

QCX
AVRO
CF105
R-7-0582-1
Iss3



TECHNICAL REPORT



J Shurston

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

ANALYZED

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT:

C105

REPORT NO

7/0582/1

FILE NO

~~CONFIDENTIAL~~

NO OF SHEETS:

160

TITLE:

C105 ELEVATOR

Classification cancelled / Changed to UNCLASS
By authority of AVES
Date 30 Sept 56
Signature AB. U.
Unit / Rank / Appointment AVES 5

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PREPARED BY *T. HAYMAN
C. NORMAN*

DATE *15-JUNE-54*

CHECKED BY

DATE

SUPERVISED BY

DATE

APPROVED BY

DATE

ISSUE NO	REVISION No	REVISED BY	APPROVED BY	DATE	REMARKS
<i>1</i>					<i>ORIGINAL.</i>
<i>2</i>		<i>G. Norman</i>		<i>8/10/54</i>	<i>SATS. 3-1, 3-8, 3-9 CORRECTED.</i>
<i>3</i>	<i>133</i>	<i>G. Norman</i>		<i>15 FEB 55</i>	<i>SATS. 3-1, 3-8, 3-9 ALTERED.</i>
					<i>15867275</i>

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0582/1

SHEET NO. 1

AIRCRAFT:

C105.

ELEVATOR

PREPARED BY

DATE

G. Norman

15 JUNE 54

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✓

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FOR EACH SECTION.

AIRCRAFT:

6105

ELEVATOR

PREPARED BY

DATE _____

6. Hernandez, H. Juan = 54.	
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INTRODUCTION.

THE C105, DUE TO ITS "DELTA" CONFIGURATION, HAS ITS ELEVATORS SET INTO THE TRAILING EDGE OF THE WING, INBOARD OF THE AILERONS.

THE ELEVATOR IS A SINGLE CELL TORQUE BOX CONTINUOUSLY HINGED TO THE WING TRAILING EDGE STRUCTURE. IT IS OPERATED BY A HYDRAULIC JACK THROUGH A LINKAGE CONSISTING OF A COMMON TIE ROD AND SIX BELL CRANKS AND LINK RODS IN PARALLEL.

LOADS ARE CALCULATED FOR A GIVEN REQUIRED HINGE MOMENT FOR FOUR CASES, 30° UP AND 20° DOWN, - THE EXTREMES OF ITS TRAVEL - IN THE SUBSONIC AND SUPERSONIC FLIGHT CONDITIONS.

THE ULTIMATE LOAD FACTOR IS 1.364.
A 1.2 "LINKAGE" FACTOR IS APPLIED TO THE
LOADS ON THE LINKAGE, THE ONLY PART OF WHICH
COVERED HEREIN IS THE LINK ROD ATTACHMENT
BOLT. A 1.33 "PEAKING" FACTOR IS APPLIED
TO THE LOADS ON THE HINGE TO ACCOUNT
FOR PEAKING OF THE LOAD NEAR THE CONTROL
POINTS.

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AIRCRAFT.

C 105

ELEVATOR

PREPARED BY

DATE

G. J. HARRISON

11-JUNE 54

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DATE

REFERENCES

1. "PRODUCT ENGINEERING" - JUNE 1946.
P. 513.
2. "ANALYSIS & DESIGN OF AIRPLANE STRUCTURES"
E. F. BRUNN 1947 EDN.
3. "STRENGTH OF METAL AIRCRAFT ELEMENTS"
ANC-5 BULLETIN.
U.S.A. DEPT. OF DEFENSE.
4. CROSS-SECTION FROM "PRODUCT ENGINEERING",
FEB. MAY, 1946. PP. 382-383.
5. "A SUMMARY OF DIAGONAL TENSION - Pt. 1"
N.A.C.A. T.N. 2661
6. "PRODUCT ENGINEERING" JUNE, 1953, P. 160.
7. AVRO GEN/1090/852. PART 5.
8. "MACHINE DESIGN", JAN. 1954, P. 117.
9. "THE EFFECT OF NON-UNIFORM TEMPERATURE DISTRIBUTION ON STIFFENED SHELL STRUCTURES"
N.A.C.A. T.N. 2240.
10. AVRO AIRCRAFT ENGINEERING MANUAL -
STRESS SECTION.

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AIRCRAFT:

C105

ELEVATOR

PREPARED BY

DATE

E. H. HARRIS

14-June-54

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DATE

DRAWING LIST.

7-0182-0003
-0006

ELEVATOR GEOMETRY.
SCHEME - CONTROL RIB.

7-1082-0001
-0002

G. A. OF ELEVATOR

-0003

TRAILING EDGE MEMBER

-0004

-0010-1

ASSY. - UPPER SKINS.

-0020-1

INTERMEDIATE RIB, DETAIL.

-0013

CONTROL RIB, DETAIL.

-0015

RIB 1, DETAIL

-0016

RIB 1A, DETAIL

-0017

RIB 1B, DETAIL

-0018

RIB 1BA, DETAIL.

-0021

SHROUD ATT'T. ANGLE.

-0022

RIB STIFFENER ANGLE - RIB 1B.

-0023

ASSY. - LOWER SKINS.

-0024

RIB WEB DOUBLER.

-0035

CONTROL RIB FITTING

-0037

RIB STIFFENER ANGLE - FWD.

-0038

RIB STIFFENER ANGLE - FWD. CENTER.

-0039

RIB STIFFENER ANGLE - CENTER.

-0041

RIB STIFFENER ANGLE - AFT CENTER.

-0042

RIB STIFFENER ANGLE - AFT.

-0043

RIB ATT'T. TEE.

-0045

RIB 1 ATT'T. TEE.

-0046

SHROUD DIAPHRAGM ANGLE.

-0047

ASSY. - CONTROL RIB.

-0048

-0050

-0060

-0200

-0210

-0070

-0080

-0071

-0072

-0073

-0074

ASSY. - TYPICAL INTERMEDIATE RIB.

INBD. WEB - NO. 1 CONTROL RIB.

SHROUD DIAPHRAGM - RIB 1B.

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AIRCRAFT

C105

ELEVATOR

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DATE

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14-JUNE-54

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DRAWING LIST CONT'D.

7-1082	- 0075	SHROUD ATT'T. ANGLE - RIB 13.
	- 0076	SHROUD ATT'T. ANGLE.
	- 0077	SHROUD ATT'T. ANGLE.
	- 0078	SHROUD ATT'T. ANGLE.
	- 0081	ATT'T. TEE - RIB 13.
	- 0082	ATT'T. TEE - RIB 13.
	- 0090	ASSY. - SPAR & SHROUD.
	- 0100	ASSY. - SPAR & SHROUD.
	- 0110	ASSY. - RIB 1.
	- 0120	ASSY. - RIB 1.
	- 0130	ASSY. - RIB 1A.
	- 0140	ASSY. - RIB 1A.
	- 0150	ASSY. - RIB 13.
	- 0160	ASSY. - RIB 13.
	- 0170	ASSY. - RIB 13A.
	- 0180	ASSY. - RIB 13A.
	- 0036	BUSHING - CONTROL FITTING.
	- 0190	ASSY. - CONTROL RIB FITTING.
7-4382	- 0001	ELEVATOR DATA DWG.
7-4410	- 0004	TRAILING EDGE STRUCTURE.
	- 0005	GEOMETRY - T/E STRUCTURE.
	- 0006	No. 1 RIB - T/E STRUCTURE.

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SHEET NO. VI

AIRCRAFT

C 105

ELEVATOR

PREPARED BY

DATE

G. Macdonald

14 JUNE 59

CHECKED BY

DATE

SYMBOLS & ABBREVIATIONS.

REF. SAT.

A	- AREA	
a	- EDGE DISTANCE OF BOLT HOLE.	3-2
B	- DENOTES A COLUMN IN A MATRIX	2-12
b	- BREADTH OF PANEL OR ELEMENT.	
	- DENOTES A COLUMN IN A MATRIX.	2-12
b _m	- EFFECTIVE WIDTH OF SKIN	3-16
C	- CHORD	
	- EXTREME FIBRE DISTANCE FROM NEUTRAL AXIS.	
D	- DIAMETER	3-2
d	- DEPTH	2-28
E	- YOUNG'S MODULUS.	
F	- ALLOWABLE STRESS	
f	- STRESS.	
G	- MODULUS OF RIGIDITY	
H	- HEIGHT ; > h.	1-8
	- A PARTICULAR LOAD	2-20 & 2-24
h	- HEIGHT OF A PANEL OR ELEMENT.	1-8
I	- MOMENT OF INERTIA	
J	- TORSIONAL STIFFNESS CONSTANT	1-7
K	- PANEL BUCKLING COEFFICIENT.	2-71
	- CONSTANT	3-2
k	- DIAGONAL TENSION FACTOR	2-71
L	- A LOAD; DEFINED WHERE USED	2-5 & 2-20
l	- LENGTH.	
M	- MOMENT.	
m	- SLOPE OF GRAPH	2-14
N	- NORMAL AIR LOAD.	2-18
P	- A LOAD.	
p	- UNIT LOAD	1-12
	- PRESSURE	3-13
q	- SHEAR FLOW.	

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REPORT NO. 7/0582/1

SHEET NO. 1-1

AIRCRAFT:

C105

ELEVATOR

PREPARED BY

DATE

C. NORMAN

14 APR 54

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DATE

DESCRIPTION

THE ELEVATOR IS A SINGLE CELL TORSION BOX OF CONSTANT CHORD (11.8 IN. $\perp$ HINGE LINE), TAPERING CHORDWISE FROM 4.72 IN. AT THE HINGE LINE TO .90 IN. DEEP AT THE TRAILING EDGE. THERE IS NO SPANWISE TAPER.

THE HINGE IS CONTINUOUS ALONG THE UPPER FWD. EDGE. THE SIX CONTROL FITTINGS ARE SPACED ALONG THE LOWER FWD. EDGE SO AS TO PARTIALLY EQUALISE THE CONTROL FORCES AT THE FITTINGS.

SKINS AND RIBS ARE OF .051 IN. SHEET ZAST; SKIN DOUBLERS & RIB WEB DOUBLERS ARE OF .072 IN. SHEET; FRONT SPAR (WITH INTEGRAL HINGE) IS A ZAST EXTRUSION; TRAILING EDGE CHANNEL IS 75 ST EXTRUSION; CONTROL FITTINGS ARE MACHINED FROM AN EXTRUDED SECTION, IN 75 ST.

THE DESIGN MAX. HINGE MOMENT ON THE ELEVATOR IS 60,000 FT. LB. THIS IS REACHED AT DEFLECTIONS OF $\pm 10^\circ$. AT GREATER DEFLECTIONS THE ELEVATOR MOMENT ARM DECREASES, RESULTING IN CORRESPONDINGLY LOWER MOMENTS. SO THE LINK LOAD WILL BE ASSUMED CONSTANT AT THE VALUE FOR $\pm 10^\circ$ DEFLECTION AND THE MOMENT ARM USED WILL BE THAT FOR 10° .

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AIRCRAFT:

C105

ELEVATOR

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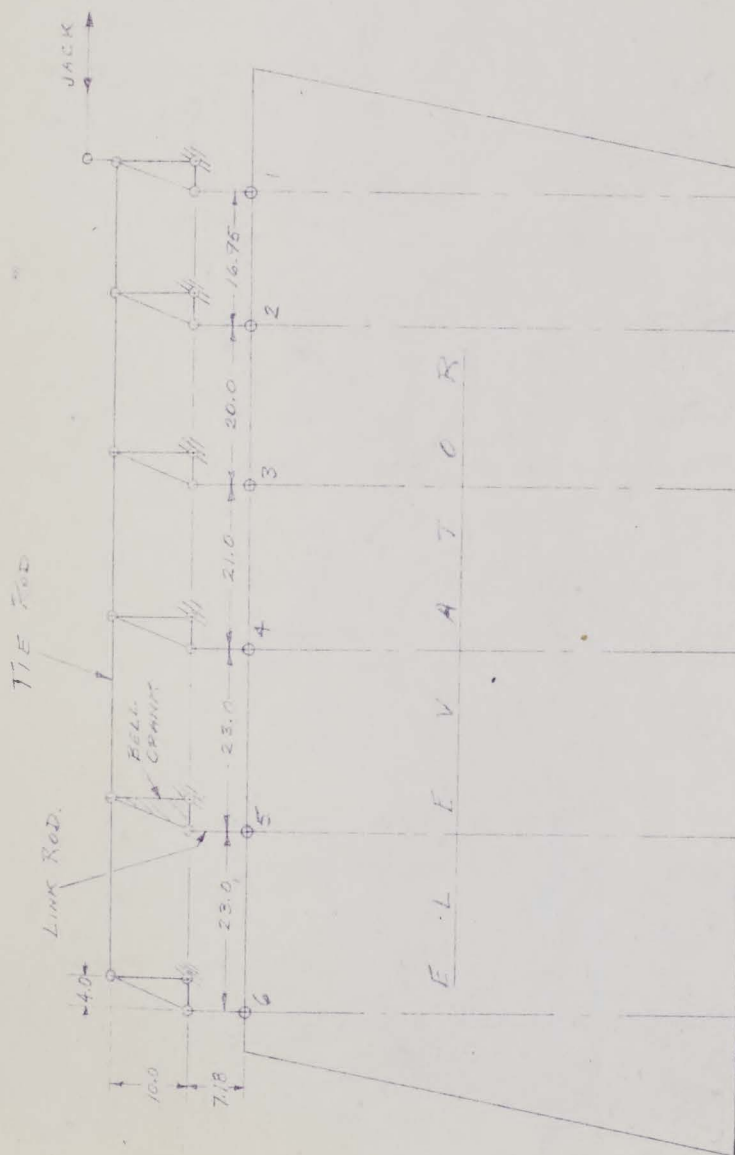
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12-APR-54

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GEOMETRY OF ELEVATOR LINKAGE.

REF. DWGS. 7-0182-0093 & 7-4415-0005

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AIRCRAFT:

C105

ELEVATOR

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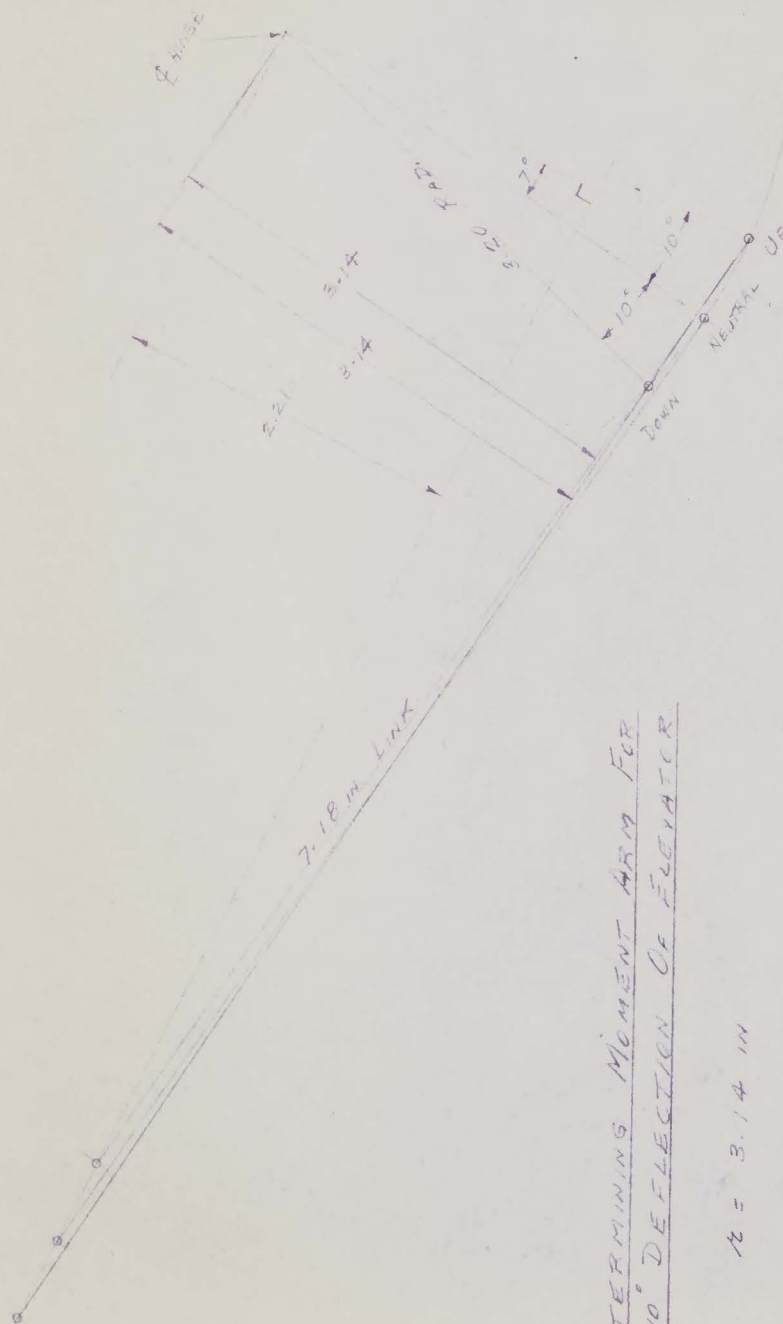
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DETERMINING MOMENT ARM FOR
 $\pm 10^\circ$ DEFLECTION OF ELEVATOR

$$h = 3.14 \text{ IN}$$

REF. DWG 7-0182-0006
7-4415-0004

TECHNICAL DEPARTMENT (Aircraft)

SHEET NO

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DATE _____

AIRCRAFT:

C103

ELEVATOR

C. Norton

26-APR-54

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DATE _____

EFFECTIVE MOMENT ARM "R"
At 30° Up & 20° Down

$$30^\circ \text{ UP}, r = 2.81 \text{ in}$$

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SHEET NO. 1-8

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AIRCRAFT:

C 105.

ELEVATOR

C. NORMAN

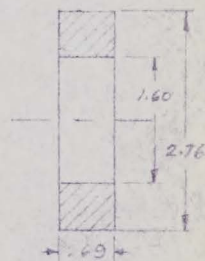
21-Apr-54

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DATE _____

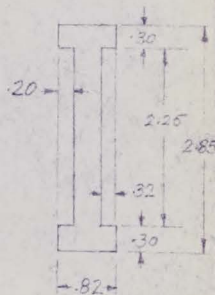
BELL CRANK - I

SECTION 1-1



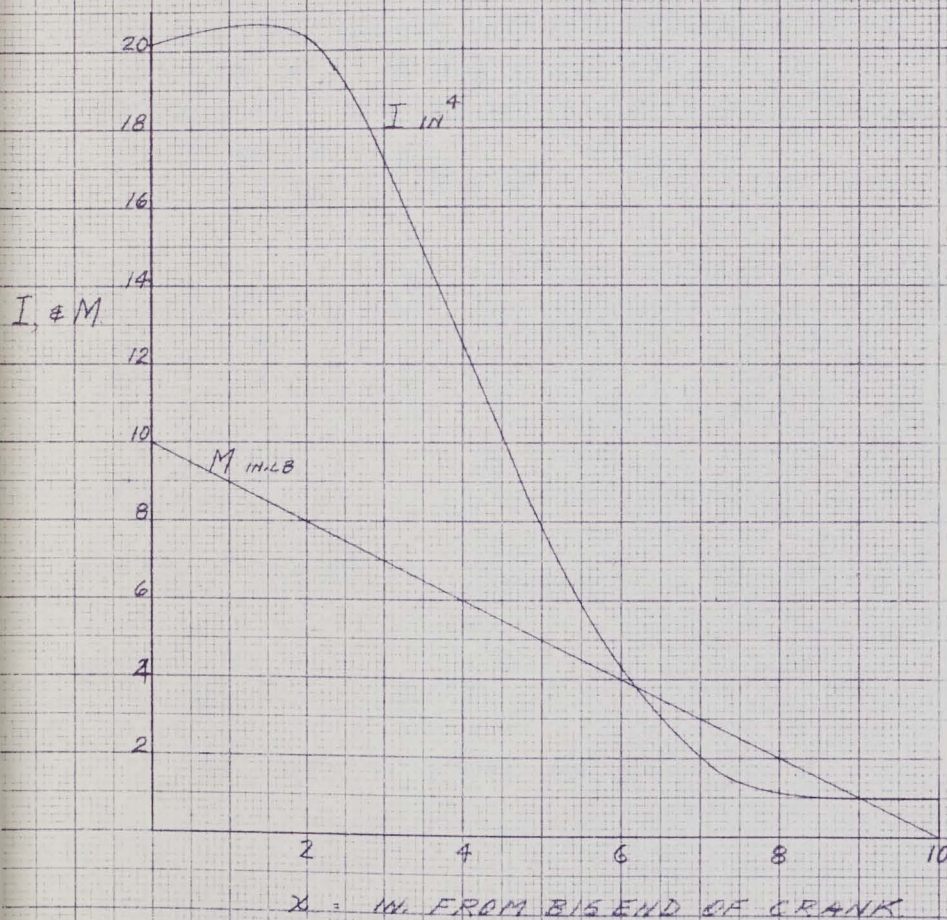
SECTION 2-2

$$I = \frac{BH^3 - (b_1 + b_2)h^3}{12}$$
$$= \frac{.82 \times 2.85^3 - (.20 + .32) \times 2.25^3}{12}$$
$$= 1.0883 \text{ in}^4$$



BELL CRANK, - I & M DUE TO 1 LB. LOAD

REF. FIG. 1-11 TO 1-12



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ELEVATOR

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SHEET NO. 1-12

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G. NORMAN

22-APR.-54

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EVALUATION OF S :-

S , THE STIFFNESS OF THE BELL CRANK, IS DEFINED AS THE RATIO $\frac{\delta}{P}$ WHERE δ IS THE DEFLECTION OF THE CRANK DUE TO LOAD P .

SET $P = 1$ LB.

$M = Px$.

NOW IN A CANTILEVER, STRAIN ENERGY $U = \frac{1}{2E} \int_0^l \frac{(M+Px)^2}{I} dx$

WHERE $P =$ A UNIT LOAD AT $x = l$.

DEFLECTION, δ (AT $x = l$) = $\frac{\partial U}{\partial P} = \frac{1}{E} \int_0^l \frac{(Mx + Px^2)}{I} dx$.

SETTING $P = 1$,

$\delta = \frac{1}{E} \int_0^l \frac{Mx dx}{I}$. SO FROM ENT. 1-12,

$\bar{x}$	dx	M	I	$M\bar{x}$	$M\bar{x} dx$	$\frac{M\bar{x} dx}{I}$
1	2	9	20.6	20.6	41.2	2.00
3	2	7	17.2	51.6	103.2	6.01
5	2	5	7.9	39.5	79.0	10.00
7	2	3	2.0	14.0	28.0	14.00
9	2	1	1.0	9.0	18.0	18.00

$\Sigma = 50.01$

$$\delta = \frac{1}{E} \sum \frac{M\bar{x} dx}{I} = \frac{50.01}{10.5 \times 10^6} = 4.76 \times 10^{-6} \text{ IN.}$$

$$S = \frac{\delta}{P} = \frac{4.76 \times 10^{-6}}{1} = 4.76 \times 10^{-6} \text{ IN.}$$

THIS IS USED ON ENT. 2-8.

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REPORT NO. 7/6583-1

SHEET NO. 2-ii

AIRCRAFT

C 105

ELEVATOR

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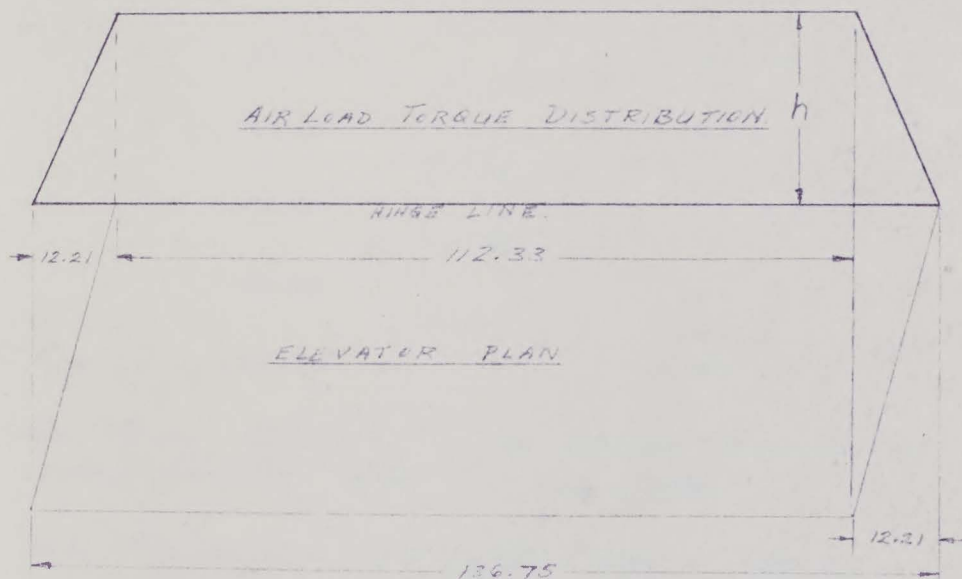
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LOADING.

LIMIT HINGE MOMENT = 60,000 FT. LB.

REF. AERODYNAMICS P/LOADS/22 SNT. 25

ULT. HINGE MOMENT = 60,000 x 1.364 = 81,900 FT. LB.



