

QCX
AVRO
CF105
R-7-0558-82



TECHNICAL REPORT



ANALYZED

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT: C.105REPORT NO. 7/0558/82

FILE NO:

NO. OF SHEETS: 277TITLE: DETAIL STRESS ANALYSIS

FOR 'LOADING' REPORT SEE 7-0558-12/2.

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ISSUE NO.	REVISION NO.	REVISED BY	APPROVED BY	DATE	REMARKS
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AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-32

SHEET NO. 5

AIRCRAFT:

C.105

TORSION BOX

PREPARED BY

DATE

J.B. YOUNG

11.5.56

CHECKED BY

DATE

CELL 2 PANEL 1-2

$$h = 3.0 \quad b = 4.8 \quad t = .0635 \quad L = L_f = .060$$

$$\frac{b}{h} = 1.23 \quad K_{33} = 7.25$$

$$\frac{E_u}{E} = \frac{E_f}{E} = .345 \quad R_u = R_d = .645$$

$$E_{ELASTIC} = 7.25 \times 10^6 \left(\frac{.0635}{.33} \right)^2 \times .645$$

$$= 11,840 \text{ lb/in}^2$$

$$\text{ACTUAL } E_{EL} = 10,600 \text{ lb/in}^2$$

$$I = \frac{.689}{.0635} = 10,800 \text{ lb/in}^2$$

SNY PANEL IS SNYIA RESISTANT

CELL 3 PANEL 1-2

$$b = 2.0 \quad h = 4.12 \quad t = .0635 \quad L = L_f = .06$$

$$\frac{b}{h} = 2.06 \quad K_{33} = 6.0$$

$$\frac{E_u}{E} = \frac{E_f}{E} = .345 \quad R_u = R_d = .645$$

$$E_{ELASTIC} = 6.0 \times 10^6 \left(\frac{.0635}{.33} \right)^2 \times .645$$

$$= 37,200 \text{ lb/in}^2$$

$$\text{ACTUAL } E_{EL} = 34,700 \text{ lb/in}^2$$

$$I = \frac{175}{.0635} = 2,760 \text{ lb/in}^2$$

PANEL IS SNYIA RESISTANT



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MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO.

7-0552-82

SHEET NO.

19

AIRCRAFT:

C.105

TORSION BOX

PREPARED BY

DATE

CHECKED BY

DATE

PANELS 1-2 SHEAR WEBS WITH LATERAL PRESSURE

CELL WITH HIGHEST $\frac{b}{d}$ RATIO IS CELL 5
CONSIDER THIS CELL WITH A LATERAL
PRESSURE OF 24.85 PSI

CELL 5

$$L = 9.85 \times 10^6 \quad b = 8.6 \quad h = 3.9 \quad e = .039$$

$$\frac{b}{d} = 145.6 \quad \left(\frac{b}{d}\right)^2 = 20600 \quad \left(\frac{b}{d}\right)^3 = 425 \times 10^6$$

$$\frac{P}{L} \left(\frac{b}{d}\right)^3 = \frac{24.85 \times 425 \times 10^6}{9.85 \times 10^6} = 1106$$

$$\frac{E_1}{L} \left(\frac{b}{d}\right)^2 = 32.5 \quad \frac{E_1}{L} \left(\frac{b}{d}\right) = 2.5$$

$$f_1 = \frac{32.5 \times 9.85 \times 10^6}{20,600} = 24,350 \text{ lb/in}^2$$

$$f_3 = \frac{24,350 \times 2.5}{52.5} = 11,580 \text{ lb/in}^2$$

$$\tau_{CR \text{ side}} = 6900 + 5930 = 12,600 \text{ lb/in}^2$$

$$\sqrt{\tau_{CR \text{ side}}} = \frac{14880}{12,600} = 1.17 \quad K_2 = .020$$

$$\text{MAX TENSION} = 11,580(1 + .020) + 12,170 = 27,470 \text{ lb/in}^2$$

$$\tau_{TALL} = 33,300 \text{ lb/in}^2$$

$$K_1 = 1.23$$

AS CELL IS SATISFACTORY OTHER 1-2 PANELS
ARE OK



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REPORT No. 7-0558-82

SHEET No. 25

AIRCRAFT:

C.105

TORSION BOX

PREPARED BY

J.B. YOUNG

DATE

9-5-56

CHECKED BY

DATE

PANELS 1-5 LIGHTNING HOLE IN 1040 DOUGLAS
IN CELLS 4-5

CELL 4

$k = 5.2$ $b = 48$ $l = 0.32$ $l_u = 0.65$ $l_f = 10$

$\frac{h}{b} = 1.06$ $K_{ss} = 8.2$

$\frac{c_u}{b} = 1.37$ $\frac{c_f}{b} = 3.12$ $R_u = 1.18$ $R_d = 1.63$

$$T_{CR, THEORETICAL} = 82.7 \times 10^5 \left(\frac{0.32}{48} \right) \left[1.18 + 0.75 \left(\frac{48}{0.32} \right)^3 \right]$$

$$= 5350 \text{ lb/in}^2$$

ACTUAL $T_{CR} = 5350 \text{ lb/in}^2$

$$C_u = \frac{447}{0.32} = 14000 \text{ lb/in}^2$$

$$\frac{T}{T_{CR}} = 2.62 \quad K = 207$$

72.0

STRESSES IN UPRIGHTS

$R_{UC} = 1153$

$\frac{R_{UC}}{C_u} = .75$

$\frac{C_u}{b} = 1.71$

$C_u = 2400 \text{ lb/in}^2$

$$C_{U, MAX} = 2400 (1 + 0.67 + 0.33 \times 2.75) = 2750 \text{ lb/in}^2$$

FORCED CRIPPLING

$$C_u = 32.5 \times 207^{1/2} \times 1.375 = 14280 \text{ lb/in}^2$$

$C_{U, MAX} < C_u$ OK

COLUMN FAILURE

$F_{CR} = 770,000 \text{ lb/in}^2$

WEB TO FLANGE ATTACHMENTS

$$R^u = 447 (1 + 1.14 \times 207) = 185 \text{ lb/in}^2$$

SEE SHEET NO



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TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 30

AIRCRAFT:

C.105

TORSION BOX

PREPARED BY

DATE

J.B. YOUNG

4-5-56

CHECKED BY

DATE

CELL 10 PANEL 45 (CONT)

TOP

SEE SHEET N°

UPRIGHT TO FLANGE RIVETS

SATISFACTORY BY INSPECTION

UPRIGHT TO WEB ATTACHMENTS

SEE DIAPHRAGM STRESSING

NOTE:

15 CELLS 2 AND 3 WEBS AND ATTACHMENTS
ARE SIMILAR BUT 7×500 LB/IN. IS OK.



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TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 34

AIRCRAFT:

C.108

TORSION BOX

PREPARED BY

J.B. YOUNG

DATE

4-5-56

CHECKED BY

DATE

CELL 6 PANEL 4-5

$$h = 3.6 \quad b = 4.1 \quad c = .05 \quad t_u = .033 \quad b_f = .043$$

$$\frac{b}{h} = 1.14 \quad k_{ss} = 7.65$$

$$\frac{t_u}{c} = 1.26 \quad \frac{c}{t} = .80 \quad R_u = .96 \quad R_D = .50$$

$$\tau_{CR ELASTIC} = 7.65 \times 9.55 \times 10^6 \times \left(\frac{.05}{3.6} \right) \left[.5 + .23 \left(\frac{3.6}{4.1} \right)^2 \right]$$

$$= 9210 \text{ lb/in}^2$$

$$\text{ACTUAL } \tau_{CR} = 8500 \text{ lb/in}^2$$

$$\tau = \frac{267}{.05} = 5340 \text{ lb/in}^2 \quad (\text{SHEAR RESISTANT})$$

720

WEB TO FLANGE ATTACHMENTS

BOTTOM $\frac{3}{16}$ RIVETS AT CP

$$\text{STRENGTH} = 1203 \text{ lb/in}$$

220

UPRIGHT TO WEB ATTACHMENTS

SEE DIAPHRAGM STRESSING

NOTE:

AS CELL 7 IS SIMILAR BUT $\tau < 2000 \text{ lb/in}^2$
ITS ATTACHMENTS AND WEB ARE OK.



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TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 35

AIRCRAFT:

C.105

TORSION BOX

PREPARED BY

DATE

J. B. YOUNG

1-5-56

CHECKED BY

DATE

CELL 7 1/8 PANEL 4 5.

$b = 3.6$ $b = 3.2$ $t = .05$ $E = 10.3$ $E_f = .010$

$\frac{A}{b} = 1.12$ $K_{ss} = 7.8$

$\frac{E_f}{E} = 1.26$ $\frac{E_f}{E} = .80$ $R_f = .96$ $R_D = .50$

$$\tau_{CR \text{ ELASTIC}} = 7.8 \times 7.55 \times 10^6 \left(\frac{.05}{3.2} \right)^2 \left[.76 - .23 \left(\frac{3.2}{3.6} \right)^3 \right]$$

$$= 19,520 \text{ lb/in}^2$$

ACTUAL $\tau_{CR} = 12,700 \text{ lb/in}^2$

$$\tau = \frac{5580}{.05} = 11,760 \text{ lb/in}^2 \quad (\text{SHEAR RESISTANT}) \quad 72.0$$

WEB TO FLANGE ATTACHMENTS

BOTTOM

1/4 IN 30 BOLTS STRENGTH 1500 lb/in

72.0

TOP

SEE SHEET NO

WEB TO UPRIGHT ATTACHMENT

SEE DIAPHRAGM STRESSING



AVRO AIRCRAFT LIMITED
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REPORT No. 7-0558-82

SHEET No. 36

AIRCRAFT:

C.105

TORSION BOX

PREPARED BY

DATE

T.B. YOUNG

2-5-36

CHECKED BY

DATE

PANELS 1-5 WEB THICKNESS REDUCED TO .040

CELL 1

$b = 3.6$ $d = 3.6$ $l = 0.1$ $l_0 = .663$ $c_f = .04$

$\frac{d}{b} = 1.0$

$R_{ss} = 8.65$

$\frac{c_0}{l} = 1.575$ $\frac{c_f}{l} = 1.0$

$R_H = 1.16$ $K_H = 1.10$

$$\tau_{CR ELASTIC} = 8.65 \times 9.55 \times 10^6 \left(\frac{.04}{3.6} \right)^2 [1 + .23] \\ = 8540 \text{ lb/in}^2$$

ACTUAL $\tau_{CR} = 8000 \text{ lb/in}^2$

$$\tau = \frac{826}{.04} = 20650 \text{ lb/in}^2$$

$\frac{\tau}{\tau_{CR}} = 1.58$

$K = 20.4$

STRESSES IN UPRIGHTS

$A_{UG} = .0553$

$\frac{A_{UG}}{b d} = .384$

$\frac{c_0}{c} = 24.5$

$c_0 = 5000 \text{ lb/in}^2$

$$c_{UNAX} = .5000 (1 + .667 \times .706 \times 24.5) = 5520 \text{ lb/in}^2$$

FORCED CRIPPLING

$$\tau_0 = 32.5 \times 20.4^{3/2} \times 1.57^{1/2} = 13,080 \text{ lb/in}^2$$

$\tau_{UNAX} < \tau_0$ OK

COLUMN FAILURE

$\tau_{CR} \approx 70,000 \text{ lb/in}^2$

WEB TO FLANGE ATTACHMENTS

$$R^* = 826 (1 + .414 \times 20.4) = 836 \text{ lb/in}$$

SEE SHEET N°

RF

146



AVRO AIRCRAFT LIMITED
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REPORT No. 7-0558-82

SHEET No. 45

AIRCRAFT:

C 105

TORSION BOX

PREPARED BY

J B YOUNG

DATE

10-5-56

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ATTACHMENTS (CONT)

CELL 1

PANEL A-S

BOTTOM

APPLIED SHEAR = 661 lb/in

ATTACHMENT - 547 $\frac{3}{16}$ RIVETS AT TP

STRENGTH = $547 \times 30 \times \frac{1}{17} = 1100 \text{ lb/in}$

R.F. = 1.28

1.28

CELL 10

PANEL A-S

$q = 1320 \text{ lb/in}$

HINGE SIDE - BETWEEN FRAMES

ATTACHMENT - $\frac{3}{16}$ 45 RIVETS AT TP
6 RIVETS

LOAD/RIVET = $\frac{1320 \times 4.9}{6} = 1051 \text{ lb}$

LOAD/RIVET DUE TO LOCAL LOADING = $\frac{600 \times 4.8}{6}$

= 487 lb

TOTAL LOAD/RIVET = $1051 + 487 = 1538 \text{ lb}$

STRENGTH = 1051 lb R.F. = 0.92

0.92

AT FRAMES

TENSION LOAD ON BOLT = 128 lb

TENSION ALLOWABLE = 653 lb

1.52

LOAD/RIVET ON DIFFERENT $\frac{800 \times 3}{12} = 397 \text{ lb}$

LOAD/RIVET DUE TO LOCAL LOAD = 487 lb

TOTAL LOAD = 487 lb

ALLOWABLE = 1281 lb

R.F. 2.6

NOTE

CELL 10 R.F.'S COVER CELL 2 AS SHEAR
FLOW IN CELL 2 IS LESS.



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REPORT NO. 7-0558-82

SHEET NO. 47

AIRCRAFT:

C 105

TORSION BOX

PREPARED BY

DATE

J. B. YOUNG

10-5-56

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DATE

ATTACHMENTS (CONT)

CELL II PANEL 2-3

BOTTOM

$\frac{5}{32}$ HONELL RIVETS AT 7P

STRENGTH = $1055 \times \frac{1}{4} = 1500 \text{ lb/in}$

APPLIED LOAD = 1975 lb/in

RF = 1.018

1.02

ATTACHMENTS OK.

AS CELL II IS NOT LOADED CELL ALL OTHER PANELS ARE OK USING $\frac{5}{32}$ HONELL AT 7P.

CELL 2 PANEL 7-2

BOTTOM

$\frac{5}{32}$ 30 BOLTS AT 8P

STRENGTH = $\frac{5}{32} \times 0.52 \times 170,000 = 1375 \text{ lb/in}$

1.46

APPLIED LOAD = 1357 lb/in

CELLS 3-5 ARE SATISFACTORY USING $\frac{5}{32}$ 30 BOLTS AS SHOWN

CELL II PANEL 3-4

TOP

ATTACHMENT CHERRY $\frac{5}{32}$ HONELL RIVETS AT 7P

APPLIED LOAD = 1126 lb/in

STRENGTH IN 051 TC = $\frac{1}{4} \times 0.52 \times 170,000 = 1738 \text{ lb/in}$

STRENGTH IN 040 753 TC = $0.52 \times 170,000 \times \frac{5}{32} = 1400 \text{ lb/in}$

RF = 0.75

0.75

ALL OTHER 3-4 PANELS HAVE $2 \times 1000 \text{ lb/in}$ ATTACHMENTS ARE OK.



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 48

AIRCRAFT:

C.105

TORSION BOX

PREPARED BY

J.B. YOUNG

DATE

10-5-56

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ATTACHMENTS (CONT)

CELL 11 PANEL 4-5

120
ATTACHMENT = $\frac{5}{32}$ MONEL RIVETS AT 6P

STRENGTH = $636 \times 146 \times \frac{825}{6} = 1278 \text{ lb/in}$

APPLIED SHEAR = 1038 lb/in

RF = 1.23

R.F.

1.23

BOTTOM

= $\frac{5}{16}$ RIVETS AT 7P

STRENGTH = $862 \times \frac{3}{4} = 1110 \text{ lb/in}$

RF = 1.07

1.07

ALL OTHER 4-5 PANEL ATTACHMENTS ARE OK BY INSPECTION DUE TO LOWER APPLIED SHEAR.

CELL 7 PANEL 7-8

ATTACHMENT = $\frac{5}{32}$ MONEL RIVETS AT 6P

STRENGTH = $811 \times 146 \times \frac{825}{6} = 1330 \text{ lb/in}$

APPLIED SHEAR = 710 lb/in

RF 1.20

1.20



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

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REPORT NO. 7-0558-82

SHEET NO. 50

AIRCRAFT:

C-105

TORSION BOX

PREPARED BY

J. B. YOUNG

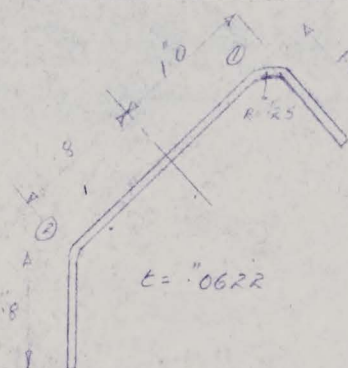
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LOCAL INSTABILITY IN COMPRESSION



SECTION ①

$$\frac{a+b}{2} = 1.0 \quad b' =$$

$$\frac{b'}{t} = 16.08 \left(\frac{b'}{t}\right)^{3/4} = 8.02$$

$$F_{cy} = 55,040$$

$$E = 9.58 \times 10^6$$

$$F_{cy} L = 52.55 \times 10^{10}$$

$$\sqrt{F_{cy} E} = 725 \times 10^3$$

$$\Delta F_{cc} = \frac{342 \times 725 \times 10^3}{8.02}$$

$$300 \times 10^3 \text{ lb/in}^2$$

$$x = (a+b) - 2t - c = 2 - (8 - 185) = 1.715$$

$$A = 1.715 \times 0.0622 = 106.8 \text{ in}^2$$

$$\text{CRIPPLING LOAD} = 300 \times 10^3 \times 106.8 = 3200 \text{ lb}$$

$$\text{CRIPPLING STRESS} = \frac{3200}{106.8} = 30,000 \text{ lb/in}^2$$

$$\text{APPLIED STRESS} = 31,503 \text{ lb/in}^2$$

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SECTION ②

$$b' = \frac{a+b}{2} = 8.0$$

$$\frac{b'}{t} = 12.86 \left(\frac{b'}{t}\right)^{3/4} = 6.73$$

$$\Delta F_{cc} = \frac{342 \times 725 \times 10^3}{6.73}$$

$$36,500 \text{ lb/in}^2$$

$$\text{APPLIED STRESS} = 26,550 \text{ lb/in}^2$$

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MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 52

AIRCRAFT:

C105

TORSION BOX AT
GEAR BOX CUT OUT.

PREPARED BY

DATE

A. FERENC

MAR/56

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DATE

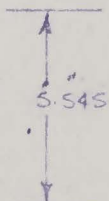
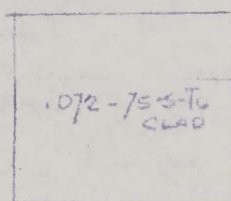
DETAIL STRESSING OF STRUCTURE 603.65 FWD TO 610.85 AFT

PANEL BUCKLING

SINCE THE MAX SHEAR STRESSES OCCUR FOR CASE 5 ON THE AFT PANELS, AND SINCE THE PANEL SIZES ON THE AFT SIDE ARE GREATER, THE STRESSING OF THE AFT PANELS WILL COVER THE FWD ONES.

UNLESS NOTED THE PANEL HEIGHT IN PLANE OF WEBS WILL BE ASSUMED TO BE BETWEEN THE AREA CENTROIDS. THIS IS CONSERVATIVE. WIDTH IS 4.8" FOR ALL PANELS. FOR PANEL HEIGHTS SEE DRWG 7-1058-2531

CONSIDERING PANEL L



PANEL ASSUMED
SIMPLY SUPPORTED

$$E \text{ FOR } 75\text{-S-TL CLAD AT } 265^{\circ}\text{F} = 9.55 \times 10^6 \text{ LBS/IN}^2$$

$$AV \text{ SHEAR STRESS CASE 5 PAGE 20} = \frac{422.43 + 429.582}{2 \times 1072} = 5830 \text{ LBS/IN}^2$$

$$a/b = \frac{5.545}{4.8} = 1.155$$

$$K_s \text{ FROM BRWHN PAGE B2-3} = 7.55$$

$$t/b = .072/4.8 = .015$$

$$F_{cr} = K_s E (t/b)^2 = 7.55 \times 9.55 \times 10^6 \times .015^2 = 16250 \text{ LBS/IN}^2$$

$$1 R_F \text{ BUCKLING} = \frac{16250}{5830}$$



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TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 53

AIRCRAFT:

C105

TORSON BOX AT
GEAR BOX CUT OUT

PREPARED BY

A. FERRIS

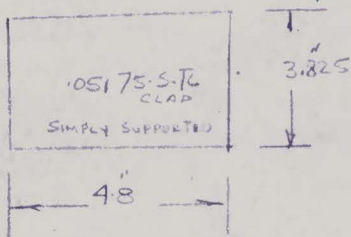
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DETAIL STRESSING CONT'D PANEL BUCKLING CONSIDERING PANEL K



AVERAGE S.S. MAX. CASE 5
 $R_{EF} S_{AT} 30 = \frac{356.3 + 509.3}{2 \times 0.051} = 8870 \text{ LBS/IN}^2$

$$a/b = \frac{4.8}{3.825} = 1.255$$

$$K_s = 7.05$$

$$t/b = \frac{0.051}{3.825} = 0.01332$$

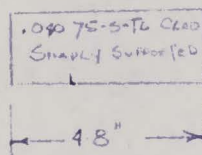
$$F_{SCR} = 7.05 \times 9.55 \times 10^6 \times 0.01332^2 = 11250 \text{ LBS/IN}^2$$

At 265°F

$$R.F. \text{ BUCKLING} = \frac{11250}{8370}$$

1.349

CONSIDERING PANEL H



AVERAGE S.S. MAX. CASE 5 = $\frac{433.3 + 439.22}{2 \times 0.040} = 11150 \text{ LBS/IN}^2$

$$a/b = \frac{4.8}{1.173} = 4.08$$

$$K_s = 5.05$$

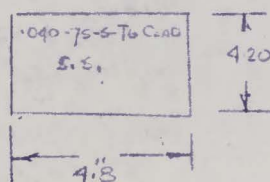
$$t/b = \frac{0.040}{1.173} = 0.0341$$

$$F_{SCR} \text{ At } 265^\circ\text{F} = 5.05 \times 9.55 \times 10^6 \times 0.0341^2 = 56200 \text{ LBS/IN}^2$$

BY INSPECTION R.F. BUCKLING

72

CONSIDERING PANEL G



AVERAGE S.S. CASE 5 = $\frac{426.5 + 420}{2 \times 0.040} = 10600 \text{ LBS/IN}^2$

$$a/b = \frac{4.8}{4.2} = 1.142$$

$$K_s = 7.4, \quad t/b = \frac{0.040}{4.2} = 0.00952$$

$$F_{SCR} = 7.4 \times 9.55 \times 10^6 \times 0.00952^2 = 6420 \text{ LBS/IN}^2$$

At 265°F

ACTUALLY DIST BETWEEN RIVETS IS SCALD AT 2.9" INSTEAD OF 4.20 (DIST BETWEEN RIVETS)

$$\text{BASED ON 2.9 DIM } F_{SCR} \text{ AT } 265^\circ\text{F} = 6.2 \times 9.55 \times 10^6 \times 0.0133^2 = 11280 \text{ LBS/IN}^2$$

$$R.F. = \frac{11280}{10600}$$

1.064



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MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 54

PREPARED BY

DATE

AIRCRAFT:

C105

TORSION BOX AT
GEAR BOX CUT OUT

A. FERENC

CHECKED BY

APR/56

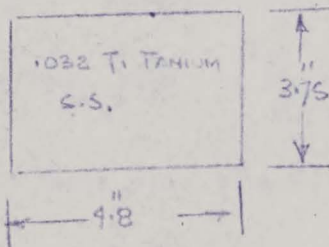
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DETAIL STRESSING CONT'D

PANEL BUCKLING

CONSIDERING PANEL F

FOR THIS PANEL, BY CONSIDERING THE PANEL HEIGHT AS THE DISTANCE BETWEEN AREA CENTROIDS, IT CAN BE SEEN THAT THIS METHOD IS TOO CONSERVATIVE, BY SCALING THE PANEL HEIGHT BETWEEN RIVET LINES A 3.75 DIMENSION WAS OBTAINED



AV SHEAR STRESS CASE 5

$$= \frac{456.8 + 332.85}{2 \times 1032} = 12320 \text{ LBS/INS}^2$$

$$a/b = \frac{4.8}{3.75} = 1.28 \quad ; \quad t/b = \frac{.032}{3.75} = .00854$$

$$K_s = 6.95$$

$$E \text{ FOR Ti AT } 265^\circ \text{F} = 14.25 \times 10^6$$

$$\therefore F_{cr} = 14.25 \times 10^6 \times 6.95 \times .00854^2 = 7230 \text{ LBS/INS}^2$$

FROM N.A.C.A - ARR-LS-B10 IT CAN BE SEEN THAT τ_{cr} INCREASES WITH NORMAL PRESSURE.

FROM FIG 7 USING RIB SPACING OF 6" WITH $R/c \infty$ THE INCREASE IN CRITICAL S.S. IS FROM 9500 TO 11600 DUE A RANGE OF 6 PSI

$$\% \text{ INCREASE} = \frac{2100}{9500} \times 100 = 22.1\%$$

$$\tau_{cr} = 7230 \times 1.221 = 8870 \text{ LBS/INS}^2$$

1. PANEL BUCKLES

USING N.A.C.A T.N. 2661

$$\tau_{cr \text{ ELASTIC}} = K_{ss} E \left(\frac{t}{h} \right)^2 \left[R_D + \frac{1}{2} (R_U - R_D) \left(\frac{h}{b} \right)^3 \right]$$

CONVERTING THE THICKNESS OF TITANIUM TO 75-S-T6 ON THE BASIS OF

$$\frac{E_{Ti \text{ TEMP}}}{E_{Al \text{ TEMP}}} = .032 \times \left(\frac{14.25}{9.55} \right)^2 = .0362$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 55

AIRCRAFT:

C105

TORSION BOX AT
GEAR BOX CUT OUT

PREPARED BY

DATE

A. FERENC

APR/56

CHECKED BY

DATE

DETAIL STRESSING CONT'D PANEL BUCKLING

CONSIDERING PANEL F CASES

THE MIN THICKNESS OF FLANGE WILL BE AT THE EXTENSION (HINGE)

$$.060 \times \left(\frac{14.25}{9.55} \right)^{1/2} = .0897 \text{ INS}$$

$$t_F/t = \frac{.0897}{.0362} = 2.48$$

THICKNESS OF FRAMES ARE .051 / 5.5-TL

$$\frac{t_V}{t} = \frac{.051}{.0362} = 1.41$$

FROM FIG 12b - $R_H = 1.08$
 $R_D = 1.28$

K_{SS} FROM FIG 12a = 6.75

$$\begin{aligned} T_{CR \text{ ELASTIC}} &= 6.75 \times 9.55 \times 10^6 \times \left(\frac{0.386}{3.75} \right)^2 \left[1.28 + \frac{1}{2} (1.08 - 1.28) \left(\frac{3.75}{4.8} \right)^3 \right] \\ &= 6840 [1.28 + .0978] = 6840 \times 1.232 = 8430 \text{ LBS/INS}^2 \end{aligned}$$

AT A SHEAR STRESS OF 12320 LBS/INS² THE TITANIUM SHEET IS CONSIDERED IN THE ELASTIC RANGE. $\therefore T_{CR} = T_{CR \text{ ELASTIC}}$

T_{CR} DUE TO PRESSURE RELIEF ON PAGE 54
 $= 8430 \times 1.221 = 10300 \text{ LBS/INS}^2$

$R_F \text{ BUCKLING} = \frac{10300}{12320}$

PANEL BUCKLES

* THIS IS VERY CONSERVATIVE BECAUSE A PRESSURE RELIEF OF 6 PSI WAS USED INSTEAD OF 24.85 PSI., BUT BECAUSE THE ONLY AVAILABLE DATA WAS FOR A 6 PSI RANGE THIS RELIEF ONLY WAS USED. BY INSPECTION OF AFR LS-BIG IT CAN BE SEEN THAT MORE RELIEF MAY BE OBTAINED:

$$T/t_{CR} = 12320/10300 = 1.195$$

$K = .025$ FROM FIG 13



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REPORT NO. 7-0558-92

SHEET NO. 56

AIRCRAFT:

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TORSION BOX AT
GEAR BOX CUT OUT

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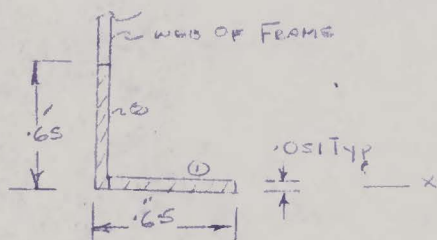
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DETAIL STRESSING CONT'D

CONSIDERING PANEL F - CASES

UPRIGHT STRESSES



Notes:

- (1) CHAMFER AREA ONLY CONSIDERED EFFECTIVE
- (2) RADII SQUARED OFF FOR CONVENIENCE

ITEM	b	t	A	y	Ay	Ay ²	I _{CG}
1	.599	.051	.03055	.0255	.000780	.0000199	NEG
2	.65	.051	.03315	.325	.01073	.00350	.00140
Σ			.0637	.1817	.01156	.0035199	.00140

$$I_{CG} = .0035199 + .00140 - .0637 \times .1817^2 = .0049199 - .00211 = .0028099 \text{ INS}^4$$

Say .00281 INS⁴

$$r = \left(\frac{I}{A} \right)^{1/2} = \left(\frac{.00281}{.0637} \right)^{1/2} = .209$$

$$A_{ve} = \frac{.0637}{1 + \left(\frac{.1817}{.209} \right)^2} = \frac{.0637}{1.757} = .0362$$

$$A_{ve}/d_c = \frac{.0362}{.0362 \times 4.8} = .209$$

FROM FIG 14 NACA 2661

$$\frac{C_u}{r} \approx .05$$



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DETAIL STRESSING CONT'D
CONSIDERING PANEL F CASES

WEB TO FLANGE RIVETING

$$\text{LOAD/INS} = \frac{SW}{h} (1 + .914K)$$

$$K = .025 \therefore .914K = .01038$$

$\therefore$ INCREASE IN WEB TO FLANGE RIVETING IS BY 1.038%
WHICH IS NEGLIGIBLE

COMP STRESS IN FLANGE DUE TO TENSION FIELD EFFECTS

$$\sigma = \frac{K SW}{2 A_F \tan \alpha}$$

FROM PAGE 57 $\tan \alpha = 1.0$

$$SW = 12320 \times .032 \times 4.78 (\text{SMTS}) = 1890 \text{ LBS}$$

$$\text{FROM 7-0558-12/314A } F = .45 \text{ IN}^2$$

$$\sigma = \frac{.025 \times 1890}{2 \times .95} = 52.5 \text{ LBS/IN}^2$$

THIS IS NEGLIGIBLE

MAX MOMENT IN FLANGE

$$M_{\text{MAX}} = KC3 \frac{SW d^2 \tan \alpha}{12 h}$$

$$C3 \text{ FROM FIG 13} = .98$$

$$M_{\text{MAX}} = .025 \times .98 \times 1890 \times 4.18^2 \times 1.0 = 23.7 \text{ LBS/INS NEGLIGIBLE}$$

FROM THE PREVIOUS RESULTS IT CAN BE SEEN THAT
IN PANEL F FOR CASE 5 THE TENSION FIELD EFFECTS
CAN BE NEGLECTED.



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SHEET NO 59

AIRCRAFT:

C105

TORSION BOX AT GEAR
BOX CUT OUT

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DETAIL STRESSING CONT'D

PANEL F CASE 2 Ref 7-0558-12/2 SMT 215

$$AV S.S = \frac{396.9 + 252.9}{2 \times 1032} = 10800 \text{ LBS/IN}^2$$

FROM SMT 55 $T_{cr} = 2430 \text{ LBS/IN}^2$ WITHOUT CONSIDERING PRESSURE RAMP.

FROM FIG 7. NACA-ARK-LS-E10 WITH R/C OF 3 USING RIB SPACING OF 6.0
CRITICAL S.S IS 9500 AT 0 PSI AND 10100 AT 2.10 P.S.I.

FOR CASE 2 THE INTERNAL PRESSURE = -2.10 P.S.I.

$$\% \text{ INCREASE} = \frac{10100 - 9500}{9500} \times 100 = 2.98\%$$

$$\therefore T_{cr} = 2430 \times 1.0298 = 2492$$

PANEL BUCKLES

$$\frac{T}{T_{cr}} = \frac{10800}{2492} = 1.168$$

K FROM FIG 13 = +23

THIS IS LESS THAN FOR CASE 5

$\therefore$ BY COMPARISON IT CAN BE SEEN THAT THE TENSION
FIELD EFFECTS ARE NEGLIGIBLE



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REPORT NO. 7-0558-82

SHEET NO. 60

AIRCRAFT:

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TORSION BOX AT
GEAR BOX CUT OUT

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DETAIL STRESSING CONT'D

CHECK RIVETTING PANEL A

MAX SHEAR FLOW CASE 2 REF 7-0558-12/2 SHT 215 = 410.6 LBS/INS

AT .70 PITCH RIVET LOAD = $410.6 \times .7 = 287$ LBS/RIVET

USING 1/8 AD 4 RIVETS

ALLOWABLE S.S. AT ROOM TEMP IN .032 = $388 \times .96 = 374$ LBS

ASSUMING 20% REDUCTION AT TEMP = $.8 \times 374 = 299$ LBS

ALLOWABLE BEARING IN .032 T_i AT 265°F

$$= .76 \times .032 \times .125 \times 170000 = 517 \text{ LBS}$$

$$R.F. \text{ SHEAR} = \frac{299}{287}$$

1.042

IN PANELS B, C, D & E, MIN RIVETTING TO BE

AN 470 AD-4'S AT .70 PITCH

RIVETTING COVERED BY ABOVE R.F.

PANELS

MAX SHEAR = 509.8 LBS/INS CASES REF 7-0558-12/2 SHT 195

RIVETTING 5/32 AD'S AT .75 PITCH

LOAD/RIVET = $.75 \times 509.8 = 382$ LBS

ALLOWABLE SHEAR STRESS OF 5/32 RIVETS IN .040 AT ROOM TEMP = $.96 \times 396 = 382$ LBS

ASSUMING 20% REDUCTION FOR TEMP 265°F THEN S.S. $.70 \times 382 = 267$ LBS

ALLOWABLE B.S. IN .040 75-S-T_i AT 265°F

$$= 636 \times 1.27 \times .84 = 731 \text{ LBS}$$

$$R.F. \text{ SHEAR} = \frac{267}{382}$$

1.205

RIVETTING TO REMAINDER OF PANELS IS TO BE AT A MIN OF 5/32 AD'S AT .75 PITCH.

∴ THE ABOVE R.F. COVERS PANELS F, L, H & K.



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TECHNICAL DEPARTMENT

REPORT NO. 7-0558-52

SHEET NO. 61

AIRCRAFT:

C105

Torsion Box At
Gear Box Cut Out

PREPARED BY

DATE

A. FERENC

Apr/56

CHECKED BY

DATE

DETAIL STRESSING OF BOOMS.

MAX BOOM COMP LOADS OCCUR BETWEEN STA'S 606.05 & 610.85
THE TENSION SIDES ARE COVERED BY THE STRESSING OF
THE COMPRESSION BOOMS.

Item	CASE	AV. COMP. LOAD (LB)	AREA IN ²	AV. COMP STRESS LB/IN ²	COLUM LENGTH Assumed Pinned (IN)
1	5	15953	.45	24350	4.8
4	2	2017	.1236	16320	4.8
5	5	3986	.3656	29600	4.8
7	2	7104	.3632	15470	4.8
8	2	5161	.2590	19900	4.8

Ref 7-0558-15
2-17-55

Boom 4

For 75-S-TL $F_{CO} = 1.075 F_{CY}$ Ref ANC-5

F_{CO} At 265°F = $1.075 \times 56200 = 60250 \text{ LB/IN}^2$

TRANSITIONAL $L/\rho = 1.914 \pi \left(\frac{E}{F_{CO}} \right)^{1/2}$ Ref ANC-5

$$= 1.914 \pi \left(\frac{9.55 \times 10^6}{60250} \right)^{1/2} = 176.$$

F_{CY} At Temp = $61000 \times .88 = 56200 \text{ LB/IN}^2$
265°F



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TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 64

AIRCRAFT:

C105

TORSION BOX AT
GEAR BOX CUT OUT

PREPARED BY

DATE

A. FERENC

MAR/56

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DATE

DETAILED STRESSING

BOOM 3

AV COMP STRESS APPLIED = 27000 LBS/INS² REF SHT 61
FOR SECTION REFER. TO REF 7-0558-12/2

CHECK LOCAL CRIPPLING

ITEM 1(a) ENDS PINNED ONE SIDE PINNED OTHER ASSUMED FREE

$$t/b = .051/.76 = .0672$$

K FROM BRUNN PAGE B2.2 = .36

$$F_{cr} = K E_t (t/b)^2$$

$$F_{cr} = .36 \times 10.5 \times 10^6 \times .0672^2 = 17100 \text{ LBS/INS}^2$$

$$E_t \text{ AT } 265^\circ = 9.55 \times 10^6 \therefore F_{cr} = \frac{9.55}{10.5} \times 17100 = 15500 \text{ LBS/INS}^2$$

ITEM 1(b) SAME END CONDITIONS AS ABOVE

$$t/b = \frac{.051}{.32} = .159$$

ASSUMING E_t AT ROOM TEMP OF 9.5×10^6

$$F_{cr} = .36 \times 9.5 \times 10^6 \times .159^2 = 25700 \text{ LBS/INS}^2$$

ASSUMING $F_{cr} = 57000$, $E_t = 6.35 \times 10^6$

$$F_{cr} = .36 \times 6.35 \times 10^6 \times .159^2 = 57000$$

$$\text{AT } 265^\circ F_{cr} = \frac{9.55}{10.5} \times 57000 = 51800 \text{ LBS/INS}^2$$

$$F_{cr} \text{ AV FOR ITEM 1} = \frac{15500 \times .76 + 51800 \times .32}{.76 + .32} = \frac{22360}{1.08} = 20694 \text{ LBS/INS}^2$$

ITEM 5

5a

$$t/b = \frac{.072}{1.08} = .0657$$

SAME END CONDITIONS AS ABOVE

$$F_{cr} = .36 \times 10.5 \times 10^6 \times .0657^2 = 16350 \text{ LBS/INS}^2$$

ROOM TEMP

E_t AT $F_{cr} = 10.5 \times 10^6$ CHECK OK

$$\text{AT ROOM TEMP } F_{cr} = \frac{16350 \times 2.55}{10.5} = 16350 \times .91 = 14850 \text{ LBS/INS}^2$$



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MALTON - ONTARIO

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REPORT NO. 7-0558-82

SHEET NO. 65

AIRCRAFT:

C105

TORSION BOX AT GEAR
FOR CUT OUT

PREPARED BY

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DETAILED STRESSING

ROOM 5

ITEM 56. SAME END CONDITIONS AS G1 ON PREVIOUS PAGE

$$t/b = .072 / .475 = .1515$$

At Room Temp

FCR ASSUMED AT 55000 $ET = 7.2 \times 10^6$

$$FCR = .36 \times 7.2 \times 10^6 \times .1515^2 = 52600$$

Assuming $FCR = 56500$ $EC = 7.0 \times 10^6$

$$FCR = .36 \times 7.0 \times 10^6 \times .1515^2 \times 10^6 = 57800 \quad \text{CONSIDERED SATISFACTORY}$$

FCR At Room Temp = $56500 \times .91 = 51300 \text{ LBS/INS}^2$

$$\text{FOR AV FOR G} = \frac{51300 \times .475 + 14350 \times 1.08}{1.08 + .475} = \frac{40400}{1.555} = 26000 \text{ LBS/INS}^2$$

EXTRUSION

Item 2 $t/b = .08 / .73 = .1025$ ENDS PINNED ONE SIDE FREE ONE SIDE FIXED

$K = 1.25$ REF BROWN PAGE E2-2

Assumed Room Temp Conditions

$$FCR = 62000 \quad EC = 47 \times 10^6$$

$$FCR = 1.25 \times 8 \times 10^6 \times .1025^2 = 61800 \quad \text{CHECK OK}$$

$$\text{AT ROOM TEMP } FCR = 61800 \times .91 = 56200 \text{ LBS/INS}^2$$

USE BLOCK FCR AT 2650 FOR 5046 = 56200 LBS/INS²

By COMPARISON, WITH THE REST OF 560 IT CAN BE SEEN THAT FCR AT TEMP SHOULD BE USED.

$$\therefore \text{AV. FCR} = \frac{26300 \times .0552 + 26000 \times .0740 + 56200 \times .2364}{.3656} = \frac{16620 + 45500 \text{ LBS/INS}^2}{.3656}$$

$$R_{FCR} = 45500 / .24600$$

1.85

CHECK COLUMN EFFECTS

TRANSIENT L/P AT TEMP = 176

} SHT 61

$$FCR \text{ AT TEMP} = 60250 \text{ LBS/INS}^2$$



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TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 66

AIRCRAFT:

C105

TENSION BOX AT GEAR
BOX CUT OUT

PREPARED BY

DATE

A. FERENC

MAY 56

CHECKED BY

DATE

DETAILED STRESSING

BOOM 5

R-F 7-0558-12/2 SHT 10

Item	A	$\bar{y}$	$\bar{y}^2$	$A\bar{y}^2$	I_{CG}	$\bar{x}$	$\bar{x}^2$	$A\bar{x}^2$	I_{CGx}	$A\bar{z}$
1	.0552	.612	.375	.0207	.0051	.300	.09	.00497	NEG	+.00101
2	.0623	.262	.0686	.00427	.00316	.175	.0306	.001908	NEG	+.00286
3	.068	.136	.0185	.001257	NEG	.515	.265	.01805	.01263	-.00476
5	.1061	.272	.074	.00785	NEG	.575	.330	.0364	.0192	+.01635
6	.0740	.228	.052	.00385	NEG	.435	.189	.02145	.00375	+.00228
Σ	.3656			.02927	.0086			.062613	.02558	.01824

$$\bar{I}_x = .037927 + .00826 = .046187 \text{ IN}^4$$

$$\bar{I}_y = .063673 + .02558 = .089253 \text{ IN}^4$$

$$\bar{I}_{xy} = .01824 \text{ IN}^4$$

$$\tan 2\theta = \frac{2 \times .01824}{.089253 - .046187} = \frac{.03648}{.043066} = .8475$$

$$2\theta = 40.3^\circ \quad \theta = 20.15^\circ$$

$$I_{MIN} = .046187 \times .925^2 + .089253 \times .344^2 - .03648 \times .925 \times .344$$

$$= .0407 + .01057 - .01178 = .03949 \text{ IN}^4$$

$$C = \left(\frac{.03949}{.3656} \right)^{1/2} = .328 \text{ IN}$$

$$L/r = 4.8 / .328 = 14.65 \text{ COLUMN IS SHORT}$$

$$F_c = 60200 \left[1 - \frac{60200 \times 46.25^2}{4\pi^2 \times 9.55 \times 10^6} \right] = 60200 \left[1 - .00364 \right] = 59000 \text{ LBS/IN}^2$$

AT 265° FOR STRESS

$$\text{APPLIED STRESS} = 24600 \text{ LBS/IN}^2$$

By Inspection Rf

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SHEET NO. 67

AIRCRAFT:

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TORISON BOX AT
GEAR BOX CUT OUTS

PREPARED BY

DATE

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1 MAR 56

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DATE

DETAILED STRESSING ROOM 1

ROOM 1 AU. APPLIED STRESS = 24350 LBS/IN²
FOR SECTION PROPERTIES SEE REP 7-0558-12/2

THE LOCAL CRIMPING FOR THIS ROOM WILL BE FOUND ON BASIS OF
75-S-T6 14TL. THE THICKNESSES OF TITANIUM PARTS HAVE
BEEN INCREASED ON BASIS OF Y_{FE}

F_{CR} FOR HINGE

BY COMPARISON WITH F_{CY} AU FOR EXTRUSION OF ROOM
S IT CAN BE SEEN THAT F_{CR} AU FOR EXTRUSION WILL
BY F_{CY} OF 75-S-T6 AT TEMP = 56200 LBS/IN²

FOR ITEM 4

4a

$$t/b = .032/.60 = .1358$$

BOTH ENDS PINNED ONE SIDE PINNED ONE SIDE FREE

$$F_{CY} = K E_T (t/b)^2$$

$$K = .36$$

ASSUMING FOLLOWING ROOM TEMP CONDITIONS

$$F_{CY} = 50000 \quad E_T = 8.7 \times 10^6$$

$$F_{CY} = .36 \times 8.7 \times 10^6 (.1358)^2 = 57200$$

ASSUMING F_{CY} = 53500 E_T = 8.0 x 10⁶

$$F_{CY} = .36 \times 8.0 \times 10^6 \times .1358^2 = 53300 \text{ LBS/IN}^2 \quad \text{CHECK OK}$$

$$F_{CY} \text{ AT } 265^\circ \text{ FOR } 50 \text{ HRS} = 53300 \times .91 = 48700 \text{ LBS/IN}^2$$

4b

$$t/b = .032/1.18 = .02695$$

$$F_{CY} = .36 \times 8.0 \times 10^6 \times .02695^2 = 13300 \text{ LBS/IN}^2 \quad E_T = 7.9 \times 10^6$$

ASSUMING F_{CY} = 17400 E_T = 10 x 10⁶

$$F_{CY} = .36 \times 10.5 \times 10^6 \times .02695^2 = 17400 \text{ LBS/IN}^2 \quad \text{CHECK OK}$$

$$\text{AT TEMP } F_{CY} = .91 \times 17400 = 15820 \text{ LBS/IN}^2$$

$$F_{CY} \text{ AU} = 48700 \times .60 + 15820 \times 1.18 = 21900 \text{ LBS/IN}^2$$

AT 265°F

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SHEET NO. 68

AIRCRAFT:

C105

TORSION BOX AT
GEAR BOX CUT OUTS

PREPARED BY

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DETAILED STRESSING BOOM 1

LOCAL CRIPPLING AU OF ITEM 5

THE 1025 TO DOUBLE DOES NOT EXIST

$$5a \quad t/b = .035 / .30 = .13$$

ONE EDGE PINNED ONE FREE - ENDS PINNED $K = .36$

ASSUMING ROOM TEMP CONDITIONS

$$F_{CY} = 52000 \quad E_T = 8.5 \times 10^6$$

$$F_{CY} = .36 \times 8.5 \times 10^6 \times .13^2 = 51300 \text{ LBS/INS}^2 \text{ (SATISFACTORY)}$$

$$F_{CY} \text{ AT TEMP} = \frac{51300 \times .91}{1.155} = 47150 \text{ LBS/INS}^2$$

5-b

$$t/b = \frac{.039}{1.855} = .0457$$

ASSUMING SAME EDGE CONDITIONS AS ABOVE

$$F_{CY} = 10.5 \times 10^6 \times .36 \times .0457^2 = 7900 \text{ LBS/INS}^2$$

$$F_{CY} \text{ AT TEMP} = \frac{.91 \times 7900}{1.155} = 7130 \text{ LBS/INS}^2$$

$$F_{CY} \text{ AU AT TEMP} = \frac{47150 \times .30 + 7130 \times .855}{1.155} = 17600 \text{ LBS/INS}^2$$

$$F_{CY} \text{ AU FOR BOOM (1)} = \frac{56200 \times .2237 + 21900 \times .1460 + 17600 \times .0451}{.4413} = 37900 \text{ LBS/INS}^2$$

$$R_{F_{CRIPPLING}} = \frac{37900}{24390}$$

1.535

CHECK BOOM 1 AS COLUMN



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MALTON - ONTARIO

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AIRCRAFT:

C105

TOPGON BOX AT GEAR
BOX CUT OUTS

REPORT NO. 7-0558-82

SHEET NO.

