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Airbus Report: Vertical Stabilizer attachment loads experienced during the flight AA903 incident and NDI finding assessment

(15 Pages)

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Contents

page

1. Introduction

2. Finite element model for vertical stabilizer and rudder structural analysis

3. Analysed load cases

4. Analysis results

4.1 Vertical stabilizer reaction loads

4.1.1 Load case L264

4.1.2 Load case L293

5. Evaluation of results

6. Assessment for the finding on the RHS rear main lug

7. Summary

1. Introduction

This report describes the calculation of the vertical stabilizer attachment loads for Airbus A300-600 subjected to the incident during flight AA903 on May 12, 1997.

An assessment is provided for the finding at the RHS rear lug as a result of an inspection performed in March 2002.

2. Finite element model for vertical stabilizer and rudder structural analysis

The FEM-analysis is performed with MSC NASTRAN/PATRAN. The analysis model (figure 1) comprises the vertical stabilizer spar box with leading and trailing edge and the rudder with its supporting hinges.

The vertical stabilizer is attached to the fuselage section 18 and 19. The structural analysis model is fixed at the perimeter of the first frame of section 18 in all 6 degrees of freedom (DOF).

The structure model is built by:

4-node plate and membrane elements QUAD4

3-node plate and membrane elements TRIA3

2-node elements BAR

2-node elements ROD

rigid body elements RBE3

multi-point constraints MPC.

The part of the model which represents the vertical stabilizer and rudder has ~ 96000 DOF and is composed of ~ 30000 elements.
The analysis is done with deflected rudder to provide forced interaction loads between vertical stabilizer and rudder.

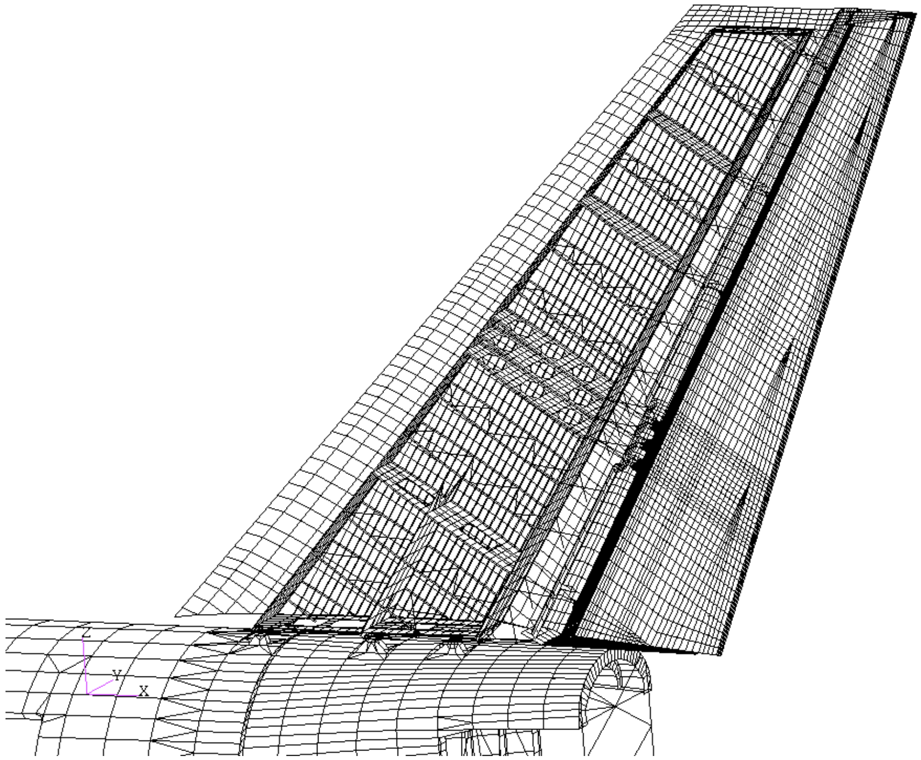

Figure 1

3. Analysed load cases

The loads are calculated using the flight data recordings. They are reported in document _________________ with the reference

LEQ1NBT2P2 264 D01ICC F0 T YM-8026 (abbreviation in this report: L264)
LEQ1NBT2P2 293 D01ICC F0 T YM-8026 (abbreviation in this report: L293).

The loads are provided as forces acting on both surfaces of the vertical stabilizer and rudder at the grid points of the analysis model.

The correlated loads lateral shear Q_y, bending moment M_{xQ} and torsional moment M_{zQ} at the root of the vertical stabilizer are listed in figure 2.