DUE TO THE OBLIQUE PLAN FORM OF THE ELEVATOR THE AIRLOAD TORQUE IS DISTRIBUTED AS SHOWN ABOVE. AIRLOAD SHEAR IS ASSUMED TO FEED DIRECTLY INTO THE CONTINUOUS HINGE, WHEREAS THE TORQUE IS REACTED BY THE 6 CONTROL ARMS.

$$M = 81,900 \times 12 = 984,000 \text{ IN. LB. ULT.}$$

$$= h \times 112.33 + 2 \times h \times 12.21 = 124.54 h$$

$$h = \frac{984,000}{124.54} = 7900 \text{ IN. LB./IN. ULT.}$$

AFT C105

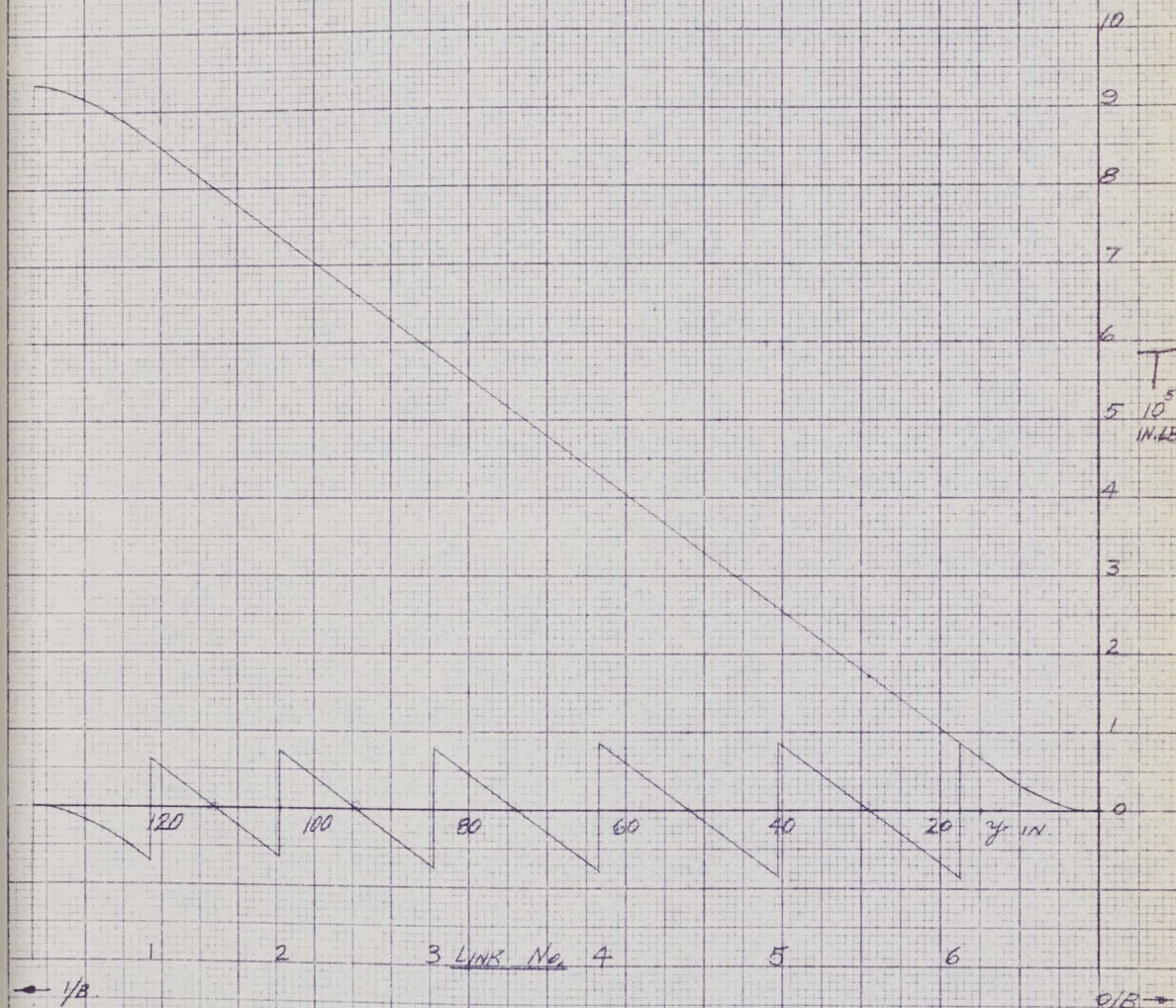
COMPONENT ELEVATOR

SHEET No. 2-3

REPORT No. 7/0582/1

DATE 19 APRIL - 54

PREP BY C. NORMAN

ELEVATOR AIRLOAD TORQUE.

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0582/1

SHEET NO. 2-4

AIRCRAFT:

C105

ELEVATOR

PREPARED BY

DATE

G. NORMAN

19-APR-54

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DATE

LINK CORRECTIVE LOADS

TO OBTAIN THE LINK ^{CORRECTIVE} LOADS $P_1, P_2, \dots, P_5$, EXPRESSIONS ARE WRITTEN FOR THE STRAIN ENERGY IN THE ELEVATOR LINK RODS, BELL CRANKS & PUSH RODS OF THE LINKAGE (SEE SHT. 1-4). THESE ENERGY EXPRESSIONS ARE THEN DIFFERENTIATED WITH RESPECT TO THE LOADS (P_i), RESULTING IN FIVE EQUATIONS IN MATRIX FORM WHICH ARE SOLVED BY THE CRUT METHOD (REF. 1) TO YIELD THE UNKNOWN CORRECTIVE LOADS WHICH ARE ADDED TO THE INITIAL LOADS TO GIVE FINAL LINK LOADS.

ON SHT. 2-5 ARE LISTED THE "INITIAL LOADINGS" DUE TO AIRLOAD ALONE WITH NO CARRY OVER OF TORQUE FROM ONE BAY OF THE ELEVATOR TO THE NEXT.

IN COLUMNS 2 TO 6 INCL. A 1 LB. LOAD IS APPLIED AT EACH LINK ROD IN TURN AND ITS EFFECT TRACED THROUGH THE LINKAGE. E.G. A ONE POUND LOAD APPLIED AT LINK NO. 3 PUTS A 3.14 IN. LB. TORQUE IN THE ELEVATOR IN BAYS 2-3 & 1-2. GOING THE OTHER WAY THROUGH THE LINKAGE, IT APPLIES A .4 LB. LOAD AT THE LONG ARMS OF CRANKS 3 & 1 BUT OF OPPOSITE SIGNS, AND APPLIES THE SAME .4 LB. LOAD TO SECTIONS 1 & 2 OF THE TIE ROD.

THESE INITIAL LOADINGS ARE USED TO WRITE THE ENERGY EXPRESSIONS ON SHTS. 2-6 ETC.

ON SHT. 2-10, THE VARIOUS COEFFICIENT COMPONENTS FROM SHTS. 2-6 TO 2-9 ARE ASSEMBLED IN TABULAR FORM TO GIVE THE MATRIX OF COEFFICIENTS, OR SET OF EQUATIONS WHICH ARE SOLVED ON SHTS. 2-11 & 12.

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TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0582/1

SHEET NO. 2-7

AIRCRAFT

C105

ELEVATOR

PREPARED BY

DATE

C. NORMAN

20-APR.-54

CHECKED BY

DATE

LINKS

$$\text{END LOAD} - U = \frac{P^2 L}{2 A E}$$

$$U_L = \frac{L_L}{2 A E} \left\{ [42,444 - (P_2 + P_6)]^2 + [44,140 + P_2]^2 + [48,965 + P_3]^2 + [52,548 + P_4]^2 + [54,936 + P_5]^2 + [54,458 + P_6]^2 \right\}$$

WHERE L_L = LINK LENGTH.

A_L = CROSS-SECTIONAL AREA OF LINK

CONSTANT TERMS COME FROM (SMT. 2-5 "LINKS")

DIFFERENTIATING -

$$\frac{\partial U_L}{\partial P_2} = \frac{L_L}{A_L E} [-42,444 + (P_2 + P_6) + 44,140 + P_2]$$

$$= \frac{L_L}{A_L E} [1636 + 2P_2 + P_3 + P_6]$$

$$\frac{\partial U_L}{\partial P_3} = \frac{L_L}{A_L E} [-42,444 + (P_2 + P_6) + 48,965 + P_3]$$

$$= \frac{L_L}{A_L E} [6521 + P_2 + 2P_3 + P_6]$$

$$\frac{\partial U_L}{\partial P_4} = \frac{L_L}{A_L E} [-42,444 + (P_2 + P_6) + 52,548 + P_4]$$

$$= \frac{L_L}{A_L E} [10,104 + P_2 + 2P_4 + P_6]$$

$$\frac{\partial U_L}{\partial P_5} = \frac{L_L}{A_L E} [-42,444 + (P_2 + P_6) + 54,936 + P_5]$$

$$= \frac{L_L}{A_L E} [12,492 + P_2 + 2P_5 + P_6]$$

$$\frac{\partial U_L}{\partial P_6} = \frac{L_L}{A_L E} [-42,444 + (P_2 + P_6) + 54,458 + P_6]$$

$$= \frac{L_L}{A_L E} [12,014 + P_2 + 2P_6]$$

$$L_L = 7.18 \text{ IN. (SMT. 1-4)} \quad A_L = \frac{\pi}{4} \times 1^2 = .786 \text{ IN.}^2 \quad (7-0015 - 0018)$$

$$\frac{L_L}{A_L E} = \frac{7.18 \times 10^{-6}}{.786 \times 29} = .31500 \times 10^{-6}$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7/0582/1

SHEET No. 2-8

AIRCRAFT:

C105

ELEVATOR.

PREPARED BY

DATE

G. NORMAN

APR. 21-54

CHECKED BY

DATE

BELL CRANKS:-

BENDING: $U = \frac{P \delta}{2}$ SET $S = \frac{\delta}{P}$

$\therefore U = \frac{P^2 S}{2}$ FROM SAT. 2-5, UNDER "BELL CRANKS" -

$$U_0 = \frac{S}{2} \left\{ [16,978 + .4(P_2 + P_6)]^2 + [17,656 + .4 P_2]^2 + [19,586 + .4 P_3]^2 + [21,019 + .4 P_4]^2 + [21,974 + .4 P_5]^2 + [21,783 + .4 P_6]^2 \right\}$$

WHERE δ = DEFLECTION OF CANTILEVER FOR UNIT LOAD P .

DIFFERENTIATING:-

$$\frac{\partial U_0}{\partial P_2} = .45 [-16,978 + .4(P_2 + P_6) + 17,656 + .4 P_2] \\ = .165 [16,95 + 2 P_2 + P_6]$$

$$\frac{\partial U_0}{\partial P_3} = .45 [-16,978 + .4(P_2 + P_6) + 19,586 + .4 P_3] \\ = .165 [6,520 + P_2 + 2 P_3 + P_6]$$

$$\frac{\partial U_0}{\partial P_4} = .45 [-16,978 + .4(P_2 + P_6) + 21,019 + .4 P_4] \\ = .165 [10,102 + P_2 + 2 P_4 + P_6]$$

$$\frac{\partial U_0}{\partial P_5} = .45 [-16,978 + .4(P_2 + P_6) + 21,974 + .4 P_5] \\ = .165 [12,990 + P_2 + 2 P_5 + P_6]$$

$$\frac{\partial U_0}{\partial P_6} = .45 [-16,978 + .4(P_2 + P_6) + 21,783 + .4 P_6] \\ = .165 [12,012 + P_2 + 2 P_6]$$

$$S = 4.76 \times 10^{-6} \text{ (SAT. 1-12)}$$

$$.165 = .7616 \times 10^{-6}$$

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7/0582/1

SHEET No. 2-11

AIRCRAFT:

C105

ELEVATOR

PREPARED BY

DATE

C. NORMAN

23-APR-54

CHECKED BY

DATE

EVALUATION OF COEFFICIENTS:

FROM SHT 2-10.

MOD. REF. SHTS. 2-6 TO 2-9.

	MOD.	P_2	P_3	P_4	P_5	P_6	CONST.
E	.06004	1.0177	1.0177	1.0177	1.0177	1.0177	0
$\frac{\partial U}{\partial P_2}$ L	.31500	.6300	.3150	.3150	.3150	.3150	534.24
C	.76160	1.5232	.7616	.7616	.7616	.7616	1230.91
T	551.72	0	0	0	0	0	9351.65
Σ	—	3.1709	2.0943	2.0943	2.0943	2.0943	11,177
E	.06004	1.0177	2.2185	2.2185	2.2185	2.2185	0
$\frac{\partial U}{\partial P_3}$ L	.31500	.3150	.6300	.3150	.3150	.3150	2054.11
C	.76160	.7616	1.5232	.7616	.7616	.7616	4265.63
T	551.72	0	0	0	0	0	26286.05
Σ	—	2.0943	4.3717	3.2951	3.2951	3.2951	27,406
E	.06004	1.0177	2.2185	3.4793	3.4793	3.4793	0
$\frac{\partial U}{\partial P_4}$ L	.31500	.3150	.3150	.6300	.3150	.3150	3,182.76
C	.76160	.7616	.7616	1.5232	.7616	.7616	7693.68
T	551.72	0	0	0	0	0	31,972.17
Σ	—	2.0943	3.2951	5.6325	4.5559	4.5559	42,849
E	.06004	1.0177	2.2185	3.4793	4.8602	4.8602	0
$\frac{\partial U}{\partial P_5}$ L	.31500	.3150	.3150	.3150	.6300	.3150	3934.28
C	.76160	.7616	.7616	.7616	1.5232	.7616	9512.38
T	551.72	0	0	0	0	0	49,661.73
Σ	—	2.0943	3.2951	4.5559	7.0134	5.9368	58,109
E	.06004	1.0177	2.2185	3.4793	4.8602	6.2412	0
$\frac{\partial U}{\partial P_6}$ L	.31500	.3150	.3150	.3150	.3150	.6300	3784.41
C	.76160	.7616	.7616	.7616	.7616	1.5232	9,148.34
T	551.72	0	0	0	0	0	57,351.29
Σ	—	2.0943	3.2951	4.5559	5.9368	8.3944	70,284

THE Σ ROWS OF THIS TABLE ARE REPEATED
ON THE NEXT SHEET AS THE "GIVEN MATRIX".

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0582/1

SHEET NO. 2-12

AIRCRAFT:

C105

ELEVATOR

PREPARED BY

DATE

G. NORMAN

23-APR-54

CHECKED BY

DATE

GIVEN MATRIX

	1	2	3	4	5	b
1	3.1709	2.0943	2.0943	2.0943	2.0943	$\bar{11}, 177$
2	2.0943	4.3717	3.2951	3.2951	3.2951	$\bar{27}, 406$
3	2.0943	3.2951	5.6325	4.5559	4.5559	$\bar{42}, 849$
4	2.0943	3.2951	4.5559	7.0134	5.9368	$\bar{58}, 109$
5	2.0943	3.2951	4.5559	5.9368	8.3944	$\bar{70}, 284$

CHECK
 $\bar{11}, 176$

$\bar{58}, 109$

AUXILIARY MATRIX & ROOTS

	1	2	3	4	5	B
1	3.1709	.6605	.6605	.6605	.6605	$\bar{3}, 525$
2	2.0943	2.9884	.6397	.6397	.6397	$\bar{6}, 700$
3	2.0943	1.9118	3.0262	.6442	.6442	$\bar{7}, 487$
4	2.0943	1.9118	1.9496	3.1512	.6584	$\bar{7}, 401$
5	2.0943	1.9118	1.9496	2.0746	3.1663	$\bar{6}, 361$
ROOTS	3,493	268	$\bar{1}, 319$	$\bar{3}, 213$	$\bar{6}, 361$	
	P_2	P_3	P_4	P_5	P_6	

$$P_1 = (6361 + 3213 + 1319) - (268 + 3493) = 7,132 \text{ LB}$$

NOTE: THE REDUNDANT LOADS ARE SELF EQUILIBRATING. $\sum_1^6 P_i = 0$

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

REPORT NO. 7/0582/1

SHEET NO. 2-13

AIRCRAFT

C105

ELEVATOR

PREPARED BY

DATE

C. NORMAN

23-APR-54

CHECKED BY

DATE

CONTROL FORCES - (LINK LOADS).

SUBSTITUTE $P_2, P_3, \dots P_6$ OF SMT. 2-12 FOR $L_2, L_3 \dots L_6$ OF SMT. 2-5 AND ADD ^{UP} THE ROWS IN THE "LINKS" TABLE (OF SMT. 2-5) TO GET THE LINK LOADS AT:-

$$\text{No. 1} = 42,444 + 7,132 = 49,576 \text{ LB. ULT.}$$

$$\text{No. 2} = 44,140 + 3,493 = 47,633 \text{ LB. ULT.}$$

$$\text{No. 3} = 48,965 + 268 = 49,233 \text{ LB. ULT.}$$

$$\text{No. 4} = 52,548 - 1,319 = 51,229 \text{ LB. ULT.}$$

$$\text{No. 5} = 54,936 - 3,213 = 51,723 \text{ LB. ULT.}$$

$$\text{No. 6} = 54,458 - 6,361 = 48,097 \text{ LB. ULT.}$$

$$\Sigma = 297,491 \text{ LB.}$$

$$\text{TOTAL LINK LOAD SHOULD BE } \frac{934,000}{3.17} = 297,452 \text{ LB.}$$

} CHECK

(SMT. 2-1)

$$\text{AVGE. LINK LOAD} = \frac{297,491}{6} = 49,582 \text{ LB.}$$

$$\text{MAX. DEVIATION FROM AVGE. (AT No. 5)} = \frac{51,723 - 49,582}{49,582} = 4.3\%$$

NOTE SINCE THE ELEVATOR JACK OUTPUT IS CONSTANT AND THE MECHANICAL ADVANTAGE OF THE LINKAGE IS REASONABLY CONSTANT, THE LINK LOADS ARE ASSUMED TO REMAIN CONSTANT AT THE VALUES QUOTED ABOVE FOR ALL ELEVATOR DEFLECTIONS FROM 30° UP TO 20° DOWN.

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0582/1

SHEET NO. 2-14

AIRCRAFT:

C105

ELEVATOR

PREPARED BY

G. NORMAN

DATE

26-APR.-54

CHECKED BY

DATE

ELEVATOR TORQUE.

$$\Delta T = \text{TORQUE TAKEN OUT AT CONTROL POINTS} \\ = \text{LINK LEADS} \times 3.14 \text{ IN.}$$

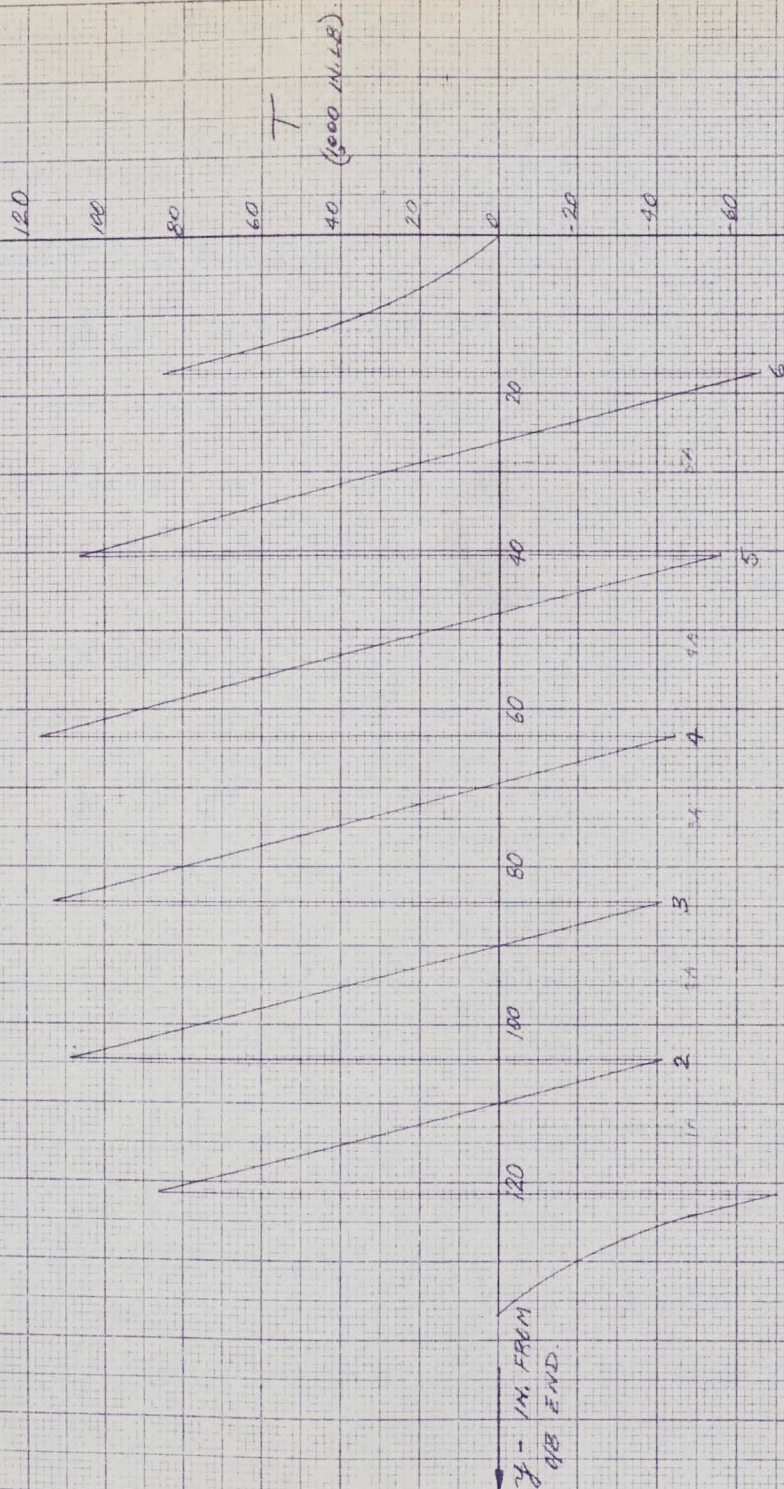
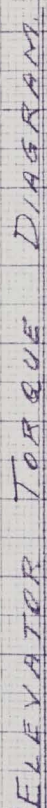
No.	y	P LB.	ΔT INLB.	
6	17.40	48,097	151,000	} USED BELOW TO FIND TORQUE.
5	44.40	51,723	162,400	
4	63.40	51,229	160,900	
3	84.40	49,233	154,600	
2	104.40	47,633	149,600	
1	121.35	49,576	155,700	
INBD. END.	136.75	0	0	

TORQUES. - SLOPE OF GRAPH = 7500 INLB/IN.
= IN.

No.		TORQUE INLB.
6	1/8 REF CNT. 2-3.	85,000
1/8	85,000 - 151,000 =	-66,000
5	1/8 $-66,000 + \frac{172,500}{23.00} \times 7500 =$	106,500
1/8	106,500 - 162,400 =	-55,900
4	1/8 $-55,900 + \frac{172,500}{23.00} \times 7500 =$	116,600
1/8	116,600 - 160,900 =	-44,300
3	1/8 $-44,300 + \frac{157,500}{21.00} \times 7500 =$	113,200
1/8	113,200 - 154,600 =	-41,400
2	1/8 $-41,400 + \frac{150,000}{20.00} \times 7500 =$	108,600
1/8	108,600 - 149,600 =	-41,000
1	1/8 $-41,000 + \frac{127,000}{16.95} \times 7500 =$	86,000
1/8	86,000 - 155,700 =	-69,700

SHOWN GRAPHICALLY ON SHT. 2-15.

NOTE $T_k \text{ C/B} = T_k \text{ I/B} + \delta y \cdot m.$
 $\text{I/B} = T_k \text{ C/B} - \Delta T_k.$



REF 547 2-14

CRAFT C105

COMPONENT ELEVATOR

SHEET No.

2-17

REPORT No.

7/0582/1

DATE

27- APRIL - 54

PREP. BY

C. NORMAN

ELEVATOR TWIST

0 DEG.

IN. FROM QIB END

RIS No.

IB END

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7/0582/1

SHEET No. 2-18

AIRCRAFT:

C105

ELEVATOR

PREPARED BY

G. NORMAN

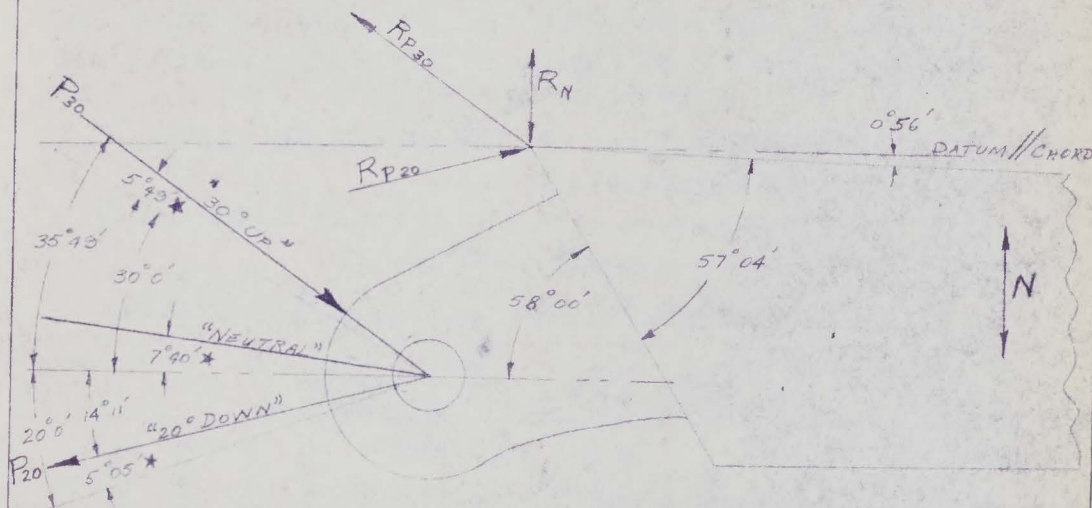
DATE

26-APR-54

CHECKED BY

DATE

ELEVATOR LOADS.



NOTE: ANGLES MARKED THUS * ABOVE ARE THE ANGLES BETWEEN THE LINK ROD AND THE WING CHORD FOR UP, NEUTRAL & DOWN POSITIONS OF ELEVATOR.

P AT ANY CONTROL POINT IS CONSTANT FOR ALL DEFLECTIONS (SHT. 2-13).

N = NORMAL AIRLOAD VARIES FOR "SUBSONIC" & "SUPERSONIC" CASES. IN THE SUBSONIC CASE, THE CHORDWISE AIRLOAD DISTRIBUTION IS ASSUMED TO BE TRIANGULAR; IN THE SUPERSONIC CASE IT IS ASSUMED TO BE RECTANGULAR.

$$C = 61.8 \text{ IN.}$$

$$M = \text{TOTAL HINGE MOMENT. } L = 124.54 \text{ IN.}$$

$$\text{SUBSONIC: } N/\text{IN.} = \frac{3}{C} \times \frac{M}{L} = \frac{3}{61.8} \times \frac{M}{124.54} = .000390 M$$

$$\text{SUPERSONIC: } N/\text{IN.} = \frac{2}{C} \times \frac{M}{L} = \frac{2}{61.8} \times \frac{M}{124.54} = .000260 M$$

SINCE LINK LOADS ARE CONSTANT, M VARIES WITH ANGLE OF ELEVATOR TRAVEL DUE TO CHANGES IN A (MOMENT ARM).