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PREPARED BY

DATE

A. FERENC

MAR/56

CHECKED BY

DATE

DETAILED STRESSING ROOM 1

ITEM	AREA	y	Ay	Ay ²	Icgy	x	Ax	Ax ²	Icgx	Axy
1	.0480	.61	.02930	.01785	.00209	.43	.02065	.00887	.000466	.01258
2	.1595	.013	.00208	NEG	NEG	.65	.1038	.06750	.0328	-.001345
3	.0162	-.11	.00229	.000197	NEG	.29	.0047	.001365	NEG	-.000517
4	.1460	-.114	.01665	.00190	NEG	1.32	.1920	.2550	.0686	.0220
5	.0451	.85	.0383	.0325	.00351	.68	.0283	.01780	.001035	.0241
Σ	.4148	.1135	.0471	.05247	.006	.367	.3505	.3505	.112921	.012818

$$I_x = .05247 + .006 - .4148 \times .1135^2 = .05847 - .00535 = .053097 \text{ INS}^4$$

$$I_y = .350535 + .112921 - .4148 \times .367^2 = .463456 - .3120 = .151456 \text{ INS}^4$$

$$I_{xy} = .012818 - .4148 \times .1135 \times .367 = .012818 - .0408 = -.027982 \text{ INS}^4$$

$$\tan 2\theta = \frac{2 \times .027982}{.151456 - .053097} = \frac{.055964}{.098359} = -.568$$

$$2\theta = 29.4^\circ \quad \theta = 14.7^\circ$$

$$I_{xp} = .053097 \times .366^2 + .151456 \times .253^2 + .055964 \times .966 \times .253$$

$$= .0496 + .0097 + .01365 = .07295 \text{ INS}^4$$

$$p = \left(\frac{.07295}{.4148} \right)^{1/2} = .1325$$

$$l_p = 4.8 / .1325 = 36.2 \quad \text{COLUMN IS SHORT}$$

$$F_c = 60250 \left[1 - \frac{36.2^2 \times 66250}{4 \pi^2 \times 3.55 \times 10^6} \right] = 60250 \left[1 - .02225 \right] = 58800 \text{ LBS} / \text{INS}^2$$

$$R_{F_{col}} = \frac{58800}{24350}$$

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TENSION LOADS FOR ALL BOLTS COVERED BY COMPRESSION



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REPORT NO. 7-0558-82

SHEET NO. 70

AIRCRAFT:

C105

TORSION BOX AT
GEAR BOX CUT OUTS

PREPARED BY

DATE

A. FERENC

MAR/56

CHECKED BY

DATE

DETAILED STRESSING ROOM 8

AU COMP STRESS = 13900 LBS/IN² REF SHT 61

FOR SECTION REF 7-0558-12/2

CHECK LOCAL CRIPPLING

CHANNEL

$$F_{cr} = \frac{342 \times (9.55 \times 10^6 \times 56200)^{1/2}}{\left(\frac{704.34}{2 \times 15}\right)^{1.75}} = \frac{342 \times 731000}{3.52} = 70700 \text{ LBS/IN}^2$$

USE F_{CY} AT TEMP = 56200 LBS/IN²

WITHOUT CONSIDERING ITEMS 1 & 4 OF PAGE 42 IT CAN BE
SEEN BY INSPECTION THAT THE R.F

CHECK AS 'A' COLUMN

ITEM	AREA	$\bar{z}$	$\bar{z}^2$	$A\bar{z}^2$	$I_{CG, z}$	$\bar{y}$	$\bar{y}^2$	$A\bar{y}^2$	$I_{CG, y}$	$A\bar{z}\bar{y}$	
1	.04165	0	0	0	.000388	.235	.0553	.00230	.000008	0	
2	.01720	.13	.0169	.00022	.000129	.245	.06	.00103	NEG	.0000549	
3	.0600	-.52	.271	.01625	.000512	.375	.1405	.00843	.001515	.0117	
4	.0300	.04	.0016	.000128	.00282	.105	.0112	.000395	.000005	.000336	
5	.0600	.41	.168	.01007	.000512	.005	NEG	NEG	.001515	.000123	
Σ	.25885			.026668	.004361			.012655	.00312	.0122139	

$$I_{\bar{A}} = .026668 + .004361 = .031029$$

$$I_{\bar{Z}} = .012655 + .00312 = .015775$$

$$I_{\bar{Z}\bar{Y}} = .0122139$$

$$\tan 2\theta = \frac{2 \times .0122139}{.015775 - .031029} = \frac{.02443}{-.015254} = -1.6$$

$$2\theta = -58^\circ \quad \theta = -29^\circ$$

$$I_{ZP} = .015775 \times .375^2 + .031029 \times .434^2 + 2 \times .0122139 \times .434 \times .375$$

$$= .01265 + .00727 + .0103 = .02962 \text{ IN}^4$$

$$I_{YP} = .031029 \times .375^2 + .015775 \times .434^2 = .0103$$

$$= .0238 + .0037 - .0103 = .0172 \text{ IN}^4 = I_{MIN}$$

$$r = \left(\frac{.0172}{.25885}\right)^{1/2} = .258 \quad \sqrt{r} = \frac{4.8}{.250} = 18.6$$

R.F. BY COMPARISON WITH SHT 61 & 69



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 71

AIRCRAFT:

C105

TORSION BOX AT
GEAR BOX CUT OUTS

PREPARED BY

DATE

A. FERENC

Apr/56

CHECKED BY

DATE

DETAILED STRESSING ROOM 7

AU COMP STRESS Ref SHT 61 = 12470 LBS/IN²

FOR SECTION PROPERTIES REFER TO 7-0558-12/2.

CHECK LOCAL CRIPPLING

CONSIDERING EXTRUSION

AN ANGLE CONTAINING THE OUTSTANDING LEG WILL BE CRITICAL.

$$F_{CY} = \frac{.342 (9.55 \times 10^6 \times 56200)^{1/2}}{\left(\frac{.155}{2 \times .11 (AV)} \right)^{.75}} = \frac{.342 \times 74000}{4.33} = 57800 \text{ LBS/IN}^2$$

$\therefore F_{CY}$ WILL BE USED = 56200
ATTN:IMP

RF BY INSPECTION OF APPLIED STRESSING

CHECK AS COLUMN

Item	A	$\bar{Z}$	$\bar{Z}^2$	$A\bar{Z}^2$	$\bar{Y}$	$\bar{Y}^2$	$A\bar{Y}^2$	I_{xx}	$A\bar{Y}\bar{Z}$
1	.0384	.07	.0042	.002161	.00109	.35	.1225	.0047	.00094
2	.05075	.05	.0025	.000127	.00642	-.20	.040	.00203	.000678
3	.0600	-.15	.25	.01500	.000113	.23	.109	.00655	.000313
4	.108	-.04	.0016	.000173	.0090	-.13	.0163	.00133	.000117
5	.108	.66	.436	.04700	.000562	.02	.0004	.00508	.001425
Σ	.36515			.062461	.01735			.01511	.007241

$$I_y = .062461 + .01735 = .07981 \text{ IN}^4$$

$$I_z = .01511 + .007241 = .022351 \text{ IN}^4$$

$$I_{yz} = .003345$$

$$\tan 2\theta = \frac{2 \times .003345}{.022351 - .07981} = \frac{.00669}{-.057459} = .291$$

$$2\theta = 16.2^\circ \quad \theta = 8.1^\circ$$

$$\text{MIN } I = .022351 \times .987^2 + .07981 \times .1404^2 - 2 \times .003345 \times .987 \times .1404$$

$$= .0218 + .001575 - .00231 = .021065 \text{ IN}^4 \text{ SAY } .0211 \text{ IN}^4$$

$$r = \sqrt{\frac{.0211}{.36515}} = .246 \quad ; \quad L/r = 418/.246 = 19.5$$

BY INSPECTION WITH SPTS 66 & 69 R.F. FAIL

72

72



AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-3558-82

SHEET NO. 12

AIRCRAFT:

C105

TORSION BOX AT GEAR
BOX CUT OUT

PREPARED BY

DATE

A. FERENC

APR/56

CHECKED BY

DATE

NO. OF ATTACHMENTS REQ'D TO DISSIPATE ENDOLOADS AT BOOM 7 & 8
CONSIDERING BOOM 7 AT STA 603.65

END LOAD MAX = 5375 LBS COMP - CASE 2 REF SHT 50

THERE ARE 14 5/32 STEEL JO BOLTS BETWEEN STA 603.65
AND STA 596.45

$$\text{LOAD/RIVET} = \frac{5375}{14} = 384 \text{ LBS/RIVET}$$

BEARING OF 5/32 STEEL JO BOLTS IN .032 Ti WILL BE THE
CRITERION.

$$\therefore \text{ALLOWABLE B.S. AT } 265^{\circ}\text{F} = .156 \times .032 \times 17000 \times .76 = 647 \text{ LBS}$$

R.F.

$$= \frac{647}{384}$$

1.68

BOOM 7 AT STA 610.85

END LOAD = 7525 LBS COMP REF SHT 50

THERE ARE 13 5/32 STEEL JO BOLTS BETWEEN STA 610.85 & 605.65

$$\text{TOTAL BEARING CAPACITY} = 13 \times 647 = 8400 \text{ LBS}$$

$$R.F. = \frac{8400}{7525}$$

1.06

CONSIDERING BOOM 8

AT STA 610.85 END LOAD = 5725 LBS (END LOAD DISSIPATION OVER 1 BAY @ 4.8")

USING 5/32 STEEL JO BOLTS AT .61 MAX PITCH

$$\text{LOAD/RIVET} = \frac{5725}{4.8} \times .61 = 727 \text{ LBS}$$

ALLOWABLE BEARING 5/32 IN .040 75-S-T6 AT TEMP = 731 LBS/RIVET REF SHT 60

$$R.F. = \frac{727}{731}$$

1.005

BOOM 8 AT STA 603.65

END LOAD = 3896 LBS

END LOAD DISSIPATES OVER 7.2" TO STA 596.45

5/32 STEEL JO BOLTS AT .75 PITCH

$$\text{LOAD/RIVET} = \frac{3896}{7.2} \times .75 = 407 \text{ LBS}$$

ALLOWABLE BEARING IN .040 75-S-T6 = 731 LBS
AT TEMP

$$R.F. = \frac{407}{731}$$

1.80

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-82

SHEET NO. 73

AIRCRAFT:

LOADS USED FOR
SPLICE AT SN 644

PREPARED BY

DATE

CHECKED BY

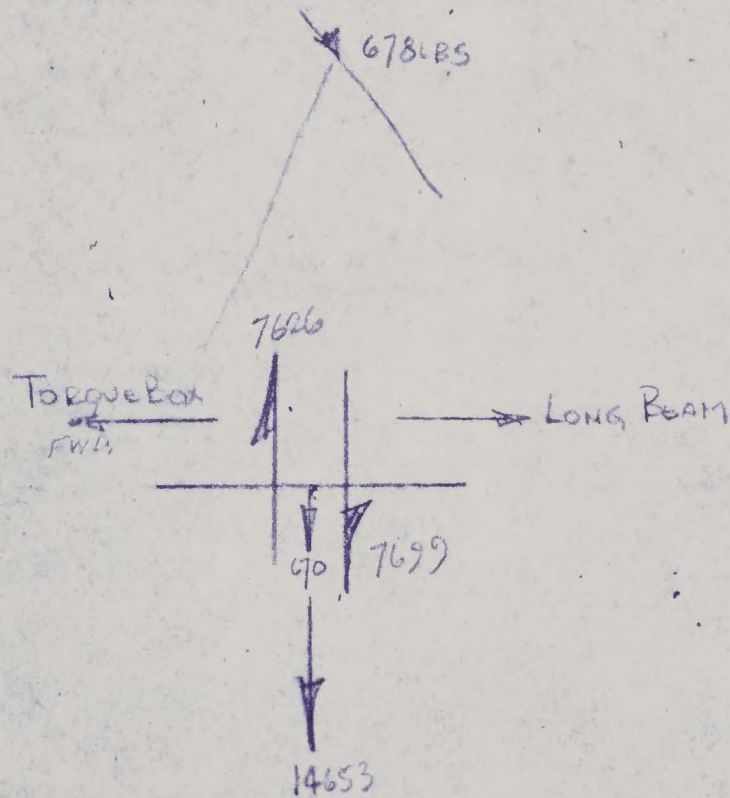
DATE

CASE S LIVE SIDE (MAX END LOAD COMP TOP & SHEAR)

END LOAD = 8320 LBS COMP
SHEAR LONG BEAM SIDE 7659 LBS
SHEAR BOX SIDE 7626 LBS

BM = 66347 LBS INS COMP ON TOP

END LOAD IN BOOM INNER LONG BEAM



TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-0558-82

SHEET No. 74

AIRCRAFT:

C105

TORQUE BOX SPACER
STA 644

PREPARED BY

DATE

J. NEEDHAM

CHECKED BY

DATE

LOADING:

LOADS TO BE TRANSMITTED ACROSS SPACER WITH MAIN BEAM IN UPPER CAP

AXIAL LOAD = 8320# (LONG) } REF RPT. 7-0558-53
B. MOMENT = 66747# } SHEET 204(a)
TENSILE BEAM SHEET = 74# (SHEET 244)

THE LOAD CASE FOR MAIN BEAM IS CASE 5

THE LOADS THAT ARE TRANSMITTED FROM THE TORQUE BOX TO THE FRAME AT STA 644 ARE:

TORQUE BOX END STA 644
TORQUE = $2430 \times 24.55 = 61700$ LB CG
SHEAR = 7620#

LONG BEAM AT STA 644
END LOAD SHORT BEAM = 498#
SHEAR = 7699#

LOADS TO BE TRANSMITTED ACROSS SPACER WITH MAIN BEAM IN LOWER CAP. (CASE A - DEADLOAD)

AXIAL LOAD = 10300# (LONG) } REF RPT.
B. MOMENT = 35193# }
TENSILE BEAM END = 216# (SHEET 244)

THE LOADS THAT ARE TRANSMITTED FROM THE TORQUE BOX TO THE FRAME ARE:

TORQUE BOX END STA 644
SHEAR = 4153#

TORQUE BOX AT STA 644
SHEAR = 3653#

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-0558-82

SHEET No. 75

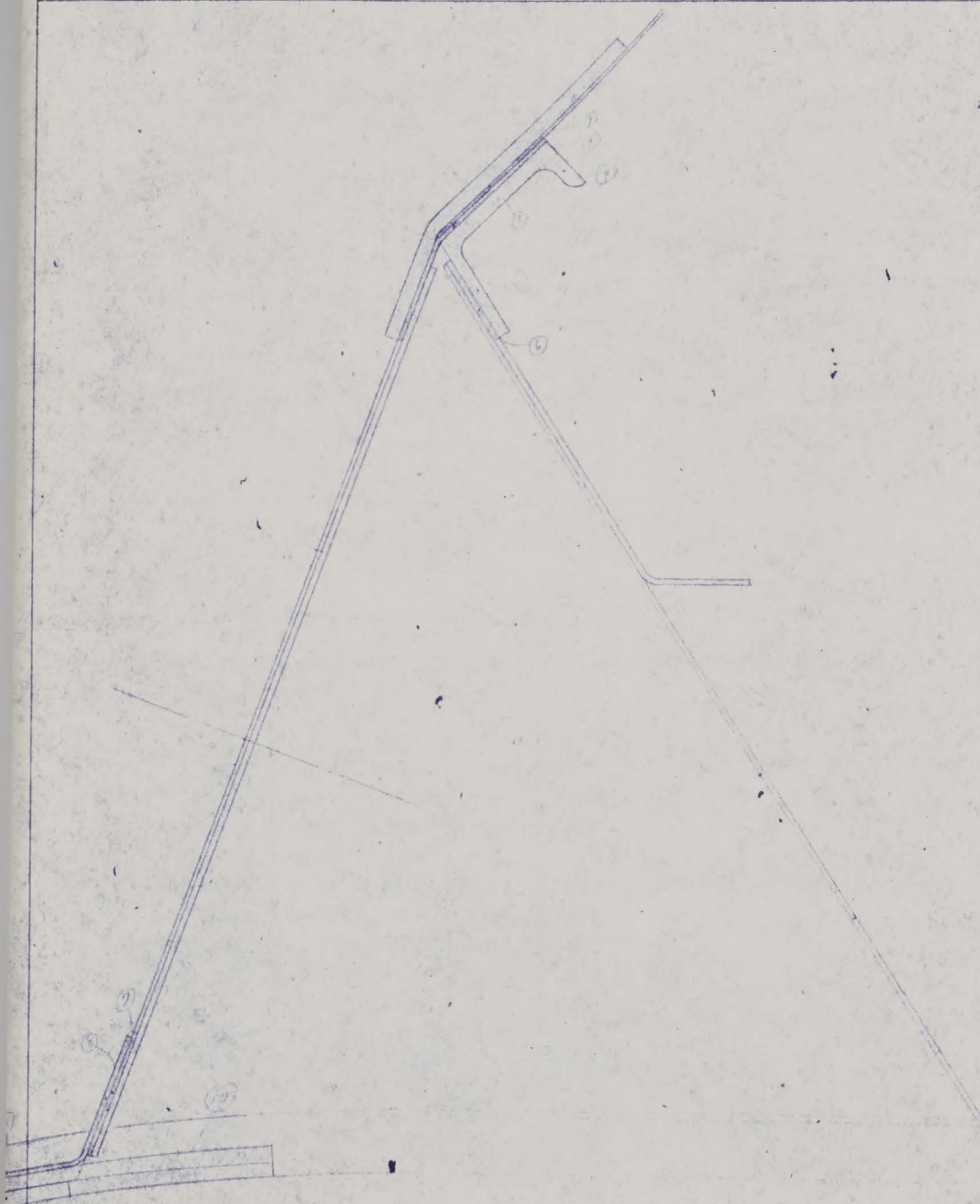
AIRCRAFT:

PREPARED BY

DATE

CHECKED BY

DATE



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

REPORT No. 7-0558-82

SHEET No. 77

AIRCRAFT:

C105

TORQUE BOX SPALICE
STA. 644

PREPARED BY

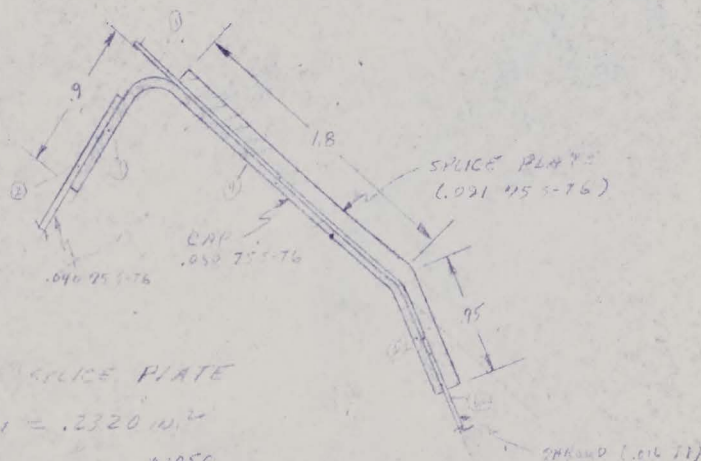
J. NEEDHAM

DATE

CHECKED BY

DATE

UPPER CAP FWD SIDE



SECTION PROPERTIES SPICE PLATE

$$A = 7.5 \times .051 + 1.8 \times .091 = .2320 \text{ IN.}^2$$

$$\bar{Y} = \frac{[.051 \times 7.5 \times 12 + .091 \times 1.8 \times 46]}{.232} = \frac{.0205}{.232} = .0885 \text{ IN.}$$

$$I = .0682(.1015)^2 + .0682(.042)^2 + \frac{.091(.4)^3}{12}$$

$$= .000704 + .000296 + .00075 = .001758$$

$$r = \left[\frac{.001758}{.232} \right]^{1/2} = \left[.00759 \right]^{1/2} = .0870 \text{ IN.}$$

ALLOWABLE COLUMN STRESS 4800 P.S.I.

$$F_y = 4800 \times .7 = 4800 \text{ P.S.I.} \quad F_c = 4800 \times .75 = 51600 \text{ P.S.I.}$$

$$F_c = 51600 \left[1 - \frac{51600 \left(\frac{L}{r} \right)^2}{4 \pi^2 E} \right] \quad E = 10.5 \times 10^6 \times .91 = 9.55 \times 10^6$$

$$F_c = 51600 - 704 \left(\frac{L}{r} \right)^2$$

SECTION PROPERTIES CAP

$$A = .9 \times .05 + 1.9 \times .05 + 1.75 \times .05 = .1775 \text{ IN.}^2$$

$$\bar{Y} = \frac{[.05 \times .9 \times 4.5 + .05 \times 1.9 \times 2.5 + .05 \times 1.75 \times 1.74]}{.1775} = \frac{.02768}{.1775} = .156 \text{ IN.}$$

$$I = .045(.294)^2 + .045(.131)^2 + .0575(.016)^2 + \frac{.05(.2)^3}{12} + \frac{.05(.3)^3}{12}$$

$$= .00889 + .00163 + .00001 + .00274 + .00011 = .00838 \text{ IN.}^4$$

$$r = \left[\frac{.00838}{.1775} \right]^{1/2} = (.0472)^{1/2} = .217 \text{ IN.}$$

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-0558-82

SHEET No. 81

AIRCRAFT:

C 105

TORQUE BOX SPLICE
STA. 644

PREPARED BY

DATE

J. NEEDHAM

CHECKED BY

DATE

SPLICE SECTION STRESSES CONTD

ALLOWABLE COMPRESSIVE STRESS OF SPLICE PLATE & FWD CAP CONTD
CRIPPLING STRESS OF FWD CAP.

$$F_{cc} = \frac{.342 \times 102000}{\left(\frac{.888}{.05}\right)^{.75}} = 27800 \text{ PSI}$$

$$F_{cc} = \frac{.342 \times 702000}{.81 \left(\frac{.825}{.05}\right)^{.75}} = 29500 \text{ PSI}$$

$$F_{cc} = \frac{.716 \times 702000}{.05 \left(\frac{1.225}{.05 + .0091}\right)^{.75}} = 42500 \text{ PSI}$$

MIN. ALLOW. $F_c = 42500 \text{ PSI}$

$$M.S. = \frac{42500}{37000} - 1 = \frac{.35}{.15}$$

ALLOWABLE COMPRESSIVE STRESS OF SPLICE PLATE & AFT CAP

SECTION PROPERTIES:

$$A = .1625 + .1232 + .046 = .4405 \text{ IN}^2$$

$$\bar{e} = \frac{.232 \times .088 + .0475 \times .60 + .090 \times .202 + .025 \times .38 + .046 \times .106}{.4405} =$$

$$= \frac{.0205 + .0285 + .0182 + .0095 + .0049}{.4405} = \frac{.0816}{.4405} = .184"$$

$$I = .232(.096)^2 + .0475(.416)^2 + .090(.418)^2 + .025(.076)^2 + .046(.098)^2 + .00176 + \frac{.076^3}{12}$$

$$= .00214 + .00823 + .00004 + .00230 + .00200 + .00176 + .00120 = .01853 \text{ IN}^4$$

$$r = \left[\frac{.01853}{.4405} \right]^{\frac{1}{2}} = \left[.0421 \right]^{\frac{1}{2}} = .205"$$

$$L = 7.16 \quad \frac{L}{r} = \frac{7.16}{.205} = 34.9$$

$$F_c = 51600 - 7.04(34.9)^2 = 49300 \text{ PSI @ 270°F}$$

$$F_c = 38700 \text{ PSI}$$

$$M.S. = \frac{49300}{38700} - 1 = \frac{.53}{.29}$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C.105

TORSION BOX SPLICE
STN 644-43.

REPORT No. 7-0558-82

SHEET No. 84

PREPARED BY

DATE

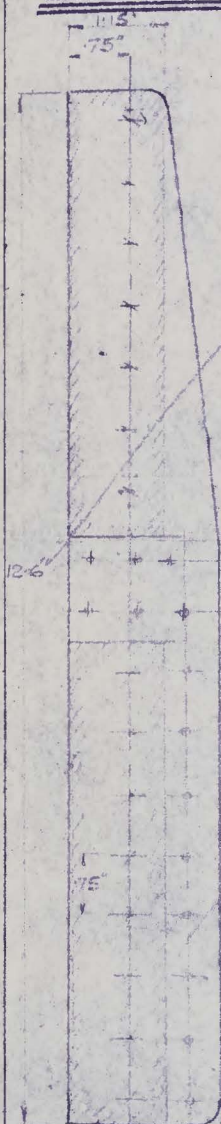
K. J. IDDON.

30 JAN '56.

CHECKED BY

DATE

LOWER SPLICE PLATE.



LOAD ON PLATE = 10,780 #
GROSS AREA = 1.90t INS².

$$B.M. = 10,780 \times .20 \\ = 2,156 \text{ LB INS.}$$

$$Z = \frac{1.90t^3}{6} \\ = .60t$$

$$\therefore f_c = \frac{10,780}{1.90t} + \frac{2,156}{.60t} \\ = 5,680/t + 3,593/t \\ = 9,273/t$$

$$P \cdot \sqrt{\frac{I}{A}} = \sqrt{\frac{190t^3}{1.90t \cdot 12}} \\ = .289t$$

$$\therefore L/p = 3.83/t\sqrt{2} \quad (L=1.11, C=2) \\ = 2.71/t$$

t	f _c	L/p	F _c	R.R.
.050	199,000	54.3	36,500	.485
.058	174,500	46.8	44,500	.656
.065	153,000	40.7	122,200	.800
.072	138,000	37.7	132,000	.955
.083	120,000	32.9	141,000	1.175
.095	105,000	28.6	147,000	1.400
.100	99,500	27.1		

USE .072" STEEL PLATE AT 180,000 PSI.
SINCE THE BENDING STRESSES WILL BE SOMEWHAT
MINIMISED BY OTHER STRUCTURE.

$$\text{LOAD/BOLT TO HINGE} = \frac{10,780}{7} \\ = 1,540 \text{ #}$$

USING 3/16" DIA HUCKS IN .1076ST6 OR .081 STL AT 265°F
= 1,910 #

$$R.F. = \frac{1,910}{1,540}$$

OBSOLETE SEE OVER

R571

R.F.
1.24



AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C105

TORSION BOX SPICE

AT STA 644.43

REPORT NO. 7-0558-82

SHEET NO. 90

PREPARED BY

DATE

G. M. CARLEY

14-1-56

CHECKED BY

DATE

CHECK ON LOADING USED BY J. NELSON FOR PREVIOUS STRESSING OF SPICE

REFERENCE	LOAD APPLIED	SHEAR FLOW IN PANEL				
		1-2	2-3	3-4	4-5	5-1
7-0558-12 ISS2 SH 51	$M_B = 66,347 \text{ L}$	- 19	- 356	- 135	0	- 135
7-0558-12 ISS2 SH 52	$2R = -8,323 \text{ L}$	+ 12	- 134	- 76	0	+ 105
" SH 78	$S = -7,626 \text{ L}$	+ 758	+ 148	- 348	- 520	+ 129
SEE BELOW	$T = 61,100 \text{ L}$	+ 911	+ 911	+ 911	+ 911	+ 911
	TOTAL	+ 1662	+ 619	+ 392	+ 381	+ 1010



SHEAR FLOW DUE TO $T = 61,100 \text{ L}$

NEW TORSION BOX AREA FOUND BY A. FLEMING 7-0558-12 IN 1
= 3350

$$q = \frac{61,100}{2 \times 3350} = 911 \frac{\text{L}}{\text{IN}}$$

NOTE

THE ABOVE LOADING WILL BE USED WHEN IT INCREASES STRESS IN THE SPICE AND SHEAR CONNECTION.

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-82

SHEET NO. 91

AIRCRAFT:

C105

TORSION BOX SPICE

STN 644-43

PREPARED BY

DATE

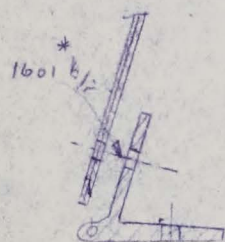
G. M. COILEY

13-2-55

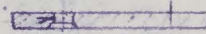
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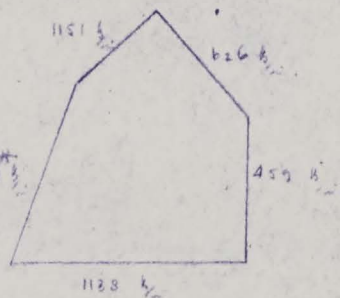
LOADING ON SPICE AT STN 644-43



2,848



633



STN 644-42

$E_L = 10,780$

505



SHEAR PER INCH BETWEEN HINGE AND STEEL PLATE
DUE TO UNLOADING OF 8,230 LBS LOAD

$$= 8,230 \div 5.5 = 1,500 \text{ lbs/in}$$

SAY 1032 SKIN AND 1040 BONDED DOUBLER SHARE THE
1,138 $\frac{1}{2}$ IN THE BOTTOM PANEL ACCORDING TO THEIR
THICKNESS

$$\text{THEN SHEAR/IN IN 1032 SKIN} = \frac{1032}{1072} \times 1,138$$

$$= 1,105 \text{ lbs/in}$$

$$\text{SHEAR/IN IN 1040 DOBLER} = 633 \text{ lbs/in}$$

$$E_L = 10,780 - (1601 - 1138) \times 5.5$$

$$= 8,230 \text{ k.}$$

* INCREASED TO 1662 $\frac{1}{2}$

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-82

SHEET NO. 92

AIRCRAFT:

C105

TORSION LOW SPLICE

AT STN 644.43

PREPARED BY

DATE

G. M. COLLEY

13-2-58

CHECKED BY

DATE

RIVETING BETWEEN HINGE ENT AND STEEL STRAP

$$\text{LOAD PER ATTACHMENT} = \frac{3162}{5.5}$$

7

$$= 2,485 \text{ lb}$$

1661
10.55
11.52

SHEAR STRENGTH OF HI-HI-SHEAR RIVETS $\frac{3}{16}$ DIA A537P.

SHEAR STRENGTH TAKEN TO BE AS FOR HUCK LOCK BOLTS GIVEN IN
AIRCRAFT PAGE 126.

FOR $\frac{3}{16}$ DIA RIVETS

$$\text{SINGLE SHEAR STRENGTH} = 2,620 \text{ lb} \quad R_F = \frac{2,620}{2,485} = 1.053$$

BEARING IN HINGE ENT

$$\text{THICKNESS REQ'D FOR REF. 10} = \frac{2,485}{.187 \times 125,000 \times .86} = .1237 \text{ in}$$

$$R_F = 1.053 = .1305 \text{ in}$$

BEARING IN STEEL STRAP

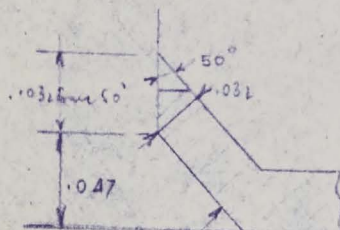
$$\text{SHEAR/IN} = 3162 - 253 = 2,909 \text{ lb}$$

$$\text{LOAD PER ATTACHMENT} = \frac{2,909 \times 5.5}{7} = 2,290 \text{ lb}$$

$$\text{DEPTH OF COUNTERSINK} = .047 + .032 \text{ from } 50^\circ$$

$$\text{FROM OUTSIDE SKIN} = .047 + .047$$

$$= .0887$$



DEPTH OF CSK IN STEEL

$$= .0887 - .0320$$

$$= .0567 \text{ in}$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT No. 7-0558-82

SHEET No. 13.98

AIRCRAFT:

C.105

TORQUE BOX SPLICE.

PREPARED BY

DATE

K. J. DOON

30 JAN '56.

CHECKED BY

DATE

ATTACHMENT OF AFT LONGITUDINAL BEAM TO
FRAME - ATTACHMENT WEB ANGLE TO DIAPHRAGM.

BOLT A IS NOW REMOVED.

BOLT	1 X	2 Y	3 $\bar{X}$ ($\frac{1}{10} - \frac{2}{10}$)	4 $\bar{Y}$ ($\frac{1}{10} - \frac{2}{10}$)	5 $\bar{X}^2$ ($\frac{1}{10}$)	6 $\bar{Y}^2$ ($\frac{1}{10}$)	7 R^2 ($\frac{1}{10}$)	8 $\bar{X}\bar{Y}$ ($\frac{1}{10}$)	9 $\bar{X}\bar{Y}$ ($\frac{1}{10}$)	10 $\bar{X}\bar{Y}$ ($\frac{1}{10}$)
B	.21	.56	.917	.175	.840	.030	.870	.0972	.0185	
C	.43	1.12	.697	.375	.486	.141	.627	.0740	.0397	
D	.65	1.68	.477	.945	.228	.892	1.120	.0506	.0000	
E	.85	.44	.277	1.175	.077	1.380	1.457	.0283	.1242	
F	1.06	.12	-.067	.615	.005	.377	.382	.0071	.0652	
G	1.38	.92	0.253	1.185	.064	.034	.098	.0268	.0196	
H	1.54	.44	.418	1.175	.170	1.380	1.550	.0438	.1242	
I	1.62	.38	.493	.355	.243	.126	.369	.0522	.0375	
J	1.73	1.42	.607	.685	.368	.470	.838	.0643	.0725	
K	1.80	2.03	.673	1.295	.453	1.680	2.133	.0712	.1370	
10 Σ	11.27	7.35	=0 ✓	=0 ✓			9.444	=0 ✓	=0 ✓	
	$\bar{X}=1.127$	$\bar{Y}=1.735$								

11 H_M	12 $M(9)$ V_M	13 H_D V_D	14 H_{TOT} V_{TOT}	15 H_{TOT} V_{TOT}	16 H_{TOT} V_{TOT}	17 H_{TOT} V_{TOT}	18 H_{TOT} V_{TOT}	19 H_{TOT} V_{TOT}	20 H_{TOT} V_{TOT}
-45.5	239.0	276.0	719.0	230.5	358.0	53.0	919.0	972.0	986
+37.5	182.0	276.0	719.0	373.5	301.0	139.0	811.0	950.0	975
+246.0	124.5	276.0	719.0	522.0	843.5	290.0	710.0	1000.0	1000
-306.0	69.6	276.0	719.0	-30.0	788.6	.9	620.0	620.9	790
-160.5	17.4	276.0	719.0	115.5	734.4	138.8	540.0	553.3	745
+48.2	86.0	276.0	719.0	224.2	653.0	105.2	426.0	531.0	730
-306.0	106.5	276.0	719.0	-30.0	613.0	.9	375.0	375.9	612
-92.2	128.2	276.0	719.0	103.8	590.8	33.7	350.0	383.7	610
+178.5	158.0	276.0	719.0	454.5	561.0	207.0	315.0	522.0	725
+337.0	175.0	276.0	719.0	613.0	544.0	375.0	295.0	670.0	820
0 ✓	0 ✓	2760.0	7190.0	2757.0	7187.1				

$$M = \frac{2460 \times 980}{16} = 1499 \times 32 = 2.460 \text{ lb ins.}$$

ALLOWABLE = 1.162 #

$$\therefore M_s = \frac{1.162}{1000} - 1$$

M/S = 46

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-0558-82

SHEET No. 100

AIRCRAFT:

C105

TURBINE BOX BRACE
STA. 644

PREPARED BY

DATE

J. NEEDHAM

CHECKED BY

DATE

ATTACH. 117 LONG BEAM TO FRAMIC CENT'D.

ATTACH. 117 ANGLE TO DIAPHRAGM 117

LOADS ON BOLTS

BOLT	$-R_{AV}$	R_{AH}	R_V	R_H	R_R
a	189	-123	843	128	853
b	150	-20	804	231	836
c	109	83	763	334	833
d	69	186	723	437	845
e	32	-204	686	47	
f	-7	-101	647	150	
g	-47	46	607	205	
h	-95	-204	559	47	
i	-110	-60	544	191	
j	-130	139	524	390	
k	-143	250	511	501	716

$$R_V = \bar{R}_V - R_{AV}$$

$$R_H = \bar{R}_H + R_{AH}$$

$$R_R = \sqrt{R_V^2 + R_H^2}$$

$$\bar{R}_V = \frac{7190}{11} = 654 \text{ #/BOLT}$$

$$\bar{R}_H = \frac{2760}{11} = 251 \text{ #/BOLT}$$

ALLOW. FOR DIA 3/16 JO-BOLT, BRD. 117, 105-76 @ 250°F

$$P_{BR} = 1162 \text{ # (SEE SHEET 100)}$$

$$M.F. = \frac{1162}{853} - 1 = .37$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-0558-82

SHEET No. 102

AIRCRAFT:

C 105

TORQUE FOR 1000
500 644

PREPARED BY

DATE

S. HEDUNDIS

CHECKED BY

DATE

AFT DIAPHRAGM CONT'D

ALLOW. $\frac{1}{2}$ " DIA 50-BOLT BRG. IN .072 75° TO 230° F.

$$P_{br} = .156 \times .072 \times 137000 \times .85 = 1328^{\#}$$

$$P_s = 1247^{\#}$$

B REACTION (1)

$$ALLOW. = 4(1247) = 4988^{\#}$$

$$R_R = 3697^{\#}$$

$$M/S = \frac{4988}{3697} = 1.35$$

C REACTION (2)

$$K_R = [1572^2 + 1247^2]^{\frac{1}{2}} = 1980^{\#}$$

$$ALLOW. = 5 \times 1247 = 6235^{\#}$$

$$M/S = 2.1$$

D REACTION (3)

$$K_R = [2131^2 + 1247^2]^{\frac{1}{2}} = 2460^{\#}$$

$$ALLOW. = 3 \times 1247 = 3741^{\#}$$

$$M/S = \frac{3741}{2460} = 1.52$$

E REACTION (4)

$$K_R = [1287^2 + 1247^2]^{\frac{1}{2}} = 1810^{\#}$$

$$ALLOW. = 6 \times 1247 = 7482^{\#}$$

$$M/S = 1.1$$

FOR COMPUTING BUCKLING ALLOWABLES OF DIAPHRAGM ASSUME
A RECTANGLE 2.85" X 4.96" (REF. 1000X)

$$\frac{b}{a} = \frac{4.96}{2.85} = 1.74 \quad K = 5.00$$

$$F_s = K \frac{E}{(1+\mu)} \left(\frac{a}{b} \right)^2 = \frac{5.00 \times 3 \times 10^6}{91} \left(\frac{2.85}{4.96} \right)^2 = 38000 \text{ PSI}$$

$$Q_s = 38000 \times .072 = 2736^{\#}/IN.$$

ALLOW. FOR AN EQUAL UNIFORM, COMPRESSIVE LOAD IN THE
EDGES.

$$K = 3.50$$

$$F_c = \frac{3.50}{5.120} (38000) = 25900 \text{ PSI}$$

$$P_c = .72 \times 25900 = 18648^{\#}/IN.$$

$$ALLOW. F = \frac{3697}{3.120} = 1188^{\#}/IN.$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-0558-82

SHEET No. 107

AIRCRAFT:

C 105

TORQUE BOX SPARE
STD. 644

PREPARED BY

S. HADHAM

DATE

14-12-55

CHECKED BY

DATE

FWD. TORQUE BOX

ATTACHMENT OF TORQUE BOX TO ENGINE JOINT

BORE 3/4" DIA. 5/8" BORE ALLOWANCE

FOR 3/4" DIA. STD. JO-BOLT (A 1000)

SHEAR = 1247#

BRC. IN .050 75 S-76 = 908#

BRC. IN .040 TITANIUM = 1040#

BRC. IN .040 75 S-76 = 1567.064 x 1.12 x 1.12 = 1162#

FOR 3/4" DIA. STD. JO-BOLT (A 1000)

SHEAR = 2220#

BRC. IN .064 75 S-76 = 187 x .064 x 1.12 x 1.12 = 1394#

FOR 3/4" DIA. WICKER KEY (A 1000)

SHEAR = 914#

BRC. IN .050 75 S-76 = 670 x .05 = 335#

FOR 3/4" DIA. 75 S-76 ALL HARD BOLT

SHEAR = 914#

BRC. IN .050 75 S-76 = 908#

ATTACHMENT ALONG SIDE 1-2

MAX. Q = 1993# IN.

