

QCX
Avro
CF105
R-7-0558
62 ~~APR 1972~~
C.2



TECHNICAL REPORT

FILE IN VAULT

NRC - ICIST
J.H. PARKIN
BRANCH

JUN 5 1995

ANNEXE
J.H. PARKIN
NRC - ICIST



A V ROE CANADA LIMITED
MALTOB - ONTARIO

ANALYZED

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT:

C105

Classification cancelled / Changed to

RECLASSIFIED 558-62

FILE NO

CONFIDENTIAL

By authority of

AVRS

Date

30 Sept 56

NO. OF SHEETS

104

Signature

AVRS

TITLE:

Unit / Rank / Appointment

AVRS

LATERAL STIFFNESS
OF
FUSELAGE FORMERS
AND
ADJACENT WING STRUCTURE
STN. 644.43, 697.28, 742.50,
538.77, 485.00

NRC - CISTI
J. H. PARKIN
BRANCH

MAY 11 1995

ANNEXE
J. H. PARKIN
CNRC - ICIST

PREPARED BY

D. Shuman

DATE

25/1/56

CHECKED BY

DATE

SUPERVISED BY

L. B. Pittfield
H. G. G. G.

DATE

Feb 56.

APPROVED BY

DATE

ISSUE NO	REVISION NO	REVISED BY	APPROVED BY	DATE	REMARKS
1					

15865828

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT:

C 105

STN. 644.43
697.28 742.50
538.77

REPORT NO. 7-0558-62

SHEET NO. 0-1

PREPARED BY

DATE

[Signature]

30 | 1 | 56

CHECKED BY

DATE

Index

CONFIDENTIAL

Section 1 Stn. 644.43

" 2 Stn. 538.77

" 3 M.I. calculations

" 4 Stn. 697.28, 742.50

" 5 Stn. 485.00

AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-62

SHEET NO. 0-2

AIRCRAFT:

C 105

PREPARED BY

D. Shaw

DATE

26/1/56

CHECKED BY

DATE

Summary

Stn.	Stiffness
644.43	3,711 lb/in.
697.28	4,000 " *
742.50	2,600 " †
538.77	13,500 "
591.65	4,943 " Ref. Rep. 7-0558-47 p. 2-47

* Revised to 4,943 lb/in (Ref. p. 4-4)

† This is maximum value

Minimum is 132 lb/in (Ref. p. 4-3)

485.00 113,000 lb/in.

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT:

C 105

REPORT NO. 7-0558-62

SHEET NO. 0-3

PREPARED BY

D. Shone

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The arrangement of Former, V brace, and Adjacent Wing structure at Stn. 644'43 and 538'77 is similar to that at Stn. 591'65. In addition to the direct connexion of Former and Wing Structure at B.L. 57, a V brace at A/c Φ connects the Former to the Wing Structure. This V brace provides most of the resistance to lateral load.

The analysis which follows is divided into

three parts:

- i Wing Structure
- ii V brace
- iii Former

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-62

SHEET NO. 1-1

AIRCRAFT:

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Wing Structure Stn. 644.43

Assumptions

The Rear Spar is assumed to be parallel to the Centre Rear Spar

The two spars are assumed to be of same overall depth = 8.0 in.

The wing anhedral (4°) is neglected

Values Assumed

Centre Rear Spar

$$I = 400 \text{ in}^4$$

$$t = 0.1 \text{ in}$$

Rear Spar

$$I = 160 \text{ in}^4 \quad \text{Ref p. 3-6 of this Report.}$$

$$t = 0.1 \text{ in}$$

Rib No 1 (@ B.L. 8.0)

$$I = 100 \text{ in}^4$$

$$t = 0.1 \text{ in}$$

Rib No 4 (@ B.L. 57.1)

$$t = 0.15 \text{ in}$$

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT:

C 105

REPORT NO.

7-0558-62

SHEET NO.

1-2a

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Spar Depth (d) + Moment of Inertia (I)

(B.L. 57.14 to A/C Φ)

Spar	d in.	d ²	Ratio	I _{in.}	Ratio	I _{in.}
Main	15	225	2.78	1110	1.56	936
Centre Fwd.	12	144	1.78	712	1.0	600
Centre Rear	9	81	1.0	400	0.56	336
Rear	6	36	0.44	176	0.25	150

Average Values for I: (in Round Figures)

Spar	I _{in.}
Main	1000
Centre Fwd.	600
Centre Rear	400
Rear	160

Ratios of I:

$$\begin{aligned} \text{Main/Centre Fwd.} &= 1000/600 = 1.67 \\ \text{Centre Fwd./Centre Rear} &= 600/400 = 1.5 \\ \text{Centre Rear/Rear} &= 400/160 = 2.5 \end{aligned}$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-62
SHEET NO. 1-3

AIRCRAFT:

C 105

STA 644.43

PREPARED BY

DATE

J. Shone

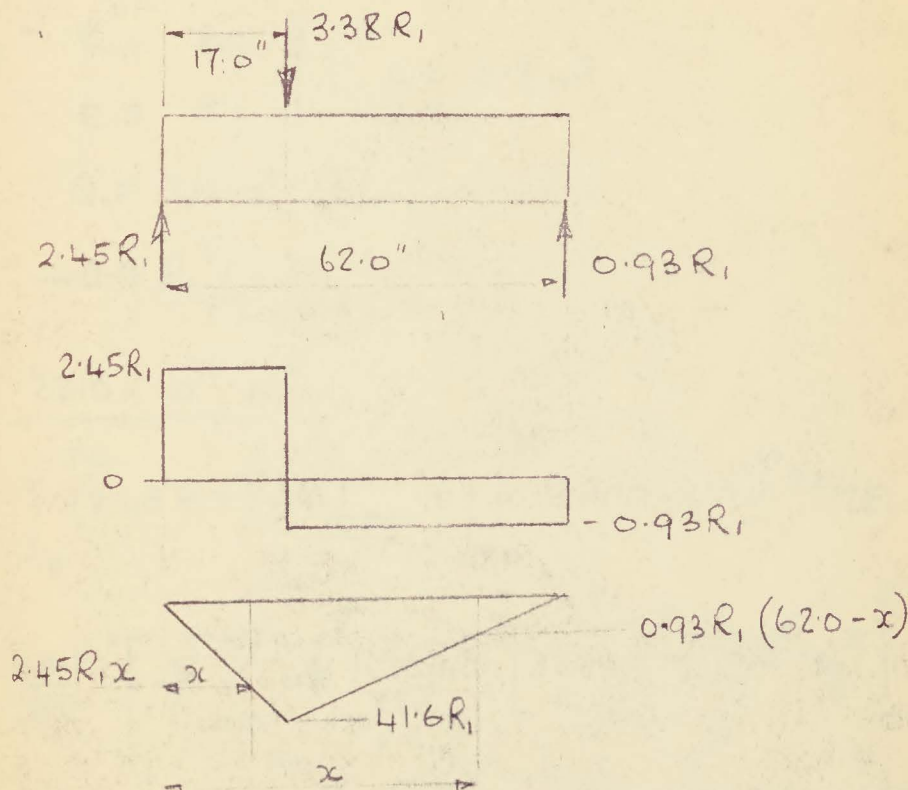
5/1/56

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DATE

VERT:

Rit @ B.L. 8.0 :



$$U_s = \int_0^{17.0} (2.45 R_1)^2 dx / 2AG + \int_{17.0}^{62.0} (-0.93 R_1)^2 dx / 2AG$$

$$= \frac{6.0 R_1^2}{2AG} [x]_0^{17.0} + \frac{0.865 R_1^2}{2AG} [x]_{17.0}^{62.0}$$

$$= \frac{R_1^2}{2AG} \left\{ 6.0 \times 17.0 + 0.865 \times 45.0 \right\} = \frac{140.9 R_1^2}{2AG}$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-62

SHEET NO. 1-4

AIRCRAFT:

C 105

STA 644.43

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VERT:

Rib @ B.L. 8.0 Cont'd.

$$\left. \begin{array}{l} \text{web } h = 8.0 \\ t = 0.1 \end{array} \right\} \therefore A = 0.8 \text{ in}^2$$

$$G = 4 \times 10^6 \text{ lb/in}^2$$

$$U_s = 140.9 R_1^2 / 2 \times 0.8 \times 4 \times 10^6$$

$$U_s = 22.0 \times 10^{-6} R_1^2$$

$$U_B = \int_0^{17.0} (2.45 R_1 x)^2 dx / 2EI + \int_{17.0}^{62.0} \{0.93 R_1 (62.0 - x)\}^2 dx / 2EI$$

$$= \frac{6.0 R_1^2}{2EI} \left[\frac{x^3}{3} \right]_0^{17.0} + \frac{0.865 R_1^2}{2EI} \left[3844 x - \frac{124 x^2}{2} + \frac{x^3}{3} \right]_{17.0}^{62.0}$$

$$= \frac{R_1^2}{2EI} \left\{ 6.0 \times \frac{4950}{3} + 0.865 \left(3844 \times 45.0 - 62 \times 3550 + \frac{235000}{3} \right) \right\}$$

$$= \frac{R_1^2}{2EI} \left\{ 9900 + 0.865 (173,000 - 220,000 + 78,300) \right\}$$

$$= \frac{R_1^2}{2EI} \left\{ 9900 + 0.865 \times 31,300 \right\}$$

$$= \frac{R_1^2}{2EI} \times 36,900$$

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT:

C 105

STA 644.43

REPORT NO.

7-0558-62

SHEET NO.

1-10

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VERT

Rear Spar cont'd.

$$U_B = \int_0^{52.9} (0.13 R_1 x)^2 dx / 2EI + \int_{52.9}^{61.5} \{0.8 R_1 (61.5 - x)\}^2 dx / 2EI$$

$$= \frac{0.0169 R_1^2}{2EI} \left[\frac{x^3}{3} \right]_0^{52.9} + \frac{0.64 R_1^2}{2EI} \left[3780x - \frac{123}{2}x^2 + \frac{x^3}{3} \right]_{52.9}^{61.5}$$

$$= \frac{R_1^2}{2EI} \left\{ 0.0169 \times \frac{149,000}{3} + 0.64 \times 300 \right\}$$

$$= \frac{R_1^2}{2EI} \{ 840 + 192 \}$$

$$= 516 R_1^2 / EI$$

$$I = 160 \text{ in}^4$$

$$E = 10.5 \times 10^6 \text{ lb/in}^2$$

$$U_B = 516 R_1^2 / 10.5 \times 10^6 \times 160$$

$$U_B = 0.308 \times 10^{-6} R_1^2$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-62

SHEET NO. 1-12

AIRCRAFT:

C105

STN. 644'43

PREPARED BY

DATE

CHECKED BY

DATE

VERT

Centre Rear Spar cont'd.

$$U_s = \int_0^{52.9} (0.34 R_1)^2 dx / 2AG + \int_{52.9}^{61.5} (2.11 R_1)^2 dx / 2AG$$

$$= \frac{0.116 R_1^2}{2AG} [x]_0^{52.9} + \frac{4.46 R_1^2}{2AG} [x]_{52.9}^{61.5}$$

$$= \frac{R_1^2}{2AG} \left\{ 0.116 \times 52.9 + 4.46 \times 8.6 \right\}$$

$$= \frac{R_1^2}{2AG} \left\{ 6.13 + 38.4 \right\}$$

$$= 44.53 R_1^2 / 2AG$$

$$\left. \begin{array}{l} \text{web. } t = 0.1 \\ h = 8.0 \end{array} \right\} \therefore A = 0.8 \text{ in}^2$$

$$G = 4 \times 10^6 \text{ lb/in}^2$$

$$U_s = 44.53 R_1^2 / 2 \times 0.8 \times 4 \times 10^6$$

$$U_s = 6.96 \times 10^{-6} R_1^2$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-62
SHEET NO. 1-13