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/6582/1

SHEET NO. 2-20

AIRCRAFT:

C105

ELEVATOR

PREPARED BY

DATE

C. NORMAN

27-APR-54

CHECKED BY

DATE

LOADS ON TRAILING EDGE STRUCTURE FROM
ELEVATOR

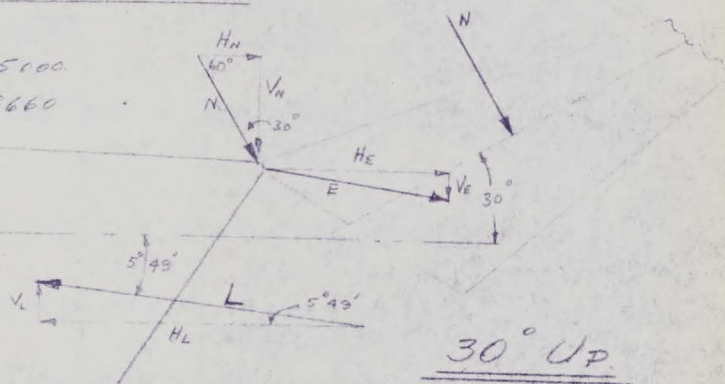
$$\sin 30^\circ = .5000$$

$$\cos = .8660$$

COORD.

$$\sin 5^\circ 49' = .1013$$

$$\cos = .9949$$

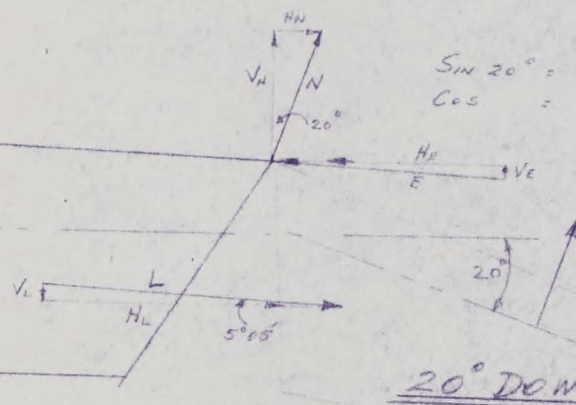


$$\sin 20^\circ = .3420$$

$$\cos = .9337$$

$$\sin 5^\circ 05' = .0886$$

$$\cos = .9961$$



IT HAS BEEN FOUND THAT THE "SUBSONIC
30° UP" CASE GIVES THE HIGHEST VERTICAL
& HORIZONTAL LOADS ON THE STRUCTURE.
THESE ARE CALCULATED ON THE NEXT PAGE
BY RESOLVING "E" & "N" INTO HORIZONTAL &
VERTICAL COMPONENTS. THE COMPONENTS OF
"L" ARE EQUAL & OPPOSITE TO THOSE OF "E".

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0582/1

SHEET NO. 2 - 21

AIRCRAFT:

C105

ELEVATOR

PREPARED BY

DATE

G. Norman 27-APR-54

CHECKED BY

DATE

HORIZONTAL & VERTICAL LOADS ON T/E HINGE
"SUBSONIC, 30° UP" CASE.

.9949 .5000 — .1013 .8660

RIB No.	E (SNT 2-13)	N (SNT 2-19)	HE = ECOS 5° 45'	HN = NSIN 30°	H = HE + HN	VE = ESW 5° 45'	VN = NCS 30°	V = VE + VN
1		695		348	348		602	602
1A		1030		515	515		892	892
2	49,600	3130	49,347	1565	50,912	5,024	2711	7,735
3		1996		998	998		1729	1,729
4	47,600	3778	47,357	1889	49,246	4,822	3272	8,094
5		2494		1247	1,247		2160	2,160
6	49,200	4108	48,949	2054	51,003	4,984	3557	8,541
7		2657		1329	1,329		2301	2,301
8	51,200	4352	50,939	2176	53,115	5,187	3769	8,956
9		2983		1492	1,492		2583	2,583
10	51,700	4515	51,436	2258	53,694	5,237	3910	9,147
11		2983		1492	1,492		2583	2,583
12	48,100	3879	47,855	1940	49,795	4,873	3359	8,232
13		1956		978	978		1694	1,694

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0582/1

SHEET NO. 2-22

AIRCRAFT:

C105

ELEVATOR

PREPARED BY

DATE

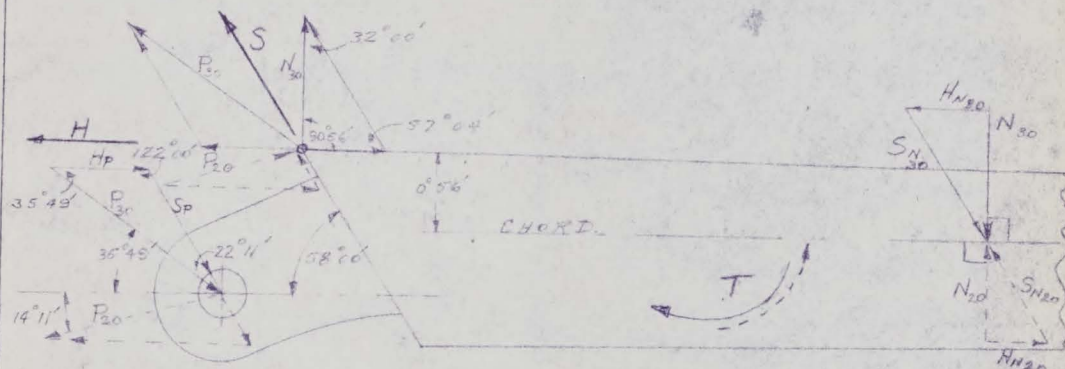
G. Hermann

CHECKED BY

DATE

ELEVATOR

LOADING.



THE APPLIED LOADS ARE:-

- P = LINK LOAD (AT CONTROL RIBS ONLY)
- N = AIRLOAD - ASSUMED CONCENTRATED AT CENTER OF PRESSURE (ALL RIBS).
- T = TORQUE FED IN TO SECTION UNDER CONSIDERATION BY THE SKIN.

THE APPLIED LOADS ARE REACTED AT THE HINGE LINE BY THE TRAILING EDGE STRUCTURE.

FOR CONVENIENCE THE LOADS ARE RESOLVED // THE SPAR WEB AND THE TOP SKIN.

THE DOTTED ARROWS IN THE FIGURE ABOVE REFER TO THE 20° DOWN CASE; THE SOLID LINES REFER TO THE 30° UP CASE; ALL UNDER THE SUBSONIC CONDITION; THIS CONDITION GIVING THE HIGHEST NORMAL LOAD (REF. ENT. 2-19).

Sp & Sn ARE COMPTS. OF P & N // THE SPAR WEB.
Hp & Hn " " " P & N // THE TOP SKIN.

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0582/1

SHEET NO. 2-23

AIRCRAFT:

C105

ELEVATOR

PREPARED BY

DATE

E. Norman

30-APR-54

CHECKED BY

DATE

FACTORS FOR DETERMINING COMPONENTS.

COMPONENT	ANGLE OPPOSITE	SIN	FACTOR. *
30° UP	P	122° 00'	.838671
	HP	22° 11'	.377571
	SP	35° 49'	.585194
	N	57° 04'	.839304
	HN	32° 00'	.529919
	SN	90° 56'	.999867
20° DOWN.	P	58° 00'	.848048
	HP	107° 40'	.952040
	SP	14° 11'	.245025
	N	57° 04'	.839304
	HN	32° 00'	.529919
	SN	90° 56'	.999867

* NOTE, IN THE TRIANGLE

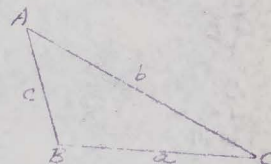
$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

$$\therefore a = b \frac{\sin A}{\sin B}$$

$\frac{\sin H}{\sin B}$ IS THE FACTOR REFERRED TO ABOVE,
USED TO DETERMINE a .

e.g. TO DETERMINE H_{P30} , FACTOR = $\frac{.377571}{.838671} = .4502$

THESE FACTORS ARE USED ON SHT. 2-24



A. V. RO

TEC

AIRCRAFT

WEIGHT

C. G. POSITION

RESOLVED LOADS TO FACILITATE

DUESSON CASE

H: CHORDWISE LOAD IN PLANE OF TOP SKIN

S: VERT. LOAD IN PLANE OF SPAR No 3

S UP +VE, H AFT +VE.

	1	2	3	4	5	6	7	8	9	10	11
			30 DEG. UP								
	P	N	H ₀	H _H	S _P	S _N	H.	S		N	H ₀
	LB	LB	0x.4572	0x.6314	0x.6956	0x.918	(3+4)	(5+6)		LB	0x.121
RIB NO.	(INT 2-13)	(INT 2-19)	(INT 2-23)	(INT 2-28)	(INT 2-23)	(INT 2-13)	LB	LB		(INT 2-13)	(INT 2-13)
1		605		430		828	430	828		735	
1A		1030		650		1227	650	1227		1030	
2	42576	3130	22,319	1,976	37,604	3,729	20,343	38,833		3360	55,60
3		1936		1,260		2,378	1,260	2,378		2,115	
4	47,633	3778	21,444	2,385	33,248	4,501	19,059	37,740		2,999	52,47
5		2434		1,575		2,971	1,575	2,971		2,632	
6	49,033	4106	22,165	2,504	34,365	4,894	19,571	39,259		4,147	55,26
7		2657		1,678		3,165	1,678	3,165		2,812	
8	51,229	4352	23,163	2,748	35,758	5,185	20,315	40,943		4,606	57,50
9		2883		1,883		3,554	1,883	3,554		2,157	
10	56,723	4575	23,286	2,851	36,103	5,373	20,435	41,482		4,778	58,66
11		2883		1,883		3,554	1,883	3,554		2,157	
12	48,097	3879	21,653	2,449	33,572	4,621	19,204	38,193		4,105	52,99
13		1956		1,235		2,330	1,235	2,330		2,070	

TECHNICAL DEPT. (AIRFRAME)

C. G. POSITION

PREPARED BY

E. Turner

9	10	11	12	13	14	15	16	17	18	19
			20		DEG.		DOWN.			
N	HP	HN	SP	SN	H	S				
48	0x.11216	0x.634	0x.2580	0x.1913	-(10.73)	-(3.15)				
(2-213)	(-)	ENT. 2-23	(-)	12	18					
735		464		876	464	876				
1030		688		1299	688	1299				
3260	55,654	2,122	14,322	4,003	55,532	10,319				
2115		1,325		2,520	1,325	2,520				
1899	53,473	2,525	13,761	4,764	50,048	8,997				
2033		1,666		3,144	1,666	3,144				
4347	55,269	2,745	14,223	5,179	52,524	9,044				
2812		1,775		3,350	1,775	3,350				
4606	57,510	2,908	14,800	5,417	54,602	9,813				
3157		1,893		3,761	1,893	3,761				
4778	58,064	3,017	14,243	5,632	55,047	9,251				
3157		1,893		3,761	1,893	3,761				
4105	53,994	2,592	13,135	4,830	51,402	9,005				
2070		1,307		2,466	1,307	2,466				

A. V. ROE CANADA LIMITED

MALTON, ONT. RIO

TECHNICAL DEPT. (AIRFRAME)

AIRCRAFT . . . C-105

WEIGHT . . . _____

C. G. POSITION . . . _____

REPORT NO. . . 7/0582/1

SHEET . . . 2-25

DATE . . . 10-MAY-54

PREPARED BY . . . E. Herman

10	11	12	13	14	15	16	17	18	19
20 DEG. DOWN.									
N _{LR}	H _P	H _N	S _P	S _N	H	S			
(67.2-19)	(11.11226)	(11.11226)	(11.11226)	(11.11226)	(11.11226)	(11.11226)			
490		309		584	-309	584			
727		459		866	-459	866			
2237	55,654	1412	14,222	2665	54,242	11,657			
1403		890		1479	-890	1479			
2666	53,473	1683	13,761	3176	56,730	11,585			
1759		1111		2095	-1111	2095			
2898	55,269	1830	14,223	3452	53,439	10,771			
1874		1183		2232	-1183	2283			
3070	57,510	1938	14,800	3657	55,572	11,142			
2104		1328		2506	-1328	2506			
3185	58,064	2011	15,343	3794	56,053	11,149			
2104		1328		2506	-1328	2506			
2737	53,994	1728	13,805	3261	52,266	10,634			
1380		871		1644	-871	1644			

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0582/1

SHEET NO. 2-26

AIRCRAFT:

C105.

ELEVATOR.

PREPARED BY

DATE

G. Norman.

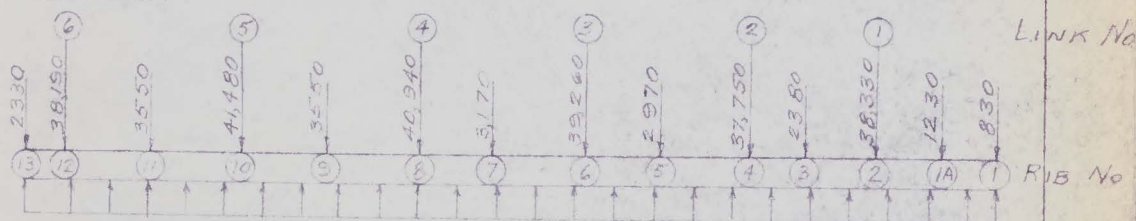
3 MAY-54

CHECKED BY

DATE

ELEVATOR SPAR LOADING.

THE GREATEST LOADS IN THE PLANE OF THE SPAR WEB OCCUR IN THE "SUBSONIC, 30° UP" CASE. THE REACTION AT THE HINGE IS ASSUMED TO BE UNIFORMLY DISTRIBUTED. THE LOADING IS AS FOLLOWS.



REFERENCES - LOADS SMT 2-24
RIB LOCATIONS SMT 1-2.

$$\Sigma \text{ CONCENTRATED LOADS } = 255,510 \text{ LB.}$$

$$\text{VALUE OF U.D. REACTION} = \frac{255,510}{124.54} = 2052 \text{ LB/IN.}$$

NOTE: REFINEMENTS TO THIS LOADING ARE MADE ON SMT 3-52.

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0582/1

SHEET NO. 2-27

AIRCRAFT:

C105.

ELEVATOR

PREPARED BY

DATE

G. Norman

4-MAY-54

CHECKED BY

DATE

CONTROL RIB LOADING. (SUBSONIC).

THE 'SUBSONIC, 20° DOWN' CASE GIVES THE GREATEST NORMAL AIR LOAD AND CONTROL MOMENT.
RIB 10 (LINK NO 5) IS MOST HEAVILY LOADED.

LOADS AT RIB 10:

NORMAL AIR LOAD = 4778 LB. (SHT. 2-12)

CONTROL LOAD = 51,723 LB. (SHT. 2-13)

CONTROL MOM. AT 17 = 2.97 IN. (SHT. 1-5A)

CONTROL MOMENT = 51,723 x 2.97 = 153,600 IN. LB.

TORQUE INTO RIB FROM SKIN

AIRLOAD TORQUE = 4778 x $\frac{61.8}{3}$ = 98,400 IN. LB.

TOTAL TORQUE IN RIB = 153,600 IN. LB. (ABOVE)

∴ TORQUE FROM SKIN = 153,600 - 98,400
= 55,200 IN. LB.

SHEAR IN RIB. DUE TO
a. TORQUE.
b. NORMAL AIR LOAD.

(1) FROM TORQUE:

$$q_t = \frac{T}{2A}$$

A = 157.7 IN.² (SHT. 1-7)

$$q_t = \frac{55,200}{2 \times 157.7} = 175 \text{ LB./IN.}$$

$V_t = q_t h$ WHERE h = HEIGHT OF RIB TO SKIN MEDIANIS.

x = DISTANCE FROM TPLNG. EDGE.

AT $x = 0$, $h = .900 - .051 = .85$ IN.

$x = 61.8$, $h = 4.718 - .051 = 4.67$ IN.

$$\therefore h = .85 + \frac{x}{61.8} (4.67 - .85) = .85 + .06182x$$

$$\therefore V_t = 175 (.85 + .06182x) = 148.7 + 10.8x$$

A. V. ROE CANADA LIMITED
MILTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0582/1

SHEET NO. 2-28

AIRCRAFT: C105.

ELEVATOR.

PREPARED BY

DATE

G. H. HARRISON

4-MAY-54

CHECKED BY

DATE

② FROM NORMAL AIR LOAD. - IN THE SUBSONIC CASE, THE AIRLOAD DISTRIBUTION IS TRIANGULAR WITH THE PEAK AT THE HINGE LINE, AS:-



$$d = 4778 \times \frac{61.8}{61.8} = 154.6 \text{ LB/IN.}$$

THE AIRLOAD "W", AT ANY STATION X, = $\frac{154.6 X}{61.8}$

$$W = 2.502 X$$

$$V_N = \int_0^x W dx = \int_0^x 2.502 X dx = \frac{2.502 X^2}{2}$$

$$V_N = 1.251 X^2$$

$$\therefore V = V_T + V_N = 1.251 X^2 + 10.8 X + 148.7 \text{ LB.}$$



① X IN. FROM TIE	② X ²	③ 1.251 X ²	④ 10.8 X	⑤ V = ③ + ④ + 148.7
10	100	125	108	382
20	400	500	216	865
30	900	1,125	324	1,608
40	1600	2,002	432	2,580
50	2500	3,127	540	3,820
57	3249	4,064	616	4,830
61.8	3819	4,778	667	5,590

V IS SHOWN GRAPHICALLY ON FIG. 2-32

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7/0582/1

SHEET No. 2-29

AIRCRAFT:

C105

ELEVATOR

PREPARED BY

DATE

H. Norman

4-MAY-54

CHECKED BY

DATE

CONTROL RIB BENDING MOMENT (SUBSONIC).

$$M = M_N + M_T$$

M_N = MOMENT DUE TO NORMAL AIR LOAD.

$$= \int V_N dx. \quad V_N = 1.251 x^2 \quad (\text{SHT. 2-28}).$$

$$= 1.251 \int x^2 dx = \frac{1.251}{3} x^3$$

$$= .417 x^3 \quad \text{IN. LB.}$$

M_T = MOMENT DUE TO TORQUE.

$$= 2 q t A. \quad \text{WHERE, } q = 175 \text{ LB./IN.} \quad (\text{SHT. 2-27}).$$

$$A = \left(\frac{.85 + h}{2} \right) x.$$

$$h = .85 + .0618 x. \quad (\text{SHT. 2-27}).$$

$$A = \left(\frac{.75 + .85 + .0618 x}{2} \right) x$$

$$= .0309 x^2 + .85 x.$$

$$\text{AT } x = 61.8, \quad A = 157.7 \text{ IN.}^2$$

$$M_T = 2 \times 175 \left(.0309 x^2 + .85 x \right)$$

$$= 10.8 x^2 + 297.5 x.$$

$$M = .417 x^3 + 10.8 x^2 + 297.5 x.$$

① x IN FROM T/E.	② x ²	③ x ³	④ 297.5x	⑤ 10.8x ²	⑥ .417x ³	⑦ M = ④+⑤+⑥ IN. LB.
10	100	1000	2975	1080	417	4,470
20	400	8000	5950	4320	3,336	13,610
30	900	27000	8925	9720	11,259	29,900
40	1600	64000	11900	17,280	26,688	55,870
50	2500	125000	14,875	27,000	52,125	94,000
57	3249	185193	16,958	35,089	77,225	129,270
61.8	3819	236029	55,200 *	98,424	153,600	

* AT $x = 61.8$, $M_T = 2 q t A = 2 \times 175 \times 157.7 = 55,200.$

M IS SHOWN GRAPHICALLY ON SHT. 2.33

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

REPORT NO. 7/0582/1

SHEET NO. 2-31

AIRCRAFT:

C 105

ELEVATOR

PREPARED BY

B. Harrison

DATE

6-MAY-54

CHECKED BY

DATE

CONTROL RIE LOADING (SUPERSONIC) CONT'D.

BENDING MOMENT: $M = M_N + M_T$

M_N = MOMENT DUE TO NORMAL AIR LOAD.

$$= \int V_N dx \quad V_N = 51.6 x \quad (\text{SNT. 2-30})$$

$$= \frac{51.6}{2} x^2 = 25.8 x^2 \text{ IN. LB.}$$

M_T = MOMENT DUE TO TORQUE IN SKIN.

$$= 2q_t A \quad \text{WHERE } q_t = 174.7 \text{ LB./IN.} \quad (\text{SNT. 2-30})$$

$$A = .0309 x^2 + .85 x \quad (\text{SNT. 2-29})$$

$$= 2 \times 174.7 (.0309 x^2 + .85 x)$$

$$= 10.8 x^2 + 297 x \quad \text{EXCEPT AT } x = 61.8,$$

$$\text{WHERE } A = 152.7 \text{ IN.}^2 \text{ \& } M_T = 2q_t A = 55,100 \text{ IN. LB.}$$

$$\therefore M = M_N + M_T = 36.6 x^2 + 297 x$$

x IN. FROM TLE	x^2	$36.6 x^2$	$297 x$	$M = 36.6 x^2 + 297 x$ IN. LB.
10	100	3,660	2,970	6,630
20	400	14,640	5,940	20,580
30	900	32,940	8,910	41,850
40	1600	58,560	11,880	70,440
50	2500	91,500	14,850	106,350
57	3249	118,913	16,929	135,840
61.8	3819	—	—	153,600 *

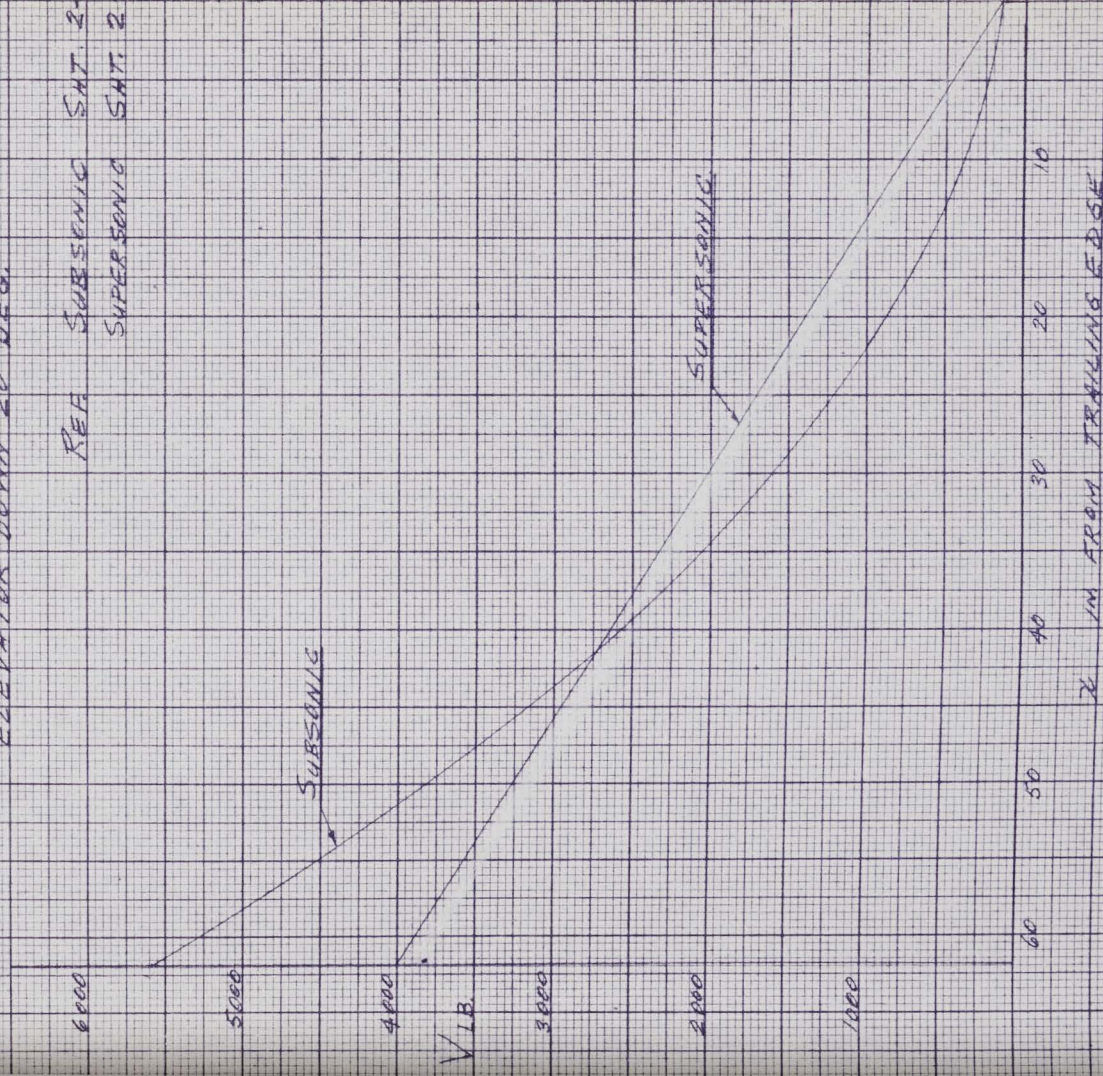
* AT $x = 61.8$, M = CONTROL MOMENT. (SNT. 2-30)

M IS SHOWN GRAPHICALLY ON SNT. 2-33

ELEVATOR CONTROL RIB SHEAR FORCE DIAGRAM.

