOAD			DUE TO SHEAR FL				
	P_x	P_y	P_z	P_x	P_y	P_z	P_x	P_y	P_z	ΣP_x	ΣP_y
1						1130			1010		
2	1066					1130			1010		
3											
4	1066									1066	
5		386	322			920		-75	250		311
6		870	322			920		1125	250		195
7		786	-214					-75	-1230		31
8		860	-214					1125	-1230		193
9	654					700				654	
10	654					700				654	
11		1673	-214								

MALTON, ONTARIO
TECHNICAL DEPT. (AIRFRAME)

SHEET . . . 10 - 13

DATE . . . AUG 55

PREPARED BY W. H. G.

AIRCRAFT . . .

WEIGHT _____

C. G. POSITION _____

8	9	10	11	12	13	14	15	16	17	18	19
TO SHEAR FL					P_R			*			
P_g	P_{Σ}	ΣP	ΣP_g	ΣP_2	RESULT LOAD	ALLOW.	TYPE OF FAILURE	M.S.			
	1010			2140	2140	6200	$\frac{1}{2}$ BOLT TACK IN 120° SCIN	1.9			
	1010			2140	2400	6200		1.6			
						6200					
		1066			1066	6200	Y	OK			
-75	250		311	1492	1530	3120	$\frac{1}{2}$ BOLT M. 291 IN DEG.	1.0			
1125	250		1955	1492	2460	3120		0.27			
-75	-1230		311	-1444	1470	3120		1.1			
1125	-1230		1985	-1444	2460	3120	Y	0.27			
		654		700	960	1900					
		654		700							

