AVRO AIRCRAFT

TECHNICAL REPORT

A. V. ROE CANADA LIMITED
MALTON · ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

ANALYZED

AIRCRAFT: C 105.

REPORT NO: 7-0558-45

FILE NO:

NO. OF SHEETS: 87

CONFIDENTIAL

TITLE:

Classification cancelled / Changed to UNCLASS
By authority of AVRS
Date 30 Sept 06
Signature [signature]
Unit / Rank / Appointment AVRS 5

PRELIMINARY INVESTIGATION
REAR FUSELAGE.

PREPARED BY [signature] DATE Nov 25 1957

CHECKED BY DATE

SUPERVISED BY [signature] DATE Feb 58

APPROVED BY DATE

ISSUE No.	REVISION No.	REVISED BY	APPROVED BY	DATE	REMARKS
1	—	—	—	—	OTHER SECTIONS TO BE ADDED LATER.
2	57	C.D. D SHONE.		15 OCT 85	SECTIONS 2 + 3 ADDED.
					15867379

FORM 1316A

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

REPORT No. 7/0553/45
SHEET No. 0-1

AIRCRAFT:		PREPARED BY	DATE
C 105	REAR FUSELAGE	C. DITCHFIELD	25 NOV 55
		CHECKED BY	DATE

GENERAL ANALYSIS

INDEX

CONFIDENTIAL

FORM 1319A

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

REPORT No. 7/0555/45 1552
SHEET No. 0-2.

AIRCRAFT:		PREPARED BY	DATE
C.105	GENERAL ANALYSIS.	C. DITCHFIELD	16 DEC 55
		CHECKED BY	DATE

PAGE INDEX

FORM 1319A

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT NO. 7/0538/45 SHEET NO. 1-0	
AIRCRAFT: C.105		PREPARED BY C. DITCHFIELD	DATE 25 NOV 55
		CHECKED BY	DATE

SECTION 1

ANTICLASTIC BENDING EFFECT FROM WING TO FUSELAGE.

FORM 1319A

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

REPORT NO. 7/0555/45
SHEET NO. 1-1

AIRCRAFT:		PREPARED BY	DATE
C 105	CENTRE FUSELAGE 455-742	C. DITCHFIELD	25 NOV 55
		CHECKED BY	DATE

ANTICLASTIC BENDING EFFECT

SUMMARY.

THE ANSWERS FROM THE FIRST APPROXIMATION ARE SUCH THAT THEY WILL NOT BE REFINED AT THIS TIME. THE ANSWERS WILL BE USED FOR THE LIGHT FORMER HINGE AND SIDESKIN STRESSING, IN CONJUNCTION WITH DIAGONAL TENSION AND INDUCED FORMER LOADS.

MAX. INDUCED LOAD/FORMER = 2000 LBS.

MAX. INDUCED SHEAR = 112 LBS/IN

FORM 1319A

A. V. ROE CANADA LIMITED MALTON - ONTARIO TECHNICAL DEPARTMENT (Aircraft)		REPORT No. 7/0551/45 SHEET No. 1-2	
AIRCRAFT:		PREPARED BY	DATE
C 105	CENTRE FUSELAGE 485-747	C. DITCHFIELD	31st OCT. 55
		CHECKED BY	DATE

TO FIND EFFECT OF ANTICLASTIC BENDING ON SIDESKINS AND LIGHT FORMERS

ASSUME THAT THE DEFLECTED SHAPE OF THE WING IN THE FORE AND AFT PLANE IS DUE TO A CONSTANT MOMENT. THE WING GROUP STATES THAT THE MAX STRESS INDUCED, IN THE FORE AND AFT PLANE, IS 12000 p.s.i., CONSIDERING THE WING ACTING BY ITSELF.

FROM THE EFFECTIVE MOMENT OF INERTIA OF THE WING IN THIS PLANE WE CALCULATE THE APPARENT CONSTANT MOMENT WHICH GIVES THE WING ITS CURVATURE. THIS MOMENT IS APPLIED TO THE WHOLE SIDE BEAM, WHICH INCLUDES RIB #4, EFFECTIVE SKIN CAPS, FUSELAGE SIDESKIN AND LOWER LONGERON, AS A COUPLE IN RIB #4.

FOR A FIRST APPROXIMATION THE END TWO LIGHT FORMERS IN EACH BAY WILL BE NEGLECTED AND THE OTHER SIX WILL BE SPLIT INTO TWO EFFECTIVE SUPPORTS OF THREE FORMERS EACH, AS THIS MAKES THE BAY SYMMETRICAL ABOUT ITS ℄. THERE IS BUT ONE REDUNDANCY.

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

REPORT No. 7/0558/45
SHEET No. 1-3

AIRCRAFT:		PREPARED BY	DATE
C 105.	CENTRE FUSELAGE.	L. H GOULD.	
		CHECKED BY	DATE

ANTI CLASTIC BENDING EFFECT ON LIGHT FORMERS

ASSUME:-

12 000 PSI REQD TO STRAIGHTEN OUT WING BY ITSELF.

14" WING DEPTH

.15" SKIN 40" WIDE

.1" RIB THICKNESS

.051" SIDE SKIN.

53" BAY LENGTH

57" SIDE BEAM TOTAL DEPTH

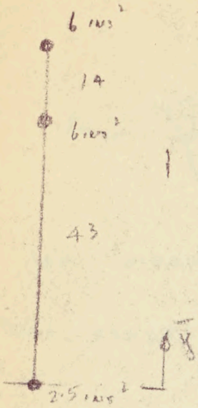
LOWER LONGERON AREA 2.5 ins^2.

FORM 1319A

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

AIRCRAFT:		REPORT No. 7/0555/45	
C.105	CENTRE FUSELAGE	SHEET No. 1-4	
		PREPARED BY	DATE
		C. DITCHFIELD	OCT 31st 55
		CHECKED BY	DATE

FUSELAGE SIDE BEAM



$$\bar{y} = \frac{6 \times 57 + 6 \times 43}{14.5}$$

$$= 41.3''$$

$$I_{NA} = 2.5 \times 41.3^2 + 6 \times 1.7^2 + 6 \times 15.7^2$$

$$= 4270 + 18 + 1478$$

$$= 5766 \text{ ins}^4$$

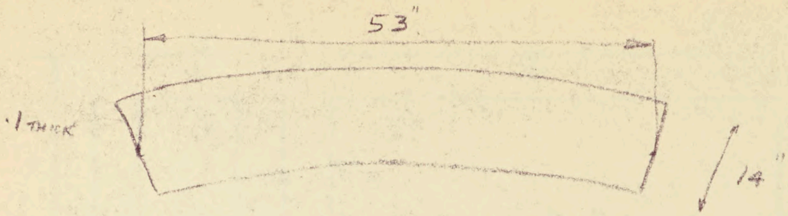
FORM 1319A

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT:		REPORT NO. 7/0558/45
C.105	CENTRE FUSELAGE.	SHEET NO. 1-5

PREPARED BY	DATE
C. DITCHFIELD	
CHECKED BY	DATE



CAP EFFECTIVE 40" × ·15" SKIN

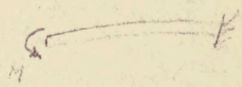
MAX. STRESS IN WING TO STRAIGHTEN SAME

= 12000 psi

$$I = 2 \times 40 \times \cdot 15 \times 6\cdot 925^2$$

$$= \underline{575 \text{ INS}^4}$$

$$f = \frac{My}{I}$$



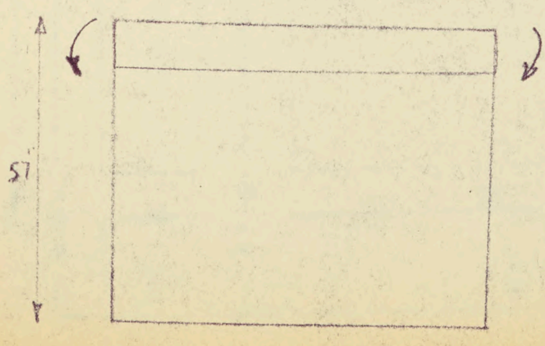
$$M = \frac{12000 \times 575}{7}$$

$$= \underline{0\cdot 985 \times 10^6 \text{ LBS INS}}$$

$$\delta = \frac{ML^2}{2EI}$$

$$\delta = \frac{\cdot 985 \times 10^6 \times 26\cdot 5^2}{2 . 10 . 10^6 . 575}$$

$$= \underline{0\cdot 06 \text{ INS}}$$

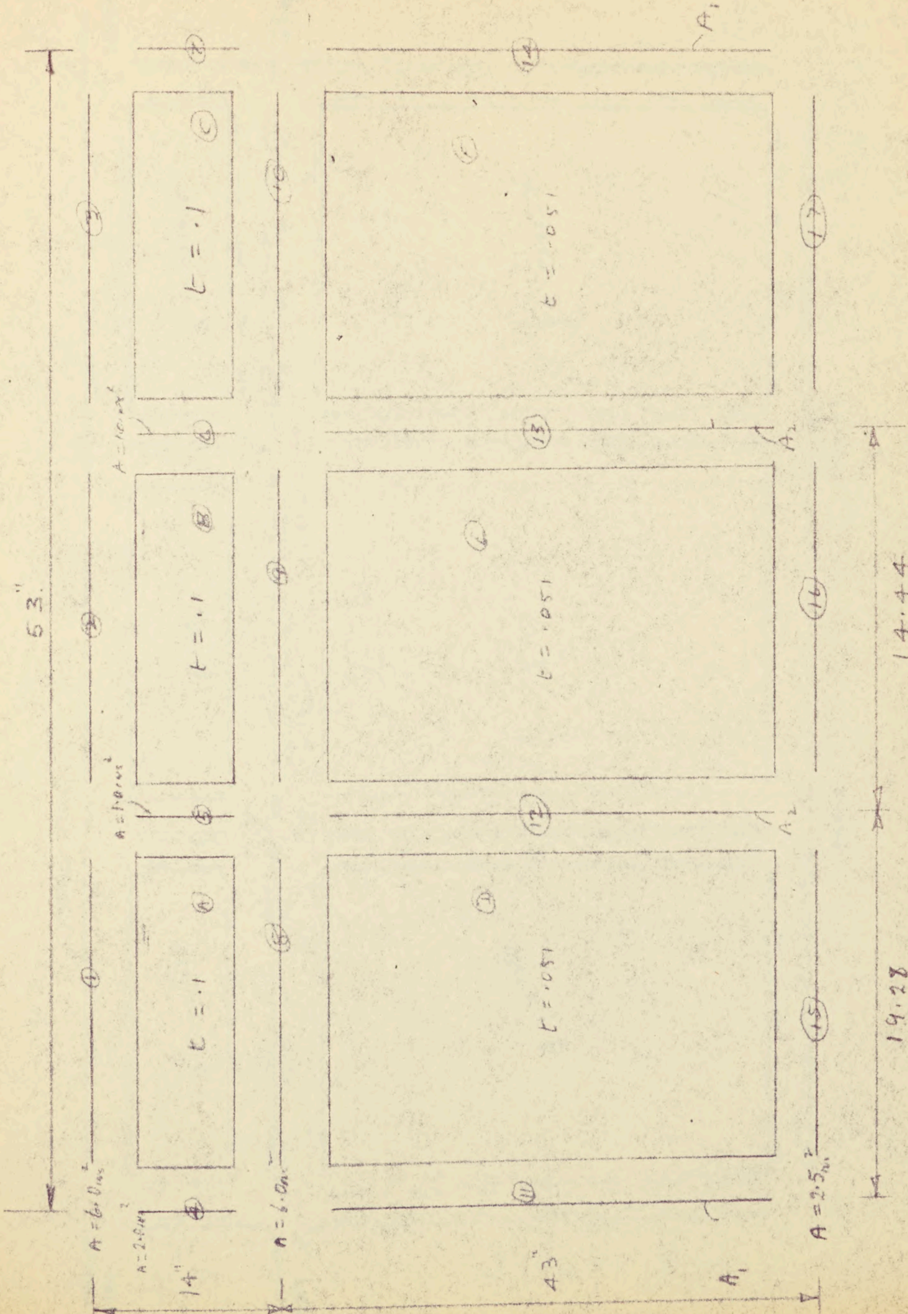


SIDE BEAM WITH RIB # 4 AND SIDESKIN AND LOWER LONGERON.

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

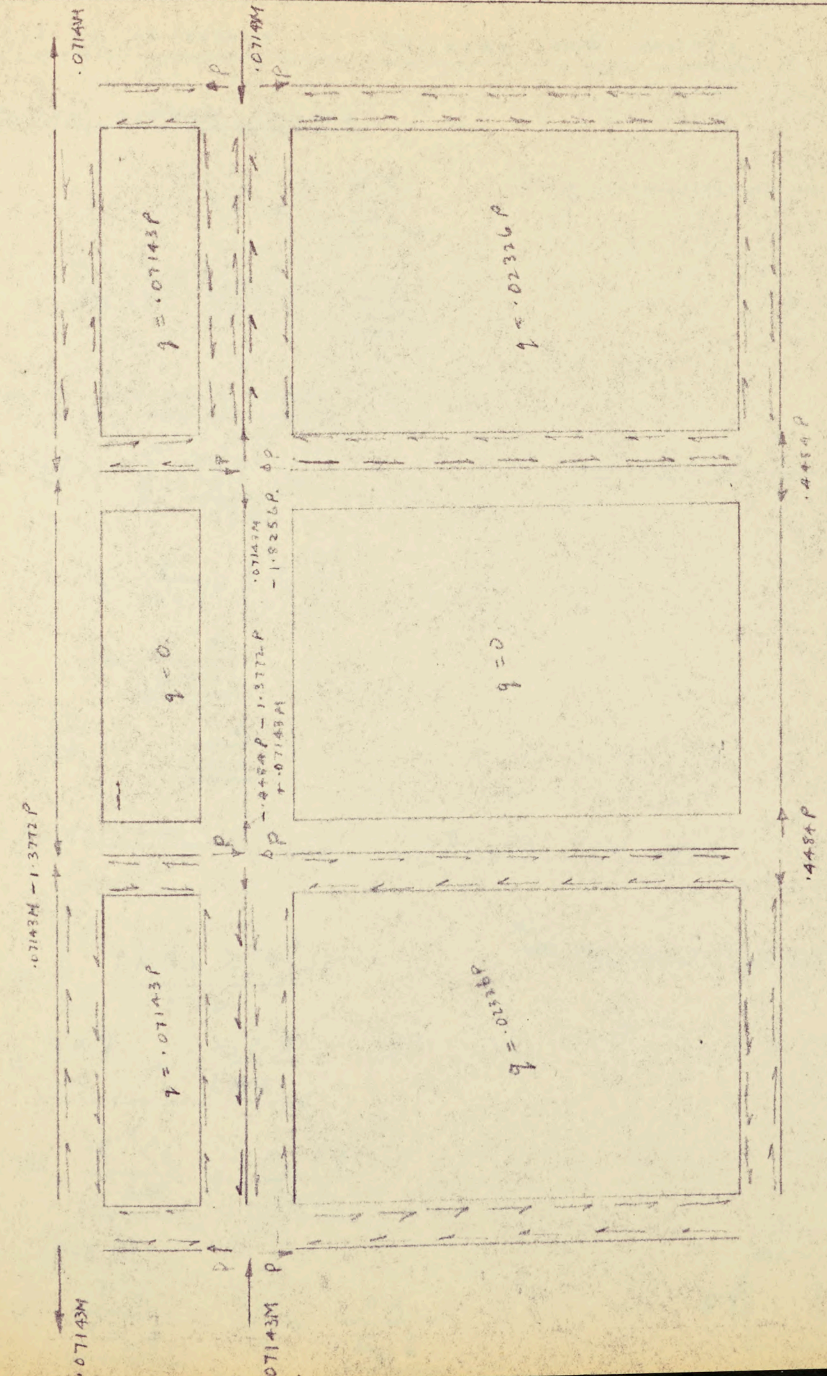
REPORT No.	7/05 58/45	
SHEET No.	1-6	
PREPARED BY	C. DITCHFIELD	DATE 31st OCT 55
CHECKED BY		DATE

AIRCRAFT: C.105. — CENTRE FUSELAGE.



FORM 1319A

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT NO. 7/0555/45 SHEET NO. 1-7	
AIRCRAFT:		PREPARED BY	DATE
C.105	CENTRE FUSELAGE	C. DITCHFIELD	31st OCT 55
		CHECKED BY	DATE



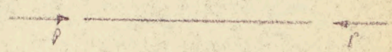
A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT:		REPORT NO. 7/0555/15	
C.105	CENTRE FUSELAGE	SHEET NO. 1-8	
		PREPARED BY	DATE
		C. DITCHFIELD	1 NOV 55
		CHECKED BY	DATE

ENERGY EXPRESSIONS IN MEMBERS AND PANELS.

CONSTANTLY LOADED MEMBER

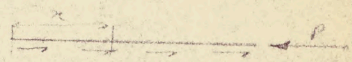
$$U = \frac{P^2 l}{2AE}$$



$$\Delta_P = \frac{\partial U}{\partial P} = \frac{Pl}{AE}$$

UNIFORMLY INCREASING LOAD.

$$U = \int_0^l \frac{\left(\frac{Px}{l}\right)^2}{2AE} dx$$



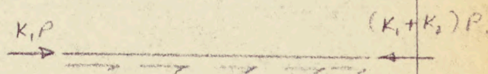
$$= \frac{P^2}{2AEl^2}\left[\frac{x^3}{3}\right]_0^l$$

$$= \frac{P^2 l}{6AE.}$$

$$\frac{\partial U}{\partial P} = \frac{Pl}{3AE}$$

UNIFORMLY INCREASING LOAD WITH LOAD AT EACH END

$$U = \int_0^l \frac{\left(K_1 P + \frac{K_2 P x}{l}\right)^2 dx}{2AE}$$

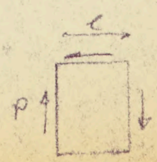


$$= \frac{K_1^2 P^2 l}{2AE} + \frac{K_2^2 P^2 l}{6AE}.$$

$$\frac{\partial U}{\partial P} = \frac{K_1^2 P l}{AE} + \frac{K_2^2 P l}{3AE}$$

SHEAR PANEL

$$U = \frac{P^2 l}{2A_w G.} \qquad \frac{\partial U}{\partial P} = \frac{Pl}{A_w G.}$$



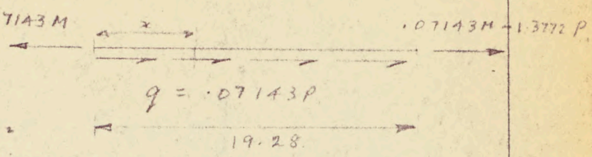
FORM 1319A

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

REPORT NO.	7/0555/45		
SHEET NO.	1-9		
AIRCRAFT: C.105	CENTRE FUSELAGE.	PREPARED BY: C. DITCHFIELD	DATE: 1 NOV. 55.
		CHECKED BY	DATE

MEMBER 1.