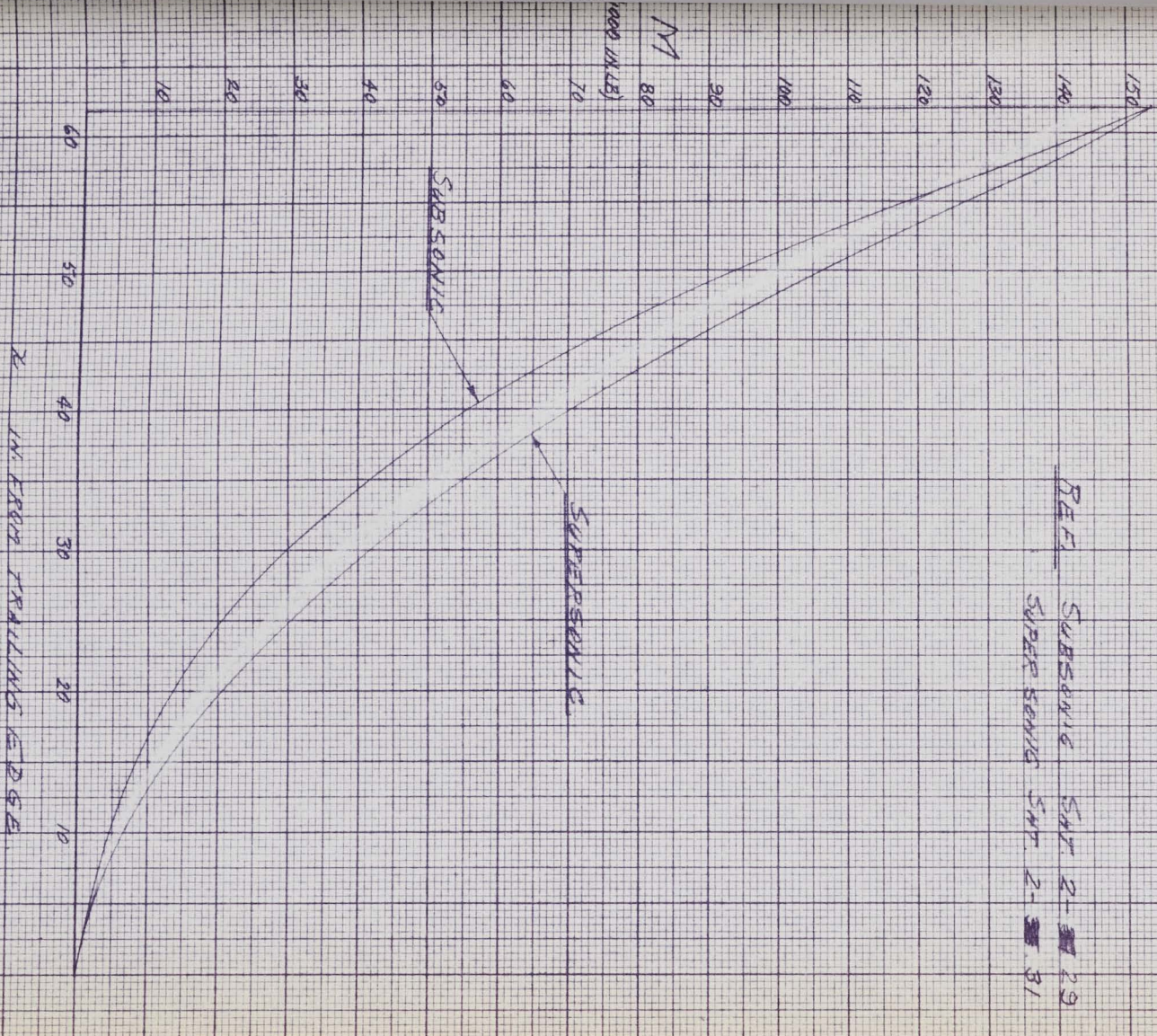
ELEVATOR DOWN 20 DEG.

REF SUBSONIC SAT. 2-2028
SUPERSONIC SAT. 2-2030



CONTROL RIB E.M. DIAGRAM
ELEVATOR DOWN 80 DEG.

REF SUBSONIC SH. 2-31 23
SUPERSONIC SH. 2-31 31



A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7/9582/1

SHEET No. 2-34

AIRCRAFT:

C105

ELEVATOR

PREPARED BY

DATE

G. Norman

5-MAY-54

CHECKED BY

DATE

INTERMEDIATE RIB LOADINGS.

FROM SHT. 2-19 IT IS SEEN THAT THE INTER-MEDIATE RIB WITH THE GREATEST NORMAL LOAD IS EITHER RIB 9 OR 11. LOADS WILL BE CALCULATED FOR "SUBSONIC & SUPERSONIC, 20° DOWN" CASES

NORMAL LOAD ≈ 3160 LB. (SUBSONIC)

≈ 2100 LB. (SUPERSONIC)

SINCE THE FRONT STAR AT THIS RIB IS UNABLE TO REACT A BENDING MOMENT IN THE RIB, THE B.M. DUE TO NORMAL LOAD IS REACTED BY TORQUE ON THE ELEVATOR SKIN. ANY TRANSIENT TORQUE ON THE ELEVATOR AT THIS STATION HAS NO EFFECT ON THIS RIB BUT IS PASSED ON TOGETHER WITH THE ABOVE "REACTING" TORQUE TO THE CONTROL RIBS.



SUBSONIC CASE.

THE MOMENT DUE TO N (M_N) = THE MOMENT DUE TO q_T . (T).

$$T = M_N = N \times \frac{C}{3} = 3160 \times \frac{64.8}{3} = 65,100 \text{ IN. LB.}$$

$$q_T = \frac{T}{2A} = \frac{65,100}{2 \times 157.7} = 206.5 \text{ LB./IN.}$$

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/4582/1

SHEET NO. 2-35

AIRCRAFT:

C105

ELEVATOR

PREPARED BY

DATE

G. Norman

5-MAY-54

CHECKED BY

DATE

SHEAR IN INTERMEDIATE RIB (SUBSONIC)

DUE TO ① TORQUE

②. NORMAL AIR LOAD.

① DUE TO TORQUE:-

$$V_T = qth \quad \text{WHERE } h = .85 + .0618x \quad (\text{SMT. 2-27})$$

$$q_T = 206.5 \text{ LB/IN.} \quad (\text{SMT. 2-34})$$

$$\therefore V_T = 206.5(.85 + .0618x) \\ = 12.8x + 176. \text{ LB.}$$

② DUE TO NORMAL AIR LOAD:- AIR LOAD DISTRIBUTION IS TRIANGULAR AS ON SMT. 2-28
WHERE $d = \frac{3160 \times 3}{61.8} = 102.3 \text{ LB/IN.}$

$$\text{AIRLOAD, } W = \frac{102.3}{61.8} x = 1.654x$$

$$V_N = \int W dx = 1.654 \int x dx = .827x^2$$

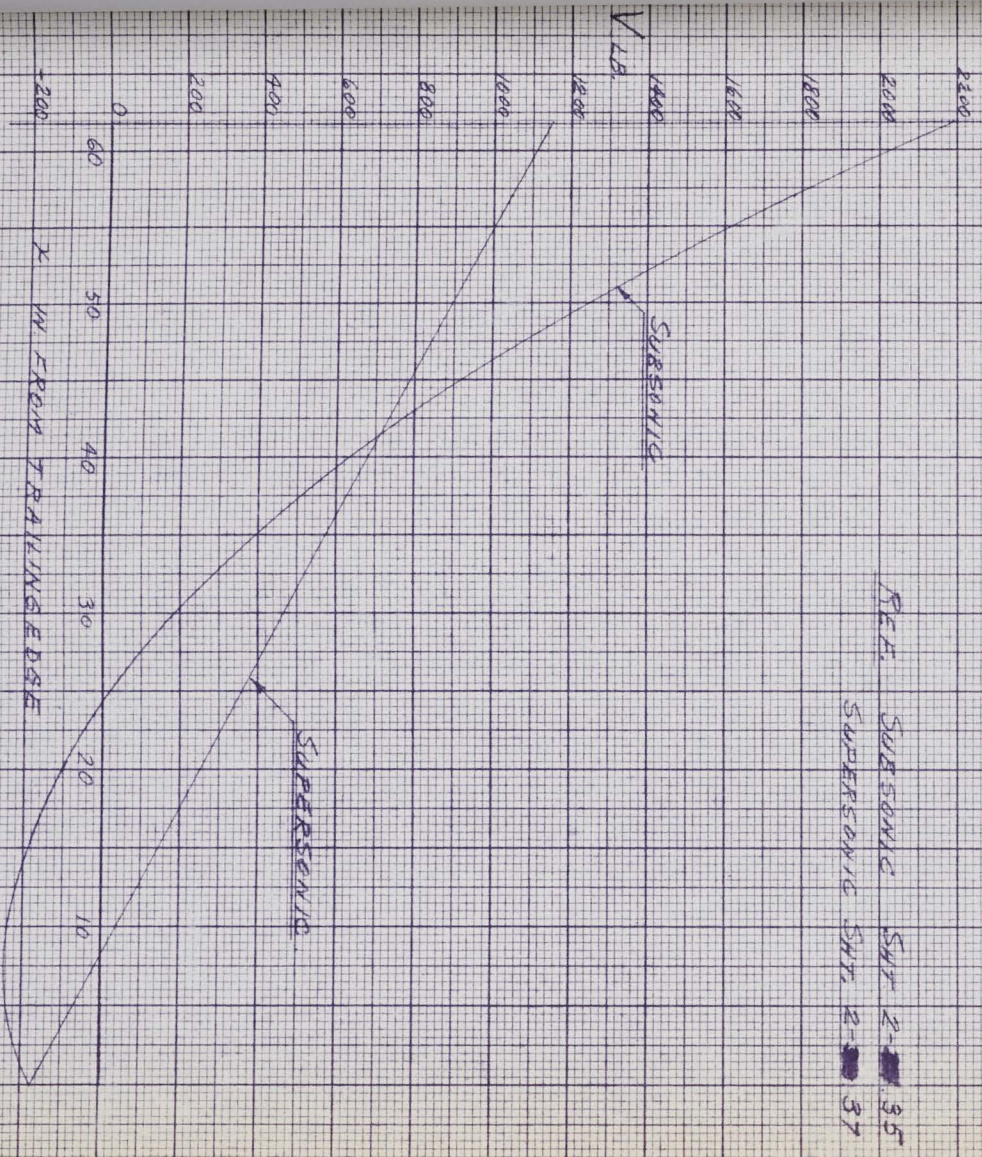
$$V = V_N - V_T = .827x^2 - 12.8x - 176.$$

① x in. FROM T/E	② x ²	③ .827x ²	④ 12.8x	⑤ V = ③ - ④ - 176.
10	100	83	128	-221
20	400	331	256	-101
30	900	744	384	184
40	1600	1323	512	635
50	2500	2067	640	1251
57	3249	2687	730	1781
61.8	3819	3158	791	2191

V IS SHOWN GRAPHICALLY ON SMT. 2-39.

INTERMEDIATE RIB SHEAR FORCE DIAGRAM

ELEVATOR DOWN 20 DEG

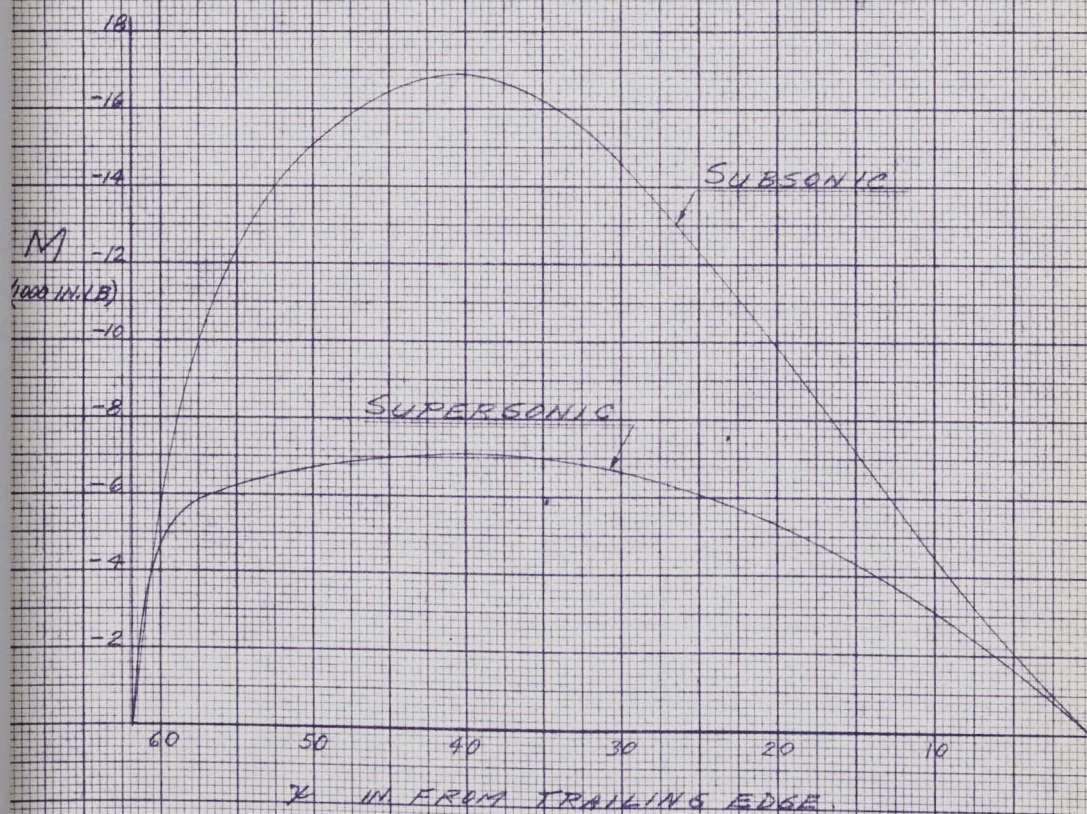


INTERMEDIATE PIV B.M. DIAGRAM

ELEVATOR DOWN 20 DEG.

REF. SUBSONIC SHT. 2-36

SUPERSONIC SHT. 2-38



DETERMINATION OF g_t & S_g (SUBSONIC CASE)

$g_t = \frac{I}{2A} = g$ DUE TO SKIN TORQUE.

MOMENT & TORQUE 4 ft
NOSE UP +VE.

S_g = SHEAR ON SPAR WEB DUE TO g .

S_g UP +VE.

A. V. RO

TEC

AIRCRAFT

WEIGHT

C. G. POSITI

	1	2	3	4	5	6	7	8	9	10	11
RIB No.	P LB (SMT. C-13)	30 DEG. U P			N LB (SMT. 2-19)	AIRLOAD TORQUE = $N \times \frac{S}{S}$ 20.6 x ④	TORQUE IN SKIN = $-(⑤ + ⑥)$	$S_g =$ $\frac{I}{2A} =$ ⑥ x .00317	$S_g =$ ⑦ x 5.47	ARM IN (SMT. 1-5A)	HINGE M ⑩ x ⑪
		ARM IN (SMT. 1-5A)	HINGE MCH. ⑩ x ⑪								
1		2.81		625	14,320	14,320	-45.4	-248		2.97	
1A				1430	21,220	21,220	-67.3	-368			
2	43,576		-	139,310	3130	64,480	74,830	237.2	1297		147,24
3				1996	41,120	41,120	-130.3	-713			
4	47,633		-	139,850	3778	77,830	56,020	177.6	971		141,47
5			1	2494	51,380	51,380	-162.9	-891			
6	49,233		-	138,340	4108	84,620	53,720	170.3	932		146,22
7				2657	54,730	54,730	-173.5	-949			
8	51,229		-	143,950	4352	89,650	54,300	172.1	941		152,15
9				2983	61,450	61,450	-194.8	-1066			
10	51,723		-	145,740	4515	93,010	52,330	165.9	907		153,62
11				2983	61,450	61,450	-194.8	-1066			
12	48,097		-	135,150	3879	79,910	55,240	175.1	958		142,85
13.		2.81		1956	40,290	40,290	-127.7	-699		2.97	

A. V. ROE CANADA LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0582/1

SHEET NO. 2-47

AIRCRAFT:

C105

ELEVATOR

PREPARED BY

DATE

G. Norman

17-MAY-54

CHECKED BY

DATE

BOLT LOADS - FITTING TO RIB ATT'T.

EACH LEG OF THE CONTROL FITTING IS SANDWICHED BETWEEN THE RIB WEB (.051) AND THE RIB WEB DOUBLER (.072). THE DOUBLER JOINS THE RIB JUST AFT OF THE CONTROL FITTING, SO, IT IS ASSUMED ① THAT THE LOADS IN THE RIB & DOUBLER DUE TO "M", THE HORIZONTAL COMPONENTS ARE TRANSMITTED DIRECTLY TO THE TOP & BOTTOM SKINS AND THE PERPENDICULAR COMPONENTS ARE SELF EQUILIBRATING; ② THAT THE LOADS DUE TO "L_H" ARE TRANSMITTED DIRECTLY TO THE SKINS; ③ THE LOADS DUE TO "L_D" ARE TRANSMITTED TO THE RIB WEB.

"M" & "L_H" WILL BE DIVIDED BETWEEN RIB & DOUBLER IN THE RATIO OF THEIR BEARING STRENGTHS. "L_D" WILL BE DIVIDED BETWEEN THEM IN THE RATIO OF THEIR STIFFNESSES. SINCE THE TWO HAVE THE SAME DEPTH THEIR VALUES OF $E^2 [I = \int z^2 dA]$ WILL HAVE A 1:1 RATIO, SO THEIR STIFFNESS RATIO WILL DEPEND ON THEIR THICKNESSES AS DO THEIR BEARING STRENGTHS, ABOVE.

LOAD PROPORTIONS -

$$\text{TO RIB} = \frac{.051}{.051 + .072} = .415.$$

$$\text{TO DOUBLER} = \frac{.072}{.051 + .072} = .585.$$

[illegible]

[illegible]

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0582/1

SHEET NO. 2-50

AIRCRAFT.

C105.

ELEVATOR

PREPARED BY

DATE

E. Hermann 18 MAY 54

CHECKED BY

DATE

BOLT LOADS - FITTING TO SPAR WEB ATT.

FROM SAT. 2-46, MAX. LOAD = 42,389 LB., IN THE
"SUBSONIC, 30° UP" CASE. THIS IS BORNE BY
8 - $\frac{3}{8}$ IN. HUCK LOCKBOLTS AND 2 - $\frac{1}{4}$ IN. BOLTS.
THE LOAD WILL BE DISTRIBUTED AMONG THEM IN
PROPORTION TO THEIR BEARING AREA IN THE
.1875 SPAR WEB - I.E. IN THE RATIO OF THEIR
DIAMETERS.

LET $\frac{3}{8}$ IN. = UNIT DIAMETER
 $\frac{1}{4}$ IN. = .67 × UNIT DIAM.

$$\text{TOTAL} = 8 \times 1 + 2 \times .67 = 9.34.$$

$$\text{LOAD PER } \frac{1}{4} \text{ IN. BOLT} = \frac{.67}{9.34} \times 42,389 = 3040 \text{ LB.}$$

$$\text{LOAD PER } \frac{3}{8} \text{ IN. BOLT} = \frac{1}{9.34} \times 42,389 = 4538 \text{ LB.}$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0582/1

SHEET NO. 2-51

AIRCRAFT:

C105.

ELEVATOR

PREPARED BY

DATE

G. Norman. 18-MAY-54

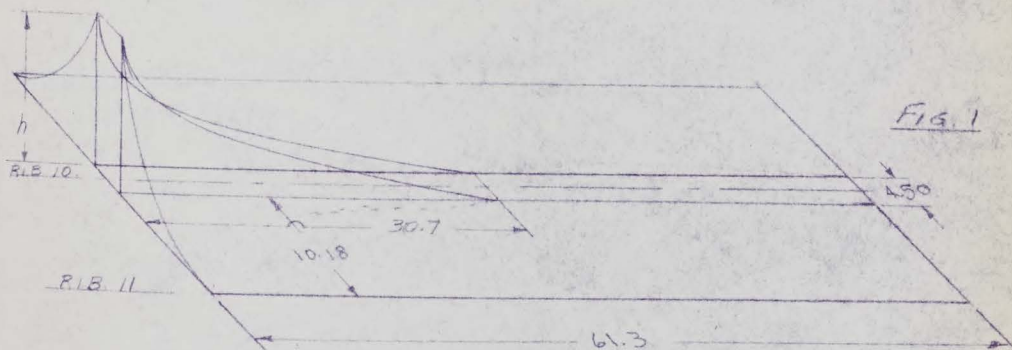
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SKIN LOADING.

TOP SKIN: THE TOP SKIN IS LOADED FROM TWO SOURCES: ① q_t DUE TO TORQUE IN THE ELEVATOR AND ② H , THE CHORDWISE COMPONENT OF THE HINGE LOAD.

THE LOADING DUE TO H IS ASSUMED TO PEAK AT THE INTERSECTION OF RIB AND FWD. EDGE OF THE SKIN AND TO FALL OFF PARABOLICALLY BOTH SPANWISE AND CHORDWISE TO ZERO AT THE INTERMEDIATE RIB AND HALF-CHORD POINT RESPECTIVELY. H IS LARGEST AT RIB 10; ALSO THE PANEL WIDTH.



CHORDWISE LOADING DUE TO H

PARABOLA: $y^2 = ax$.

$$y = h - g$$

At $x = 30.7$, $y = h$

$$\text{i.e. } h^2 = 30.7 a$$

$$a = \frac{h^2}{30.7}$$

$$\therefore (h - g)^2 = \frac{h^2 x}{30.7}$$

$$h - g = \sqrt{\frac{h^2 x}{30.7}}$$

$$g = h - \sqrt{\frac{h^2 x}{30.7}} = h \left(1 - \sqrt{\frac{x}{30.7}} \right)$$

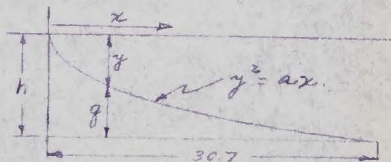


FIG. 2

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

REPORT NO. 7/0582/1

SHEET NO. 2-52

AIRCRAFT:

C105

ELEVATOR.

PREPARED BY

DATE

B. Norman

18-MAR-54

CHECKED BY

DATE

EVALUATING "h" -

IN FIG. 2, SHT. 2-51, THE AREA UNDER THE CURVE

$$= \int_0^{30.7} g dx = \int_0^{30.7} \left(h - \sqrt{\frac{h^2}{30.7}} x^{\frac{1}{2}} \right) dx = \left[hx - \frac{2}{3} \sqrt{\frac{h^2}{30.7}} x^{\frac{3}{2}} \right]_0^{30.7}$$

$$= 30.7h - \sqrt{h^2} \times \frac{2}{3} \times 30.7^{\frac{3}{2}} = 30.7h \left(1 - \frac{2}{3} \right) = \frac{30.7}{3} h$$

$$= 10.233h$$

THIS AREA = $\frac{H}{2}$ ($\frac{1}{2}H$ TO EACH HALF OF RIB).

$$\therefore h = \frac{H}{2 \times 10.233} = \frac{H}{20.47}$$

$$\therefore g_{H0} = \frac{H}{20.47} (1 - .1805 \sqrt{x}) = H (.0489 - .0088 \sqrt{x})$$

SPANWISE LOADING DUE TO "H"

EQUATION IS SIMILAR TO THE ABOVE EXCEPT THAT AT $x = 10.18$, $y = h$

$$\therefore a = \frac{h^2}{10.18}$$

$$\therefore g = h \left(1 - \sqrt{\frac{x}{10.18}} \right) = \frac{H}{20.47} \left(1 - \sqrt{\frac{x}{10.18}} \right)$$

$$g_{H5} = H (.0489 - .0154 \sqrt{x})$$

FACTOR FOR DETERMINING g_{H0} .

x IN	x' IN	$\sqrt{x}$	$.0088 \sqrt{x}$	$.0489 - .0088 \sqrt{x}$
61.3	0	0	0	.0489
56.3	5	2.24	.0197	.0292
51.3	10	3.16	.0278	.0211
46.3	15	3.87	.0341	.0148
41.3	20	4.47	.0394	.0095
36.3	25	5.00	.0440	.0049
30.6	30.7	5.55	.0489	0

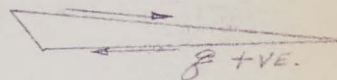
x IS MEASURED FROM TRAILING EDGE.

x' IS MEASURED FROM FWD EDGE OF SKIN.

SHEAR FLOW IN TOP SKIN.
EVALUATION OF 1. g_{HC} & g AT RIB 10

AT INED. WEB.

2. g_{HS} & g ALONG FRONT SPAR.



A. V. ROE

M

TECH

AIRCRAFT

WEIGHT

C. G. POSITION

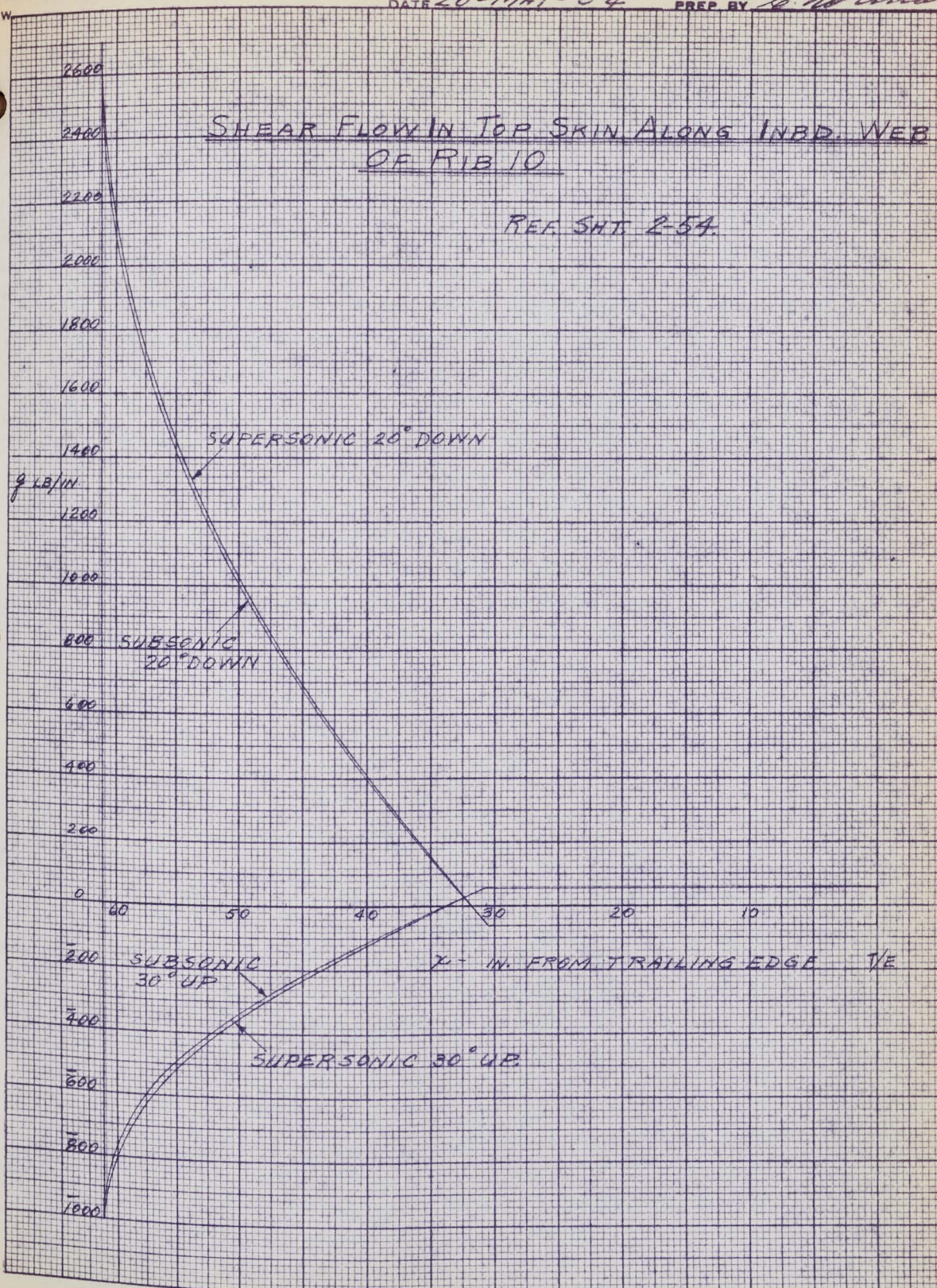
1	1	2	3	4	5	6	7	8	9	10	11
1	FACTOR	SUBSONIC 30° UP			SUBSONIC 20° DOWN			SUPERSONIC 30° UP			SUPERSONIC
		$g_{HC} = .345 g_T$ ① x 20,435 (SNT. 2-52)	g (SNT. 2-24)	g (SNT. 2-41)	$g_{HC} = .345 g_T$ ① x 55,047 (SNT. 2-24)	g (SNT. 2-41)	g (⑤ + ⑥)	$g_{HC} = .345 g_T$ ① x 21,389 (SNT. 2-25)	g (SNT. 2-42)	g (⑧ + ⑨)	g_{HC} ① x 56,053 (SNT. 2-25)
61.3	.0489	599	57	542	2692	60	2632	1046	57	589	2741
56.3	.0292	597		542	1607		1547	625		568	1637
51.3	.0211	431		374	1161		1101	451		394	1183
46.3	.0148	302		245	815		755	317		260	830
41.3	.0095	194		137	523		463	203		146	533
36.3	.0049	100		43	270		210	105		48	275
30.6	0	0	57	57	0	60	60	0	57	57	0
2	FACTOR	$g_{HS} = .345 g_T$ ① x 20,435 (SNT. 2-52)			$g_{HS} = .345 g_T$ ① x 55,047 (SNT. 2-24)			$g_{HS} = .345 g_T$ ① x 21,389 (SNT. 2-25)			g_{HS} ① x 56,053 (SNT. 2-25)
		g_{HS} (SNT. 2-52)	g (SNT. 2-24)	g (SNT. 2-41)	g_{HS} (SNT. 2-24)	g (SNT. 2-41)	g (⑤ + ⑥)	g_{HS} (SNT. 2-25)	g (SNT. 2-42)	g (⑧ + ⑨)	g_{HS} (SNT. 2-25)
0	.0489	599	57	542	2692	60	2632	1046	57	589	2741
2	.0271	554		497	1492		1432	580		523	1519
4	.0181	370		313	996		936	387		330	1015
6	.0112	229		172	617		557	240		183	628
8	.0053	108		51	292		232	113		56	297
10.18	0	0	57	57	0	60	60	0	57	57	0

SHEAR FLOW IN TOP SKIN.
EVALUATION OF 1. $g_{HC} \# 8$ AT RIB 10.
2. $g_{HS} \# 8$ ALONG FRONT SPAR
AT OUTBD. WEB.