AIRCRAFT:

C105

STN 64443

PREPARED BY

DATE

CHECKED BY

DATE

VERT

Centre Rear Spar cont'd.

$$U_B = \int_0^{52.9} \frac{(0.34 R_1 x)^2 dx}{2EI} + \int_{52.9}^{61.5} \frac{\{2.11 R_1 (61.5 - x)\}^2 dx}{2EI}$$

$$= \frac{0.116 R_1^2}{2EI} \left[\frac{x^3}{3} \right]_0^{52.9} + \frac{4.46 R_1^2}{2EI} \left[3780x - \frac{123}{2}x^2 + \frac{x^3}{3} \right]_{52.9}^{61.5}$$

$$= \frac{R_1^2}{2EI} \left\{ 0.116 \times \frac{149,000}{3} + 4.46 \left(32,500 - 61.5 \times 990 + \frac{86,000}{3} \right) \right\}$$

$$= \frac{R_1^2}{2EI} \left\{ 5760 + 4.46 \times 300 \right\}$$

$$= \frac{R_1^2}{2EI} \left\{ 5760 + 1338 \right\}$$

$$= 3549 R_1^2 / EI$$

$$I = 400 \text{ in}^4$$

$$E = 10.5 \times 10^6 \text{ lb/in}^2$$

$$U_B = 3549 R_1^2 / 10.5 \times 10^6 \times 400$$

$$U_B = 0.845 \times 10^{-6} R_1^2$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-62

SHEET NO. 1-16

AIRCRAFT:

C 105

STN. 644.43

PREPARED BY

D. Shuman

DATE

9/1/56

CHECKED BY

DATE

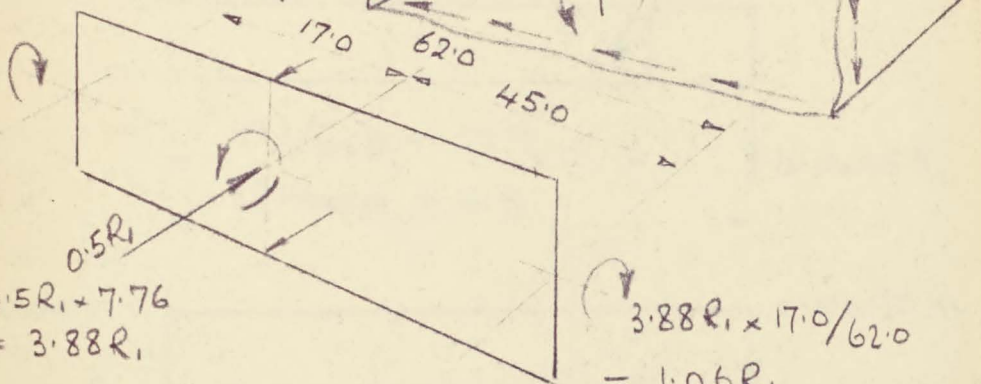
HORIZ

Rib @ B.L. 8.0

$$T = 3.88 R_1 \times 0.4 = 1.55 R_1$$

$$q = 1.55 R_1 / 2 \times 62.0 \times 8.0 = 0.00156 R_1$$

$$3.88 R_1 \times 45.0 / 62.0 = 2.82 R_1$$



$$0.5 R_1 \times 7.76 = 3.88 R_1$$

$$3.88 R_1 \times 17.0 / 62.0 = 1.06 R_1$$

$$\theta = 21.9^\circ \quad \tan \theta = 0.4$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-62

SHEET NO. 1-17

AIRCRAFT:

C 105

STN. 644.43

PREPARED BY

DATE

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DATE

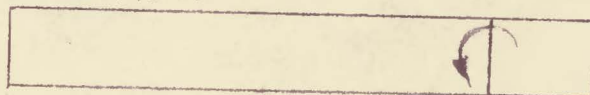
HORIZ

Centre Rear Spar

$$\theta = 21.9^\circ \quad \cos \theta = 0.93$$

$$\begin{aligned} & \uparrow 3.04 R_1 / 61.5 \\ & = 0.0495 R_1 \end{aligned}$$

$$2.82 R_1 / \cos \theta = 3.04 R_1$$



$$49.1 / \cos \theta = 52.9$$

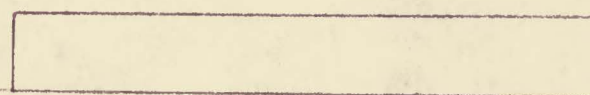
$$57.1 / \cos \theta = 61.5$$

$$\downarrow 0.0495 R_1$$

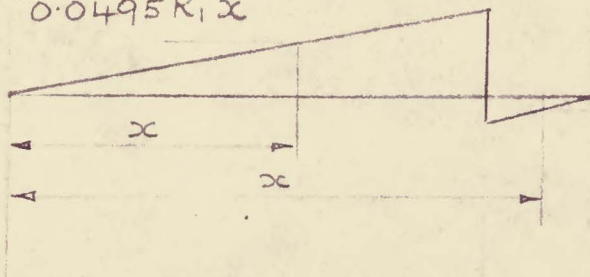
$$0.0495 R_1$$

$$0.0495 R_1$$

0



$$0.0495 R_1 x$$



$$0.0495 R_1 (61.5 - x)$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-62

SHEET NO. 1-22

AIRCRAFT:

C 105

STN. 644.43

PREPARED BY

DATE

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9/1/56

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DATE

HORIZ

Rear Spar

$$\begin{aligned}
 U_B &= \int_0^{52.9} \frac{(0.0185 R_1 x)^2 dx}{2EI} + \int_{52.9}^{61.5} \frac{\{0.0185 R_1 (61.5 - x)\}^2 dx}{2EI} \\
 &= \frac{0.000342 R_1^2}{2EI} \left[\frac{x^3}{3} \right]_0^{52.9} + \frac{0.000342 R_1^2}{2EI} \left[3780x - \frac{123}{2}x^2 + \frac{x^3}{3} \right]_{52.9}^{61.5} \\
 &= \frac{0.000342 R_1^2}{2EI} \left\{ \frac{149,000}{3} + 32,500 - 60,900 + 28,700 \right\} \\
 &= \frac{0.000342 R_1^2}{2EI} \times 50,000
 \end{aligned}$$

$$U_B = 8.55 R_1^2 / EI$$

$$I = 160 \text{ in}^4$$

$$E = 10.5 \times 10^6 \text{ lb/in}^2$$

$$U_B = 8.55 R_1^2 / (10.5 \times 10^6 \times 160)$$

$$U_B = 0.0051 \times 10^{-6} R_1^2$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-0558-62
1-25

SHEET No.

AIRCRAFT:

C 105

STN. 644-43

PREPARED BY

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HORIZ

Top Skin

$$U_s = \int_0^{49.1} \frac{(0.001155 R_1)^2 h}{2tG} dx + \int_{49.1}^{57.1} \frac{(0.00272 R_1)^2 h}{2tG} dx$$

$$= \frac{1.33 \times 10^{-6} R_1^2 h}{2tG} [x]_0^{49.1} + \frac{7.4 \times 10^{-6} R_1^2 h}{2tG} [x]_{49.1}^{57.1}$$

$$= \frac{1.33 \times 10^{-6} R_1^2 h \times 49.1}{2tG} + \frac{7.4 \times 10^{-6} R_1^2 h \times 8.0}{2tG}$$

$$= \frac{62.3 \times 10^{-6} R_1^2 h}{tG}$$

$$h = 62.0 \text{ in}$$

$$t = 0.15 \text{ in}$$

$$G = 4 \times 10^6 \text{ lb/in}^2$$

$$U_s = \frac{62.3 \times 10^{-6} \times 62.0}{0.15 \times 4 \times 10^6} R_1^2$$

$$U_s = 0.00644 \times 10^{-6} R_1^2$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-0558-62

SHEET No. 1-27

AIRCRAFT:

C 105

STN. 644.43

PREPARED BY

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VERT

Item	U_s	U_b
Rib @ B.L. 8.0	$22.0 \times 10^6 R_1^2$	$17.55 \times 10^6 R_1^2$
" " " 57.1	$0.0272 \times 10^6 R_1^2$	
Centre Rear Spar	$6.96 \times 10^6 R_1^2$	$0.845 \times 10^6 R_1^2$
Rear "	$1.0 \times 10^6 R_1^2$	$0.308 \times 10^6 R_1^2$
Top Skin	$0.194 \times 10^6 R_1^2$	
Bottom "	$0.208 \times 10^6 R_1^2$	

HORIZ.

Rib @ B.L. 8.0		
" " " 57.1	$0.00055 \times 10^6 R_1^2$	
Centre Rear Spar	$0.0236 \times 10^6 R_1^2$	$0.0146 \times 10^6 R_1^2$
Rear "	$0.00328 \times 10^6 R_1^2$	$0.0051 \times 10^6 R_1^2$
Top Skin	$0.00644 \times 10^6 R_1^2$	
Bottom "	$0.0069 \times 10^6 R_1^2$	

$\Sigma \quad 30.43 \times 10^6 R_1^2 \quad 18.72 \times 10^6 R_1^2$

$U_s + U_b \quad 49.15 \times 10^6 R_1^2 \quad \text{FOR HALF STRUCTURE}$

$98.3 \times 10^6 R_1^2 \quad \text{" WHOLE "}$

$\frac{du}{dR_1} = 0.0001966 R_1$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO 7-0558-62
SHEET NO 1-28

AIRCRAFT:

PREPARED BY

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V Brace and Former, Stn 644.43

These are assumed to be identical to those
@ Stn. 591.65.

Accordingly the equation used Stn. 591.65
is used for Stn. 644.43.

Ref Rep. 7-0558-47 p 2-47

$$0.00179 Q_1 + 0.001904 R_1 = \frac{\partial U}{\partial R_1} = 0$$

Spar Effect (Ref. p 1-27 of this report)

$$\frac{dU}{dR_1} = 0.0001966 R_1$$

$$\therefore 0.00179 Q_1 + 0.0021 R_1 = 0$$

$$R_1 = -0.00179/0.0021 Q_1$$

$$R_1 = -0.853 Q_1$$

$$R_3 = \frac{Q_1 - 0.853 Q_1}{2}$$

$$= 0.0735 Q_1$$

$$\delta_3 = 0.00538 Q_1 - 0.00538 \times 0.853 Q_1 - 0.0735 \times 0.00717 Q_1$$

$$= 0.00538 Q_1 - 0.00458 Q_1 - 0.000527 Q_1$$

$$= 0.00027 Q_1$$

$$Q_1/8 = 3711 \text{ lb./in.}$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-62

SHEET NO. 2-1

AIRCRAFT.

PREPARED BY

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J. Shone

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DATE

Wing Structure Str 538.77

Assumptions

The Main Spar is assumed to be parallel to the Centre Fwd. Spar

The two spars are assumed to be of same over-all depth = 14.0 in.

The wing anhedral (4°) is neglected

Special Considerations:

The V Brace is connected at the top by means of truss members to two ribs (1 and 2).

The elastic strain energies of bending and shear are calculated for these ribs but are neglected for the connecting truss members

TECHNICAL DEPARTMENT (Aircraft)

REPORT No.

7-0558-62

SHEET No.

2-2

AIRCRAFT:

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Wing Structure Str 538.77

Values Assumed

Main Spar

$$I = 1000 \text{ in}^4$$

$$t = 0.1 \text{ in}$$

Centre Fwd Spar

$$I = 600 \text{ in}^4$$

$$t = 0.1 \text{ in}$$

Rib No 1

$$I = 332 \text{ in}^4$$

$$t = 0.1 \text{ in}$$

Rib No 2

$$I = 170 \text{ in}^4$$

$$t = 0.051 \text{ in}$$

} see pp. 3-1 to 3-5 of this report
for calculation of these values.