END LOAD



$A = 6.0 \text{ ins}^2$

AT x

END LOAD $P_x = \cdot 07143M - \cdot 07143\,x\,P.$ $\qquad \frac{\partial P_x}{\partial P} = -\cdot 07143\,x$

$$\frac{\partial U}{\partial P} = \int_0^{19\cdot 28} \frac{\cdot 07143\,(M - Px)(-\cdot 07143\,x)\,dx}{6 \times 10^7}$$

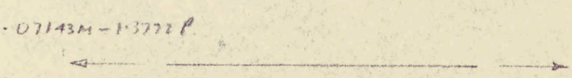
$$= \frac{-(\cdot 07143)^2}{6 \times 10^7} \int_0^{19\cdot 28} (Mx - Px^2)\,dx$$

$$= -\cdot 8504 \times 10^{-10} \left[M\left(\frac{x^2}{2}\right) - \frac{Px^3}{3} \right]_0^{19\cdot 28}$$

$$= -\cdot 8504 \times 10^{-10} \left[185\cdot 86\,M - 2388\cdot 9\,P \right]$$

$$= 10^{-8} \left[20\cdot 315\,P - 1\cdot 581\,M \right].$$

MEMBER 2.



$P_x = \cdot 07143M - 1\cdot 3772\,P \qquad \frac{\partial P_x}{\partial P} = -1\cdot 3772$

$$\frac{\partial U}{\partial P} = \int_0^{14\cdot 44} \frac{(\cdot 07143M - 1\cdot 3772\,P)(-1\cdot 3772)\,dx}{6 \times 10^7}$$

$$= \frac{1\cdot 8967\,P - \cdot 09837\,M}{6 \times 10^7} \times 14\cdot 44$$

$$= 10^{-8} \left[45\cdot 647\,P - 2\cdot 367\,M \right]$$

FORM 1319A

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

REPORT No.	7/0558/45
SHEET No.	1-10

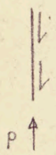
AIRCRAFT:		PREPARED BY	DATE
C. 105.	CENTRE FUSELAGE.	C. DITCHFIELD.	1 NOV 55.
		CHECKED BY	DATE

MEMBER 3.

SAME AS MEMBER 1.

$$\frac{\partial U}{\partial P} = 10^{-8}\left[20.315 P - 1.581 M\right]$$

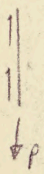
MEMBER 4



$$\frac{\partial U}{\partial P} = \frac{P.\ 14}{3.\ 2.0.\ 10^{7}}$$

$$= 10^{-8}\left[23.333 P\right]$$

MEMBER 5



$$\frac{\partial U}{\partial P} = \frac{P.\ 14}{3.\ 1.0.\ 10^{7}}$$

$$= 10^{-8}\left[46.667 P\right]$$

MEMBER 6

AS MEMBER 5

$$\frac{\partial U}{\partial P} = 10^{-8}\left[46.667 P\right]$$

MEMBER 7

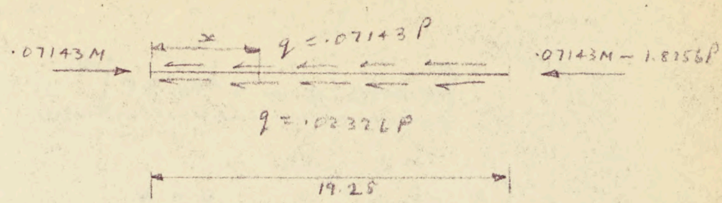
AS MEMBER 4

$$\frac{\partial U}{\partial P} = 10^{-8}\left[23.333 P\right]$$

FORM 1319A

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT NO. 7/0555/45 SHEET NO 1-11	
AIRCRAFT: C.105	CENTRE FUSELAGE	PREPARED BY C. DITCHFIELD	DATE 1 NOV 55
		CHECKED BY	DATE

MEMBER 8.



END LOAD $P_x = \cdot 07143M - \cdot 09469 P_x$

$$\frac{\partial P_x}{\partial P} = -\cdot 09469x$$

$$A = 6.0 \text{ ins}^2$$

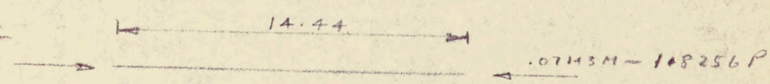
$$\frac{\partial U}{\partial P} = \int_0^{19.25} \frac{(-\cdot 09469x)(-\cdot 09469P_x + \cdot 07143M)\,dx}{6.0 \times 10^7}$$

$$= \int_0^{19.28} \frac{\cdot 0089662\,P x^2 - \cdot 00676\,Mx}{6 \times 10^7}\,dx$$

$$= 10^{-8}\left[\frac{\cdot 0089662\,P}{\cdot 6}\cdot\frac{19.28^3}{3} - \frac{\cdot 00676}{\cdot 6}\cdot\frac{19.28^2}{2}\right]$$

$$= 10^{-8}\left[35.699\,P - 2.094\,M\right]$$

MEMBER 9.



$$\frac{\partial U}{\partial P} = \int_0^{14.44} \frac{(\cdot 07143M - 1.8256P)(-1.8256)\,dx}{6 \times 10^7} \qquad \frac{\partial P_x}{\partial P} = -1.8256$$

$$= 10^{-8}\left[\frac{3.3328\,P}{\cdot 6} \times 14.44 - \frac{\cdot 1304\,M}{\cdot 6} \times 14.44\right]$$

$$= 10^{-8}\left[80.209\,P - 3.139\,M\right]$$

FORM 1319A

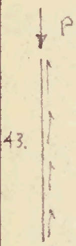
MEMBER 10

SAME AS MEMBER 8.

$$\frac{\partial U}{\partial P} = 10^{-8}\left[35.699P - 2.094M\right]$$

MEMBER 11

$$A = A_1$$



$$\frac{\partial U}{\partial P} = \frac{P.\,43}{3.A_1.\,10^7}$$

$$= 10^{-8}\left[\frac{430}{3A_1}P\right]$$

MEMBER 12

SAME AS MEMBER 11 EXCEPT $A = A_2$

$$\frac{\partial U}{\partial P} = 10^{-8}\left[\frac{430}{3A_2}P\right].$$

MEMBER 13

AS 12.

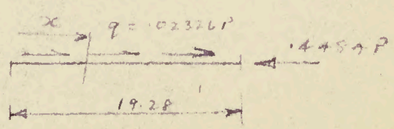
$$\frac{\partial U}{\partial P} = 10^{-8}\left[\frac{430}{3A_2}P\right]$$

MEMBER 14

AS 10

$$\frac{\partial U}{\partial P} = 10^{-8}\left[\frac{430}{3A_1}P\right].$$

MEMBER 15.



$$P_x = .02326\,Px$$

$$\frac{\partial P_x}{\partial P} = .02326\,x$$

$$\frac{\partial U}{\partial P} = \int_0^{19.28}\frac{.02326^2 P x^2\,dx}{2.5\times10^7}$$

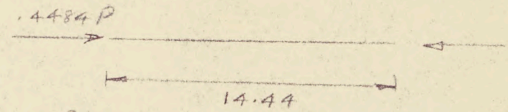
$A = 2.5\ \text{INS.}^2$

MEMBER 15

$$\frac{\partial U}{\partial P} = 10^{-8}\left[\frac{.000541\,P \, . \, 19.28^3}{.75}\right]$$

$$= 10^{-8}\left[5.170\,P\right]$$

MEMBER 16



$A = 2.5 \text{ ins}^2$

$$P_x = .4484\,P$$

$$\frac{\partial P_x}{\partial P} = .4484$$

$$\frac{\partial U}{\partial P} = \int_0^{14.44} \frac{.4484^2\,P}{2.5 \times 10^7}\,dx$$

$$= 10^{-8}\left[11.613\,P\right]$$

MEMBER 17

AS MEMBER 15.

$$\frac{\partial U}{\partial P} = 10^{-8}\left[5.170\,P\right]$$

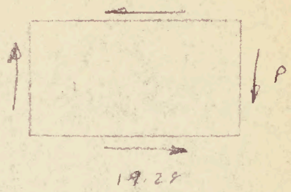
A. V. ROE CANADA LIMITED MALTON · ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**	REPORT NO. 7/0555/45 SHEET NO. 1-14

AIRCRAFT: C.105	CENTRE FUSELAGE	PREPARED BY: C. DITCHFIELD	DATE: 1 NOV 55
		CHECKED BY	DATE

PANEL A.

$$\frac{\partial U}{\partial P} = \frac{P \cdot 19.28}{1.4 \times 4 \times 10^6}$$

$$= 10^{-8}\left[344.285P\right]$$



$A_W = 14 \times .1 = 1.4 \text{ ins}^2$.

PANEL B. $\frac{\partial U}{\partial P} = 0$

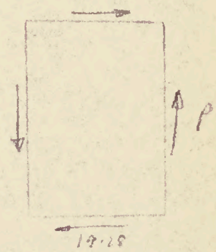
PANEL C. AS PANEL A

$$\frac{\partial U}{\partial P} = 10^{-8}\left[344.285P\right]$$

PANEL D

$$\frac{\partial U}{\partial P} = \frac{P \cdot 19.28}{2.15 \times 4 \times 10^6}$$

$$= 10^{-8}\left[224.186P\right]$$



$A_W = 43 \times .05 = 2.15 \text{ ins}^2$

PANEL E.

$$\frac{\partial U}{\partial P} = 0$$

PANEL F. AS PANEL D.

$$\frac{\partial U}{\partial P} = 10^{-8}\left[224.186P\right]$$

FORM 1319A

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

REPORT No.	7/0558/45
SHEET No.	1-15

AIRCRAFT:		PREPARED BY	DATE
C 105	CENTRE FUSELAGE	C. DITCHFIELD	2 NOV 55
		CHECKED BY	DATE

FOR THE SYSTEM SHOWN

$$\Sigma \frac{dU}{dP} = 0$$ [P IS A SELF EQUILIBRATING LOAD WITHIN THE SYSTEM].

$$\Sigma \frac{dU}{dP} = 10^{-8} \Big[20.315P - 1.581M$$
$$45.647P - 2.367M$$
$$20.315P - 1.581M$$
$$23.333P$$
$$46.667P$$
$$46.667P$$
$$23.333P$$
$$35.699P - 2.094M$$
$$80.209P - 3.139M$$
$$35.699P - 2.094M$$
$$\frac{286.7P}{A_1}$$
$$\frac{286.7P}{A_2}$$
$$5.170P$$
$$11.613P$$
$$5.170P$$
$$344.285P$$
$$344.285P$$
$$224.186P$$
$$224.186P \Big]$$

LET $\left(\frac{1}{A_1}+\frac{1}{A_2}\right) = K_1$

$$= 10^{-8}\left[1536.779P + 286.7P\left(\frac{1}{A_1}+\frac{1}{A_2}\right) - 12.856M\right].$$

$$P(1536.779P + 286.7K_1) = 12.856M$$

$$P = \frac{12.856M}{1536.779 + 286.7K_1}.$$

FORM 1319A

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

REPORT NO. 7-0558-45/2	SHEET NO. 2-0	
AIRCRAFT: C 105	STA 591.65	
PREPARED BY D Sh[illegible]	DATE 15/12/55	
CHECKED BY	DATE	

SECTION 2

STIFFNESS OF WING STRUCTURE UNDER VERTICAL LOAD APPLIED TO FORMER

FORM 1319A

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

REPORT NO. 7-0558-45/2
SHEET NO. 2-1

AIRCRAFT:		PREPARED BY	DATE
C 105	STA 591·65	D Shaw	14/12/55
		CHECKED BY	DATE

Purpose:
The following analysis is to calculate the stiffness of the wing structure under a vertical load applied to it by the former

---

The initial calculations had assumed that the former was mounted directly onto a span which was normal to A/C ℄

Subsequent calculations assumed a certain displacement at the pin connexion between the former and the wing structure

The present analysis will enable an effective I of the swept back wing structure to be calculated which may be compared with that used in the initial calculations.

It also gives a value for the displacement

FORM 1319A

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

REPORT No.	7/05SF/45.
SHEET No.	1-16
PREPARED BY	DATE
C. DITCHFIELD	7 NOV 55
CHECKED BY	DATE

AIRCRAFT: C-105 — CENTRE FUSELAGE

LET $A_1 = 1.0 \times .5 = 0.5 \text{ ins}^2$ SAY

$A_2 = \dfrac{3 \times .37}{2} = 0.55 \text{ ins}^2$ SAY

$K_1 = \dfrac{1}{0.5} + \dfrac{1}{0.55}$

$= 3.818$

$$P = \frac{12.856\ M}{1536.779 + 1094.621}$$

$= 0.004886\ M$

WHEN $M = .985 \times 10^6$ LBS INS.

$P = \underline{4812 \text{ LBS}}$.

LOAD/LIGHT FORMER = <u>1604 LBS</u> AVERAGE.

USING TRIANGULAR DIST^N

LOAD/LIGHT FORMER = <u>2000 LBS</u> MAX.

SHEAR IN .051 PANEL ADJACENT TO HEAVY FRAME

$q = .02326 \times 4812$

$= \underline{112 \text{ LBS/IN}}$.

FORM 1319A

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

REPORT NO. 7-0558-45/2			
SHEET NO 2-2			
AIRCRAFT: C 105	STA 591.65	PREPARED BY D Shaw	DATE 14/12/55
		CHECKED BY	DATE

Purpose cont'd

of the former - wing structure pin connexion, this may be compared with the value assumed in the second calculations.

FORM 1319 A

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

REPORT NO. 7-0558-45/2
SHEET NO. 2-3

AIRCRAFT:		PREPARED BY	DATE
C 105	STA 591·65	[signature]	14/12/55
		CHECKED BY	DATE

Assumptions:

The wing (between the centre fwd and the centre rear spars) is assumed to be of uniform chord = 52·8"
(chord @ ℄ = 621·68 − 568·78 = 52·90
" " B.L. 57·14 644·43 − 591·65 = 52·78)

Similarly these two spars are assumed to be of the same, and of uniform, depth = 11·0"

The wing has an anhedral of 4°, however this is neglected when applying the loads to the wing structure; these are assumed to act normally to a plane through the wing axis.

Both ribs are assumed to be parallel to A/c ℄.

The horizontal load at rib B.L. 8·0, and the moment that it applies at N.A. of spars, are considered negligible.

FORM 1319A

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

AIRCRAFT:		REPORT NO. 7-0558-45/2	
		SHEET NO. 2-4	
		PREPARED BY	DATE
C 105	STA. 591·65	D'Shone	14/12/55
		CHECKED BY	DATE

Values assumed:

Centre Fwd Spar: $I = 600 \text{ in}^4$
$t = 0{\cdot}1$ in.

Centre Rear Spar: $I = 400 \text{ in}^4$
$t = 0{\cdot}1$ in.

Rib @ B.L 8·01 $I = 200 \text{ in}^4$
$t = 0{\cdot}1$ in

Rib @ B.L. 57·1 $t = 0{\cdot}15$ in

Top Skin $t = 0{\cdot}15$ in

Bottom Skin $t = 0{\cdot}14$ in

Young's Modulus $= 10{\cdot}5 \times 10^6 \text{ lb/in}^2$
Shear " $= 4 \times 10^6 \text{ lb/in}^2$

FORM 1319A

Analysis:

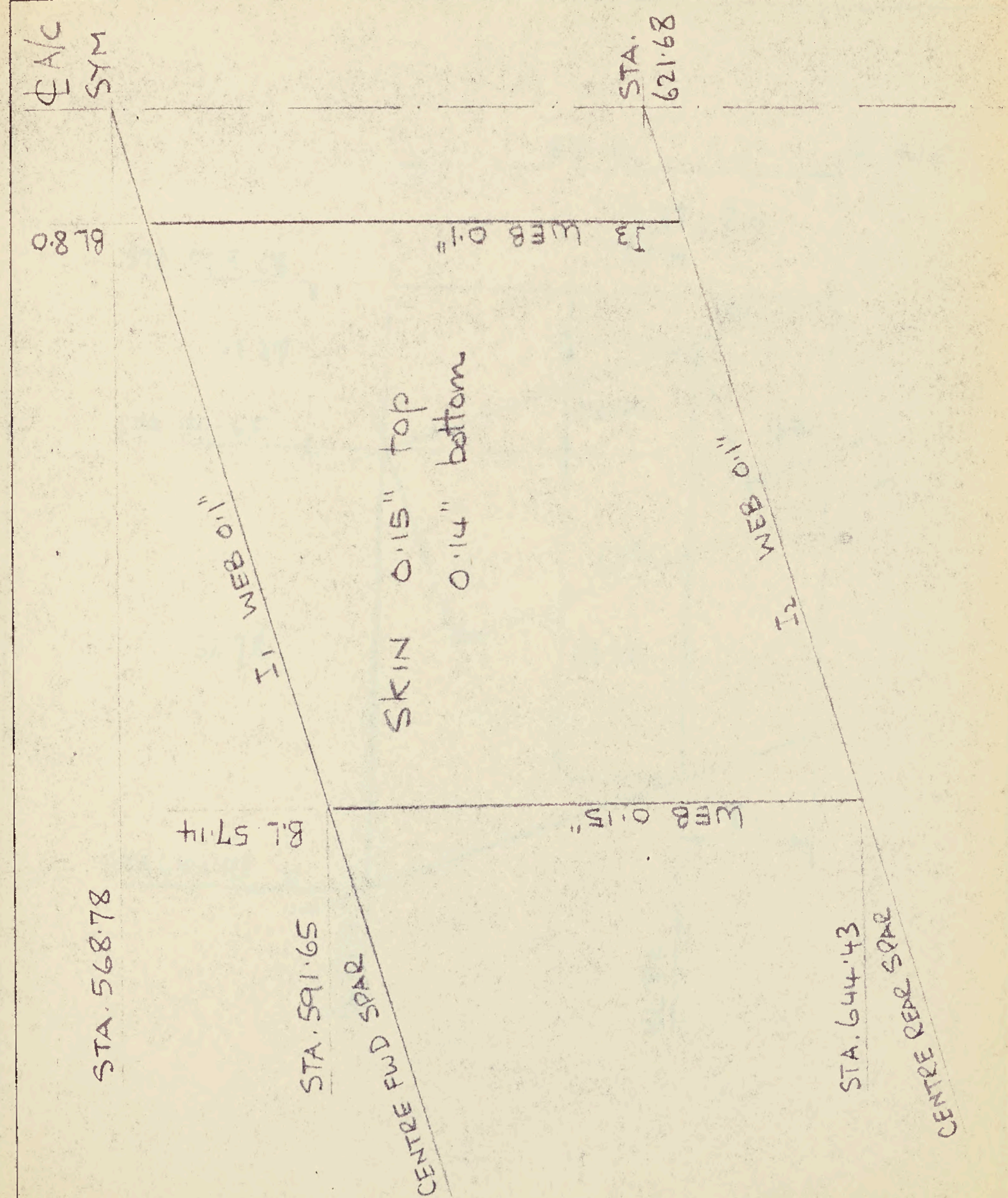
Both the structure and the loading are symmetrical about A/C ℄, the only action at the ℄ is, therefore, a bending moment; the shearing force is zero

The elastic strain energy is taken to be the sum of that caused by bending and that caused by shearing.

Only half the structure is considered.