A. V. ROE
M
TECH
AIRCRAFT
WEIGHT
C. G. POSITION

1	1	2	3	4	5	6	7	8	9	10	11		
X-IN. FROM T/E	FACTOR	SUBSONIC 30° UP			SUBSONIC 20° DOWN			SUPERSONIC 30° UP			SUBSONIC 20° DOWN		
		g_{HC} ①x20,435 (SNT.2-52)	.6558T (SNT.2-24)	8 (SNT.2-41)	②+③	g_{HC} ①x55,047 (SNT.2-24)	.6558T (SNT.2-41)	8 (SNT.2-41)	⑤+⑥	g_{HC} ①x21,389 (SNT.2-25)	.6558T (SNT.2-42)	8 (SNT.2-42)	⑧+⑨
61.3	.0489	999	109	890	2692	115	2577	1046	109	937	2741		
56.3	.0292	597		488	1607		1492	625		516	1637		
51.3	.0211	431		322	1161		1046	451		342	1183		
46.3	.0148	302		193	815		700	317		208	830		
41.3	.0095	194		85	523		408	203		94	533		
36.3	.0049	100		9	270		155	105		4	275		
30.6	0	0	109	109	0	115	115	0	109	109	0		
2	FACTOR	g_{HS}	.6558T	8	g_{HS}	.6558T	8	g_{HS}	.6558T	8	g_{HS}		
X-IN. FROM 1/8 WEB RIB 10		①x20,435 (SNT.2-53)	(SNT.2-24)	(SNT.2-41)	②+③	①x55,047 (SNT.2-24)	(SNT.2-41)	⑤+⑥	①x21,389 (SNT.2-25)	(SNT.2-42)	⑧+⑨	①x56,053 (SNT.2-25)	
0	.0489	999	109	890	2692	115	2577	1046	109	937	2741		
2	.0271	554		445	1492		1377	580		471	1519		
4	.0181	370		261	996		881	387		278	1015		
6	.0112	229		120	617		502	240		131	628		
8	.0053	108		1	292		177	113		4	297		
10.18	0	0	109	109	0	115	115	0	109	109	0		



2600

2400

2200

2000

1800

1600

1400

1200

1000

800

600

400

200

0

200

400

600

800

1000

SHEAR FLOW IN TOP SKIN ALONG
FRONT SPAR - RIB 10 TO RIB 9

REF. SHT. 2-54.

SUPERSONIC 20° DOWN

SUBSONIC
20° DOWN

8 LB/IN

X - IN. FROM INBD. WEB OF RIB 10

2

4

6

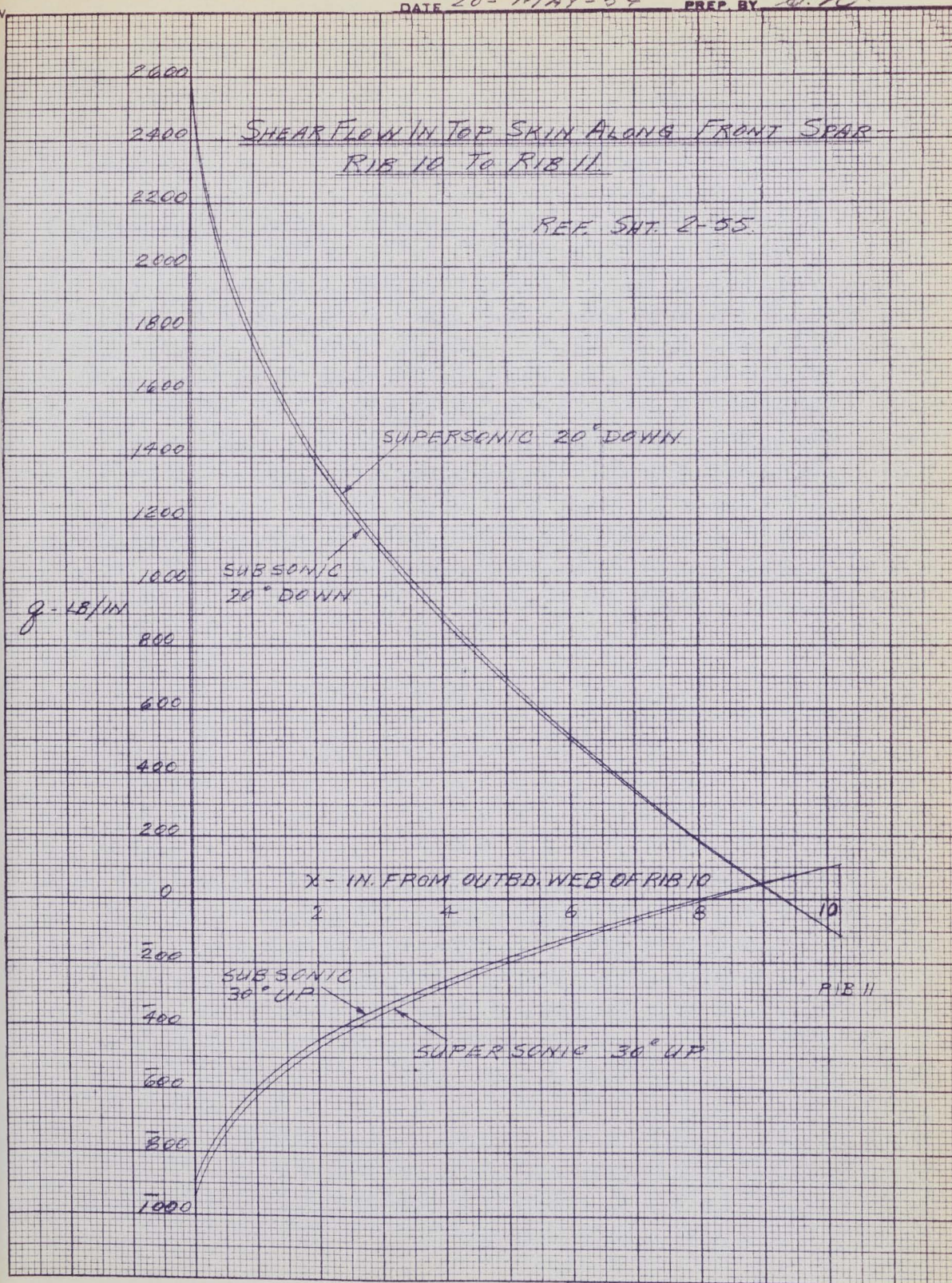
8

10

SUBSONIC 30° UP

SUPERSONIC 30° UP

RIB 9



A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0582/1

SHEET NO. 2-61

AIRCRAFT

C105

ELEVATOR

PREPARED BY

DATE

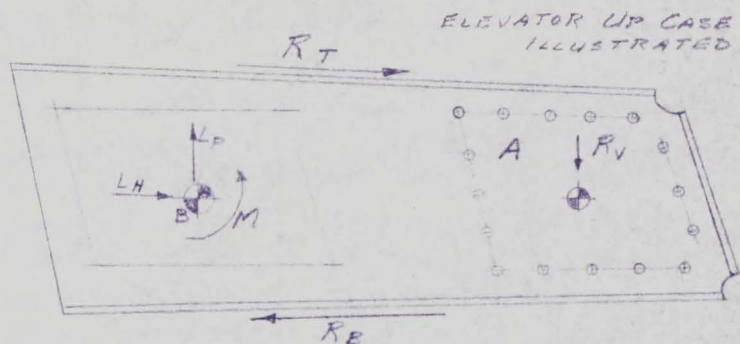
B. Norman

20-MAY-54

CHECKED BY

DATE

RIVET LOADS - RIB DOUBLER TO SKIN & RIB.



FROM SMT. 2-47, THE LOADS PUT INTO THE DOUBLER BY THE CONTROL FITTING ARE $.585 \times \frac{1}{2} \text{ OF } M$, LP & LH AS QUOTED ON SMT. 2-46.

M IS ASSUMED REACTED BY THE SKIN RIVETS

EQUALLY

LH IS ASSUMED REACTED BY THE SKIN RIVETS. RT & RB .

LP IS ASSUMED REACTED BY GROUP "A".

MOMENT ARMS - FOR $RT = 2.04 \text{ IN.}$ } REF. SMT. 2-43 &
 $RB = 2.06 \text{ IN.}$ } 7-1082-0033 & 34.
 $RV = 7.86 \text{ IN.}$

ASSUME RT & RB EQUALLY LOADED BY M ; AVG. ARM = 2.05 IN.

RT , RB & RV ARE CALCULATED ON THE NEXT PAGE

A. V ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0582/1

SHEET NO. 2-62

AIRCRAFT:

C 105

ELEVATOR

PREPARED BY

DATE

G. Norman 21-MAY-54

CHECKED BY

DATE

PIVET LOADS - RIB DOUBLER TO SKIN & RIB CONTD.
FOR SOURCES & REFS SEE SAT. 2-61.

		SUB SONIC		SUPER SONIC	
		30° UP	20° DOWN	30° UP	20° DOWN
1	.293 M ^(SAT. 2-61) IN LB.	22,800	5,100	24,500	7,290
2	R _V = .293 L _p LB	1,560	1,650	1,115	1,180
3	.293 L _H LB	5,850	15,990	6,130	16,270
4	② x 7.86 IN. LB	12,250	12,950	8,760	9,270
5	④ + ① IN. LB	10,550	7,850	15,740	1,980
6	② x 2.05 TOP LB	2,570	1,915	3,840	480
7	② x 2.45 BTM. LB	2,570	7,915	3,840	480
8	③ 1/2 TOP LB	2,925	7,995	3,065	8,135
9	③ 1/2 BTM LB	2,925	7,995	3,065	8,135
10	R _T = ② + ③ LB	355	9,910	775	8,615
11	R _B = ② + ③ LB	5,495	6,080	6,905	7,655
12					

SIGN CONVENTION. UP, AFT & NOSE UP +VE.

THE FORWARD PORTION OF THE RIB WILL BE ASSUMED TO BE LOADED IN THE SAME MANNER AS IS THE RIB DOUBLER AND THE ATTACHMENT LOADS CALCULATED ACCORDINGLY. FOR THE REMAINDER OF THE RIB THE PINAT LOADS WILL BE ASSUMED TO BE THE AVERAGE OF THE LOADS FOR INBD. & OUTBD. WEBS AS SHOWN ON SITS 2-56 & 2-57. THIS ASSUMPTION IS MADE BECAUSE OF THE EQUALIZING EFFECT OF THE SKIN BETWEEN THE TWO RIB HALVES.

R2 "ELEVATOR UP" CASE SHOWN

DATE 25-MAY-54

PREP BY

B.M.

ATTACHMENT SHEAR ON TOP SKIN
RIVETS AT CONTROL RIB (ONE SIDE)
20° DOWN CASE

REF. SHT. 2-65.

9.13/in.

6-IN. FROM T/E.

T/E.

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/05824

SHEET NO. 2-67

AIRCRAFT:

CICR.

ELEVATOR

PREPARED BY

DATE

A. Wymann

25-APR-54

CHECKED BY

DATE

RIVET LEADS - INTERMEDIATE RIB-TO-SPIN.

TOP & BOTTOM.

THE HIGHER - RIB LEADS FOR INTERMEDIATE RIBS
LOCUS AT RIBS 9 & 11 WHERE $q = 200$ LB./IN. IN
THE "20° DOWN" CASES. (REF. GT. OF CASE 2-71842).

$$x = 1.012 = 200 \text{ LB./IN. (SAT. 2-71)}$$

RIVET LEADS - SPIN-TO-TRAILING EDGE.

MOST CRITICAL RAY IS FROM RIB 11 TO RIB
11 IN THE "20° DOWN" CASE WHERE $q = 115$ LB./IN.
(REF. SAT. 2-55).

$$x = 1.012 = 115 \text{ LB./IN. (SAT. 2-71)}$$

RIB LEAD - SPIN-TO-FRONT SPAR. (TOP)

MOST CRITICAL RAY IS FROM RIB 9 TO RIB 10 (20° DOWN, SUPERSONIC)
LEAD IS THE RESULTANT OF ① STARWISE SHEAR
(4" CHORD 2", CASE SUPERSONIC 20° DOWN, SAT. 2-54).

AND ② CIRCUMFERENTIAL END LOAD IN SKIN FRONT
HINGE. THIS END LOAD IS ASSUMED TO BE A
U.D.L. WITH A FACTOR OF 1.32 APPLIED TO ALLOW
FOR PENALTY NEAR THE CONTROL POINT.

"H" (REF. SAT. 2-25, "20° DOWN SUPERSONIC") FOR
RIB 10 MUST BE COMBINED WITH "H" FOR RIBS 9 & 11
AND SPREAD OVER THE SPAN FROM RIB 9 TO RIB 11.
I.E.

$$U.D.L. = \left(\frac{-1500}{2} + 56000 - \frac{1300}{2} \right) 1.32 = 3160 \text{ LB./IN.}$$

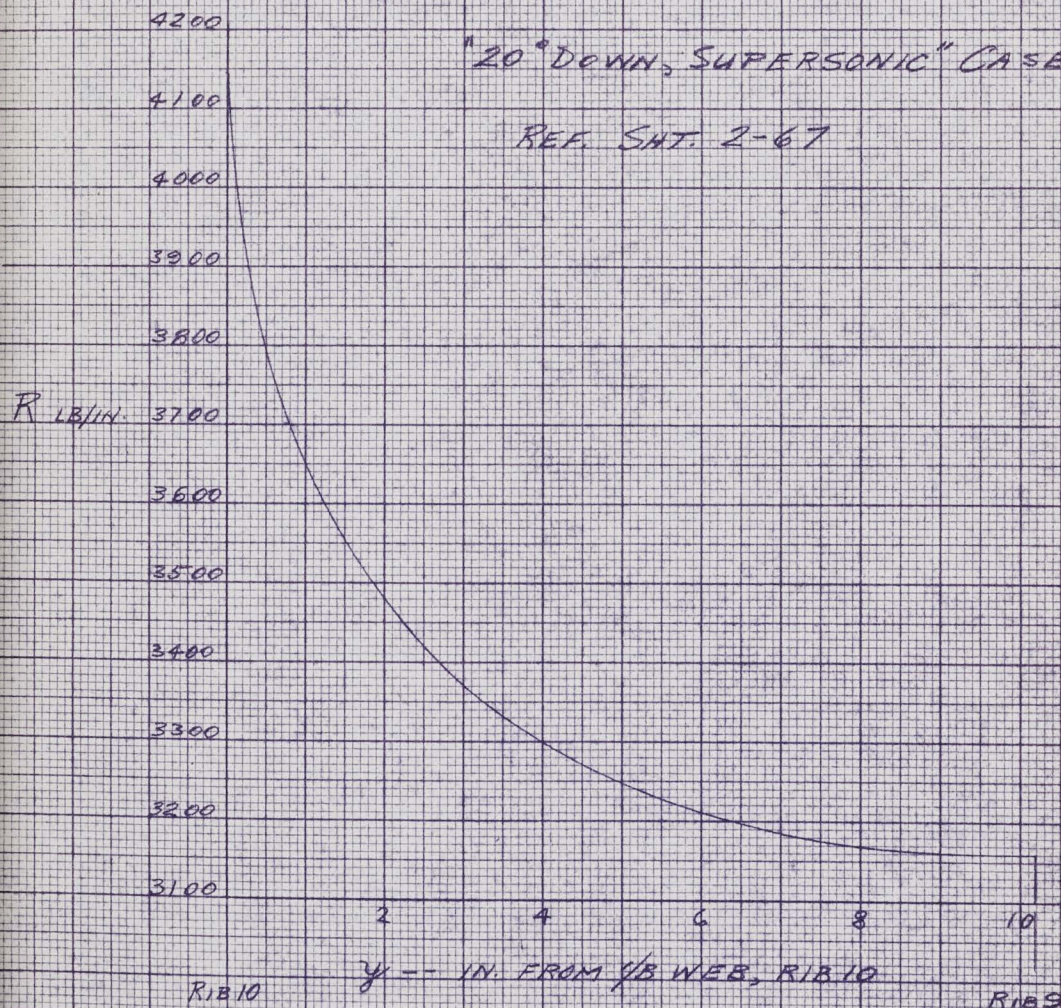
23.0

Y N. FROM RIB 10	① U.D.L.	② P	③ P ²	④ R ² = ① + ②	⑤ R = √④ LB./IN.
0	↑	2681	7,187,761	17,173,400	4144
2		1459	2,128,681	12,114,300	3480
4	9385.600	885	912,825	10,897,600	3301
6		568	323,624	10,308,200	3211
8		237	56,169	10,041,800	3169
10.18	↓	-60	3,600	9,988,200	3160

R. 10 CHORD GRAPHICAL ON SAT. 2-58

RESULTANT LOAD /IN. ON UPPER
SKIN-TO-SPAR ATTACHMENT"20° DOWN, SUPERSONIC" CASE

REF. SMT. 2-67



A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0582/1

SHEET NO. 3-11

AIRCRAFT:

C105

ELEVATOR

PREPARED BY

DATE

G. Norman

11-JUNE-54

CHECKED BY

DATE

PART 3 CONTENTS.

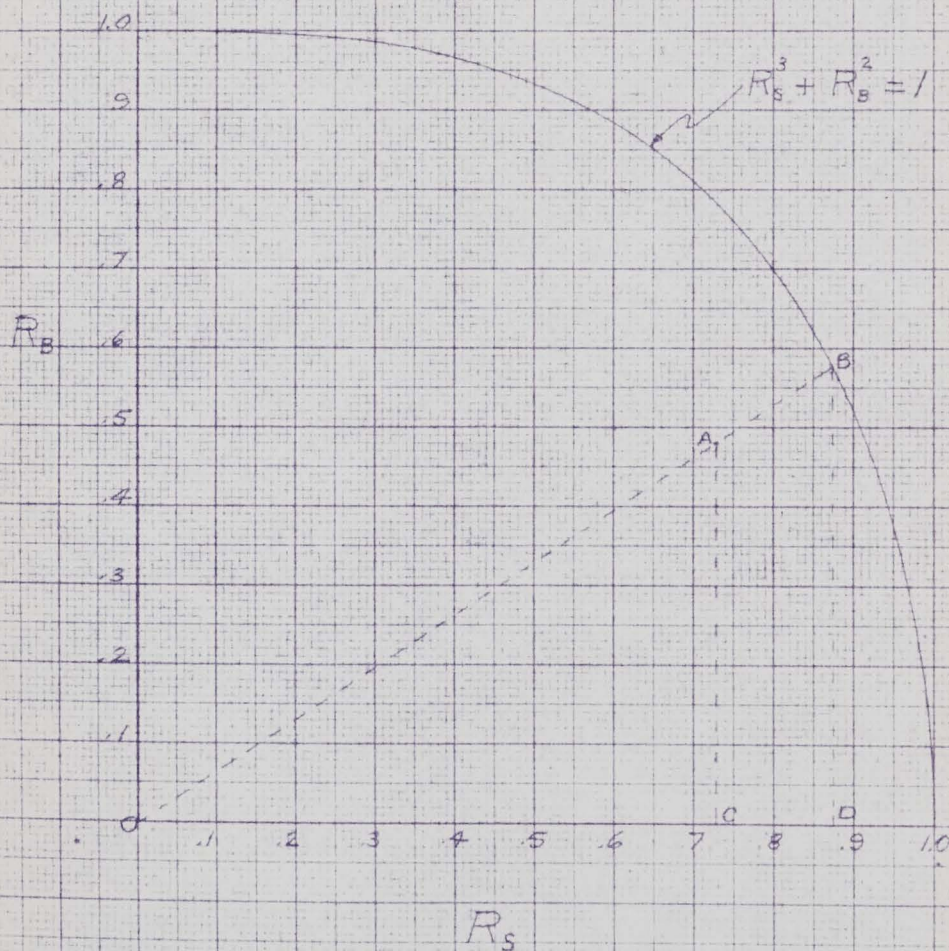
	SHT. No
CONTROL FITTING	3-1
CONTROL FITTING ATTACHMENTS	3-10
LINK ROD ATT. BOLT	3-11
CONTROL FITTING BUSHING	3-14
CONTROL RIBS	3-15
CONTROL RIB ATTACHMENTS	3-29
INTERMEDIATE RIBS	3-34
INTERMEDIATE RIB ATTACHMENTS	3-41
SKINS	3-43
SKIN ATTACHMENTS	3-44
HINGE	3-47
SPAR	3-53
SPAR ATTACHMENTS	3-61
END RIB ATTACHMENTS	3-61

INTERACTION CURVE FOR SHEAR & BENDING

$$R_s = \frac{f_s}{F_{su}}$$

$$R_B = \frac{f_b}{F_{tu}}$$

REF. ANC-5 FIG. 2.6111.

LOCATE THE POINT "A" (R_s, R_B). JOIN OA & PRODUCE TO B

$$M. S. = \frac{OD}{OC} - 1.$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-1082-11

SHEET No. 3-3

AIRCRAFT:

C 105.

ELEVATOR

PREPARED BY

DATE

G. Norman

31 MAR - 54

CHECKED BY

DATE

CONTROL FITTING CONT'D

$$I = 1.66 \text{ in.}^4 \quad A = 2.21 \text{ in.}^2$$

BENDING, DIRECT & SHEAR STRESSES AT SECT. A-A.

(ONE LEG OF FITTING)

	ELEVATOR 30° UP	ELEVATOR 20° DOWN
P (SAT 2-24)	25,862	25,862
θ (SAT 2-2)	22° 11'	72° 11'
$\sin \theta$	.3776	.9520
$\cos \theta$	.9260	.3060
$P_L = P \sin \theta$	9,765	- 24,621
$P_H = P \cos \theta$	- 23,948	7,914
ARM $\perp$ IN. *	2.11	2.11
ARM II IN. *	.45	.45
$M_L = P_L \times \text{ARM } \perp$	4,394	- 11,079
$M_{II} = P_H \times \text{ARM II}$	- 50,530	16,699
$M = M_L + M_{II}$ IN. LB	- 46,136	5,620
Y IN.	1.48	1.48
$f_L = \frac{M}{I}$ (I, SAT 3-8)	$\pm 42,676$	$\pm 5,139$
$\frac{P_L}{A}$ (A, SAT 3-2)	- 4,419	11,141
$A f = f_b + \frac{P_L}{A}$ PSI	- 47,095 (COMPRESS)	16,340 (TENS.)
$T = \frac{P_H}{A}$ PSI	10,836	3,581

* REF. SAT 3-1. ARM $\perp$ IS THE PERP. DISTANCE FROM CENTER OF CONTROL PIN HOLE TO SECT. A-A. ARM II IS DISTANCE, IN PLANE OF SECT. A-A, FROM CENTROID OF SECT. A-A TO HORIZONTAL $\perp$ OF CONTROL PIN HOLE. BOTH DIMS. REF. 7-1082-0038.

SIGN CONVENTION. $\downarrow$, $\nearrow$ & $\curvearrowright$ +VE.

THE "ELEVATOR 30° UP" CASE IS MOST CRITICAL FOR BOTH DIRECT STRESS AND SHEAR.

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 710542/1

SHEET NO. 3-4

AIRCRAFT

C 115

FLAPLATOR

PREPARED BY

DATE

E. Morrison

31-MAY-54

CHECKED BY

DATE

CONTROL PLATING CONTD.

SECTION A-A CONTD.