Q = 1531 x 6.28 = 10800#

ATTACH. 1000 STD. JO-BOLT (18) 3/4" DIA. (6) 3/4" DIA. BRC. IN

.050 75 S-76.

ALLOW. LOAD = 15 x 908 + 2 x 908 = 18160#

AL.S. = $\frac{18160}{1993} - 1 = .68$

ATTACHMENT ALONG SIDE 2-3

MAX. Q = 1147# IN. (2042 SMT 1)

Q = 1147 x 1.28 = 2270# = 9020#

ATTACH. CONSISTS OF (4) 3/4" JO-BOLTS BRC. IN .050 75 S-76

ALLOW. LOAD = 3 x 908 = 2724#

3 x 1370 = 4110#

AL.S. = $\frac{2724}{2270} - 1 = .21$ (.02)

In Addition There Is An Off Set Moment. But Because OF PREVIOUS STRESSING METHOD THIS IS CONSIDERED SATISFACTORY. Ref S. 4000.

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-0558-82

SHEET No. 108

AIRCRAFT:

C 105

TORQUE BOX SPARE
STA. 644

PREPARED BY

DATE

J. NEEDHAM

CHECKED BY

DATE

FWD. TORQUE BOX

ATTACH FWD. TORQUE BOX TO WING FROM CENTER

$$q = 1126 \text{ PSI}$$

ATTACHMENT ALONG SIDE 3-4

$$\text{MAX. } g = 641 \text{ PSI}$$

$$Q = 6.11 \times 461 = 2805 \text{ #}$$

$$6 \frac{5}{32} \text{ Steel Bolts (allow } 164 \times 17000 \times 2 \times 6 \times 4 = 4300 \text{ #)}$$

ATTACH. BOLTS OF (2) 7/8 IN DIA. (4) 1/2 IN DIA. (4) 1/4 IN DIA.

$$\text{BOLTS IN } 10 \times 16 \times 16$$

1090

$$\text{ALLOW. } 2 \times 708 + 4 \times 586 = 4162$$

$$\left(\frac{1090}{2805} - 1 \right) = .45$$

$$\text{MS } \frac{430}{1126 \times 4.0}$$

ATTACHMENT ALONG SIDE 4-5

$$\text{MAX. } g = 585 \text{ PSI (RTT. 4000' 10' ST. 100)}$$

$$g = 1038 \text{ PSI}$$

$$Q = 3.84 \times 585 = 2245 \text{ #}$$

ATTACH. BOLTS OF (5) 7/8 IN DIA. 75 TO 76 LUGS - BOLTS 4000' 10' ST. 100

$$\text{ALLOW. } 5 \times 88 \times 5 = 4540 \text{ #}$$

$$4 \frac{5}{32} \text{ JO } 1 \frac{3}{8} \text{ AD IN 051}$$

$$\text{MS } = \frac{4540}{2245} - 1 = 1.02$$

ATTACHMENT ALONG SIDE 5-6

$$\text{MAX. } g = 1118 \text{ PSI}$$

$$Q = 1118 \times 4.26 = 7250 \text{ #}$$

$$\text{MS } = \frac{4540}{384 \times 10.08} - 1$$

74

ATTACH. BOLTS OF (14) 7/8 IN DIA. 75 TO 76 LUGS - BOLTS 4000' 10' ST. 100

$$\text{ALLOW. } 14 \times 88 \times 5 = 690 \times 10 = 586 \text{ #}$$

$$\text{ALLOW. } 14 \times 88 \times 5 = 690 \times 10 = 586 \text{ #}$$

$$\text{ALLOW. } 14 \times 88 \times 5 = 690 \times 10 = 586 \text{ #}$$

SKIN IS ALSO CONTINUOUS TO THE FLOOR AND ATTACHED TO THE FLOOR

$$\text{ALLOW. } 14 \times 88 \times 5 = 690 \times 10 = 586 \text{ #}$$

$$\text{TOTAL TENSION CONNECTION } = 114 \times 71586 = 12,310 \text{ #}$$

$$\text{MS } = \frac{12310}{7250} - 1 = .70$$

$$\% \text{ LONG TO DIAPHRAGM } = \left(\frac{14}{21} \right) = .66$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-0558-82

SHEET No. 110

AIRCRAFT:

C105

TORQUE BOX SPLICE
511 644.

PREPARED BY

J. NEEDHAM

DATE

CHECKED BY

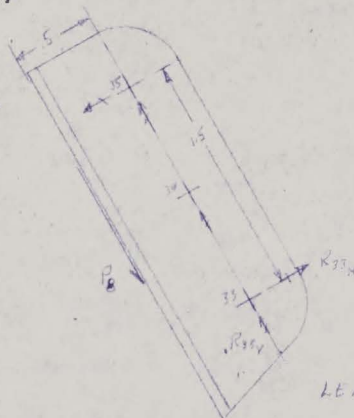
DATE

REVISED ATTACHMENT OF TORQUE BOX DIAPHRAGM TO
FRAME DIAPHRAGM

THE MAJOR OF REACTIONS, R_B & R_A , IS TRANSFERRING
LOAD BETWEEN DIAPHRAGMS IS DIFFERENT FROM THE
REMAINING REACTIONS. FOR NO. 511, THE LOAD PATH IS
FROM TORQUE BOX DIAPHRAGM TO CLIP AND THEN TO THE
FRAME OR FRAME DIAPHRAGM.

TO COMPUTE THE BOLT LOADS, THE ALLOWABLE LOAD OF
REACTIONS R_B & R_A ARE FIRST COMPUTED. THIS LOAD IS TAKEN
FROM THE END OF THE LOAD WITH THE REMAINING LOAD APPLIED
TO THE REACTION R_B FROM 2.

ALLOWABLE OF REACTION (R_B).



$$R_{BV} = \frac{P_B}{2} = .33 P_B$$

$$R_{BH} = \frac{5P_B}{1.5} = .333 P_B$$

$$R_{B2} = 1.414 \times .333 P_B = .471 P_B$$

ALLOWABLE OF $\frac{3}{16}$ IN BOLT B.C. 20
1064 755-76 @ 2500 = 1328 #

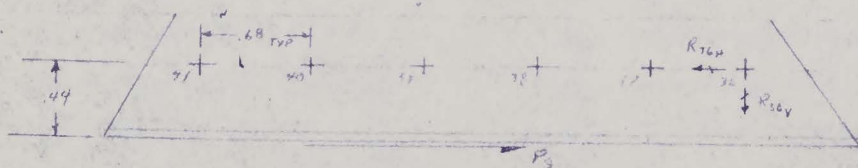
$$\therefore \text{MAX } P_B = \frac{1328}{.471} = 2810 \#$$

$$\text{LET } P_B = 2810 \times .45 = 1264 \#$$

LEAVING

M.S. = .05

ALLOWABLE OF REACTION (R_A)



$$R_{AH} = \frac{P_A}{6} = .1667 P_A$$

$$\text{I OF BOLT PATTERN} = 2 [(1.44)^2 + (1.01)^2 + (1.70)^2] = 8.09$$

$$R_{AV} = \frac{44 P_A (1.70)}{8.09} = .9325 P_A$$

$$R_{A2} = [(1.01)^2 + (.9325)^2]^{1/2} P_A = .1905 P_A$$

ALLOWABLE $\frac{3}{16}$ DIA. 20 BOLT B.C. 1064 755-76 @ 2500 = 1162 #

$$\text{MAX } P_A = \frac{1162}{.1905} = 6100 \#$$

$$\text{LET } P_A = 6100 \times .25 = 1525 \#$$

M.S. = .05

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-82

SHEET NO. 116

AIRCRAFT:

C105

TORQUE RIX TRICES
STA 6.44

PREPARED BY

DATE

J. NEEDHAM

CHECKED BY

DATE

ATTACH FRAME DIAPHRAGM TO FRAMIT

FIND STRESS FIELDS

$$812 = 535 + \frac{399}{40.5 \times 10^{-3}} = 535 + 665 = 1200 \text{ #/in.}$$

$$823 = 489 + \frac{805}{48.3 \times 10^{-3}} = 489 + 669 = 1158 \text{ #/in.}$$

$$814 = 489 + \frac{1379}{45.1 \times 10^{-3}} = 489 + 630 = 1119 \text{ #/in.}$$

$$845 = 489 + \frac{2070}{41.2} = 489 + 664 = 1153 \text{ #/in.}$$

$$856 = 535 + \frac{2220}{41.2} = 535 + 680 = 1215 \text{ #/in.}$$

$$816 = 535 + \frac{2640}{41.3} = 535 + 625 = 90 \text{ #/in.}$$

$$845 = 46 + \frac{1350}{1.20} = 46 + 582 = 628 \text{ #/in.}$$

CHECK

$$\Sigma F_x = 7626$$

$$1200 \times 4.06 \times 1.410 + 1158 \times 4.83 \times 2.49 + 1119 \times 2.77 \times 9.74 + 20 \times 4.30 + 628 \times 3.70 = 7626$$

$$= 713 + 1392 + 2800 + 387 + 2325 = 7623 = 7626 \text{ OK}$$

$$\Sigma F_y = 0$$

$$1200 \times 4.06 \times 9.89 + 1158 \times 4.83 \times 9.29 - 1119 \times 2.77 \times 2.21 - 1153 \times 4.10 - 1215 \times 4.0 = 0$$

$$= 4820 + 5410 - 646 - 4720 - 4860 = 1230 - 1026 = 6 \text{ OK}$$

ALLOW. STRESS TO BODY 1040 IN. 0.04 95% TO AREA 16 250°F

$$P_{11} = 1162 \times 0.04 \times 177000 \times 1.85 = 1162 \text{ #}$$

ALLOW. STRESS TO BODY 1040 IN. 0.04 95% TO AREA 16 250°F

$$P_{11} = 1162 \left(\frac{1.092}{1.064} \right) = 1308 \text{ #}$$

ALLOW. STRESS TO BODY 1040 IN. 0.04 95% TO AREA 16 250°F

$$P_{21} = 1162 \left(\frac{1.187}{1.064} \right) = 1405 \text{ #}$$

ALLOW. STRESS TO BODY 1040 IN. 0.04 95% TO AREA 16 250°F

$$P_{11} = 1405 \left(\frac{1.024}{1.064} \right) = 1580 \text{ #}$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-82

SHEET NO. 119

AIRCRAFT:

C105

TORQUE BOX TO
FORMER JOINT, AT
STN 591.65

PREPARED BY

DATE

G. M. COLLEY

15-11-57

CHECKED BY

DATE

FOR LOADING SEE Report AIR 7-0558-12/2 p. 181

RIGGING - TORSION BOX TO DIAGRAM

PANEL 1-2

(EX 10517) 5/32 HUCK LOCK BOLTS 765-T6

BOLT PITCH = $\frac{7.5}{16} = .469$

(a) 265°F { SHEAR STRENGTH = $.996 \times .79 = 786$ k.
BEARING IN .050 T6 (AC 110A) = $.156 \times .050 \times 170,000 \times .76 = 1,005$ k.
BEARING IN .040 765-T6 = $.156 \times .040 \times 137,000 \times .77 = 669$ k. 1,050 k.
STRENGTH / IN = $\frac{786}{.469} = 1,670$ k/in.

SHEAR / IN = 1,174 k/in.

PANEL 2-3

(EX 064) 5/32 HUCK LOCK BOLTS 765-T6

LOAD TO RIGHT = 2 X 266 = 532 k.

DIRECT LOAD / BOLT = 544 k

M = 532 X .35 = 186 k-in.

LOAD DUE TO M PER BOLT = $\frac{571}{1.01} = 565$ k

RESULTANT LOAD / BOLT = $\sqrt{(544)^2 + (565)^2}$

= 770 k

(BEARING IN .040 765-T6 = 1,050 k)

SHEAR STRENGTH AS ABOVE = 786 k

PANEL 3-4

(EX 040)

5/16 CLEVIS BUSH 2100-1 (IN ALLOY)

RIVET PITCH = $\frac{5.4}{8} = .675$

(a) 200°F IN .040" STRENGTH = 425 k.

STRENGTH / IN = $\frac{425}{.675} = 630$ k/in.

SHEAR / IN = 526 k/in.

PANEL 4-5

AN 470-405

(EX 051)

RIVET PITCH = $\frac{3.7}{6} = .617$

(a) 200°F { SHEAR STRENGTH = $.96 \times .96 = 552$ k.

BEARING IN .040 765-T6 = $.156 \times .051 \times 137,000 \times .90 = 768$ k.

SHEAR / IN = 524 k/in.

STRENGTH / IN = $\frac{552}{.617} = 873$ k/in.

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-82

SHEET NO. 120

AIRCRAFT:

C105

TORQUE BOX TO FORMER

Joint AT 3" IN 591.6"

PREPARED BY

DATE

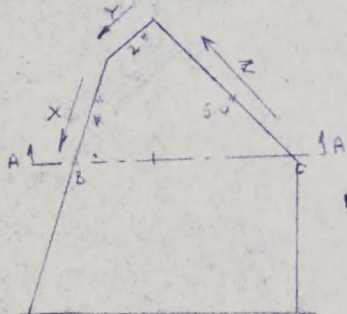
G. M. COILEY

15-11-58

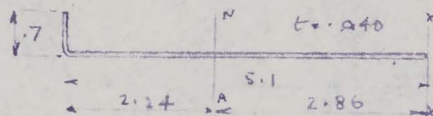
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DATE

STRESSES IN DIAPHRAGM:



SECTION 'AA'



1st MOMENTS ABOUT XX

$$0.40 \times 5.1 \times 2.55 = .520$$

$$0.40 \times 0.7 \times 5.1 = .143$$

$$\text{TOTAL} = .663 \text{ in}^3$$

$$\text{AREA} = 5.8 \times 0.40 = 2.32 \text{ in}^2$$

$$\bar{x} = 2.86 \text{ in}$$

$$I_{NA} = 0.40 \times 2.86^3 \times \frac{1}{3} = 0.312$$

$$0.40 \times 2.24^3 \times \frac{1}{3} = 0.150$$

$$0.40 \times 0.7 \times 2.24^2 = 0.140$$

$$\text{TOTAL} = 0.602 \text{ in}^4$$

BM & DIRECT LOAD IN TERMS OF X, Y, & Z.

$$\text{BM} = +2.2X + 3.68Y + 2.8Z \quad (\text{TENSION AT B FOR THE BM})$$

$$\text{DIRECT LOAD} = +X \cos 22^\circ + Y \cos 56^\circ - Z \cos 22^\circ \quad (\text{TENSION FOR THE D.L.})$$

$$= +.927X + .559Y - .927Z$$

$$= .927(X-Z) + .559Y$$

COND- ITION	X	Y in	Z	2.2X	3.68Y	2.8Z	BM	X-Z
9	+4700	+1632	+1590	+10,330	+6010	+4450	+20,790	+3,110
2	+68	+172	+1010	+150	+633	+2820	+3,603	-942
6	+3310	+1408	+2840	+7280	+5180	+7950	+20,410	+470
4	-216	+326	+2580	-475	+1200	+7220	+7,945	-2,796
COND.	.927(X-Z)	.559Y	DIRECT LOAD	DIRECT STRESS	BEND STRESS AT B	BEND STRESS AT C	STRESS AT B	STRESS AT C
9	+2,880	+912	+3,792	+16,400	+77,200	-98,700	+93,600	-82,300
2	-873	+96	-777	-3,350	+13,400	-17,100	+10,050	-20,450
6	+436	+787	+1223	+5,270	+75,800	-97,000	+81,070	-91,730
4	-2,590	+182	-2,408	-10,400	+29,600	-37,700	+19,200	-48,100

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-82.

SHEET NO. 122

AIRCRAFT:

CIDS

Take Box To Forward

Joint at 571-60

PREPARED BY

DATE

G. A. COLE

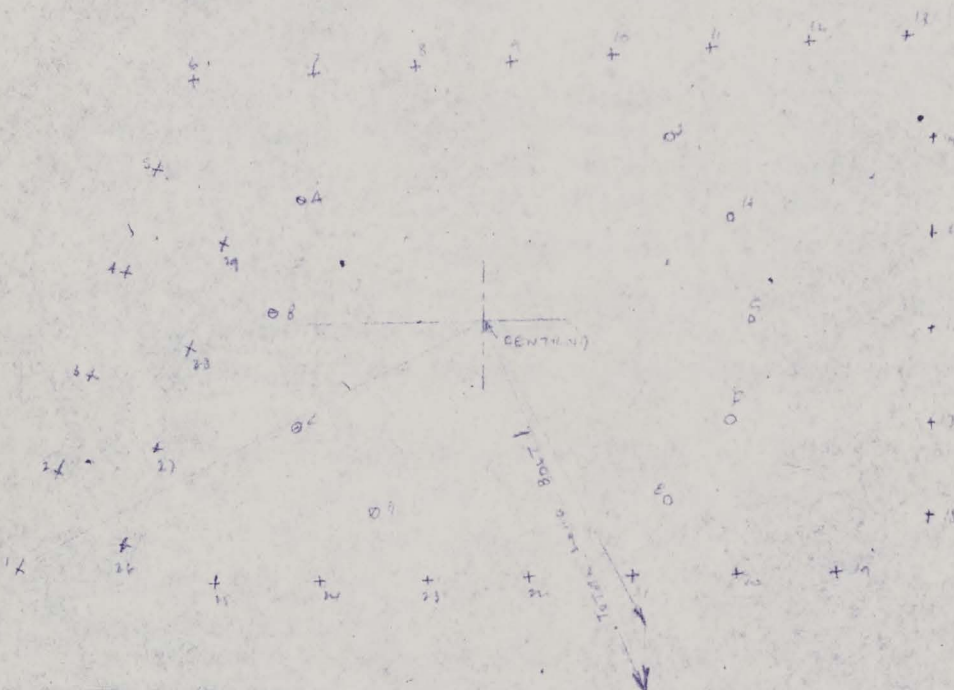
16-4-55

CHECKED BY

DATE

MOMENT OF RESISTANCE OF ATTACHMENTS BETWEEN DIAPHRAGMS

+ Jo-Bolts $\bar{y}_n$ ARM TO CENTROID $+ a_n$
0 AN470-N24 b_n



BOLT	a^2	BOLT	a^2	BOLT	a^2
1	10.40	13	9.58	25	5.28
2	7.65	14	8.70	26	6.73
3	5.88	15	7.84	27	4.62
4	4.84	16	7.45	28	3.24
5	4.84	17	7.82	29	2.74
6	5.28	18	8.80		
7	3.42	19	7.00		
8	2.56	20	4.60		
9	2.56	21	3.36		
10	3.33	22	2.56		
11	4.60	23	2.60		
12	6.74	24	3.60		
TOT	62.10	TOT	73.93	TOT	22.61

$$\sum a^2 = 158.64 \text{ in}^2$$

$$\sum b^2 = 19.60 \text{ in}^2$$

$$A_1 \sum a^2 + A_2 \sum b^2 = K$$

$$K = 10192 \times 158.64$$

$$+ 10123 \times 19.60$$

$$= 3041.241$$

$$= 3.28124$$

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-82

SHEET NO. 41 123

AIRCRAFT:

C105

TORQUE BOX TO FORWARD

JOINT AT STN. 591.61

PREPARED BY

DATE

G. A. COLLEY

16-11-55

CHECKED BY

DATE

ATTACHMENTS BETWEEN DIAPHRAGMS

29 - $\frac{5}{32}$ JO- BOLTS (AL ALLOY)

9 - AN 470 - AD4

A₁ = 0.1920" - P EALH

A₂ = 0.1230" - 64 P EALH

DIRECT LOAD

$$R_1 = 23P + 9 \times .64P$$

$$R_1 = 34.76 P$$

DIRECT LOAD ATT	COND 9	($R_1 = 5740 \text{ lb}$)	=
"	" 2	($R_2 = 1110 \text{ lb}$)	=
"	" 6	($R_1 = 1960 \text{ lb}$)	=
"	" 4	($R_2 = 3480 \text{ lb}$)	=

JO BOLTS	AN 470-AD4
165.4 lb	105.5 lb
32.0 lb	20.5 lb
56.7 lb	36.3 lb
100.2 lb	64.1 lb

$$\begin{aligned} \frac{5}{32} \text{ JO - BOLTS } \left\{ \begin{array}{l} \text{SHEAR STRENGTH @ } 200^\circ\text{F} = 1815 \times .91 = 1653 \text{ lb} \\ \text{BEARING IN 1064 T55-T6 @ } 200^\circ\text{F} = 1064 \times 1.56 \times 187,000 \times .90 = 1230 \text{ lb} \end{array} \right. \end{aligned}$$

$$\begin{aligned} \text{AN 470-AD4 } \left\{ \begin{array}{l} \text{SHEAR STRENGTH @ } 200^\circ\text{F} = 389 \times .96 = 372 \text{ lb} \\ \text{BEARING IN T55-T6 @ } 200^\circ\text{F} = 822 \times 1.37 \times .90 = 1012 \text{ lb} \end{array} \right. \end{aligned}$$

WORST LOADED JO-BOLT

BOLT 1 FOR COND 9

$$\text{DIRECT LOAD} = 165.4 \text{ lb}$$

$$\text{MOMENT LOAD} = \frac{44,100 \times 3.21 \times .0191}{3.281} = 838 \text{ lb}$$

$$\text{VECTOR SUM} = 990 \text{ lb}$$

RF = 1.24

WORST LOADED RIVET

RIVET B, COND 9

$$\text{DIRECT LOAD} = 105.5 \text{ lb}$$

$$\text{MOMENT LOAD} = \frac{44,100 \times 1.28 \times .013}{3.281} = 212 \text{ lb}$$

$$\text{VECTOR SUM} = \text{ALGEBRAIC SUM} = 317.5 \text{ lb}$$

RF = 1.17



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 127

AIRCRAFT:

C.105

TORSION BOX

PREPARED BY

J. B. YOUNG

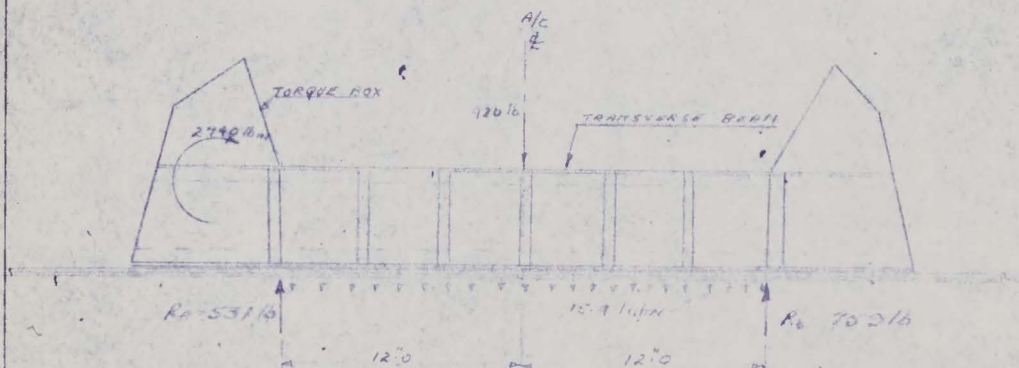
DATE

11-5-56

CHECKED BY

DATE

TRANSVERSE BEAMS 606-05 AND 625-25
CHECK ON SHEAR WEBS AND ATTACHMENTS ONLY



NOTE

① DUE TO DIFFERENCE IN PRESSURE INSIDE SHROUD (-4.1 PSI) A MOMENT OF $660 \times 4.1 = 2740 \text{ LB IN}$ IS APPLIED AT S.C. OF TORQUE BOX.

② GEAR BOX STRUT LOAD = 320 LB. THIS LOAD ONLY OCCURS ON TRANSVERSE BEAM AT 625-25. HOWEVER THE LOADING WILL BE ASSUMED SAME FOR BOTH BEAMS.

③ SUCTION PRESSURE LOADING = 3.21 PSI.

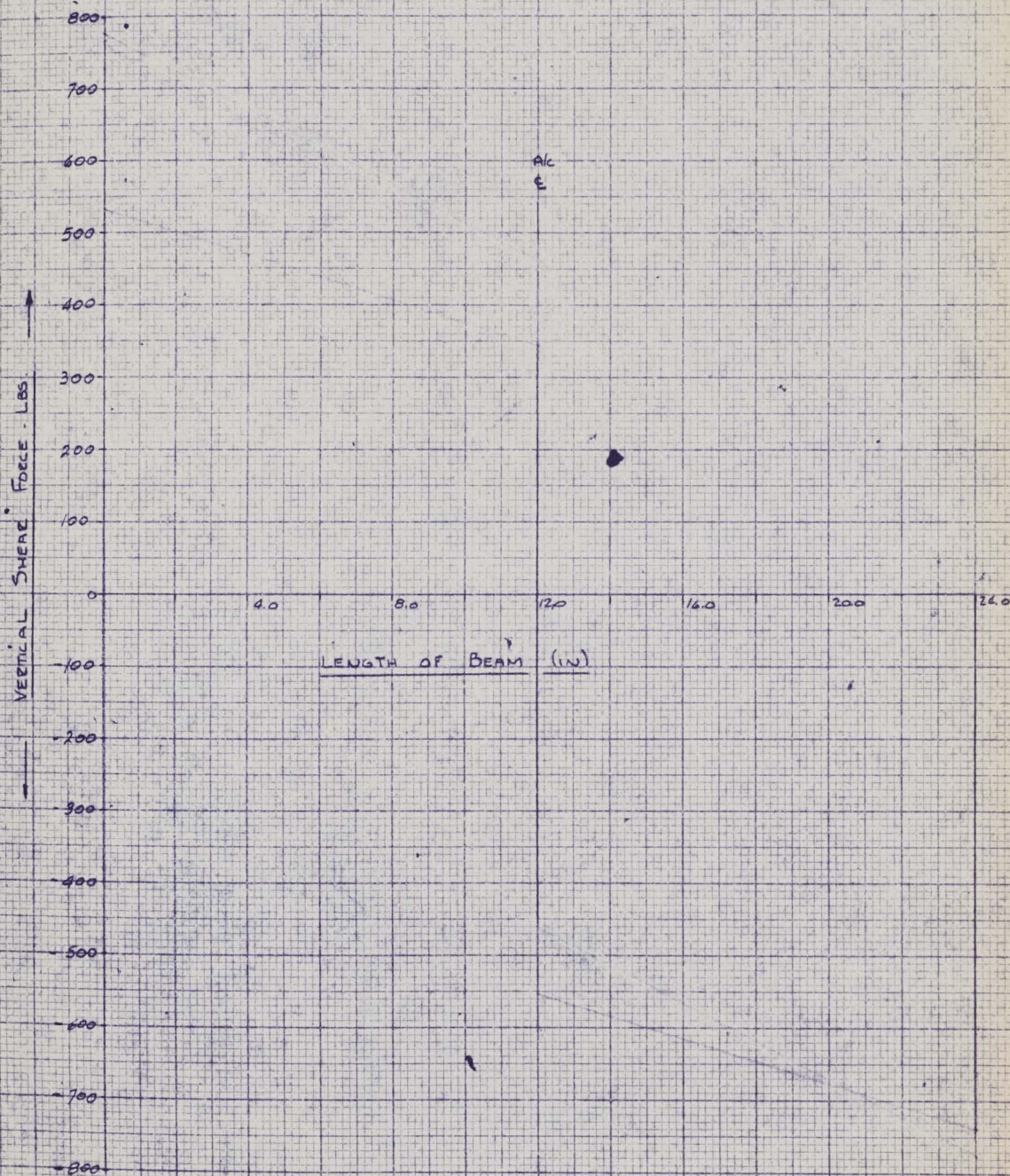
DOOR AND RIPPED PANEL SPACING 4.8". LOAD = $3.21 \times 4.8 = 15.4 \text{ LB/IN}$

BEAM REACTIONS

ASSUME BEAM ON SINGLE SUPPORTS AT 1/8 EDGES OF TORQUE BOX. (BEAM LENGTH = 24.0)

$$R_A = \frac{15.4 \times 24}{2} + \frac{320}{2} - \frac{2740}{24} = 531 \text{ LB}$$

$$R_B = 753 \text{ LB}$$

VERTICAL SHEAR FORCE DIAGRAMTRANSVERSE TORQUE BOX BEAM 625.25NOTE - VALUES OF SHEAR ARE ULT

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-82

SHEET NO. 129

AIRCRAFT:

C105

Torque Box

PREPARED BY

DATE

G. L. SLADSK

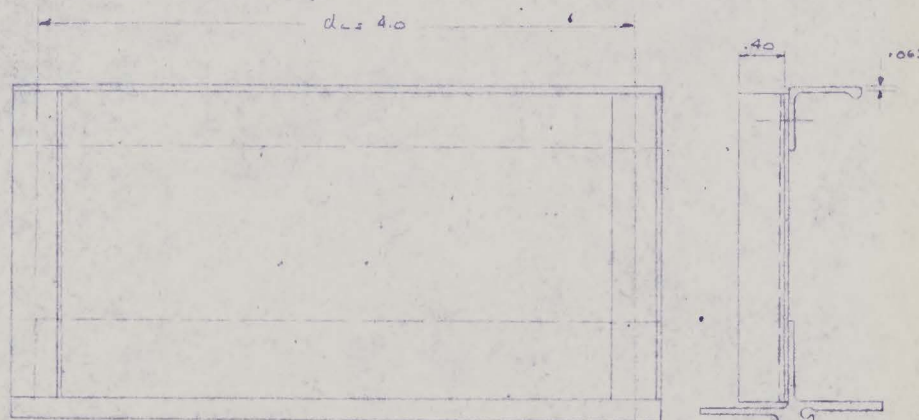
JAN 1966

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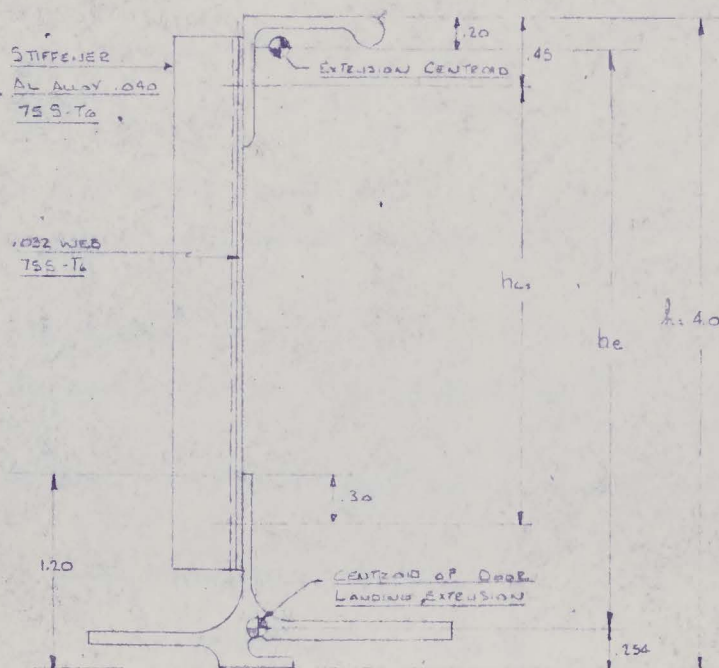
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TRANSVERSE BEAMS 600 75 AND 625 25

SHEAR STRENGTH - DIAPHRAGM



TYPICAL BEAM PANEL (.025 DIAPHRAGM NOW ADDED AT BEAM ENDS)



TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-82

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AIRCRAFT:

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TRANSVERSE BEAMS 606.05 AND 625.25

SHEAR STRENGTH DIAPHRAGM CONT'

τ_{CE} ELASTIC = 11,000 P.S.I.

FROM FIG. 12(C) FOR 755-T6 MAT'L

$\tau_{CE} = 8,500$ P.S.I.

FROM SHT

MAX VERTICAL SHEAR ON PANEL = 759 LBS

$\tau_s = \frac{V}{h_e t}$ WHERE $h_e = 3.506$ IN (SEE SHT 12 D)

$\therefore \tau_s$ AVERAGE = $\frac{759}{3.506 \times .032} = 6630$ P.S.I. ULT

SINCE THE VERTICAL SHEAR "V" USED, REPRESENTS THE MAX. RATHER THAN THE AVERAGE PANEL SHEAR LOAD, τ_s AVERAGE WILL BE COMPARED TO τ_{CE} . THE DIRECT TENSION LOADING ON THE PANEL DUE TO THE SECTION DOWEL LOADS IS SMALL, SO THAT ITS EFFECTS MAY BE DISREGARDED

R.F. SHEAR BUCKLING = $\frac{3500}{6630} = 1.12^*$

* THIS R.F. IS NOW CONSERVATIVE, SINCE THE EXTREME (ENDS) PANELS OF THE BEAM HAVE BEEN REINFORCED BY AN .025 755-T6 DOUBLER BONDED TO THE .032 DIAPHRAGM

TECHNICAL DEPARTMENT (Aircraft)

SHEET NO. 133

6105

Torque Box

PREPARED BY

DATE _____

G. L. SLADEK

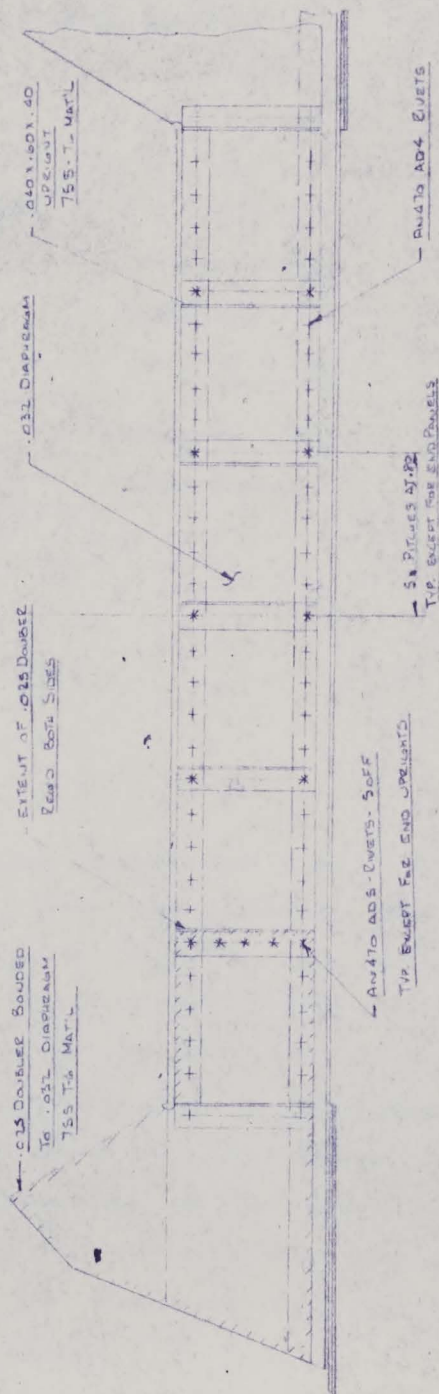
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TRANSVERSE BEAMS 604.05 AND 625.25

FLANGE AND UPRIGHT RIVETING

 Δ/L 

AIRCRAFT:

Los

Tobacco Box

PREPARED BY

DATE _____

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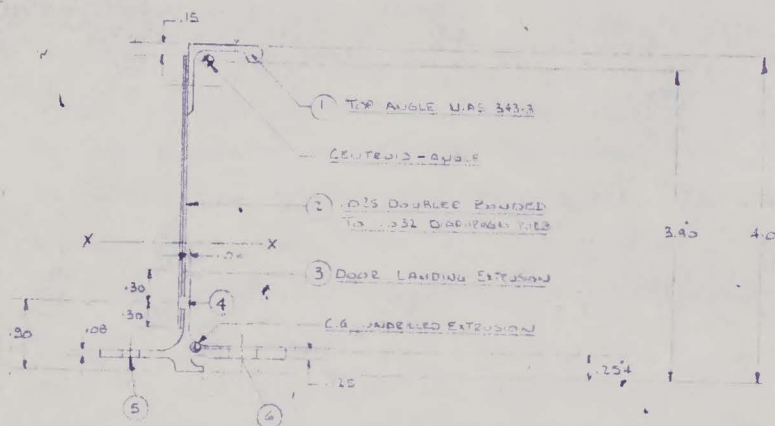
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TRANSVERSE BEAMS 606.03 AND 625.25

FLANGE RIVETING



ITEM (4) - 1/2 DIA HOLE

⑤ 3

(6) $3/9$ " "

SHEAR FLOW ALONG FLANGE RIVET LINES : Vfy/I
THE MAX RIVET LOADS WILL THEREFORE OCCUR AT THE BEAM ENDS, SINCE THE MAX SHEAR LOADING OCCURS AT THESE POINTS AND ALSO I IS AT ITS LOWEST VALUE IN THIS AREA DUE TO THE DISCONTINUITY OF THE SERVICE DOOR AND PINNED PANEL MEMBERS. HOWEVER, TO FACILITATE THE WORK REQ'D IN CHECKING THE RIVET STRENGTHS, RIVET LOADS WILL BE ASSUMED CONSTANT BASED ON ON SHEAR FLOWS OBTAINED AT THE BEAM ENDS. (CONSERVATIVE)
SINCE THE WEB IS ONLY 1032 THICK OVER THE CENTRE PORTION OF THE BEAM THE RIVETS IN THIS AREA WILL OBVIOUSLY BE MORE CRITICALLY LOADED.

TECHNICAL DEPARTMENT (Aircraft)

SHEET NO. 135

PREPARED BY

DATE _____

G. L. SLADEK

15. 10. 1956

CHECKED BY

DATE _____

AIRCRAFT:

6105

Torsion Box

TRANSVERSE BEAMS 602.105 AND 625.25

FLANGE RIVETING

From S_{NT} $Q_T = 176.0 \text{ LBS/IN.}$

$$q_B = 247 \text{ LBS/min.}$$

SINCE THE RIVET TYPE AND PITCHING IS THE SAME ALONG BOTH THE TOP AND BOTTOM SOES OF THE BEAM, ONLY THE DOOR LAMB EXTENSION RIVETS NEED BE CHECKED. THE MOST CRITICALLY LOADED RIVETS ARE THOSE IN THE CENTRAL PORTION OF THE BEAM WHERE THE .022 DIAPHRAGM IS NO LONGER REINFORCED BY THE .025 DOUBLER.

RIVET PITCH: .20 (SEE THE PRECEDING SHEET)

$$A. \text{ SHEAR / RIVET} = 247 \times .50 = 123.5 \text{ LBS}$$

032 DIAPHRAGM REPRESENTS THINNESS GAUGE TUBE' WHICH RIVETS PAGE

RIJET TYPE A325 A44 (EXCEPT AT UPRIGHTS)

FROM ANG-9

SINGLE SHEAR STRENGTH OF AN470 ADP RIVET IN .032" HAZL = $.964 \times 328 = 314$ LBS

RIKET MATERIAL A-17ST

ASSUME RIVET SHEAR STRENGTH VARIES WITH TEMPERATURE AND HOURS OF EXPOSURE IN THE SAME RATIO AS FLOW FOR 245 TO SHEET (MATH)

Fsw AT 20.3°F For 1000 Hours = 20 Fsw AT Room Temp (0 Hours) For 24 STA MAT(L)

∴ SINGLE SHEAR STRENGTH OF ABOVE RIVET. $374 \times .80 = 336$ LBS.

BEARING STRENGTH OF .032 SHEET ON AN 470 AD4 RIVET = 411 LBS

DIAPHRAGM MAT'L - 75 STD SHEET

FORU AT 200°F FOR 1000 HOURS = $133,000 \times .855 = 113,800$ P.S.I.

Frey $28,000 \times .84 = 22,400$ P.S.

$F_{BY} \times 1.365 / 1.125 < F_{BU}$ So That F_{BY} is Critical

2. BEARING STRENGTH OF .032 SHEET AND RIVET: $411 \times \frac{82,400}{100,000} \times 1.365 = 411 \text{ LBS}$

∴ RIVET CRITICAL IN SINGLE SHEAR

R.F. : 336 - 1.70
198

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-82

SHEET NO. 136

AIRCRAFT

C 105

Torsion Box

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DATE

G. L. SLADEK

JAN 1956

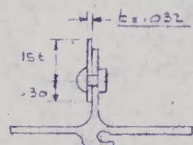
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TRANSVERSE BEAMS, 606.03 AND 625.25

FLANGE RIVETING CONT

CHECK INTER-RIVET BUCKLING.



ASSUME THAT A WIDTH OF 15t ON ONE SIDE OF RIVET

LINE IS EFFECTIVE IN CARRYING THE RIVET LOAD

TOTAL EFFECTIVE WIDTH = $(15 \times 0.032) + 30 = .48 + .30 = .78$ IN.

MAX RIVET LOAD = 138 LBS

$$f_c = \frac{138}{.78 \times 0.032} = 7340 \text{ P.S.I.}$$

WEB MATERIAL 705 T-6

F_{TY} 60,000 P.S.I.

F_{TY} AT 200° F FOR 1000 HOURS = .895 x F_{TY} AT ROOM TEMP.

F_{TY} " " " " " 53.700 P.S.I.

