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REPORT FZS-36-242A

DATE 5/27/48

MODEL XB-36

TITLE

STRESS ANALYSIS
OF OUTER WING BULKHEADS
AND AUXILIARY SPAR

SUBMITTED UNDER

Contract W535-ac-22352

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TABLE OF CONTENTS

	PAGE
Introduction	1
Summary of Critical Margins of Safety	3
Determination of Correction Factors, Table I . . .	4
Wing Bulkhead No. 29 Margins of Safety, Table II .	5
Trailing Edge Rib, Sta. 29 Margins of Safety, Table III	6
Bulkhead & Trailing Edge Rib No. 30 Margin of Safety, Table IV	7
Outer Panel Wing Leading Edge	8
Auxiliary Spar Outer Panel Trailing Edge	8

INTRODUCTION

This report is an analysis of representative wing outer panel bulkheads for the XB-36 Airplane. These bulkheads are the same as those contained in the YB-36 Airplane, Ref. Report FZS-36-141A.

The analysis of the following XB-36 bulkheads are made by a comparison of XB-36 and B-36A loadings.

1. Inter-Spar Bulkhead #29
2. Trailing Edge Bulkhead #29
3. Inter-Spar Bulkhead #30
4. Trailing Edge Bulkhead #30
5. Typical Airload Nose Rib, Sta. 1013" from ℄ Ship.

In addition, a check is made of a typical portion of the Wing Auxiliary Spar

METHOD OF ANALYSIS

A rational analysis for the XB-36 bulkheads at Stations 29 and 30 is obtained by making a conservative comparison of XB-36 and B-36 air loads on these members. This results in the development of an approximate set of correction factors for the various flight conditions which can be used to correct the B-36 margins of safety to applicable values for the XB-36 Airplane.

These correction factors may be determined in the following manner.

1. HAA & IHAA - The correction factor is dependent on the ratio of the airplane gross weights

2. LAA & ILAA -
Correction factor $= \left(\frac{q_{XB} \times G.W_{XB} \times n_{XB}}{q_B \times G.W_B \times n_B}\right)$

where

$$q = \rho \frac{V^2}{2}$$

GW = gross weight of airplane

n = limit load factor of airplane

This is conservative since the $(\text{speed})^2$ is considered twice in obtaining the correction factor.

3. DGW, Aileron Roll Condition

The XB-36 loading will be conservatively assumed equal to the B-36A since the factor "n" is the same and the weight reduced. The aileron loading depends on the speed and aileron deflection and for this reason will remain practically unchanged.

Wing Station 29 & 30

Table I, page 4 contains XB-36 and B-36A aerodynamic data used in the comparison of bulkhead loads at Wing Station #29 and 30. The correction factors used in the determination of margins of safety for the XB-36 airplane bulkheads are contained in this table.

SUMMARY OF CRITICAL MARGINS

	M.S.	PAGE
Wing Bulkhead No. 29 Lower Chord (K-4)	+.25	5
Trailing Edge Rib Sta. No. 29 Lower Chord (d-e)	+.09	6
Wing Bulkhead No. 30 Diagonal Member (2-3)	+.23	7
Trailing Edge Rib Sta. No. 30 Diagonal Member (3-4)	+.02	7
Wing Nose Rib Sta. 1013 Compression Flange	+.58	8
Auxiliary Spar Lower Flange Sta. 30	+.35	8

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STA. 29 & 30, DETERMINATION OF CORRECTION FACTORS

TABLE I

CONDITION	G.W.	SPEED	FACTOR "n"	q	C_L
— FZS-36-136, PAGE 30 —					
B-36A AIRPLANE					
D.G.W.-L.H.A. (L.D.S.) @ 5000'	278000	308	2.51	209.0	.7242
D.G.W.-H.A.A. @ 5000'	278000	219.8	2.67	106.5	1.50
D.G.W.-L.A.A. (L.D.S.) @ 5000'	278000	308	-1.51	209.0	-.41
D.G.W.-L.A.A. (H.S.) @ 5000'	278000	275	-1.67	166.4	-.5786
D.G.W.-AIL. ROLL @ S.L.	278000	188.5	1.78	90.6	1.18
D.G.W.-I.H.A.A. @ 5000'	278000	203	-1.670	90.64	-1.10
— FZS-36-126, PAGE 35 —					
XB-36 AIRPLANE					
D.G.W.-L.A.A. @ 5000'	265192	311	2.793	213.1	.7531
D.G.W.-H.A.A. @ 5000'	265192	214.8	2.67	101.7	1.50
D.G.W.-L.A.A. @ 5000'	265192	311	-1.67	213.1	-.4249
D.G.W.-AIL ROLL @ S.L.	265192	188.3	1.78	90.6	—
D.G.W.-I.H.A.A. @ 5000'	265192	198.1	-1.67	86.5	-1.10

CORRECTION FACTORS
(USED TO OBTAIN XB-36 LOADINGS FROM B-36A)

D.G.W., L.A.A. @ 5000' $\frac{213.1}{209} \times \frac{265192}{278000} \times \frac{2.793}{2.51} = 1.08$

D.G.W., H.A.A. @ 5000' $\frac{265192}{278000} = .953$

D.G.W.-L.A.A. @ 5000' $\frac{213.1}{209} \times \frac{265192}{278000} \times \frac{1.67}{1.51} = 1.077$ (FOR B-36A L.D.S.)