	L264	L293
Q_y [N]	271 350	-297 300
M_{xQ} [Nm]	-1 133 336	-1 320 510
M_{zQ} [Nm]	-161 820	-82 490
Rudder hinge moment [Nm]	-9 200	-16 420
Rudder deflection angle [°]	2.94	13.39

Figure 2

The loads are given in the fin coordinate system (see figure 3).

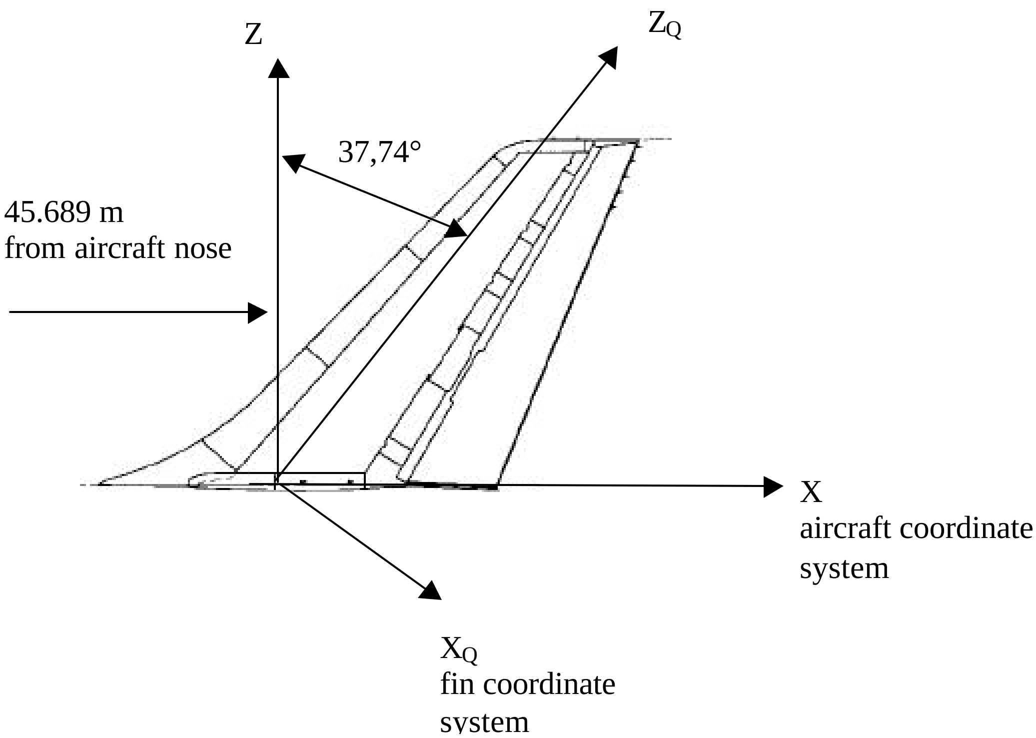

Figure 3

4. Analysis results

4.1 Vertical stabilizer reaction loads

The results are given as reaction forces at the main lugs and the lateral yokes which are attached to the transverse load fittings (see figure 4).