THE ABOVE ALLOWABLES FROM AISC

WITH REF TO AISC DATA SHEET .02 .01 .15

l = RIVET PITCHING = .80 IN.

t = WEB THICKNESS

f = STRESS AT WHICH SHEET BUCKLES BETWEEN RIVETS

THEN f = 33,000 P.S.I. (APPROX)

ACTUAL SHEET STRESS: f_c = 7340 P.S.I.

DIAPHRAGM IS SATISFACTORY FOR INTER-RIVET BUCKLING.

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-82

SHEET NO

137

AIRCRAFT:

C105

Torque Box

PREPARED BY

DATE

G. L. SLADEK

JAN 1956

CHECKED BY

DATE

TRANSVERSE BEAMS 600.05 AND 625.25

UPRIGHT STRENGTH

CHECK BUCKLING STRENGTH OF UPRIGHTS

FROM BROWN C.6.8

$$I_{st} = \frac{2.29 d}{t} \frac{V h_w^{4/3}}{33 E}$$

WHERE I_{st} = STIFFNESS MOMENT OF INERTIA REQ'D TO MAKE WEB
(DIAPHRAGM) SHEAR RESISTANT.

d = CENTRE LINE DISTANCE BETWEEN UPRIGHTS = 4.0 IN

t = WEB THICKNESS = .032

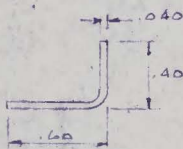
V = VERTICAL SHEAR AT SECTION = 750 LBS MAX. (REF SHT)

h_w = DEPTH OF WEB = 3.25 IN

E = 3.93×10^6 REF SHT

$$\text{THEN } I_{st} = \frac{2.29 \times 4.0}{.032} \left(\frac{750 \times 3.25}{33 \times 3.93 \times 10^6} \right)^{4/3} = 2.86 \times (2.61 \times 10^{-6})^{4/3}$$

$$I_{st} = 2.86 \times 1510 \times 10^{-8} = 4.32 \times 10^{-5} \text{ IN}^4$$



CONSIDER THE I OF THE .40 FLANGE ALONE

$$I = .040 \times (.4)^3 / 12 = 2.13 \times 10^{-4} \text{ IN}^4$$

$\therefore I$ OF UPRIGHT SECTION IS $> 2.13 \times 10^{-4} \text{ IN}^4$

$$I_{\text{REQUIRED}} = 4.42 \times 10^{-5} \text{ IN}^4$$

$\therefore$ UPRIGHT IS OBVIOUSLY SATISFACTORY.

UPRIGHT RIVETING

UPRIGHTS ATTACHED TO DIAPHRAGM BY 5 AN470 ADS RIVETS

SINCE WEB IS SHEAR RESISTANT, THE ATTACHMENTS ARE P.B.I.



AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

REPORT No. 7-0558-82

SHEET No. 142

AIRCRAFT:

C-105

BEAM - FRAME 625.25

PREPARED BY

DATE

MURPHY

APRIL '56

CHECKED BY

DATE

BEAM - FRAME 625.25

THE BEAM WAS MODIFIED BY TWO CLEARANCE NOTCHES. STRUCTURE WAS ADDED AND OTHER CHANGES MADE THAT RESULTED IN A BEAM OF EQUIVALENT STRENGTH & STIFFNESS.

THE EQUIVALENT STRENGTH BASIS IS THE CRIPPLING OF THE BULB ANGLE FLANGE, AND THE EQUIVALENT STIFFNESS IS BASED ON A FUNCTION OF THE MOMENT OF INERTIA AND THE MODULUS OF ELASTICITY.



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MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0559-82

SHEET NO. 143

AIRCRAFT:

C-105

BEAM - FRAME 625.25

PREPARED BY

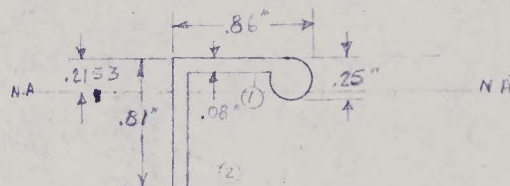
DATE

MORGAN

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DATE

ALLOWABLE - FLANGE (SECTION 0-0)



EFFECTIVE b/t

SECTION (1)

$$b/t(\text{ACTUAL}) = .82 / .08 = 10.25$$

$$b/t = .25 / .08 = 3.12$$

$$b/t(\text{EFF}) = 5.3^*$$

SECTION (2)

$$b/t(\text{EFF}) = .77 / .08 = 9.6$$

AVG

$$b/t(\text{EFF}) = (9.6 + 5.3) / 2 = 7.45$$

ALLOWABLE STRESS

$$F_{CC} = 59300 \text{ P.S.I.}^{**}$$

ALLOWABLE LOAD

$$P = 59300 (.0491 + .0448 + .0648)$$

$$= 59300 (.1587) = 9400 \text{ LB}$$

DISTANCE C.G. - BULB ANGLE

ELEMENT	AREA	Y	AY
1	.0491	3.875	.19026
2	.0448	3.960	.17741
3	.0648	3.595	.23296
Σ	.1587		.60063

$$\bar{Y} = 4.000 - .60063 / .1587$$

$$= 4.000 - 3.7847 = .2153$$

* REF G. L. M. MANUAL Pg 403.331P

** REF G. L. M. MANUAL Pg 403.331C



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TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 145

AIRCRAFT:

C-105

BEAM - FRAME 625

PREPARED BY

DATE

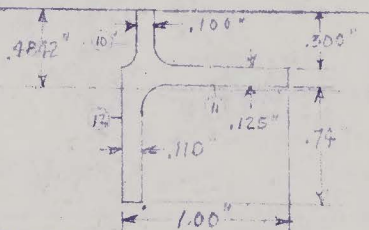
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ALLOWABLE - FLANGE (SECTION C-C)



ALLOWABLE - CRIPPLING SECTION (10)

$$b/t = .363 / .100 = 3.63$$

$$F_{cc} = 70000 \text{ P.S.I.}$$

SECTION (11)

$$b/t = .870 / .125 = 6.95$$

$$F_{cc} = 60000 \text{ P.S.I.}$$

SECTION (12)

$$b/t = .803 / .110 = 7.30$$

$$F_{cc} = 57000 \text{ P.S.I.}$$

RESULTANT LOAD

$$P = \frac{70000 \times .363 \times .100 + 60000 \times .870 \times .125 + 57000 \times .803 \times .110}{.363 \times .100 + .870 \times .125 + .803 \times .110} \times .2364$$

$$= (14100 / .23338) \times .2364 = 60400 \times .2364 = 14300 \text{ LB}$$

DISTANCE C.G.

ELEMENT	AREA	Y	AY
10	.0300	3.300	.09900
11	.1250	3.088	.38600
12	.0814	2.655	.21612
Σ	.2364		.70112

$$\bar{Y} = 4.000 - .70112 / .2364 - .850 + .300$$

$$= 4.000 - 2.9658 - .8500 + .3000 = .4842 \text{ IN}$$



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TECHNICAL DEPARTMENT

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AIRCRAFT:

C-105

BEAM ~ FRAME 625.25

PREPARED BY

DATE

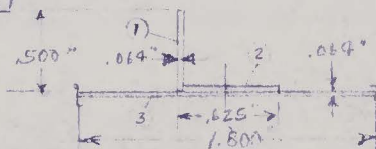
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APRIL 1945

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DATE

ALLOWABLE ~ UPRIGHT



(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
ELEM	THICK	WIDTH	AREA	Y	AY	AY ²	I _o	I _{x-x}
			(2)(3)		(4)(5)	(5)(6)		(7)+(8)
1	.064	.500	.0320	.3140	.01005	.00316	.00067	.00383
2	.064	.560	.0358	.0960	.00344	.00033	-	.00033
3	.064	1.800	.1152	.0320	.00369	.00012	.00004	.00016
Σ			.1830		.01718			.00432

$$\bar{Y} = .01718 / .1830 = .0939 \text{ IN}$$

$$I = .00432 - .1830 \cdot .0939^2 = .00432 - .00161 = .00271 \text{ IN}^4$$

ALLOWABLE ~ CRIPPLING

UPRIGHT

EFFECTIVE b/t

$$b/t = (.468 / .064 + .593 / .064) / 2 = 8.30$$

$$F_{cc} = 46500 \text{ P.S.I.}^*$$

ALLOWABLE ~ LOAD

(SECTION 2 & 3 ARE ASSUMED TO CARRY LOAD DUE TO SHORT DISTANCE FOR SHEAR LAG)

$$P = 46500 \times (.0358 + .1152) = 46500 \cdot .1510 = 7000 \text{ LB}$$

* REF G.L.M. MANUAL Pg 403.331n, 403.331a, 4403.331r



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

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SHEET NO. 147

AIRCRAFT:

C-105

BEAM ~ FRAME 625.25

PREPARED BY

DATE

MORGAN

APRIL 1961

CHECKED BY

DATE

ALLOWABLE JO-BOLT ~ 5/32" DIA. STEEL

SHEAR

$$P_s = 2000 \text{ LB}$$

BEARING ~ .064 755-T6 CLAD

$$P_b = .164 \times .064 \times 100,000 \times 1.37 = 1440 \text{ LB}$$

BEARING ~ .080 755-T6 ~ EXTRUSION

$$P_b = .164 \times .081 \times 100,000 \times 1.46 = 1940 \text{ LB}$$

ALLOWABLE WEB ~ .064 755-T6 CLAD

SHEAR ~ INITIAL BUCKLING

$$F_{sp} = 1950 \text{ LB/IN}^*$$

$$d = 2.4''$$

BENDING ~ INITIAL BUCKLING

$$F_{bm} = 46500 \times (12 / (.064 \times 2.4^3 \times 1.2)) = 2860 \text{ IN LB}$$



AVRO AIRCRAFT LIMITED
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TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 148

AIRCRAFT:

C-105

BEAM & FRAME 625 J

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LOAD FOR UNIT MOMENT

(THE ALLOWABLE MOMENT AT SECTIONS O-O, B-B, & C-C IS BASED ON LOCAL CONDITIONS)

LOAD ~ BOLT ANGLE ~ FOR UNIT MOMENT ~ STATION O-O

$$P = .1587 \times (4.000 - 1.5477 - .2153) / 1.5734 = .1587 \times 2.237 / 1.5734$$

$$P = .2256 \text{ LB / UNIT MOMENT}$$

LOAD ~ DOUBLER SECT. ~ FOR UNIT MOMENT ~ STATION B-B

$$P = .2764 (3.850 - 2.0159 - .1852) / 2.14322 = .2764 \times 1.6489 / 2.14322$$

$$P = .1353 \text{ LB / UNIT MOMENT}$$

LOAD ~ BOLT ANGLE ~ FOR UNIT MOMENT ~ STATION B-B

$$P = .1587 (4.000 - 2.0159 - .2153) / 2.14322 = .1587 \times 1.7688 / 2.14322$$

$$P = .1310 \text{ LB / UNIT MOMENT}$$

LOAD ~ DOUBLER SECT. ~ FOR UNIT MOMENT ~ STATION C-C

$$P = .2364 (3.450 - 1.4586 - .4842) / 1.18206 = .2364 \times 1.5072 / 1.18206$$

$$P = .3014 \text{ LB / UNIT MOMENT}$$

LOAD ~ ATTACHMENTS 1, 2, 3, 4 & 5 ~ FOR UNIT MOMENT

(CONSIDER RIVETS 1, 2, 3, 4, & 5 AS REACTING DIRECT LOAD

(RIVETS 0, 1, 2, 3, 4, & 5 AS REACTING UNBALANCED MOMENT)

MOMENT

$$M = .2256 (4.500 - .2153) = .2256 \times 4.2847$$

$$= .9662 \text{ IN. LB.}$$

$\sum x^2$

$$\sum x^2 = 2 (.30^2 + .90^2 + 1.50^2) = 6.30$$

LOAD ~ MOMENT ~ RIVET 5

$$V = .9662 \times 1.50 / 6.300 = .2316 \text{ LB / UNIT MOMENT}$$

LOAD ~ DIRECT

$$H = .2256 / 5 = .0451 \text{ LB / UNIT MOMENT}$$

LOAD ~ RESULTANT ~ RIVET 1 OR 5

$$P = \sqrt{.0451^2 + .2316^2} = \sqrt{.002034 + .000159}$$

$$= .0468 \text{ LB. / UNIT MOMENT}$$



AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

REPORT NO.

7-0558-82

SHEET NO.

149

AIRCRAFT:

C-105

BEAM ~ FRAME 6255

PREPARED BY

DATE

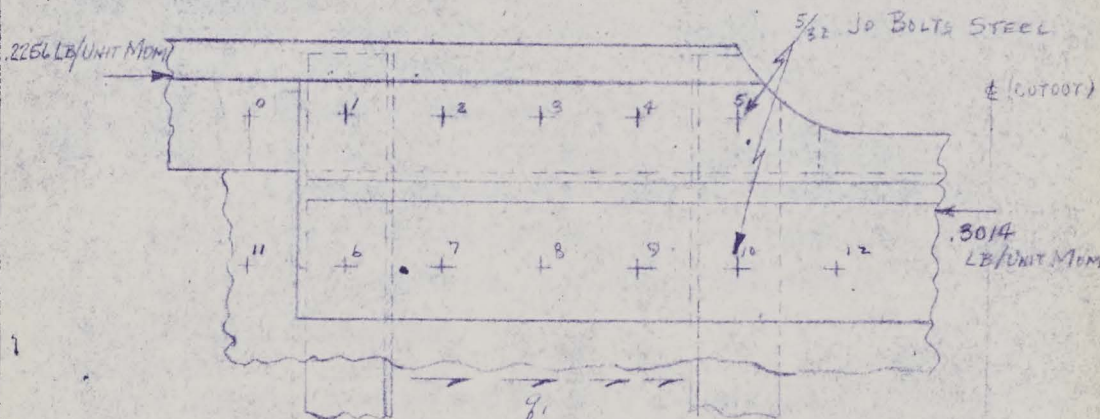
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LOAD FOR UNIT MOMENT



LOAD ~ ATTACHMENTS

(Jo-BOLTS 6, 7, 8, 9, 10 DISTRIBUTE q , SHEAR LOAD
 Φ Jo-BOLTS 6, 7, 9, 10, 11 Φ 12 DISTRIBUTE UNBALANCED
 MOMENT)

SHEAR q

$$q = (.3014 - .2256) / 2.4 = .0316 \text{ LB/IN/UNIT MOMENT}$$

LOAD ~ RIVETS

$$H = .0316 \times 2.4 / 5 = .01516 \text{ LB}$$

MOMENT

$$M = .2256 (.5500 + .4842 - .2153) - (.3014 - .2256) .360$$

$$= .2256 \times .8189 - .0758 \times .360 = .1572 \text{ IN LB/UNIT MOMENT}$$

LOAD ~ RIVETS ~ 6 OR 10

$$V = .1572 / 2.4 \times 3 = .0219 \text{ LB/UNIT MOMENT}$$

RESULTANT LOAD

$$P = \sqrt{.0219^2 + .01516^2} = \sqrt{.0007094} = .0266 \text{ LB/UNIT MOMENT}$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 150

AIRCRAFT:

C-105

BEAM ~ FRAME 625.25

PREPARED BY

DATE

MORGAN

APRIL 1954

CHECKED BY

DATE

LOAD FOR UNIT MOMENT

LOAD ~ UPRIGHT

$$P = [1.572 + (400 \times .064 (4.000 - 1.5477 - .325) / 1.5734) \times (.2300 + .4842)] / 2.4$$

$$= .07579 \text{ LB / UNIT MOMENT}$$

LOAD ~ WEB ~ DIRECT SHEAR

$$P = [3.014 + .400 \times .064 (3.450 - 1.4586 - .200) / 1.18204$$

$$- .2756 + .400 \times .064 (4.000 - 1.5477 - .325) / 1.5734]$$

$$= .3402 - .2602 = .0800 \text{ LB / UNIT MOMENT}$$

$$19 = .0800 / 2.4 = .0333 \text{ LB / IN / UNIT MOMENT}$$

LOAD ~ WEB ~ BENDING

MOMENT

$$M = .0800 \times .8189 / 2 = .0328 \text{ IN. LB / UNIT MOMENT}$$

(AS THE PANEL IS SMALL EDGE SUPPORTS WILL PREVENT BUCKLING EXCEPT IN CENTER)

ASSUMING ULTIMATE MOMENT OF ORIGINAL BEAM EQUAL TO CRIPPLING OF BOLT ANGLE

MOMENT

$$M = 9400 / .2256 = 41700 \text{ IN LB}$$

①	②	③	④	⑤
ELEMENT	LOAD UNIT MOMENT	LOAD 41700 IN LB	ALLOWABLE	M.S.
BOLT ANGLE STA 0-0	.2256	9400 LB	9400 LB	0
DOUBLER SECTION STA 0-0	.3014	12550 LB	14300 LB	+1.4
JO-BOLTS 1 LR 5	.0468	1940 LB	1940 LB	0
JO-BOLTS 6 OR 10	.0266	1100 LB	1400 LB	+1.27
UPRIGHT	.0758	3150 LB	7000 LB	+1.22
WEB	.0333	1375 LB/IN	1950 LB/IN	+1.17 *
	.0328	1363 IN LB	2860 IN LB	

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

$$R_b = 1363 / 2860 = .477 \quad R_s = 1375 / 1950 = .705$$

$$M.S. = \sqrt{.477^2 + .705^2} - 1 = +1.17$$



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C-105

SPLICE DETAILS OF
FWD.-AFT. BEAM & TOR
QUE BOX (STA. 591.65)

REPORT NO. 7-0558-82

SHEET NO. 152

PREPARED BY

G. ISAACS

DATE

2-2-56

CHECKED BY

DATE

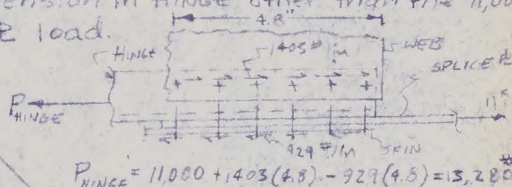
LOADS ON FWD.-AFT BEAM & TORQUE BOX

LOADS: See Torque Box

Report # 7-0558-12(2)

* LOAD DISTRIBUTION AT SPLICE

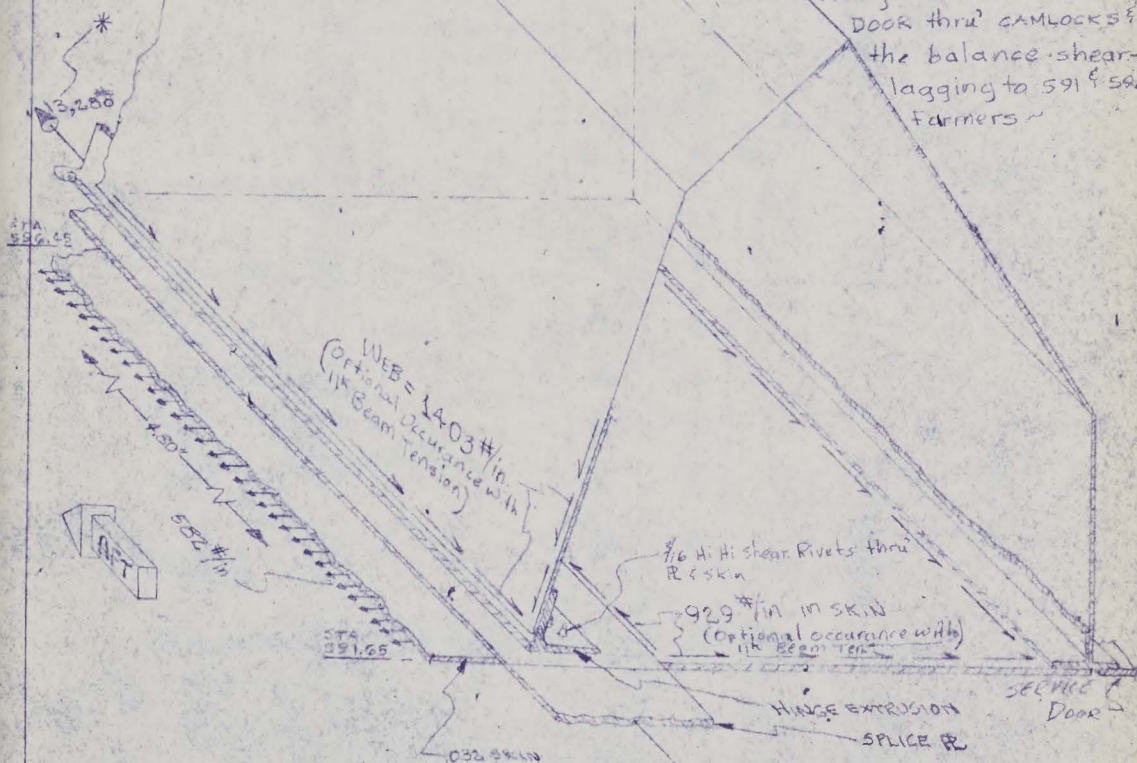
(a) Skin shear of 929 #/in produces compression in HINGE while box web shear of 1403 #/in causes tension in HINGE other than the 11,000 # splice # load.



$$P_{HINGE} = 11,000 + 1403(4.8) - 929(4.8) = 3,280$$

(b) Side loading of 582 #/in continues across thru skin under the splice # to partially feed to SERVICE DOOR thru CAMLOCKS & the balance shear-lagging to 591.558 Farmers ~

Fig. 1



SUMMARY OF LOAD PATHS

(a) Splice # resists 11,000 # tensile load with resulting eccentricities only ~

(b) Attach. outbd. of HINGE thru skin resist not only the 11,000 # loading but also the 929 #/in skin loading

11,000 # Ten. From 7-0156-320 BEAM

FWD.-AFT. BEAM

TECHNICAL DEPARTMENT

AIRCRAFT:

C-105

SPLICE DETAILS OF
FWD-AFT BEAM & TOR-
QUE BOX (STA. 591.65)

PREPARED BY

G. ISAACS

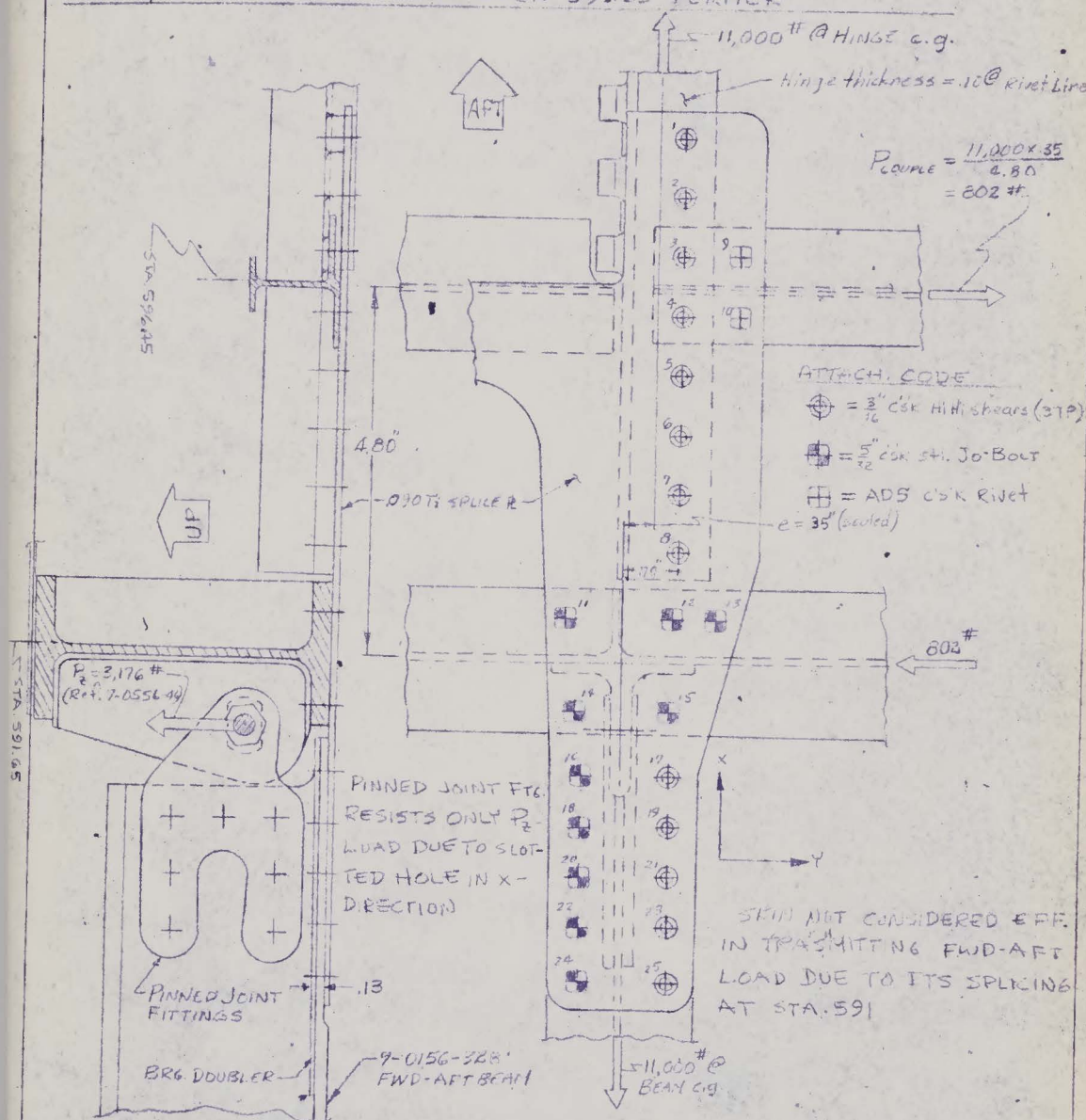
DATE _____

2-10-56

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DATE _____

FWD-AFT BEAM SPLICE 12 OVER 591.65 FORMER



LOAD PATHS

Direct Load of 11K is fed into SPLICE R from BEAM to attach. #² 16 thru 25 with due regard to eccentricity imposed by variable attach. allowances. It remains in the SPLICE R over 591 FORMER & reacted by attach. 1 thru 8 with resulting eccentric loads. Couple loads of 919# are transferred via attach. #3, 4, 9, 10 & 11, 12, 13, 14, 15, to FORMERS -

Vert. shear load of 8176 lb @ PINNED JOINT slot causes mom. about FOR-
MER WES that looks like about #2111.5 lb-in. @ #2111.5 lb-in.



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-02

SHEET NO. 154

AIRCRAFT:

C-105

SPLICE DETAILS OF
FWD AFT BEAM & TOR
QUE BOX (STA. 591.65)

PREPARED BY

G. ISAACS

DATE

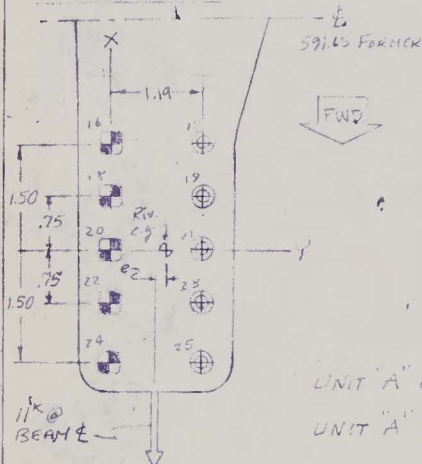
2-10-56

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DATE

FWD AFT BEAM SPLICE R OVER 591.65 FORMER - Cont'd
RIVET REACTIONS ON SPLICE R RESISTING 11K TEN. LOAD

ATTACH. #
FWD 591.65



Value of #16, 18, 20, 22, 24 3/16" Hi Hi Shear

Even though these attach. possess higher shear allow. than NAS 177 Rivets, NAS 177 values for csk. .091 AL sheet (actually Ti sheet with > F_{BRU}) will be conservatively used:

ALLOW csk. ON .090 = 1509#

Value of #16, 18, 20, 22, 24 5/32" Jo+ Bolts

The same high shear attach. & sheet bry. qualities exist as above; however, no csk. values for this size are available at this time. A conservative guess will be used:

∴ ALLOW csk. ON .090 = 1000# [Ref. L. GOULD]

UNIT "A" OF 3/16" Hi Hi Shear = $\frac{1509}{1509} = 1.0000$

UNIT "A" OF 5/32" Jo+ Bolt = $\frac{1000}{1509} = .6627$

ATTACH. #	UNIT "A"	Y	A-Y	A-Y ²	X	A-X ²
16	.6627	0	0	0	1.50	1.491
17	1.0000	1.19	1.19	1.416	1.50	2.250
18	.6627	0	0	0	.75	.373
19	1.0000	1.19	1.19	1.416	.75	.562
20	.6627	0	0	0	0	0
21	1.0000	1.19	1.19	1.416	0	0
22	.6627	0	0	0	.75	.373
23	1.0000	1.19	1.19	1.416	.75	.562
24	.6627	0	0	0	1.50	1.491
25	1.0000	1.19	1.19	1.416	1.50	2.250
Σ	8.3135	—	5.95	7.080	—	9.352

$\bar{X} = 0$; $\Sigma(A-X^2) = 9.352 \text{ in}^2$

$\bar{Y} = \frac{5.95}{8.3135} = .716$

$\Sigma(A-Y^2) = 7.080 - .716(5.95) = 2.82 \text{ in}^2$

$MOM = P \cdot e = 11,000 \left(\frac{1.19}{2} - .716 \right)$
 $= 11,000(.121) = 1331 \text{ in} \cdot \text{lb}$

MOM. REACTIONS ON ATTACH. #16 THRU #25

$$P_{X16} = P_{X18} = P_{X20} = P_{X22} = P_{X24} = \frac{M \cdot Y \cdot A}{\Sigma(A-X^2) + \Sigma(A-Y^2)} = \frac{1331(.716)(.6627)}{9.352 + 2.82} = \frac{1331(.716)(.6627)}{12.172} = 52 \text{ #}$$

$$P_{X17} = P_{X19} = P_{X21} = P_{X23} = P_{X25} = \frac{M \cdot Y \cdot A}{\Sigma(A-X^2) + \Sigma(A-Y^2)} = \frac{1331(.716)(1.000)}{12.172} = 52 \text{ #}; P_{X1} = P_{X11} = 0$$

$$P_{Y16} = P_{Y24} = \frac{M \cdot X \cdot A}{\Sigma(A-X^2) + \Sigma(A-Y^2)} = \frac{1331(.150)(.6627)}{12.172} = 109 \text{ #}; P_{Y17} = P_{Y25} = \frac{1331(.150)(1.000)}{12.172} = 164 \text{ #}$$

$$P_{Y18} = P_{Y22} = \frac{M \cdot X \cdot A}{\Sigma(A-X^2) + \Sigma(A-Y^2)} = \frac{1331(.75)(.6627)}{12.172} = 54 \text{ #}; P_{Y19} = P_{Y23} = \frac{1331(.75)(1.000)}{12.172} = 82 \text{ #}$$

DIRECT LOAD ON ATTACH. #16 THRU #25

$$P_{X16} = P_{X18} = P_{X20} = P_{X22} = P_{X24} = 11,000 \frac{.6627}{8.3135} = 877 \text{ #} \uparrow \text{React.}$$

$$P_{X17} = P_{X19} = P_{X21} = P_{X23} = P_{X25} = 11,000 \left(\frac{1.000}{8.3135} \right) = 1,324 \text{ #} \uparrow \text{React.}$$

RESULTANT P_X REACTIONS

$$P_{X16} = P_{X18} = P_{X20} = P_{X22} = P_{X24} = 877 + 52 = 929 \text{ #}; P_{X17} = P_{X19} = P_{X21} = P_{X23} = P_{X25} = 1324 - 52 = 1272 \text{ #}$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-82

SHEET NO. 156

AIRCRAFT:

C-105

SPLICE DETAILS OF
FWD. AFT BEAM & TOR-
QUE BOX (STA. 591.65)

PREPARED BY

G. ISAACS

DATE

2-1-56

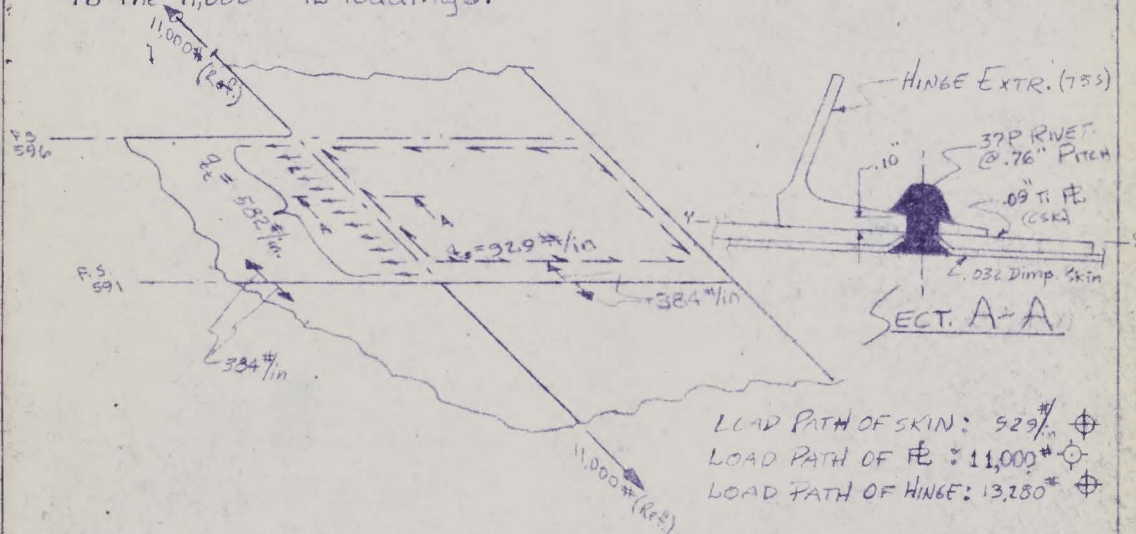
CHECKED BY

DATE

FWD. AFT. BEAM SPLICE & OVER 591.65 FORMER - Cont'd.

RIVET CHECK BETWEEN HINGE, SPLICE & SKIN (NO. 3 T-TRU'S)

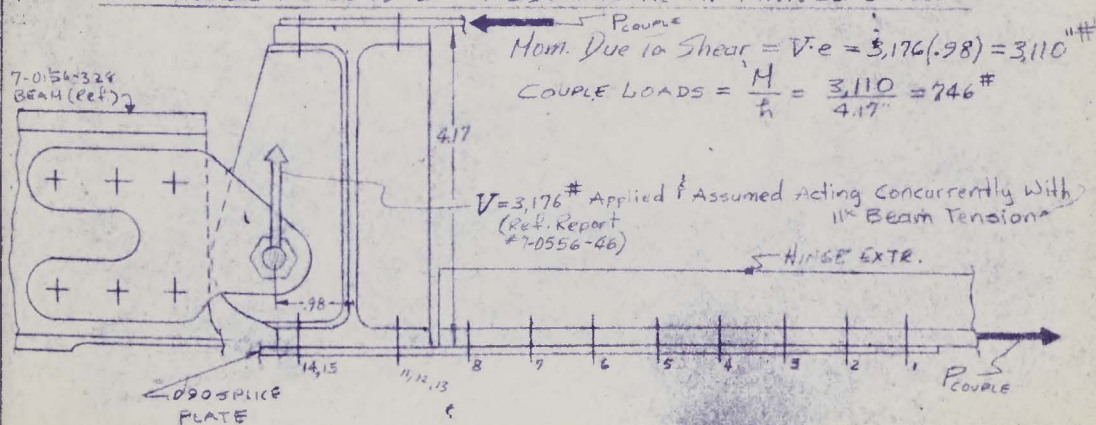
Loads as shown on p. 4, Fig. 2 (Ref.) are per the 11,000# tensile direct load with its resulting eccentric loading only. The existing shear flow in the skin was not shown as it did not affect the loading on splice & however, the rivets (common to skin as well as splice &) do transmit the skin shear flow to the hinge extrusion in addition to the 11,000# & loadings.



DESIGN LOADING FOR RIVET CHECK

With reference to SECT. B-B above it can be seen that it would be conservative to neglect the 929#/in shear-flow in the skin as it loads oppositely to 11# load in splice & along line Y-Y (shown in view). The 11,000# Beam Tensile Load may act without the 929#/in (see 7-0558-12(1)).

RIV. LOADS IMPOSED BY INBD. SHEAR AT PINNED JOINT



LOADS ON 14, 15, 11, 12, 13

$$P_{14} = P_{15} = P_{11} = P_{12} = P_{13} = \frac{746}{5} = 149 \#$$

LOADS ON 1 THRU 8

$$P_1 = P_2 = P_3 = P_4 = P_5 = P_6 = P_7 = P_8 = \frac{746}{8} = 93 \#$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 157

AIRCRAFT:

C-105

SPICE DETAILS OF
FWD. ATT. BEAM (TO
QUE BOX (STA. 591.05))

PREPARED BY

G. J. A. G. S.

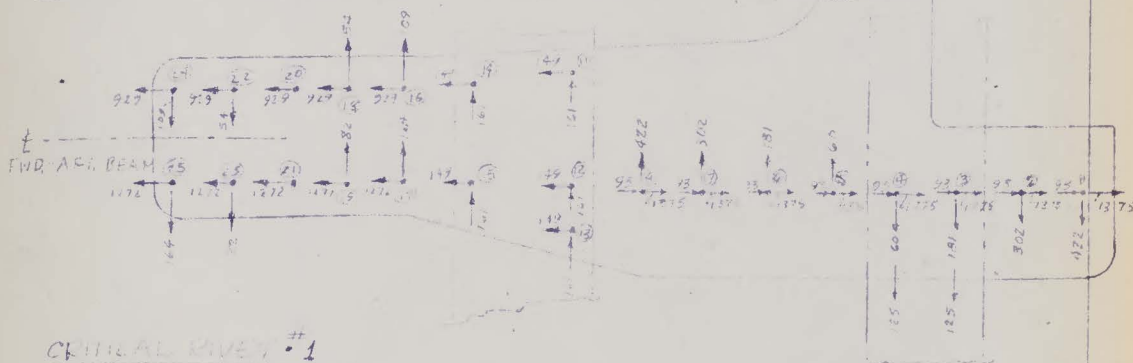
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2-6-56

CHECKED BY

DATE

FWD. ATT. BEAM SPICE 1B OVER 591.05 FORMER - CONT'D.
RIVET CHECK BETWEEN HINGE, SPICE 1B, FORM (NO. 2 THRU 8) - CONT'D.
MAX. DESIGN LOADING ON ATTACHMENTS





AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 158

AIRCRAFT:

C-105

SPLICE DETAILS OF
FWD-AFT. BEAM & TOR-
QUE BOX (STA. 591.65)

PREPARED BY

G. ISAACS

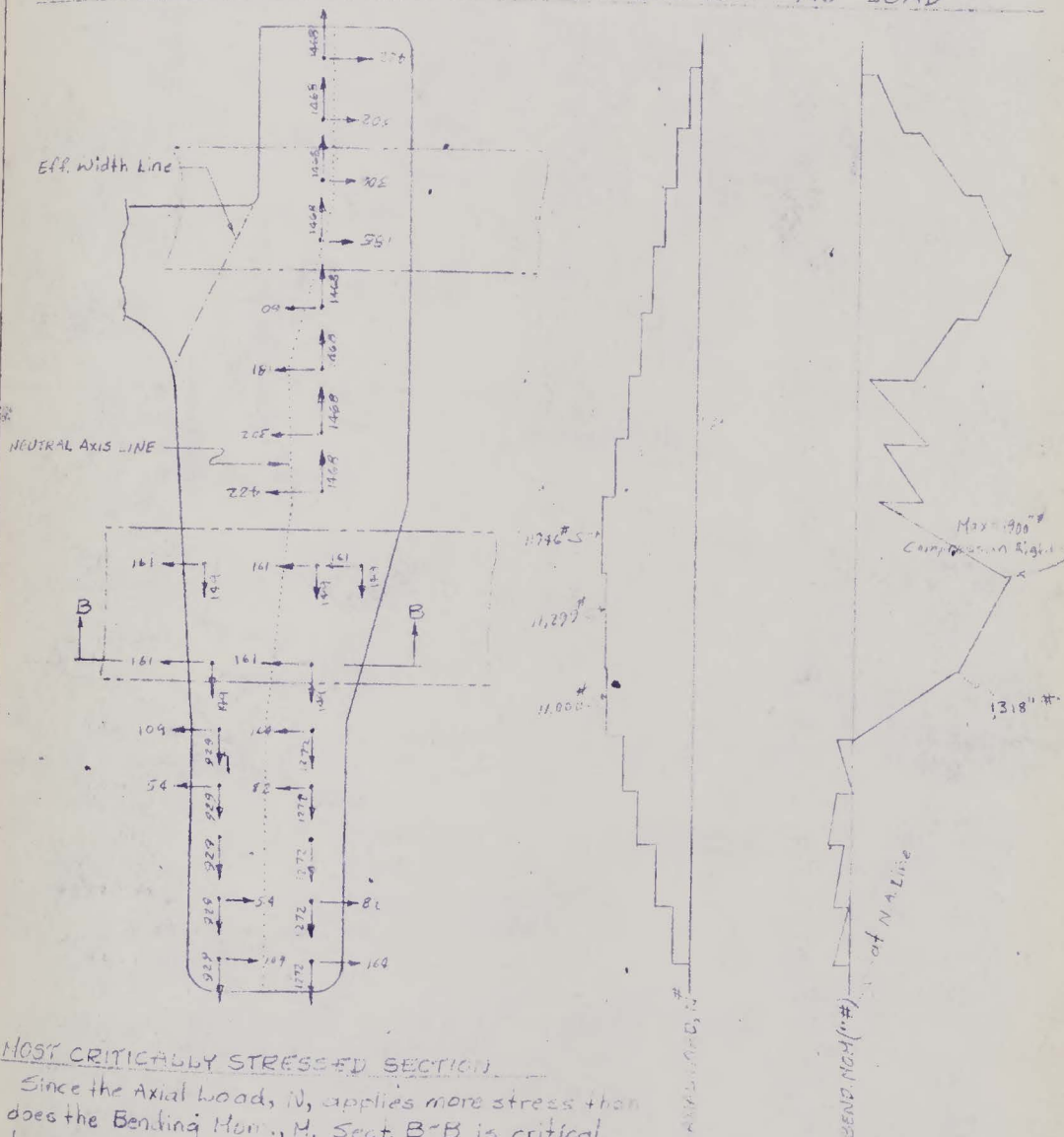
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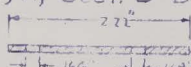
DATE

FWD-AFT BEAM SPLICE @ OVER 591.65 FORMER - Cont'd.
BENDING & AXIAL CHECK OF TS SPLICE @ DUE TO 11K+746# LOAD



MOST CRITICALLY STRESSED SECTION

Since the Axial Load, N, applies more stress than does the Bending Moment, M, Sect B-B is critical by inspection: ~



0.09" RC-110AT Titanium @ 265°F / 50 Hrs.

$$\text{AXIAL STRESS: } F_N = \frac{N}{A} = \frac{11,299}{0.9(2.22-2 \times 0.164)} = 66,400 \text{ psi Tension}$$

$$\text{BEND. STRESS: } F_t = \frac{M}{I} = \frac{6(1318)}{0.09(2.22)^2} = 17,820 \text{ psi}$$

$$\text{TOTAL STRESS: } F_t + F_N = 17,820 + 66,400 = 84,220 \text{ psi}$$

p. 173 ANG-5

$$\text{ALLOW. STRESS @ 265°F} = F_{t0} \cdot K_{265°F} = 120,000(0.75) = 90,000$$

$$114 = 90,000 - 1 +$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 159

AIRCRAFT:

C-105

SPLICE DETAILS OF
FWD. - AFT BEAM & TOR
QUE BOX (STA. 591.65)

PREPARED BY

G. ISAACS

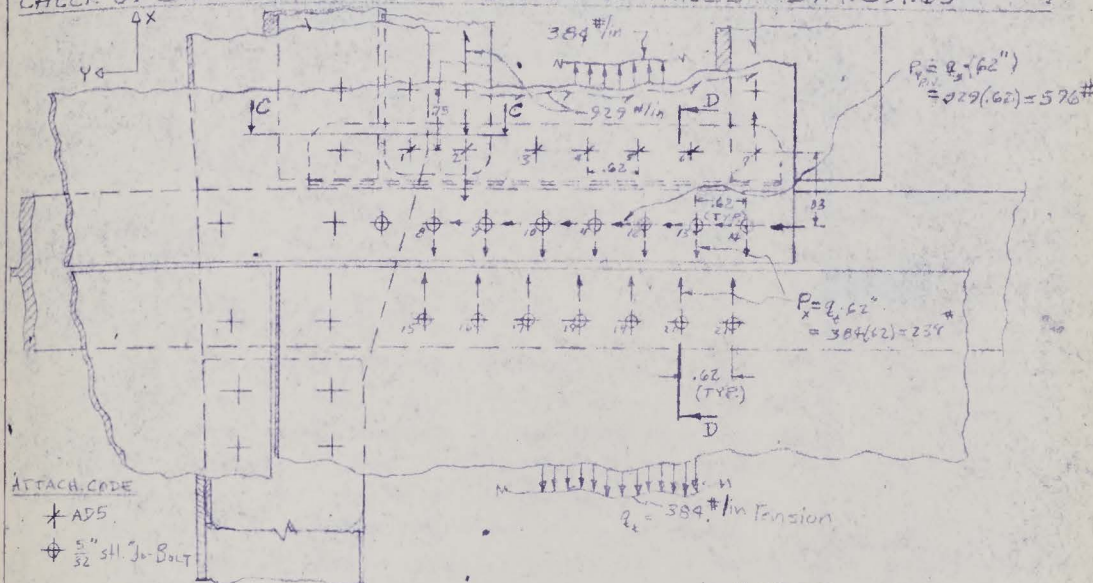
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2-7-56

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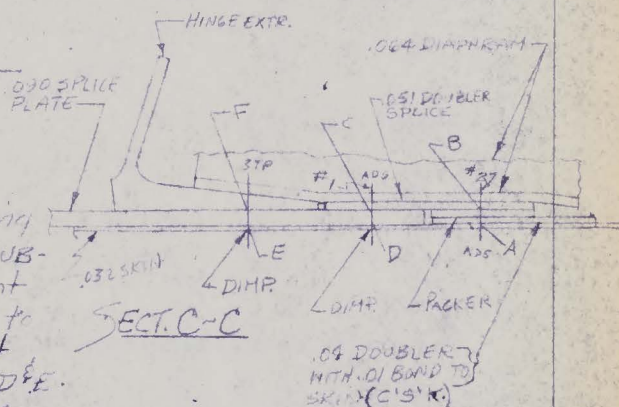
CHECK OF SKIN SPLICE FROM BEAM TO HINGE @ STA. 591.65



CRITICAL ADS ATTACH.: #1 & 2

$$P_x \text{ Load on } \#2 = q_x \times \text{pitch} \\ = 929 \times \frac{.83 + .75}{2} = 734 \#$$

*This load at point A is reacted along two (2) load-paths: the .04 SKIN DOUBLER transferring its portion via point B to C & thence into SPLICE PLATE to be finally reacted by HINGE EXTR. at point F; the .032 SKIN loads point D & E which is also received at F to HINGE



$$V_A = V_F = 734 \#$$

$$V_A (\text{IN SKIN}) = \frac{734(.032)}{(.032 + .040)} = \frac{734(.032)}{(.072)} = 326 \#; V_D = V_E = \frac{V_A (\text{IN SKIN})}{2} = \frac{326}{2} = 163$$

$$V_F = \frac{734(.040)}{(.032 + .040)} = \frac{734(.040)}{(.072)} = 408 \# = V_C$$

$$V_{CD} = V_C + V_D = 408 + 163 \# = 571 \#$$

ALLOW. CSK. VALUE OF ADS INTO .072 @ POINT "A" = 542 #
LOAD REACTED AT B FROM A 408 #

$$M.S. = \frac{542}{408} - 1 = +.33$$

ALLOW. VALUE OF ADS ON .051 DOUB. @ POINT "B" = 596 #

$$M.S. = \frac{596}{418} - 1 = +.46$$

ALLOW. DIMPLED VALUE OF ADS AT POINT "D" = 599 #

ALLOW. CSK. OF 0.01 FOR ADS AT "CD" = 575 #

$$M.S. = \frac{599}{163} - 1 = +2.6$$

LOAD OVER "CD" = 571

$$M.S. = \frac{575}{571} - 1 = .00$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C-105

SPLICE DETAILS OF
FWD.-AFT BEAM & TOR-
QUE BOX (STA. 591.65)

REPORT NO.