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

REPORT No. 7-0558-45/2	SHEET No. 2-6	
AIRCRAFT: C 105	STA 591·65	
PREPARED BY [signature]	DATE 14/12/55	
CHECKED BY	DATE	

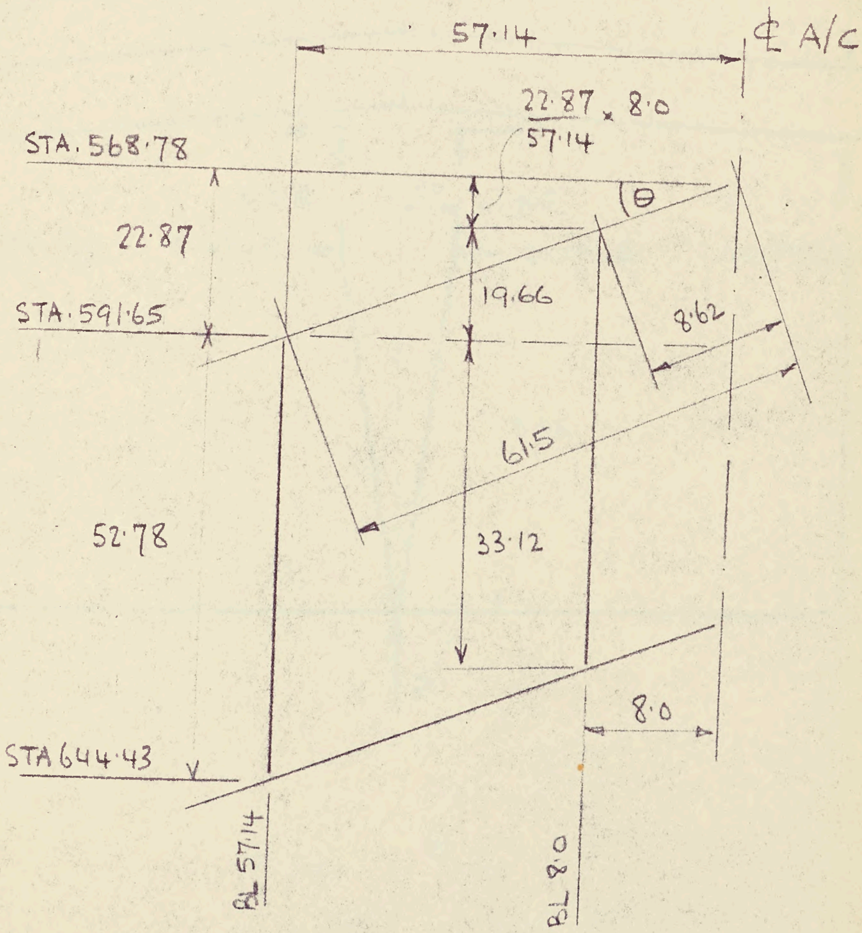


FORM 1319A

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

REPORT No. 7-0558-45/2
SHEET No. 2-7

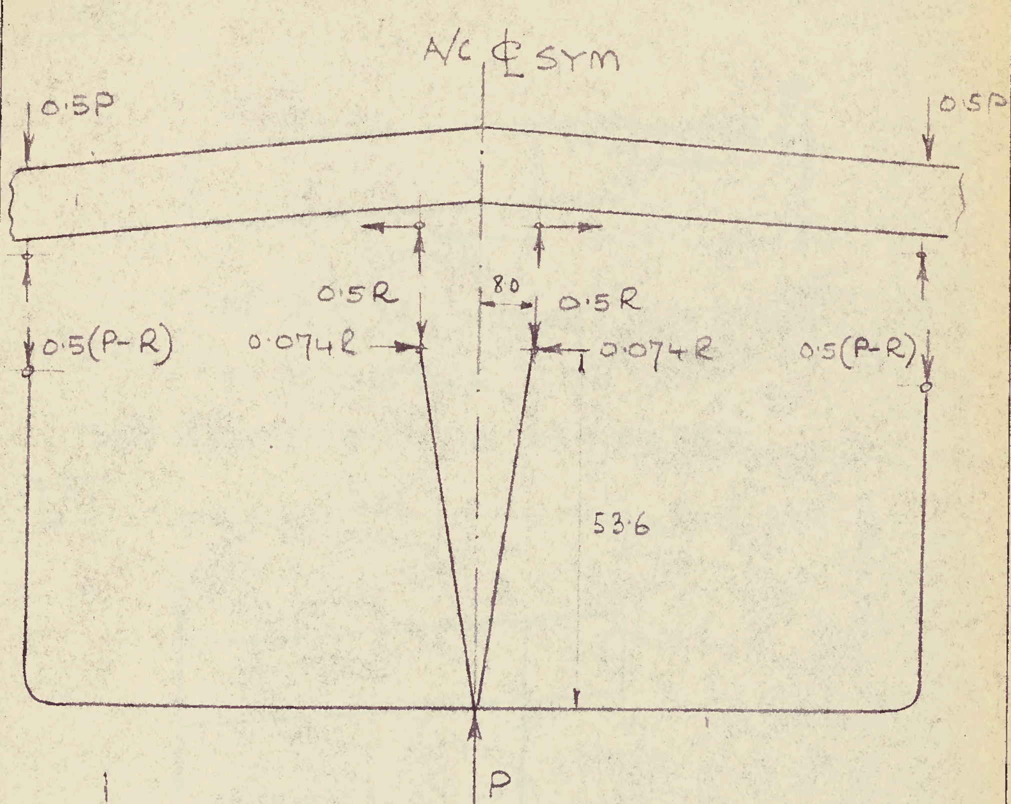
AIRCRAFT:		PREPARED BY	DATE
C 105	STA. 591·65	[signature]	14/12/55
		CHECKED BY	DATE



FORM 1319A

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

AIRCRAFT:		REPORT No. 7-0558-45/2	
C 105	STA 591.65	SHEET No. 2-8	
		PREPARED BY	DATE
		[signature]	12/12/55
		CHECKED BY	DATE

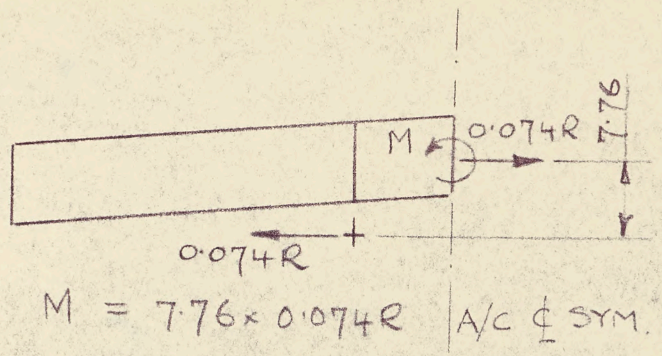


FORM 1319A

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

REPORT No. 7-0558-45/2	SHEET No. 2-9	
PREPARED BY [signature]	DATE 12/12/55	
CHECKED BY	DATE	
AIRCRAFT: C 105	STA 591·65	

HORIZ:

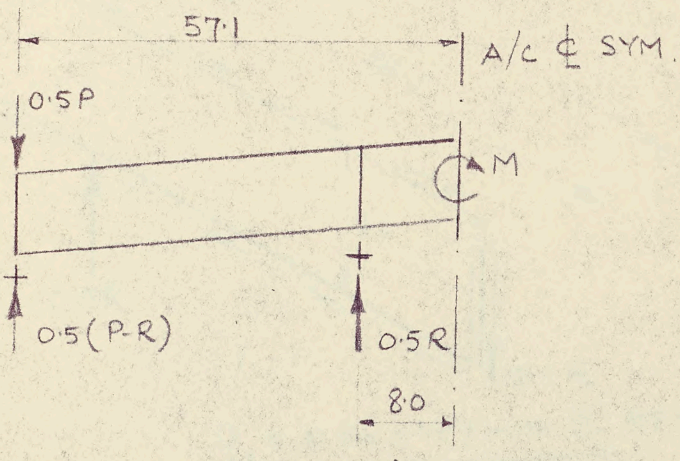


$M = 7{\cdot}76 \times 0{\cdot}074R$

$M = 0{\cdot}574R$

THIS COMPONENT IS NEGLECTED

VERT:



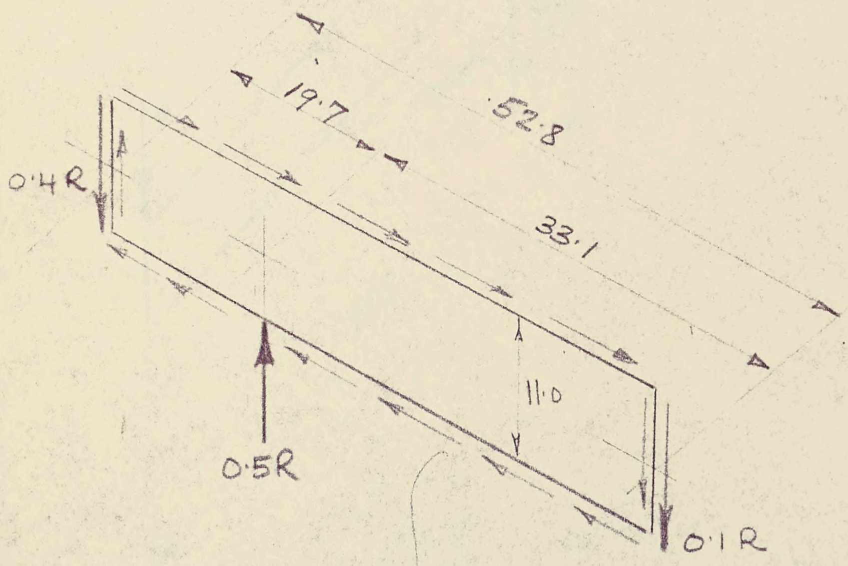
$M = 0{\cdot}5R\,(57{\cdot}1 - 8{\cdot}0)$

$M = 24{\cdot}6R$

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

AIRCRAFT:		REPORT NO. 7-0558-45/2	
C 105	STA. 591.65	SHEET No 2-10	
		PREPARED BY	DATE 12/12/55
		CHECKED BY	DATE

VERT
Rib @ B.L. 8.0



$$q = \frac{0.5R \times 19.7 - 0.1R \times 52.8}{2 \times 52.8 \times 11.0}$$

$$= 0.00394R$$

FORM 1319A

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

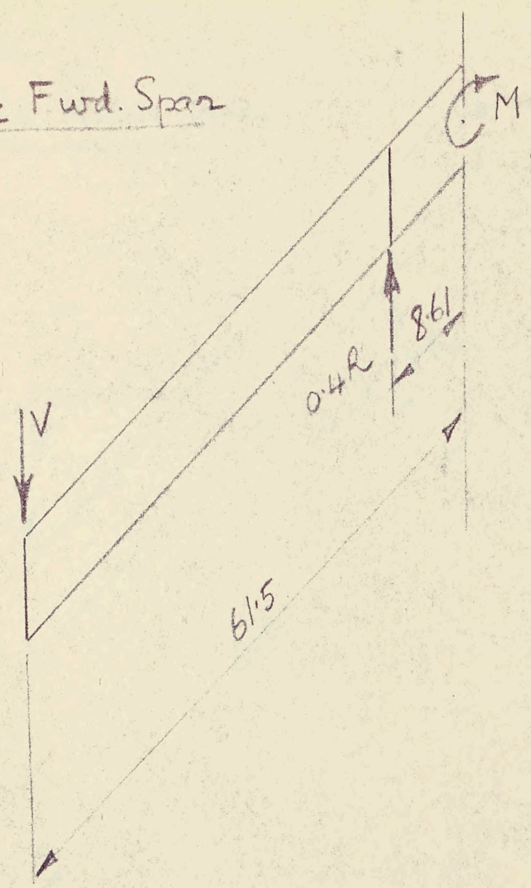
REPORT No. 7-0558-45/2		
SHEET No. 2-11		
PREPARED BY		DATE 12/12/55
CHECKED BY		DATE

AIRCRAFT: C 105

STA 591·65

VERT.

Centre Fwd. Spar



$V = 0{\cdot}4R$

$M = 0{\cdot}4R\,(61{\cdot}5 - 8{\cdot}61)$

$M = 21{\cdot}1\,R$

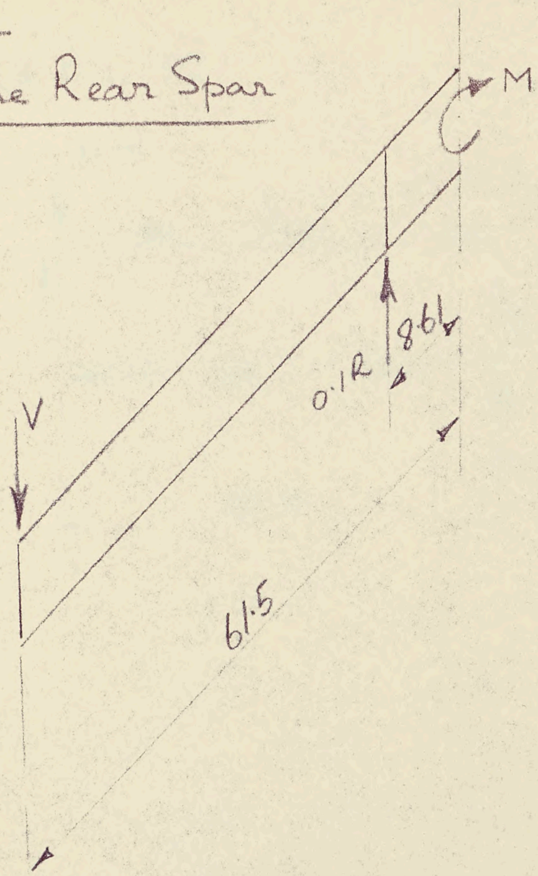
A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-45/2
SHEET NO. 2-12

AIRCRAFT:		PREPARED BY	DATE
C 105	STA 591·65	[signature]	12/12/55
		CHECKED BY	DATE

VERT

Centre Rear Spar



V = 0·1 R

M = 0·1 R (61·5 − 8·61)

M = 5·29 R

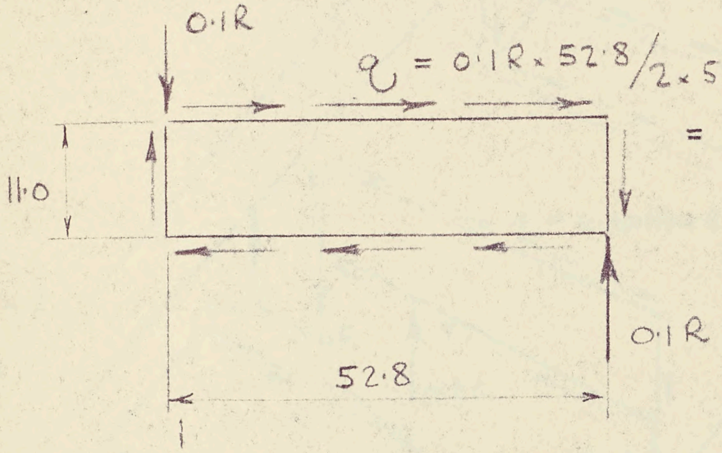
ORM 1319A

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

AIRCRAFT:		REPORT NO. 7-0558-45/2	
C 105	STA 591·65	SHEET NO. 2-13	
		PREPARED BY	DATE 12/12/55
		CHECKED BY	DATE

VERT.

Rib @ B.L. 57·1



$q = 0{\cdot}1R \times 52{\cdot}8 / 2 \times 52{\cdot}8 \times 11{\cdot}0$

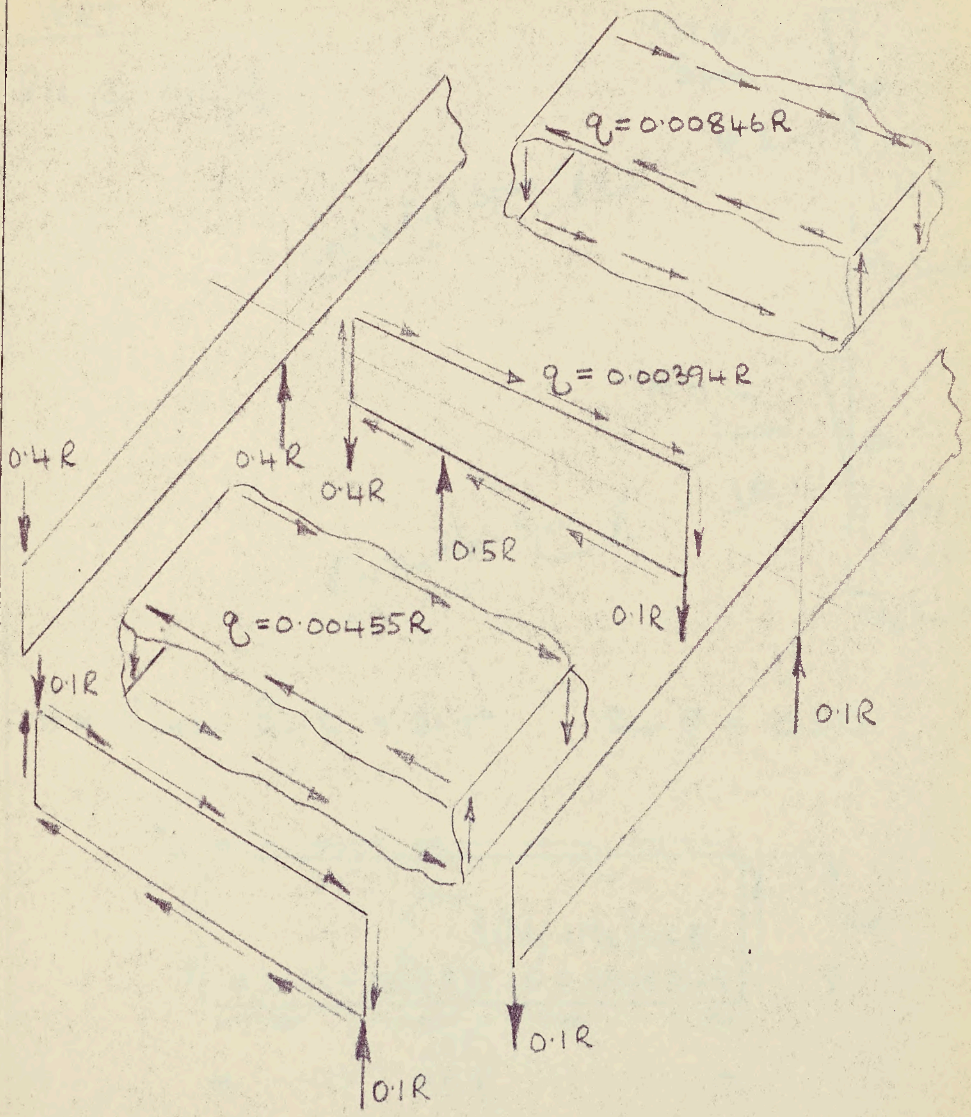
$= 0{\cdot}00455R$

FORM 1319A

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

REPORT No. 7-0558-45 | 2
SHEET No. 2-14

AIRCRAFT:		PREPARED BY	DATE
C 105	STA 591·65	[signature]	12 12 55
		CHECKED BY	DATE



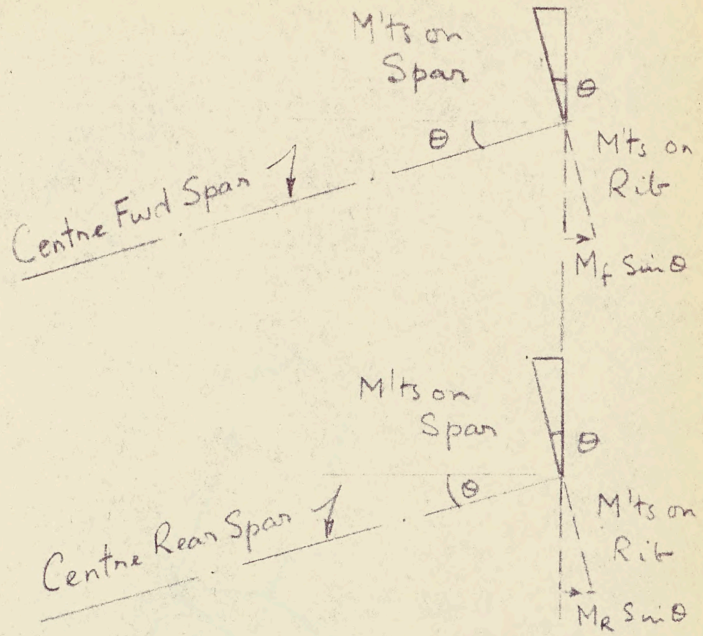
FORM 1319A

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

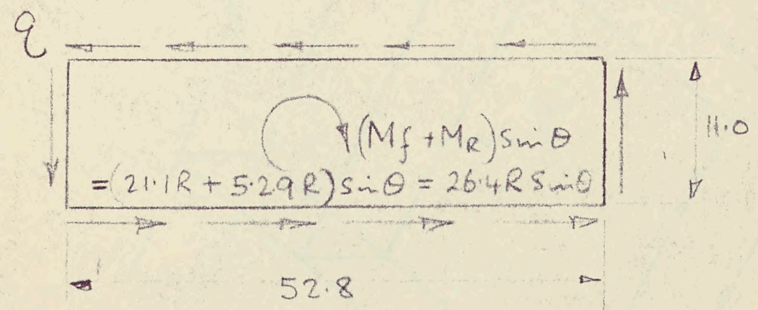
AIRCRAFT:		REPORT No. 7-0558-45/2	
C 105	STA 591·65	SHEET No. 7-15	
		PREPARED BY: D Shaw	DATE: 12/12/55
		CHECKED BY	DATE