COMBINED SHEAR & COMPRESSION:

Using THE INTERACTION FORMULA OF ANC-5,
SAT. 3-4

$$\frac{\sigma^2}{\sigma_u^2} + \frac{\tau^2}{\tau_u^2} \leq 1 \quad \text{or} \quad R_s^2 + R_D^2 \leq 1 \quad \text{WHERE}$$

R_s = SHEAR STRESS RATIO = τ/τ_u

R_D = DIRECT STRESS RATIO = f_c/f_{cu}

$$\tau = 10,836 \text{ PSI} \quad (\text{SAT. 3-2})$$

$$\tau_u = 29,400 \text{ PSI} \quad (\text{SAT. 3-1})$$

$$R_s = \frac{10,836}{29,400} = .369$$

$$f_c = 47,000 \text{ P.S.I.} \quad (\text{SAT. 3-2})$$

$$f_{cu} = 46,900 \text{ PSI} \times 1.32 = 61,910 \text{ PSI} \quad (\text{SAT. 3-1})$$

(FROM FACTOR, ACFT. P. 116)

$$R_D = \frac{47,000}{61,910} = .762$$

$$M.S. \text{ SAT. (SAT. 3-III)} = \frac{.46}{.463} - 1 =$$

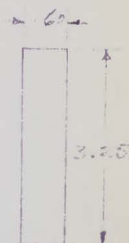
.25

BLADE 'B' (SAT. 3-1)

SECTION B-B:

$$A = .60 \times 3.25 = 1.95 \text{ in}^2$$

$$I = \frac{60 \times 3.25^3}{12} = 1.72 \text{ in}^4$$



SECT. B-B

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0582/1

SHEET NO. 3-14

AIRCRAFT:

C 105

ELEVATOR

PREPARED BY

DATE

W. Norman

4-JUNE-54

CHECKED BY

DATE

CONTROL FITTING CONT'D.

LUG A CONT'D.

TENSION ON SEC. N-N (SAT 3-13)

CONSIDER BOTH LUGS

$$\text{NET AREA} = 2 \times .75 \times (2.4 - 1.0) = 2.10 \text{ IN}^2$$

$$f_{cu} = \frac{51,723}{2.10} = 24,600 \text{ P.S.I.} \quad \left. \vphantom{\frac{51,723}{2.10}} \right\} (\text{SAT. 3-2})$$

$$f_{tlim.} = \frac{37,900}{2.10} = 18,100 \text{ P.S.I.}$$

$$F_{tu} = 46,900 \text{ P.S.I.}$$

$$F_{ty} = 34,200 \text{ P.S.I.}$$

$$\text{M. S. } ULT = \frac{46,900}{24,600} - 1 = .90$$

$$\text{YIELD} = \frac{34,200}{18,100} - 1 = .89$$

BUSHING IN LUG "A"; REF. 7-1082-0036.

FROM REF 6, P. 170;

$P_{bry} = 1.85 F_{cy} \text{ Alrb. WHERE:}$

$$\text{Alrb} = .85 \times .846 = .689 \text{ IN}^2$$

$$F_{cy} = 100,000 \text{ P.S.I. (AIRC-5)}$$

$$P_{bry} = 1.85 \times 100,000 \times .689 = 127,500 \text{ LB.}$$

$$\text{Lim. Load (ONE LUG)} = \frac{54,360}{2} = 27,180 \text{ LB (SAT 3-13)}$$

$$\text{YIELD M. S.} = \frac{127,500}{27,180} - 1 = 3.69$$

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-1082-11

SHEET No. 9-125

AIRCRAFT:

C 105

ELEVATOR

PREPARED BY

DATE

T. HAYMAN

MAR 20/54

CHECKED BY

DATE

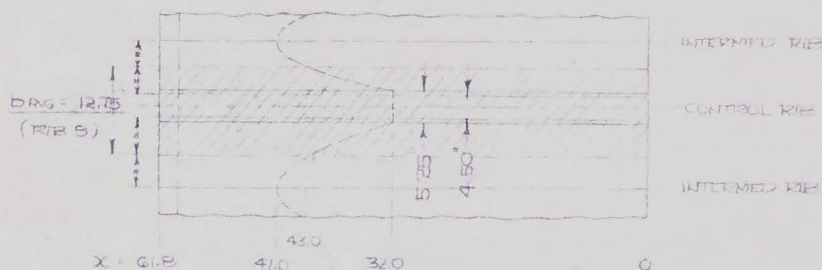
CONTROL RIBS

DRG. REFS: 7-1082-0010 & 0030 (SKIN)

7-1082-0050 (RIB ASSY)

7-1082-0015 (RIB DETAIL)

EFFECTIVE WIDTH OF TOP SKIN (COMPRESSION):

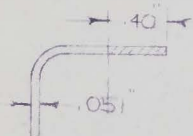


SKIN PANEL DETAIL
(REF: 7-1082-0010 & SHIT 1, 2, 3)

FROM $x = 0$ - 32.0 (.051" SKIN - NO DOUBLER)

COMPRESSION STRESS IN FLG. OF RIBS:

FLG. EFFECTIVE WIDTH:



ASSUME $b = .40$ (1/2" EDGE DIST)

REF: 7-1082-0015

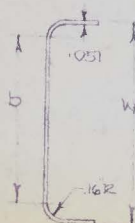
FLG. ULT CRIPPLING STRESS:

$$b/t = .40/.051 = 7.84; F_{cr} = 34,500 \text{ psi (BRUHN FIG B5112)}$$

$$\text{REDUCED } F_{cr} = \frac{10.2^*}{10.5} \times 34,500 = 33,500 \text{ psi. (245 T ALCLAD ONE EDGE REEL)}$$

BINDING STRESS IN RIB WEB:

* $E = 10.2$ REDUCED FROM 10.5
ON BASIS OF THICK 3.1211 (b)
THICK & FOR TEMP OF 250°F
- SEE SHIT. 8-28



$$b = W - 2(R + t), \text{ SAY}$$

MAX. W (FOR LEAST t_b), STA. 32.0 = 2.75 (7-1082-0050)

$$b_{\text{MAX}} = 2.75 - 2(.162 + .051) = 2.75 - .412 = 2.33"$$

$$\& b/t = 2.33/.051 = 45.7$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 110582

SHEET NO. 3-16

AIRCRAFT:

C105

ELEVATOR

PREPARED BY

DATE

T. HEDYMAN

MAY 20/54

CHECKED BY

DATE

CONTROL RIBS (CONT.):

EFFECTIVE WIDTH OF TOP SKIN, $x = 0.320$ (TAB. 1)

WEB BENDING BUCKLING STRESS, $F_{br} = K_b \cdot E / (b/t)^2$ (EQUATION 3-1)

MINI $K_b = 2.16$ (EQUATION 3-1)

$$F_{br} = \frac{2.16 \times 102 \times 10^6}{(45.7)^2} = 106,000 \text{ psi} \quad \left(\begin{array}{l} E = 102 \text{ REDUCED FROM 105} \\ \text{ON BASIS OF THE } E \text{ 31211 b} \\ \text{INSTEAD OF THE } E \text{ 31211 b} \\ \text{GIVE SH 3-18} \end{array} \right)$$

FLG. ULT. CRIMPING STRESS, $F_{cr} = 33,500 \text{ psi}$, IS CRITICAL

EFFECTIVE WIDTH OF SKIN:

ASSUME $b_{ms} = 12.75$ DIVIDED 0.375 / HALF RIB

$$b/t = 0.375 / 0.051 = 125$$

$$F_{br} = 360 E / (b/t)^2 = \frac{360 \times 102 \times 10^6}{125^2} = 2350 \text{ psi} \quad \text{EQUATION 3-1}$$

$$F_{br} / F_{cr} = 2350 / 33,500 = 0.070$$

$$b_m / b = 0.372 \text{ (FROM CURVE)} \quad \text{OR } b_m = 0.372 \times 0.375 = 0.231$$

$$\text{TOTAL } b_m = 2 \times 0.231 = 0.462 \text{ (0.051 SKIN)}$$

FROM $x = 0.320 - 0.430$ (0.051 SKIN - 0.072 THIN PLATE DOUBLET)

COMPRESSION STRESS IN FLG. OF RIB:

AS FOR $x = 0.320$;

(SEE 3-15 & 3-16)

FLG. ULT. CRIMPING STRESS, $F_{cr} = 33,500 \text{ psi}$, IS CRITICAL

$$(F_{br} = 69,300 \text{ psi @ } 0.430, \quad b = 0.288, \quad t = 0.051 \Rightarrow b/t = 564 \text{ (SEE 3-15, 3-16)})$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7/1382/1

SHEET No. 3-17

AIRCRAFT:

C 105

ELEVATOR

PREPARED BY

DATE

T. W. W. W.

MAY 20/54

CHECKED BY

DATE

CONTROL RIBS (CONT.)

EFFECTIVE WIDTH OF TOP SKIN, $x = 320-430$ (mm):

- AT $x = 320$, DOUBLER WIDTH = 5.25" (BETWEEN RIBS)

- AT $x = 430$, DOUBLER WIDTH = 12.75" (OUTER PANEL WIDTH)

- DOUBLER WIDTH VARIES PARABOLICALLY ($y^2 = ax$ OR $y \propto \sqrt{x}$)

EFFECTIVE WIDTH @ 320: (SEE SHEET 3-15/18)

- SKIN & DOUBLER BETWEEN RIBS: $\frac{b}{L} = \frac{4.50}{12.2} = .366$

$$f_{cr} = \frac{360 E}{(b/L)^2} = \frac{360 \times 10^6 \times 10^6}{(36.6)^2} = 27,400 \text{ PSI} \quad \text{BRAIN B54}$$

$$f_{cr}/f_{cr} = 27,400/33,500 = .817$$

$$b_m/b = .910 \text{ (KORRE CURVE) OR } b_m = .910 \times 430 = 400$$

- SKIN OUTSIDE RIBS: $\frac{b}{L} = \frac{12.75-4.50}{12.2} = \frac{8.25}{12.2} = .676$

$$f_{cr} = \frac{360 E}{(b/L)^2} = \frac{360 \times 10^6 \times 10^6}{(10.2)^2} = 14,000 \text{ PSI} \quad \text{BRAIN B54}$$

$$f_{cr}/f_{cr} = 14,000/33,500 = .418$$

$$b_m/b = .310 \text{ (KORRE CURVE) OR } b_m = .310 \times 825 = 256$$

- DOUBLER OUTSIDE RIBS: $\frac{b}{L} = \frac{5.25-4.50}{12.2} = \frac{.75}{12.2} = .061$

$$f_{cr} = \frac{360 E}{(b/L)^2} = \frac{360 \times 10^6 \times 10^6}{(10.2)^2} = 32,500 \text{ PSI} \quad \text{BRAIN B54}$$

$f_{cr} > F_{cr}$ OF DOUBLER OUTSIDE RIBS THEN EFFECTIVE $b_m = 75$

$$\text{TOTAL EFFECTIVE WIDTH } .051 \text{ SKIN} = 400 + 256 = 656$$

$$\text{TOTAL EFFECTIVE WIDTH } .072 \text{ DOUBLER} = 400 + 75 = 475$$

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7/0582/1

SHEET No. 3-15

AIRCRAFT:

C 105

ELEVATOR

PREPARED BY

DATE

T. HANNAN

MAY 21/54

CHECKED BY

DATE

CONTROL RIBS (CONT.):

EFFECTIVE WIDTH OF TOP SKIN (CONT.):

FROM X-43.0-61.8 (.051" SKIN + .072" FULL DOUBLER):

COMPRESSION STRESS IN FLG. OF RIB:

DWGS. 7-1082-0010 & 7-1082-0015 SHOW THAT THE FLG. WIDENS AT STA 47.0 (APPROX.) TO ACCOMMODATE TWO ROWS OF RIVETS. THE FLG. EFFECTIVE WIDTH (= EDGE DIST.) REMAINS THE SAME AS FOR X-0-32.0 HOWEVER,

AS FOR X-0-32.0 (SHT 3-15 & 16)

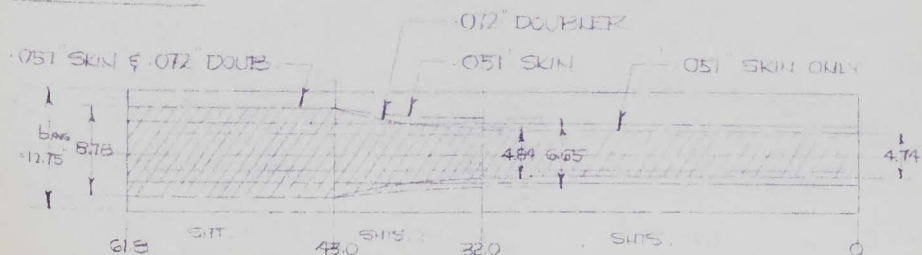
FLG. ULT. CRIPPLING STRESS, $F_{cr} = 33,500 \text{ psi}$, IS CRITICAL

EFFECTIVE WIDTH OF SKIN & DOUBLER: ($F_{br} 40,500 \text{ psi @ } 57.5$
 $b = 377, t = .051, b/t = 73.3$)

THE SKIN & DOUBLER PANEL WIDTH REMAINS CONSTANT AT $b_{avg} = 12.75$ FROM X-43.0-61.8. THE EFFECTIVE WIDTH INDICATED @ 43.0 WILL HOLD FOR X-43.0-61.8, OR

EFFECTIVE WIDTH 43.0-61.8, $b_{eff} = 8.78$ (SHT 3-15)

SUMMARY:

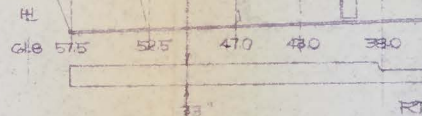


SKIN & DOUBLER EFFECTIVE WIDTHS AT CONTROL RIB

ELEVATOR CONTROL RIBS

SECTION PROPERTIES

(SEE SH. 3-22 FOR I PLOT)



ELEMENT NO.	A (b x h) IN ²	y (REF. AXIS) IN.	A.y IN ³	$\bar{y}$ (NEUTRAL AXIS) IN.	$A\bar{y}^2$ IN ⁴	I_o $= \frac{b \cdot h^3}{12}$ IN ⁴	ELEMENT NO.	A (b x h) IN ²	y (REF. AXIS) IN.	A.y IN ³	$\bar{y}$ (NEUTRAL AXIS) IN.
①	.260 (.474 x .51)	1.487	.3866	.956	.23764	.00005	①	.260 (.474 x .51)	2.107	.5478	1.34
③ x 2	.0896 (.238 x .51)	1.435	.1286	.904	.07320	.00002	③ x 2	.0896 (.238 x .51)	2.055	.1841	1.29
④ x 2	.144 (.051 x .1.4)	.807	.1162	.276	.01094	.02383	④ x 2	.207 (.051 x 2.03)	1.113	.2312	.35
⑤ x 2	.0896 (.238 x .51)	.076	.0068	-.455	.01855	.00002	⑤ x 2	.0896 (.238 x .51)	.076	.0068	-.68
⑦	.650 (12.75 x .51)	.025	.0163	-.506	.16640	.00014	⑦	.650 (12.75 x .51)	.025	.0163	-.73
$\Sigma = 1.233$		$\Sigma = .6545$		$\Sigma = .50673$	$\Sigma = .02406$		$\Sigma = 1.236$		$\Sigma = .9862$		
$y_o = \frac{\Sigma A y}{\Sigma A} = \frac{.6545}{1.233} = .531$				$I_{NA} = (\Sigma I_o + A y_o^2) = .5308$			$y_o = \frac{\Sigma A y}{\Sigma A} = \frac{.9862}{1.236} = .796$				
①	.339 (.625 x .51)	2.830	.959	1.626	.83632	.00007	①	.419 (.812 x .51)	3.100	1.324	1.60
②	.949 (1.84 x .51)	2.763	.966	1.565	.85470	.00015	②	.558 (1.175 x .51)	3.099	1.729	1.54
③ x 2	.0896 (.238 x .51)	2.707	.243	1.503	.20241	.00002	③ x 2	.0896 (.238 x .51)	3.027	.272	1.46
④ x 2	.260 (.051 x 2.6)	1.479	.393	.275	.02022	.15113	④ x 2	.300 (.051 x 2.34)	1.041	.493	.09
⑤ x 2	.0896 (.238 x .51)	.148	.013	-1.056	.09999	.00002	⑤ x 2	.0896 (.238 x .51)	.148	.013	-1.40
⑥	.396 (.550 x .51)	.081	.034	-1.117	.49421	.00017	⑥	.396 (.550 x .51)	.081	.034	-1.40
⑦	.650 (12.75 x .51)	.025	.016	-1.179	.90350	.00014	⑦	.650 (12.75 x .51)	.025	.016	-1.52
$\Sigma = 2.179$		$\Sigma = 2.624$		$\Sigma = 3.47126$	$\Sigma = .15170$		$\Sigma = 2.502$		$\Sigma = 3.881$		
$y_o = \frac{\Sigma A y}{\Sigma A} = \frac{2.624}{2.179} = 1.204$				$I_{NA} = (\Sigma I_o + A y_o^2) = 3.0230$			$y_o = \frac{\Sigma A y}{\Sigma A} = \frac{3.881}{2.502} = 1.551$				
①	.448 (.878 x .51)	3.770	1.689	1.878	1.58010	.00010	①	.448 (.878 x .51)	4.100	1.837	2.04
②	.632 (.878 x .51)	3.709	2.344	1.817	2.06623	.00027	②	.622 (.878 x .51)	4.020	2.553	1.98
③ x 2	.136 (.133 x .51)	3.647	.496	1.755	.41888	.00003	③ x 2	.136 (.133 x .51)	3.877	.541	1.92
④ x 2	.362 (.051 x 3.5)	1.949	.706	.057	.00116	.38028	④ x 2	.396 (.051 x 3.85)	2.114	.837	.05
⑤ x 2	.136 (.133 x .51)	.148	.020	-1.744	.41371	.00003	⑤ x 2	.136 (.133 x .51)	.148	.020	-1.90
⑥	.443 (.615 x .51)	.087	.039	-1.805	1.44329	.00019	⑥	.443 (.615 x .51)	.087	.039	-1.97
⑦	.650 (12.75 x .51)	.025	.016	-1.867	2.26590	.00014	⑦	.650 (12.75 x .51)	.025	.016	-2.0
$\Sigma = 2.807$		$\Sigma = 5.310$		$\Sigma = 8.20727$	$\Sigma = .38104$		$\Sigma = 2.841$		$\Sigma = 5.843$		
$y_o = \frac{\Sigma A y}{\Sigma A} = \frac{5.310}{2.807} = 1.892$				$I_{NA} = (\Sigma I_o + A y_o^2) = 8.5903$			$y_o = \frac{\Sigma A y}{\Sigma A} = \frac{5.843}{2.841} = 2.057$				

A. V. ROE CANADA LIMITED

MALTON, ONTARIO
ENGINEERING DIVISION - AIRCRAFT

AIRCRAFT - C105

WEIGHT -

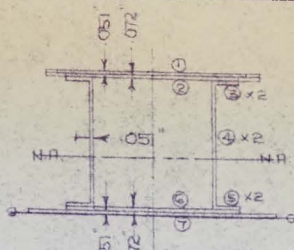
C. G. POSITION -

REPORT NO. 7/0582/1

SHEET 3-20

DATE MAY 25/54

PREPARED BY J. HAYMAN



17	18	19	20	21	22	23	24	25	26	27	28	29
y (REF. AXIS) IN	Ay IN ²	$\bar{y}$ (NEUTRAL AXIS) IN	$A\bar{y}^2$ IN ⁴	I_o $= \frac{bh^3}{12}$ IN ⁴		ELEMENT NO.	A ($b \times h$) IN ²	y (REF. AXIS) IN	Ay IN ³	$\bar{y}$ (NEUTRAL AXIS) IN	$A\bar{y}^2$ IN ⁴	I_o $= \frac{bh^3}{12}$ IN ⁴
2.827	.7350	1.790	.83304	.00005								
2.775	.2486	1.738	.27063	.00002								
1.477	.4136	.440	.05432	.17676								
.076	.0068	-.961	.08279	.00002								
.085	.0163	-1.012	.66567	.00014								
$\Sigma = 1.4203$			$\Sigma = 1.90643$	$\Sigma = .17699$								
$\frac{1.4203}{1.369}$	$= 1.037$		$I_{NA} = \Sigma(I_o + A\bar{y}^2) = 2.0834$									
3.520	1.577	1.780	1.41926	.00010		①	.448 (8.78 x .051)	3.770	1.689	1.908	1.63072	.00010
3.453	2.186	1.719	1.86756	.00027		②	.632 (8.78 x .072)	3.709	2.344	1.847	2.15575	.00027
3.427	.307	1.687	.25500	.00002		③ x 2	.0836 (.83 x .031)	3.647	.327	1.785	.28547	.00002
1.824	.613	.084	.00239	.30547		④ x 2	.302 (.051 x 2.55)	1.949	.706	.087	.00275	.38028
.148	.020	-1.592	.34462	.00003		⑤ x 2	.136 (1.33 x .051)	.148	.020	-1.714	.39957	.00003
.087	.039	-1.653	.121028	.00019		⑥	.443 (6.15 x .072)	.087	.039	-1.775	1.39589	.00019
.025	.016	-1.715	.191165	.00014		⑦	.650 (2.75 x .051)	.025	.016	-1.837	2.19375	.00014
$\Sigma = 4.758$			$\Sigma = 7.01076$	.30672			$\Sigma = 2.761$		$\Sigma = 5.141$		$\Sigma = 8.06390$	.38103
$\frac{4.758}{2.735}$	$= 1.740$		$I_{NA} = \Sigma(I_o + A\bar{y}^2) = 7.3170$				$y_o = \frac{\Sigma A \cdot y}{\Sigma A} = \frac{5.141}{2.761} = 1.862$			$I_{NA} = \Sigma(I_o + A\bar{y}^2) = 8.4449$		
4.410	1.976	2.198	2.16429	.00010		①	.413 (8.22 x .051)	3.160	1.324	1.660	1.15476	.00009
4.349	2.749	2.137	2.88634	.00027		②	.558 (1.75 x .072)	3.039	1.729	1.599	1.42681	.00024
4.287	.583	2.075	.58562	.00003		③ x 2	.0836 (.83 x .051)	3.037	.272	1.537	.21164	.00002
2.269	.971	.057	.00137	.62526		④ x 2	.300 (.051 x 2.34)	1.644	.493	.044	.00057	.21600
.148	.020	-2.064	.57936	.00003		⑤ x 2	.136 (1.33 x .051)	.148	.020	-1.352	.16379	.00003
.087	.039	-2.125	.200053	.00019		⑥	.443 (6.15 x .072)	.087	.039	-1.413	.79081	.00019
.025	.016	-2.187	.310835	.00014		⑦	.650 (2.75 x .051)	.025	.016	-1.475	1.41440	.00014
$\Sigma = 6.354$			$\Sigma = 11.32652$	.62802			$\Sigma = 2.596$		$\Sigma = 3.893$		$\Sigma = 5.16278$	.21671
$\frac{6.354}{2.873}$	$= 2.212$		$I_{NA} = \Sigma(I_o + A\bar{y}^2) = 11.9525$				$y_o = \frac{\Sigma A \cdot y}{\Sigma A} = \frac{3.893}{2.596} = 1.500$			$I_{NA} = \Sigma(I_o + A\bar{y}^2) = 5.3795$		

X = .470"
(.072 DOUBLER
DOUB. FLG. B.M.)

X = .380"
(.072 DOUBLER
DOUB. FLG. B.M.)

A. V. ROE CANADA LIMITED

MALTON, ONTARIO

TECHNICAL DEPT. (AIRFRAME)

REPORT NO. . 7/05+2/1

SHEET . . 3-21

DATE . . MAY 26/54

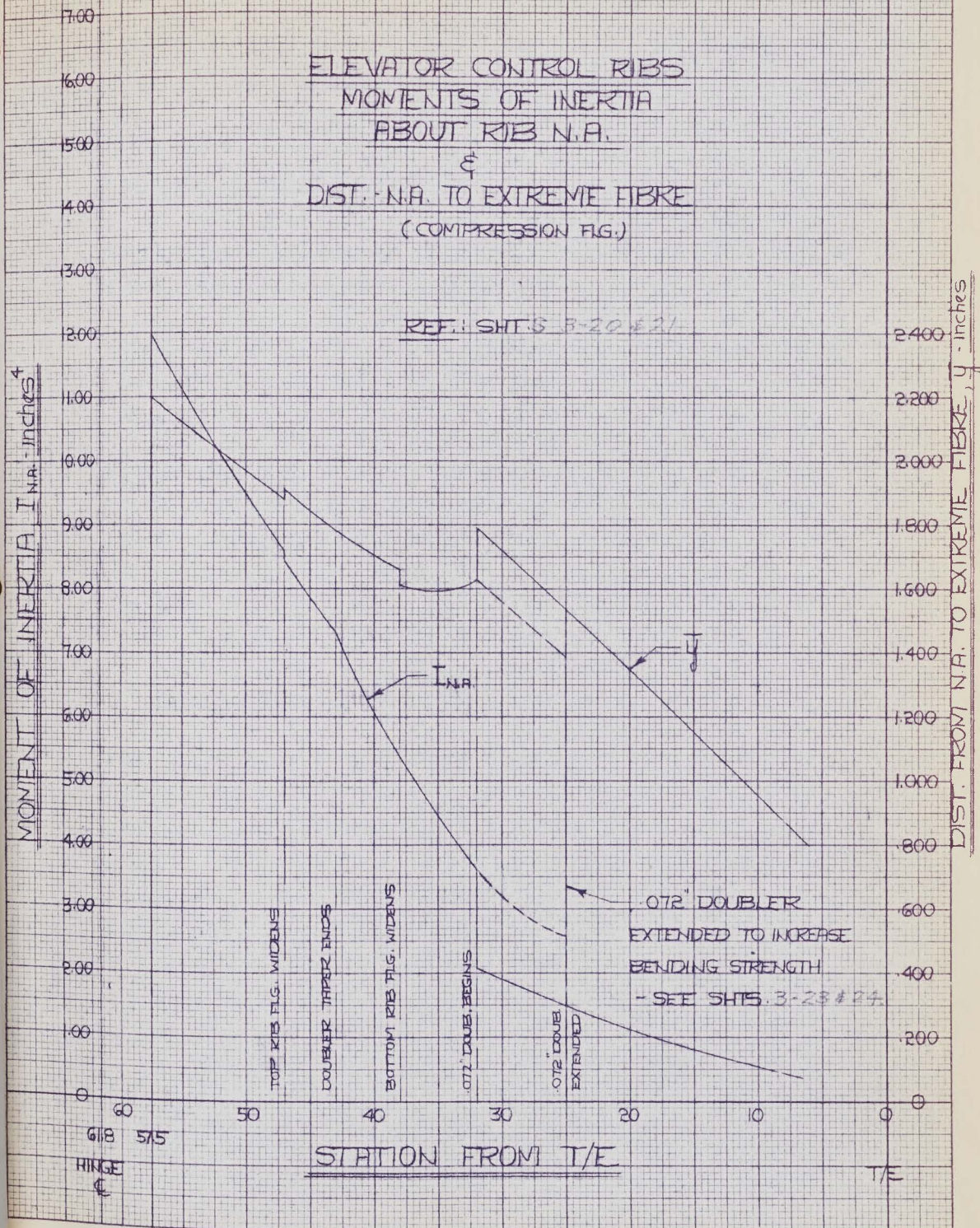
PREPARED BY . T. HAYMAN

AIRCRAFT . . C105

WEIGHT . . _____

C. G. POSITION . . _____

8	9	10	11	12	13	14	15	16	17	18	19
	ELEMENT NO.	A (b x h) IN ²	y (REF. AXIS) IN.	Ay IN ³	y (NEUTRAL AXIS) IN.	Ay ² IN ⁴	I ₀ = $\frac{bh^3}{12}$ IN ⁴				
	①	.339 (6.95 x .05)	2.410	.817	1.336	.65122	.00007				
	②	.349 (4.84 x .072)	2.349	.820	1.325	.61234	.00015				
X = 25.0 (.072 DOUBLER)	③ x2	.0896 (.88 x .051)	2.287	.205	1.263	.14291	.00002				
	④ x2	.223 (.051 x 2.19)	1.269	.283	.245	.01338	.08128				
	⑤ x2	.0896 (.88 x .051)	.148	.013	-.876	.06872	.00002				
	⑥	.396 (5.50 x .072)	.087	.034	-.937	.34763	.00017				
	⑦	.650 (12.75 x .051)	.025	.016	-.999	.64870	.00014				
		$\Sigma = 2.136$		$\Sigma = 2.188$		$\Sigma = 2.4546$	$\Sigma = .09985$				
		$U_0 = \frac{\Sigma Ay}{\Sigma A} = \frac{2.188}{2.136} = 1.024$				$I_{NA} = \Sigma (I_0 + Ay^2) = 2.5753$					



A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7/058 E. 1

SHEET No. 3-23

AIRCRAFT:

C105

ELEVATOR

PREPARED BY

DATE

T. HENNING

MAY 26/54

CHECKED BY

DATE

CONTROL RIBS (CONT.)