7-0558-82

SHEET NO.

160

PREPARED BY

G. ISAACS

DATE

2-8-56

CHECKED BY

DATE

CHECK OF SKIN SPLICE FROM BEAM TO HINGE @ STA. 591.65
CRITICAL $\frac{5}{32}$ " JO-BOLTS ARE #9 THRU #13

$$P_x = q_t \cdot \text{Pitch} = 384(.66) = 239 \# \text{ (Ref.)}$$

$$P_y = q_s \cdot \text{Pitch} = 329(.62) = 526 \#$$

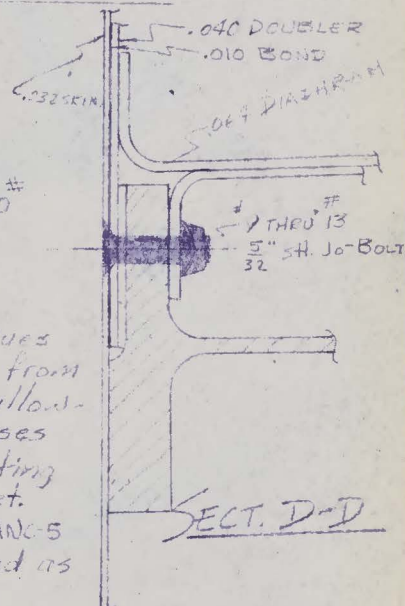
$$\text{Resultant Load} \left[\begin{matrix} 9 \\ 13 \end{matrix} \right] = 239 + 526 = 630 \#$$

VALUE OF $\frac{5}{32}$ " JO-BOLT (CSK. IN .072)

There are not at this time any known values for this size CSK. connection; however, from ANC-5, Ref. p.122, values show that the allowable increase as the rivet material increases in shear per the same size shank indicating rivet failure rather than bearing of sheet.

The highest value shown on p.122 of ANC-5 of the AL. rivets will be conservatively used as allow. for the steel bolt.

Allow. CSK. value in .072 = 690 # *



$$1.5 = \frac{690}{630} - 1 = +.11$$

*NOTE: See p.154 for higher assumed value of 1,000 #



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 162 (a)

AIRCRAFT:

C.105

Torsion box
HINGE STRESSING

PREPARED BY

K. J. Loden

DATE

23 Jan '56

CHECKED BY

DATE

Resolve vertically.

$$V = P_3 \sin 70^\circ + P_4 \cos 70^\circ - P_1 \sin 7^\circ$$

$$\therefore V = .93969 P_3 + .34202 P_4 - .12187 P_1 \quad (1)$$

Resolve horizontally.

$$H = P_3 \cos 70^\circ - P_4 \sin 70^\circ + P_1 \cos 7^\circ + P_2$$

$$H = .34202 P_3 - .93969 P_4 + .99255 P_1 + P_2 \quad (2)$$

Moments about A.

$$46H - .49V = P_1 \sin 7^\circ \times .47 + .46 P_1 \cos 7^\circ + .57 P_2$$

$$\therefore 46H - .49V = .45500 P_1 + .57 P_2 - .05720 P_1$$

$$\therefore 46H - .49V = .39780 P_1 + .570 P_2 \quad (3)$$

relation of P_1 to P_2 - let P_1 and P_2 be in proportion of bearing thickness of the two skins.

$$\therefore P_1 = P_2 \times \frac{.100}{.072}$$

$$= 1.387 P_2$$

From (3)

$$46H - .49V = .5515 P_2 + .570 P_2$$

$$\therefore 46H - .49V = 1.1215 P_2$$

$$\therefore P_2 = .410H - .438V$$

$$\therefore P_1 = .570H - .609V$$

From (1) and (2)

$$.93969 P_3 + .34202 P_4 = .0695H + .9257V \quad (4)$$

$$.34202 P_3 - .93969 P_4 = .0250H + 1.0420V \quad (5)$$

Multiply (5) by $\frac{.93969}{.34202}$ and subtract from (4)

$$\therefore .93969 P_3 + .34202 P_4 = .06950H + .92570V \quad (4)$$

$$.93969 P_3 - 2.57500 P_4 = .06860H + 2.8620V \quad (5a)$$

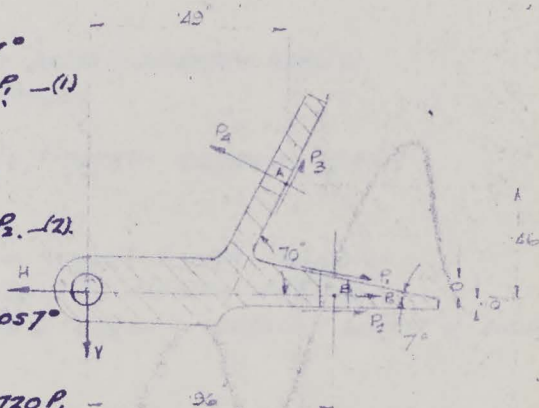
$$2.91702 P_4 = .00090H - 1.93430V$$

$$\therefore P_4 = .00030H - .6650V$$

substitute in (4)

$$\therefore P_3 = (.0695H + .9257V - .0001H + .2275V) \div .93969$$

$$= .0740H + 1.2290V$$





AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 2 163

AIRCRAFT:

C.105

Torsion box

PREPARED BY

DATE

K.S. Iddow

22 JAN '56

CHECKED BY

DATE

check by substitution.

Ans (1)

$$V = .93969 (.0740H + 1.2290V) + .34202 (.00030H - .6650V) - .12187 (.5700H - .6090V)$$

$$= .06950H + 1.1500V + .0001H - .2275V - .0695H + .0744V$$

$$\therefore V = .0001H + .9963V$$

Ans (2)

$$H = .34202 (.0740H + 1.2290V) - .93969 (.0003H - .6650V) + .99255 (.5700H - .6090V) + (.4100H - .4380V)$$

$$= .0253H + .4200V - .0003H + .6250V + .5650H - .6050V + .4100H - .4380V$$

$$= 1.0H + .0020V$$

Ans (3)

$$.46H - .49V = .39780 (.5700H - .6090V) + .5700 (.410H - .438V)$$

$$= .2260H - .2420V + .2340H - .2500V$$

$$= .4600H - .4920V$$

$$\therefore \left\{ \begin{array}{l} P_1 = .570H - .609V \\ P_2 = .410H - .438V \\ P_3 = .074H + 1.229V \\ P_4 = .000H - .665V \end{array} \right\}$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 3. 164

AIRCRAFT:

C.105

TORSION BOX

PREPARED BY

K. J. IODON

DATE

22 JAN '56.

CHECKED BY

DATE

LOADS FOR VARIOUS CONDITIONS.

$T_1 - T_6 (=H)$

(SEE 7-0558-30 SHTS 26, 27, 33)

FRAME	CONDITION.									
	1	2	3	4	5	6	7	8	9	10
596	360	-107	539	34	307	31	383	-230	77	-306
601	372	-306	338	-155	109	147	353	-145	132	-321
606	40	-413	183	-268	-71	-281	358	-116	147	-330
610	-37	-455	93	-331	-187	-349	350	75	162	-328
615	-97	-505	16	-381	-218	-362	367	42	210	-288
620	-107	-495	22	-341	-158	-312	383	2	170	-288
625	-23	-435	109	-221	-7	-169	410	50	18	-148
630	67	-358	217	-73	199	-69	473	129	153	+20
634	208	-223	406	90	449	313	533	185	278	139
639	398	8	669	226	687	531	553	130	363	194

$V_1 (=V)$

ALL	119	620	472	966	1385	1626	586	1082	1440	1575
-----	-----	-----	-----	-----	------	------	-----	------	------	------

BOLT LOADS/MAX.

P ₁	+227	-665	+307	-806	-966	-1194	-385	-789	-876	-1148
P ₂	+163	-479	+67	-589	-698	-860	-31	-568	-484	-815
P ₃	+176	+764	+1075	+1207	+1751	+2039	+763	+1340	+1797	+1950
P ₄	-78	-412	-315	-643	-920	-1080	-390	-720	-955	-1045

DETAIL STRESSING.

SHEAR AND BEARING P₁.

($t = .100$ TEST-6 EXT-1 AT 265°F BOLT 2x3/16" DIA STL HI-SHEAR.)

MAX LOAD = 1194 lb.

= 597 lb/BOLT.

SHEAR ALLOW = 2020 lb

BEARING " = 1,910 lb

SHEAR AND BEARING P₂.

($t = .072$ " TEST-6 PLATE DIMPLED & SUB C'SK AT 265°F USING 3/16" DIA HI-SHEAR RIVET).

MAX LOAD = 860 lb

∴ MAX LOAD/BOLT = 430 lb

ALLOWABLE = 71634 lb

REF 1.

REF 2.



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 4. 165

AIRCRAFT:

C.105

TORSION BOX.

PREPARED BY

DATE

K. J. IODON.

22 JAN '56

CHECKED BY

DATE

SHEAR AND BEARING ($P_1 + P_2$)

$$\text{LOAD/BOLT} = \frac{1194 + 860}{2}$$

$$= 1027 \text{ lb}$$

$$\text{ALLOWABLE IN } \cdot 10 = 1.910 \text{ lb}$$

$$RF = 1.87$$

BOLT IN UPPER LEG.

$$\text{SHEAR} = 2039 \text{ lb}$$

$$\text{TENSION} = 1080 \text{ lb}$$

$$\therefore \text{PRIN SHEAR} = \sqrt{2039^2 + 540^2}$$

$$= \sqrt{4.15 \times 10^6 + .29 \times 10^6}$$

$$= 2.100 \text{ lb}$$

$$\text{PRIN TENSION} = 2.640 \text{ lb}$$

IT WOULD SEEM ADVISABLE TO USE TWO $\frac{5}{32}$ " DIA JO-BOLTS.

$$\therefore \text{PRIN SHEAR/BOLT} = 1.050 \text{ lb} \quad \text{ALLOW } 1810 \text{ lb}$$

$$\text{PRIN TENS/BOLT} = 1320 \text{ lb} \quad \text{ALLOW. } 1290 \text{ lb}$$

$$\therefore \text{USE TWO } \frac{3}{16} \text{ DIA JO-BOLTS (STL) TENS ALLOW} = 1900 \text{ lb}$$

REUSE

$$RF = 1.44$$

BEARING OF BOLT IN VERT LEG.

$$\text{SHEAR} = 1020 \text{ lb}$$

$$\text{ALLOWABLE} = 1140 \text{ lb} \quad (.060 \text{ TEST6 BTEN AT } 265^\circ \text{F})$$

$$RF = 1.11$$

BEARING OF BOLT IN TEE.

BY COMPARISON WITH ABOVE .06" MIN IS NECESSARY.

CLERT.

$$\text{MAX BM} = 540 \times .375$$

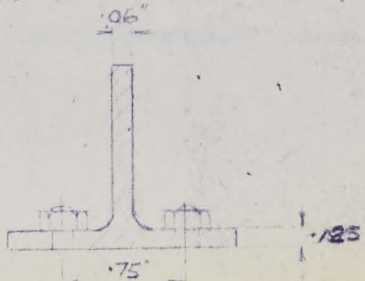
$$= 202 \text{ lb INS}$$

$$\therefore f = \frac{202 \times 6}{.125 \times 1.0 \times 1.5} \quad (\text{INC FORM FACTOR})$$

$$= 58,600 \text{ PSI}$$

$$F_u = 78,000 \times .66$$

$$= 51,480 \text{ PSI}$$



$$RF = .98$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 9 166

AIRCRAFT:

C.105

TORSION BOX

PREPARED BY

DATE

K. J. IODON

22 JAN '56

CHECKED BY

DATE

CONSIDER BOLT GROUP.

$$\bar{x} = .682$$

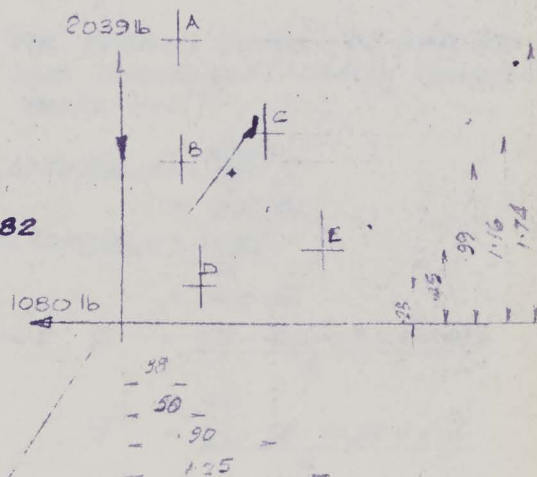
$$\bar{y} = .914$$

$$T = 1080 \times .914 - 2039 \times .682$$

$$= 985 - 1390$$

$$= 405 \text{ lbs}$$

$$T_{\frac{1}{2}} = 202 \text{ lbs.}$$



BOLT	x	y	$\bar{x}$	$\bar{y}$	$\bar{x}^2$	$\bar{y}^2$	$\bar{x}\bar{y}$	$\frac{\bar{x}}{\sum \bar{x}^2}$	$\frac{\bar{y}}{\sum \bar{y}^2}$	$\frac{\bar{x}\bar{y}}{\sum \bar{x}\bar{y}}$	$\frac{\bar{x}}{\sum \bar{x}}$	$\frac{\bar{y}}{\sum \bar{y}}$	V_0	H_0	V_{0T}	H_{0T}
A	.38	1.74	.302	.826	.091	.682	.773	.161	.413	.38	83	408	216	438	299	
B	.38	.99	.302	.076	.091	.0058	.097	.151	.038	.30	7	408	216	438	223	
C	.90	1.16	.218	.226	.0475	.051	.099	.109	.113	.22	23	408	216	386	239	
D	.50	.23	.182	.684	.0330	.466	.499	.091	.342	.18	69	408	216	826	147	
E	1.25	.45	.568	.464	.3220	.215	.537	.284	.242	.58	49	408	216	350	167	

Σ 3.41 4.57

2.005

$$\therefore \text{MAX BOLT LOAD} = \sqrt{438^2 + 299^2}$$

$$= 1000 \sqrt{.192 + .090}$$

$$= 531 \text{ lb.}$$

ALLOWABLE RD-5 IN .040 T55T6 AT 265°F FOR 50 HRS

$$\text{BEARING} = 636 \times 1.37 \times .82 = 715 \text{ lb}$$

$$\text{SHEAR} = 596 \times .964 \times .92 = 530 \text{ lb.}$$

THIS MARGIN IS CONSIDERED UNSATISFACTORY AND
THE GROUP WILL BE REBALANCED.



REPORT NO. 7-0558-92

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BOLT GROUP.

CONSIDER THAT THE VERTICAL LOADS ARE APPLIED TO BOLTS A TO J AND HORIZONTAL LOADS TOGETHER WITH MOMENTS ON BOLTS H-L

DIRECT VERT LOAD/BOLT = $\frac{2039}{9}$

= 226 lb.

DIRECT HORIZ LOAD/BOLT = $\frac{1080}{4}$

• 260 lbs.

MOMENT GROUP H→L. $\bar{x} = \frac{.35 + .50 + .90 + 1.25}{4}$

* 75

$$\bar{y} = \frac{.10 + .38 + .94 + 1.10}{4}$$

• '63

$\therefore$ TORQUE

$$= 1080 \times .75 - 2039 \times .35$$

$$= 810 - 710$$

= 100 lb ins.

$$\frac{T}{\epsilon R^2} = 100 \text{ A}$$

BOLT.	$\bar{x}$	$\bar{y}$	$\bar{x}^2$	$\bar{y}^2$	R^2	$\frac{T\bar{x}}{\sum R^2}$	$\frac{T\bar{y}}{\sum R^2}$
H	.40	.31	.160	.096	.256	31.8	24.6
J	.25	.53	.063	.280	.343	19.8	42.0
K	.15	.47	.023	.220	.248	11.9	45.2
L	.50	.25	.250	.063	.313	39.6	19.8
Σ					1.260		

$\therefore \text{MAX LOAD } A \rightarrow G = 590 \text{ N}$

H - 558 16

$\angle = 57.0^\circ$

K 45 116

L ' 20 16

$$\therefore \text{BOLT J} = \sqrt{570^2 \times 2}$$
$$= 805 \text{ lb}$$

• 805 16

ALLOW 106 IN 104
75516 AT 265°F
= 79516.

$$BOLT\ H = \sqrt{558^2 + 235^2}$$

$$\sqrt{.310 + .055 \times 1000}$$

= 605 lb.

ALLOW ADG IN .040 PBSTG AT 265°F
= T64 lb

764 46

RP
99



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MALTON - ONTARIO

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REPORT NO. 7-0058-82

SHEET NO. 168

AIRCRAFT:

C.105

TORSION BOX
HINGE

PREPARED BY

K.J. IDDON

DATE

2 FEB '56

CHECKED BY

DATE

TORSION BOX HINGE.

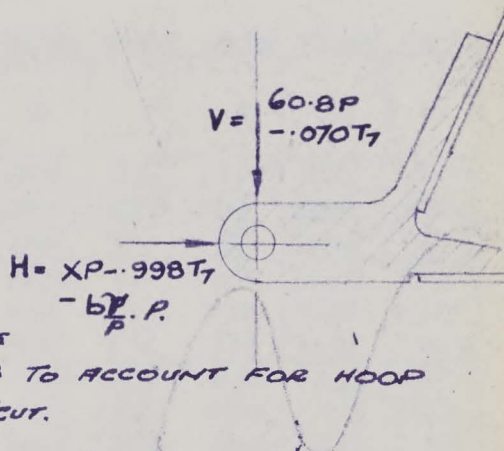
TO DETERMINE V & H AT FRAMES.
(SEE ENGINE DOOR REPORT).

γ = HOOP TENSION

b = EFFECTIVE WIDTH OF LUG AT
FRAME (2.0").

AT EACH SIDE OF CUT-OUT 'X' WILL BE
REDUCED IN THE RATIO $\frac{A-B}{A} = 1.5 = .688$ TO ACCOUNT FOR HOOP
TENSIONS BALANCED IN DOOR AT 3" CUT.

FINAL VALUE OF X .



FRAME	'X'	$\frac{b}{P}$ $= \frac{X}{A}$	$X - \frac{bT}{P}$ $= X - .998T$	ADJ FOR CUT-OUTS
596	119.3		69.5	69.5
601	123.7		72.0	72.0
606	124.6		72.5	72.5
610	125.5		73.0	73.0
615	125.0		72.8	72.8
620	121.0		70.5	70.5
625*	118.0	49.2	68.8	32.0
630*	113.0	47.2	65.8	38.7
634	107.2		62.5	62.5
639	103.0		60.0	60.0
649*	97.0	40.5	56.5	26.2
654*	96.2	40.3	55.9	25.9
659	95.8	40.0	55.8	55.8

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H.

(P) (11.97) (10.20) (7.77) (16.00) (22.82) (26.06) (9.67) (17.90) (22.82) (26.00)

FRAME	COND. No.	1	2	3	4	5	6	7	8	9	10
596	P	138	710	540	1115	1585	1800	672	1245	1585	1800
	T	601	1118	1469	1886	3047	3221	1553	1970	2723	2884
	E	-463	-408	-929	-771	-1462	-1421	-881	-725	-1138	-7084
601	P	141	725	560	1150	1640	1870	697	1290	1640	1870
	T	420	937	1288	1805	2909	3113	1568	2105	2738	2939
	E	-279	-212	-728	-655	-1269	-1257	-871	-805	-1098	-7069
606	P	143	740	565	1160	1654	1880	702	1300	1654	1880
	T	291	872	1107	1742	2799	3029	1583	2164	2753	2980
	E	-148	-132	-592	-562	-1145	-1149	-881	-864	-1099	-7100
610	P	144	745	568	1170	1665	1895	705	1305	1665	1895
	T	215	845	1079	1709	2733	2981	1580	2210	2758	3002
	E	-71	-100	-513	-539	-1068	-1086	-875	-905	-1093	-7107
615	P	143	745	565	1160	1662	1890	704	1300	1662	1890
	T	154	805	1008	1659	2682	2948	1592	2238	2790	3022
	E	-9	-60	-443	-500	-1020	-1066	-888	-938	-1132	-7132
620	P	139	720	548	1130	1610	1830	682	1260	1610	1830
	T	154	805	1008	1659	2682	2948	1592	2238	2790	3022
	E	-15	-85	-460	-529	-1072	-1118	-910	-978	-1180	-7208
625	P	1435	745	565	1160	1662	1890	704	1300	1662	1890
	T	215	845	1079	1709	2733	2981	1580	2210	2758	3002
	E	-90	-143	-544	-609	-1163	-1181	-916	-980	-1188	-7212
630	P	131	740	560	1150	1640	1870	697	1290	1640	1870
	T	291	872	1107	1742	2799	3029	1583	2164	2753	2980
	E	-160	-102	-527	-562	-1145	-1149	-881	-864	-1099	-7100
634	P	123	637	485	1000	1425	1620	605	1120	1425	1620
	T	420	937	1288	1805	2909	3113	1568	2105	2738	2939
	E	-297	-300	-803	-805	-1484	-1493	-933	-985	-1313	-7319
639	P	118	613	466	960	1370	1560	580	1170	1370	1560
	T	601	1118	1469	1886	3047	3221	1553	1970	2723	2884
	E	-583	-508	-1003	-926	-1677	-1661	-973	-800	-1353	-7324
649	P	110	615	466	960	1370	1560	580	1170	1370	1560
	T	609	952	1509	1822	3112	3235	1590	1903	2756	2877
	E	-587	-506	-1004	-927	-1677	-1661	-973	-800	-1353	-7324
654	P	110	615	466	960	1370	1560	580	1170	1370	1560
	T	622	945	1492	1810	3087	3214	1591	1916	2757	3038
	E	-578	-507	-1005	-927	-1677	-1661	-973	-800	-1353	-7324
659	P	106	364	418	862	1225	1390	520	965	1225	1390
	T	639	952	1509	1822	3112	3235	1590	1903	2756	2877
	E	-533	-588	-1091	-960	-1887	-1845	-1070	-938	-1531	-7487



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 170

AIRCRAFT:

C.105.

TORSION BOX
HINGE.

PREPARED BY

K. J. ODDON.

DATE

2 FEB '56

CHECKED BY

DATE

V

CONDN.	1	2	3	4	5	6	7	8	9	10.
ALL FANS.										
60.8 P.	119	620	472	970	1385	1580	588	1185	1385	1580

596	77	544	369	838	1165	1356	480	1047	1194	1378
601	80	534	382	844	1181	1364	478	1038	1189	1374
606	90	558	392	848	1189	1368	479	1034	1187	1372
610	104	561	397	850	1193	1372	478	1030	1175	1370
615	108	566	402	864	1197	1373	478	1028	1173	1368
620	108	566	402	854	1197	1373	478	1028	1173	1368
625	104	561	397	850	1193	1372	478	1030	1175	1370
630	99	558	392	848	1189	1368	479	1034	1177	1372
634	89	534	382	844	1181	1364	478	1038	1189	1374
639	77	544	369	838	1165	1356	480	1047	1194	1378
649	74	535	367	842	1168	1354	477	1052	1192	1379
654	76	534	368	844	1169	1354	477	1051	1192	1366
659	74	535	367	842	1168	1354	477	1052	1192	1379

CHECK SECTION :: FOR 1379 ¹⁰⁹⁷ ~~1379~~
ACTING ON A 2.0" WIDTH OF HINGE (STN 654 CONDIN 6).

BOLT LOADS TO DIAPHRAGM.

$$\begin{aligned} P_1 &= 1460 - 840 = 620 \text{ lb} \\ P_2 &= 1052 - 605 = 447 \text{ lb} \\ P_3 &= 190 + 1691 = 1881 \text{ lb} \\ P_4 &= 0 - 920 = -920 \text{ lb} \end{aligned} \quad \left. \begin{array}{l} \text{(HORIZ LEG SHEAR)} \\ \text{(VERT LEG SHEAR)} \\ \text{(VERT LEG TENS)} \end{array} \right\}$$

THESE LOADS COVERED BY PREVIOUS STRESSING.



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4 SHEET NO 171

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HINGE.

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3 FEB '56

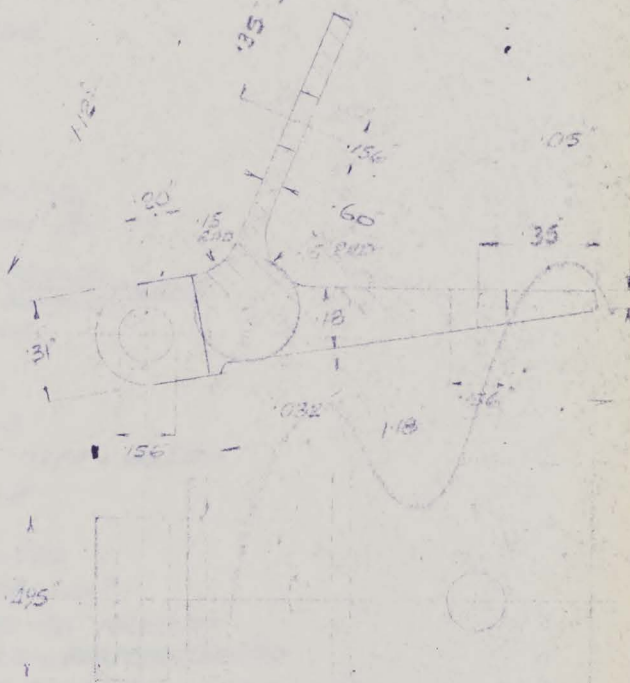
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DATE

DETAIL STRESS OF HINGE

GEOMETRY.

MATERIAL OF HINGE
75 ST6, MATERIAL OF PIN.
SPRING STEEL



LUG STRESSING - AXIAL

$$\text{MAX AXIAL LOAD } P_u = \frac{1887}{2.566/2} = \frac{944}{1.293} \text{ lb.}$$

TENSION FAILURE -

$$\begin{aligned} A_g &= 1.56 \times .495 \\ &= .0774 \text{ IN}^2 \\ W/D &= 2.0 \\ K_t &= .96 \\ F_u &= 57,000 \text{ PSI} \\ \therefore P_u &= .0774 \times 57,000 \times .96 \\ &= 4,240 \text{ lb} \end{aligned}$$

SHEAR-BEARING FAILURE -

$$\begin{aligned} d/d &= 1.0 \\ d/l &= .316 \\ A_{be} &= .0774 \\ K_{be} &= .85 \\ F_{ux} &= 54,900 \text{ PSI} \\ P_{be} &= .0774 \times 54,900 \times .85 \\ &= 3,605 \text{ lb.} \end{aligned}$$

3.82
REV 2.02



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LUG YIELD-

$$\begin{aligned} P_u \text{ MIN} &= 3,605 \\ P_u \text{ MIN} &= .85 \\ P_{u \text{ FUX}} &= .85 \\ C &= 1.10 \\ F_{UX} &= 54,900 \text{ PSI} \\ F_{UY} &= 56,000 \text{ PSI} \\ \therefore P_y &= 1.10 \times \frac{56,000}{54,900} \times 3,605 \\ &= 4,050 \# \end{aligned}$$

BUSHING YIELD-

$$\begin{aligned} F_{BY} &= 60,800 \\ P_{BY} &= 1.85 \times .0774 \times 60,800 \\ &= 8,700 \# \end{aligned}$$

PIN SHEAR-

$$\begin{aligned} A_3 &= 2 \times .01918 \\ &= .03836 \text{ IN}^2 \\ F_{SU} &= ~~28,700~~ \text{ PSI } 100,000 \\ P/S &= .03836 \times ~~28,700~~ 100,000 \\ &= ~~4,400~~ \# 3,836 \quad \text{RF} = ~~1.12~~ \end{aligned}$$

TRANSVERSE SHEAR BEARING FAILURE-

$$\begin{aligned} A_1 &= .0495 \\ A_2 &= .0774 \cdot 0387 \\ A_3 &= .0774 \cdot 0387 \\ A_4 &= .0495 \\ A_N &= \frac{6}{.0495 + \frac{1}{.0387} + \frac{1}{.0387} + \frac{1}{.0495}} \\ &= \frac{6}{4/.0495 + 2/.0387} \\ &= \frac{6}{80.8 + 51.8} \\ &= 6/132.6 \\ &= .0453 \text{ IN}^2 \end{aligned}$$

$$A_N / P_{BY} = .585$$

$$K_{TR} = .70$$

$$P_{TRY} = 2,970 \#$$

$$R.F. = 43$$

$$R.F. = 43$$



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IT HAS NOW BEEN DECIDED TO ELIMINATE THE SLOTS IN THE HINGE AND HENCE THE LOADINGS PREVIOUSLY SHOWN HAVE BEEN REVISED.

∴ RF ON LUGS.

$$= \frac{1}{\left\{ \left(\frac{1}{3.82} \right)^{1.6} + \left(\frac{1}{4.3} \right)^{1.6} \right\} \cdot 625}$$

$$= \frac{1}{\left\{ .262^{1.6} + .232^{1.6} \right\} \cdot 625}$$

$$= \frac{1}{\left\{ .1175 + .0966 \right\} \cdot 625}$$

$$= \frac{1}{.2141 \cdot 625}$$

$$= \frac{1}{.381}$$

$$= 2.63$$

R.F. ON PIN SHEAR.

$$R_s = \frac{3836}{\sqrt{944^2 + 690^2}}$$

$$= 3.29$$

RF =
2.63

RF =
3.29

R.F. ON PIN BENDING.

EFFECTIVE LUG WIDTH (MIN) FOR BEARING = .495
R.F.

$$= \frac{.495}{2.63}$$

$$= .188$$

$$\therefore \text{MAX BM ON PIN} = \frac{1180}{2} \times \left(\frac{.188}{4} + .009 + \frac{.188}{4} \right)$$

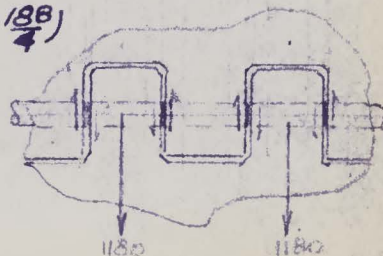
$$= 590 \times .193$$

$$= \frac{61}{16} \text{ LB INS}$$

$$\therefore f_b = \frac{\frac{61}{16} \times .078}{.00002926}$$

$$= 162,500 \text{ PSI}$$

$$\text{FORM FACTOR } F_u = 272,000 \text{ PSI}$$



RF =
1.67

∴ MEAN RF = 1.33



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HINGE.

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IN BENDING AT ENDS OF HINGE.

1ST END WILL BE CRITICAL

$$\text{LOAD/IN} = \sqrt{944^2 + 584^2}$$

$$= \sqrt{890,000 + 340,000}$$

$$= 1,110 \text{ #}$$

EFF. WIDTH OF LAST

$$\text{MALE} = \frac{.495}{2.63} \times \frac{11.10}{1180}$$

$$= .177"$$

$$\therefore \text{OFFSET MOM} = \left(\frac{.177}{4} + .009 + .125 \right) 555$$

$$= (.044 + .009 + .125) 555$$

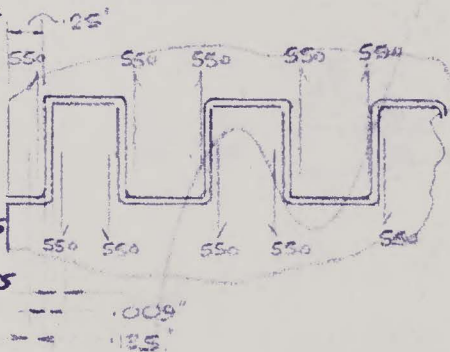
$$= .178 \times 555$$

$$= 99 \text{ lb ins}$$

$$\therefore f_b = \frac{99 \times .078}{.00002926}$$

$$= 264,000 \text{ Psi}$$

$$F_{all} = 272,000 \text{ Psi}$$



BENDING AT BASE OF LUG.

$$M = 944 \times .20 + 584 \times .20$$

$$= 117 \text{ lb ins.}$$

$$\therefore f_t = \frac{117 \times .156}{.31^3 \times .495/12 + \frac{944}{.31 \times .495}}$$

$$= \frac{117 \times 6}{.31^2 \times .495} + \frac{944}{.31 \times .495}$$

$$= 14,700 + 6,150$$

$$= 20,850 \text{ Psi}$$

$$F_u = 56,400 \text{ Psi}$$

RF:
1.03

RF: 2.



AVRO AIRCRAFT LIMITED
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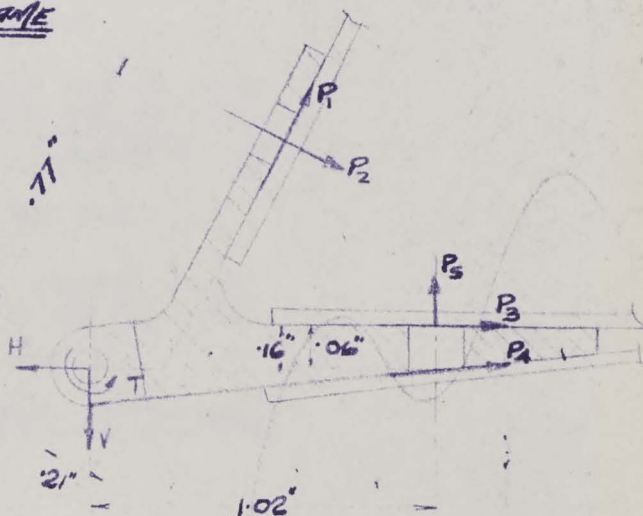
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HINGE REACTIONS AT FRAME



SUMMATING VERTICAL LOADS:-

$$V = P_1 \cos 22^\circ - P_2 \sin 22^\circ + P_4 \cos 8^\circ 30'$$

$$\therefore V = .927 P_1 - .375 P_2 + .148 P_4 + P_5$$

SUMMATING HORIZONTAL LOADS:-

$$H = P_1 \sin 22^\circ + P_2 \cos 22^\circ + P_3 + P_4 \cos 8^\circ 30'$$

$$\therefore H = .375 P_1 + .927 P_2 + P_3 + .989 P_4$$

SUMMATING MOMENTS ABOUT PIN:-

$$M = P_2 \cdot 71 - 21 P_1 + 16 P_3 + 84 P_4 + 102 P_5$$

$$\therefore T = -.21 P_1 + .77 P_2 + .16 P_3 + .14 P_4 + 1.02 P_5$$

NOW BY RATIO OF THICKNESSES $P_3 = 2 P_4$

$$\therefore V = .927 P_1 - .375 P_2 + .148 P_4 + P_5$$

$$H = .375 P_1 + .927 P_2 + 2.989 P_4$$

$$T = -.210 P_1 + .770 P_2 + .180 P_4 + 1.020 P_5$$

LET $P_5 = 0$

$$\therefore V = .927 P_1 - .375 P_2 + .148 P_4 \quad \text{--- (1)}$$

$$H = .375 P_1 + .927 P_2 + 2.989 P_4 \quad \text{--- (2)}$$

$$T = -.210 P_1 + .770 P_2 + .180 P_4 \quad \text{--- (3)}$$

MULTIPLY (2) BY $\frac{.927}{.375}$ AND SUBTRACT FROM (1).

$$V = .927 P_1 - .375 P_2 + .148 P_4 \quad \text{--- (1)}$$

$$2.47 H = .927 P_1 + 2.290 P_2 + 7.400 P_4 \quad \text{--- (2a)}$$

$$V - 2.47 H = -2.665 P_2 - 7.252 P_4 \quad \text{--- (4)}$$



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MULTIPLY (3) BY $\frac{.927}{.210}$ AND ADD TO (1)

$$V = .927 P_1 - .375 P_2 + .148 P_4 \quad (1)$$

$$4.410T = -.927 P_1 + 3.400 P_2 + .795 P_4 \quad (3a)$$

$$V + 4.410T = 3.025 P_2 + .943 P_4 \quad (5)$$

MULTIPLY (5) BY $\frac{2.665}{3.025}$ AND ADD TO (4)

$$V - 2.470H = -2.665 P_2 - 7.258 P_4 \quad (4)$$

$$.833V + 3.900H = 2.665 P_2 + .831 P_4 \quad (5a)$$

$$1.833V + 2.470H + 3.900T = -6.421 P_4$$

$$\therefore P_4 = .386H - .294V - .625T$$

SUBSTITUTE IN. (5)

$$V + 4.410T = 3.025 P_2 + .364H - .275V - .590T$$

$$\therefore 3.025 P_2 = 1.275V + 5.000T - .364H$$

$$\therefore P_2 = .421V + 1.653T - .120H$$

SUBSTITUTE IN. (1)

$$V = .927 P_1 - .158V - .620T + .045H + .057H - .043V - .087T$$

$$.927 P_1 = 1.201V + .707T - .102H$$

$$\therefore P_1 = 1.294V + .762T - .110H$$

CHECKING.

$$\begin{aligned} (1) \quad V &= 1.201V + .707T - .102H \\ &= .157V - .620T + .045H \\ &= .043V - .093T + .057H \\ &= 1.001V - .006T - 0H \quad \checkmark \end{aligned}$$

$$\begin{aligned} (2) \quad H &= .485V + .286T - .041H \\ &= .381V + 1.530T - .111H \\ &= .870V - 1.870T + 1.152H \\ H &= .004V - .054T + 1.000H \quad \checkmark \end{aligned}$$

$$\begin{aligned} (3) \quad T &= -.272V - .160T + .023H \\ &= .324V + 1.273T - .092H \\ &= .053V - .113T + .069H \\ T &= -.001V + 1.000T + 0H \quad \checkmark \end{aligned}$$

$$\begin{aligned} \therefore P_1 &= 1.294V + .762T - .110H \\ P_2 &= .421V + 1.653T - .120H \\ P_3 &= -.585V - 1.250T + .772H \\ P_4 &= -.294V - .625T + .386H \end{aligned}$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 180

AIRCRAFT:

PREPARED BY

DATE

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DATE

Box 1.

$$\text{Max } \tau = \frac{2R}{(1+m^2)} \left[1 + .15 \left(m^2 \frac{R}{\rho} \right) \right] \frac{T}{J}$$

$$m = \frac{\pi \times .03^2}{.0366}$$

$$= .0772$$

$$m^2 = .006$$

$$\rho = \infty$$

$$\therefore \tau = \frac{.06}{1.006} \left[1 + .0009 \right] \frac{T}{.00222}$$

$$= 37T$$

Box 2. $\text{MAX } \tau = \frac{2R}{(1+m^2)} \left[1 + \frac{\tanh 2\beta}{\pi} \left\{ (.118 \log_e (1 - \frac{R}{\rho}) - .238 \frac{R}{\rho}) \right\} \right] \frac{T}{J}$

$$= \frac{.30}{1+.525} \left[1 + \frac{.995}{\pi} \left\{ (.118 \times .695 + .238) \right\} \right] \frac{T}{J}$$

$$= .197 \left[1 + .316 \{ .320 \} \right] \frac{T}{.0022}$$

$$= \frac{.216}{.0022} T$$

$$= 97.4 T$$

$$\text{MAX TORQUE} = 2.4 \times 682 \times .140$$

$$= 229 \text{ lb. in.}$$

$$\therefore \text{MAX } \tau = 229 \times 97.4$$

$$= 22,200 \text{ PSI SHEAR.}$$

RCRAFT
J. W.