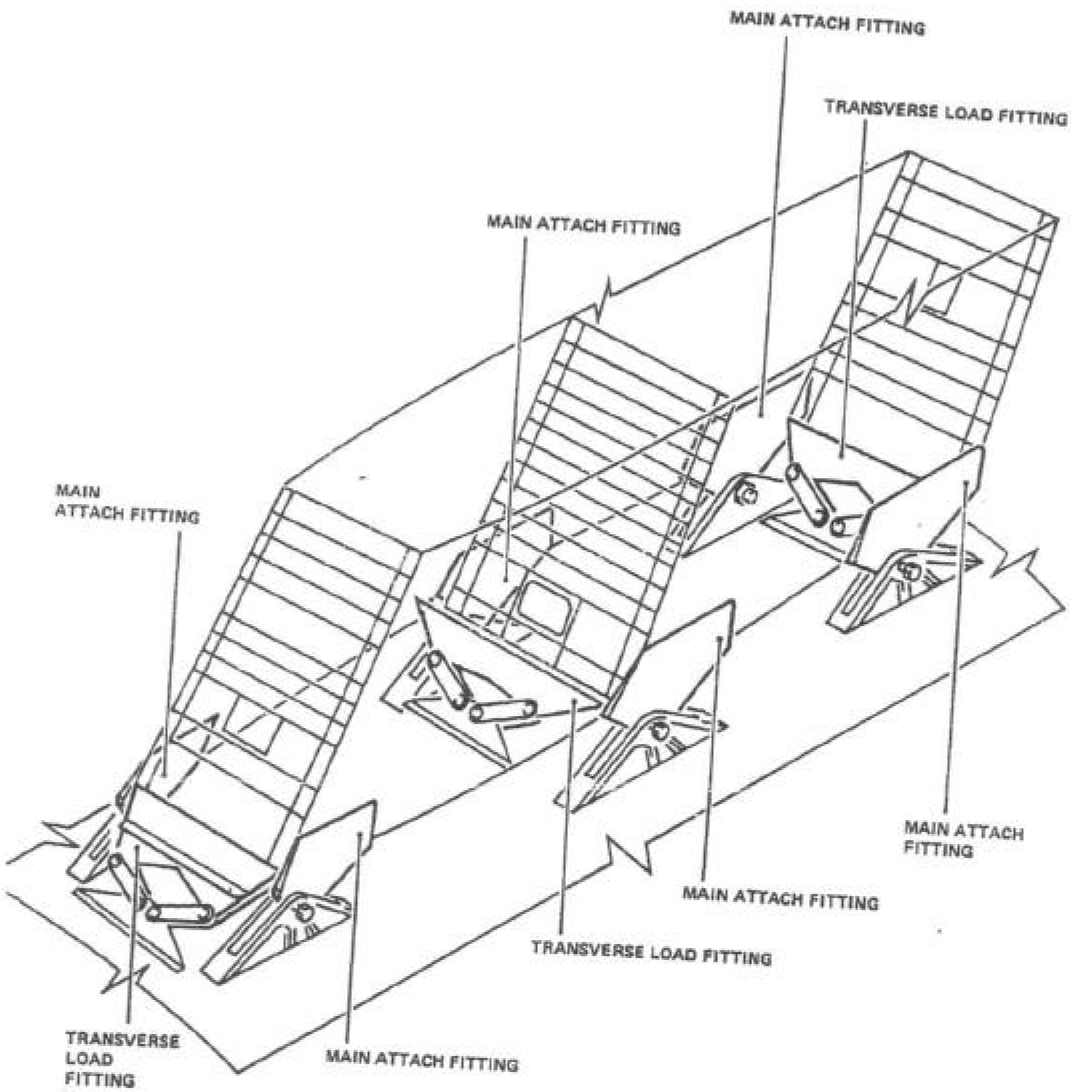

Figure 4

4.1.1 Load case L264

Reaction forces at main lugs

Load component	Front [N]		Center [N]		Rear [N]	
	LHS	RHS	LHS	RHS	LHS	RHS
F_x	71 284	-80 322	86 157	-88 191	146 507	-141 788
F_y	872	1 180	9 127	9 338	15 975	15 715
F_z	63 025	-74 193	178 279	-179 470	257 154	-241 351
F_{res}	95 154	109 351	198 216	200 186	296 391	280 359
M_x [Nm]	-527	-591	-2 001	-2 036	-3 161	-2 983
M_z [Nm]	17	-4	372	340	1 394	1 290
angle [°]	41	43	64	64	60	60

Reaction forces at lateral load yokes

Load component	Front [N]		Center [N]		Rear [N]	
	LHS	RHS	LHS	RHS	LHS	RHS
F_x	366	-409	209	-246	-4 204	4 401
F_y	-4 929	-5 505	-2 856	-3 369	34 541	36 162
F_z	417	-466	318	-375	-6 415	6 716
F_{res}	4 960	5 540	2 881	3 399	35 383	37 043

Figure 5

4.1.2 Load case L293

Reaction forces at main lugs

Load component	Front [N]		Center [N]		Rear [N]	
	LHS	RHS	LHS	RHS	LHS	RHS
F_x	-197 567	186 374	-181 140	180 842	-298 776	303 039
F_y	-8 334	-7 862	-25 857	-25 946	-33 907	-34 551
F_z	-235 674	223 400	-497 135	494 247	-618 701	637 490
F_{res}	307 643	291 040	529 739	526 932	687 901	706 697
M_x [Nm]	2 169	2 124	5 623	5 673	7 724	7 942
M_z [Nm]	-14	-57	-805	-753	-3 098	-3 059
angle [°]	50	50	70	70	64	65

Reaction forces at lateral load yokes

Load component	Front [N]		Center [N]		Rear [N]	
	LHS	RHS	LHS	RHS	LHS	RHS
Fx	696	-744	371	-336	7 533	-7 248
Fy	-9 369	-10 021	-5 068	-4 592	-61 893	-59 552
Fz	792	-847	565	-512	11 494	-11 060
Fres	9 428	10 084	5 113	4 632	63 400	61 002

Figure 6

5. Evaluation of results

The load level at the rear attachment lugs of the vertical stabilizer as a result of the cases L264 and L293 are calculated in relation to the sizing case (lateral gust load case as required by FAR25) (see figure 7).