VERT:

Rib @ A/C ℄



θ = Sweep Back = 21·9°   Sin θ = 0·372



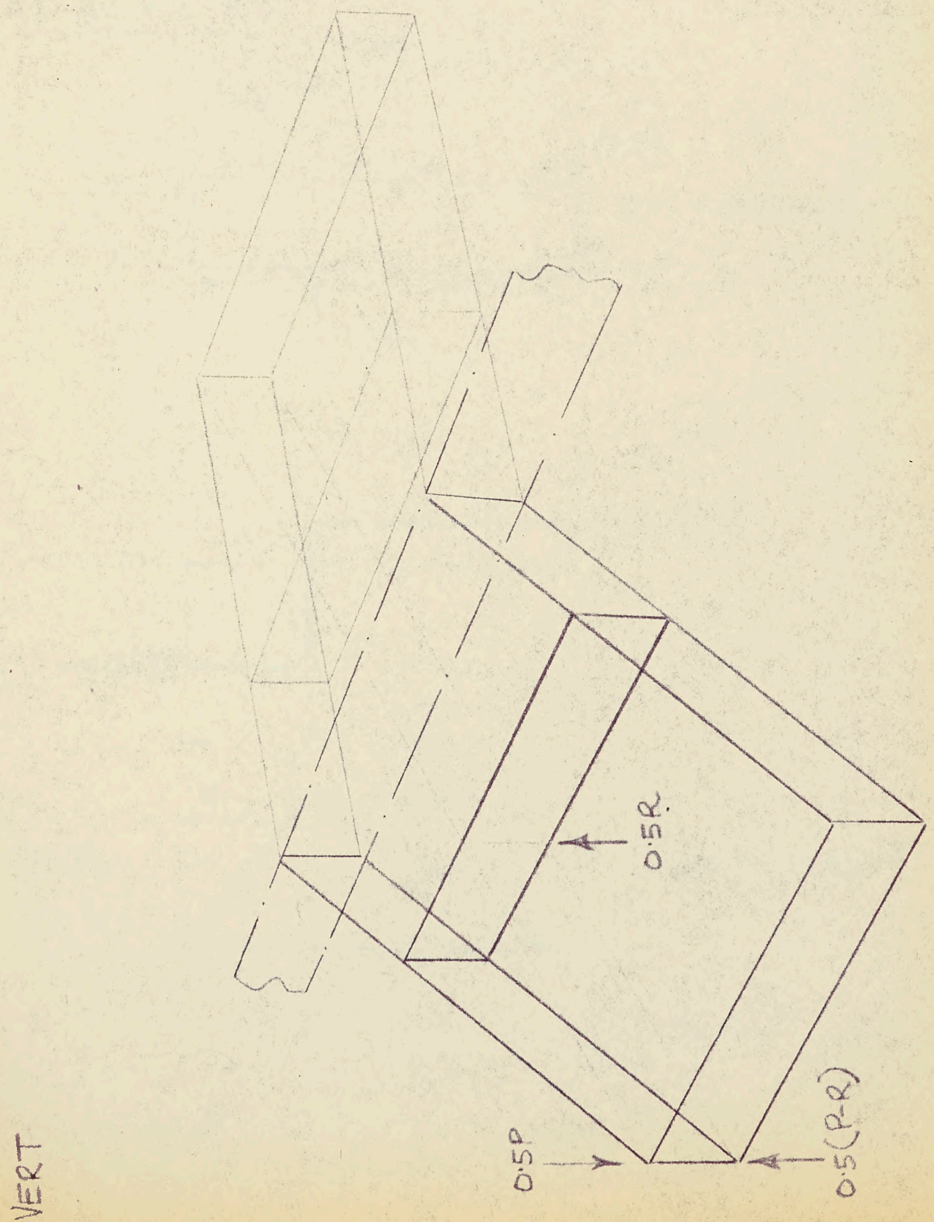
$q = 26{\cdot}4R \times 0{\cdot}372 / 2 \times 52{\cdot}8 \times 11{\cdot}0 = 0{\cdot}00846R$

FORM 1319A

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

REPORT NO. 7-0558-45 | 2
SHEET NO. 2-16

AIRCRAFT:		PREPARED BY	DATE
C 105	STA 591·65	[signature]	12/12/55
		CHECKED BY	DATE



FORM 1319A

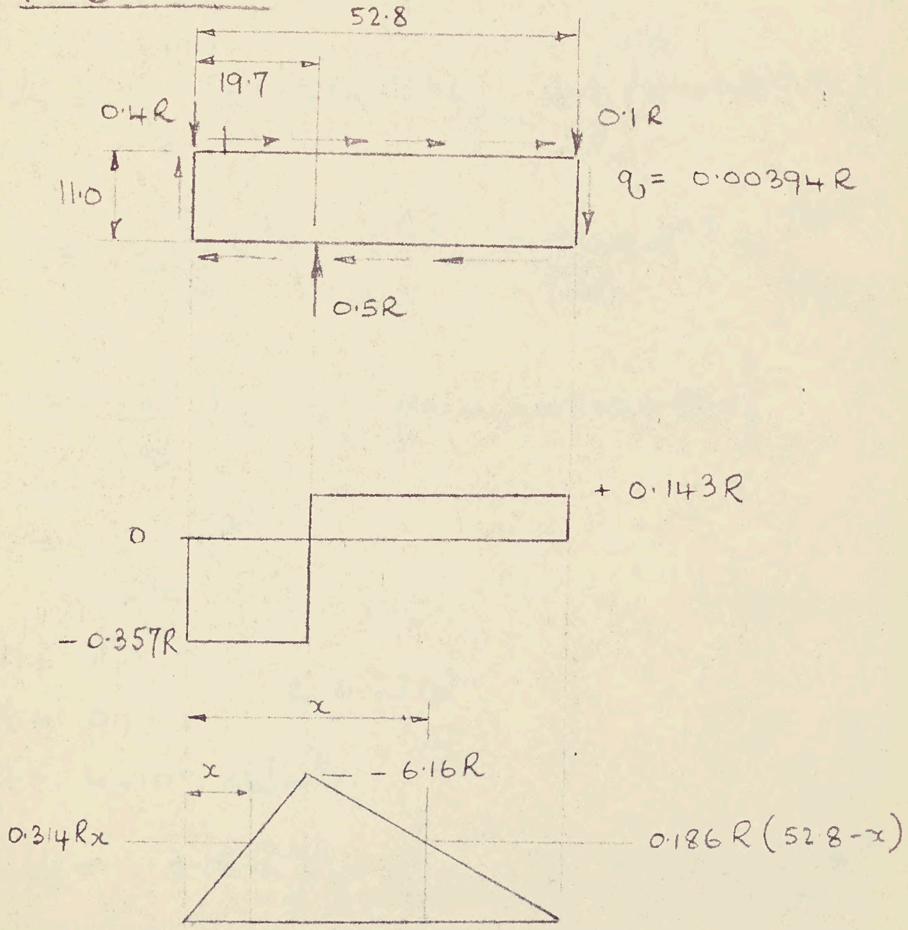
A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7-0558-45|2
SHEET NO. 2-17

AIRCRAFT:		PREPARED BY	DATE
C 105	STA. 591·65	[signature]	12/12/55
		CHECKED BY	DATE

VERT:

Rib @ B.L. 8.0



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

REPORT No. 7-0558-45/2
SHEET No. 2-18

AIRCRAFT:		PREPARED BY	DATE
C 105	STA. 591·65	J. Shorne	12/12/55
		CHECKED BY	DATE

VERT:

Rib @ B.L. 80

$$U_S = \int_0^{19.7} (-0.357R)^2 \, dx/2AG + \int_{19.7}^{52.8} (0.143R)^2 \, dx/2AG$$

$$= \frac{0.127R^2}{2AG}\Big[x\Big]_0^{19.7} + \frac{0.0205R^2}{2AG}\Big[x\Big]_{19.7}^{52.8}$$

$$= \frac{R^2}{2AG}\Big\{0.127 \times 19.7 + 0.0205 \times 33.1\Big\}$$

$$= \frac{3.18R^2}{2AG}$$

$h = 11.0$, $t = 0.1$ $\Big\}$ $\therefore A = 1.1 \text{ in}^2$

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

$$\therefore U_S = 3.18R^2/2 \times 1.1 \times 4 \times 10^6 = \underline{0.362 \times 10^{-6} R^2}$$

$$U_B = \int_0^{19.7} (0.314Rx)^2 \, dx/2EI + \int_{19.7}^{52.8} \{0.186R(52.8 - x)\}^2 \, dx/2EI$$

FORM 1319A

VERT

Rib @ B.L. 8·0

$$U_B = \frac{0.0985 R^2}{2EI}\left[\frac{x^3}{3}\right]_0^{19.7} + \frac{0.0345 R^2}{2EI}\left[2790x - \frac{105.6x^2}{2} + \frac{x^3}{3}\right]_{19.7}^{52.8}$$

$$= \frac{R^2}{2EI}\left\{0.0985 \times \frac{7700}{3} + 0.0345\left(2790 \times 33.1 - 52.8 \times 2402 + \frac{140,300}{3}\right)\right\}$$

$$= \frac{R^2}{2EI}\left\{253 + 0.0345(92,300 - 127,800 + 46,800)\right\}$$

$$= \frac{R^2}{2EI}\left\{253 + 0.0345 \times 11,300\right\}$$

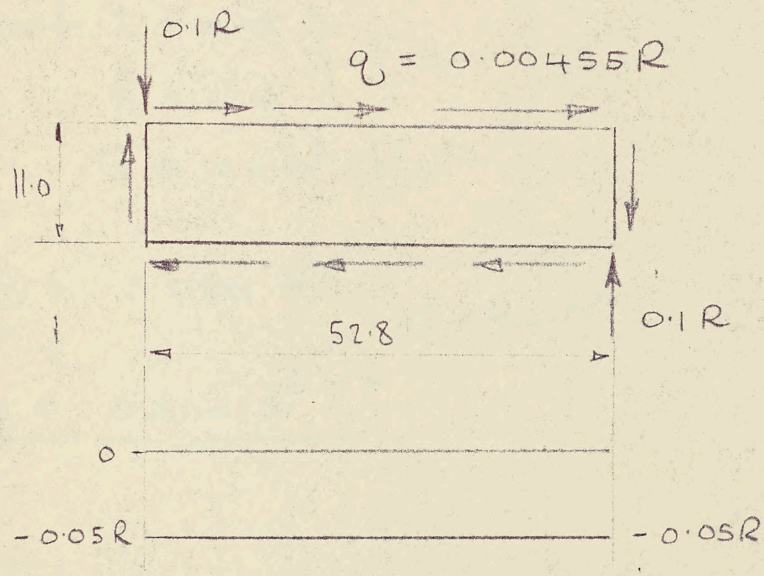
$$U_B = \frac{R^2}{2EI} \times 643$$

$I = I_3 \text{ in}^4 \quad E = 10.5 \times 10^6 \text{ lb/in}^2$

$$U_B = R^2 \times 643 / 2 \times 10.5 \times 10^6 \times I_3 = 30.6 \times 10^{-6} R^2 / I_3$$

VERT

Rib @ B.L. 57.1



B.M. = 0 along rib.

$$U_s = \int_0^{52.8} (-0.05R)^2 dx / 2AG$$

$$= \frac{0.0025}{2AG} R^2 \left[x \right]_0^{52.8}$$

$$= \frac{0.0025}{2AG} R^2 \times 52.8$$

$$U_s = 0.066 R^2 / AG$$

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

AIRCRAFT:		REPORT NO. 7-0558-45/2
C 105	STA 591·65	SHEET NO. 2-21
		PREPARED BY [signature] DATE 12/12/55
		CHECKED BY DATE

VERT

Rib @ B.L 57·1

web $t = 0{\cdot}15$, $h = 11{\cdot}0$ $\}$ $\therefore A = 1{\cdot}65 \ in^2$

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

$$U_S = 0{\cdot}066 \ R^2 / 1{\cdot}65 \times 4 \times 10^6$$

$$U_S = 0{\cdot}01 \times 10^{-6} \ R^2$$

FORM 1319 A

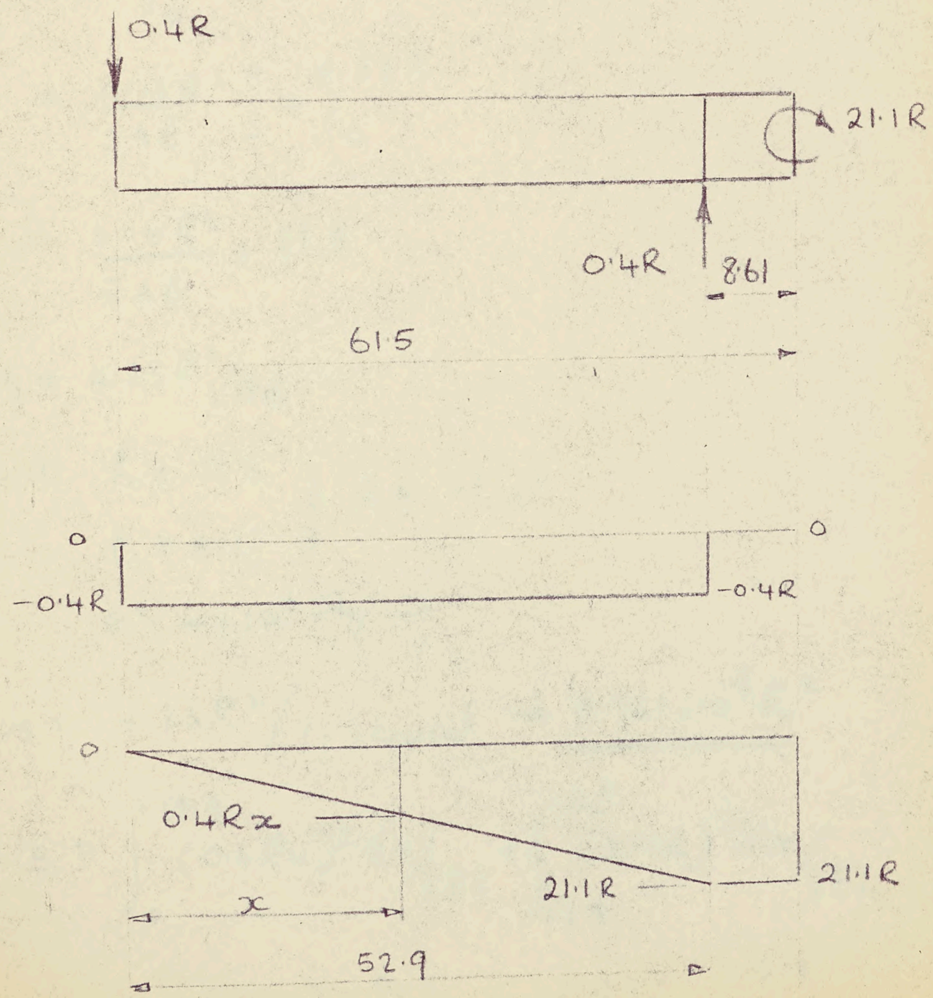
A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT NO.	7-0558-45/2
SHEET NO.	2-22

AIRCRAFT:		PREPARED BY	DATE
C 105	STA 591·65	D. Shaw	12/12/55
		CHECKED BY	DATE

VERT

Centre Fwd. Spar.