COMPONENT

SHEET No.

183

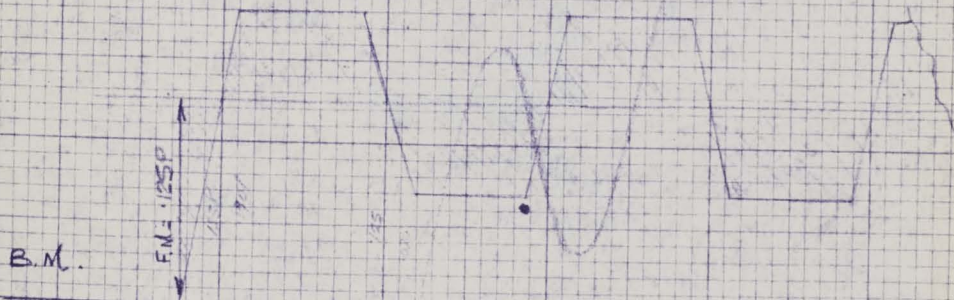
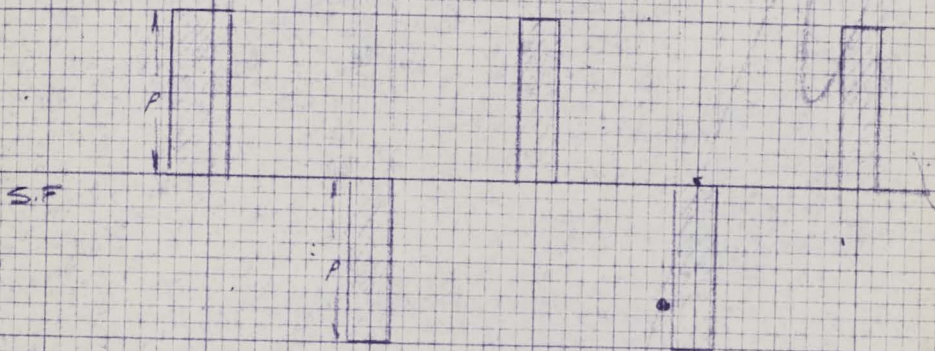
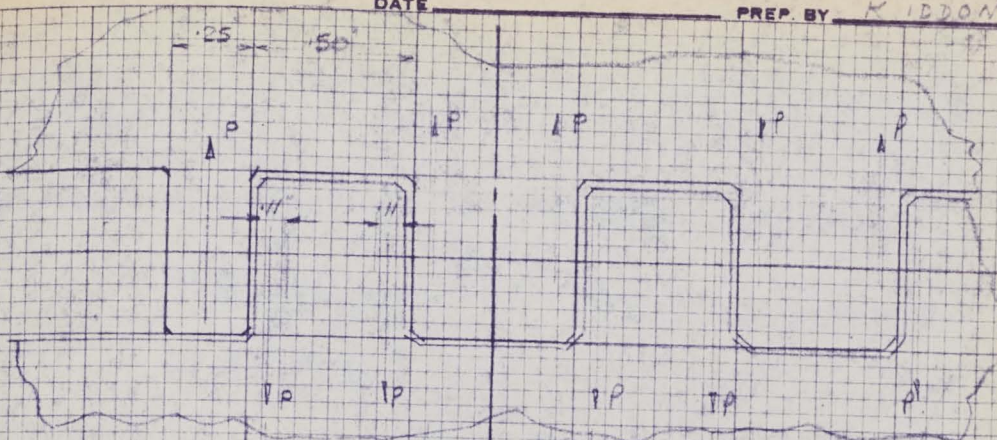
REPORT No.

7-0558-82

DATE

PREP. BY

KIDDON



FIXING MOMENT ON LIG AT CUT-OUT.



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C-105

TORSION BOX
HINGE.

REPORT No. 7-0538-82

SHEET No. 184

PREPARED BY

K. J. IDDON

DATE

8 FEB '56.

CHECKED BY

DATE

- ASSUMPTIONS
- (1) ALL DIRECT VERT LOAD DISTRIBUTED ON BOLTS A & H
i.e. 243 lb/BOLT
 - (2) ALL HORIZONTAL LOADS DISTRIBUTED ON BOLTS G, H & J
i.e. 348 lb/BOLT
 - (3) ALL TORQUE TAKEN ON BOLTS G, H & J

$$T = 1952 \times .54 - 1044 \times .48$$

$$= 1055 - 502$$

$$= 553 \text{ LBS.}$$

$$eR^2 = 3 \times .48^2$$

$$= .69$$

ON RIVET G - VERT COMPT = $\frac{553 \times .48}{.69}$

$$= 385 \text{ SIN } 25^\circ$$

$$= 162 \text{ #}$$

HORIZ COMPT = $385 \text{ COS } 25^\circ$

$$= 348 \text{ #}$$

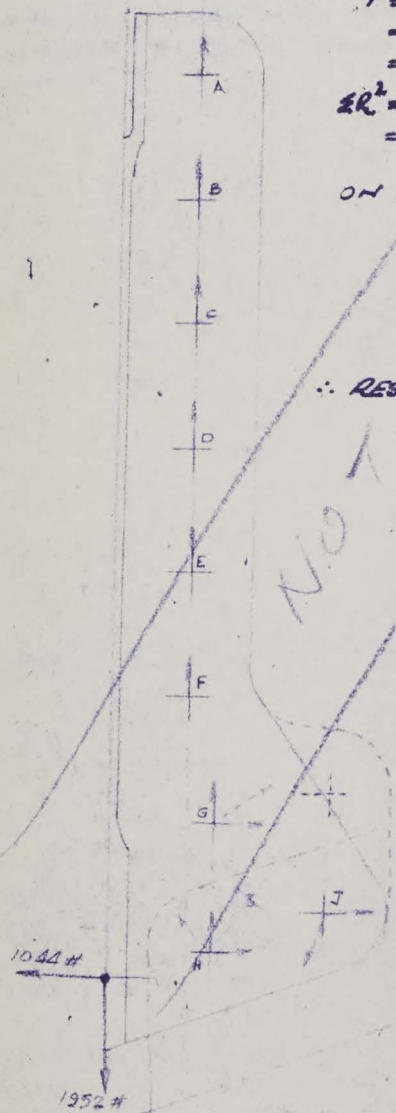
$$\therefore \text{RESULTANT} = \sqrt{405^2 + 696^2}$$

$$= \sqrt{164,000 + 485,000}$$

$$= 805 \text{ #}$$

$$\text{ALLOWABLE} = 764 \text{ #}$$

ADDITIONAL BOLT SHOWN
DOTTED MUST BE LEFT IN.



R.F. 35
OK.

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-82

SHEET NO. 186

AIRCRAFT:

C.105

TORSION BOX
HINGE.

PREPARED BY

DATE

K. J. IDDON.

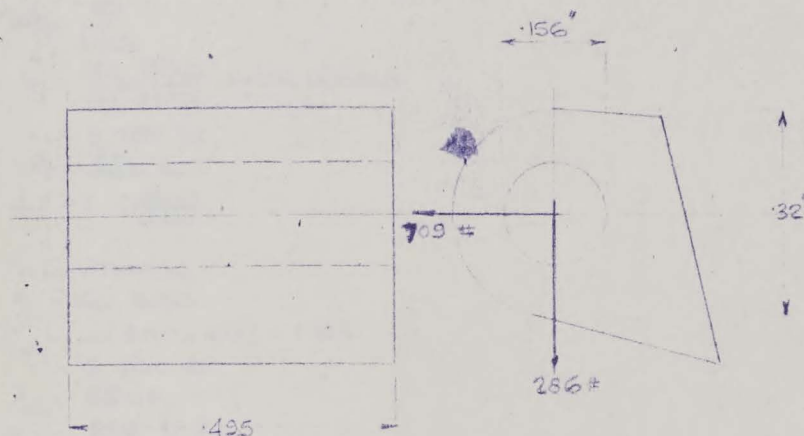
7 MAY 56

CHECKED BY

DATE

2. LUG STRESSING

USING METHOD OF MELCON AND HOBBLITT.



TENSION FAILURE (AXIAL):-

$$A_t = .164 \times 4.95$$

$$= .082 \text{ INS}^2$$

$$W/D = 2$$

$$K_t = .97$$

$$F_{TJ} = 57,000 \text{ PSI}$$

$$\therefore P_{TJ} = .97 \times .082 \times 57,000$$

$$= 4,530 \text{ lb}$$

$$P_U = 709 \text{ lb}$$

$$R.F. > 2 \left(\frac{6.37}{3.14} \right)$$

SHEAR BEARING FAILURE (AXIAL):-

$$A_{br} = .495 \times 1.56$$

$$= .077 \text{ INS}^2$$

$$a/d = 2.08$$

$$D/t = .316$$

$$K_{br} = .85$$

$$F_{TJx} = 54,900 \text{ P.S.I.}$$

$$\therefore P_{BRU} = .077 \times 54,900 \times .85$$

$$= 3,605 \text{ lb}$$

$$P_U = 709 \text{ lb}$$

$$R.F. > 2 \left(\frac{5.06}{2.54} \right)$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-82

SHEET NO. 188

AIRCRAFT:

C.105.

TORSION BOX
HINGE.

PREPARED BY

DATE

K. J. IDDON.

7 MAY '56

CHECKED BY

DATE

RESULTANT LOADING ON LUG (SHEAR BEARING).

$$\begin{aligned}
 RF_L &= \frac{1}{\left\{ \left(\frac{1}{5.06} \right)^{1.6} + \left(\frac{1}{13.80} \right)^{1.6} \right\}^{0.625}} \\
 &= \frac{1}{\left(.0198^{1.6} + .0073^{1.6} \right)^{0.625}} \\
 &= \frac{1}{\left(.00188 + .000762 \right)^{0.625}} \\
 &= \frac{1}{(.00264)^{0.625}} \\
 &= .0227 \\
 &= 4.61
 \end{aligned}$$

RF =
4.61

YIELD FACTOR.

BETTER BY INSPECTION.

BUSHING YIELD:-

$$\begin{aligned}
 P &= \sqrt{709^2 + 286^2} \\
 &= \sqrt{500,000 + 82,000} \\
 &= 764 \text{ lb.} \\
 &= 559 \text{ lb LIMIT} \\
 RF &= 16.7 \times 520 / 559 \\
 &= 15.5
 \end{aligned}$$

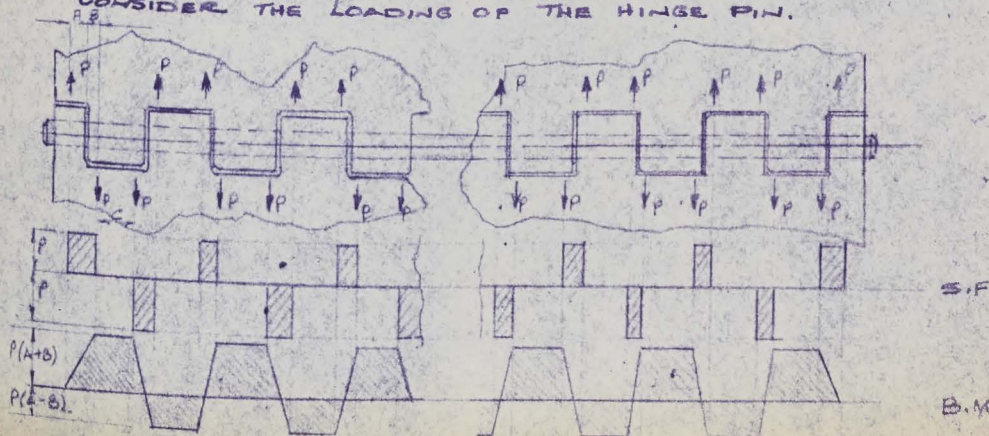
PIN SHEAR:-

$$\begin{aligned}
 P &= 764 \text{ lb.} \\
 2A_s &= .0384 \text{ IN}^2 \\
 F_{su} &= 100,000 \text{ Psi} \\
 \therefore P_s &= 3,840 \text{ lb} \\
 RF &= 5.02
 \end{aligned}$$

RF =
5.02

PIN BENDING:-

CONSIDER THE LOADING OF THE HINGE PIN.



TECHNICAL DEPARTMENT (Aircraft)

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AIRCRAFT:

C.105

TORSION BOX
HINGE.

PREPARED BY

DATE

K. J. IODON

7 MAY 56

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DATE

NOW OBVIOUSLY THE LAST LUG IS CRITICAL.

$$B = \frac{E}{R.F.} \text{ MIN ON LUG} \times 4$$

$$= \frac{495}{4 \times 5.02}$$

$$= 0.246 \text{ INS.}$$

$$R = 0.125 \text{ INS.}$$

$$\therefore \text{MAX } B \cdot \eta = \frac{764 \cdot (0.125 + 0.025)}{2}$$

$$= 57.4 \text{ LB/INS.}$$

$$Z = 0.00002926 / 0.078$$

$$= 0.000375$$

$$\therefore f_b = 153,000 \text{ PSI}$$

$$F = 240,000 \times \text{MIL. } 6713 \text{ COND. B}$$

$$= \text{[REDACTED]}$$

$$R.F. = 1.57$$

NOW THIS IS WITH R.F. = 1.0 ON LUG. LUG FAILS WHEN R.F. ON PIN IS EQUAL TO R.F. ON LUG. LET R.F. = ϕ

$$\therefore \phi = 240,000 / f_b$$

$$f_b = \frac{382 \cdot (0.125 + 0.025 \times \phi)}{0.000375}$$

$$= 127,000 (1 + 5 \times \phi)$$

$$\therefore \phi = \frac{1.895}{1 + 5 \times \phi}$$

$$\therefore \phi + 5 \phi^2 = 1.895$$

$$\phi = 0.37 \text{ (approx.)}$$

$$R.F. = 1.45$$

ATTACHMENTS.

CONSIDER NOW THE BALANCE OF THE COMPLETE EXTRUSION. BETWEEN FRAMES A TORSION WILL BE DEVELOPED DUE TO OFFSETS AND THIS MUST BE TAKEN OUT AT EACH DIAPHRAGM.

CONSIDER THE BALANCE BETWEEN DIAPHRAGMS. WHEN $R_2 = 0$

$$\Sigma V \quad 286 = 0.90631 R_1 + 0.10453 R_3$$

$$\Sigma H \quad 709 = 0.42262 R_1 + 0.99452 R_3$$

$$\therefore R_1 = \frac{286 - 0.10453 R_3}{0.90631}$$

$$\therefore R_1 = 316 - 0.115 R_3$$

$$\therefore 709 = 133.5 - 0.0485 R_3 + 0.995 R_3$$

$$\therefore 575.5 = 0.9465 R_3$$

$$\therefore R_3 = 608 \text{ LB/IN}$$

$$R_1 = 316 - 0.115 \times 608$$

$$= 206 \text{ LB/IN}$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-82

SHEET NO. 190

AIRCRAFT:

C.105

TORSION BOX
HINGE.

PREPARED BY

DATE

K. J. LADDON

7 MAY, '56

CHECKED BY

DATE

TORQUE DEVELOPED

$$= 246 \times .23 + 609 \times .084$$

$$= 56.6 + 51.1$$

$$= 107.7 \text{ lb ins/in}$$

$$\therefore \text{TORQUE AT FRAME} = 2.4 \times 107.7$$

$$= 269 \text{ lb ins}$$

$$\text{AND TORQUE TO BE TAKEN OUT AT FRAME} = 2 \times 269$$

$$= 538 \text{ lb ins.}$$

THERE ARE TWO PATHS FOR THE TORQUE REACTION BOTH OF APPROXIMATELY EQUAL STIFFNESS (I.E. R_2 & R_3 BALANCING COUPLE AND R_1 & R_4 BALANCING COUPLE) CONSIDER HALF THE 'MOMENT TO TAKE EACH PATH.

(i) MOMENT REACTED BY HORIZONTAL COUPLE.

$$\therefore \text{COUPLE} = 269 / .60$$

$$= 450 \text{ lb}$$

$$\therefore R_2 = 450 \times .90631 = 408 \text{ lb}$$

$$R_1 = 450 \times .42262 = 190 \text{ lb}$$

$$R_3 = .9945 \times 450 = 448 \text{ lb}$$

$$R_4 = .10453 \times 450 = 47 \text{ lb}$$

(ii) MOMENT REACTED BY VERTICAL COUPLE

$$\text{COUPLE} = 269 / .565$$

$$= 477 \text{ lb}$$

$$R_1 = 477 \times .90631 = 432 \text{ lb}$$

$$R_2 = 477 \times .42262 = 201 \text{ lb}$$

$$R_3 = 477 \times .10453 = 50 \text{ lb}$$

$$R_4 = 477 \times .99452 = 475 \text{ lb}$$

$\therefore$ TOTAL REACTIONS ARE

$$R_1 = 622 + 246 \text{ lb/in}$$

$$R_2 = 207 + 201$$

$$R_3 = 498 + 609 \text{ lb/in}$$

$$R_4 = 428 + 428 \text{ lb}$$

CHECK ON 4-8"

$$R_1 = 1802 \quad M_{R_1} = 1802 \times .23 = 415$$

$$R_2 = 207 \quad M_{R_2} = 207 \times .77 = 159$$

$$R_3 = 2422 \quad M_{R_3} = 2422 \times .084 = 204$$

$$R_4 = 428 \quad M_{R_4} = 428 \times 1.035 = 443$$

TECHNICAL DEPARTMENT (Aircraft)

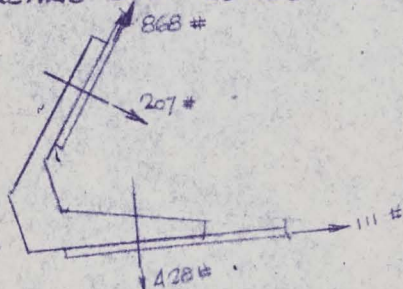
REPORT NO.	7-0559-82
SHEET NO.	191
PREPARED BY	K.J. IDDON
CHECKED BY	
DATE	7 MAY '56

AIRCRAFT:

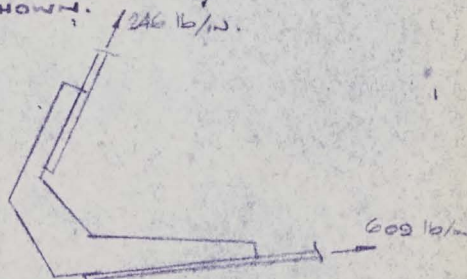
C.105

TORSION BOX
HINGE.

... ASSUMING THE REACTION IS TAKEN ON A STRIP 1.0" WIDE
THE REACTING BOLT LOADS ARE AS SHOWN.



AT FRAMES (1" STRIP)



BETWEEN FRAMES

~~FOR THE DESIGNER'S USE~~

~~STATION 15~~

BENDING STRESSES

ON UPPER LEG AT FRM

$$M = 868 \times .055 - 207 \times .25$$

$$= 47.7 - 51.7$$

$$= 7.0 \text{ lb ins}$$

$$Z = .11^2/6$$

$$= .00202 \text{ ins}^3$$

$$\therefore f_b = 3,460 \text{ psi AT. RA.}$$

ON LOWER LEG AT FRM.

$$M = .084 \times 111 - .375 \times 428$$

$$= 9 - 160$$

$$= 151 \text{ lb ins}$$

$$Z = .18^2/6$$

$$= .0054 \text{ ins}^3$$

$$f_b = 28,000 \text{ psi}$$

TORSIONAL SHEAR STRESS.

$$T = 269 \text{ lb ins MAX.}$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-82

SHEET NO. 192

AIRCRAFT:

C.105.

TORSION BOX
HINGE.

PREPARED BY

DATE

K. J. LODON

8 MAY '56

CHECKED BY

DATE

COMPARTMENT	R.	2A	P	2A/R _C	R/C	λ	c ²	λc ²	ΔJ = $\frac{A}{2} \lambda c^2$
1	.105	.096	1.14	.0842	.595	.785	.0071	.0056	.000134
2	.175	.474	1.80	.2630	.666	.862	.0690	.0696	.007030
3	.075	.154	1.34	.1150	.652	.851	.0432	.0112	.000425

$$A = .362 \text{ in}^2$$

$$J = .007589$$

$$\begin{aligned} \therefore \tau_{\text{MAX}} &= \frac{T}{J} \cdot \frac{2R}{1+m^2} \left[1 + \tanh \frac{2\lambda R}{\sqrt{1+m^2}} \left\{ .118 \log_e \left(1 - \frac{R}{\rho} \right) - .238 \frac{R}{\rho} \right\} \right] \\ &= \frac{269}{.00759} \cdot \frac{.350}{1+.264^2} \left[1 + \tanh .725 \left\{ .118 \log_e -.40 - .334 \right\} \right] \\ &= 35,500 \times .327 \left[1 + .605 \left\{ .118 \times \frac{.315}{.390} - .334 \right\} \right] \\ &= 11,600 [1 + .136] \\ f_s &= 10,000 \text{ PSI} \end{aligned}$$

LONGITUDINAL SHEAR.

$$\begin{aligned} \text{MAX SHEAR/IN IN REGION OF HINGE} &= 1304 \text{ lb/in} \\ &= 1304 / .12 \\ &= 10,900 \text{ PSI} \end{aligned}$$

AXIAL END LOAD

$$\begin{aligned} \text{MAXIMUM } f_t &= \frac{13,000}{.362} \\ &= 35,900 \text{ PSI} \end{aligned}$$

TOTAL STRESSES.

$$\text{MAX PRIN } f_t = 35,900 \text{ PSI}$$

$$\text{MAX PRIN } f_s = \frac{35,900 + 28,000}{2} + \sqrt{10,000^2 + 10,900^2}$$

$$= 31,950 + 14,800$$

$$= 46,750 \text{ PSI}$$

$$f_{su} = 43,000 \times .90$$

$$= 38,700 \text{ PSI}$$

$$RF = .83$$

BUT ALL THESE STRESSES DO NOT OCCUR AT THE SAME POINT. MAXIMUM TORSIONAL STRESS IS AT REENTERANT CORNER
MAX BENDING AT BS

$\therefore$ CONSIDERED SATISFACTORY.

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-82

SHEET NO. 196

AIRCRAFT:

C105

Torque Box

PREPARED BY

DATE

G. L. SLADEK

FEB. 1966

CHECKED BY

DATE

Torque Box Joints 60000 and 62525

ATTACHMENT LOADS CONT

CONSIDER ATTACHMENTS 6, 7, 8 AND 9

THE ABOVE ATTACHMENTS REPRESENT 5/32 DIA JO-BOLTS (AL STEEL) ALTHOUGH NO FIGURES ARE AVAILABLE FOR THE SHEAR STRENGTH OF 5/32 STEEL JO-BOLTS. A CLOSE APPROXIMATION MAY BE OBTAINED BY USING ISSUED DATA FOR 3/16 AND 1/4 JO-BOLTS AND COMPARING THESE VALUES WITH THOSE GIVEN FOR AN BOLTS.

BOLT DIA	SINGLE SHEAR STRENGTH		STRENGTH RATIO
	AN BOLT	JO-BOLT	
5/32	1438 LBS		
3/16	2070	2620 LBS	2620/2070 = 1.265
1/4	3680	4650	4650/3680 = 1.265

FROM THE ABOVE TABLE, THE EXPECTED SINGLE SHEAR STRENGTH OF A 5/32 DIA JO-BOLT = $1438 \times 1.265 = 1820$ LBS.

THINNEST GAUGE MATERIAL THRU WHICH ABOVE ATTACHMENTS PASS IS .080 (SEE THE PRECEDING SHEET).

BEARING STRENGTH OF (.080) 75 ST-L MAT'L ON ABOVE ATTACHMENTS

$$= 1250 \times \frac{100000}{100000} \times \frac{1.345}{1.125} \times \frac{.080}{.081} = 1560 \text{ LBS}$$

∴ ALLOWABLE SHEAR LOAD ON ABOVE ATTACHMENTS = 1560 LBS

TECHNICAL DEPARTMENT (Aircraft)

SHEET No. 198

DATE _____

FEB. 1956

DATE _____

602

Topic: _____

Torque Box Joints 658.05 AND 625.25

CONSIDER ATTACHMENTS 3.4 AND 5 (1/4" 10-BOLTS)

TOTAL HORIZONTAL SHEAR LOAD ON BOLT GROUP = 7830 LBS

TOTAL ASSUMED AREA OF BOAT GROUP, 250 A.

ASSUMED AREA OF A_{20} IS ATTACHMENT, A

Then Horizontal Shear Load/Bolt: $P/5.633 \times 7830 = 1400 \text{ LBS}$

My = 1423 N. Les.

DATE: 27 APR 1960 (ATTACHEMENTS (2) AND (5) . 1425/1.70 = 838 LBS (SEE SHI 194)

Resultant = $\sqrt{(1400^2 + 838^2)^{1/2}} = 1632 \text{ LBS}$

ALLOWABLE SINGLE SHEAR LOAD ON ABOVE ATTACHMENTS: 2410 LBS.

$$ZF = \frac{2410}{1633}$$

1.475

2. CONSIDER ATTACHMENTS 01, (7), (8) AND (9)

TYPE 5/32 Steel Jo. 20075

EQUVALENT AGER OF ABOVE ATTACHMENTS: 16479A

Horizontal Shear Load/Bolt = $16475/550 \times 7230 = 267.5 \text{ LBS}$

204 SHEET

$$I \text{ or } B_{\text{max}} \text{ Gauss} = 2 (21^2 + 306^2) = 1.880 \times 10^5$$

$M_x = 2760 \text{ lb}$ $LBS.$

VERTICAL SHEAR LOAD - ATTACHMENTS 161 AND 131: $(.92 / 1.82) \times 2760 = 1350 \text{ LBS}$

(7) AND (8) = $(3067/100) \times 2760 = 450$

RESULTANT SHEAR ON ATTACHMENTS (6) $\therefore (9) = (907.5^2 + 1350^2)^{1/2}$, 1625 LBS

ALLOWABLE SINGLE SUGAR LOAD ON ADJ. ATTACHMENTS = 1500 LBS

R.F. 1540 / 16292 .3.4 *

* A portion of "M" may be reacted by the 2nd. Is. Only

20 THE LENGTH OF THE 5/32 ATTACHMENTS IS

CONSIDERED SATISFACTORY.

TECHNICAL DEPARTMENT (Aircraft)

SHEET NO.

199

DATE _____

FEB. 1956

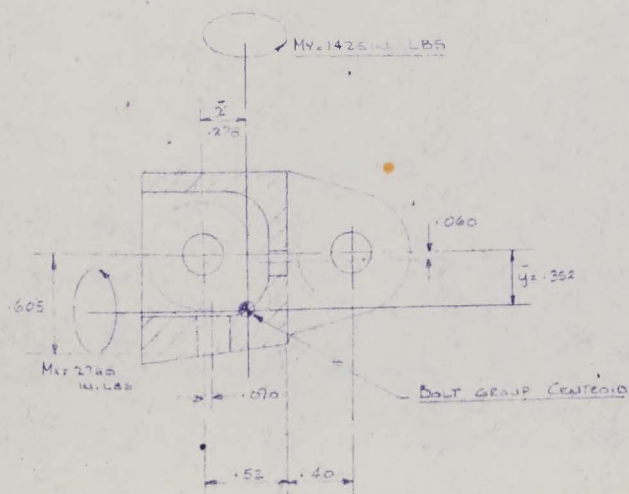
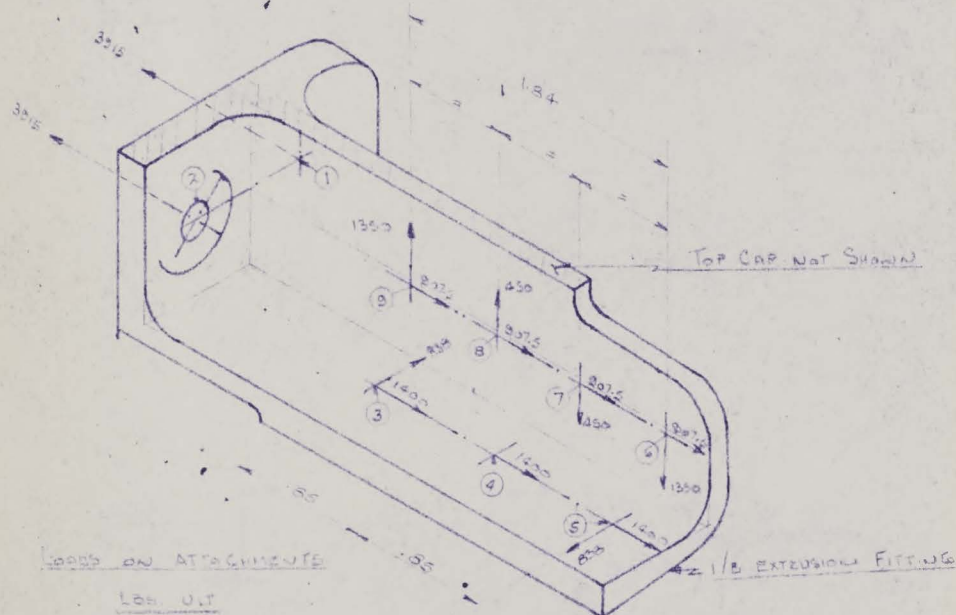
DATE _____

CLOS

To RHOUE Box

Torque Box joints 600.00 and 625.25

ATTACHMENT LOADS



SECTION TWO FITTING

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-82

SHEET No. 1200

AIRCRAFT:

C105

TORQUE BOX

PREPARED BY

DATE

G. L. SLADEK

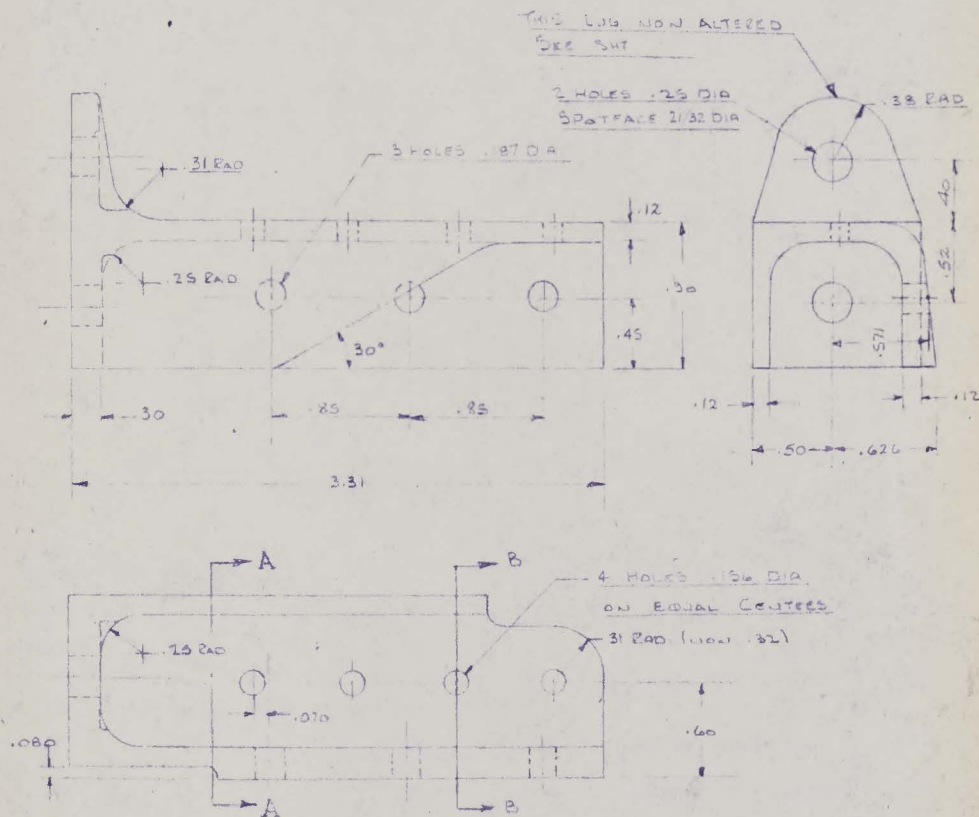
FEB. 1986

CHECKED BY

DATE

TORQUE BOX JOINTS 606.05 AND 625.23

1/8 EXTENSION FITTING



MAT'L

AL ALLOY 6061-T6 COND. T6 (145-F6)

F_T = 63,000 PSI

F_T = 52,000

F_W = 33,000

F_W = 105,000 F_W = 24,000 PSI

NOTE: THE FITTING JUST AFT OF JOINT 606.05 IS SELECTED AS THE CRITICAL ONE, SINCE THE DEPTH AND CONSEQUENTLY THE SECTION PROPERTIES ARE THE LOWEST FOR THIS FITTING.

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-82

SHEET NO. 202

AIRCRAFT:

C105

Torque Box

PREPARED BY

DATE

G. L. SLADEK

FEB 1956

CHECKED BY

DATE

Torque Box Joints 602.05 AND 475.25

1/8 EXTRUSION FITTING - SEE ALSO A.A. CONT.

MOMENT OF INERTIA I_y

ITEM	b	d	A	y	Ax	Ax ²	I _{oy}	y	Ax ²
1	.12	.77	.02330	.51	.04774	.02434	.00475	.826	.04707
2	.12	.77	.02360	.51	.04774	.02434	.00475	.860	.00228
3	.15	.15	.01125	.17	.00131	.00032	.00001	.876	.00167
4	.15	.15	.01125	.17	.00131	.00032	.00001	.17	.00032
5	.826	.12	.11112	.06	.00667	.00040	.00013	.523	.00383
6	.156	.12	.01792	.06	.00112	.00007	.00002	.52	.00058
7	.12	.122	.02256	.45	.01015	.00459	.00007	.065	.00061
			.27354		.02470	.04508	.00256		.05462

$$\bar{x} = .03470 + .3388 \text{ IN}$$

$$.27354 \text{ SAT } .3388 \text{ IN}$$

$$I_y = (.00032 + .04508) - .03470 \times .3388$$

$$= .05464 - .03203 = .02256 \text{ IN}^4$$

$$I_{xy} = .05462 - .27354 \times .3388 \times .2322$$

$$= .05462 - .05535 = -.00073 \text{ IN}^4$$

FROM A13 BROWNE

$$f_b = -(K_3 M_y - K_1 M_x)x - (K_2 M_x - K_1 M_y)y \text{ WHERE}$$

$$K_1 = \frac{I_{xy}}{I_x I_y - I_{xy}^2} = \frac{-.00073}{(.04508 \times .02256) - (.00073)^2} = \frac{-.00073}{.0010287 - 0}$$

$$K_1 = \frac{-.00073}{.0010287} = -.710$$

$$K_2 = I_y / (I_x I_y - I_{xy}^2) = .02256 / .0010287 = 21.930$$

$$K_3 = I_x / (I_x I_y - I_{xy}^2) = .04508 / .0010287 = 44.328$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-9558-82

SHEET NO. 204

AIRCRAFT:

C105

Torque Box

PREPARED BY

DATE

G. L. SLADEK

FEB 1956

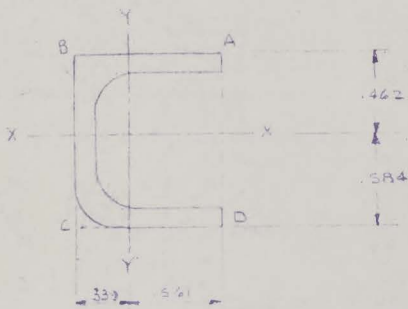
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DATE

Torque Box Joints 606.05 AND 625.25

1/8 EXTRUSION FITTING

TOTAL STRESS SECTION A-A



POINT	X	Y	-2700X	-2020Y	$f_b - 2700X - 2020Y$	P/A	$f_b + P/A$
A	561	462	-54300	-3740	-58040	28000	-30240
B	-333	462	32300	-3740	28560	28000	56560
C	-333	-584	32300	4720	37020	28000	65020
D	561	-584	-54300	4720	-49580	28000	-21780

NOTE - -VE STRESSES INDICATE COMPRESSION - ALL STRESSES P.S.I. ULT.

FROM THE ABOVE TABLE THE MAX STRESS: 65020 P.S.I. (TENSION)

FW: 63000 P.S.I. (1/8 T-6 MAT'L)
EXTENDED

$$P.F. = 63000 / 65020 = .26^*$$

* THIS P.F. CONSERVATIVE SINCE

(1) NO FORM FACTOR USED

(2) NO BOLT HOLES SHOULD HAVE BEEN DEDUCTED AT SECTION A-A

∴ SECTION IS CONSIDERED SATISFACTORY.

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-82

SHEET NO. 208

AIRCRAFT:

C105

TORQUE BOX

PREPARED BY

DATE

G. L. SLADEK

FEB. 1956

CHECKED BY

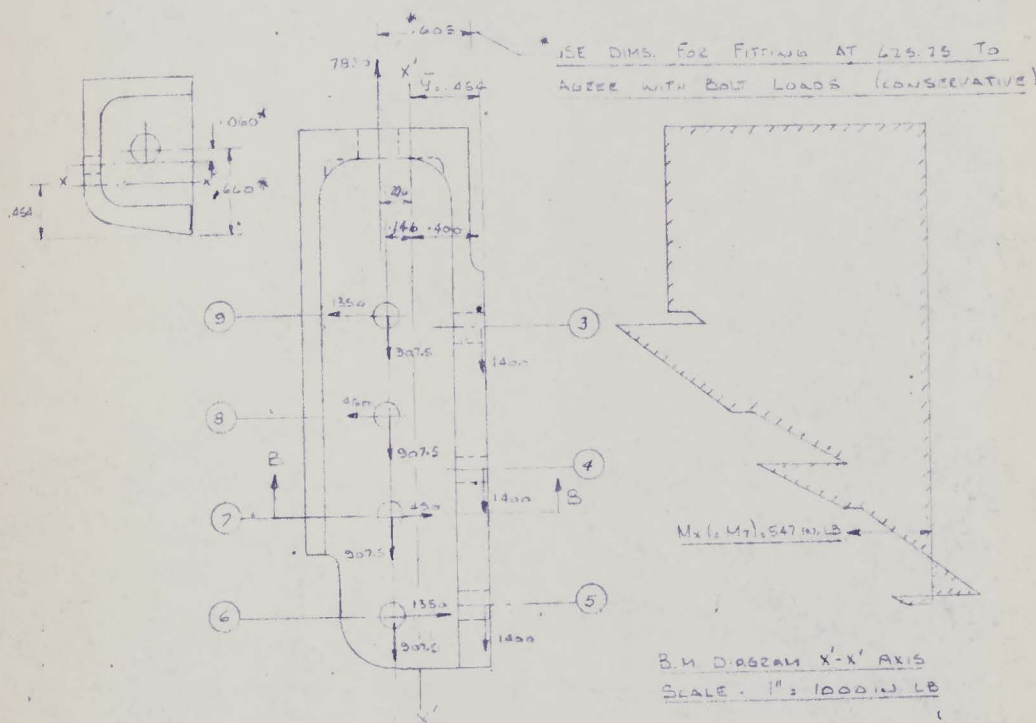
DATE

TORQUE BOX JOINTS 66.03 AND 62.25

1/2 EXTRUSION FITTING - SECTION B-B CONT'

BENDING MOMENT M_x ABOUT X'-X' AXIS (SEE SH203)

NOTE - X'-X' AXIS PASSES THROUGH CENTROID SECTION B-B.



B.M. CALCULATIONS

SECTION JUST FWD (UP)

$$\begin{aligned} M_0 &= 7830 \times .206 = 1615 \\ M_1 &= 1482 - 1350 \times .07 = 1482 - 95 = 1387 \\ M_2 &= 1247 - 1350 \times .54 = 1247 - 729 = 518 \\ M_3 &= 1085 - 1300 \times .31 = 1085 - 552 = 527 \\ M_4 &= 1087 - 1300 \times .30 = 1087 - 540 = 547 \\ M_5 &= 414 - 1350 \times .55 = 414 - 743 = -329 \\ M_6 &= 231 - 1350 \times .07 = 231 - 95 = 136 \end{aligned}$$

SECTION JUST AFT (DOWN)

$$\begin{aligned} M_0 &= 1615 - 907.5 \times .10 = 1615 - 133 = 1482 \\ M_1 &= 1387 + 1400 \times .40 = 1387 + 560 = 1947 \\ M_2 &= 1218 - 133 = 1085 \\ M_3 &= 527 + 560 = 1087 \\ M_4 &= 547 - 133 = 414 \\ M_5 &= 329 + 560 = 889 \\ M_6 &= 136 - 133 = 3 \end{aligned}$$

NOTE - ABOVE B.M.'S ARE IN. LBS. U.L.T.