Rib No 4

$$t = 0.15 \text{ in}$$

Top Skin

$$t = 0.15 \text{ in}$$

Bottom Skin

$$t = 0.14 \text{ in}$$



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TECHNICAL DEPARTMENT

REPORT NO. 7-0558-62

SHEET NO. 2-4

AIRCRAFT:

C 105

STN. 538.77

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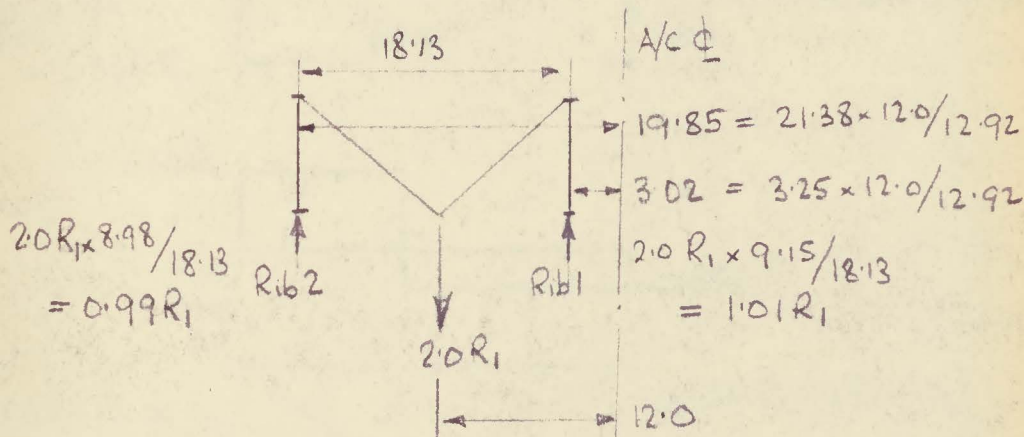
DATE

VERT.

Rib 1 (~ @ B.L. 3.02)

Ref DWG 7-4362-2

Rib 2 (~ @ B.L. 19.85)





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MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-62
SHEET NO. 2-5

AIRCRAFT:

C105

STN. 538.77

PREPARED BY

DATE

J. Hume

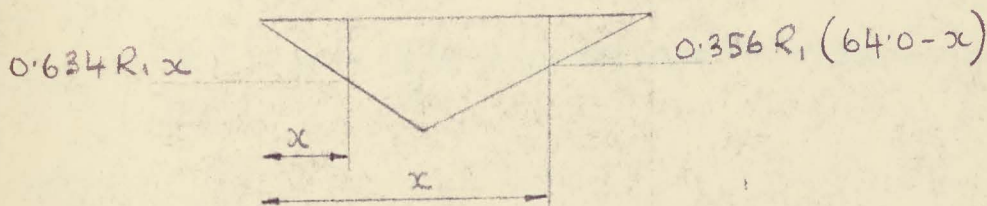
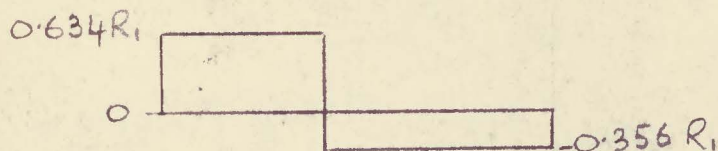
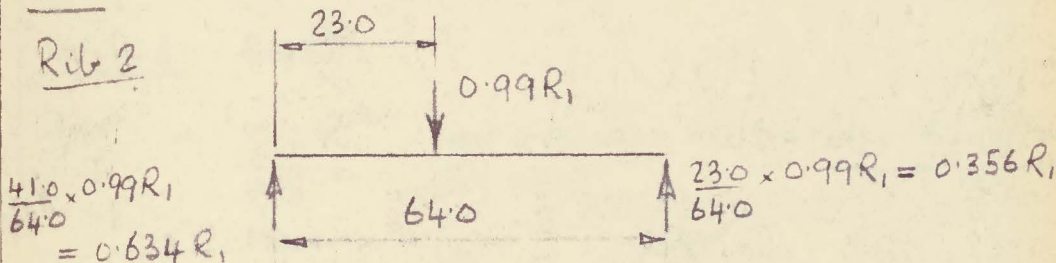
12/1/56

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VERT.

Rib 2



$$U_s = \int_0^{23.0} (0.634 R_1)^2 dx / 2AG + \int_{23.0}^{64.0} (-0.356 R_1)^2 dx / 2AG$$

$$= \frac{0.401 R_1^2}{2AG} [x]_0^{23.0} + \frac{0.127 R_1^2}{2AG} [x]_{23.0}^{64.0}$$

$$= \frac{R_1^2}{2AG} \left\{ 0.401 \times 23.0 + 0.127 \times 41.0 \right\}$$



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MALTON, ONTARIO

TECHNICAL DEPARTMENT

REPORT NO. 7-0558-62

SHEET NO. 2-8

AIRCRAFT:

C 105

STN. 538.77

PREPARED BY

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VERT

Rib 1 cont'd.

$$U_s = \frac{8.15}{1.4 \times 4 \times 10^6} R_1^2$$

$$U_s = 1.46 \times 10^{-6} R_1^2$$

$$U_B = 2 \int_0^{32.0} \frac{(0.505 R_1 x)^2 dx}{2EI}$$

$$= \frac{2 \times 0.255 R_1^2}{2EI} \left[\frac{x^3}{3} \right]_0^{32.0}$$

$$= \frac{2 \times 0.255 R_1^2 \times 32,800}{2EI}$$

$$U_B = \frac{8,370 R_1^2}{EI}$$

$$I = 332 \text{ in}^4$$

$$E = 10.5 \times 10^6 \text{ lb/in}^2$$

$$U_B = \frac{8,370 R_1^2}{10.5 \times 10^6 \times 332}$$

$$U_B = 2.4 \times 10^{-6} R_1^2$$



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MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT No. 7-0558-62

SHEET No. 2-9

AIRCRAFT:

C 105

STN. 538.77

PREPARED BY

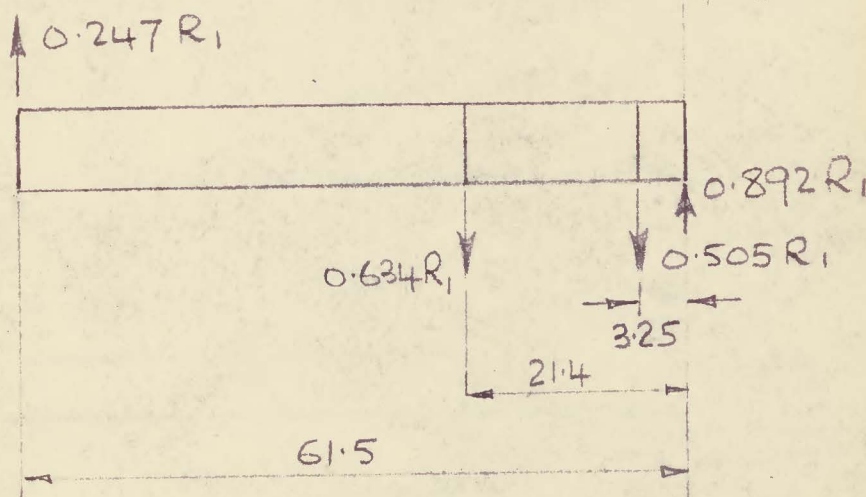
DATE

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VERT

Main Spar



$$(0.634 R_1 \times 21.4 + 0.505 R_1 \times 3.25) / 61.5$$

$$= (13.55 R_1 + 1.64 R_1) / 61.5$$

$$= 15.19 R_1 / 61.5 = 0.247 R_1$$

$$0.634 R_1 + 0.505 R_1 - 0.247 R_1 = 0.892 R_1$$



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TECHNICAL DEPARTMENT

REPORT NO.

7-0558-62

SHEET NO.

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Main Spar cont'd.

$$U_s = \int_0^{40.1} \frac{(0.247 R_1)^2 dx}{2AG} + \int_{40.1}^{58.25} \frac{(-0.387 R_1)^2 dx}{2AG} \\ + \int_{58.25}^{61.5} \frac{(-0.892 R_1)^2 dx}{2AG}$$

$$= \frac{0.061 R_1^2}{2AG} [x]_0^{40.1} + \frac{0.15 R_1^2}{2AG} [x]_{40.1}^{58.25}$$

$$+ \frac{0.795 R_1^2}{2AG} [x]_{58.25}^{61.5}$$

$$= \frac{R_1^2}{2AG} \left\{ 0.061 \times 40.1 + 0.15 \times 18.15 + 0.795 \times 3.25 \right\}$$

$$= \frac{R_1^2}{2AG} \left\{ 2.45 + 2.72 + 2.48 \right\}$$

$$U_s = \frac{3.83 R_1^2}{AG}$$

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TECHNICAL DEPARTMENT

REPORT NO. 7-0558-62

SHEET NO. 2-13

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VERTMain Spar cont'd.

$$U_B = \frac{0.061 R_1^2 \times (40.1)^3}{2EI}$$

$$+ \frac{R_1^2}{2EI} \left\{ 645 \times 18.15 - \frac{19.65 \times 18.15 \times 98.35}{2} \right. \\ \left. + \frac{0.15 \times 18.15 (58.25^2 + 40.1^2 + 58.25 \times 40.1)}{3} \right\}$$

$$+ \frac{0.795 R_1^2}{2EI} \left\{ 3780 \times 3.25 - 61.5 \times 3.25 \times 119.75 \right. \\ \left. + \frac{1}{3} \times 3.25 (61.5^2 + 58.25^2 + 61.5 \times 58.25) \right\}$$

$$U_B = \frac{R_1^2}{2EI} \left\{ 1311 + 18.15 (645 - 966 + 367) \right. \\ \left. + 0.795 \times 3.25 (3780 - 7365 + 3586) \right\}$$

$$= \frac{R_1^2}{2EI} \{ 1311 + 835 + 3 \} = \frac{R_1^2}{2EI} \times 2149$$

$$U_B = \frac{1075 R_1^2}{EI}$$

$$I = 1000 \text{ in}^4 \quad E = 10.5 \times 10^6 \text{ lb/in}^2$$

$$U_B = 1075 R_1^2 / 1000 \times 10.5 \times 10^6$$

$$U_B = 0.1023 \times 10^{-6} R_1^2$$



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AIRCRAFT:

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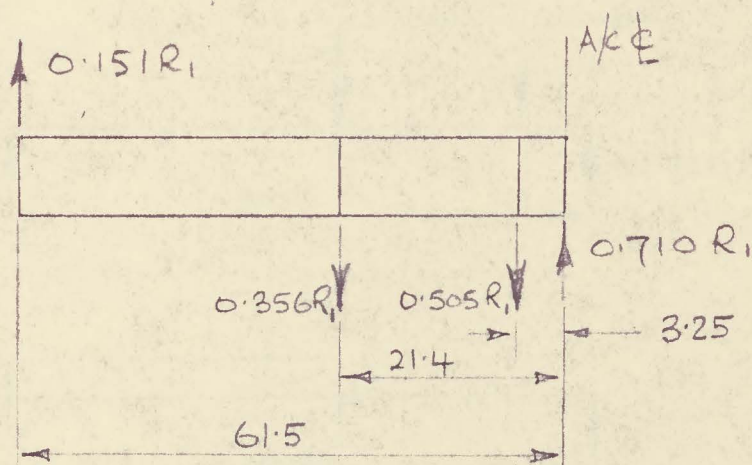
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VERT
Centre Fwd Spar



$$\begin{aligned} & (0.356 R_1 \times 21.4 + 0.505 R_1 \times 3.25) / 61.5 \\ & = (7.62 R_1 + 1.64 R_1) / 61.5 \\ & = 9.26 R_1 / 61.5 = 0.151 R_1 \end{aligned}$$

$$(0.356 + 0.505) R_1 - 0.151 R_1 = 0.710 R_1$$



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REPORT No. 7-0558-62
SHEET No. 2-15