D.G.W. L.A.A. @ 5000' $\frac{213.1}{166.4} \times \frac{265192}{278000} \times \frac{1.67}{1.67} = 1.22$ (FOR B-36A H.S.)

D.G.W.-I.H.A.A. @ 5000' $\frac{265192}{278000} = .953$

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TABLE II

WING BULKHEAD NO. 29 MARGINS OF SAFETY

MEMBER				B-36A CONDITION	M.S.	CORRECTION FACTOR	XB-36 CONDITION	M.S.
			1	2	3	4	5	6
						PAGE 4		$\frac{1.00}{\phi}-1.0$
UPPER CHORD	(E-5)	REF. FZS-36-142A P.	36	D.G.W., L.A.A., L.O.S. @ 5000'	+.98	1.08	D.G.W., L.A.A. @ 5000'	+.84
LOWER CHORD	(K-4)	REF. FZS-36-142A P.	38	D.G.W., L.A.A., L.O.S., @ 5000'	+1.35	1.077	D.G.W., L.A.A., @ 5000'	+.25
DIAGONAL	(1-2)	REF. FZS-36-142A P.	39	D.G.W., H.A.A. @ 5000'	+4.90	.953	D.G.W., H.A.A., @ 5000'	+5.20
DIAGONAL	(2-3)	REF. FZS-36-142A P.	39	D.G.W., L.A.A., L.O.S. @ 5000'	+2.40	1.077	D.G.W., L.A.A. @ 5000'	+2.16
DIAGONAL	(3-4)	REF. FZS-36-142A P.	39	D.G.W., AIL. ROLL @ S.L.	+.42	1.00	D.G.W., AIL. ROLL @ S.L.	+.42
DIAGONAL	(4-5)	REF. FZS-36-142A P.	40	D.G.W., L.A.A., L.O.S. @ 5000'	+.50	1.077	D.G.W., L.A.A. @ 5000'	+.39

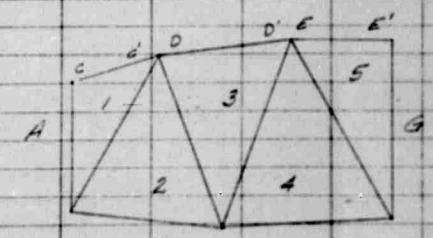

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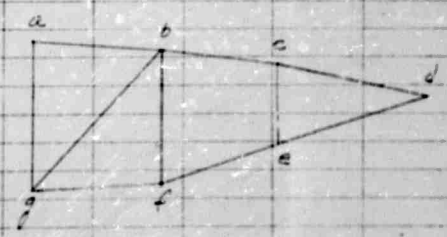
TABLE III

TRAILING EDGE RIB NO. 29 MARGINS OF SAFETY

MEMBER			B-36A CONDITION	M.S.	CORRECTION FACTOR	XB-36 CONDITION	M.S.
		1	2	3	4 PAGE 4	5	6 $\frac{1.0+②}{④}-1.0$
UPPER CHORD (a-b)	REF. FZS-36-142A P.	49	DGW, AIL. ROLL @ S.L.	+.33	1.00	DGW, AIL. ROLL @ S.L.	+.33
UPPER CHORD (b-c)	REF. FZS-36-142A P.	50	DGW, AIL. ROLL @ S.L.	+.37	1.00	DGW, AIL. ROLL @ S.L.	+.37
UPPER CHORD (c-d)	REF. FZS-36-142A P.	50	DGW, AIL. ROLL @ S.L.	+.54	1.00	DGW, AIL. ROLL @ S.L.	+.54
LOWER CHORD (d-e)	REF. FZS-36-142A P.	51	DGW, AIL. ROLL @ S.L.	+.09	1.00	DGW, AIL. ROLL @ S.L.	+.09
LOWER CHORD (e-f)	REF. FZS-36-142A P.	51	DGW, AIL. ROLL @ S.L.	+.34	1.00	DGW, AIL. ROLL @ S.L.	+.34
LOWER CHORD (f-g)	REF. FZS-36-142A P.	53	DGW, ILLA. @ 5000'	+.29	1.077	DGW, ILLA. @ 5000'	+.20
DIAGONAL (g-b)	REF. FZS-36-142A P.	52	DGW, AIL. ROLL @ S.L.	+.47	1.00	DGW, AIL. ROLL @ S.L.	+.47