FORM 1319A

VERT

Centre Fwd Spar

$$U_S = \int_0^{52.9} (0.4R)^2 dx / 2AG$$

$$= \frac{0.16R^2}{2AG} \Big[x \Big]_0^{52.9}$$

$$= \frac{0.16R^2}{2AG} \times 52.9$$

$$U_S = 4.23 R^2 / AG$$

web $h = 11.0$, $t = 0.1$ } $A = 1.1 \text{ in}^2$

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

$$U_S = 4.23 R^2 / 1.1 \times 4 \times 10^6 = 0.961 \times 10^{-6} R^2$$

$$U_B = \int_0^{52.9} (0.4Rx)^2 dx / 2EI + \int_{52.9}^{61.5} (21.1R)^2 dx / 2EI$$

$$= \frac{0.16R^2}{2EI} \Big[\frac{x^3}{3} \Big]_0^{52.9} + \frac{445R^2}{2EI} \Big[x \Big]_{52.9}^{61.5}$$

FORM 1319A

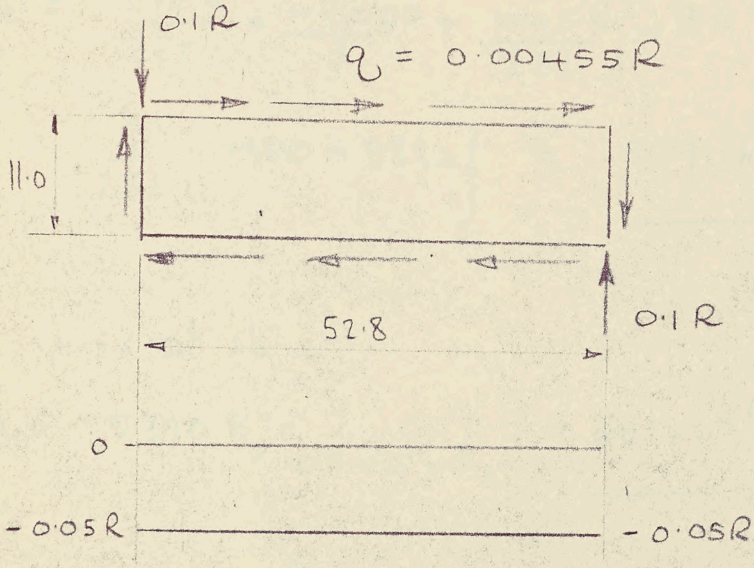
A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-0558-45 | 2
SHEET No. 2-20

AIRCRAFT: C 105 | STA 591.65

PREPARED BY: D S [illegible] | DATE: 12/12/55
CHECKED BY: | DATE:

VERT
Rib @ BL 57.1



BM = 0 along rib.

$$U_s = \int_0^{52.8} (-0.05R)^2 dx / 2AG$$

$$= \frac{0.0025 R^2}{2AG} \Big[x \Big]_0^{52.8}$$

$$= \frac{0.0025 R^2}{2AG} \times 52.8$$

$$U_s = 0.066 R^2 / AG$$

FORM 1319A

VERT

Centre Fwd Spar

$$U_B = \frac{0.16R^2}{2EI} \times \frac{149{,}000}{3} + \frac{445R^2}{2EI} \times 8.6$$

$$= \frac{R^2}{2EI}\left\{7950 + 3820\right\} = 5890R^2/EI$$

$I = I_1 \ in^4$

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

$$U_B = 5890R^2/10.5\times10^6 \times I_1 = 561\times10^{-6}R^2/I_1$$

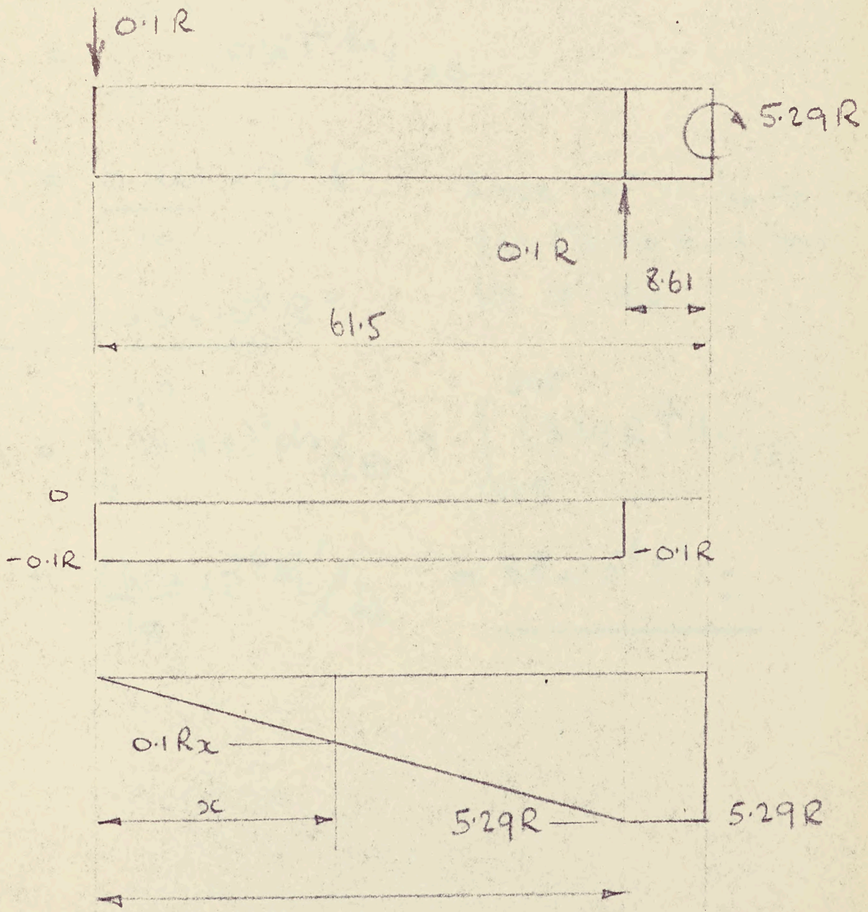
A. V. ROE CANADA LIMITED
MALTON - ONTARIO
TECHNICAL DEPARTMENT (Aircraft)

REPORT NO.	7-0558-45/2
SHEET NO.	2-25

AIRCRAFT:		PREPARED BY	DATE
C 105	STA 591·65	D Stone	12/12/55
		CHECKED BY	DATE

VERT

Centre Rear Spar



FORM 1319 A

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

REPORT No. 7-0558-45/2
SHEET No. 2-26

AIRCRAFT:		PREPARED BY	DATE
C 105	STA 591.65	[signature]	12/12/55
		CHECKED BY	DATE

VERT

Centre Rear Spar

$$U_S = \int_0^{52.9} (0.1R)^2 dx / 2AG$$

$$= \frac{0.961 \times 10^{-6} R^2}{16}$$

Since S.F is 1/4 of that for Centre Fwd Spar Us is 1/16

$$\underline{U_S = 0.06 \times 10^{-6} R^2}$$

$$U_B = \int_0^{52.9} (0.1Rx)^2 dx / 2EI + \int_{52.9}^{61.5} (5.29R)^2 dx / 2EI$$

$$U_B = \frac{561 \times 10^{-6} R^2}{16} / I_2 = \underline{35 \times 10^{-6} R^2 / I_2}$$

FORM 1319A

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

REPORT No. 7-0558-45/2	SHEET No. 2-27	
AIRCRAFT: C 105	STA 591·65	
PREPARED BY [signature]	DATE 12/12/55	
CHECKED BY	DATE	

VERT

Top Skin:

$$U_s = \int_0^{49.1} (0.00455R)^2 h\, dx / 2tG + \int_{49.1}^{57.1} (0.00846R)^2 h\, dx / 2tG$$

$$= \frac{20.7 \times 10^{-6} R^2 h}{2tG} \left[x \right]_0^{49.1}$$

$$+ \frac{71.6 \times 10^{-6} R^2 h}{2tG} \left[x \right]_{49.1}^{57.1}$$

$$= \frac{R^2 h \times 10^{-6}}{2tG} \left(1015 + 573 \right) = 794 R^2 h \times 10^{-6} / tG$$

$h = 52.8$ in

$t = 0.15$ in

$G = 4 \times 10^6$ lb/in²

$$U_s = 794 R^2 \times 52.8 \times 10^{-6} / 0.15 \times 4 \times 10^6$$

$$\underline{U_s = 0.0699 \times 10^{-6} R^2}$$

RM 1319A

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

REPORT No. 7-0558-45/2
SHEET No. 2-28

AIRCRAFT:		PREPARED BY	DATE
C 105	STA 591.65	D Shaw	12/12/55
		CHECKED BY	DATE

VERT

Bottom Skin

$$U_S = 794 R^2 h \times 10^{-6} / t G$$

$h = 52.8$ in

$t = 0.14$ in

$G = 4 \times 10^6$ lb/in²

$$U_S = 794 R^2 \times 52.8 \times 10^{-6} / 0.14 \times 4 \times 10^6$$

$$U_S = 0.0748 \times 10^{-6} R^2$$

FORM 1319A

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

REPORT No. 7-0558-45/2
SHEET No 2-29

AIRCRAFT:		PREPARED BY	DATE
C.105	STA. 591.65	[signature]	
		CHECKED BY	DATE

VERT

Item	U_S	U_B
Rib @ BL 8.0	$0.362 \times 10^{-6} R^2$	$30.6 \times 10^{-6} R^2 / I_3$
" " 57.1	$0.01 \times 10^{-6} R^2$	—
Centre Fwd Span	$0.96 \times 10^{-6} R^2$	$561 \times 10^{-6} R^2 / I_1$
" Rear "	$0.06 \times 10^{-6} R^2$	$35 \times 10^{-6} R^2 / I_2$
Top Skin	$0.0699 \times 10^{-6} R^2$	—
Bottom "	$0.0748 \times 10^{-6} R^2$	—

$$\Sigma U_S = 1.54 \times 10^{-6} R^2$$

If $I_1 = 600 \text{ in}^4$ $\quad 561 \times 10^{-6} R^2 / 600 = 0.935 \times 10^{-6} R^2$

$I_2 \quad 400 \quad 35 \times 10^{-6} R^2 / 400 = 0.0875 \times 10^{-6} R^2$

$I_3 \quad 200 \quad 30.6 \times 10^{-6} R^2 / 200 = 0.153 \times 10^{-6} R^2$

$$1.1755 \times 10^{-6} R^2$$

$U = 2.72 \times 10^{-6} R^2$ FOR HALF STRUCTURE

$U = 5.44 \times 10^{-6} R^2$ " WHOLE "

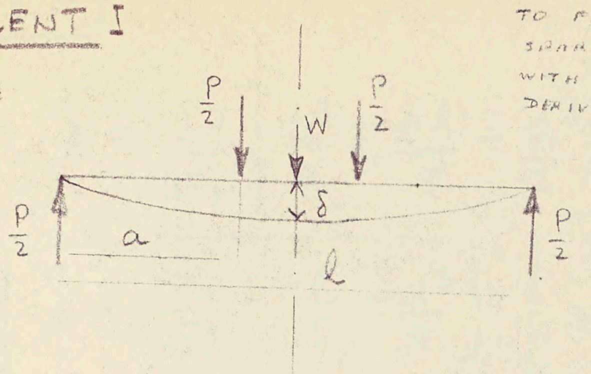
$$\frac{dU}{dR} = 10.88 \times 10^{-6} R$$

FORM 1319A

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**	REPORT No. 7-0558-45/2 SHEET No. 2-30	
AIRCRAFT: C 105	STA 591·65	PREPARED BY: D. Sh[illegible] — DATE: 14/12/55 CHECKED BY: — DATE:

EQUIVALENT I

TO FIND EQUIV. I OF A SPAR NORMAL TO A/C ℄ WITH SAME ENERGY DERIVATIVE AS P 2-29



$$\delta = \frac{\partial U}{\partial W} \quad \text{for } W = 0$$

$$= \frac{\partial U}{\partial M} \cdot \frac{\partial M}{\partial W} = \int \frac{M\,dx}{EI} \frac{\partial M}{\partial W}$$

$0 < x < a \quad M = \left(\frac{P}{2} + \frac{W}{2}\right)x \qquad \frac{\partial M}{\partial W} = \frac{x}{2}$

$a < x < \frac{l}{2} \quad M = \left(\frac{P}{2} + \frac{W}{2}\right)x - \frac{P}{2}(x - a) \qquad \frac{\partial M}{\partial W} = \frac{x}{2}$

$$\delta = 2\int_0^a \frac{P}{2}x \times \frac{x}{2} \frac{dx}{EI} + 2\int_a^{\frac{l}{2}} \frac{Pa}{2} \times \frac{x}{2} \frac{dx}{EI}$$

$$= \frac{2P}{4EI}\left[\frac{x^3}{3}\right]_0^a + \frac{2Pa}{4EI}\left[\frac{x^2}{2}\right]_a^{l/2}$$

$$= \frac{2P}{4EI}\left\{ \frac{a^3}{3} + \frac{a}{2} \times \frac{l^2}{4} - \frac{a}{2} \times a^2 \right\}$$

FORM 1319A

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

REPORT No. 7-0558-45/2
SHEET No. 2-31

AIRCRAFT: C 105 | STA 591·65

PREPARED BY: D. Sh[illegible] DATE: 14/12/55
CHECKED BY: DATE:

EQUIVALENT I

$$\delta = \frac{2P}{4EI}\left\{\frac{a^3}{3} + \frac{al^2}{8} - \frac{a^3}{2}\right\}$$

$$\boxed{\delta = \frac{Pa}{4EI}\left\{\frac{l}{4} - \frac{a^2}{3}\right\}}$$

$l = 2 \times 57{\cdot}1 = 114{\cdot}2$

$a = 57{\cdot}1 - 8{\cdot}0 = 49{\cdot}1$

$E = 10{\cdot}5 \times 10^6$

$$\delta = \frac{P \times 49{\cdot}1}{4 \times 10{\cdot}5 \times 10^6 I}\left\{\frac{(114{\cdot}2)^2}{4} - \frac{(49{\cdot}1)^2}{3}\right\}$$

$$= \frac{P \times 49{\cdot}1}{4 \times 10{\cdot}5 \times 10^6 I}\left\{3{,}260 - 804\right\}$$

$$\delta = \frac{1{\cdot}168 \times 10^{-6} P}{I} \times 2456 = 2870 \times 10^{-6} P/I$$

RM 1319A

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

AIRCRAFT: C 105	STA 591·65	REPORT No. 7-0558-45/2	SHEET No. 2-32
		PREPARED BY [signature]	DATE 14/12/55
		CHECKED BY	DATE

EQUIVALENT I

$$\delta = 10{\cdot}88 \times 10^{-6} P$$

$$2870 \times 10^{-6} P / I = 10{\cdot}88 \times 10^{-6} P$$

$$I = 2870 / 10{\cdot}88$$

$$I = 264 \text{ in}^4$$

ORM 1319A

ELASTIC STRAIN ENERGY IN BRACE

Each member carries an axial load

$= \left(\overline{0.5}^2 + \overline{0.074}^2\right)^{1/2} R$

$= 0.506R = P$

Length = 48.2 in Ref 7/0558/46 p 2A

Area = 0.343 in² " "

E = 2.9×10^7 lb/in²

There are two struts

$\therefore U = 2 \times \dfrac{P^2 L}{2AE}$

$= \dfrac{2 \times (0.506R)^2 \times 48.2}{2 \times 0.343 \times 2.9 \times 10^7}$

$U = 12.35 \times 10^{-7} R^2$

$\dfrac{dU}{dR} = 24.7 \times 10^{-7} R = 2.47 \times 10^{-6} R$

TOTAL $U = (5.44 + 1.24)10^{-6} R^2 = 6.68 \times 10^{-6} R^2$

$\dfrac{dU}{dR} = 13.36 \times 10^{-6} R$

EQUIVALENT I = 2870/13.36 = 215 in⁴

SECTION 3

PREDICTION OF FATIGUE LIFE OF A COMPLETE BAY LENGTH OF WING TO FUSELAGE HINGE.

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

REPORT NO. 7/0558/45-2.
SHEET NO. 3-1

AIRCRAFT:		PREPARED BY	DATE
C 105.	WING TO FUSELAGE JOINT.	C. RITCHFIELD	8 DEC 55
		CHECKED BY	DATE

THE PROBLEM IS TO PREDICT THE FATIGUE LIFE FOR THE TOTAL WING TO FUSELAGE JOINT

VARIOUS ASSUMPTIONS WILL BE MADE AND LISTED BUT THE MAIN ONE IS THAT ONLY ONE LUG ON EACH HINGE SECTION IS IN CONTACT WITH ITS EQUIVALENT ON THE WING HINGE AND THAT ALL OTHER LUGS ARE THE MAX TOLERANCE APART. THIS ASSUMPTION IS MADE AS THE LIGHT ALLOY HINGE TEST SHEWED THAT ALTHOUGH THE GAPS WERE A VARYING SIZE THE ASSUMPTION STATED ABOVE GAVE THEORETICAL RESULTS WHICH CHECKED WITH TEST RESULTS.

FIRST EACH TYPE OF HINGE SECTION WILL BE ANALYSED TO FIND THE STIFFNESS. THEN THE HINGE SECTIONS WITH THE LONGERON, IN A BAY LENGTH, WILL BE ANALYSED TO FIND THE DISTRIBUTION OF SHEAR LOAD.

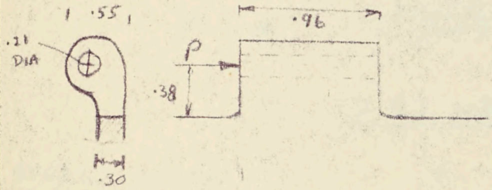
FORM 1319A

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT NO. 7/0558/45-2 SHEET NO. 3-2	
AIRCRAFT: C.105	WING TO FUSELAGE HINGE	PREPARED BY C. DITCHFIELD	DATE 8 DEC 55
		CHECKED BY	DATE

ALUMINUM HINGE. 7 - 1062 - 4075 / 4076.

MAX. TOLERANCE = ·004 INS.

ASSUMING FUSELAGE AND WING HINGE PARTS HAVE EQUAL STIFFNESSES THEN ONE LUG IS LOADED UNTIL IT DEFLECTS ·002 INS. BEFORE THE OTHERS START TO TAKE LOAD, THEN ALL LUGS TAKE THE ADDITIONAL LOAD EQUALLY



DEFLECTION IS CAUSED BY BENDING, SHEAR & END LOAD.

BENDING.

$E = 10{\cdot}5 \times 10^{6}$

$I = \dfrac{{\cdot}96^{3} \times {\cdot}30}{12} = {\cdot}0221 \text{ INS}^{4}$

$Z = {\cdot}0461 \text{ INS}^{3}$

$$\delta = \frac{P \cdot {\cdot}38^{3}}{3 . E . {\cdot}221}$$

$$= 0{\cdot}0788 \times P \times 10^{-6}$$

END LOAD

ASSUME ·1 WIDTH

$$\delta = \frac{P.L}{3AE}$$

$$= \frac{P \quad {\cdot}96}{3 \times {\cdot}1 \times {\cdot}34 \times 10{\cdot}5 \times 10^{6}}$$

$$= 0{\cdot}897 \times P \times 10^{-6}$$

FORM 1319 A

SHEAR

$$\delta = \frac{P\,l}{A_w G}$$

$$= \frac{P \cdot .38}{.288 \times 4 \times 10^6}$$

$$= 0.33 P \times 10^{-6}$$

$G = 4 \times 10^6$

$A_W = .3 \times .96$

$= .288 \, INS^2$

$$10^6 \times .002 = .0788 P + .897 P + .33 P$$

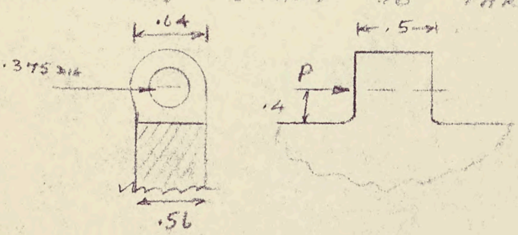
$$P = \frac{2000}{1.3058}$$

$$= \underline{1532 \text{ LBS}}$$

STEEL HINGE 7-1062-2245
2246

MAX. TOLERANCE = .004 INS.