AIRCRAFT:

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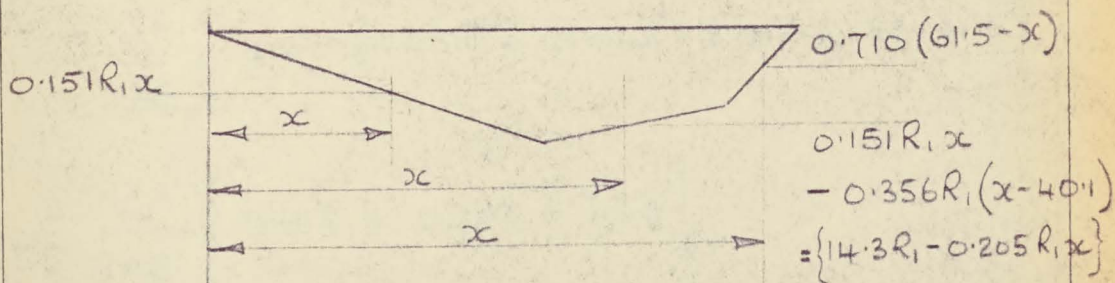
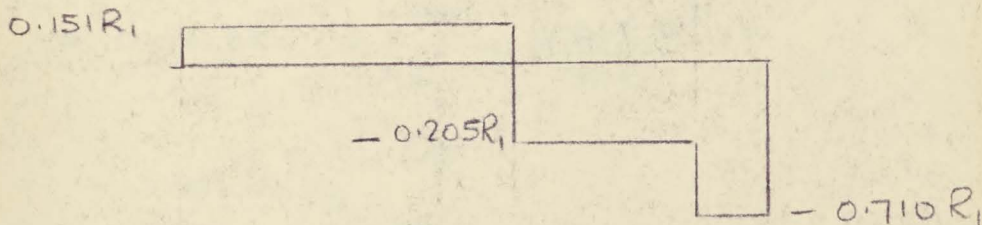
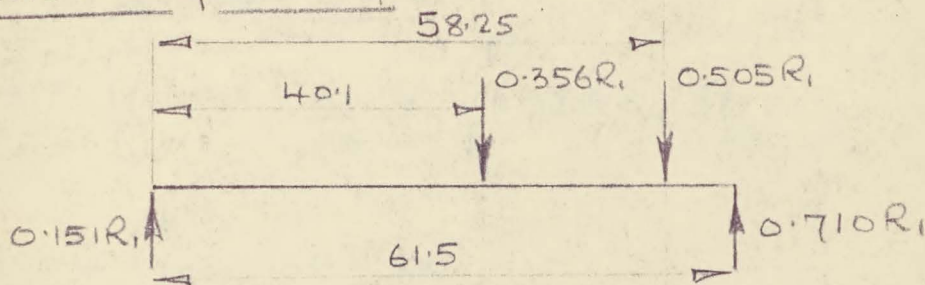
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VERT

Centre Fwd Spar cont'd.





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TECHNICAL DEPARTMENT

REPORT NO. 7-0558-62

SHEET NO. 2-17

AIRCRAFT:

C 105

STN 53877

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VERT

Centre Fwd. Spar cont'd.

$$A = 0.1 \times 14.0 = 1.4 \text{ m}^2$$

$$G = 4 \times 10^6 \text{ lb/in}^2$$

$$U_s = 1.65 R_1^2 / 1.4 \times 4 \times 10^6$$

$$U_s = 0.295 \times 10^{-6} R_1^2$$

$$U_B = \int_0^{40.1} \frac{(0.151 R_1 x)^2 dx}{2EI} + \int_{40.1}^{58.25} \frac{(14.3 R_1 - 0.205 R_1 x)^2 dx}{2EI}$$

$$+ \int_{58.25}^{61.5} \frac{\{0.710 R_1 (61.5 - x)\}^2 dx}{2EI}$$

$$= \frac{0.0228 R_1^2}{2EI} \left[\frac{x^3}{3} \right]_0^{40.1}$$

$$+ \frac{R_1^2}{2EI} \left[205x - 5.86 \frac{x^2}{2} + 0.042 \frac{x^3}{3} \right]_{40.1}^{58.25}$$

$$+ \frac{0.502 R_1^2}{2EI} \left[3780x - 123 \frac{x^2}{2} + \frac{x^3}{3} \right]_{58.25}^{61.5}$$



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TECHNICAL DEPARTMENT

REPORT NO. 7-0558-62

SHEET NO. 2-18

AIRCRAFT:

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STN 538.77

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DATE

VERT

Centre Fwd Spar cont'd.

$$U_B = \frac{0.0228 R_1^2}{2EI} \times \frac{(40.1)^3}{3}$$

$$+ \frac{R_1^2}{2EI} \left\{ 204 \times 18.15 - \frac{5.86 \times 18.15 \times 98.35}{2} \right. \\ \left. + \frac{0.042 \times 18.15 (58.25^2 + 40.1^2 + 58.25 \times 40.1)}{3} \right\}$$

$$+ \frac{0.502 R_1^2}{2EI} \left\{ 3780 \times 3.25 - 61.5 \times 3.25 \times 119.75 \right. \\ \left. + \frac{1}{3} \times 3.25 (61.5^2 + 58.25^2 + 61.5 \times 58.25) \right\}$$

$$U_B = \frac{R_1^2}{2EI} \left\{ 490 + 18.15 (204 - 288 + 103) \right. \\ \left. + 0.502 \times 3.25 (3780 - 7365 + 3586) \right\}$$

$$= \frac{R_1^2}{2EI} \{ 490 + 345 + 2 \} = \frac{R_1^2}{2EI} \times 837$$

$$U_B = \frac{419 R_1^2}{EI} \quad I = 600 \text{ in}^4 \quad E = 10.5 \times 10^6 \text{ lb/in}^2$$

$$U_B = 419 R_1^2 / 600 \times 10.5 \times 10^6$$

$$U_B = 0.0666 \times 10^{-6} R_1^2$$



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO.

7-0558-62

SHEET NO.

2-20

AIRCRAFT:

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STN. 538.77

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VERT

Rib @ B.L. 57.1 cont'd.

$$\left. \begin{array}{l} \text{web } t = 0.15 \text{ in} \\ h = 14.0 \text{ in} \end{array} \right\} \therefore A = 2.1 \text{ in}^2$$

$$G = 4 \times 10^6 \text{ lb/in}^2$$

$$U_s = 0.182 R_1^2 / 2.1 \times 4 \times 10^6$$

$$\underline{U_s = 0.0217 \times 10^6 R_1^2}$$



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REPORT NO. 7-0558-62
SHEET NO. 2-21

AIRCRAFT:

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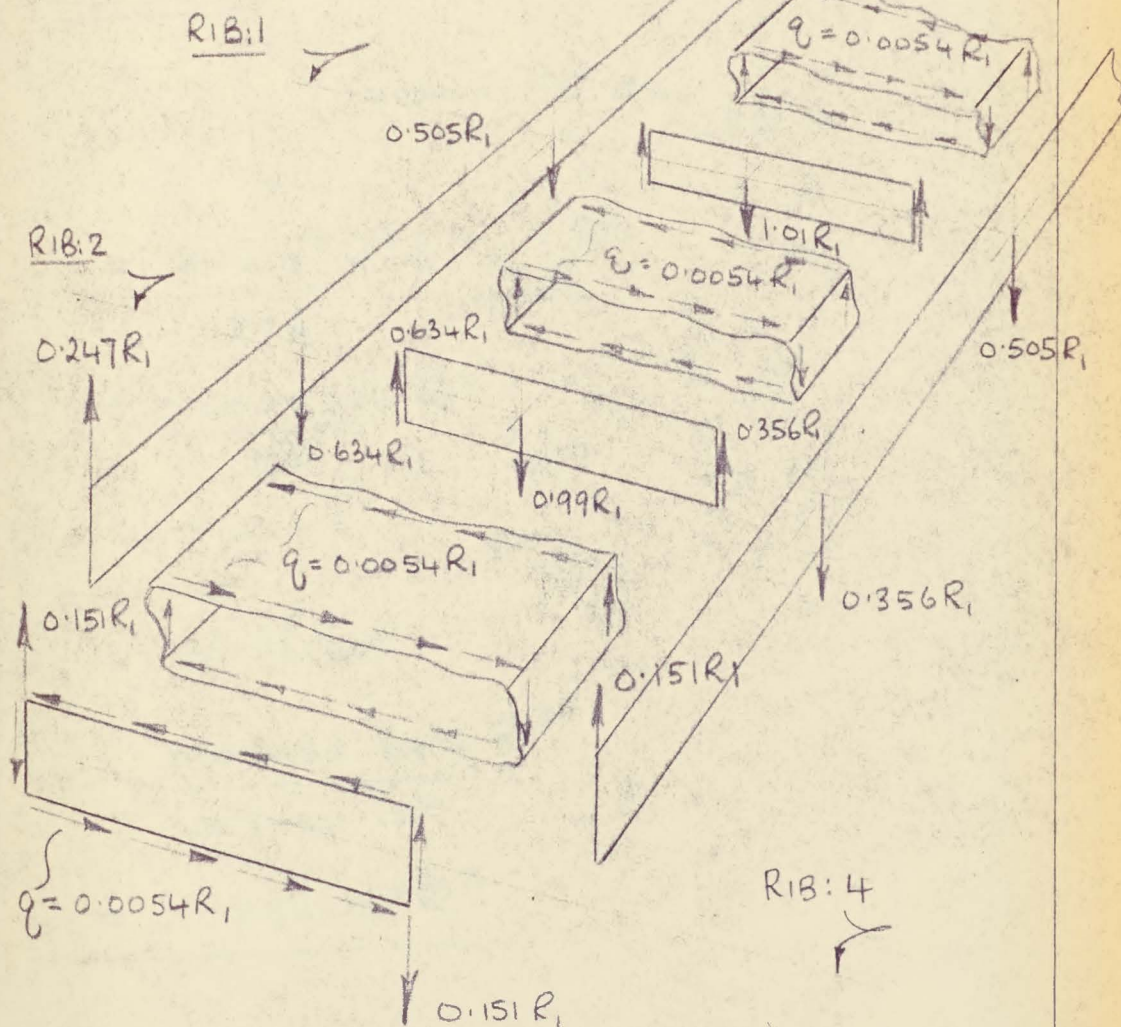
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VERT



AVRO AIRCRAFT LIMITED
MALTON ONTARIO

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REPORT NO. 7-0558-62
SHEET NO. 2-23

AIRCRAFT:

C 105

STN. 538.77

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VERTBottom Skin:

$$U_s = \frac{0.00083 h R_1^2}{t G}$$

$$h = 64.0 \text{ in}$$

$$t = 0.14 \text{ in}$$

$$G = 4 \times 10^6 \text{ lb/in}^2$$

$$U_s = \frac{0.00083 \times 64.0}{0.14 \times 4 \times 10^6} R_1^2$$

$$\underline{U_s = 0.095 \times 10^{-6} R_1^2}$$



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TECHNICAL DEPARTMENT

REPORT NO. 7-0558-62

SHEET NO. 2-24

AIRCRAFT:

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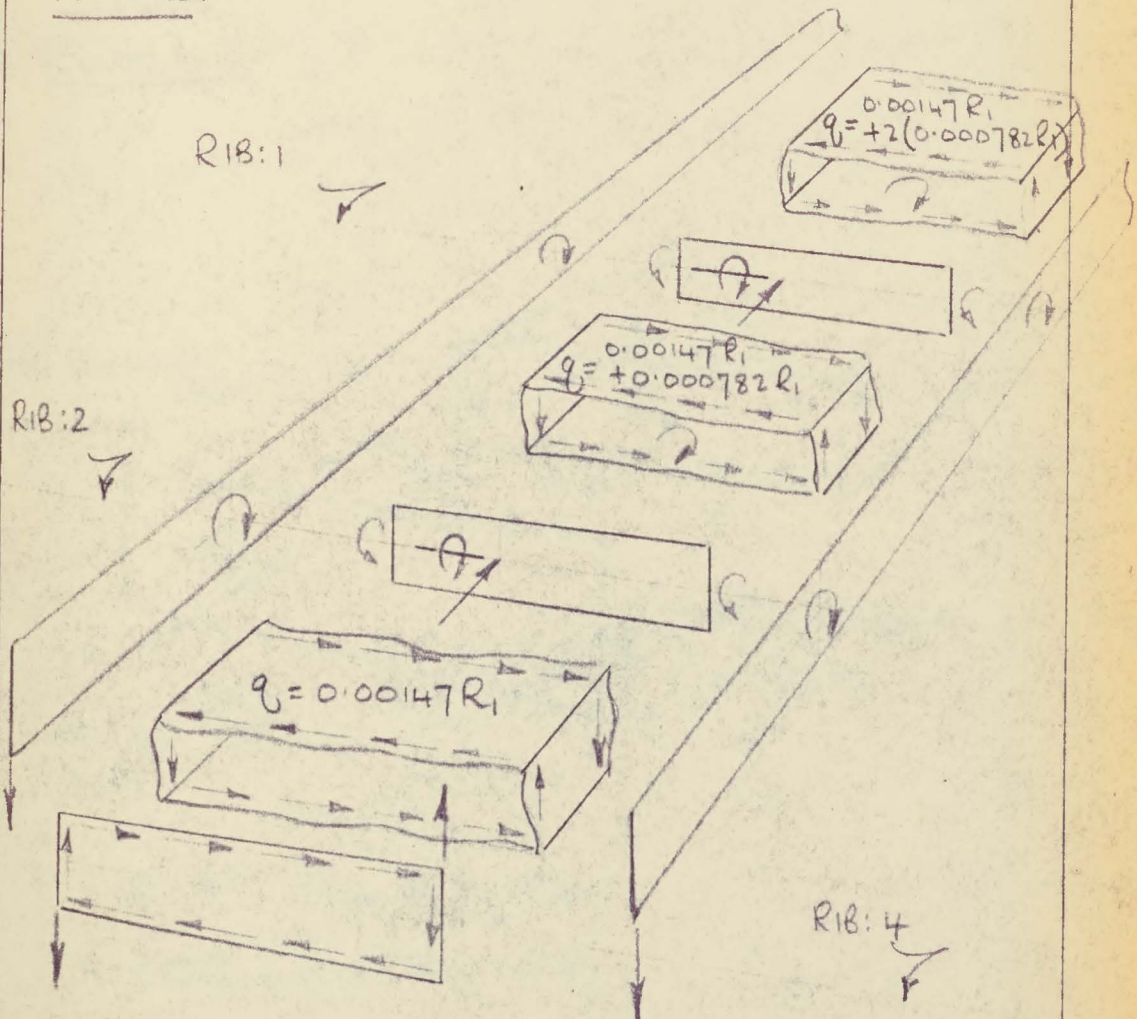
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HORIZ.





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TECHNICAL DEPARTMENT

REPORT NO.

7-0558-62

SHEET NO.

2-25

AIRCRAFT:

C105

STN 538.77

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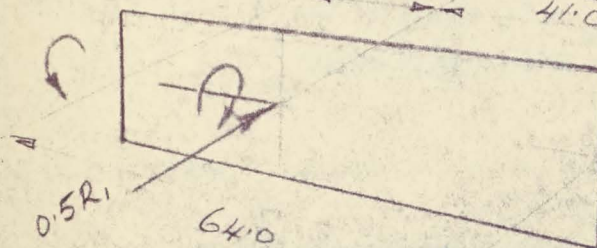
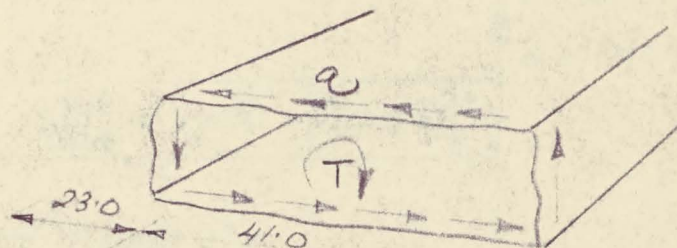
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HORIZ

Ribs 1, 2

$$3.5R_1 \times 41.0 / 64.0$$

$$= 2.24R_1$$



$$0.5R_1 \times 7.0$$

$$= 3.5R_1$$

$$3.5R_1 \times 23.0 / 64.0$$

$$= 1.26R_1$$

$$\theta = 21.9^\circ \quad \tan \theta = 0.4$$

$$T = 3.5R_1 \times 0.4 = 1.4R_1$$

$$q = 1.4R_1 / (2 \times 64.0 \times 14.0) = 0.000782R_1$$



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TECHNICAL DEPARTMENT

REPORT NO. 7-0558-62

SHEET NO. 2-26

AIRCRAFT:

C105

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HORIZ

Main Spar

$$\theta = 21.9^\circ \quad \cos \theta = 0.93$$

$$61.5 / \cos \theta = 66.2$$

$$\begin{aligned} & 2 \times 2.41 R_1 / 66.2 \\ & = 0.0728 R_1 \end{aligned}$$

$$\frac{2.24 R_1}{\cos \theta} = 2.41 R_1 \quad \left(\rightarrow 2.41 R_1 \right)$$

$$0.0728 R_1$$

$$40.1 / \cos \theta = 43.1$$

$$58.25 / \cos \theta = 62.6$$

$$-0.0728 R_1$$

$$-3.14 R_1$$

$$-0.73 R_1$$

$$-2.15 R_1$$

$$+0.26 R_1$$



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TECHNICAL DEPARTMENT

REPORT NO. 7-0558-62

SHEET NO. 2-28

AIRCRAFT:

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HORIZ

Main Spar

B.M. $0 < x \leq 43.1$ $M = -0.0728 R_1 x$

$43.1 < x < 62.6$ $M = -0.0728 R_1 x + 2.41 R_1$

$62.6 < x < 66.2$ $M = 0.0728 R_1 (66.2 - x)$

$$U_B = \int_0^{43.1} \frac{(-0.0728 R_1 x)^2 dx}{2EI} + \int_{43.1}^{62.6} \frac{(2.41 R_1 - 0.0728 R_1 x)^2 dx}{2EI}$$

$$+ \int_{62.6}^{66.2} \frac{\{0.0728 R_1 (66.2 - x)\}^2 dx}{2EI}$$

$$= \frac{0.0053 R_1^2}{2EI} \left[\frac{x^3}{3} \right]_0^{43.1}$$

$$+ \frac{R_1^2}{2EI} \left[5.8x - 0.351 \frac{x^2}{2} + 0.0053 \frac{x^3}{3} \right]_{43.1}^{62.6}$$

$$+ \frac{0.0053 R_1^2}{2EI} \left[4380x - 132.4 \frac{x^2}{2} + \frac{x^3}{3} \right]_{62.6}^{66.2}$$



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TECHNICAL DEPARTMENT

AIRCRAFT:

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STN. 538.77

REPORT No. 7-0558-62

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HORIZ

Centre Fwd Spar

$$U_s = \int_0^{64.0} \frac{(-0.0411 R_1)^2 dx}{2AG}$$

$$= \frac{0.00169 R_1^2}{2AG} \left[x \right]_0^{64.0}$$

$$= \frac{0.054 R_1^2}{AG}$$

$$A = 1.4 \text{ in}^2$$

$$G = 4 \times 10^6 \text{ lb/in}^2$$

$$\therefore U_s = 0.054 R_1^2 / (1.4 \times 4 \times 10^6)$$

$$\underline{U_s = 0.00965 \times 10^{-6} R_1^2}$$



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2-32

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HORIZ

Centre Fwd Spar

B.M. $0 < x \leq 43.1$ $M = -0.0411 R_1 x$

$43.1 < x < 62.6$ $M = -0.0411 R_1 x + 1.36 R_1$

$62.6 < x < 66.2$ $M = 0.0411 R_1 (66.2 - x)$

$$U_B = \int_0^{43.1} \left(-0.0411 R_1 x \right)^2 \frac{dx}{2EI} + \int_{43.1}^{62.6} \left(1.36 R_1 - 0.0411 R_1 x \right)^2 \frac{dx}{2EI}$$

$$+ \int_{62.6}^{66.2} \left\{ 0.0411 R_1 (66.2 - x) \right\}^2 \frac{dx}{2EI}$$

$$= \frac{0.00169 R_1^2}{2EI} \left[\frac{x^3}{3} \right]_0^{43.1}$$

$$+ \frac{R_1^2}{2EI} \left[1.85x - 0.112 \frac{x^2}{2} + 0.00169 \frac{x^3}{3} \right]_{43.1}^{62.6}$$

$$+ \frac{0.00169 R_1^2}{2EI} \left[4380x - 132.4 \frac{x^2}{2} + \frac{x^3}{3} \right]_{62.6}^{66.2}$$



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TECHNICAL DEPARTMENT

REPORT NO. 7-0558-62
2-36

SHEET NO.

AIRCRAFT:

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HORIZ

Top Skin

$$h = 64.0 \text{ in.}$$

$$t = 0.15 \text{ in.}$$

$$G = 4 \times 10^6 \text{ lb/in}^2$$

$$U_s = \frac{98.65 \times 10^{-6} \times 64.0}{0.15 \times 4 \times 10^6} R_1^2$$

$$U_s = 0.01052 \times 10^{-6} R_1^2$$

Bottom Skin:

$$h = 64.0 \text{ in.}$$

$$t = 0.14 \text{ in.}$$

$$G = 4 \times 10^6 \text{ lb/in}^2$$

$$U_s = \frac{98.65 \times 10^{-6} \times 64.0}{0.14 \times 4 \times 10^6} R_1^2$$

$$U_s = 0.01128 \times 10^{-6} R_1^2$$

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REPORT NO. 7-0558-62

SHEET NO. 2-37

AIRCRAFT

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VERT.

Item	US	UB
Rib @ BL 3.0	$1.46 \times 10^{-6} R_1^2$	$2.4 \times 10^{-6} R_1^2$
" " "	$2.52 \times 10^{-6} R_1^2$	$3.02 \times 10^{-6} R_1^2$
" " " 57.1	$0.0217 \times 10^{-6} R_1^2$	
Main Spar	$0.685 \times 10^{-6} R_1^2$	$0.1023 \times 10^{-6} R_1^2$
Centre Fwd "	$0.295 \times 10^{-6} R_1^2$	$0.0666 \times 10^{-6} R_1^2$
Top Skin	$0.0886 \times 10^{-6} R_1^2$	
Bottom "	$0.095 \times 10^{-6} R_1^2$	

HORIZ.