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-0558-82

SHEET No. 211

AIRCRAFT:

C105

Torque Box

PREPARED BY

DATE

G. L. SLADEK

FEB 1956

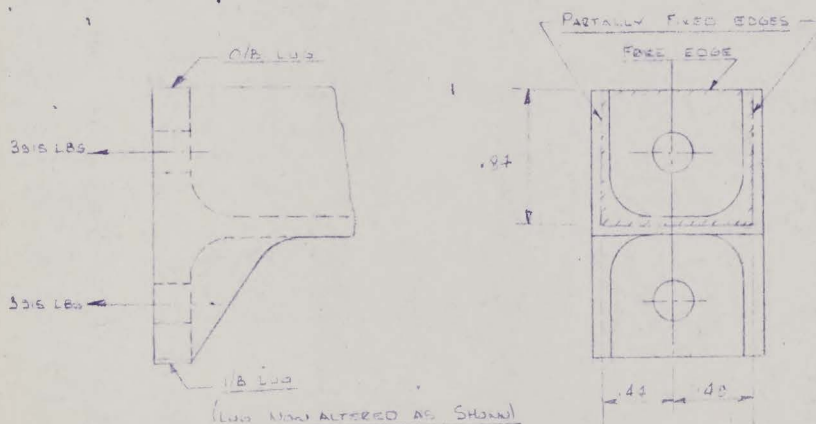
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DATE

Torque Box Joints 606.05 AND 625.25

1/8 EXTENSION FITTING

LUG STRESSING.



CONSIDER THE O/B LUG

THE O/B LUG MAY BE ANALYZED AS A BEAM ON END SUPPORTS AT THE MORNINGS OF THE OUTSTANDING LEGS OF THE CHANNEL SECTION AND UNDER THE ACTION OF A PARTIAL UNIFORMLY DISTRIBUTED LOAD AND UNIFORM END COUPLES.

THE BOLT LOAD WILL THEN BE DISTRIBUTED ON THE BASIS OF THE HEAD AREA OF THE BOLT.

BOLT HEAD DIA. .430 IN.

1/2 THE BOLT LOAD MAY THEN BE DISTRIBUTED AT .430/.42 = 1.025 (SEV. MIN.) ON EACH SIDE OF BOLT L.

• TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-82

SHEET NO. 2/3

AIRCRAFT

C105

Torque Box

PREPARED BY

DATE

G. L. SLADEK

FEB 1956

CHECKED BY

DATE

Torque Box Joints Bolts and Nuts

1/8 Extrusion Forming

a/b Lug Stressing

SINCE M_1 & M_2 WERE NEARLY THE END FIXING MOMENTS
WILL BE EQUAL TO $422/2 = 211$ IN LBS APPROXIMATELY (AVERAGE
OF M_1 AND M_2) FOR A BEAM HAVING FULLY FIXED ENDS.

HOWEVER, FOR THE BEAM UNDER CONSIDERATION THE ENDS
ARE OBVIOUSLY NOT FULLY FIXED A REASONABLE ASSUMPTION

WOULD BE TO ASSUME $M_1 = M_2 = 1/2 \times 422 = 211$ IN LBS

THE MAX B.M. = $211 \times 0.3 = 63.3$ IN LBS AT POINT 'C'

WIDTH OF BEAM = .24 IN ± .01

DESIGN 1/8 DIA BOLT HOLE SO THAT $b = .24 - .25 = .01$ IN

LUG THICKNESS = .30 IN

$Z = bt^2/6 = .01 \times .3^2/6 = .00015$ IN³

Fls. $M/c = 63.3 / .00015 = 422,000$ PSI (COMP OR TENSION)

$F_{cy} = 57,000$ PSI (MIN)

$R.F. = 57,000 / 422,000 = .135$

THE ABOVE R.F. IS CONSERVATIVE SINCE

(1) NO FORM FACTOR USED

(2) RESTRAINING EFFECTS OF VERTICAL EDGE NEGLECTED

∴ BY INSPECTION R.F. = 7/10

SHEAR OUT OF BOLT HEAD (N.A.S. 44 BOLT)

BOLT HEAD DIA = .420 IN BOLT LOAD = 3315 LBS

MEAN DIA = $.254 + (.420 - .254)/2 = .340$ IN

ASSUME 180° SEGMENT OF BOLT HEAD EFFECTIVE IN BEARING

$A_{SW} = \pi/2 D t = \pi/2 \times .340 \times .30 = .1605$ IN²

$P_s = \frac{3315}{.1605} = 20,654$ PSI (ULT)

$F_{SW} = 20,000$ PSI

$R.F. = \frac{20,000}{20,654} = .968$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-82

SHEET NO. 216

AIRCRAFT:

C105

Torque Box

PREPARED BY

DATE

G. L. SLADEK

FEB. 1956

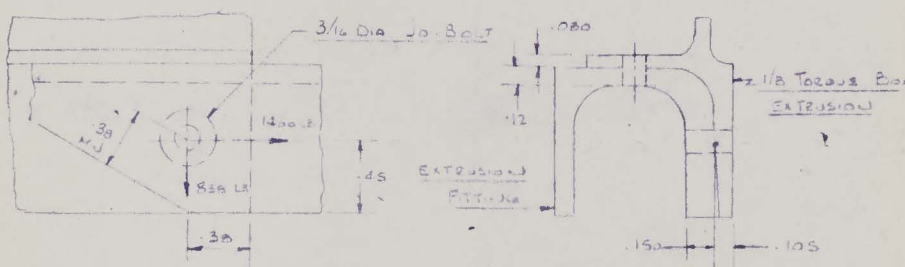
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DATE

Torque Box Joints 606.05 AND 625.25

SHEAR OUT OF ATTACHMENTS

ATTACHMENT #3 (REF. SMT)



SHEAR OUT CRITICAL IN 1/8 TORQUE BOX EXTRUSION

MAT'L 75S-T₂ F_{SM} = 44,000 PSI

AS BASED ON .38 DIM. = $1.75 \times .105 (.38 - .113/2) = .0525 \text{ IN}^2$ (CONSERVATIVE)

RESULTANT BOLT LOAD $[14.00^2 + 8.38^2]^{1/2} = 1632 \text{ LBS (SHEAR)}$

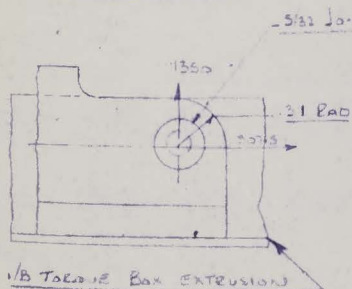
$f_s = 1632 / .0525 = 31,100 \text{ PSI, ULT.}$

R.F. = $44,000 / 31,100 = 1.415$

ATTACHMENT #5

PASSED BY INSPECTION.

ATTACHMENT #6



SHEAR OUT CRITICAL IN 1/8 TORQUE BOX EXTRUSION
(SEE SECTION ABOVE)

AS BASED ON .31 DIMENSION =

$1.75 \times .105 (.31 - .136/2) = .0325 \text{ IN}^2$ (CONSERVATIVE)

RESULTANT BOLT LOAD $[1350^2 + 307.5^2]^{1/2} = 1425 \text{ LBS}$

$f_s = 1425 / .0325 = 43,800 \text{ PSI, ULT.}$

USING 1350 LB. LOAD

$f_s = 1350 / .0325 = 41,500 \text{ PSI, ULT.}$

R.F. = $44,000 / 41,500 = 1.06$

INCREASE RAD TO .32



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT No. 7-0558-52

SHEET No. 221

AIRCRAFT:

C.105

TENSION BOX

PREPARED BY

J.B. Young

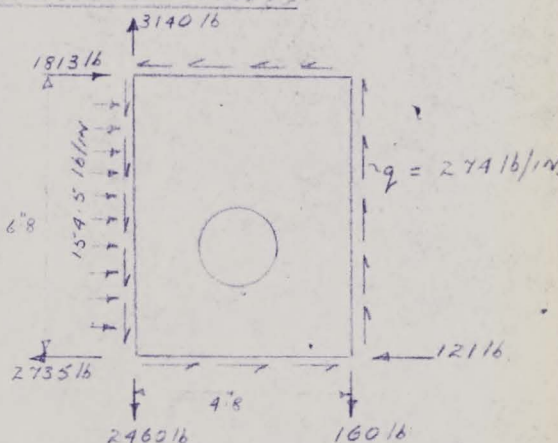
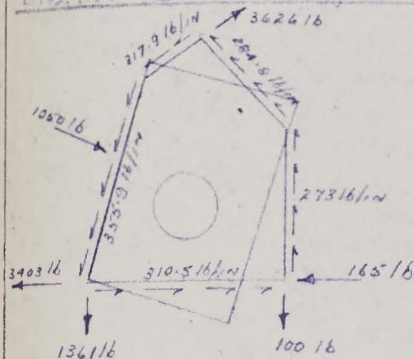
DATE

24-5-56

CHECKED BY

DATE

CHECK ON TYPICAL SYMPHASEN (CONT.)



TYPICAL PANEL SHOWN ON LEFT WITH IDEALISED
PANEL SHOWN IN RED. PANEL ON RIGHT IS
IDEALISED PANEL WITH EXTERNAL LOADS
RESOLVED INTO ITS OWN AXIS

CHECK VERTICALLY $3140 - 2180 - 160 = 520 \text{ lb}$

ACTUAL $V = 505 \text{ lb}$ SAY OK

CHECK HORIZONTALLY $1813 + 154.5 \times 6.8 - 2735 - 121$
 $= 7$ (SHOULD BE 0)

MOMENT $= 3140 \times 2.4 + 1813 \times 3.4 + 2735 \times 3.4 + 160 \times 2.4$
 $+ 121 \times 3.4 - 2460 \times 2.4 = 17831 \text{ lb/in}$

$2A = 2 \times 4.8 \times 6.8$

$\bar{q} = \frac{17831}{65.28} = 274 \text{ lb/in}$

CHECK PANEL AS A SHEAR PANEL WITH A
SHEAR FLOW $= 300 \text{ lb/in}$ SAY

$a = 6.8$ $b = 4.8$ $t = .051$ $L_1 = .06$ $b_f = .051$

$\eta/b = 1.415$ $K_{55} = 6.74$ $C_1 = 1.177$ $C_2 = 1.0$ $K_{45} = .736$ $R_0 = .70$

$\bar{q}_{\text{SHEAR}} = 6.74 \times 1.415 \times 10^4 \left(\frac{.051}{1.5} \right)^2 \left[.736 - .015 \left(\frac{1.415}{.51} \right) \right]$
 $= 5200 \text{ lb/in}$

$\bar{q} = \frac{300}{.051} = 5880 \text{ lb/in}$ $\bar{q}_{\text{SHEAR}} = 5200$ $K = .019$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-82

SHEET NO. 231

AIRCRAFT:

C105

TORSION BOX BL18-5

PREPARED BY

DATE

E.J. MANNING

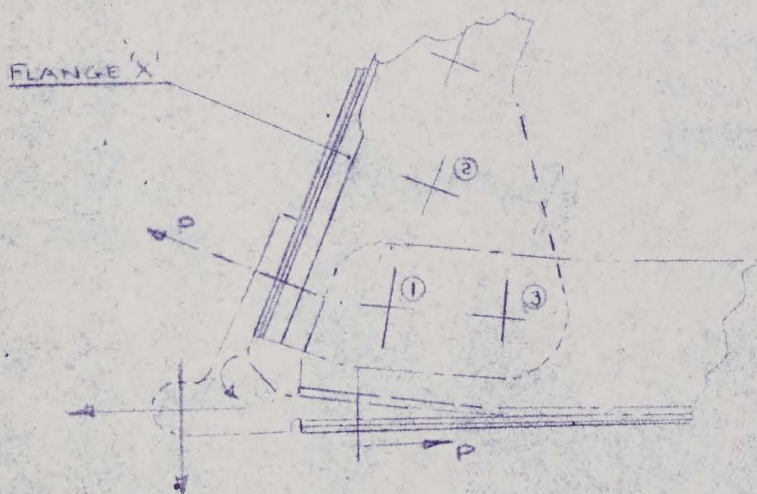
MAY '56

CHECKED BY

DATE

DUE TO RECENT ENG. DOOR MOD IE NOW JOINED TOGETHER AT CENTRE WITH LATCHES. LOAD DISTRIBUTION TO HINGE ALTERED AS 'HOOD TENSION' BALANCE USED ON DOOR LOADING BEFORE

THIS CHECK WILL COVER SIZE AND NUMBER OF RIVET ATTACHMENTS 12#304 ALSO LOCAL BENDING OF FLANGE 'X'



*ASSUMPTIONS: HINGE LOADS WILL PEAK AT DIAPHRAGM. OFFSET MOMENTS TAKEN OFF AS SHOWN ON SKETCH AS COUPLE 'P'. TRANSVERSE LOAD FROM DOOR TAKEN AS HORIZONTAL. LOADS ARE MAX APPLIED BY DOOR TO BOX.

THESE ASSUMPTIONS ARE PESSIMISTIC AS OFFSET MOMENT COULD ALSO BE TAKEN OFF VERTICALLY ALSO PEAKING IS SEVERE. THIS CHECK IS CALCULATED TO GIVE HIGHEST LOADS ON SAID ATTACHMENTS.

LOADS APPLIED

- 1) LOCAL LOADS FROM HINGE
- 2) TORQUE APPLIED TO BOX FROM DIAPHRAGM
- 3) PRESSURE ON PANELS

* IT IS FURTHER ASSUMED THAT THE ATTACHMENT GROUP TAKES ALL LOAD DUE TO OFFSET MOMENTS WHILST DIRECT LOAD IS SHARED BY ALL ATTACHMENTS IN THE SIDE & BOTTOM ANGLES



AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C 105

TORSION BOX

REPORT NO. 7-0538-82

SHEET NO. 232

PREPARED BY

DATE

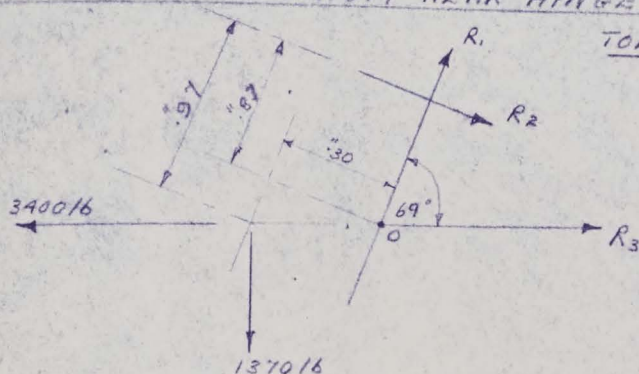
J.B. YOUNG

25-5-56

CHECKED BY

DATE

ATTACHMENTS ON DIAPHRAGM NEAR HINGE FOR MAX
TORQUE CASE



TO FIND LOADS APPLIED TO DIAPHRAGM FROM HINGE
PIN. GEOMETRY FROM 7-1058-2517-8.

MOMENTS ABOUT O

$$87 R_2 \quad 1370 \times 0.3 \sin 21^\circ = 1370 \times 0.3 \times 1.07114$$

$$R_2 = 506 \text{ lb}$$

ΣH

$$3400 = R_3 + R_2 \cos 21^\circ + R_1 \cos 69^\circ$$

$$3400 = R_3 + 9336 R_2 + 3584 R_1$$

ΣV

$$1370 = -3584 R_2 + 9336 R_1$$

$$R_1 = \frac{1370 + 181.4}{9336} = 1661.7 \text{ lb}$$

$$8 \text{ RIVETS} \quad \therefore = \frac{1661.7}{8} = 208 \text{ lb/RIVET}$$

$$R_3 = 3400 - 9336 \times 506 - 3584 \times 1661.7$$

$$= 2331.9 \text{ lb}$$

$$7 \text{ RIVETS} = \frac{2331.9}{7} = 333 \text{ lb/RIVET}$$



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT No. 7-0558-82

SHEET NO. 235

AIRCRAFT:

C.105

TORSION BOX

PREPARED BY

DATE

J. B. YOUNG

28-5-56

CHECKED BY

DATE

DIAPHRAGM ATTACHMENTS (CONT)

MAX LOAD ON OTHER VERTICAL RIVETS = 15816.
SATISFACTORY BY INSPECTION

MAX LOAD ON OTHER HORIZONTAL RIVETS = 58316.
 $\frac{3}{16}$ AD AN 470 RIVETS WILL BE SATISFACTORY.

TECHNICAL DEPARTMENT

REPORT NO. 7-05358-82

SHEET NO. 236

AIRCRAFT:

C105

TORSION BOX

PREPARED BY

DATE _____

G. M. COILEY

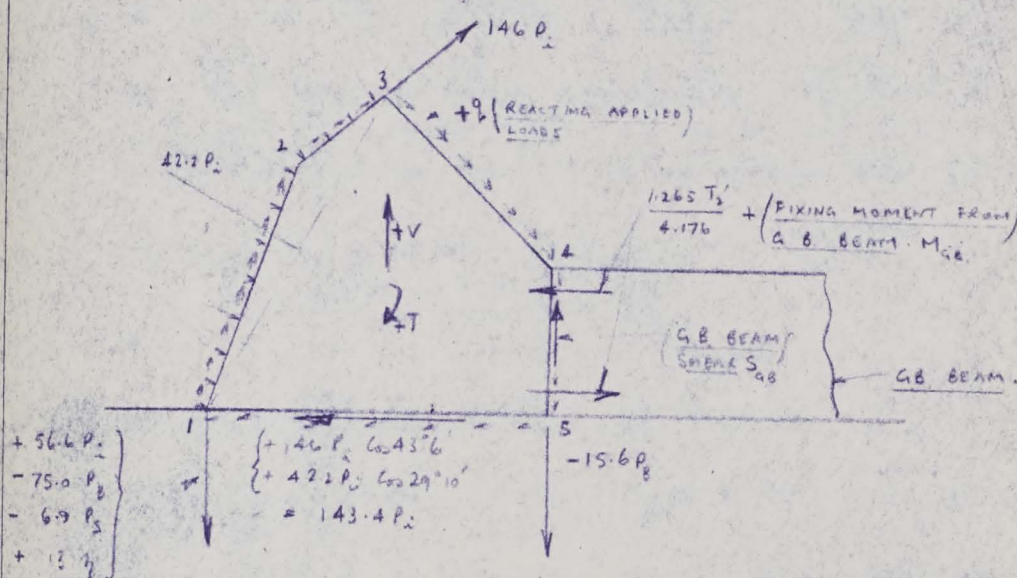
22-3-56

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DATE _____

DIAPHRAGMS AT STN 615.65

3. ADPRAGIM IN LINE WITH G R BEAM



TO FIND TOTAL MOMENT APPLIED TO DIAPHRAGM (T)

TAKING MOMENTS ABOUT THE SHEAR CENTRE

MOMENT DUE TO P_1

$$= +1.15 \times +2.2 P_u + 3.19 \times 146 P_u + 2.30 \times 148.4 P_u - 3.07 \times 56.6 P_u$$

$$= +48.5 P_u + 466 P_u + 330 P_u - 173.5 P_u$$

$$= 671 P_u$$

MOMENT DUE TO P_1, P_2, P_3 ETC.

$$= 3.07 (+75.0 P_0 + 6.9 P_5 - 3.7) - 3.63 \times 15.6 P_0$$

MOMENT DUE TO GEAR BOX BEARING LOADS

MOMENT REACTING TENSION BOX TO RQVE = $-\frac{1.265 T_2}{4.176}$ WHERE $T_2 = 28.28\% T$

$$= 0.0856 T \quad (T = \text{TOTAL APPLIED G.B. TORQUE})$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 237

AIRCRAFT:

C105

GEAR BOX BEAMS

PREPARED BY

DATE

G. M. COLLEY

22-3-56

CHECKED BY

DATE

MOMENT DUE TO G.B. BEAM SHEAR = $-4.18 S_{GB}$

MOMENT DUE TO G.B. BEAM FIXING MOMENT = $-M_{GB}$

(S_{GB} & M_{GB} ARE FUNCTIONS OF DIFFERENTIAL P_n ; P_g ; DOWN, AFT & SIDE INERTIA; & GEAR BOX TORQUE, AND MAY BE FOUND FROM THE ANALYSIS OF GEAR BOX BEAMS IN THE PINNED PANEL REPORT 7/0558/13)

TOTAL MOMENT DUE TO G.B. BEAM LOADS

$$= -1.0856T - 4.18 S_{GB} - M_{GB}$$

TO DETERMINE THE DESIGN CONDITION FOR THE DIAPHRAGMS.

1. THE DESIGN CRITICING SECTION WILL BE A HORIZONTAL SECTION ALONG THE TOP LEG OF G.B. BEAM FITTING.
2. CONSIDERING LOADS ABOVE THIS SECTION, DESIGN CONDITION WILL BE GIVEN WHEN q ADDS TO P_n LONGITUD.
3. MAX. P_n IS REQUIRED IN 24.85 IN.
4. MAX. q IS REQUIRED IN $+P_g$, DOWN AND AFT INERTIAS, $-P_s$

THIS CONDITION 5 (MODIFIED BY COND 2, L.A.) GIVES DESIGN CONDITIONS.

$$\begin{cases} Z = -4.25g \\ X = -.93g \\ P_g = +3.47 \text{ psi} \\ P_s = -0.68 \text{ psi} \\ P_n = +24.85 \text{ psi} \end{cases}$$

FROM 7/0558/13 FOR THIS CASE:

$$\begin{cases} S_{GB} = +680 \text{ lb.} & (\text{FROM LOADING FOR BEAM END FITTING}) \\ M_{GB} = +1900 \text{ lb.} & (\text{FROM BM DIAG. BY G. NORMAN}) \end{cases}$$



AVRO AIRCRAFT LIMITED
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TECHNICAL DEPARTMENT

AIRCRAFT:

C105

Torsion Box

REPORT NO. 7-0558-82

SHEET NO. 238

PREPARED BY

DATE

G. M. COLLEY

22-3-56

CHECKED BY

DATE

THUS TOTAL MOMENT APPLIED TO DIAPHRAGM:-

$$= 671 \times 24.85 + 173.4 \times 3.47 - 21.2 \times 0.68 + .9 \times 4.25 - .0856 \times 184,000 \\ - 4.18 \times 680 = 1900$$

$$= +1,667 + 602 - 14 + 4 - 15,750 - 2,840 - 1,900$$

$$= -4,482 \text{ Lb-in. (ADDITION INCORRECT, CORRECT VALUE = 3,225 Lb-in. ERROR NEGLIGIBLE)}$$

ALL THIS INPUT WILL BE ASSUMED TO ACT FWD

TORQUE FWD OF STN 615.65 = +9,940 Lb-in.

$$\text{H. APT. = H. 615.65} = +10,910 + 4,482 = 15,392 \text{ Lb-in.}$$

$$\text{S/L REACTION TORQUE} = +4,482 = +80.5 \text{ Lb-in.}$$

4,482
1,200
3,282

TO FIND TOTAL VERTICAL LOAD APPLIED TO DIAPHRAGM:-

VERTICAL LOAD DUE TO P_2

$$= +146 P_2 \sin 43^\circ 6' - 42.2 P_2 \sin 29^\circ 10' - 56.6 P_2$$

$$= +99.7 P_2 - 20.6 P_2 - 56.6 P_2$$

$$= +22.5 P_2$$

VERTICAL LOAD DUE TO $P_6, P_5 \text{ \& } P_7$

$$= +75.5 P_6 + 15.6 P_7 + 6.9 P_5 - 32$$

$$= +91.1 P_6 + 6.9 P_5 - 32$$

VERTICAL LOAD DUE TO GEAR BOX BEAM LOADS

$$= +548$$

THUS TOTAL VERTICAL LOAD APPLIED TO DIAPHRAGM FOR COMB S

$$= +22.5 \times 24.85 + 91.1 \times 3.47 - 6.9 \times .68 + .3 \times 4.25 + 680$$

$$= +559 + 316 - 5 + 1 + 680$$

$$= +1,551 \text{ Lb}$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 239

AIRCRAFT:

C105

Torsion Box

PREPARED BY

DATE

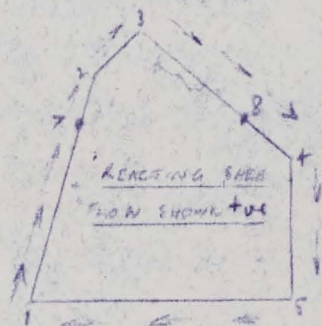
G. M. COLE

21-1-56

CHECKED BY

DATE

SHEAR FLOW DISTRIBUTION AROUND DIAPHRAGM AT STN. 615.65



SIN AROUND DIAPHRAGM AT STN 615.65 FOR CONDITION 5

LOADING		VERTICAL	BM DUE TO	BM DUE TO	AXIAL LOAD	
PANEL	TORQUE (4432 #.-in)	SHEAR (+1,551 #)	VERTICAL SHEAR (39,803 #.-in)	AXIAL LOAD (+9,350)		TOTAL
DERIVATION	MOMENT APPLIED TO DIAPHRAGM ÷ 2A	SHEAR APPLIED TO DIAPHRAGM # (PRELIM) 7-0558-12 P 13	7-0558-11.2 938 (PRELIM)	SIN DUE TO VERT. SHEAR ON X + 9,350 - 29,888	SHEAR APPLIED TO DIAPHRAGM (7-0558-12) X 7290 14,250	Σ COLUMNS
1-7	80.5	-113.8	-188.5	+44.2	+68.1	-245.7
7-2	80.5	-113.8	+695.0	-162.9	+168.0	+666.8
2-3	80.5	3.3	+67.01	-15.7	+17.1	+152.2
3-8	80.5	103.5	+475.96	+111.6	-83.1	-268.5
8-4	80.5	103.5	+207.9	-48.6	+87.7	+427.5
4-5	80.5	141.0	+208.5	-48.9	+64.4	+445.5
5-1	80.5	8.59	+305	-7.2	+5.1	+117.4

(BENDING MOM. DUE TO
AXIAL LOADS CONSIDERED = $-11,000 \times \frac{4.11}{10.0}$)

AXIAL LOAD CONSIDERED = $17,81 \times \frac{4.25}{10.0} = -7290 \text{ lbs}$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT No. 7-0558-82

SHEET No. 240

AIRCRAFT:

C 105

TORSION

BOX

PREPARED BY

K.O. HILLYER

CHECKED BY

DATE

8 MAY 56

DATE

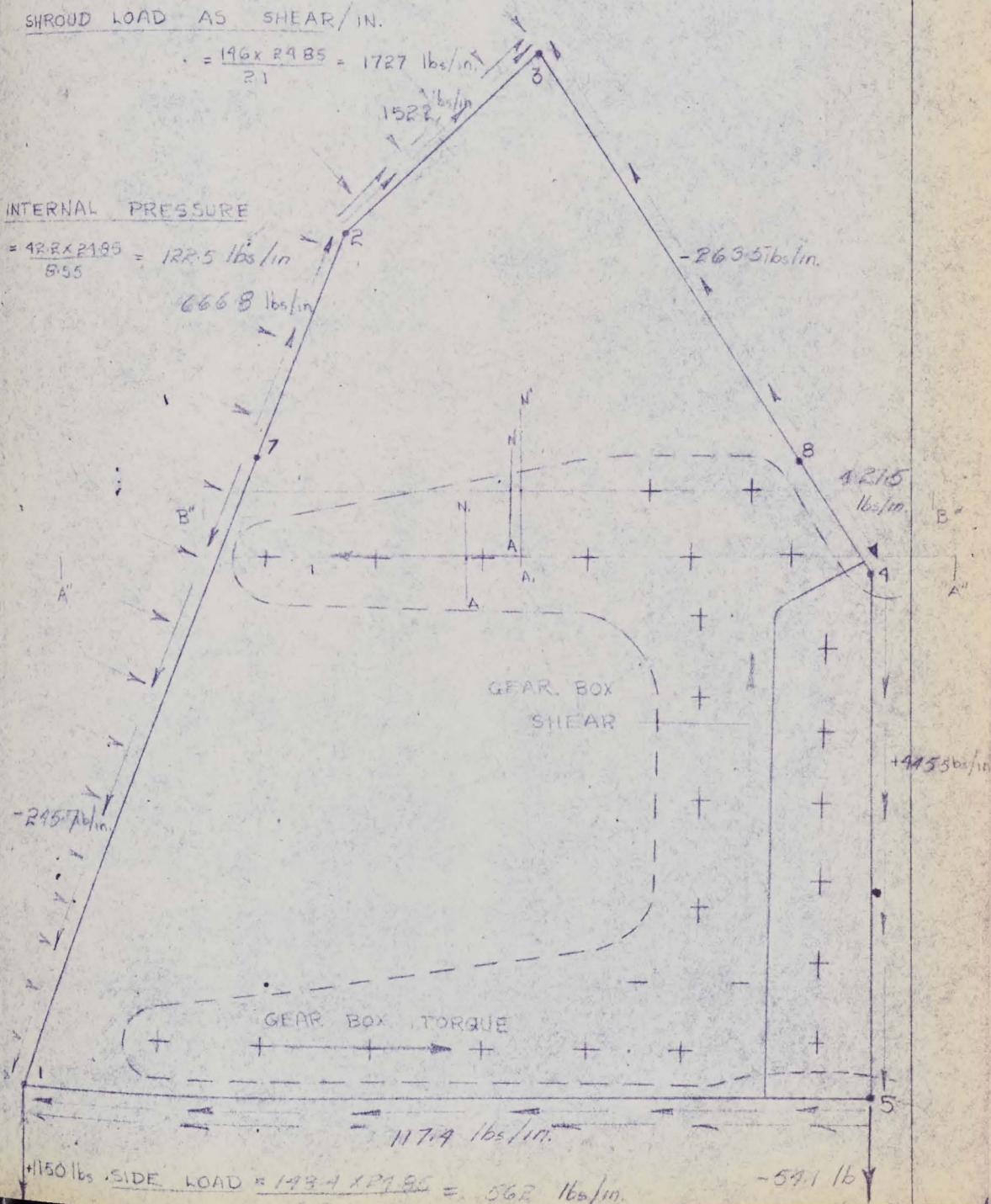
LOADING OF DIAPHRAGM 615.65

SHROUD LOAD AS SHEAR/IN.

$$= \frac{196 \times 2985}{2.1} = 1727 \text{ lbs/in.}$$

INTERNAL PRESSURE

$$= \frac{42.2 \times 2185}{8.55} = 122.5 \text{ lbs/in.}$$





AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 241

AIRCRAFT:

2105

Torsion Box

PREPARED BY

DATE

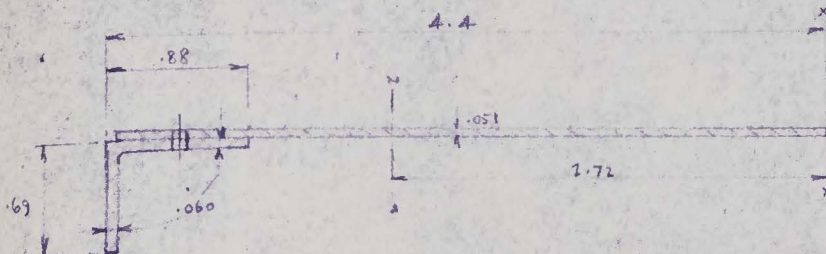
A. M. COILEY

23-3-56

CHECKED BY

DATE

BENDING ACROSS SECTION 'AA'



1. MOMENTS ABOUT XX

$$4.2 \times .051 \times 2.1 = 0.450$$

$$.63 \times .060 \times 4.37 = 0.165$$

$$.75 \times .060 \times 3.95 = 0.178$$

$$\text{TOTAL} = 0.809 \text{ in}^3$$

$$\bar{x} = 2.72 \text{ in}$$

AREA

$$4.2 \times .051 = .214$$

$$.63 \times .060 = .038$$

$$.75 \times .060 = .045$$

$$\text{TOTAL} = .297 \text{ in}^2$$

2. ABOUT N.A.

$$.051 \times 2.75 \times \frac{1}{3} = .354$$

$$.051 \times 1.48 \times \frac{1}{3} = .055$$

$$.63 \times .060 \times 1.65^2 = .098$$

$$.75 \times .060 \times 1.25^2 = .068$$

$$\text{TOTAL} = .575 \text{ in}^4$$

MOMENT OF LOADING ABOUT SECTION 'AA' ABOUT N.A.

$$\begin{aligned} &= -2457 \times 76 \times 1.69 + 6668 \times 77 \times 1.69 + 1522 \times 1.95 \times 2.32 + 1727 \times 1.95 \times 2.32 \\ &- 268.5 \times 3.06 \times 2.47 + 427.5 \times 83 \times 2.47 + 122.5 \times 1.95 \times 1.95 + 122.5 \times 2.55 \times 61 \\ &= -323.9 + 1994.6 + 688.6 + 7813.0 - 2317 + 876.9 + 965.8 + 1901.5 \\ &= 9389 \text{ in. lbs} \end{aligned}$$

$$\text{MAX COMPRESSIVE STRESS} = \frac{9389 \times 2.72}{.575} = 44,409 \text{ psi}$$

THIS SOLUTION IS OBVIOUSLY UNSATISFACTORY. THEREFORE THE FITTING WILL BE EXTENDED VERTICALLY AND THE DESIGN SECTION WILL BE THAT SHOWN BE THE FLANGE BEING EFFECTIVE AT THIS SECTION.



AVRO AIRCRAFT LIMITED
MILTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0658-82

SHEET NO. 242

AIRCRAFT:

C105

Torsion Box

PREPARED BY

DATE

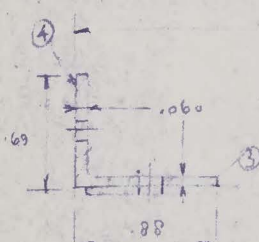
C.M. COLLET

27-9-56

CHECKED BY

DATE

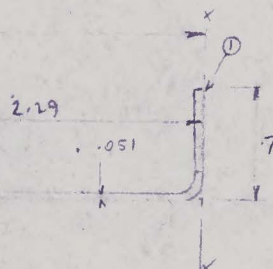
SENDING AIRPORT SECTION 28.



4.25

N

A ②



ITEM	b	t	A	y	Ay	Ay ²	I _a
1	.65	.051	.0332	.026	.000862	.0000224	
2	4.10	.051	.2090	2.07	.433000	.8950000	.293
3	.72	.060	.0432	3.81	.164600	.6270000	
4	.47	.060	.0282	4.22	.119000	.5020000	
			.3136		.717462	2.0240224	

$$\bar{y} = \frac{.71746}{.3136} = 2.29$$

$$I_{NA} = Ay^2 - Ay\bar{y} - I_a$$

$$= 2.024 - 1.642 + .293$$

$$= .675$$

MOMENT OF LOADING ABOVE BB ABOUT N.A.

$$= -2457 \times .27 \times .191 + 666.8 \times .77 \times .181 + 1528 \times .95 \times .219 + 1727 \times .95 \times .219$$

$$- 263.5 \times 3.56 \times 1.92 + 927.5 \times 2.61 \times 1.92 + 122.5 \times 2.04 \times 1.32 + 122.5 \times 1.95 \times 1.37$$

$$= -120.1 + 2136.2 + 6500 + 7375.2 - 180.1 + 213.4 + 80.0$$

$$+ 327.3$$

$$= 8,861 \text{ in lbs}$$

$$\text{MAX. COMPRESSIVE STRESS} = \frac{2.29 \times 8,861}{.675} = 30,062 \text{ psi}$$

CRITICAL STRESS FOR FLANGE BUCKLING

$$= 40,200 \text{ psi}$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C105

TORSION BOX

REPORT NO. 7-0558-82

SHEET NO. 243

PREPARED BY

DATE

G.M. COILET

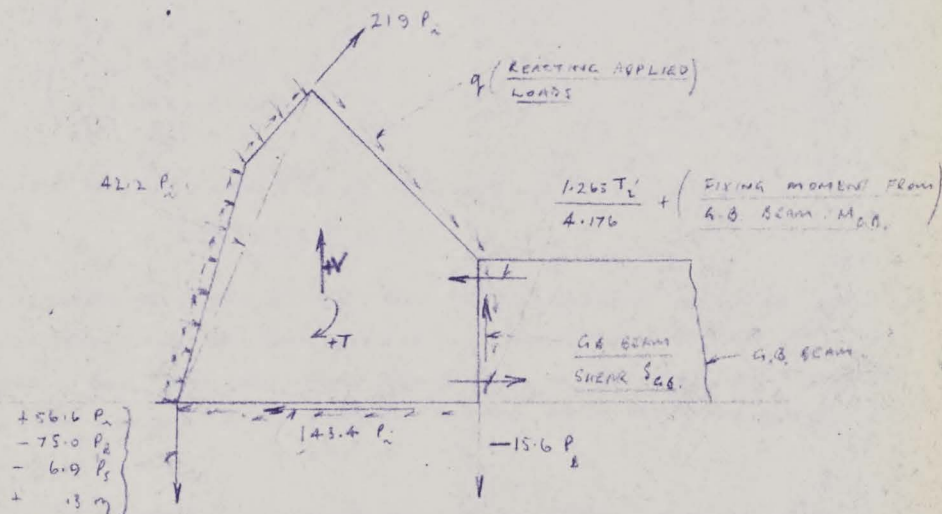
26-3-56

CHECKED BY

DATE

DIAPHRAGM AT STN. 610.05

(DIAPHRAGM IN LINE WITH G.B. BEAM)



TO FIND TOTAL MOMENT APPLIED TO DIAPHRAGM T.

TAKING MOMENT ABOUT THE SHEAR CENTRE

MOMENT DUE TO P2

1. THE SHROUD HOOP TENSION LOAD APPLIED TO THIS DIAPHRAGM IS 1.5 TIMES THE LOAD FOR OTHER DIAPHRAGMS DUE TO THE CUTOUT FOR THE GEAR BOX DRIVE CUTTING AWAY THE DIAPHRAGM AT STN 606.05

2. THE LOADING DUE TO INTERNAL PRESSURE ON THE IN & OUT SURFACES OF THE BOX WILL BE ASSUMED TO BE THE SAME AS FOR OTHER DIAPHRAGMS.

$$\begin{aligned} \text{THEN } T_2 &= 1.15 \times 42.2 P_2 + 3.19 \times 219 P_2 + 2.10 \times 143.4 P_2 - 3.07 \times 56.6 P_2 \\ &= 448.5 P_2 + 698 P_2 + 330 P_2 - 173.5 P_2 \\ &= 903 P_2 \end{aligned}$$

MOMENT DUE TO $\left\{ \begin{array}{l} P_2, P_1, T \\ \text{G.B. BEAM LOADS } (M_{G.B.} \text{ \& } S_{G.B.}) \end{array} \right.$

AS FOR DIAPHRAGM AT STN. 615.65

$$= 173.4 P_2 + 21.2 P_1 - 1.9 T - 0.856 T - 4.18 S_{G.B.} - M_{G.B.}$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT No. 7-0538-52

SHEET No. 245

AIRCRAFT:

C105

Torsion Box

PREPARED BY

DATE

G. M. COLLEY

26-3-56

CHECKED BY

DATE

To FIND VERTICAL LOAD APPLIED TO DIAPHRAGM (STN. 610.85)

VERTICAL LOAD DUE TO P_2

$$= + 219 P_2 \sin 43^\circ 6' - 422 P_2 \sin 29^\circ 16' - 56.6 P_2$$

$$= + 149.5 P_2 - 20.6 P_2 - 56.6 P_2$$

$$= + 72.3 P_2$$

VERTICAL LOAD DUE TO $\left\{ \begin{array}{l} P_B, P_S, P_T \\ \text{Gear, Low beam loads} \end{array} \right\}$

AS FOR DIAPHRAGM AT 615.85

$$= + 91.9 P_B + 6.9 P_S - .37 + S_{qd}$$

THUS TOTAL VERTICAL LOAD APPLIED TO DIAPHRAGM FOR COND. 5.

$$= + 72.3 \times 24.81 - 125.0 - 4.7 - 2.5 + 680$$

$$= + 12349.5 \text{ lbs.}$$



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MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT No. 7-0558-82

SHEET No.

246

AIRCRAFT:

C105

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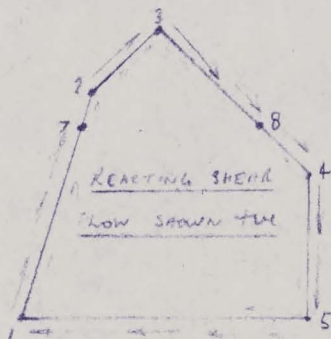
G.M. COLLEY

21-3-56

CHECKED BY

DATE

SHEAR FLOW DISTRIBUTION BEARING DIAPHRAGM AT STN 610.85



SIN AROUND DIAPHRAGM AT STN 610.85 FOR CONDITION 5 -

LOADING	TORQUE	VERTICAL * SHEAR	SM DUE TO VERTICAL SHEAR	SM DUE TO AXIAL LOAD	AXIAL LOAD (14,510 lb)	TOTAL
PANEL	(-1692 in)	(+2344.5 in)	(8175 in)	(18,590 in)		
DERIVATION	MOMENT APPLIED TO DIAPHRAGM + 2A	SHEAR APPLIED TO DIAPHRAGM (PRELIM) 7-0558-12 P13	7-0558-12 P13 (PRELIM)	SIN DUE TO VERT SHEAR B.M. x 148,540 3,175	SIN APPLIED TO DIAPHRAGM (7-0558-12) x (14,510) 102,500	Σ COLUMNS
1-7	-30.77	-172.1	+ 15.0	+ 87.8	- 203.1	-303.2
7-2	-30.77	-172.1	- 55.8	- 323.8	+ 502.7	-79.3
2-3	-30.77	5.0	- 5.3	- 31.0	+ 151.6	-10.5
3-8	-30.77	156.4	+ 37.9	+ 221.9	- 247.7	+137.7
8-4	-30.77	156.4	- 16.5	- 96.6	+ 253.2	+265.7
4-5	-30.77	213.1	- 16.6	- 97.2	+ 193.0	+261.5
5-1	-30.77	12.9	- 2.4	- 14.1	+ 15.8	-18.6

* ALL THE VERTICAL SHEAR APPLIED TO THE DIAPHRAGM IS ASSUMED TO BE
REACTED BY THE AFT PORTION OF THE BOX



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MALTON - ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C 105

TORSION BOX

REPORT NO. 7-0558-82

SHEET No. 247

PREPARED BY

DATE

K.O. HILLYER

8-MAY-56

CHECKED BY

DATE

LOADING OF DIAPHRAGM 610.85

SHROUD. LOAD AS

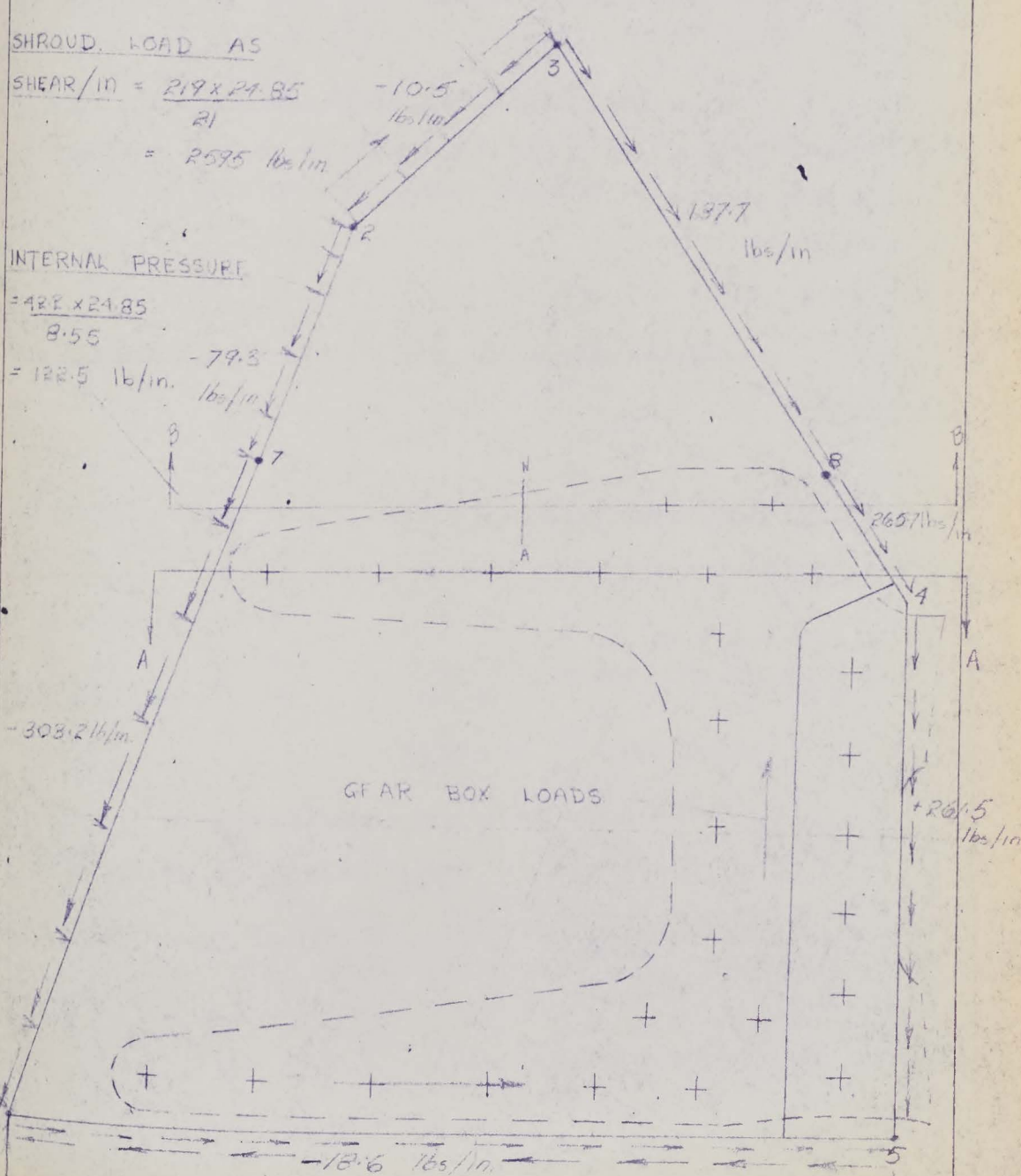
$$\text{SHEAR/IN} = \frac{219 \times 24.85}{21}$$

$$= 259.5 \text{ lbs/in}$$

INTERNAL PRESSURE

$$= \frac{422 \times 24.85}{8.55}$$

$$= 122.5 \text{ lb/in.}$$



$$\text{SIDE LOAD} = \frac{143.4 \times 24.85}{6.55} = 562 \text{ lb/in}$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT No. 7-0558-82

SHEET No. 248

AIRCRAFT:

C-105

TORQUE BOX

PREPARED BY

DATE

K. HILLYER

9-MAY-56

CHECKED BY

DATE

IT IS ASSUMED THAT THE SECTION PROPERTIES AT 'BB' OF DIAPHRAGM AT 610.85 ARE THE SAME AS THOSE AT 615.65.