Load case	Load level at rear lug (x L.L. of lateral gust A36RBI17 SD06)
L264	1.33
L293	1.53

Figure 7

6. Assessment for the finding on the RHS rear main lug

The finding (see figure 8) has been detected by ultrasonic inspection in a depth of 3 mm measured from the outer surface of the lug.

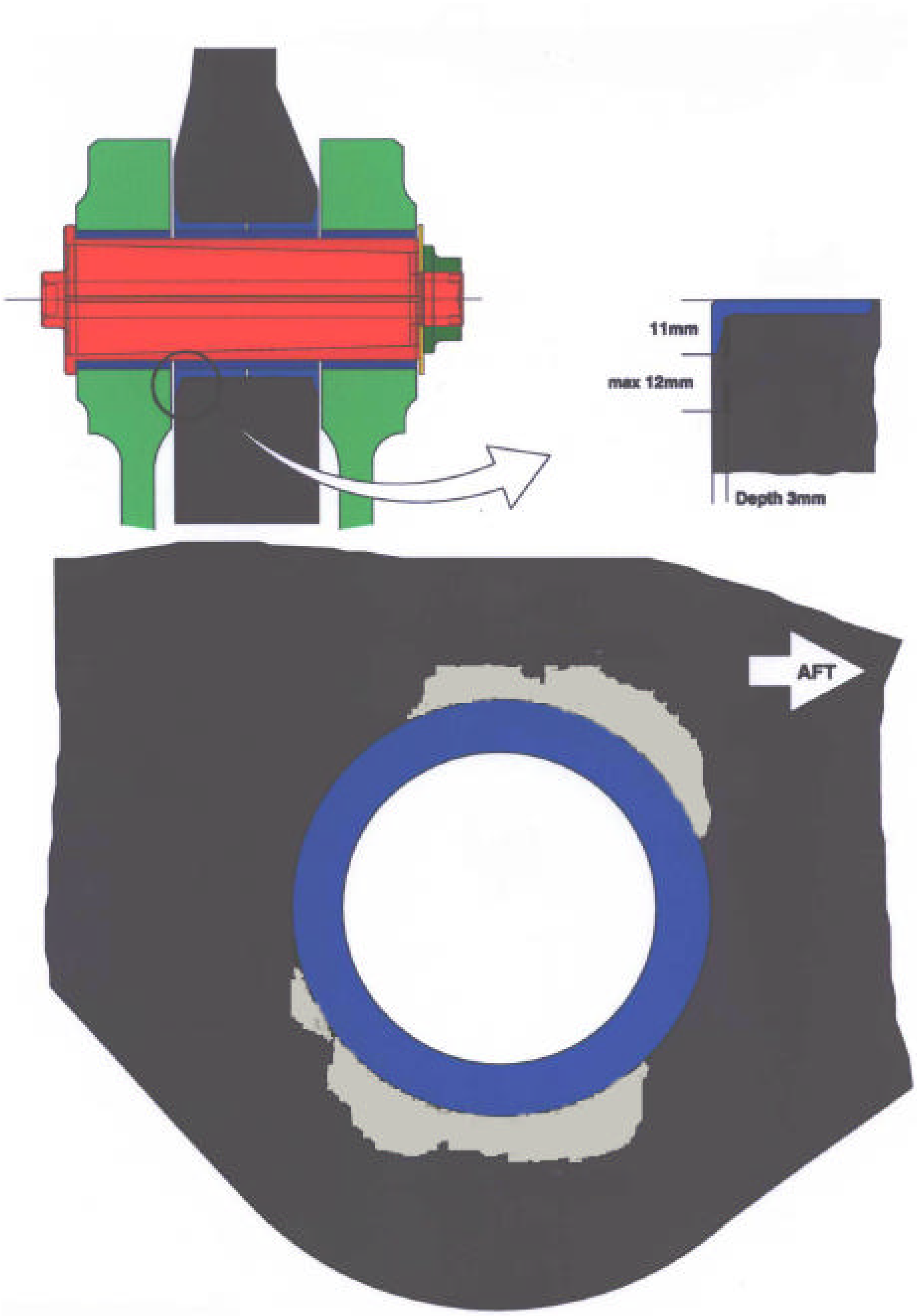

Figure 8

The effect on the strength of the lug is assessed by reducing the thickness of the lug by 3 mm. The strains caused by the local bending moment and the tension / compression forces are then increasing by 9.7% due to lower cross section and bending stiffness. The residual strength capability of the lug is 822.000 N (equal to 1.75 x L.L. for lateral gust case A36RBI17 SD06).

7. Summary

The loads of the vertical stabilizer attachments have been above ultimate load (1.53 x L.L.).

The residual strength of the RHS rear lug including the finding is significantly above ultimate load requirement (1.75 x L.L.).