Rib		
"		
"	$0.00162 \times 10^{-6} R_1^2$	
Main Spar	$0.0302 \times 10^{-6} R_1^2$	$0.00882 \times 10^{-6} R_1^2$
Centre Fwd	$0.00965 \times 10^{-6} R_1^2$	$0.00421 \times 10^{-6} R_1^2$
Top Skin	$0.0105 \times 10^{-6} R_1^2$	
Bottom "	$0.0113 \times 10^{-6} R_1^2$	



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$$\sum U_s = 5.329 \times 10^{-6} R_1^2$$

$$\sum U_B = 5.602 \times 10^{-6} R_1^2$$

$$\sum = 10.93 \times 10^{-6} R_1^2 \quad \text{FOR HALF STRUCTURE}$$

$$21.86 \times 10^{-6} R_1^2 \quad \text{" WHOLE "}$$



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MALTON, ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

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STN. 538.77

REPORT NO. 7-0558-62

SHEET NO. 2-40

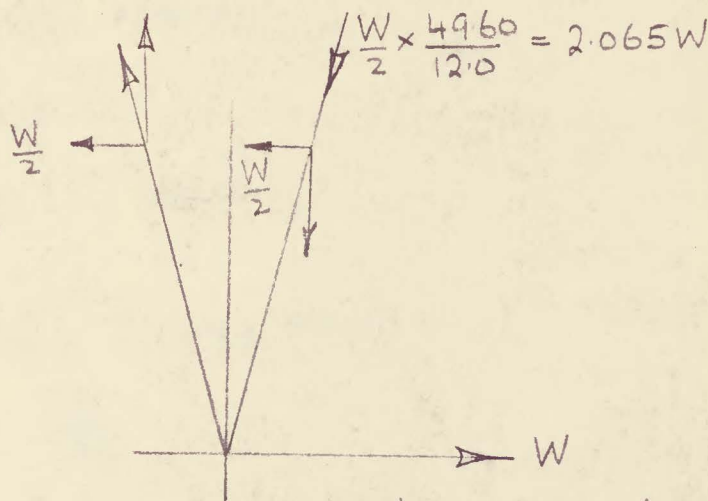
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V BRACE



Deflexion corresponding to $W = \delta = \frac{du}{dW}$

$$\frac{du}{dW} = \frac{du}{dP} \cdot \frac{dP}{dW} = \sum \frac{PL}{AE} \times \frac{dP}{dW}$$

$$P = 2.065W \quad \therefore \frac{dP}{dW} = 2.065$$

$$L = 45.46 \text{ in}$$

$$A = 0.3773 \text{ in}^2$$

$$E = 30 \times 10^6 \text{ lb/in}^2$$

$$\frac{PL}{AE} = \frac{2.065W \times 45.46}{0.3773 \times 30 \times 10^6} = 8.3 \times 10^{-6} W$$

$$\frac{PL}{AE} \times \frac{dP}{dW} = 8.3 \times 10^{-6} W \times 2.065 = 17.15 \times 10^{-6} W$$

$$\sum \frac{PL}{AE} \times \frac{dP}{dW} = 2 \times 17.15 \times 10^{-6} W = 34.30 \times 10^{-6} W$$

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT:

REPORT NO. 7-0558-62

SHEET NO. 2-41

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DATE

V Brace Str. 538.77

$$\delta = 34.3 \times 10^{-6} \text{ W ins}$$

$$\frac{W}{\delta} = 29,200 \text{ lb/in}$$

Elastic Strain Energy stored in V Brace

$$U = \sum \frac{P^2 L}{2AE}$$

$$= \frac{2 (2.065 \text{ W})^2 \times 45.46}{2 \times 0.3773 \times 30 \times 10^6}$$

$$= 17.08 \times 10^{-6} \text{ W}^2$$

∴ Stiffness of Wing Structure and V Brace is obtained by considering energy of both

$$\text{Total Energy} = (17.08 \times 10^{-6} + 21.86 \times 10^{-6}) R_1^2$$

$$U = 38.94 \times 10^{-6} R_1^2$$

$$\delta = \frac{dU}{dR_1} = 77.88 \times 10^{-6} R_1$$

$$\text{stiffness} = \frac{R_1}{\delta} = 12,800 \text{ lb/in.}$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-62
SHEET NO. 2-42

AIRCRAFT:

PREPARED BY

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Former Stn. 538.77

The lateral stiffness of this former is estimated by comparing the maximum M.I. with that of Stn. 742.50, whose lateral stiffness is known.

Rep 7-0558-8 p. 742.5 F15B gives

$$\delta_3 = 0.00758 Q_1 \text{ for Stn. 742.5, } I_{\max} = 4.0 \text{ in}^4$$

$$\therefore \frac{Q_1}{\delta_3} = 132 \text{ lb./in.}$$

Stn. 742.50 has $I_{\max} \approx 20.0 \text{ in}^4$

$$\therefore \frac{Q_1}{\delta_3} \text{ is estimated to be } 660 \text{ lb./in.}$$

$$\begin{aligned} \text{Total Stiffness} &= 12,800 + 660 \\ &\sim 13,500 \text{ lb./in.} \end{aligned}$$

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

REPORT NO. 7-0558-62
SHEET NO. 3-3

AIRCRAFT:

C105

STN 538.77

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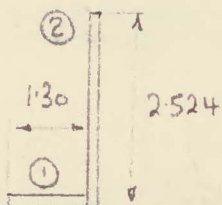
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RIB 2 (Between Main Centre
Fwd Spars)
Bottom Chord: C.S.E. 1291

Ref DW'g. 7-1062-927/928



REF. AXIS

El.	Dim.	Area	y	A _y	A _y ²	I _{oo}
①	0.090 × 1.30 =	0.117	0.045	0.00527	0.000237	—
②	× 2.524 =	0.227	1.262	0.287	0.362	0.1216
		0.344		0.29227	0.362237	0.1216

$$\bar{y} = 0.292 / 0.344 = 0.848 \text{ in}$$

$$I = 0.362 + 0.122 - 0.344 (0.848)^2$$

$$= 0.484 - 0.247 = 0.237 \text{ in}^4$$

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-62

SHEET NO. 3-1

AIRCRAFT:

C105

STN 538.77

PREPARED BY

DATE

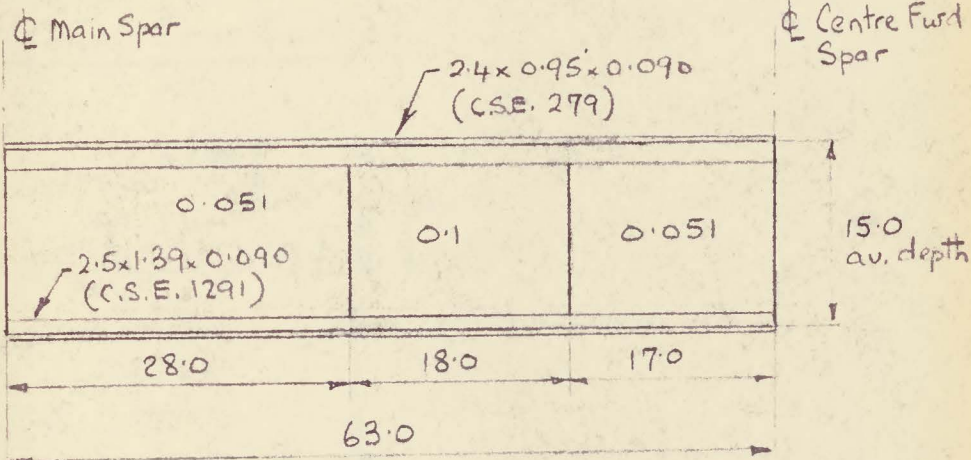
D. Shuman

12/1/56

CHECKED BY

DATE

RIB 2 Between Main + Centre Fwd Spars



Simplified Sketch showing Panel Sizes, Cap Ls,
Web thicknesses: Ref. Dwg. 7-1062-927/928

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-0558-62
SHEET No. 3-6

AIRCRAFT:

PREPARED BY

DATE

J. Shown

30/1/56

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DATE

Estimation of M.I. of Main and Rear
Spars based on comparison of spar depths
with those for Centre Fwd and Centre Rear
Spars.

Spar	d	d ²	Ratio	I	Ratio	I
Main	15	225	2.78	1110	1.56	936
C. Fwd	12	144	1.78	712	1.0	600
C. Rear	9	81	1.0	400	0.56	336
Rear	6	36	0.44	176	0.25	150

Average Values for I (in Round Figures)

Spar	I
Main	1000
C. Fwd	600
C. Rear	400
Rear	160



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

REPORT NO.

7-0558-62

SHEET NO.

4-D

AIRCRAFT:

C105

PREPARED BY

J. Stone

DATE

26/1/56

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DATE

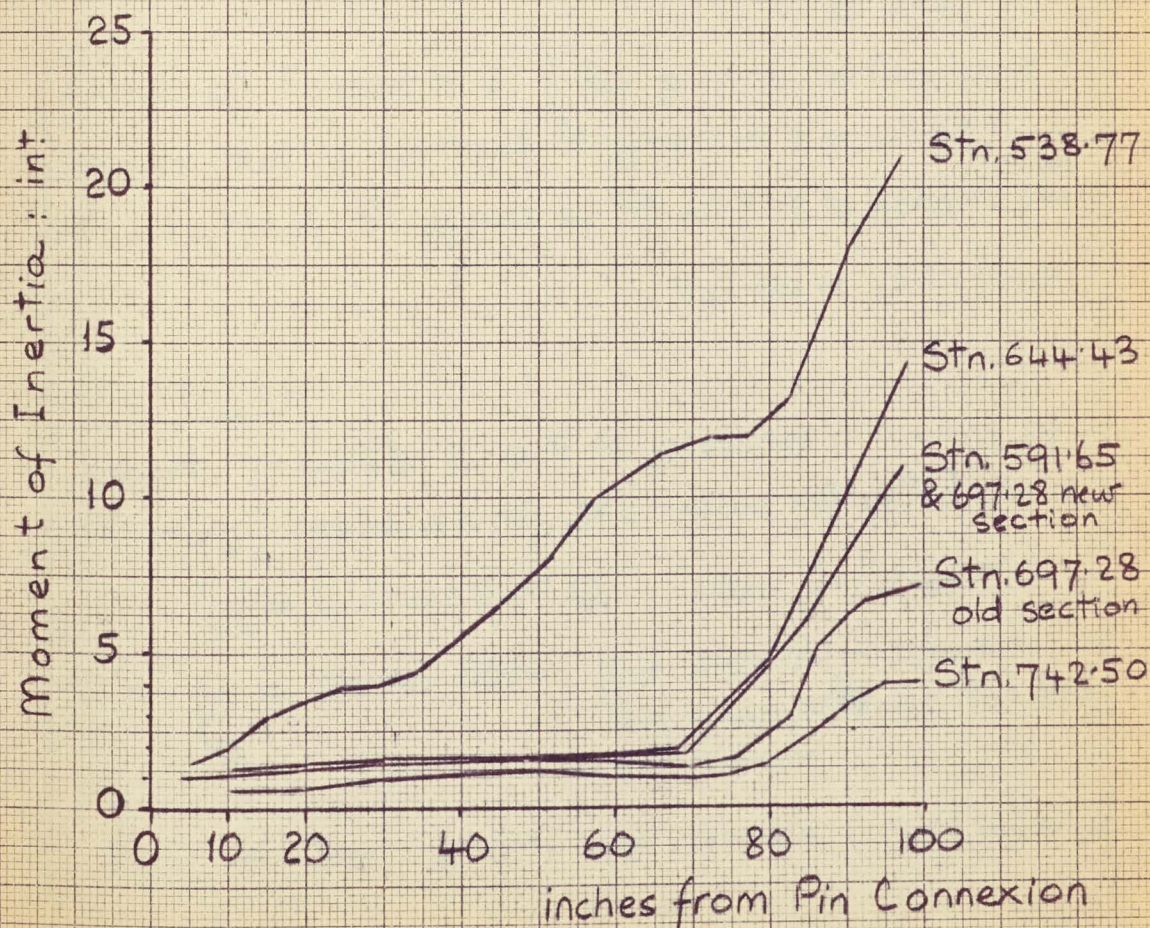
SECTION: 4

Stn. 697.28, 742.50

M.I. of Heavy Formers - Distance from Pin connexion

References: 538.77 7-0556-6 p.2-18
 591.65 7-0558-19 p.A-11
 644.43 " " " p.A-25
 697.28 " " " p.1-12
 742.50 " " " " "