MOMENT OF LOADING ABOUT BB' ABOUT N.A.

$$= -3032 \times 274.181 - 793 \times 177 \times 181 - 105 \times 195 \times 217 + 2525 \times 195 \times 217 + 137.7 \times 256 \times 192 + 26074.22 \times 192 + 1225 \times 209 \times 132 + 1225 \times 192 \times 127$$

$$= -14812 - 25911 - 448 + 11,031.9 + 941.2 + 1326 + 80 + 3273$$

$$= 12,116 \text{ in lbs.}$$

MAX COMPRESSIVE STRESS IN BLIND UP FLANGE

$$= 12,116 \div 288$$

$$= 41,105 \text{ psi}$$

CRITICAL STRESS FOR FLANGE BUCKLING (COMPRESSION)

$$f_{cr} = \frac{k \pi^2 E}{12(1-\nu^2)} \left(\frac{t}{b} \right)^2$$

REF. STEINBERGER & GERARD

$$= \frac{.48 \pi^2}{12(1-0.3^2)} E \left(\frac{t}{b} \right)^2 = \frac{.48 \pi^2}{12 \times .81} \times 10,000 \times 10^3 \times .005 \times \left(\frac{.051}{.6} \right)^2$$

$$= 24,700 \text{ psi} - \text{TOO LOW}$$

THUS IT IS NECESSARY TO RE-CALCULATE

REF. J. A. E. G. APRIL 1954

$$f_{cc} = \frac{C_e f_{cy} E}{\left(\frac{L}{t} \right)^2} = \frac{.818 \times 64,000 \times 9,700 \times 90 \times 10^3}{\left(\frac{6}{.051} \right)^2}$$

$$= 24 \times 10^3 \times .818 \times 750,000$$

$$= 40,300 \text{ psi}$$

THUS THE SHEET GAUGE IS MADE .064



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT No. 7-0538-82

SHEET No. 251

AIRCRAFT:

C 105

TORQUE BOX

PREPARED BY

DATE

K.O. HILLYER

9-MAY-56

CHECKED BY

DATE

IT IS ASSUMED THAT THE PRESSURE AXIAL COMPONENT IS NOT CRITICAL, AND SINCE THE TENSILE COMPONENT WILL HINDER BUCKLING IT IS ALSO NEGLECTED.

SHEAR BUCKLING ON TOP PORTION OF DIAPHRAGM (610)

ASSUMING SHEAR/IN. AT SECT. CC = $\frac{5740}{2.9} - \frac{10.5 \times 1.95}{(+79.3 \times 1.7)} + \frac{30 \times 2.05 \times 10.26}{2.9}$

EFF. WIDTH = $3.4 - \frac{2.5}{16} = 3.24$

$= 1880 - \frac{203 + (10.5 + 2570 \times 0.899)}{2.9}$

$= 2.9$

$= 1880 - 130$

$= 1750 \text{ lbs/in}$

TO ACCOUNT FOR NON UNIFORM STRESS DISTRIBUTION MULTIPLY BY 1.2.

SHEAR STRESS $\tau = \frac{1750}{0.64} = 27,350 \text{ psi}$

MAX. SHEAR STRESS = $38,800 \text{ psi}$

ALLOWABLE $\tau_{50} = 87.5\% \times 43,000 = 37,500 \text{ psi}$

R.F. = 1.17

BUCKLING

ASSUMING AN EFFECTIVE PANEL OF

d=2.0

ALL SIDES ARE SIMPLY SUPPORTED

$\tau_{CR} = k_{35} E \left(\frac{t}{d_c} \right)^3 \left[R_H + \frac{1}{2} (R_D - R_H) \frac{d_c}{h_c} \right]^2$

ELASTIC

$\frac{h_c}{d_c} = 1.75$

$k_{35} = 6.05$

$t/d_c = 0.10$

$t/d_c = 0.10$

$R_H = 1.23$

$R_H = 1.7$

1.18

$\tau_{CR} = 6.05 \times 97 \times 10^6 \times (0.10)^3 \left[1.23 + \frac{1}{2} (1.53 \times 0.57) \right]^2$

ELASTIC

$= 64,245 \text{ psi}$

ACTUAL $\tau_{CR} = 34,750 \text{ psi}$

R.F. = 1.06



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 255

AIRCRAFT:

C-105

TORQUE BOX

STA. 615.65

PREPARED BY

DATE

K.O. HILLYER

19-MAY-56

CHECKED BY

DATE

TO FIND MAX. SHEAR FLOW IN PANELS

(SEE PREV. PAGES)

VERTICAL SHEAR

$$= +285 P_L + 911 P_B + 64 P_S - .371 S_{82} \quad \text{Max. } T = 129,000 \text{ lbs.}$$

MOMENT

$$= 671 P_L + 1734 P_B - 212 P_S + 971 S_{82} - 0.856 T - 4.18 S_{82} - \text{Max}$$

CASE 7

$$P_S = -350 \text{ psi}$$

$$P_B = 450 \text{ psi}$$

$$P_L = 1540 \text{ psi}$$

$$q = -4219$$

$$V.S. = 3465 + 403.75 - 2445 + 1409 + 680 = 1912.5 \text{ lbs}$$

$$\text{Mom.} = 10325.4 + 1780.3 + 14.2 - 3.81 - 15150 = -2849 - 1700 = -4549 \text{ in. lbs.}$$

LOADING PANEL	TORQUE (+9327 in. lbs.)	VERTICAL SHEAR (413.5 lb.)	B.M. DUE TO VERT. SHEAR (-561.75)	B.M. DUE TO AXIAL LOAD (+9250 in. lbs.)	AXIAL LOAD (+1290 lbs.)	TOTAL
DERIVATION	MOMENT → + PA	7.058 lb. per in.	1.118	Shear due to Vert. P.M. 9327 Shear 1.118 -9253	Shear due to AXIAL LOAD 1290 -7458 lb. +266	Σ COLUMNS
1-7	+169	-103.7	-267	+44.2	-68.1	-221.4
7-2	+169	-103.7	+99.4	-162.9	+168.0	+1062.9 *
2-3	+169	+29.7	+96.1	-15.7	+17.1	+1268.5
3-8	+169	+94.4	-877	+111.6	-83.1	-787.1
8-4	+169	+94.4	+282	-48.6	-84.7	+154.5 *
4-5	+169	+109.7	+2945	-48.9	+69.9	+610.9 *
5-1	+169	7.77	+92.5	-7.2	+5.1	+188.2

CASE 9.

$$P_S = 10, P_B = 347, P_L = 2465 \quad V.S. = 1565 \text{ lbs}$$

$$q = -421$$

$$\text{Mom.} = -3,412 \text{ in. lbs.}$$

LOADING PANEL	TORQUE (+3291.3)	VERTICAL SHEAR (+1565 lb.)	B.M. DUE TO VERT. SHEAR (+56.722 in. lbs.)	B.M. DUE TO AXIAL LOAD (+3220 in. lbs.)	AXIAL LOAD (+1560 lbs.)	TOTAL
DERIVATION	MOMENT → + PA	7.065 lb. per in.	1.118	Shear due to Vert. P.M. 3291 Shear B.M. 1.118 -3220	Shear due to AXIAL LOAD 1560 +710	Σ COLUMNS
1-7	+58.9	-114.7	-268.1	+44.2	-68.1	-347.9 *
7-2	+58.9	-114.7	+986.4	-162.9	+168.0	+1937.7
2-3	+58.9	+3.3	+93.3	-15.7	+17.1	+1158.9
3-8	+58.9	+104.4	-676.9	+111.6	-83.1	-485.1 *
8-4	+58.9	+104.4	+235.0	-48.6	+84.7	+494.4
4-5	+58.9	+142.4	+296.5	-48.9	+69.9	+1513.3
5-1	+58.9	86.1	+92.9	-7.2	+5.1	+156.2



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 257

AIRCRAFT:

C-105

TORQUE BOX

DIAPHRAGM

PREPARED BY

K.O. HILLYER

DATE

15-MAY-56

CHECKED BY

DATE

THE ABOVE CALCULATIONS ARE FOR CASE 7 (SEE PREV. PAGE)

CASE 9

VERT. SHEAR = $17967 + 218.7 + 6.9 + 128 + 680 = 22033 \text{ lbs.}$

MOMENT = $22,440 + 601.7 + 212 + 2.8 - 15750 - 2840 - 1900 = 12567 \text{ in lbs.}$

LOADING	TORQUE	VERTICAL SHEAR	BEND MOM DUE TO VERT. SHEAR	B.M. DUE TO AXIAL LOAD	AXIAL LOAD	TOTAL
PANEL	(+25767 in lbs)	(+28033 lbs)	(-16.142 in lbs)	(+2320 in lbs)	(-1270 lbs)	lbs/in.
DERIVATION	MOMENT ÷ 2A	7-0558-12 P.52	7-0558-12 P.118	in due to VERT. SHEAR B.M. $\times \frac{25767}{32.452}$	5/in due to Ax. LOAD $\times \frac{2320}{12.252}$	Σ COLS.
1-7	-96.85	-205.5	+1268.1	+44.2	+68.1	123.05
7-2	-96.85	-205.5	+988.4	-162.7	-168.0	1571.7 *
2-3	-96.85	+59	+90.3	-15.7	-17.1	-169.5
3-8	-96.85	+1570	+676.9	+111.6	+83.1	+1011.8
8-4	-96.85	+1570	-271.0	-98.6	-84.7	-282.2
4-5	-96.85	1255.1	-206.5	-198.9	-64.4	-201.5
5-1	-96.85	+15.4	-47.4	-1.2	-5.1	-87.2

CASE 3

VERT. SHEAR = $831.45 + 413.55 - 12.0 - 3.0 + 680 = 1910 \text{ lbs.}$

MOMENT = $10,384.5 + 730.3 - 36.85 - 9 - 15750 - 2540 - 1700 = -9371 \text{ lbs.}$

LOADING	TORQUE	VERTICAL SHEAR	BENDING MOM. DUE TO V. SHEAR	B.M. DUE TO AXIAL LOAD	AXIAL LOAD	TOTAL
PANEL	(+9371 in lbs)	(+1910 lbs)	(-22.607 in lbs)	(-27,000)	(+17.181 lbs)	lbs/in.
DERIVATION	MOMENT ÷ 2A	7-0558-12 P.52	7-0558-12 P.118	in due to VERT. SHEAR B.M. $\times \frac{9371}{22.607}$	5/in due to Ax. LOAD $\times \frac{17.181}{14.252}$	Σ COLS.
1-7	+170.4	-190.0	+159.1	+104.0	-270.5	+18.0
7-2	+170.4	-190.0	-563.2	-333.4	+595.2	-326.0
2-3	+170.4	+9.01	-57.8	-37.0	+61.1	+193.7
3-8	+170.4	+127.4	+389.2	+262.5	-293.3	+656.2
8-4	+170.4	+127.4	-167.6	-114.4	+299.7	+313.7 *
4-5	+170.4	+175.8	-170.5	-115.0	+228.5	+287.2 *
5-1	+170.4	+10.5	-24.9	-16.8	+18.7	+157.9

* FIGURES OUTLINED IN RED ARE THE MAX. SHEAR FLOWS ENCOUNTERED IN THE RESPECTIVE PANELS.



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TECHNICAL DEPARTMENT

AIRCRAFT:

C-105

TORQUE BOX

FLANGE ATTACHMENTS

REPORT NO. 7-0558-82

SHEET NO. 258

PREPARED BY

DATE

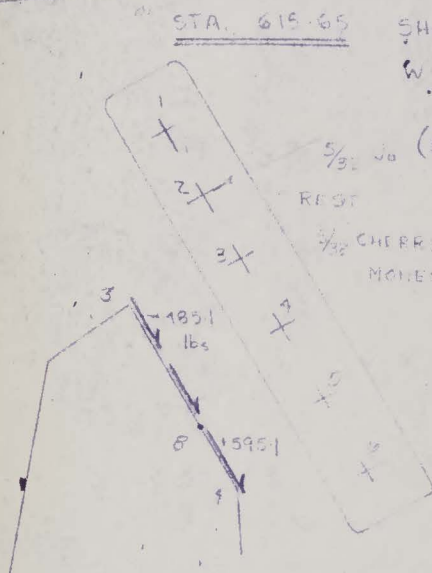
K.O. HILLNER

15-MAY-56

CHECKED BY

DATE

FLANGE RIVETS



THE WORST CASE OCCURS WHEN THE
SHEAR FLOW IN PANEL 3-8 IS
WITHSTOOD ONLY BY RIVETS 1-9

$$\frac{5}{32} J_0 (3-8) \text{ TOTAL LOAD} = 4851 \times 3.56$$

$$= 1728 \text{ lbs}$$

$$\frac{1}{32} \text{ CHERRY MONEL TOTAL ALLOWABLE LOAD} = 1827.5 + 3(1090)$$

$$= 5097.5$$

$$R.F. = > 2$$

$$(8-4) \text{ TOTAL LOAD} = 5951 \times 1.05$$

$$= 625 \text{ lbs}$$

$$\text{ALLOWABLE LOAD} = 2180$$

$$R.F. > 2$$

STA. 610.85

$$(3-8) \text{ TOTAL LOAD} = 11261 \times 3.56$$

$$= 4010 \text{ lbs}$$

$$\text{ALLOWABLE} = 5097.5 \text{ lbs}$$

$$R.F. = 1.27$$

$$(8-4) \text{ TOTAL LOAD} = 313.7 \times 1.05$$

$$= 329.5 \text{ lbs}$$

$$R.F. > 2$$

THE MAX. LOAD IN ANY RIVET IS 1002 lbs.
(ASSUMING JO + CHERRY MONEL WITH SAME ET)

$$\text{ALLOWABLE PEERING LOAD} = 141,000 \times 0.64 \times 1562 \times .83$$

$$= 1168 \text{ lbs}$$

$$R.F. = 1.165$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 259

AIRCRAFT:

C-106

TORSION BOX

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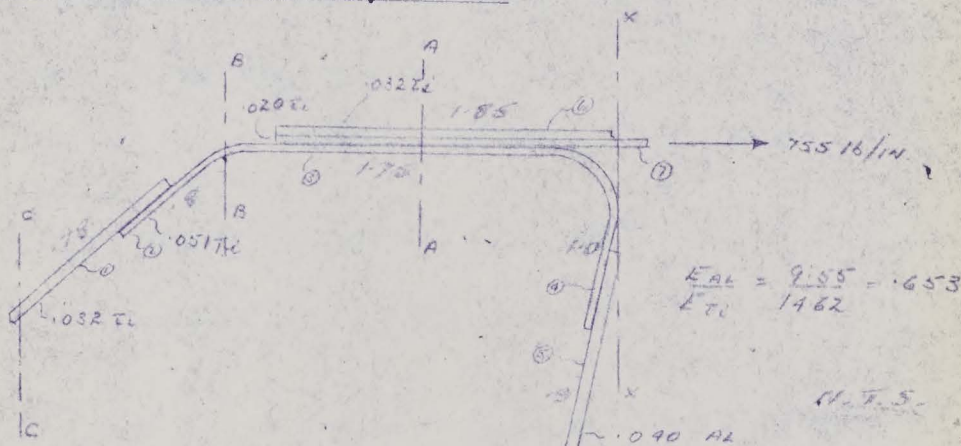
J.B. YOUNG

22-8-56

CHECKED BY

DATE

TOTAL STRESS IN CAP (C)



ITEM	AREA	$\bar{y}$	$A\bar{y}$	$A\bar{y}^2$	I_{xx}	I_{yy}
①	0.250	2.46	0.615	1.515	0.0102	15.232
②	0.408	2.16	0.882	2.084	0.0166	14.006
③	0.652	1.12	0.730	1.113	0.0280	13.470
④	0.510	0.6	0.306	0.092	-	0.0020
⑤	0.235	0.6	0.141	0.081	-	0.0010
⑥	0.591	0.25	0.147	0.036	0.1620	0.6750
⑦	0.370	0.25	0.092	0.023	0.1268	0.4428
Σ	2.256	-	1.470	-	-	60.916

$$\bar{y} = \frac{1.47}{2.256} = 0.656$$

$$I_{NA} = 60.916 - 1.47 \times 0.656^2 = 60.916 - 0.592 = 60.324$$

$$\text{DUCT HOOP TENSION} = 24.85 \times 30 \times 4 = 755 \text{ lb/in}$$

$$M_{max} = \frac{755 \times 4.8^2}{12} = 1450 \text{ lb/in}$$

$$C_{top} = \frac{755 \times 12}{2332} = 728 \text{ lb/in}^2 (C)$$

$$C_{bot} = \frac{755 \times 1.85}{2332} = 5160 \text{ lb/in}^2 (T)$$

$$C_{web} = \frac{755 \times 1.70}{2332} = 9520 \text{ lb/in}^2 (T)$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-82

SHEET NO. 264

AIRCRAFT:

C.105

TORSION BOX

PREPARED BY

DATE

J.B. YOUNG

22-5-56

CHECKED BY

DATE

TOTAL STRESSES IN CAP (A) (ONE)

SUMMARY

$$H-A = -728 + 11,547 - 10,610 + 29,800 + 21,181$$

$$B-B = 5160 - 864 + 704 - 48,400 - 21,600 = 64,910 \text{ lb/in}^2 (C)$$

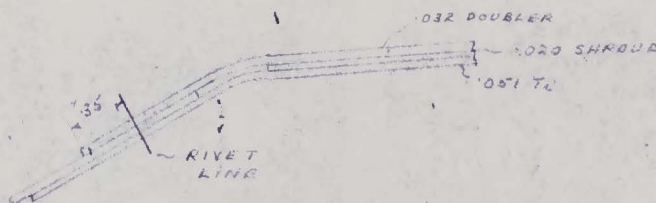
$$C-C = 9520 - 14,725 + 13,070 - 48,400 - 21,600 = 61,635 \text{ lb/in}^2 (C)$$

MAX SHEAR STRESS IS AT C-C = 34,600 lb/in²

$$\sigma_p = \frac{61,635}{2} + \frac{(61,635)^2 + 34,600^2}{2} = 76,871 \text{ lb/in}^2 (C)$$

CHANGE IN SECTION

"032 DOUBLER NOW EXTENDED ROUND CORNER AS SHOWN BELOW.





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CHAPTER IV SECTION PROPERTIES AT CAP @

DUCT TENSION SECTION

ITEM	AREA	y	Ay	Ay ²	I _{xx}	I _{yy}
0-①	.3256		.3470			.60916
②	.0256	2.46	.0630	.1550	.00077	.18077
	.3512		.4100			.78993

$$\bar{y} = \frac{.41}{.3512} = 1.168$$

$$I_{NN} = .78993 - .3512 \times 1.168^2 = .1853 \text{ in}^4$$

$$I_{xx} = \frac{.2852}{.136} = .21 \text{ in}^3$$

ACCA BENDING SECTIONS

ITEM	AREA	y	Ay	Ay ²	I _{xx}	I _{yy}
0-⑤	.1435		.1230			.14379
⑥	.0256	.40	.0102	.0041	.00137	.00547
	.1691		.1332			.14926

$$\bar{y} = \frac{.1332}{.1691} = .789$$

$$I_{NN} = .14926 - .1691 \times .789^2 = .044 \text{ in}^4$$

$$I_{xx} = \frac{.044}{.573} = .076 \text{ in}^3$$

PRESSURE BENDING SECTION

ITEM	AREA	y	Ay	Ay ²	I _{xx}	I _{yy}
0-⑧	.1435		.0435			.01356
⑨	.0256	.36	.0092	.00332	.00007	.00339
	.1691		.0527			.01695

$$\bar{y} = \frac{.0527}{.1691} = .311$$

$$I_{NN} = .01695 - .1691 \times .311^2 = .000595 \text{ in}^4$$

$$I_{xx} = \frac{.000595}{.01} = .0595 \text{ in}^3$$



AVRO AIRCRAFT LIMITED
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C-105

SHROUD ATTACH. TO
TORSION BOX

REPORT NO. 7-0558-82

SHEET NO. 267

PREPARED BY

DATE

G. ISAACS

5-25-56

CHECKED BY

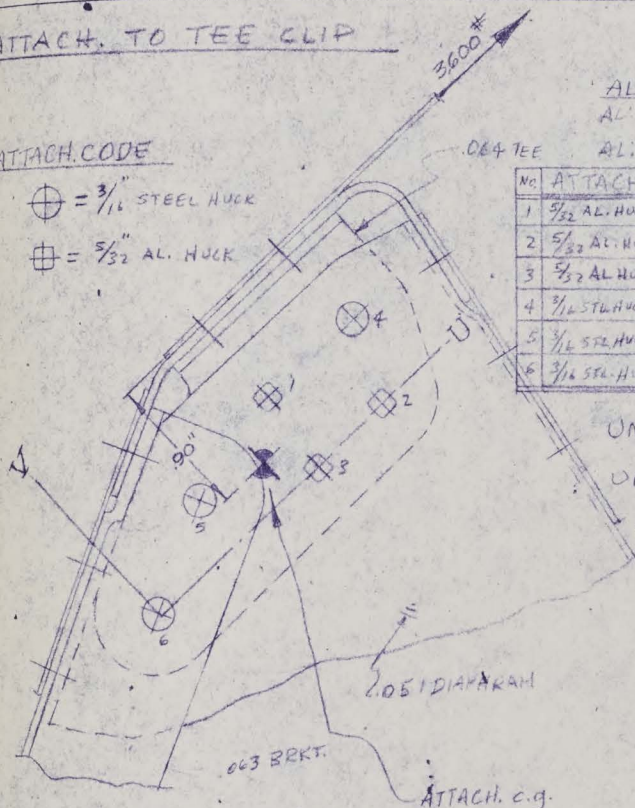
DATE

ATTACH. TO TEE CLIP

ATTACH. CODE

⊕ = 3/16" STEEL HUCK

⊗ = 5/32" AL. HUCK



ALLOW. ATTACH. LOAD

$$AL: P_{d1} = P_{d1} K_{TSP} = P_{d1} (90\%) [P_{95, ANC-5}]$$

$$AL: P_{d1} = P_{d1} (K_{TEMP}) = P_{d1} (82\%) [P_{95, ANC-5}]$$

NO	ATTACH	SHEAR ALLOW	BRC. ALLOW	CRITICAL
1	3/32 AL. HUCK	895#	911#	895#
2	5/32 AL. HUCK	895	911	895
3	5/32 AL. HUCK	895	911	895
4	3/16 STEEL HUCK	2620	1,165	1,165
5	3/16 STEEL HUCK	2620	1,461	1,461
6	3/16 STEEL HUCK	2620	1,461	1,461

$$UNIT ALLOW (1, 2, 3) = \frac{895}{1,461} = .613$$

$$UNIT ALLOW (4) = \frac{1,165}{1,461} = .798$$

$$UNIT ALLOW (5, 6) = \frac{1,461}{1,461} = 1.00$$

ATTACH. NO.	UNIT AREA	V	AV	AV ²	U	A·U	A·U ²
1	.613	.53"	.324	.1720	1.41	.863	1.216
2	.613	0	0	0	1.88	1.152	2.166
3	.613	0	0	0	1.33	.815	1.084
4	.798	.50	.399	.1995	2.12	1.691	3.587
5	1.000	.35	.350	.1226	.67	.670	.449
6	1.000	.03	.030	.0009	0	0	0
Σ	4.637	—	1.103	.4950	—	5.191	8.502

$$\bar{V} = \frac{1.103}{4.637} = .238"; \quad \Sigma(AV) = .4950 - 4.637(.238) = .495 - 1.093 = .2320$$

$$\bar{U} = \frac{5.191}{4.637} = 1.12"; \quad \Sigma(AU) = 8.502 - 5.191(1.12) = 8.502 - 5.814 = 2.688$$

$$MOM. @ ATTACH. C.G. = 3,600(.90) = 3,240" \# \curvearrowright$$



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SHEET NO. 270

AIRCRAFT:

C105

TORSION BOX

PREPARED BY

DATE

G. M. COLLET

9-3-56

CHECKED BY

DATE

FRAME AT 610.85 & 615.65

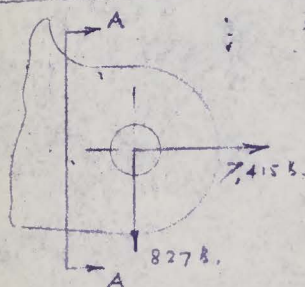
LUGS FOR GEAR BOX BEAM ATTACHMENT

THE TENSION AND SHEAR BEARING STRENGTHS FOR THESE LUGS WERE FOUND IN CALCS FOR LUGS ON GEAR BOX BEAM BRACKETS IN RPT 7-0558/13

RF FOR PIN BENDING = 1.0

" " SHEAR BEARING OF TORSION BOX LUGS = 1.0.

STRESSES AT ROOT OF LUGS



SECTION A-A

$$\text{DIRECT STRESS} = \frac{7415}{.288 \times .98} = 26,300 \text{ lb/in}^2$$

BENDING STRESS

$$BM = .45 \times 827 = 372 \text{ lb-in}$$

$$Z = \frac{.288 \times .98^2}{6} = .0461 \text{ in}^3$$

$$f_{30.0} = \frac{372}{.0461} = 8070 \text{ lb/in}^2$$

$$\text{TOTAL STRESS} = 34,370 \text{ lb/in}^2$$

$$F_{tu} @ 250^\circ F \text{ 50485 } 75 \text{ 576 } = 77,000 \times .77 = 59,300 \text{ lb/in}^2$$

3
24
288

52,300
338
58,800



AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C105

TORSON BOX

REPORT NO. 7-0558-82

SHEET NO. 272

PREPARED BY

DATE

G. M. COLLEY

MAY 56

CHECKED BY

DATE

RIVETS ALONG TOP AND BOTTOM LEGS

$$\begin{aligned} \text{APPLIED MOMENT} &= 7415 \times 2.56 + 1,660 \times 1.0 + 240 \times 1.63 \\ &= 19,000 + 1,660 + 384 \\ &= 21,214 \text{ LBS.} \end{aligned}$$

DIST. BETWEEN CENTRALS = 3.18"

$$\text{LOAD ALONG EACH RIVET LINE} = \frac{21,214}{3.18} = 6,680 \text{ LBS.}$$

TOP LEG

STRENGTH OF 8 - 5/16 INCH 75S-76 ALCLAD

$$\begin{aligned} \left\{ \begin{array}{l} \text{SHEAR} - 8 \times 996 = 7968 \\ \text{BEARING} - 8 \times .161 \times .064 \times 127,000 \times .86 = 9710 \text{ LBS.} \end{array} \right\} R.F. = \frac{7968}{6,680} = 1.19 \end{aligned}$$

BOTTOM LEG

STRENGTH OF 5 - 3/16 AN. RIVETS IN .064 75S-76 ALCLAD

$$\left\{ \begin{array}{l} \text{SHEAR} - 5 \times 861 \times 1.0 \times .94 = 4050 \\ \text{BEARING} - 5 \times 1220 \times 1.37 \times .064 = 7180 \text{ LBS.} \end{array} \right\} \text{STRENGTH} = 4050 \text{ LBS.}$$

STRENGTH OF 2 - 3/16 70-BOLTS IN .064 75S-76 ALCLAD

$$\left\{ \begin{array}{l} \text{SHEAR} - 2 \times 2620 = 5240 \\ \text{BEARING} - 2 \times 199 \times .064 \times 127,000 \times .86 = 3000 \text{ LBS.} \end{array} \right\} \text{STRENGTH} = 3000 \text{ LBS.}$$

$$\text{TOTAL STRENGTH} = 4050 + 3000 = 7050 \text{ LBS.}$$

$$R.F. = \frac{7050}{6,680} = 1.050$$

* FROM THE OVERALL LOADING OF THE DIAGRAM IT CAN BE SEEN THAT THE SHEAR FROM THE CLIP ON THE OTHER SIDE OF THE DIAGRAM RELIEVES THE BEARING IN THE DIAGRAM AND IS NEGLECTED.



AVRO AIRCRAFT LIMITED
MALTON ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT,

REPORT NO. 7-0538-82

SHEET NO. 276

PREPARED BY

DATE

S. YOUNG

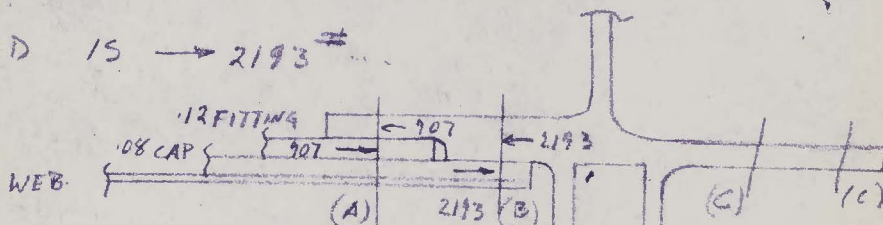
APRIL 5/56

CHECKED BY

DATE

5/32 JO BOLT LOAD FROM BATHTUB
FITTING IS 907# 00 3/16 JO BOLT
1350#

LOAD IS 2193#



NOTE: TEMP REDUCTION NEED NOT
THE 3000# LOAD IS BASED

BE TAKEN SINCE
ON R.T. STRESSES.

(A) 5/32 JO BOLT STEEL
SHEAR = 1800

$$\text{BRG } .12 = 125000 \times .162 \times .12 = 2420$$

$$\text{RF} = \frac{1800}{907 + 1350}$$

1.10

(B) 3/16 JO BOLT STEEL

$$\text{SHEAR} = 2620\#$$

$$\text{BRG } .08 = 125000 \times .199 \times .08 = 1990\#$$

$$\text{RF} = \frac{1990}{2193}$$

.90

00 AVERAGE R.F.'S $\frac{1.10 + .90}{2}$

1.0

(C) 3/16 JO BOLT STEEL
LOAD = 3000/2 = 1500#
ALLOW = 1990#

$$\text{RF} = \frac{1990}{1500}$$

1.32



AVRO AIRCRAFT LIMITED
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TECHNICAL DEPARTMENT

AIRCRAFT

C105

Torsion Box

REPORT No. 7-0558-32

SHEET No. 27B

PREPARED BY

DATE

S. YOUNG

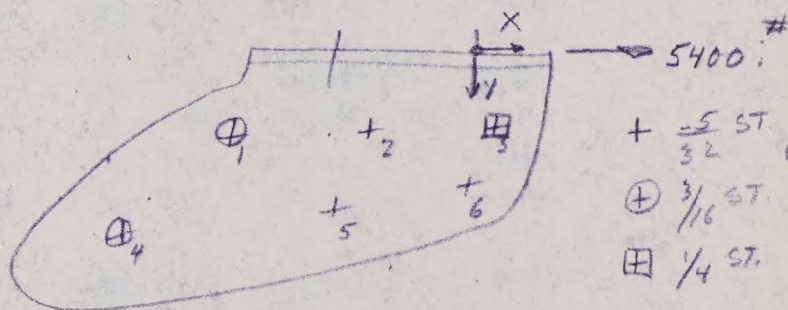
MAY 24/53

CHECKED BY

DATE

TORQUE BOX CLEAT

STA 603 & 610



ALLOWABLES

5/32 ST. JO = 1800 SHEAR

$$BRG \ 064 = 141000 \times .162 \times .064 \times .82 \text{ TEMP} = \underline{1200}$$

3/16 ST. JO = 2620 SHEAR

$$BRG \ 064 = 141000 \times .197 \times .064 \times .82 = \underline{1460}$$

$$BRG \ 064 \text{ WEB} + .063 (2006) \text{ EXTRUSION} = .121''$$

BRG 125 EXTRUDED CLIP LEG

$$BRG \approx 133000 \times .197 \times .121 \times .82 = \underline{2600}$$

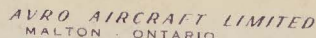
1/4 ST. JO = SHEAR

$$BRG \ 064 = 141000 \times .258 \times .064 \times .82 = \underline{1910}$$

$$BRG \ \text{AREA} \ 5/32 = .064 \times .162 = .01038 \text{ sq. in.}$$

$$3/16 = .064 \times .197 = .0126 \quad \& \ 197 \times .121 = .0238$$

$$1/4 = .064 \times .258 = .0165$$



REPORT NO. 7-0558-82

SHEET NO. 281

AIRCRAFT:

Torsion Box

PREPARED BY

DATE _____

C105

A. FERENC

Sept/56

CHECKED BY

DATE _____

DESIGN STRESSING OF TORSION BOX DIAPHRAGM STA 603.20
CASE 6

INTERNAL PRESSURE, $P_i = 24.85$ psia
SIDE PRESSURE, $P_s = -1.68$ psia
BOTTOM PRESSURE, $P_b = 11.36$ psia
 $g = 8.43$

} ULT
REF 7-0558-12/2
SHT 2a

Normal Diaphragm Pitch = 4"8

In this region shroud & one bay pitch is cut away for gear box, therefore the input of the shroud hoop tension into the diaphragm will be $\frac{1}{2} \times$ pitch width.

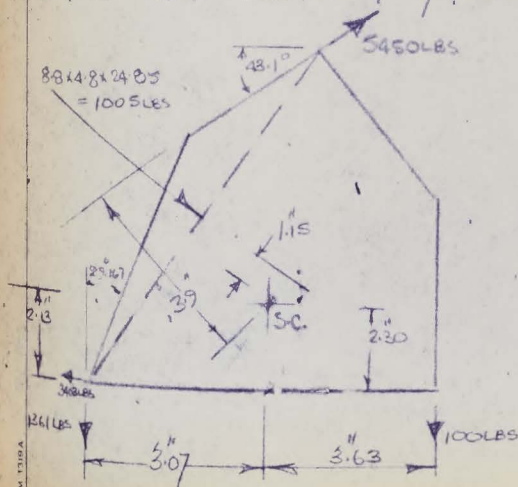
SHROUD HOOP TENSION LOAD

$R = 30.4$ REF 7-0558-12/2 SHT 74 (a)

$$\text{Hoop Tens Load} = 30.4 \times 1.5 \times 4.8 \times 24.95 = 5450 \text{ lbs}$$

THE EFFECTS OF g AND P_0 ARE NEGIGIBLE AND WILL BE OMITTED

THE REMAINDER OF LOADS ARE AS SHOWN ON SHT
74c OF REPORT 7-0558-12/2.



REF GEO. ON SHT 6A
7-0558-12/e



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C106

TORSION BOX

REPORT NO. 7-0558-B2

SHEET NO. 282

PREPARED BY

A. FERENC

CHECKED BY

DATE

SEP/56

DATE

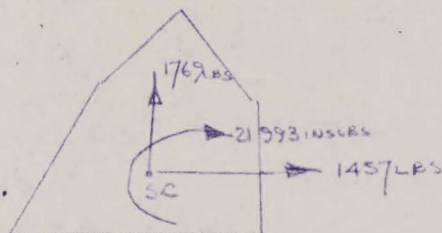
DESIGN STRESSING OF DIAPHRAGM STA 603.20

LOADS AT SHEAR CENTER (SC)

$$\begin{aligned}\text{VERT LOAD} &= 5450 \sin 43.1^\circ - 1005 \sin 29.167^\circ - 1361 - 100 \\ &= 3720 - 490 - 1361 - 100 = 1769 \text{ LBS}\end{aligned}$$

$$\begin{aligned}\text{SIDE LOAD} &= 5450 \cos 43.1^\circ + 1005 \cos 29.167^\circ - 3403 \\ &= 3580 + 880 - 3403 = 1457 \text{ LBS}\end{aligned}$$

$$\begin{aligned}\text{MOMENT} &= 5450 \times 3.19 + 1005 \times 1.15 + 3403 \times 2.13 + 100 \times 3.63 \\ &\quad - 1361 \times 3.07 \\ &= 17400 + 1135 + 7250 + 363 - 4175 = 21993 \text{ INSLBS}\end{aligned}$$





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A. FERENC

DATE

SEP 56

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DESIGN STRESSING OF DIAPHRAGM STA 603.20
LOADS AT S.C. AND REACTIONS (CONT'D)

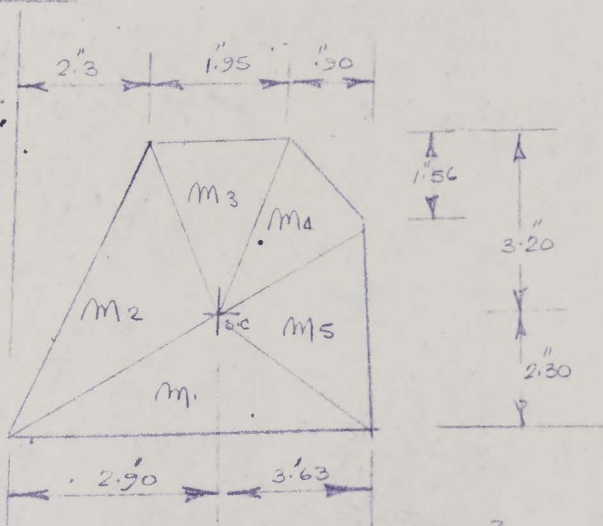
$$-97.2 + 72 R_4 + R_4 + 1240 \times \cos 68^\circ = 1457$$

$$1.72 R_4 = 1457 + 97.2 - 467 = 1087.2$$

$$R_4 = \frac{1087.2}{1.72} = 632 \text{ LBS}$$

$$R_1 = 455 - 97.2 = 357.8 \text{ LBS}$$

BATHO SHEAR



$$\begin{aligned} m_1 &= 2 \times 6.53 \times 2.30 &= 30.1 \text{ INS}^2 \\ m_2 &= 2.90 \times 5.50 - 2.30 \times 2.30 &= 10.65 \text{ INS}^2 \\ m_3 &= 1.95 \times 3.30 \times 2 &= 12.45 \text{ INS}^2 \\ m_4 &= 3.63 \times 3.20 - 2.73 \times 1.64 &= 7.12 \text{ INS}^2 \\ m_5 &= 3.63 \times 2 \times 3.94 &= 28.7 \text{ INS}^2 \end{aligned}$$

$$\Sigma M = 2 A = 89.02 \text{ INS}^4$$

$$q = \frac{21993}{89.02} = 246 \text{ LBS/INS}$$



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C 105

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DATE

A. FORENC

5/21/56

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DATE

DESIGN STRESSING OF DIAPHRAGM STACO 3.20

TOTAL LOAD IN ANGLE 7-1058-1003/5 & 7-1058-1004/6

$$= 357.8 + 246 \times 1.95 = 837.8 \text{ LBS}$$

CHECK ATTACHMENTS ANGLE TO WEB

3 AN 470 AD 4'S AN 1 3/16 HUCK LOCKBOLT

ALLOWABLE S.S AD 4'S ASSUMING 20% REDUCTION AT TEMP

$$= 2 \times .80 \times 383 = 930 \text{ LBS}$$

ALLOWABLE S.S HUCK LOCKBOLT = 2620 LBS

BEARING STRENGTH AD 4'S IN .05175 S-T6 AT 265°F

$$= 3 \times .84 \times 1.37 \times 655 = 2260 \text{ LBS}$$

ALLOWABLE BEARING HUCK LOCKBOLT = $\frac{974 \times 34 \times 1.37}{\text{IN .051}} = 1120 \text{ LBS}$

MIN CAPACITY = $930 + 1120 = 2050 \text{ LBS}$

$$RF \text{ JOINT} = \frac{2050}{837.8}$$

CHECK ATTACHMENTS ALONG TO P PANEL GEAR

Box CUTOUT - 5 1/3 AN 470 AD 4'S

CAPACITY (SS) = $\frac{5}{3} \times 930 = 1550 \text{ LBS}$

$$RF = \frac{1550}{837.8}$$

1.855

SNAP-LOCK BINDER, 1½ inch capacity

NO. 4872-W

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