ASSUMING MATING PARTS HAVE EQUAL STIFFNESSES THEN DEFLECTION OF LUG = .002 INS BEFORE OTHER LUGS START TO TAKE LOAD



BENDING

$$\delta_B = \frac{P \cdot .4^3}{3 \cdot 29 \cdot 10^6 \cdot .00429}$$

$$= .171 P \times 10^{-6}$$

$E = 29 \times 10^6$

$G = 11 \times 10^6$

$I = \frac{.412 \times .5^3}{12}$

$= .00429 \, INS^4$

$Z = .0172 \, INS^3$

FORM 1319A

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

REPORT No.	7/0558/45-2
SHEET No.	3-4

AIRCRAFT:		PREPARED BY	DATE
C.105	WING TO FUSELAGE HINGE	C. DITCHFIELD	8 DEC 55
		CHECKED BY	DATE

END LOAD.   ASSUME 1" BEARING WIDTH.

$$\delta_{11} = \frac{P \cdot .5}{3 \times .1 \times .265 \times 29 \times 10^6}$$

$$= .217\,P \times 10^{-6}.$$

SHEAR

$$\delta_s = \frac{P \cdot .4}{.206 \times 11 \times 10^6}$$

$A_w = .5 \times .412$ (AV WIDTH)
$= .206$ ins^2.

$$= .177\,P \times 10^{-6}$$

THUS

$$10^6 \times .002 = .171\,P + .217\,P + .177\,P.$$

$$P = \frac{2000}{.565}$$

$$= 3540 \text{ LBS}$$

FORM 1318A

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

REPORT NO. 7/0558/45-2	SHEET NO. 3-5	
AIRCRAFT: C 105	WING TO FUSELAGE HINGE.	
PREPARED BY: C. DITCHFIELD	DATE: 9 DEC 55.	
CHECKED BY:	DATE:	

ASSUMING TWO ADJACENT BAYS WITH THE MAX. SHEAR FLOW OF 1200 LBS/IN. ALSO ASSUMING THAT THE SHEAR IS APPLIED UNIFORMLY FROM THE SHEET TO THE LONGERON. THUS THE BAY TO BE ANALYSED WILL EXTEND FROM THE CENTRE OF ONE A/C BAY TO CENTRE OF THE NEXT. THERE ARE FOUR ALUMINUM HINGES AND ONE STEEL HINGE

TO FIND THE BALANCING SHEARS ON EACH HINGE SECTION WE MUST USE COMPATABILITY OF DEFLECTION. THERE ARE THREE TYPES OF DEFLECTION LUG, BOLT SLIP AND END LOAD DEFLECTION IN LONGERON, WHICH WILL BE USED TO FIND THE MAXIMUM BALANCING SHEAR ON THE STEEL AT A LOW LOAD LEVEL.

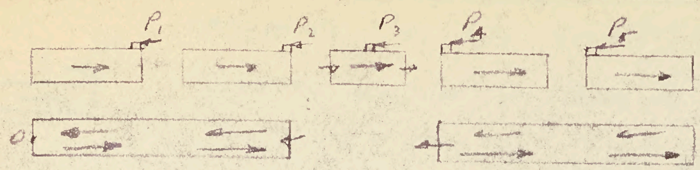
THE STEEL FITTING IS ATTACHED TO THE LONGERON BY MEANS OF TWO BOLTS AT EACH END.

FORM 1319A

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

REPORT No. 7/0558/45-2
SHEET No. 3-6.

AIRCRAFT:		PREPARED BY	DATE
C 105.	WING TO FUSELAGE HINGE.	C. DITCHFIELD	9 DEC 55
		CHECKED BY	DATE



FOR BAY LENGTH OF 53" STEEL HINGE 7" LONG
ALUMINIUM HINGE 11.5" LONG.

FOR 20% LOAD LEVEL AT 1200 LBS/IN ULTIMATE

SHEAR = 240 LBS/IN

SHEAR /AL. = $240 \times 11\frac{1}{2}$

= 2760 LBS.

SHEAR / ST. = 1680 LBS

ASSUME LUGS BEARING AS SHOWN ABOVE.

$$2P_1 + 2P_2 + P_3 = 240 \times 53 = 12720 \text{ LBS.}$$

THE BASE TO WHICH THE HINGE SECTIONS ARE JOINED IS ASSUMED RIGID AND THE SHEAR LOAD IS ASSUMED UNIFORMLY DISTRIBUTED ON BOLT CONNECTIONS.

TAKE LONGERON L.H. END AS DATUM.

ALUMINUM LUG DEFLECTS .001 FOR 766 LBS
STEEL — " — " — 1770 "

HINGE AREA = 0.3 INS^2 LONGERON AREA = 0.23 INS^2
$E_{ALUM} = 10.5 \times 10^6$, $E_{STEEL} = 29 \times 10^6$.
BOLT SLIP ASSUME .001 IN. FOR 625 LBS

FORM 1319A

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

AIRCRAFT:		REPORT No. 7/0558/45-2
C. 105	WING TO FUSELAGE HINGE	SHEET No. 3-7
		PREPARED BY: C DITCHFIELD. — DATE: 9 DEC 55.
		CHECKED BY: — DATE:

ASSUMING P_1 + P_5 GREATER THAN 1532 LBS

LOAD ON END LUG $= 1532 + \frac{P_1 - 1532}{6}$

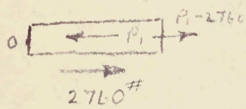
$$= 1277 + \frac{P_1}{6}$$

$$\delta_{LUG} = \frac{1277 + .167 P_1}{766} \times .001$$

$$= (1667 + .218 P_1)\, 10^{-6}$$

$$\delta_{EL_H} = \frac{P_1 \cdot 11.5}{.3 \times 3 \times 10.5 \times 10^6}$$

$$= (1.217 P_1)\, 10^{-6}$$



$$\delta_{BOLT\ SLIP} = \frac{P_1}{10} \times \frac{.001}{625}$$ [10 BOLTS PER HINGE]

$$= (.16 P_1)\, 10^{-6}$$

$$\delta_{EL_L} = -\frac{(P_1 - 2760)\, 11.5}{3 \cdot .23 \times 10.5 \times 10^6}$$

$$= (-1.588 P_1 + 4380)\, 10^{-6}$$

DEFLECTION OF LUG (1) RELATIVE TO O.

$$= \begin{pmatrix} .218 P_1 & + 1667 \\ 1.217 P_1 & \\ -1.588 P_1 & + 4380 \end{pmatrix} 10^{-6}$$

$$= \underline{(-.153 P_1 + 6047)\, 10^{-6}}$$

FORM 1319A

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

REPORT No. 7/0555/45-2		SHEET No. 3-8	
AIRCRAFT: C.105	WING TO FUSELAGE	PREPARED BY: C. DITCHFIELD	DATE: 9 DEC 55.
		CHECKED BY:	DATE:

$$\delta_{LUG} = \frac{P_2}{766} \times .001$$

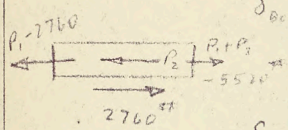
ASSUMING P_2 & P_4 LESS THAN 1532.#

$$= 1.307\, P_2 \times 10^{-6}$$

$$\delta_{LL_H} = \frac{P_2 \quad 11.5}{3 \times .3 \times 10.5 \times 10^6}$$

$$= 1.217\, P_2 \times 10^{-6}$$

$$\delta_{BOLT\ SLIP} = .16\, P_2 \times 10^{-6}$$ AS P



$$\delta_{LL_1} = -\frac{(P_1 - 2760)\ 11.5}{.23 \times 10.5 \times 10^6} - \frac{(P_2 - 2760)}{3 . .23 \times 10.5 \times 10^6}$$

$$= (-4.764 P_1 + 13140 - 1.588 P_2 + 4380)\ 10^{-6}$$

$$= (-4.764 P_1 - 1.588 P_2 + 17520)\ 10^{-6}$$

DEFLECTION OF LUG (2) RELATIVE TO O

$$= \delta_L + \delta_{LL_H} + \delta_{BS} + \delta_{LL_1} + \delta_{LL_2}$$

$$= 1.307\, P_2 + 1.217 P_2 + .16 P_2 - 4.764 P_1 - 1.588 P_2 + 17520$$
$$- 1.588 P_1 \qquad + 4380$$

$$= \underline{(-6.352 P_1 + .952\, P_2 + 21900)\ 10^{-6}}$$

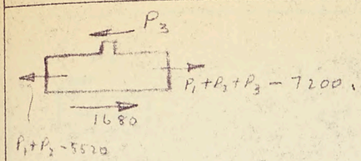
M 1319A

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

REPORT NO.	7-0555/45-2
SHEET NO.	3-9
PREPARED BY	E. DITCHFIELD
DATE	9 DEC '55
CHECKED BY	
DATE	

AIRCRAFT: C.105

WING TO FUSELAGE HINGE



$A_{STEEL} = 0.6 \text{ ins}^2$ (SAY)

ASSUMING P_3 LESS THAN 3540 LBS.

$$\delta_{LUG} = \frac{P_3}{1770} \times .001$$

$$= .565\, P_3 \times 10^{-6}$$

FOR HALF HINGE

$$\delta_{EL} = -\frac{(P_1+P_2-5520)\,3\tfrac{1}{2}}{0.6 \times 29 \times 10^6} - \frac{(P_3-1680)\,3\tfrac{1}{2}}{3 \times .6 \times 29 \times 10^6}$$

$$= \tfrac{1}{2}(-.403P_1 - .403P_2 + 2225 - .134P_3 + 226)10^{-6}$$

$$= \tfrac{1}{2}(-.403P_1 - .403P_2 - .134P_3 + 2451)\,10^{-6}$$

$$= (-.201P_1 - .201P_2 - .067P_3 + 1225)\,10^{-6}$$

LH END

$$\delta_{BS_1} = \frac{P_1+P_2-5520}{2} \times \frac{.001}{625} \quad \text{(2 BOLT ATTACHMENT)}$$

$$= (.8P_1 + .8P_2 - 4420)\,10^{-6}$$

R.H END

$$\delta_{BS_2} = \frac{P_1+P_2+P_3-7200}{2} \times \frac{.001}{625}$$

$$= (.8P_1 + .8P_2 + .8P_3 - 5760)\,10^{-6}$$

DEFLECTION OF LUG (3) FROM 0.

$$= (.565P_3 - .201P_1 - .201P_2 - .067P_3 + 1225 + .8P_1 + .8P_2 - 4410$$
$$- 4.764P_1 - 1.588P_2 + 17520 - 1.588P_1 + 4380)\,10^{-6}$$

$$= (-5.753P_1 - .989P_2 + .498P_3 + 18705)\,10^{-6}$$

RM 1319A

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT No. 7/0558/45-2 SHEET No. 3-10	
AIRCRAFT:		PREPARED BY	DATE
C. 105	WING TO FUSELAGE HINGE	C. DITCHFIELD.	9 DEC 55
		CHECKED BY	DATE

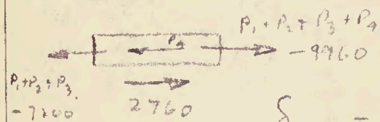
$$\delta_{LUG} = \frac{P_4}{766} \times .001$$

$$= 1.307\, P_4 \times 10^{-6}$$

$$\delta_{EL_H} = -\frac{P_4 .\ 11.5}{3 \times .3 \times 10.5 \times 10^6}$$

$$= -1.217\, P_4 \times 10^{-6}$$

$$\delta_{BS} = .16\, P_4 \times 10^{-6} \qquad \text{SEE P. 3-7}$$



$$\delta_{EL_L} = \frac{-(P_1 + P_2 + P_3 - 7200)\,11.5}{.23 \times 10.5 \times 10^7} - \frac{(P_4 - 2760)\,11.5}{3 \times .23 \times 10.5 \times 10^6}$$

$$= (-4.764 P_1 - 4.764 P_2 - 4.764 P_3 + 34300$$
$$- 1.588 P_4 + 4380)\, 10^{-6}$$

$$= (-4.764 P_1 - 4.764 P_2 - 4.764 P_3 - 1.558 P_4 + 38680)\, 10^{-6}$$

DEFLECTION OF LUG A RELATIVE TO O

$$= 1.307 P_4 - 1.217 P_4 + .16 P_4 - 4.764 P_1 - 4.764 P_2 - 4.764 P_3$$
$$- 1.558 P_4 + 38680 + .8 P_1 + .8 P_2 + .8 P_3 - 5760 + .8 P_1 + .8 P_2$$
$$- 4420 - .403 P_1 - .403 P_2 - .134 P_3 + 2451 - 4.764 P_1$$
$$- 1.558 P_2 + 17520 - 1.558 P_1 + 4350)\, 10^{-6}$$
$$= (-9.916 P_1 - 5.155 P_2 - 4.098 P_3 - 1.338 P_4 + 52851)\, 10^{-6}$$

M 1319 A

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

REPORT NO. 7/0555/45-2	SHEET NO. 3-11	
AIRCRAFT: C. 105	WING TO FUSELAGE HINGE	
PREPARED BY: D. DITCHFIELD	DATE: 9 DEC 55.	
CHECKED BY:	DATE:	

$$\delta_{LUG} = \frac{1277 + .167 P_5}{766} \times .001$$ SEE P.3-7

$$= (1667 + .218 P_1) 10^{-6}$$

$$\delta_{ELM} = -1.217 P_5 \times 10^{-6}$$

$$\delta_{BS} = .16 P_5 \times 10^{-6}$$

$$P_5 = 12720 - P_1 - P_2 - P_3 - P_4.$$

$$\delta_{ELL} = \frac{(P_5 - 2760) 11.5}{3 . 23 \times 10.5 \times 10^6}$$

$$= (1.588 P_5 - 4380) 10^{-6}$$

DEFLECTION OF LUG 5 RELATIVE TO O.

$$= (1667 + .218 P_5 - 1.217 P_5 + .16 P_5 + 1.588 P_5 - 4380) 10^{-6} +$$

$$(-9.916 P_1 - 5.155 P_2 - 4.098 P_3 - 1.338 P_4 + 52851) 10^{-6}$$

$$- (1.307 P_4 - 1.217 P_4 + .16 P_4) 10^{-6}$$

$$= (-9.916 P_1 - 5.155 P_2 - 4.098 P_3 - 1.588 P_4 + 0.749 P_5 + 50138) 10^{-6}.$$

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT No. 7/0558/45 ISS 2 SHEET No. 3-12	
AIRCRAFT:		PREPARED BY	DATE
C.105	WING TO FUSELAGE HINGE	C. DITCHFIELD	9 DEC 55
		CHECKED BY	DATE

AS WE ASSUME THAT THE REACTIONS P_1 - P_5 ARE PROVIDED BY AN INFINITE FOUNDATION THEN THE CALCULATED DEFLECTIONS MUST BE EQUAL

THUS WE HAVE 5 EQUATIONS AND SIX UNKNOWNS. THE SIXTH EQUATION IS PROVIDED BY $P_5 = 12720 - P_1 - P_2 - P_3 - P_4$ — (6)

$$10^6 \delta = (6047 - .153P_1) \quad (1)$$

$$= (21900 - 6.352P_1 + .952P_2) \quad (2)$$

$$= (18705 - 5.753P_1 - .989P_2 + .498P_3) \quad (3)$$

$$= (52551 - 9.916P_1 - 5.155P_2 - 4.098P_3 - 1.338P_4) \quad (4)$$

$$= (50138 - 9.916P_1 - 5.155P_2 - 4.098P_3 - 1.588P_4 + 0.749P_5) \quad (5)$$

SUBSTITUTING (6) IN (5)

$$\delta . 10^6 = 50138 - 9.916P_1 - 5.155P_2 - 4.098P_3 - 1.588P_4$$
$$9527 - 0.749P_1 - 0.749P_2 - 0.749P_3 - 0.749P_4$$

$$= 59665 - 10.665P_1 - 5.904P_2 - 4.847P_3 - 2.337P_4 \quad (7)$$

SUBST. (1) IN (2), (3), (4) & (7)

$$15853 - 6.199P_1 + .952P_2 = 0 \quad (8)$$

$$12658 - 5.600P_1 - .989P_2 + .498P_3 = 0 \quad (9)$$

$$46804 - 9.763P_1 - 5.155P_2 - 4.095P_3 - 1.338P_4 = 0 \quad (10)$$

$$53618 - 10.512P_1 - 5.904P_2 - 4.847P_3 - 2.337P_4 = 0 \quad (11)$$

FORM 1319A

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT No. 7/0555/45-2 SHEET No. 3-13	
AIRCRAFT: C.105.	WING TO FUSELAGE JOINT	PREPARED BY C. DITCHFIELD.	DATE 9 DEC 55
		CHECKED BY	DATE

FROM (8)

$$P_1 = 2557 + \cdot 153 P_2$$

SUBST. IN (9), (10) + (11).

$12658 \quad - \cdot 489 P_2 \quad + \cdot 498 P_3$

$-14319 \quad - \cdot 860 P_2$

$-1661 \quad - 1\cdot 849 P_2 \quad + \cdot 498 P_3 = 0.$ (12)

$46804 \quad - 5\cdot 155 P_2 - 4\cdot 098 P_3 - 1\cdot 338 P_4$

$-24964 \quad - 1\cdot 499 P_2$

$21840 - 6\cdot 654 P_2 - 4\cdot 098 P_3 - 1\cdot 338 P_4 = 0$ (13)

$53618 \quad - 5\cdot 904 P_2 - 4\cdot 847 P_3 - 2\cdot 337 P_4$

$-26879 \quad - 1\cdot 614 P_2$

$26839 - 7\cdot 528 P_2 - 4\cdot 847 P_3 - 2\cdot 337 P_4 = 0$ (14)

FROM (12)

$$P_2 = -898 + \cdot 269 P_3$$

SUBST IN (13) + (14)

$21840 \quad - 4\cdot 098 P_3 - 1\cdot 335 P_4$

$+ 5975 \quad - 1\cdot 790 P_3$

$27815 \quad - 5\cdot 888 P_3 - 1\cdot 338 P_4 = 0.$ (15)

$26839 \quad - 4\cdot 847 P_3 \quad - 2\cdot 337 \; P_4$

$+ 6760 - 2\cdot 025 P_3$

$33599 - 6\cdot 872 P_3 - 2\cdot 337 P_4 = 0$ (16)

FROM (15)

$$P_3 = 4724 - \cdot 227 P_4$$

SUBST IN (16)

$33599 \quad - 2\cdot 337 P_4$

$- 32463 \quad + 1\cdot 560 P_4$

$+ 1136 \quad - 0\cdot 777 P_4 = 0$

$P_4 = 1462$ LBS.

FORM 1319A

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

REPORT NO. 7/0555/45 iss 2
SHEET NO 3-14

AIRCRAFT:		PREPARED BY	DATE
C-105.	WING TO FUSELAGE HINGE	C DITCHFIELD	9 DEC 55.
		CHECKED BY	DATE

$P_3 = 4724 - .227 \times 1462$

$= 4392$ LBS.

$P_2 = -898 + .269 \times 4392$

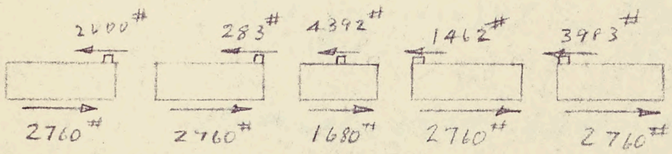
$= 283$ LBS

$P_1 = 2557 + 43$

$= 2600$ LBS

$P_5 = 12720 - 2600 - 283 - 4392 - 1462$

$= 3983$ LBS

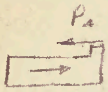


ORM 1319A

A. V. ROE CANADA LIMITED MALTON · ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT No. 7/0558/45 1112 SHEET No. 3-15	
AIRCRAFT: C 105	WING TO FUSELAGE HINGE	PREPARED BY: C. DITCHFIELD	DATE: 12 DEC 55.
		CHECKED BY	DATE

PUTTING LUGS AT 4.75 AT R.H. ENDS OF HINGES.