N.B stn. 697.28 has recently (17/2/56) been stiffened so that it approximates stn. 591.65



D. Shum 26/1/56

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT:

C 105

REPORT NO. 7-0558-62

SHEET NO. 4-2

PREPARED BY

DATE

D. Shaw

30 1 56

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DATE

Estimation of Lateral Stiffness of Stn. 697.28
and 742.50 based on comparisons of M.I.
of Formers with That @ Stn. 591.65

Lateral Stiffness of Stn. 591.65

$$= 4943 \text{ lb/in } (\approx 5000 \text{ lb/in}) \text{ Ref Rep. 7-0558-47}$$

p. 2-47

Curve of Former M.I. (Ref p 4-1 of this report)
shows that if Lateral Stiffness of Former M.I.
then Lateral Stiffness of Stn 697.28 $\approx 4000 \text{ lb/in}^*$
" " " " 742.50 $\approx 2500 \text{ lb/in}$

Stn. 742.50

Report 7-0558-8 p. F15 provides a means of
obtaining, independently, the value estimated above.

$$\delta_3 = 0.0003849 Q_1 \text{ when } P_1 = P_2 = Q_2 = 0$$

$$K = \frac{Q_1}{\delta_3} = 2600 \text{ lb/in (c.f. 2500 lb/in above)}$$

This value assumes that there
is a V brace

* See p 4-4 for revised (19/2/56) value



AVRO AIRCRAFT LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C105

FORMER
STN. 742.50

REPORT NO. 7-0558-62

SHEET NO. 4-3

PREPARED BY

DATE

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19/2/56

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DATE

Estimation of Lateral Stiffness of Stn. 742.50:

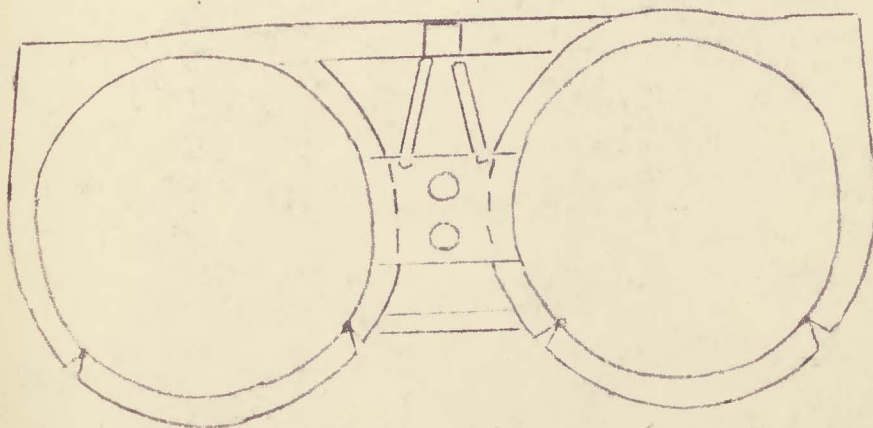
If the V Brace is assumed to be removed

Report 7-0558-8 p F15B gives

$$\delta_3 = 0.00758 Q \text{ for } P_1 = P_2 = 0$$

$$K = Q / \delta_3 = 132 \text{ lb/in.}$$

It is felt that str. 753 will give some lateral stiffness to 742.50, and the true value of K will be between 132 and 2600 lb/in



Sketch of str. 753 (Ref. Rep. 7-0559-20)
p.1.



AVRO AIRCRAFT LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT

AIRCRAFT:

C 105

FORMER
STN 697.28

REPORT NO.

7-0558-62

SHEET NO.

4-4

PREPARED BY

DATE

CHECKED BY

DATE

Estimation of Lateral Stiffness of Stn. 697.28

The value of 4000 lb/in for Stn. 697.28
(Ref p. 4-2 of this report) should be
revised to 4943 lb/in (same value as
Stn. 591.65)

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-62

SHEET NO. 5-0

AIRCRAFT:

C.105

FORMER 456

PREPARED BY

DATE

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28 FEB 56

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DATE

TOTAL ENERGY DERIVATIVES. SUMMARY

$$\text{BENDING } \frac{\partial U}{\partial S} = (6.5 + 4.1 + 1.34 + 9.67) \frac{S}{E}$$

$$= \frac{21.615}{E}$$

$$\text{END LOAD } \frac{\partial U}{\partial S} = \frac{S}{E} (1.99 + 5.44)$$

$$= \frac{7.435}{E}$$

$$\text{SHEAR } \frac{\partial U}{\partial S} = \frac{S}{E} (3.84 + 11.47) = \frac{15.315}{E}$$

$$\Sigma \frac{\partial U}{\partial S} = (15.31 + 7.43 + 21.61) \frac{S}{E} \quad \text{FOR WHOLE FORMER}$$

$$= \frac{88.705}{E}$$

$$\text{LATERAL STIFFNESS} = \frac{S}{\delta_s} = \frac{E}{88.70}$$

$$= \underline{113,000 \text{ LBS/IN.}}$$

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TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-62
SHEET NO. 5-

AIRCRAFT:

C.105.

FORMER 485

PREPARED BY

DATE

C. DITCHFIELD

FEB 27. 56.

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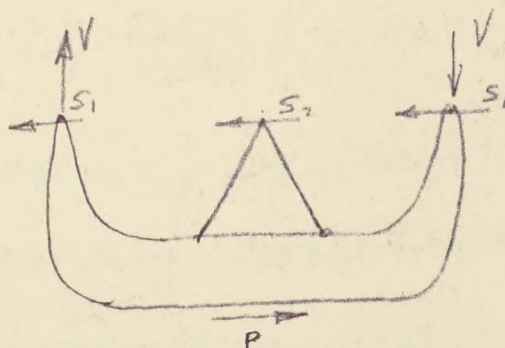
DATE

LATERAL STIFFNESS

THIS IS A QUICK CALCULATION TO GET AN IDEA OF THE STIFFNESS OF 485 UNDER LATERAL SHEAR LOADS FROM THE BOTTOM SKIN. SECTION PROPERTIES ARE TAKEN FROM THE 485 DETAIL STRESS REPORTS 7/0556/30

39
40.

THE CENTRE PORTION OF THE FORMER WILL BE ASSUMED TWO TUBES ^{AT THE TOP} AND A PARALLEL PIECE OF FORMER ACROSS THE CENTRE AT THE BOTTOM (SEE SKETCH).



S2 WILL BE ASSUMED TO ACT ON THE SAME LEVEL AS S1.

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-0558-62

SHEET No. 5-2

AIRCRAFT:

C 105

FORMER 485

PREPARED BY

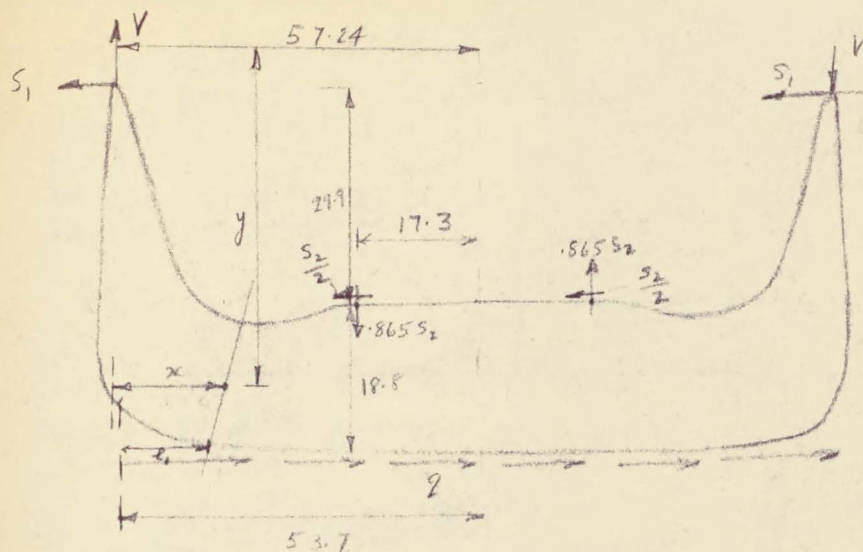
DATE

C DITCHFIELD

27 FEB 56

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DATE



$$q = \frac{S}{107.4} = .00935$$

$$V = \frac{S \times 48.7}{2 \times 57.24} = 0.4265$$

$$M = Vx - S_1 y - l_1 q (48.7 - y) - \frac{S_2}{2} (y - 29.9) - .865 S_2 (x - 39.94)$$

$$= .4265x - S_1 y - .453 S_1 l_1 + .00935 l_1 y + 49.5 S_2 - .5 S_2 y - .865 S_2 x$$

$$= S (.426x - .453 l_1 + .00935 l_1 y) - S_1 y + S_2 (49.5 - .5y - .865x)$$

(A)

(B)

(C)

(D)

(E)

(F)

(G)

PARTS (A) + (D) ONLY APPLY TO SECTIONS DOWN TO 7.

PARTS (A), (B), (C) & (D) ONLY APPLY TO SECTIONS 7 TO 10.

THE REST APPLY TO SECTIONS 10 TO 13

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT:

C 105

FORMER 485

REPORT NO. 7-0558-62

SHEET NO. 5-3

PREPARED BY

DATE

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28 FEB 56

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DATE

SECTIONS DOWN TO 7

$$M = S(.426x) - S_1 y$$

$$1 \quad \frac{\partial M}{\partial S_1} = -y$$

$$\begin{aligned} \frac{\partial U}{\partial S_1} &= \int_0^7 \frac{M(-y) ds}{I} \\ &= \frac{S_1}{E} \int_0^7 \frac{y^2}{I} ds - \frac{S}{E} \int_0^7 \frac{.426xy}{I} ds \end{aligned}$$

$$I_1 = \sum_0^7 \frac{y_{MEAN}^2}{I_{MEAN}} \Delta s = 587.$$

$$I_2 = \sum_0^7 \frac{(.426xy)_{MEAN}}{I_{MEAN}} \Delta s = 29.5. \quad \frac{\partial U}{\partial S_1} = \frac{587S_1}{E} - \frac{29.5S}{E}$$

SECTIONS 7 TO 10.

$$M = S(.426x - .453x + .0093x^2) - S_1 y$$

$$\frac{\partial U}{\partial S_1} = \int_7^{10} \frac{M(-y) ds}{I}$$

$$\frac{\partial M}{\partial S_1} = -y$$

$$= \frac{S_1}{E} \int_7^{10} \frac{y^2}{I} ds - \frac{S}{E} \left[\int_7^{10} \frac{.426xy}{I} ds - \int_7^{10} \frac{.453xy}{I} ds + \int_7^{10} \frac{.0093x^2 y}{I} ds \right]$$

$$I_1 = \sum_7^{10} \frac{y_{MEAN}^2}{I_{MEAN}} \Delta s = 475.$$

$$I_2 = \sum_7^{10} \frac{(.426xy)_{MEAN}}{I_{MEAN}} \Delta s = 117.2.$$

$$I_3 = \sum_7^{10} \frac{(.453xy)_{MEAN}}{I_{MEAN}} \Delta s = 103.2$$

$$I_4 = \sum_7^{10} \frac{(.0093x^2 y)_{MEAN}}{I_{MEAN}} \Delta s = 87.6.$$

$$\frac{\partial U}{\partial S_1} = \frac{475S_1}{E} - \frac{101.6S}{E}$$

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-62

SHEET NO. 5-5

AIRCRAFT:

C 105.