RIE BENDING STRENGTH

ALLOWABLE BENDING STRESS IS DICTATED BY RIB WEB & FLANGE CRIPPLING STRESSES.

SHPS 3-15/6#19 SHOW THE FLANGE ULT. CRIPPLING STRESS.

$F_{cr} = 33,500$ PSI, FB CRITICAL, OR

$$F_b = F_{cr} = 33,500 \text{ PSI}$$

SECTION PROPERTIES GIVEN ON SHPS 3-20-22 ARE A FUNCTION OF F_{cr} , OR REPRESENT THE EFFECTIVE SECTION WHEN WORKING TO FLANGE ULTIMATE CRIPPLING STRESS.

ALLOWABLE B.M. FOR RIB ULT. CRIPPLING STRESS = 33,500 PSI IS

$$M_{cr} = \frac{F_{cr} I}{y} = \frac{33,500 \times I}{y} \quad (F_b = \frac{M}{I})$$

$$\text{M.S., MARGIN OF SAFETY, M.S.} = \frac{M_{cr}}{M} - 1$$

RESULTS ARE TABULATED BELOW

STA.	M	y	I	F_{cr}	$F_{cr} I$	M_{cr}	RAT	M.S.	
	IN LB	IN	IN ⁴	PSI	LB IN ²	IN LB	= $\frac{M_{cr}}{M}$	= $\frac{M_{cr}}{M} - 1$	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
100	6630	.956	5305	33500	17,780	18,000	2.805	1.805	@ 30-30
200	20,580	1.346	1.1131	1	37,290	27,700	1.346	346	1.5
300	41,850	1.720	1.9000		63,550	37,010	.891	-1.16	NEUTRAL
320	46,800	1.730	2.0834		69,190	38,320	.893	-1.127	-5%
		1.626	3.2230		54,310	34,640	1.505	.505	< 3-24
330	64,200	1.609	5.3777		120,210	102,500	1.609	.609	
		1.660 <	5.3795 <						
400	70,440	1.704	6.0700		203,350	119,340	1.694	.694	
430	80,600	1.780	7.3170		245,120	137,710	1.780	.780	
470	95,000	1.908 <	8.4419 <		282,900	148,270	1.521	.521	
		1.815	8.5303						
525	116,500	2.043	10.2310	1	343,410	128,000	1.443	.443	
575	139,000	2.198	11.7525	33,500	401,410	152,170	1.320	.320	

SHPS 2-23
7/058 E. 1

SHPS 3-20 & 22

SHPS 5-20 & 22

SHPS 8-16 & 19

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-1582/1

SHEET No. 2-24

AIRCRAFT:

C 105

FUELVATOR

PREPARED BY

DATE

T. H. (MIDN)

MAY 24/54

CHECKED BY

DATE

CONTROL RIBS (CONT.)

RIB BENDING STRENGTH (CONT.)

- FRONT SHIT 3-23, M.S. IS UNACCEPTABLE IN VICINITY OF STA. 32.0 (RIT OF .072" SKIN DOUBLER).

- TRY EXTENDING .072" SKIN DOUBLER TO STA. 25.0.

SECTION PROPERTIES @ STA. 25.0 - SEE SHTS 3-21 & 22

REVISED MARKING OF SHITTY

STA.	M	$\bar{y}$	I	F_{or}	$F_{or I}$	M_{or}	P.F.	M.S.	
	IN LB.	IN	IN ⁴	PSI	LB IN ²	IN LB	M_{or}/M	$M_{or}/M-1$	@ 25.0
	①	②	③	④	⑤	⑥	⑦	⑧	F.B. BENDING
25.0	39,400	1.531	1.4172	32,500	40,400	32,300	1.063	.063	.023
		1.364	2.5153		32,270	62,240	2.047	1.047	
30.0	41,250	1.560	3.2000		107,200	68,720	1.545	.545	
32.0	46,800	1.626	3.0230	33,500	121,310	74,640	1.595	.595	
	SHIT 233 7/1058-1	SHIT 3-20-22	SHIT 3-20-22	SHIT 3-20-22					

WEB STRENGTH

WEB STRENGTH IS INDICATED BY COMBINING WEB BENDING BUCKLING & WEB SHEAR STRESSES.

CRITICAL BENDING BUCKLING STRESS,

$$F_{b1} = K_b E / (b/t)^2 \text{ P.S.I.}$$

BRUNN, B2-3

& CRITICAL SHEAR BUCKLING STRESS,

$$F_{s1} = \frac{K_s E}{12(1-\nu^2)} \left(\frac{t}{b} \right)^2 \text{ P.S.I.}$$

BRUNN, B2-3

- COMBINING, USING STRESS RATIOS,

ANCS R2-11

$$R_b^2 + R_s^2 \leq 1 \text{ OR, M.S.} = \frac{1}{\sqrt{R_b^2 + R_s^2}} - 1$$

WHEAT

$$R_b = f_b / F_{b1}$$

$$R_s = f_s / F_{s1}$$

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT:

C 105

ELEVATOR

REPORT NO.

210-850

SHEET NO.

2-26

PREPARED BY

DATE

T. H. M. M. M.

MAY 21/54

CHECKED BY

DATE

CONTROL RIBS (CONT.)

WEB STRENGTH (CONT.)

AT STD 250: (MIN. M.V. FOR NO. 501 DOUB. (LONG. SH. L.))

BENDING BUCKLING:

$$F_{b1} = \frac{k_b F}{(L/b)^2} = \frac{215 \times 102 \times 10^6}{(131/0.051)^2} = \frac{215 \times 102 \times 10^6}{(2580)^2} = 15700 \text{ p.s.i.}$$

$$f_b = \frac{M/I}{L} = \frac{30,400 \times 1315}{14112} = 28700 \text{ p.s.i.}$$

$$\text{STRESS RATIO, } R_b = \frac{f_b}{F_{b1}} = \frac{28700}{15700} = 1.83$$

(AK 5, P. 11)

SHITZ BUCKLING:

$$F_{s1} = \frac{K \pi^2 E}{12(1-\mu^2)} \left(\frac{t}{L} \right)^2 = \frac{5.35 \times 10^6 \times 102 \times 10^6}{12(1-0.342^2)} \left(\frac{0.051}{131} \right)^2$$

$$= \frac{5.35 \times 10^6 \times 102 \times 10^6}{12(0.883)} (0.000389)^2 = 36240 \text{ p.s.i.}$$

$$f_s = \frac{V}{L} = \frac{1700}{2(131 \times 0.051)} = 8730 \text{ p.s.i.}$$

$$\text{STRESS RATIO, } R_s = \frac{f_s}{F_{s1}} = \frac{8730}{36240} = 0.241$$

(AK 5, P. 11)

COMBINED BENDING BUCKLING & SHITZ BUCKLING:

$$R_{\text{COMBINED}} = R_b^2 + R_s^2 \leq 1 \text{ TO BE ACCEPTABLE}$$

$$= 1.83^2 + 0.241^2 = 0.335 + 0.0581 = 0.3936$$

$$M.S. = \frac{1}{\sqrt{R_b^2 + R_s^2}} - 1 = \frac{1}{\sqrt{0.3936}} - 1 = 3.302 - 1 = 2.302$$

FORMULA

$F_{b1} = 215 F_{0.825}$

$L/b = 2580$

$k_b = 1$

$F_{b1} = 15700$

$f_b = 28700$

$R_b = 1.83$

$F_{s1} = 36240$

$f_s = 8730$

$R_s = 0.241$

$R_{\text{COMBINED}} = 0.3936$

$M.S. = 2.302$

$F_{b1} = 15700$

$f_b = 28700$

$R_b = 1.83$

$F_{s1} = 36240$

$f_s = 8730$

$R_s = 0.241$

$R_{\text{COMBINED}} = 0.3936$

$M.S. = 2.302$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 2105-22/1

SHEET NO. 3-27

AIRCRAFT:

C105

ELEVATOR

PREPARED BY

DATE

T. J. HAYMAN

MAY 28/54

CHECKED BY

DATE

CONTROL RIBS (CONT.):

STIFFENER:

REQUIRED MOMENT OF INERTIA OF STIFFENER TO PREVENT WEB BUCKLING:

(STIFFENERS @ 3005492)
(7-1082-0053) - (STIFFENERS)

$$I_{st} = \frac{2.29 d}{E} \left(\frac{V \cdot h_w}{32E} \right)^{\frac{4}{3}}$$

WHERE: (EQUATION C6-5)

WHERE: $d = 4$ DIST BWN STIFF = 100

h_w WEB PLATE DEPTH = 2.71"

(Wt 480 - 2(1.1) = 3.13 - 42)

V VERT SHEAR AT 400 = 2030/2

E WEB THICK = .051 = 1325 LB

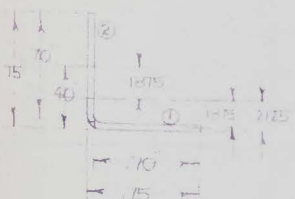
E 10.2 x 10⁶ PSI (2-317600/4)
(SIP-3-28)

$$= \frac{2.29 \times 100}{.051} \left(\frac{1325 \times 2.71}{32 \times 10.2 \times 10^6} \right)^{\frac{4}{3}}$$

$$= \frac{2.29 \times 100}{.051} (10.6 \times 10^{-6})^{\frac{4}{3}}$$

$$= \frac{2.29 \times 100}{.051} (23.4 \times 10^{-6}) = 443.0 (23.4 \times 10^{-6}) = .000105 \text{ IN}^4$$

I_{stiff} : RIGID IS 75 x 75 x .051 (20-05 R-205) (7-1082-005)
(STIFFENERS)



ELEMENT A y Ay $\bar{y}$ $A\bar{y}^2$ I_o

① .0357 .075 .0005 .1875 .00015 .00018

② .0357 .075 .0005 .1875 .00015 .00018

$\Sigma = .0714$ $\Sigma = .0151$ $\Sigma = .00230$ $\Sigma = .00136$

$$I_{stiff} = \frac{\Sigma Ay^2}{\Sigma A} = \frac{.0151}{.0714} = .212, I_{stiff} = .00230 + .00136 = .00366$$

MARGIN OF SAFETY

$$MOS = \frac{I_{stiff}}{I_{REQD}} - 1 = \frac{.00366}{.000105} - 1 = 34.9 - 1 = 33.9$$

@ 400

STIFFENERS

OK

TEMPERATURE EFFECT ON ELASTIC PROPERTIES OF 24S-T ALUM.

REF.: E VALUES - TABLE 3.1211 (b) ANC-5
- μ & G ASSUMED TO VARY IN SAME
MANNER OR PROPORTION AS E.

MODULUS OF ELAST., E & MOD. OF RIGIDITY, G - PSI. $\times 10^6$

17.0
16.0
15.0
14.0
13.0
12.0
11.0
10.0
9.0
8.0
7.0
6.0
5.0
4.0
3.0
2.0
1.0
0

E_c - COMPRESSION
 E - TENSION

μ

G

ELEVATED TEMP. $\uparrow$ 250 $^{\circ}$ F

POISSON'S RATIO, μ

TEMPERATURE, $^{\circ}$ F

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7405-824

SHEET No. 3-31

AIRCRAFT:

C 105

ELEVATOR

PREPARED BY

DATE

G. H. H. H. H.

26 MAR 54

CHECKED BY

DATE

CONTROL RIB ATTTS. CONTD.

TO BOTTOM SKIN - REAR PORTION.

BY CKL-100V5-B HUCK BLIND RIVETS (7-1082-0001 & 2)

@ 1.0 IN. PITCH (7-1082-0015 & 0016)

VALUES: (ANG-5)

SHEAR = 505 LB. ULT. (SHT. 3-30)

CSK. IN. 051 SKIN = $471 \times .85 \times .87 = 349$ LB. ULT.

$221 \times .85 \times .87 = 163$ LB. YIELD.

LOAD = .88 LB./IN. ULT. (SHT. 2-65)

LOAD PER RIVET = 88 LB. ULT.

= 15 LB. LIM.

M.S. ULT. = $\frac{349}{88} - 1 = 2.57$

YIELD = $\frac{163}{65} - 1 = 1.51$

TO CONTROL FITTING. (7-1082-0001 & 0002)

BY 16 BLB HUCK BLIND LOCKBOLTS. (1/4 IN)

VALUES: BRNG IN. 051 RIB = $1310 \times 1.14 \times .87 = 1300$ LB. ULT.

(ANG-5) = $1310 \times .73 \times .87 = 833$ LB. YIELD.

SHEAR = 3680 LB.

BEARING GOVERNS.

LOAD - ON MOST CRITICAL BOLT (SHT. 2-49 & 47)

= $.415 \times \frac{4444}{2} = 922$ LB. ULT. (SUPERSEDED 70' 47)

= 675 LB. LIM.

M.S. ULT. = $\frac{1300}{922} - 1 = .41$

YIELD = $\frac{833}{675} - 1 = .22$

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/65-82/1

SHEET NO. 3-35

AIRCRAFT:

C 105

ELEVATOR

PREPARED BY

DATE

T. HAYMON

MAY 3/51

CHECKED BY

DATE

INTERMEDIATE RIBS (CONT.)

EFFECTIVE WIDTH OF TOP SKIN (CONT.)

WEB BENDING BUCKLING STRESS $F_{b(w)} = K_b \cdot E / (b/L)^2$ BRUHNS B23

MIN. $K_b = 21.6$ (BRUHNS, FIG B2.6)

$$\therefore F_{b(w)} = \frac{21.6 \times 10.2 \times 10^6}{(73.9)^2} = 40,300 \text{ p.s.i.} \quad \left(\begin{array}{l} * E = 10.2 \text{ RECALCULATED FROM 10.5} \\ \text{ON BASIS OF MEAT 31.211(b)} \\ \text{AND 5 FOR 250 F. - SEE SHEET 3-28} \end{array} \right)$$

TLG. ULT. CRIPPLING STRESS, $F_c = 38,900 \text{ p.s.i.}$, IS CRITICAL.

EFFECTIVE WIDTH OF SKIN:

FRONT $X = 0.470$ (.051 SKIN - NO DOUBLER):

PANEL WIDTH, $b_{avg} = 8.25$; $b/L = 8.25/.051 = 165$

$$\therefore f_{cr} = \frac{360E}{(b/L)^2} = \frac{360 \times 10.2 \times 10^6}{165^2} = 1350 \text{ p.s.i.} \quad \text{BRUHNS B5.4}$$

$$\epsilon f_{cr}/F_c = 1350/38,900 = .0349$$

$$\therefore b_m/b = .292 \text{ (KOTTER CURVE) OR } b_m = .292 \times 8.25 = 2.41" \quad (.051 \text{ SKIN})$$

FRONT $X = 47.0 - 61.8$ (.051 SKIN - .072 DOUBLER):

PANEL WIDTH, $b_{avg} = 8.25$; $b/t = 8.25/.123 = 67.1$

$$\therefore f_{cr} = \frac{360E}{(b/t)^2} = \frac{360 \times 10.2 \times 10^6}{67.1^2} = 860 \text{ p.s.i.} \quad \text{BRUHNS B5.4}$$

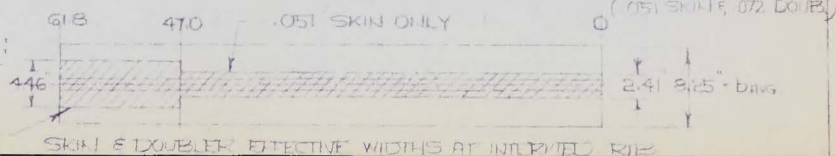
$$\epsilon f_{cr}/F_c = 860/38,900 = .021$$

$$\therefore b_m/b = .540 \text{ (KOTTER CURVE) OR } b_m = .540 \times 8.25 = 4.46"$$

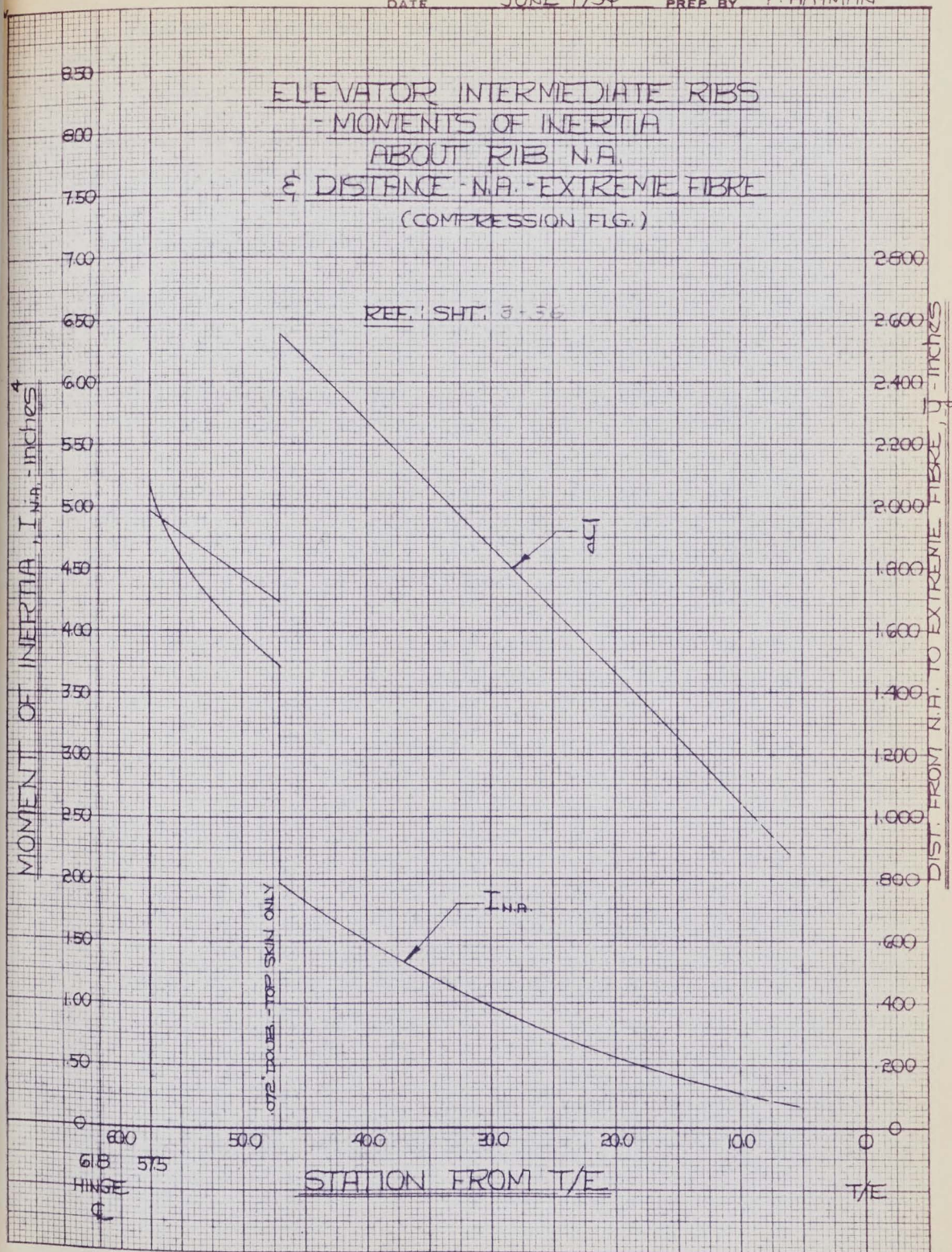
SUMMARY:

.051" SKIN ϵ

.072 DOUBLER



SKIN & DOUBLER EFFECTIVE WIDTHS AT INTERMEDIATE RIB



A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0582/1

SHEET NO. 3-58

AIRCRAFT:

C 105

ELEVATOR

PREPARED BY

DATE

T. HAMMILL

JUNE 1/54

CHECKED BY

DATE

INTERMEDIATE RIBS (CONT.)

RIE BENDING STRENGTH:

ALLOWABLE BENDING STRESS IS DICTATED BY RIB WEB & FLANGE CRIPPLING STRESSES.

SHS 3-34835 SHOW THE FLANGE ULT CRIPPLING STRESS,
 $F_{01} = 38,900$ PSI AS CRITICAL OR

$$F_b = F_0 = 38,900 \text{ psi}$$

SECTION PROPERTIES GIVEN ON SHS 3-34837 ARE A FUNCTION OF F_b , OR REPRESENT THE EFFECTIVE SECTION WHEN WORKING TO FLANGE ULTIMATE CRIPPLING STRESS.

ALLOWABLE B.M. FOR FLG. ULT CRIPPLING STRESS = 38,900 PSI IS

$$M_b = F_b \frac{I}{y} = 38,900 \times \frac{I}{y} \quad (F_b = \frac{M_b}{I} \frac{y}{I})$$

$$\text{A MARGIN OF SAFETY, M.S.} = \frac{M_b}{M} - 1$$

RESULTS ARE TABULATED BELOW:

STA.	M	y	I	F_b	$F_b I$ = (4) x (5)	M_b = (6) / (7)	R.F. = (8) / (7)	M.S. = (9) - 1	
	IN LB	IN.	IN ⁴	PSI	LB IN ³	IN LB	%		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	
10.0	4500	1.043	2.679	38,900	1,452.0	9930	2.220	1.220	@ 30°
200	9900	1.426	5.637	↑	21,930	14,960	1.511	.511	RIE
32.0	15,400	1.945	1.0538		41,230	21,200	1.377	.377	BENDING
470 (102.008)	16,000	2.554	1.9746		76,800	30,070	1.813	.813	
470 (102.008)	16,000	1.638	3.1090	↑	144,280	25,220	5.326	4.326	
575	10,000	1.985	5.563	38,900	200,580	101,050	13.105	9.105	

SHS 2-40
7/0582/1

SHS
3-34837

MAY, M = 16,900 IN LB @ 40.5 (SHS 2-40), I = 1.530 IN⁴ (SHS 3-37)

$$\therefore \text{M.S. @ 40.5} = \frac{F_b I}{y M} - 1 = \frac{38,900 \times 1.530}{2.2 \times 16,900} - 1 = 1.535 - 1 = .535 \quad \text{O.K.}$$

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT No. 7-05821

SHEET No. 3-41

AIRCRAFT:

C105

QUANTON

PREPARED BY

DATE

E. Thompson

9-June-54

CHECKED BY

DATE

INTERMEDIATE RIB ATTACHMENTS:

TO TOP SKINS. (AT RIB 9)

BY AN 126-AD4 RIVETS C/R IN SKIN. (7-1082-10042)

AT 1.0 IN PITCH. (7-1082-00138 C/R)

Hot VALUES - (ANC-5)

SHEAR = $388 \times .87 = 338$ LB. ULT.

C/R IN .051 = $340 \times .87 = 296$ LB. ULT.

= $261 \times .87 = 227$ LB. YIELD.

LOAD = 206 LB/IN. ULT. (ST - SNT 2-41-20 DUNN)

= 151 LB/IN. LIM.

M.S. ULT. = $\frac{338}{296} - 1 =$

.44

YIELD = $\frac{227}{151} - 1 =$

.50

TO BOTTOM SKINS. (AT RIB 9)

BY C/L-100 V4 BLIND RIVETS C/R IN SKIN.

AT 1.0 IN. PITCH.

Hot VALUES - (ANC-5)

SHEAR = $445 \times .87 = 387$ LB. ULT.

C/R IN .051 = $302 \times .87 = 262$ LB. ULT.

= $196 \times .87 = 170$ LB. YIELD.

LOAD = 206 LB/IN. ULT. } SEE ABOVE.

151 LB/IN. LIM. }

M.S. ULT. = $\frac{387}{262} - 1 =$

.27

YIELD = $\frac{170}{151} - 1 =$

.12

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 710522/1

SHEET NO. 3 - 4

AIRCRAFT:

C145

ELEVATOR

PREPARED BY

DATE

G. H. HARRIS

7-JUNE-54

CHECKED BY

DATE

INTERMEDIATE RIB ATT'CH. CONT'D.

TO SPAR WEB. AT RIB 3.

BY A.0625 EXTRUDED TEE, -71082-0043.
AND TWO GROUPS OF 8 AN470 AD6 RIVETS;
ONE GROUP - RIB TO TEE; THE OTHER GROUP -
TEE TO SPAR. RIVET EDGE DISTANCE = 2 D.
RIB TO TEE GROUP:

RIVET VALUES, -HOT; (ANC-5).