FROM P3-10



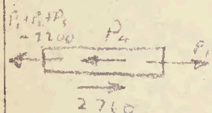
$$\delta_{LUG} = \frac{P_A}{766} \times .001$$

$$= 1.307\, P_4 \times 10^{-6}$$

$$\delta_{EL_H} = \frac{P_4 \cdot 11.5}{3 \times .3 \times 10.5 \times 10^6}$$

$$= 1.217\, P_4 \times 10^{-6}$$

$$\delta_{BS} = .16\, P_4 \times 10^{-6}$$



$$\delta_{EL_1} = \frac{-(P_1+P_2+P_3-7200)\,11.5}{.23 \times 10.5 \times 10^6} - \frac{(P_4-2760)\,11.5}{3 \times .23 \times 10.5 \times 10^6}$$

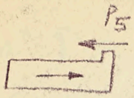
$$= (-4.764P_1 - 4.764P_2 - 4.764P_3 - 1.588P_4 + 38680)\,10^{-6}$$

DEFLECTION OF LUG 4 RELATIVE TO O

$$= (-9.916P_1 - 5.155P_2 - 4.098P_3 - 1.338P_4 + 52851)\,10^{-6}$$
$$+ 2.434P_4 \times 10^{-6}$$

$$= (-9.916P_1 - 5.155P_2 - 4.098P_3 + 1.096P_4 + 52851)\,10^{-6}$$

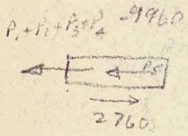
FORM 1319A



$$\delta_{LUG} = (1667 + .218 P_5)\, 10^{-6}$$

$$\delta_{EL_H} = 1.217\, P_5 \times 10^{-6}$$

$$\delta_{RS} = -.16\, P_5 \times 10^{-6}$$



$$\delta_{EL_1} = (1.558\, P_5 - 4350)\, 10^{-6}$$

DEFLECTION OF LUG 5 RELATIVE TO O

$$= (-9.916P_1 - 5.155P_2 - 4.098P_3 - 1.558P_4 + .749P_5 + 50138)\, 10^{-6}$$
$$+ 2.434 P_5 \times 10^{-6}$$

$$= (-9.916P_1 - 5.155P_2 - 4.098P_3 - 1.558P_4 + 3.183P_5 + 50138)\, 10^{-6}$$

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

AIRCRAFT: C105.	WING TO FUSELAGE HINGE.	REPORT NO. 7/0558/45-2	SHEET No 3-17
		PREPARED BY: C. DITCHFIELD	DATE: 12 DEC 55
		CHECKED BY	DATE

$10^6 \delta = 6047 - .153P_1$ (1)

$= 21900 - 6.352P_1 + .952P_2$ (2)

$= 18705 - 5.753P_1 - .984P_2 + .498P_3$ (3)

$= 52151 - 9.916P_1 - 5.155P_2 - 4.098P_3 + 1.096P_4$ (4)

$= 50138 - 9.916P_1 - 5.155P_2 - 4.098P_3 - 1.588P_4 + 3.183P_5$ (5)

$P_5 = 12720 - P_1 - P_2 - P_3 - P_4$ (6)

SUBST. (6) IN (5)

$$10^6\delta = 50138 - 9.916P_1 - 5.155P_2 - 4.098P_3 - 1.588P_4$$
$$40488 - 3.183P_1 - 3.183P_2 - 3.183P_3 - 3.183P_4$$
$$90626 - 13.099P_1 - 8.338P_2 - 7.281P_3 - 4.771P_4$$ (7)

SUBTRACTING (1) FROM (2) (3) (4) & (7)

$0 = 15853 - 6.199P_1 + .952P_2$ (8)

$0 = 12658 - 5.600P_1 - .984P_2 + .498P_3$ (9)

$0 = 46804 - 9.763P_1 - 5.155P_2 - 4.098P_3 + 1.096P_4$ (10)

$0 = 84579 - 12.946P_1 - 8.338P_2 - 7.281P_3 - 4.771P_4$ (11)

FROM (8)

$6.199P_1 = 15853 + .952P_2$

$\therefore P_1 = \underline{2557 + .153P_2}$ (12)

RM 1319A

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

AIRCRAFT:		REPORT No. 7/0558/45-2	
C.105	WING TO FUSELAGE HINGE	SHEET No. 3-18	
		PREPARED BY: C DITCHFIELD	DATE: 12 DEC 53
		CHECKED BY	DATE

SUBSTIT. (12) IN (9) (10) + (11)

$12658 \quad -.989 P_2 \quad +.498 P_3$

$-14319 \quad -.860 P_2$

$-1661 \quad -1.849 P_2 \quad +.498 P_3 = 0$ (13)

$46804 \quad -5.155 P_2 - 4.098 P_3 + 1.096 P_4$

$-24964 \quad -1.499 P_2$

$21840 - 6.654 P_2 - 4.098 P_3 + 1.096 P_4 = 0$ (14)

$84579 \quad -8.338 P_2 - 7.281 P_3 - 4.771 P_4$

$-33103 \quad -1.982 P_2$

$41476 \quad -10.320 P_2 - 7.281 P_3 - 4.771 P_4 = 0$ (15)

FROM (13)

$1.849 P_2 = -1661 + .498 P_3$

$P_2 = -898 + .269 P_3$ (16)

SUBSTIT. (16) IN (14) + (15)

$21840 - 4.098 P_3 + 1.096 P_4$

$+ 5975 - 1.790 P_3$

$27815 - 5.888 P_3 + 1.096 P_4 = 0$ (17)

$41476 - 7.281 P_3 - 4.771 P_4$

$+ 9267 - 2.776 P_3$

$50743 - 10.057 P_3 - 4.771 P_4 = 0$ (18)

FROM (17)

$5.888 P_3 = 27815 + 1.096 P_4$

$P_3 = 4724 + .186 P_4$ (19)

SUBST (19) IN (18)

$50743 \quad - 4.771 P_4$

$-47509 \quad -1.870 P_4$

$3234 - 6.641 P_4 = 0$

$P_4 = 487$ LBS.

$P_3 = 4815$ LBS. $\qquad P_1 = 2615$ LBS

$P_2 = 397$ LBS. $\qquad P_5 = 4403$ LBS.

FORM 1319A

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

REPORT NO. 7/0558/45-2		SHEET NO. 3-19	
AIRCRAFT: C. 105	WING TO FUSELAGE HINGE	PREPARED BY: C. DITCHFIELD	DATE: 12 DEC 55
		CHECKED BY	DATE

IF LUG 4 IS BEARING AT L.H. END + 5 AT R.H. END.

EQUS. ① ② ③ + ④ AS P.3-12. ⑤ AS P.3-17.

FROM P3-13 & 3-18 EQUS. 15 + 18 RESP.

$$27515 - 5.888\,P_3 - 1.338\,P_4 = 0 \quad ①$$

$$50743 - 10.057\,P_3 - 4.771\,P_4 = 0 \quad ②$$

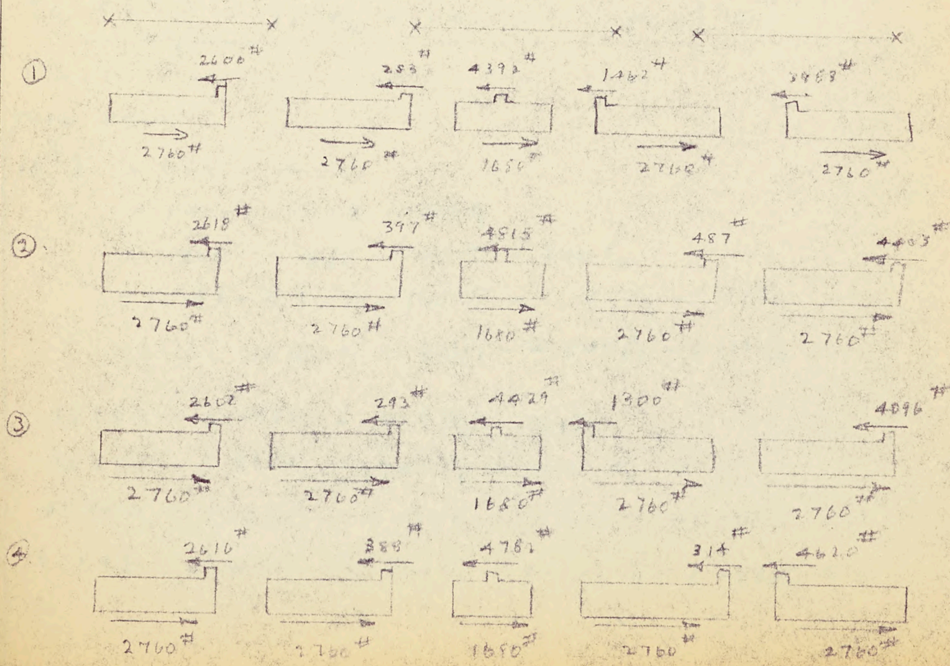
FROM ①

$$P_3 = 4724 - .227\,P_4$$

SUBSTIT. IN ②

$$50743 - 4.771\,P_4$$
$$-47509 + 2.283\,P_4$$
$$3234 - 2.488\,P_4 = 0$$

$$P_4 = 1300 \text{ LBS.}$$
$$P_3 = 4429 \text{ LBS.}$$
$$P_2 = 293 \text{ LBS.}$$
$$P_1 = 2602 \text{ LBS.}$$
$$P_5 = 4096 \text{ LBS.}$$



AS ALL P_3 LOADS ARE OVER 3540 LBS

ALL SOLUTIONS WILL HAVE TO BE RECALCULATED. SEE P3-20-25.

FORM 1319A

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

REPORT No. 71/0555/45-2		SHEET No. 3-20	
AIRCRAFT: C-105.	WING TO FUSELAGE HINGE	PREPARED BY: C. DITCHFIELD	DATE: 12 DEC 55
		CHECKED BY	DATE

TAKING THE STEEL HINGE LOAD AS GREATER THAN $3540^{\#}$. THIS CHANGES δ_{LUG} AND TOTAL DEFLECTION EQUATION, ON P3-9

OVER $3540^{\#}$ LOAD / LUG $= \dfrac{P_3 - 3540}{5} + 3540$

$$= \frac{P_3}{5} + \frac{4}{5}\,3540$$

$$\delta_{LUG} = \left(\frac{P_3}{5} + \frac{4}{5}\,3540\right)\frac{.001}{1770}$$

$$= (.113P_3 + 1600)\,10^{-6}$$

DEFL. OF LUG ③ FROM O

$$= (.113P_3 + 1600 - .201P_1 - .201P_2 - .067P_3 + 1225 + .8P_1 + .8P_2$$
$$- 4420 - 4.764P_1 - 1.588P_2 + 17520 - 1.588P_1 + 4380)\,10^{-6}$$

$$= (-5.753P_1 - .989P_2 + .046P_3 + 20305)\,10^{-6}$$

OTHER EQUATIONS STAY THE SAME

FROM P3-12

$10^6\,\delta = 6047 - .153P_1$ A

$= 21900 - 6.352P_1 + .952P_2$ B

$= 20305 - 5.753P_1 - .989P_2 + .046P_3$ C

$= 52851 - 9.916P_1 - 5.155P_2 - 4.098P_3 - 1.338P_4$ D

$= 59665 - 10.665P_1 - 5.904P_2 - 4.847P_3 - 2.337P_4$ E

$15853 - 6.199P_1 + .952P_2 = 0$ ①

$14258 - 5.600P_1 - .989P_2 + .046P_3 = 0$ ②

$46804 - 9.763P_1 - 5.155P_2 - 4.098P_3 - 1.338P_4 = 0$ ③

$53618 - 10.513P_1 - 5.904P_2 - 4.847P_3 - 2.337P_4 = 0$ ④

FORM 1319A

AIRCRAFT:		PREPARED BY	DATE
C.105	WING TO FUSELAGE HINGE	C DITCHFIELD	12 DEC 55
		CHECKED BY	DATE

FROM (1)

$$P_1 = 2557 + .153P_2$$

SUBST IN (2) (3) & (4).

$14258 - .989P_2 + .046P_3$

$-14319 - .860P_2$

$-61 - 1.849P_2 + .046P_3 = 0$ (5)

$21840 - 6.654P_2 - 4.098P_3 - 1.338P_4 = 0$ (6)

$26839 - 7.528P_2 - 4.847P_3 - 2.337P_4 = 0.$ (7)

SEE P.

FROM (5).

$$P_2 = -33 + .025P_3$$

SUBST. IN (6) & (7)

$21840 - 4.098P_3 - 1.338P_4$

$+ 220 - .165P_3$

$22060 - 4.263P_3 - 1.338P_4 = 0.$ (8)

$26839 - 4.847P_3 - 2.337P_4$

$+ 248 - .187P_3$

$27087 - 5.034P_3 - 2.337P_4 = 0$ (9)

FROM (8)

$$P_3 = 5175 - .314P_4$$

SUBSTIT IN (9).

$27087 - 2.337P_4$

$26051 - 1.581P_4$

$1036 - 3.918P_4 = 0.$

$$P_4 = 264 \text{ LBS}$$

$P_3 = $ 5092 LBS. $P_2 = $ 94 LBS. $P_1 = $ 2571 LBS

$P_5 = $ 4699 LBS.

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

REPORT No. 7/0558/45-2
SHEET No. 3-22

AIRCRAFT:		PREPARED BY	DATE
C 105	WING TO FUSELAGE HINGE	C. DITCHFIELD	12 DEC 55.
		CHECKED BY	DATE

ALL ALUMINUM LUGS AT R.H. END
FROM P3-17.
EQU (3) BECOMES

$$10^6 \delta = 20305 - 5.753 P_1 - .989 P_2 + .046 P_3$$

ALL OTHERS THE SAME.
(5) (9) (10) & (11) BECOME.

$$0 = 15853 - 6.199 P_1 + .952 P_2$$ (1)

$$0 = 14258 - 5.660 P_1 - .989 P_2 + .046 P_3$$ (2)

$$0 = 46806 + 9.763 P_1 - 5.155 P_2 - 4.098 P_3 + 1.096 P_4$$ (3)

$$0 = 84579 - 12.940 P_1 - 8.328 P_2 - 7.281 P_3 - 4.771 P_4$$ (4)

FROM (1)

$$P_1 = 2557 + .153 P_2$$

SUBST. IN (2) (3) & (4).

$$14258 - .989 P_2 + .046 P_3$$
$$-14319 - .860 P_2$$
$$-61 - 1.849 P_2 + .046 P_3 = 0$$ (5)

$$21840 - 6.654 P_2 - 4.098 P_3 + 1.096 P_4 = 0$$ (6)

$$41476 - 10.320 P_2 - 7.281 P_3 - 4.771 P_4 = 0$$ (7)

FROM (5)

$$P_2 = -33 + .025 P_3$$

SUBST. IN (6) & (7).

$$21840 - 4.098 P_3 + 1.096 P_4$$
$$+ 220 - .165 P_3$$
$$22060 - 4.263 P_3 + 1.096 P_4 = 0$$ (8)

$$41476 - 7.281 P_3 - 4.771 P_4$$
$$+ 341 - .258 P_3$$
$$41817 - 7.539 P_3 - 4.771 P_4 = 0$$ (9)

FORM 1319 A

AIRCRAFT:		PREPARED BY	DATE
C 105	WING TO FUSELAGE HINGE	C. DITCHFIELD.	12 DEC 55
		CHECKED BY	DATE

FROM ⑧.

$$P_3 = 5175 + .257 P_4$$

SUBST. IN ⑦.

$$4181? - 4.771 P_4$$
$$- 39014 - 1.938 P_4$$
$$2803 - 6.709 P_4 = 0$$

$$P_4 = \underline{418 \text{ LBS}}$$

$P_3 = \underline{5282 \text{ LBS}}$ $P_2 = \underline{99 \text{ LBS}}$ $P_1 = \underline{2572 \text{ LBS}}$

$$P_5 = \underline{4349 \text{ LBS}}$$

IF LUG 4 IS AT L.H. END + 5 AT R H END

EQUS. A, B C + D AS P3-20 E AS ⑦. P3-17.

$10^6 \delta = 6047 - .153 P_1$

$= 21900 - 6.352 P_1 + .952 P_2$

$= 20305 - 5.753 P_1 - .989 P_2 + .046 P_3$

$= 52851 - 9.916 P - 5.155 P_2 - 4.098 P_3 - 1.338 P_4$

$= 90626 - 13.099 P_1 - 8.338 P_2 - 7.281 P_3 - 4.771 P_4$

$15853 - 6.199 P_1 + .952 P_2 = 0$ ①

$14258 - 5.600 P_1 - .989 P_2 + .046 P_3 = 0$ ②

$46804 - 9.763 P_1 - 5.155 P_2 - 4.098 P_3 - 1.338 P_4 = 0$ ③

$84579 - 12.946 P_1 - 8.338 P_2 - 7.281 P_3 - 4.771 P_4 = 0$ ④

FROM ①. $P_1 = 2557 + .153 P_2$

SUBST. IN ② ③ + ④

$-61 - 1.849 P_2 + .046 P_3 = 0$ ⑤

$21840 - 6.654 P_2 - 4.098 P_3 - 1.338 P_4 = 0$ ⑥

$84579 - 8.338 P_2 - 7.281 P_3 - 4.771 P_4$
$- 33103 - 1.988 P_2$

$41476 - 10.320 P_2 - 7.281 P_3 - 4.771 P_4 = 0$ ⑦

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

AIRCRAFT:		REPORT No. 7/0558/45-2	SHEET No. 3-24
C 105	WING TO FUSELAGE HINGE	PREPARED BY: C DITCHFIELD	DATE: 12 DEC 55
		CHECKED BY	DATE

FROM (5)

$$P_2 = -33 + .025 P_3$$

SUBST IN (6) + (7).

$21840 - 4.098 P_3 - 1.335 P_4$
$220 - .165 P_3$

$21060 - 4.263 P_3 - 1.335 P_4 = 0$

$41476 - 7.281 P_3 - 4.771 P_4$
$341 - .258 P_3$

$41817 - 7.539 P_3 - 4.771 P_4 = 0$ (9)

FROM (8) $P_3 = 5175 - .314 P_4$

SUBST. IN (9)

$41817 - 4.771 P_4$
$-39014 + 2.367 P_4$

$2803 - 2.404 P_4 = 0$

$P_4 = \underline{1166 \text{ LBS}}$

$P_3 = \underline{4809 \text{ LBS}}$ $P_2 = \underline{87 \text{ LBS}}$ $P_1 = \underline{2570 \text{ LBS}}$.