FORMER 485.

PREPARED BY

DATE

C. DITCHFIELD.

28 FEB 51

CHECKED BY

DATE

$$\frac{\delta U}{\delta S_1} = \frac{S_1}{E} \int_{10}^{13} \frac{(99-1.73x)^2}{I_1} ds - \frac{S}{E} \left[\int_{10}^{13} \frac{(99-1.73x) \cdot 44.5}{I_2} ds - \int_{10}^{13} \frac{(99-1.73x) \cdot 43.9x}{I_3} ds \right. \\ \left. - \int_{10}^{13} \frac{(99-1.73x) \cdot 453.1}{I_4} ds + \int_{10}^{13} \frac{(99-1.73x) \cdot 00931.8}{I_5} ds - \int_{10}^{13} \frac{(99-1.73x) \cdot 5.9}{I_6} ds \right]$$

$$I_1 = \sum_{10}^{13} [(99-1.73x)^2]_{\text{MEAN}} \frac{\Delta s}{I_{\text{MEAN}}} = 52.5$$

$$I_2 = \sum_{10}^{13} [(99-1.73x) \cdot 44.5]_{\text{MEAN}} \frac{\Delta s}{I_{\text{MEAN}}} = 109.7$$

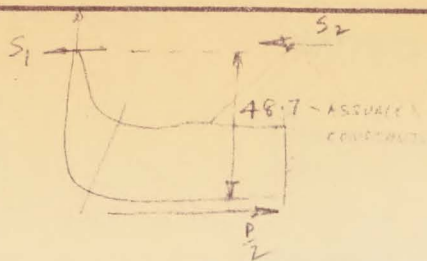
$$I_3 = \sum_{10}^{13} [(99-1.73x) \cdot 43.9x]_{\text{MEAN}} \frac{\Delta s}{I_{\text{MEAN}}} = 42.4$$

$$I_4 = \sum_{10}^{13} [(99-1.73x) \cdot 453.1]_{\text{MEAN}} \frac{\Delta s}{I_{\text{MEAN}}} = 41.2$$

$$I_5 = \sum_{10}^{13} [(99-1.73x) \cdot 00931.8]_{\text{MEAN}} \frac{\Delta s}{I_{\text{MEAN}}} = 34.6$$

$$I_6 = \sum_{10}^{13} [(99-1.73x) \cdot 5.9]_{\text{MEAN}} \frac{\Delta s}{I_{\text{MEAN}}} = 45.3$$

$$\frac{\delta U}{\delta S_1} = \frac{52.5 S_1}{E} - \frac{15.4 S}{E}$$



FORMER 485.

LATERAL STIFFNESS.

Y ASSUMED (L/W)

SECTION	1	2	3	4	5	6	7	8	9
S	4.28	7.6	13.6	18.8	24.8	32.96	39.6	48.0	56.7
I	2.4	4.9	11.2	17.4	29.0	72.5	127.6	105.6	93.6
x	0.8	0.8	1.44	1.8	2.12	4.8	8.8	16.7	25.45
y	4.24	7.52	13.43	18.55	24.5	32.4	38.05	41.4	41.8
l ₁	1-	-	-	-	-	-	0	11.67	22.10
ΔS	4.24	3.36	6.0	5.2	6.0	8.16	6.64	8.4	8.7
I_{MEAN}	1.2	3.65	8.05	14.3	23.2	50.75	100	116.6	94.6
① $\frac{\Delta S}{I_{MEAN}}$	3.5	.92	.745	.364	.259	.161	.066	.072	.092
y^2	18	57	180	344	600	1050	1448	1714	1717
② y^2_{MEAN}	9	38	119	262	472	825	1249	1582	1716
① x ②	31	35	89	95	122	133	82	114	158
.426 x y	1	2	8	14	22	66	143	295	453
③ (.426 y) _{MEAN}	1.5	1.5	5	11	18	44	104.5	219	374
① x ③	1.75	1.38	3.73	4.00	4.66	7.08	6.92	15.8	34.4

52

48.7 - ASSUMED
CONSTANT

FORMER 485.

LATERAL STIFFNESS

* ASSUMED (L.W.)

A. V. ROE CANADA LIMITED

MALTON, ONTARIO

TECHNICAL DEPT. (AIRFRAME)

AIRCRAFT . . . C 105

WEIGHT . . .

C. G. POSITION . . .

	2	3	4	5	6	7	8	9	10	11	12	13	14	15
	7.6	13.6	18.8	24.8	32.46	39.6	48.0	56.7	69.35	77.35	83.35	88.39		
4	4.9	11.2	17.4	29.0	72.5	127.6	105.6	93.6	126.6	150	150	150		
8	0.8	1.44	1.8	2.12	4.8	8.8	16.7	25.45	38.1	46.20	52.20	57.24		
24	7.52	13.43	18.55	24.5	32.4	38.05	41.4	41.8	40.8	40.8	40.8	40.8		
	-	-	-	-	-	0	11.67	22.10	36.8	42.7	48.7	53.7		
24	3.36	6.0	5.2	6.0	8.16	6.64	8.4	8.7	12.65	8.0	6.0	5.04		
2	3.65	8.05	14.3	23.2	50.75	100	116.6	94.6	105.1	139.3	150	150		
5	.92	.745	.364	.259	.161	.066	.072	.092	.120	.058	.040	.034		
8	57	180	344	600	1050	1448	1714	1717	1665	1665	1665	1665		
9	38	119	262	472	825	1249	1582	1716	1691					
1	35	89	95	122	133	82	114	158	203					$\sum_0^7 = 587$
	2	8	14	27	66	143	295	453	662					
5	1.5	5	11	18	44	104.5	219	374	558					
15	138	373	400	466	708	692	15.8	34.4	67.0					$\sum_0^7 = 29.5$

A. V.

AIRCR.

WEIGH

C. G.

FORMER 485

SECTION	1	2	3	4	5	6	7	8	9	10
(10) (99-173x)										33.1
(11) .439x										16.7
(12) (10) x (11)										553
(13) (12) MEAN										
(1) x (13)										
(14) .453x										16.7
(15) (10) x (14)										553
(16) (15) MEAN										
(1) x (16)										
(17) .00136x										13.96
(18) (10) x (17)										462
(19) (18) MEAN										
(1) x (19)										
(20) (99-173x) .5 y										675
(21) (20) MEAN										
(1) x (21)										

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-62

SHEET NO. 5-9

AIRCRAFT:

C.105.

FORMER 485

PREPARED BY

DATE

C. DITCHFIELD

28 FEB 56

CHECKED BY

DATE

$$\begin{aligned} \text{LOAD IN TUBE} &= \sqrt{\left(\frac{S_2}{2}\right)^2 + (.865 S_2)^2} \\ &= S_2 \sqrt{.25 + .7412} \\ &= S_2 \\ &= \underline{S - 2S_1} \end{aligned}$$

$$A = .562 \text{ IN}^2$$

1.75 O.D. X .109 WALL THICKNESS.

$$E = 30 \times 10^6$$

$$\text{EQUIV. ALUM. AREA} = 1.686 \text{ IN}^2$$

$$L = \sqrt{29.9^2 + 17.3^2} = 34.54"$$

$$P = S - 2S_1$$

$$\frac{\partial P}{\partial S_1} = -2$$

$$\frac{\partial U}{\partial S_1} = \int \frac{(S - 2S_1)(-2) ds}{1.686 E_{AL}}$$

$$= \frac{(4S_1 - 2S) 34.54}{1.686 E_{AL}}$$

$$= \frac{82S_1 - 41S}{E}$$

FORMER 495

SECTION	1	2	3	4	5	6	7	8	9	
x	.5	.8	1.44	1.8	2.12	4.8	8.8	16.7	5.45	31
y	4.24	7.52	13.43	18.55	24.5	32.4	38.65	41.4	41.8	40
l_1	-	-	-	-	-	-	0	11.07	21.16	30
① $\frac{4s}{\text{INTERVAL}}$	3.5	.92	.745	.364	.259	.111	.066	.072	.092	.1
② $.416s$	.34	.34	.61	.77	.90	2.04	3.75	7.11	10.54	16
③ $18.67y$	.66	1.18	2.10	2.41	3.54	5.08	5.96	6.49	6.59	6
④ $(.416x - .1817y)^2$	.1	.7	2.22	4.58	8.64	9.24	4.88			
⑤ ② MINUS	.05	.4	1.46	3.40	6.61	8.94	7.06			
⑥ ① X ③	.18	.37	1.09	1.24	1.71	1.44	.47			
⑦ $.453l_1$							0	5.29	10.4	16
⑧ $.0093l_1y$							0	4.49	8.59	13
⑨ ④ - ⑤ - ⑥ + ⑦							-2.21	-1.8	2.87	7
⑩ ⑤ ²							4.88	.03	8.29	5
⑪ ③ MINUS								2.45	4.14	29
⑫ ① X ⑩								.18	.37	3

TECHNICAL DEPT. (AIRFRAME)

AIRCRAFT

WEIGHT

C G. POSITION

REPORT NO.

SHEET

DATE _____

PREPARED BY -

7-0558-62

5-12

28 14536

C 210 541 1060

[illegible]

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-62

SHEET NO. 5-13

AIRCRAFT:

C. 105.

FORMER 415

PREPARED BY

DATE

C. DITCHFIELD

28 FEB 56

CHECKED BY

DATE

SECTION 10 Y. 13

$$M = S(49.5 - .439x - .453l, + .0093l, y - .5y)$$

$$- .15675(97.0 - 1.73x)$$

$$= S(34.0 - .168x - .453l, + .0093l, y - .5y)$$

$$\frac{\partial U}{\partial S} = \frac{S}{2} \int \frac{(34 - .168x - .453l, + .0093l, y - .5y)^2}{I} dx$$

$$= \frac{1.345}{E}$$



$$\text{LOAD IN STRUT} = .6866 S.$$

SPAR CAP.
END LOAD ENERGY

$$\frac{\partial U}{\partial S} = \frac{0.5^2 \cdot 5724}{3.2 \cdot 4.6}$$

$$= \frac{1.995}{E}$$

$$\frac{\partial U}{\partial S} = \frac{.6866^2 S \cdot 34.54}{1.686 E}$$

$$= \frac{9.675}{E}$$

$$\text{TOTAL (BENDING)} \quad \frac{\partial U}{\partial S} = 2(6.5 + 4.1 + 1.34 + 9.67) \frac{S}{E}$$

$$= \frac{2 \times 21.61 S}{E}$$

BOTH SIDES.

$$= \frac{43.22 S}{E}$$

$$\text{LATERAL STIFFNESS} \quad \frac{S}{\delta_s} = \frac{E}{43.22} = \underline{232,000 \text{ LBS/IN.}}$$

THIS FIGURE SHOWS THAT BENDING ENERGY ALONE IS INSUFFICIENT AND END LOAD AND SPAR ENERGY SHOULD BE TAKEN INTO ACCOUNT.

$$\frac{\partial U}{\partial S} = \frac{S}{E}(21.61 + 5.44 + 3.84 + 11.47 + 1.11) \times 2 = \frac{88.75}{E}$$

$$\text{LATERAL STIFFNESS} = \frac{S}{\delta_s} = \underline{113,000 \text{ LBS/IN.}}$$