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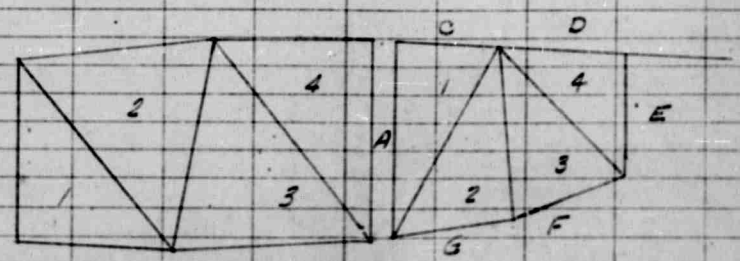
BULKHEAD AND T.E. RIB NO. 30 MARGINS OF SAFETY

TABLE IV

MEMBER			B-36A CONDITION		M.S.	CORRECTION FACTOR	XB-36 CONDITION		M.S.
		1	2		3	4	5		6
						PAGE 4			$\frac{1.0 \div ④}{③} - 1$
BULKHEAD NO. 30									
UPPER CHORD	REF. FZS-36-142A P.	76	DGW, XAA, LDS @ 5000'		LARGE	1.077	DGW, 1LAA, @ 5000'		LARGE
LOWER CHORD	REF. FZS-36-142A P.	76	DGW, 1LAA, LDS @ 5000'		LARGE	1.077	DGW, XLAA, @ 5000'		LARGE
DIAGONAL (1-2)	REF. FZS-36-142A P.	76	DGW, 1HAA, @ 5000'		+.34	.953	DGW, 1HAA, @ 5000'		+.41
DIAGONAL (2-3)	REF. FZS-36-142A P.	76	DGW, 1LAA, LDS @ 5000'		+.32	1.077	DGW, 1LAA, @ 5000'		+.23
DIAGONAL (3-4)	REF. FZS-36-142A P.	76	DGW, 1HAA, @ 5000'		+.19	.953	DGW, 1HAA, @ 5000'		+.25
T.E. RIB NO. 30									
UPPER CHORD (C-1)	REF. FZS-36-142A P.	87	DGW, LAA, LDS @ 5000'		+.43	1.08	DGW, LAA, @ 5000'		+.32
UPPER CHORD (D-4)	REF. FZS-36-142A P.	85	DGW, LAA, @ 5000'		+1.24	1.08	DGW, LAA, @ 5000'		+1.07
DIAGONAL (1-2)	REF. FZS-36-142A P.	87	DGW, 1HAA, LDS @ 5000'		+.09	.953	DGW, 1HAA @ 5000'		+.14
DIAGONAL (2-3)	REF. FZS-36-142A P.	88	DGW, 1LAA, LDS @ 5000'		LARGE	1.077	DGW, 1LAA @ 5000'		LARGE
DIAGONAL (3-4)	REF. FZS-36-142A P.	88	DGW, 1AA, LDS, @ 5000'		+.10	1.08	DGW, 1AA, @ 5000'		+.02
LOWER CHORD (G-2)	REF. FZS-36-142A P.	88	DGW, 1AA, LDS, @ 5000'		LARGE	1.08	DGW, 1AA, @ 5000'		LARGE



WING BLK'D NO. 30 TE. RIB NO. 30

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Outer Panel Wing Leading Edge

A typical airload nose rib at wing station 1013 is analyzed for the B-36A Airplane, Ref. Report FZS-36-142A, pp. 96-103. The critical loading condition is

DGW HAA @ 5,000'

The DGW HAA correction factor is .953, Ref. p. 4.

The minimum margin of safety occurs in the compression flange of the rib, Ref. Fig. 21, p. 97 and p. 102 of FZS-36-142A.

M.S. (B-36) = +.51

M.S. (XB-36) = $\left(\frac{1+.51}{.953}\right) - 1 =$ +.58

The B-36A analysis shows the margin of safety in all other parts of the nose rib to be high.

Auxiliary Spar, Outer Panel Trailing Edge

A typical portion of the auxiliary spar in the outer panel wing trailing edge is analyzed for the B-36 Airplane in Report FZS-36-142A, pp. 104-117. This same auxiliary spar is used in the XB-36 Airplane.

The critical loading condition for the B-36 Airplane is

DGW LAA (LDS) @ 5,000'

The DGW LAA correction factor for the XB-36 is 1.08, Ref. p. 4.

The minimum margin of safety occurs in the lower flange of the spar at Sta. 30, Ref. FZS-36-142A, p. 117

M.S. (B-36) = +.46

M.S. (XB-36) = $\frac{(1 + .46)}{1.08} =$ +.35

All other margins of safety are high.

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ABSTRACT:

A stress analysis is made of the outer wing bulkheads and auxiliary spar of the XB-36 bomber. The analysis covers the inter-spar and trailing edge bulkheads Nos. 29 and 30, a typical airload nose rib, and a typical portion of the wing auxiliary spar. A summary of the critical margins of safety is included.

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