$P_5 = \underline{4088 \text{ LBS}}$

FOR LUG 4 AT R.H.END + LUG 5 AT L H END

$10^6 \delta = 6047 - .153 P_1$

$= 21900 - 6.352 P_1 + .952 P_2$ P 3-20

$= 20305 - 5.753 P_1 - .989 P_2 + .046 P_3$

$= 52851 - 9.916 P_1 - 5.155 P_2 - 4.098 P_3 + 1.096 P_4$

$= 59665 - 10.665 P_1 - 5.904 P_2 - 4.847 P_3 - 2.337 P_4$

FORM 1319A

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

REPORT No. 7/0558/45-2
SHEET No. 3-25

AIRCRAFT:		PREPARED BY	DATE
C-105	WING TO FUSELAGE HINGE	C. DITCHFIELD	12 DEC 55
		CHECKED BY	DATE

THESE EQUATIONS REDUCE TO:-

$$22060 - 4.263P_3 + 1.096P_4 = 0 \quad (1)$$

$$27087 - 5.034P_3 - 2.337P_4 = 0 \quad (2)$$

} P 3-21

FROM (1)

$$P_3 = 5175 + .257P_4$$

SUBST. IN (2)

$$27087 - 2.337P_4$$

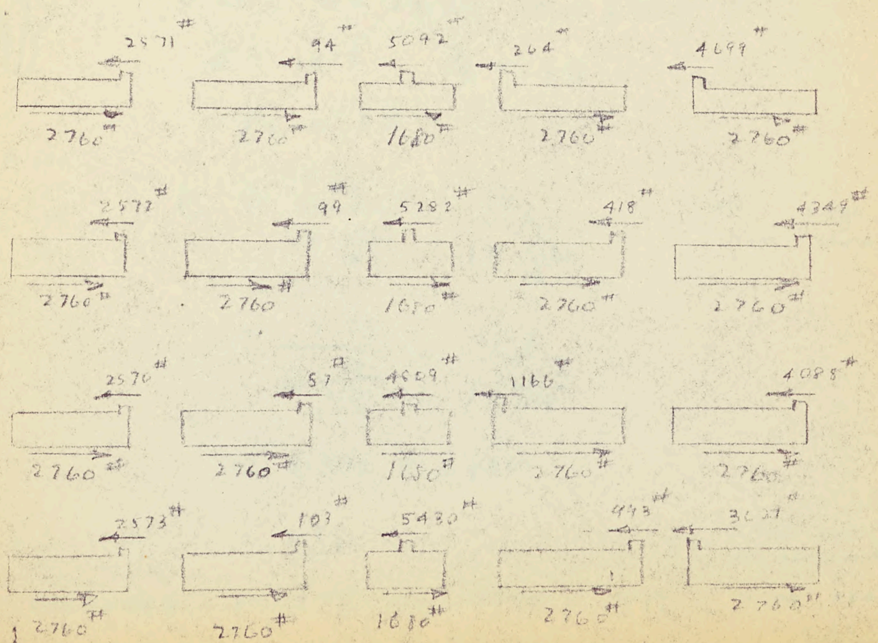
$$26051 - 1.294P_4$$

$$1036 - 1.043P_4$$

$$P_4 = \underline{993 \text{ LBS}}$$

$P_3 = 5430$ LBS. $P_2 = 103$ LBS $P_1 = 2573$ LBS

$P_5 = 3621$ LBS.



FORM 1319A

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT No. 7/0555/45-2 SHEET No. 3-26	
AIRCRAFT: C 105	WING TO FUSELAGE HINGE.	PREPARED BY C. DITCHFIELD	DATE 13 DEC 55
		CHECKED BY	DATE

ALUMINIUM HINGE.

MAX. LOAD = 4699#. P. 3-25 20% LOAD LEVEL.

MAX. LOAD ON ONE LUG $= \frac{4699 - 1532}{6} + 1532$

$= 2060$ LBS.

BENDING STRESS $= \frac{2060 \times .38}{.0461}$

$= 17000$ p.s.i

FROM PETERSON'S "STRESS CONCENTRATION FACTORS" FIG. 60

$r = .12$ $D = 1.92$ $d = .96$

$r/d = .125$ $D/d = 2.0$

$K_t = 1.73.$

IN OTHER PLANE FIG. 57

$r = .25$ $D = 2 \times .57$ $d = 2 \times .30$

$r/d = .417$ $D/d = 1.9$

$K_T = 1.5$

ASSUMING

$$K_F = \frac{K_{T_1}}{1 + \frac{a_1}{\sqrt{b_1 r_1}}} \cdot \frac{K_{T_2}}{1 + \frac{a_2}{\sqrt{b_2 r_2}}}$$

AIRCRAFT ENGG MARCH 1947.

$$= \frac{1.73}{1 + \frac{.09}{\sqrt{.12}}} \times \frac{1.5}{1 + \frac{.09}{\sqrt{.25}}}$$

$= 1.372 \times 1.436$

$= \underline{1.97}$

P. 3-29
FROM FATIGUE CURVE AT $16.75 \times 10^3 \pm 16.75 \times 10^3$ GOOD FOR 1.65×10^6 CYCLES.

MAX. FACTORED STRESS $= 17000 \times 1.97$

$= 33,500$ p.s.i

FORM 1319A

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT No. 7/0555/45-2 SHEET No. 3-27	
AIRCRAFT:		PREPARED BY	DATE
C 105	WING TO FUSELAGE HINGE	C. DITCHFIELD	13 DEC 55.
		CHECKED BY	DATE

STEEL HINGE

AT 1.0 h MAX. LOAD = 5430 LBS. P 3-25.

$$\text{MAX. LOAD ON ONE LUG} = \frac{5430 - 3540}{5} + 3540$$

$$= 3918 \text{ LBS.}$$

$$\text{BENDING STRESS} = \frac{3918 \times .4}{.0172}$$

$$= 91{,}100 \text{ psi.}$$

$$\text{END LOAD STRESS} = \frac{50000 \times .2}{5 \times .5 \times .56}$$

$$= 7150 \text{ psi.}$$

FROM PETERSON'S "STRESS CONCENTRATION FACTORS" FIG. 60.

$r_1 = .05 \ (.09) \ (.11)$ NOM. $.06 \ (.11) \ (.12)$

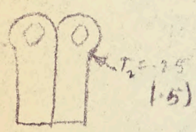
$D = 1.0$ (SAY) $d = 0.5$

$r/d = .1 \ (.18) \ (.22)$ $D/d = 2.0$

$K_T = 1.85 \ (1.55) \ (1.46)$

IN OTHER PLANE

FIG. 57.



$d = 1.12$ $D = 1.28$

$r/d = .223$ (.446) $D/d = 1.14$

$K_T = 1.44 \ (1.15)$

RM 1319 A

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT NO. 7/0558/45-2 SHEET NO. 3-28	
AIRCRAFT:		PREPARED BY	DATE
C 105.	WING TO FUSELAGE HINGE	C. DITCHFIELD.	13 DEC 55.
		CHECKED BY	DATE

ASSUMING AIRCRAFT ENGG. MAR 1947.

$$K_F = \frac{K_{T_1}}{1+\frac{a_1}{\sqrt{b_1 t_1}}} \times \frac{K_{T_2}}{1+\frac{a_2}{\sqrt{b_2 t_2}}} \qquad \frac{1.46}{1+\frac{.03}{\sqrt{.11}}} \cdot \frac{1.15}{1+\frac{.03}{\sqrt{.5}}}$$

$$= \frac{1.85}{1+\frac{.03}{\sqrt{.05}}} \times \frac{1.44}{1+\frac{.03}{\sqrt{.125}}} \left(\frac{1.55}{1+\frac{.03}{\sqrt{.09}}} \cdot \frac{1.44}{1+\frac{.03}{\sqrt{.15}}} \right)$$

$$= 1.63 \times 1.36 \qquad (1.41 \times 1.36) \; (1.34 \times 1.105)$$

$$= 2.22 \quad (1.92) \quad (1.48)$$

MAX FACTORED STRESS $= 98{,}250 \times 2.22\,(1.92)\,(1.48)$

$= 218000\ (189{,}000).\ (145000).$

[ELIMINATE DUAL RADII EFFECT GIVES 98250. ~~.41~~ = 135000 psi]

FROM UNIVERSITY OF ILLINOIS BULLETIN No 334.

$$f_{ALT} = f_r \left[1 - \frac{f_{mean}}{f_{ult}} \right].$$

f_{ALT} = ALTERNATING STRESS

(MODIFIED GOODMAN CURVE EQU.).

IF $f_{ALT} = f_{MEAN}$ FOR STRESS RATIO = 0.

f_R = REVERSED BENDING FATIGUE STRENGTH

$$f_{MEAN} = .48\, f_{ULT} \left[1 - \frac{f_{MEAN}}{f_{ULT}} \right]$$

.48 FACTOR COMES FROM PRODUCT ENGG. OCT. 1953 P 136 FOR 180.000 p.s.i.

$$1.48\, f_{MEAN} = .48\, f_{ULT}$$

$$f_{MEAN} = .324\, f_{ULT}.$$

FOR 180.000 psi. f_{MEAN} = 58500 psi AT 10^7 CYCLES.

MAX. ALLOW. STRESS = 117000 p.s.i. AT 10^7 CYCLES

(SAY) MAX. ALLOW. STRESS = 120,000 p.s.i AT 2.5×10^6 CYCLES

FRM 1319A

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

REPORT No. 7/0558/45-2
SHEET No. 3-28A

AIRCRAFT:		PREPARED BY	DATE
C 105	WING TO FUSELAGE HINGE	C DITCHFIELD	DEC 55
		CHECKED BY	DATE

USING THE CURVE PLOTTED ON P. 3-29 BOTH THE FIRST AND SECOND CALCULATIONS ARE UNSATISFACTORY THE THIRD CALCULATION SHOWS A MEAN STRESS OF 72,500 psi FOR A STRESS RATIO OF ZERO.

THIS IS SATISFACTORY FOR 0.1×10^6 CYCLES AT 20% LOAD LEVEL.

CONDITIONS

·12 RADIUS IN LUG

·5 RADIUS AT SIDE OF LUG.

IF SIDE RADIUS IS MADE 1" THEN DUAL RADIUS EFFECT CAN BE NEGLECTED.

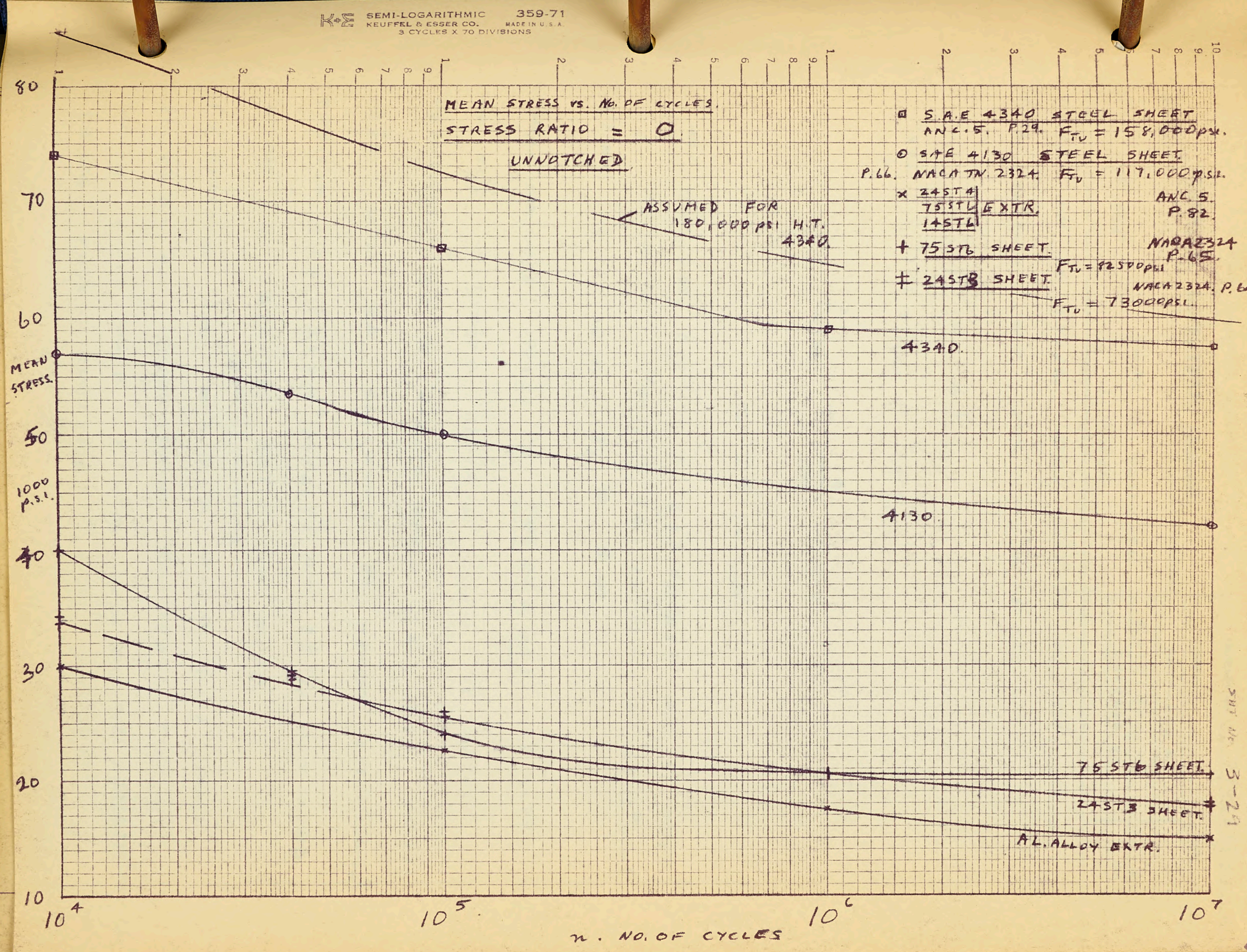
$$K_F = 1.34$$

MAX. FACTORED STRESS $= 98250 \times 1.34$

$= 131,600$ psi.

OR A MEAN STRESS OF 65,800 psi AT A STRESS LEVEL $= 0$.

THIS IS GOOD FOR 0.8×10^6 CYCES.


SEMI-LOGARITHMIC 359-71
KEUFFEL & ESSER CO. MADE IN U.S.A.
3 CYCLES X 70 DIVISIONS
MEAN STRESS vs. No. OF CYCLES.
STRESS RATIO = 0
UNNOTCHED
ASSUMED FOR 180,000 psi H.T. 4340
□ S.A.E 4340 STEEL SHEET ANC.5. P.29. F_{TU} = 158,000 psi.
○ SAE 4130 STEEL SHEET P.66. NACA TN. 2324. F_{TU} = 117,000 psi.
× 24ST4 75ST6 14ST6 EXTR. ANC 5. P.82.
+ 75ST6 SHEET F_{TU} = 82500 psi NACA 2324 P.65.
‡ 24ST3 SHEET NACA 2324. P.64 F_{TU} = 73000 psi.
4340.
4130.
75ST6 SHEET.
24ST3 SHEET.
AL. ALLOY EXTR.
MEAN STRESS.
1000 p.s.i.
80
70
60
50
40
30
20
10
10^4
10^5
10^6
10^7
n. NO. OF CYCLES

A. V. ROE CANADA LIMITED MALTON - ONTARIO **TECHNICAL DEPARTMENT (Aircraft)**		REPORT No. 7/0558/45-2 SHEET No. 3-30	
AIRCRAFT:		PREPARED BY	DATE
C.105	WING TO FUSELAGE HINGE.	C. DITCHFIELD	16 DEC 55
		CHECKED BY	DATE

USING EN 30 STEEL HEAT TREATED TO 240,000 p.s.i.

FROM PRODUCT ENG. OCT 1953 P.136.

$$f_r = \cdot 4 f_{ULT}$$

THUS $$1\cdot 4 f_{MEAN} = \cdot 4 f_{ULT}$$

$$f_{MEAN} = \frac{\cdot 4}{1\cdot 4} 240000$$

$$= 68,500 \text{ psi}$$

MAX ALLOWABLE STRESS = 137,000 p.s.i AT 10^7 CYCLES

(SAY) = 141,000 p.s.i AT 2.5×10^6 CYCLES.

USING $r_1 = \cdot 12$ INS $r_2 = \cdot 5$ INS.

MAX. FACTORED STRESS = 145000 p.s.i P. 3-28.

AS THE MODIFIED GOODMAN CURVE IS RATHER PESSIMISTIC AT A STRESS RATIO = 0, THE ABOVE PART WILL BE ACCEPTED AS HAVING A SATISFACTORY FATIGUE LIFE (2.5×10^6 CYCLES) AT 20% ULT. LOAD WITH A STRESS RATIO OF ZERO.

X—————X

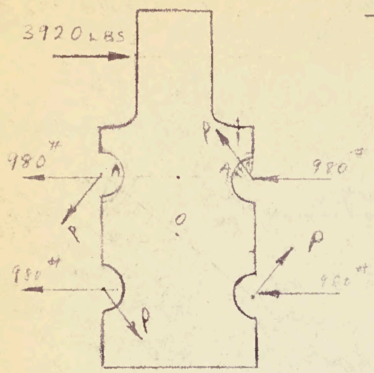
F.P. MITCHELL HAS DECIDED THAT THIS PART SHOULD BE MADE FROM 180,000 p.s.i STEEL, WHICH WOULD HAVE A MUCH LOWER FATIGUE LIFE ($0\cdot 1 \times 10^6$ CYCLES) USING THIS ANALYSIS.

FORM 1319A

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

REPORT NO.	7/0555/45-2	
SHEET NO.	3-31	
AIRCRAFT: C.105	WING TO FUSELAGE HINGE	
PREPARED BY	C. DITCHFIELD	DATE 16 DEC 55.
CHECKED BY		DATE

THIS ARRANGEMENT IS NO LONGER USED.



CHECKING THE MAXIMUM FACTORED STRESS ON SECTION AA

AT 20% LOAD LEVEL

LUG LOAD = 3920 LBS. P3-27.

BALANCING THIS AS SHOWN IN THE DIAGRAM.

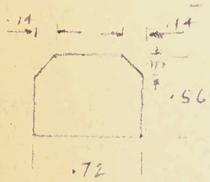
$M_o = 1.23 \times 3920$

$P = \frac{1.23 \times 3920}{4 \times .6}$

$= 2010$ LBS.

$M_{AA} = 3920 \times .83 - 2010 \times .4$

$= 2450$ LBS INS.



$I_{NA} = \frac{.72^3 \times .56}{12} - 2 \times .117 \times .14 \times \frac{1}{2} \times .32^2$

$= .0174 - .0017$

$= .0157$ INS^4.

$\bar{y} = .36$

$f_b = \frac{2450 \times .36}{.0157} = 56,200$ p.s.i.

FROM PETERSON FIG 8D.
$K_F = 2.12$

MAX. FACTORED STRESS = 119,000 psi

SATISFACTORY FOR 10×10^4 CYCLES

FORM 1319A

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

REPORT NO. 7/0551/45-2		
SHEET NO. 3-32		
AIRCRAFT: C.105.	WING TO FUSELAGE HINGE	PREPARED BY: C. DITCHFIELD — DATE: 14 DEC 55.
		CHECKED BY: — DATE:

SUMMARY

FROM THE PRECEDING PAGES :-

AT 20% ULTIMATE LOAD

LIFE EXPECTANCY FOR ALUMINUM HINGE

$= 1.65 \times 10^6$ CYCLES.

LIFE EXPECTANCY FOR STEEL HINGE (180,000psi).
WITH $\frac{1}{4}$" SIDE RADIUS

$= 0.10 \times 10^6$ CYCLES.

WITH 1" SIDE RADIUS

$= 0.80 \times 10^6$ CYCLES.

FORM 1319A