SHEAR = $862 \times .87 \times .972 = 730$ LB. ULT.

BRNG. IN .051 RIB WEB. = $974 \times .87 \times 1.14 = 965$ LB. ULT.
= $974 \times .87 \times .73 = 618$ LB. YIELD.

LOAD = 3761 LB. ULT. (SHT. 2-24, "20" DOWN, RIB 3)
= 2760 LB. LIM.

LOAD PER RIVET = $\frac{3761}{8} = 470$ LB. ULT.
= 345 LB. LIM.

M.S. ULT. = $\frac{730}{470} - 1 =$

.55

YIELD = $\frac{618}{345} - 1 =$

.79

TEE TO SPAR GROUP. THIS GROUP IS COVERED
ADEQUATELY BY THE ABOVE GROUP SINCE ITS
RIVET SHEAR VALUES ARE EQUAL TO, AND
BEARING VALUES GREATER THAN THOSE OF
THE ABOVE GROUP.

TEE. ITEM 7-1082-0043.

IS CONSIDERED TO BE SUFFICIENTLY STRONG
SINCE IT CARRIES THE SAME SHEAR LOAD AS
THE RIB WEB BUT IS THICKER BY $\frac{.0625}{.051} = 1.22$.

TECHNICAL DEPARTMENT (Aircraft)

SHEET NO

PREPARED BY

DATE _____

AIRCRAFT:

C 105

LEWIS

CHECKED BY

DATE _____

TOP SKIN ATTACHED. CENT'D

BY AN426-AD4-6 RIVETS @ .75 IN. PITCH

VACUUM - (4 NC-5.)

$$S_{\text{HAR}} = 3881.87 = 338 \text{ L.H. Unit}$$

Cex. In .051 SKIN: 340A. B7: 295 LB. 4LT.

 $261 \times .87 = 227 \text{ lb. Yield}$

CS. 44. 44. 45. 6. 1. 1. 1.

Load = 116 lb/sq. ft. (SMT. 2-67)

$$\text{LOAD/RIVET} = 116 \times .75 = 87 \text{ LB. ULT.}$$

$$= 64 \text{ LB. LIM.}$$

2.3.4.

$$YIELD = \frac{222}{64} = 3.47$$

2. 5. 56

BOTTOM SHOWN ATT'YS.

To CONTROL R.I.B. SEE CONTROL R.I.B. ATTS.
CHATS 3-30 & 31.

TO FRONT SPAR

By CKL-100 VS - K HUCK BLIND PIVOTS
(7-1082-0001 & 0002)

@ 1.0 IN. PITCH (7-1082-0030 & 0040)

VALUES - GOVERNANCE - (SHT 3-31)

= 349 lb. GWT. 163 lb. YIELD.

$$\text{LOAD/IN.} = \text{LOAD/RIVET} = 116 \text{ LB. CLT (SNT. 2-69)}$$

$$= 85 \text{ LB. YIELD.}$$

M/S ULT. = 340/116 - 1

2.00

$$YIELD = 163/85 = 1.91$$

29.

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0582/1

SHEET NO. 3-47

AIRCRAFT:

C 105

ELEVATOR

PREPARED BY

DATE

T. HAYMAN

JUL 3/56

CHECKED BY

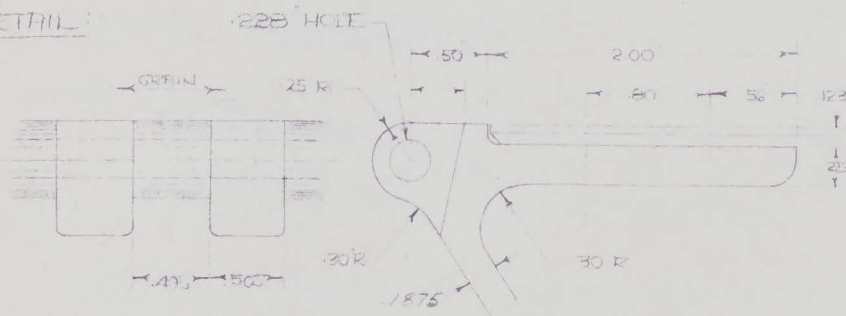
DATE

ELEVATOR HINGE:

DRG REF'S: 7-1082-0050 (CONTR. RIB)

7-1082-0050 (SPR & SHRD)

DETAIL:



MAT'L. SPEC.: 24S-T4 EXTRUSION (CS H-126)

DESIGN PROPERTIES:

NORMAL (RM. TEMP.)

HOT (250T 333HP'S)

(AUC-5, R5.53, 64 & 66)

(L 0.250-.749)

(.92 x UCT, .95 x YIELD)

$E = 10.5 \times 10^6$ PSI NORMAL

$F_{TU} = 51,000$ PSI (T)

$= 46,900$ PSI (T)

$\times 10.2 \times 10^6$ PSI HOT

$F_{TU} = 36,000$ PSI (T)

$= 34,200$ PSI (T)

(TABLE 3.12/6) AUCS &
SHT 3.2B)

$F_{CY} = 39,000$ PSI (T)

$= 37,100$ PSI (T)

$F_{SU} = 32,000$ PSI

$= 29,450$ PSI

$F_{EPU} = 108,000$ PSI (% 20)

$= 99,400$ PSI (% 20)

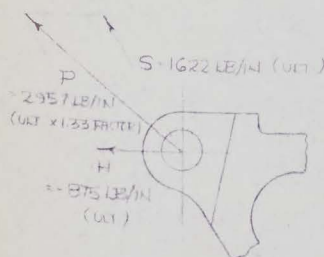
$F_{ERY} = 69,000$ PSI (% 20)

$= 65,000$ PSI (% 20)

LOADING:

HINGE LOADING IS RESULTANT OF UDL
COMPONENTS H (ILL TO TOP SKIN) & S

(ILL TO SHRD WEB) (SHT. 2.70 7/0582/1)



$H_{UCT} = 875$ LB/IN ; $S_{UCT} = 1622$ LB/IN

RESULTANT $P_{LT} = 2223$ LB/IN

& $P_{UCT} \times 1.33$ PEAKING FACTOR $= 2957$ LB/IN UCT

$F_{LIM} = \frac{2957}{1.364} = 2167$ LB/IN LIM

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/1582/1

SHEET NO. 3-4-E

AIRCRAFT:

C105

ELEVATOR

PREPARED BY

DATE

T. HEDWIG

JUNE 3/54

CHECKED BY

DATE

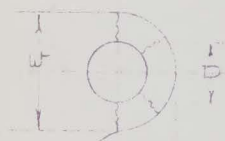
HINGE (CONT.)

LUG STRENGTH OF HINGE FITMENT

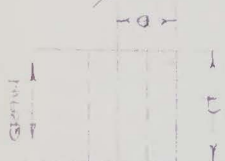
EXAMINATION OF THE HINGE FITMENT LUG, CONSIDERING DIRECTION OF THE APPLIED OR DESIGN LOAD, INDICATES THAT IT IS REASONABLE TO ASSUME THE LUG AS BEING AXIALLY LOADED FOR STRESSING PURPOSES.

THE METHOD OUTLINED BY COZZONE, KILSON & HOBBS IN ANALYSIS OF LUGS, PROD. ENG. M17/5, IS USED.

LUG RICH = 100 (TYP. 1000)



AXIAL LOAD/LUG, $P_L = 205715 \text{ LB}$
F. $P_L = 205715 \text{ LB}$



$\alpha = 25^\circ$, $W = 50$, $D = 228$, $L = 495$

$W/D = \frac{50}{228} = 2.194$, $H/D = \frac{228 \times 495}{1123} = 1.123$

$\alpha/D = \frac{25}{228} = 1.007$, $A_L = (W/D) \times (L/D) \times 495$
 $272 \times 495 = 1346 \text{ IN}^2$

RAT. PRO. ENGR.

M17/50 - DIM. OF LUG

$D/L = \frac{228}{495} = .46$

TENSION ACROSS NET SECTION:

ALLOW. U.T. STRESS, $P_{LU} = K_L T_{LU} A_L$
 $= 920 \times 46900 \times 1346$
 $= 5810 \text{ LB}$

$K_L = 920 \text{ PSI}$, PROD. ENGR. M17/50
($W/D = 2.194$ - 24ST LUGS M17/50)

$P_{LU} = 46900 \text{ PSI}$ (1) - EN 3-47 LUG
 $A_L = 1346 \text{ IN}^2$ NET

$M/S = \frac{P_L}{P_{LU}} - 1 = \frac{205715}{5810} - 1 = 35.4 - 1 = 34.4$ (1) - 34.4 (1)

(CONT.)

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

REPORT NO. 7/0582/1

SHEET NO. 3-49

AIRCRAFT:

C105

ELEVATOR

PREPARED BY

DATE

T. HAYMAN

JUNE 4/54

CHECKED BY

DATE

HINGE (CONT.)

LUG STRENGTH OF HINGE ELEMENT (CONT.)

SHEAR BEARING:

ALLOW. ULT. LOAD, $P_{b,u} = K_{b,u} A_b F_{b,u}$ $K_{b,u} = .90$ (R 4 MODIFIED, MAR/53)

$$= .90 \times .1129 \times 46,900 \quad (d/D = 1.097 \quad D/t = .461)$$

$$= 4770 \text{ LB}$$

$$A_b = .1129 \text{ in}^2 \quad \text{SHEAR 3-48}$$

$$F_{b,u} = 46,900 \text{ PSI (T) SHEAR 3-47}$$

$$\text{M.S.} = \frac{P_{b,u}}{P_u} - 1 = \frac{4770}{2957} - 1 = 1.613 - 1 = .613 \quad (\text{ULT})$$

LUG
SHEAR
BEARING
.613
(ULT)

LUG YIELD:

ALLOW. YIELD LOAD, $P_y = C \frac{F_{t,y}}{F_{t,u}} P_{b,u}$

$$= 110 \frac{34,200}{46,900} \times 4770$$

$$= 3830 \text{ LB}$$

$P_{b,u} = \text{LEAST OF } P_{b,u} \text{ OR } P_{b,y}$
 $= 4770 \text{ LB (P}_{b,u} \text{ HIGHER)}$

$$F_{t,u} = 46,900 \text{ PSI} \quad \text{SHEAR 3-47}$$

$$F_{t,y} = 34,200 \text{ PSI}$$

$$C = 110 \quad (\text{TYPE } P_{b,u} / A_b F_{t,u})$$

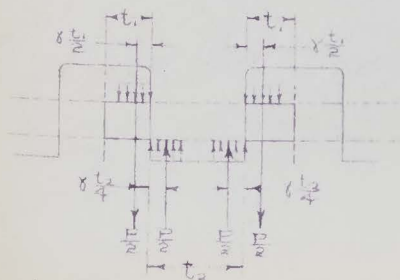
$$= 4770 / .1129 \times 46,900$$

$$\text{M.S.} = \frac{P_y}{P_u} - 1 = \frac{3830}{2167} - 1 = 1.768 - 1 = .768 \quad (\text{YLD})$$

LUG
YIELD
.768
(YLD)

PIN STRENGTH

PIN STRENGTH IS CHECKED USING THE METHOD OUTLINED BY MELCON & HOBLIT IN "DEVELOPMENTS IN THE ANALYSIS OF LUGS & SHEAR PINS", PROD ENG, JUNE/53



PIN: .235 D CORR RESIST. STEEL
(QQ-W-423 = MIL-S-5059 CR 1/2 HARD)

NORMAL (RM TEMP)
(ANC 5, PG 25)

HOT (250°F, 333°K)

$$F_{tu} = 150,000 \text{ PSI (LET) ELEVATED TEMP (250°F)}$$

$$F_{ty} = 110,000 \text{ PSI (LET) EFFECT ON DESIGN}$$

$$F_{su} = 80,000 \text{ PSI}$$

PROP. ASSUMED NEG

$$F_{bu} = 130,000 \text{ PSI } (\sigma_p = 20) \quad \text{USABLE FOR STEEL}$$

$$t_1 = 505/2 = 252.5; P_{b,u} = 2957 \text{ LB}$$

$$t_2 = 495 \text{ (SHEAR)}; P_{b,u} = 2167 \text{ LB (SHEAR)}$$

TECHNICAL DEPARTMENT (Aircraft)

AIRCRAFT:

C105

ELEVATOR

REPORT NO. 7/0582/1

SHEET NO. 3-51

PREPARED BY

DATE

G. Thorne

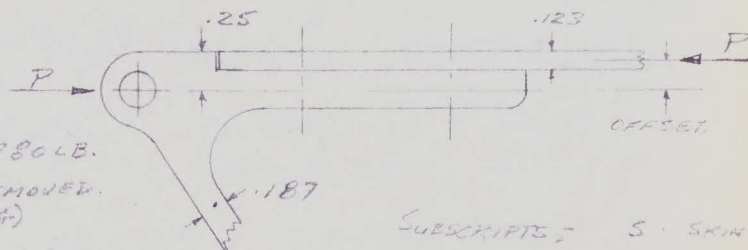
9-JUNE-54

CHECKED BY

DATE

HINGE CONT'D.

BENDING AT HINGE DUE TO SKIN OFFSET LOAD.



$$P = 3700 \times .75 = 2780 \text{ LB.}$$

(PEAKING FACTOR REMOVED.
SAT. 8-94)

$$\text{OFFSET} = \frac{.25 - .123}{2} = .19 \text{ IN.}$$

SUBSCRIPTS: S - SKIN
W - WEB (SPAR)

$$\text{MOMENT} = .19 \times 2780 = 530 \text{ IN. LB.}$$

THE MOMENT IS DISTRIBUTED BETWEEN THE SKIN AND THE SPAR WEB ACCORDING TO THEIR STIFFNESSES.

CONSIDER A STRIP OF HINGE 1 IN. WIDE.

$$\text{THE STIFFNESS FACTOR } K = \frac{4EI}{L} \text{ (REF. 2, P. A11.3)}$$

NOW $I \propto t^3$; "E" IS COMMON; L ASSUMED COMMON.
 $\therefore K \propto t^3$

$$K_S \propto .123^3 = .00186 \quad K_W \propto .187^3 = .00655$$

$$\text{DISTRIBUTION FACTOR "D"} = K / \Sigma K \text{ (REF. 2, P. A11.2)}$$

$$D_S = \frac{.186}{.186 + .655} = .221 \quad D_W = \frac{.655}{.186 + .655} = .779$$

$$\therefore M_S = .221 \times 530 = 117 \text{ IN. LB.}; M_W = .779 \times 530 = 413 \text{ IN. LB.}$$

$$\text{SKIN: } Z = \frac{b t^2}{6} = \frac{1 \times .123^2}{6} = .00252$$

$$f_b = \frac{M_S}{Z} = \frac{117}{.00252} = 52,000 \text{ PSI (ACT.)}$$

$$= 38,100 \text{ PSI LIM.}$$

$$F_{by} = 58,500 \times .91 \times 1.37 = 73,000 \text{ PSI}$$

(.91 TEMP. FACTOR REF. ANC-5; 1.37 FORM FACTOR REF. 7 P. 5-2)

$\therefore$ SKIN WILL NOT YIELD & CAN BE CONSIDERED SATISFACTORY.

A. V. ROE CANADA LIMITED
MALTON, ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 7/0582/1

SHEET NO. 3-54

AIRCRAFT:

C105

ELEVATOR

PREPARED BY

DATE

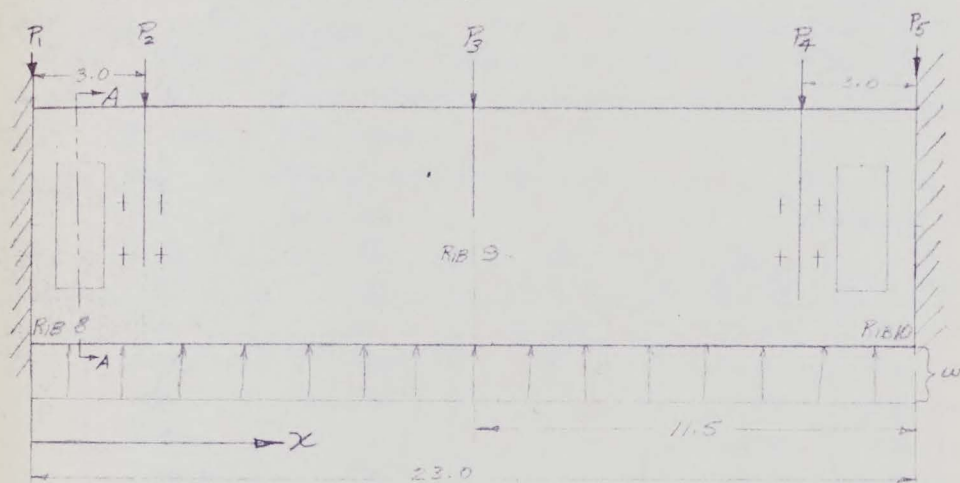
E. Norman 8-JUNE-54

CHECKED BY

DATE

SPAR CANTO

LOADING



$$P_2 = \text{At RIB 8, } S = 40,942 \text{ LB (SMT 2-24); } S_g = 941 \text{ LB (SMT 2-41)} \\ S + S_g = 41,884 \text{ LB}$$

$$P_2 = \frac{4}{9.34} \times 41,884 = 17,940 \text{ LB. (SMT 2-50)}$$

$$P_3 = \text{At RIB 9, } S = 3,554 \text{ LB (SMT 2-24); } S_g = 706 \text{ LB (SMT 2-41)} \\ P_3 = S + S_g = 2,488 \text{ LB}$$

$$P_4 = \text{At RIB 10, } P_4 = 4 \times 4,538 = 18,150 \text{ LB. (SMT 2-50)}$$

$$P_5 = \frac{1}{2} (2 \times 3040) = 3,040 \text{ LB (SMT 2-50)}$$

$$P_1 = \frac{1}{2} \left(\frac{2}{9.34} \times 41,884 \right) = 4,490 \text{ LB. (SMT 2-50 & } P_2 \text{ ABOVE)}$$

$$w = \frac{1}{23} \sum_1^5 P_i = \frac{46,110}{23} = 2,005 \text{ LB/IN.}$$

A. V. ROE CANADA LIMITED
MALTON - ONTARIO

TECHNICAL DEPARTMENT (Aircraft)

REPORT NO. 70582

SHEET NO. 2-57

AIRCRAFT:

C 105

FLYER

PREPARED BY

DATE

E. H. HARRIS

10 June 54

CHECKED BY

DATE

SPAR CONT'D.

PENDING MOMENTS CONT'D.

SUMMATION OF E.M.'S

THE E.M. PUTS TOP FLANGE IN COMPRESSION.

X IN.	MOMENT DUE TO				Σ M. IN. LB.
	W	P ₂	P ₃	P ₄	
0	88,300	70,600	7,160	6,180	34,360
1.5	56,020	74,940	5,300	4,910	36,870
3.0	28,240	10,710	-3,420	3,640	31,890
7.0	23,980	7,370	1,560	260	15,310
11.5	44,040	3,610	7,160	3,560	29,710
15.5	28,360	260	2,180	6,930	18,930
20.0	28,240	3,500	-3,420	16,740	32,600
21.5	56,020	4,750	5,300	15,210	39,760
23.0	88,300	6,010	7,160	41,160	33,970

Σ M IS PLOTTED ON SNT 3-58.

MAX E.M. OCCURS IN THE REGION OF THE ALLES IN THE SPAR WEB. THIS SECTION WILL BE CHECKED (SECT. A-A, SNT 3-54), THE MOMENT BEING REACTED AS A COUPLE BY THE TOP & BOTTOM FLANGES. (SNT. 3-53).

SPAR SHEAR

W = 2005 LB/IN

P₂ PER SNT. 3-54.

X	V.S.F.		
0	1/8	- 4430	
3	1/8	- 4490 + 3 x 2005 =	1530
	1/8	1530 - 17,940 =	-16,410
11.5	1/8	-16,410 + 8.5 x 2005 =	630
	1/8	630 - 2490 =	-1860
20	1/8	-1860 + 8.5 x 2005 =	15,180
	1/8	15,180 - 18,150 =	-2970
23	1/8	-2970 + 6010 =	3040

SHOWN

GRAPHICALLY

ON

SNT.

3-58.

RCRAFT 6105
U. W.

COMPONENT ELEVATOR SHEET NO. 3-58

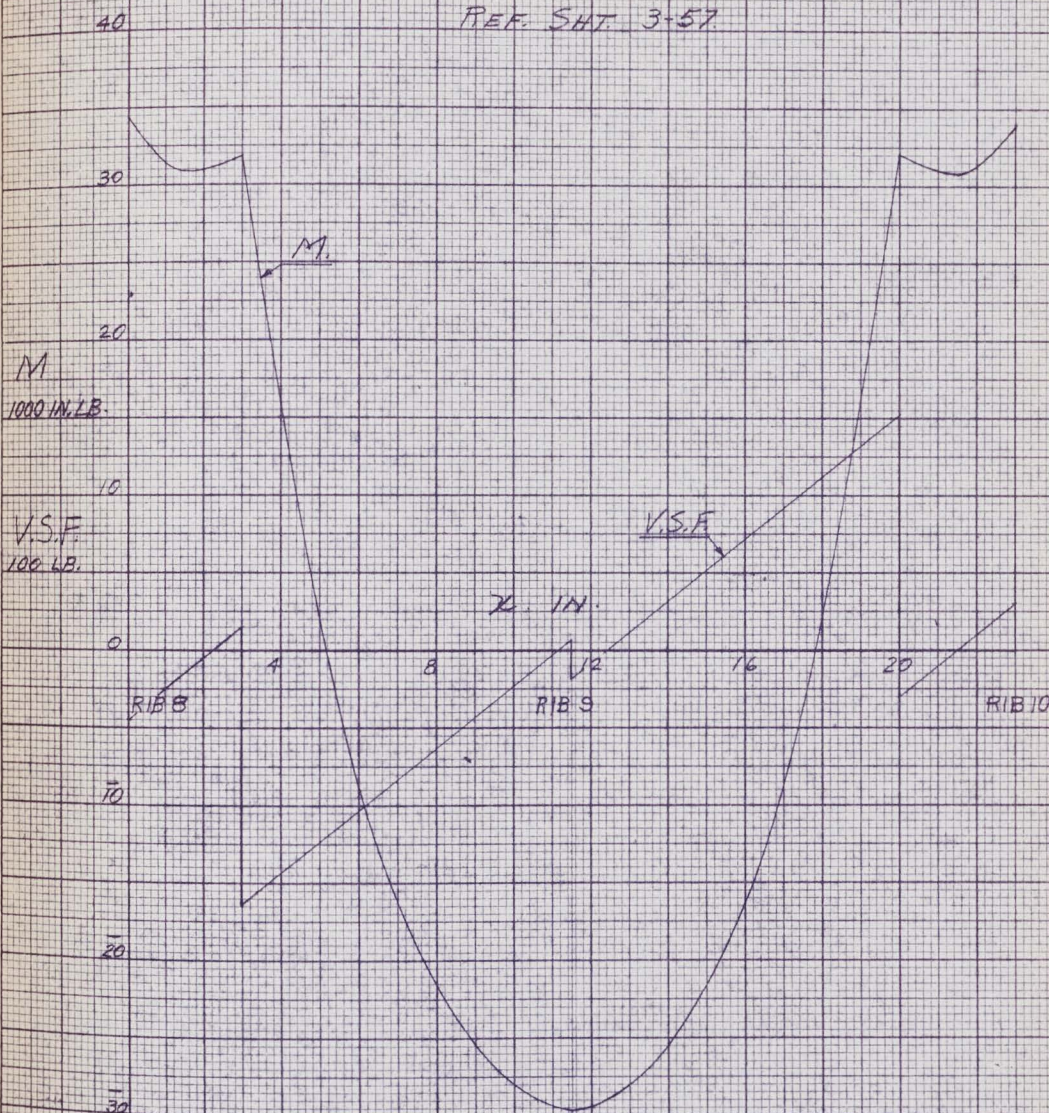
REPORT NO. 7/0582/1

DATE 10-JUNE-54

PREP BY E. Norman

SPAR BENDING MOMENT AND V.S.F. BETWEEN RIBS 8 & 10

REF. SHT. 3-57



+VE. B.M. PUTS TOP FLANGE IN COMPRESSION

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

REPORT No. 7-10582/1

SHEET No. 3 - 61

AIRCRAFT:

C105.

ELEVATOR

PREPARED BY

DATE

G. H. HARRISON

11 JUNE 54

CHECKED BY

DATE

SPAR ATTACHMENTS

TO CONTROL RIB, - SEE SNT. 3-10.

TO INTERMEDIATE RIB, - SEE SNT. 3-42.

TO TOP SKIN, - SEE SNT. 3-44.

TO BOTTOM SKIN, - SEE SNT. 3-45.

END RIB ATT'T. TO SPAR.

THE ATT'T. AT RIB 13 HAS THE GREATEST
LOAD = 2070 LB. IN THE "20° DOWN, SUBSONIC" CASE.
THIS LOAD IS $\perp$ THE CHORD SO THE COMPONENT
// THE SPAR WEB = $2070 / \sin 58^\circ$ (SNT. 2-22).
 $= \frac{2070}{.848} = 2460$ LB. ULT.
 $= 1700$ LB. LIM.

THE ATT'T. IS BY 8 AN470-AD5 RIVETS AND A TEE SECTION,
IDENTICAL TO THE INTERMEDIATE RIB ATT'T.

SINCE THE INTERMEDIATE RIB LOADING $\approx 1.5 \times$ THE
ABOVE LOAD, THIS END RIB ATT'T. IS WELL
COVERED BY THE INTERMEDIATE RIB ATT'T. OF
SNT. 3-42.

ATT'T. RIB 13.4 TO RIB 13.

BY 4 AN470-AD5 RIVETS.

VALUES: $SHEAR = 596 \times .87 \times .796 = 517$ LB. ULT. } ANG-5
 $PRNG. ON .051 = 811 \times .87 \times 1.14 = 805$ LB. ULT. }
 $811 \times .87 \times .73 = 516$ LB. YIELD.

THE LOAD IS ASSUMED TO BE $\frac{1}{2}$ THE LOAD AT RIB 13, ABOVE.

L.B. = 1035 LB. ULT. & 850 LB. LIM.

$$M.S. \text{ ULT} = \frac{4 \times 517}{1035} - 1 =$$

1.00

$$YIELD = \frac{4 \times 516}{850} - 1 =$$

1.43

SNAP-LOCK BINDER, 1½ inch capacity

NO. 4872-W

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

