NATIONAL TRANSPORTATION SAFETY BOARD
Office of Aviation Safety
Aviation Engineering Division
Washington, DC 20594

February 27, 2004

ADDENDUM NUMBER 1A TO THE STRUCTURES GROUP CHAIRMAN'S FACTUAL REPORT

DCA02MA001

A. ACCIDENT

Location: Belle Harbor, NY
Date: November 12, 2001
Time: 09:16:14 EST
Aircraft: American Airlines Flight 587, Airbus Model A300-605R, N14053
Manufactures Serial Number (MSN) 420

B. STRUCTURES GROUP

Chairman: Brian K Murphy
National Transportation Safety Board
Washington, DC

C. AIRBUS REPORT

1. AAL587 Investigation, A300-600R Fin Root CSF Diagram

AIRBUS

Technical Note

Report Nr.: TN – EGLG – A00ME0316813 issue 2

Title

AAL587 Investigation

A300-600R Fin Root CSF diagrams (Public docket version)

Date: 20.02.2004

Summary:

This memorandum gives an overview for the establishment and interpretation of the so-called **C**orrelated-**S**hear-**F**orces diagrams, used besides envelope values at a certain output station as additional more detailed information. Sometimes those diagrams are also called phase-plane diagrams. As an example the Fin Root station for the CFRP Vertical Tailplane of the A300-600R (common to A310-300) has been chosen.

Issue	Date	No. of page	Revised pages	Valid from/for
2	20.02.2004		1 TO 9 pages revised for public docket version	

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1. General

This memorandum gives an overview for the establishment and interpretation of the so-called **C**orrelated-**S**hear-**F**orces diagrams, used besides envelope values at a certain output station as additional more detailed information. Sometimes those diagrams are also called phase-plane diagrams. As an example the Fin Root station for the CFRP Vertical Tailplane of the A300-600R (common to A310-300) has been chosen.

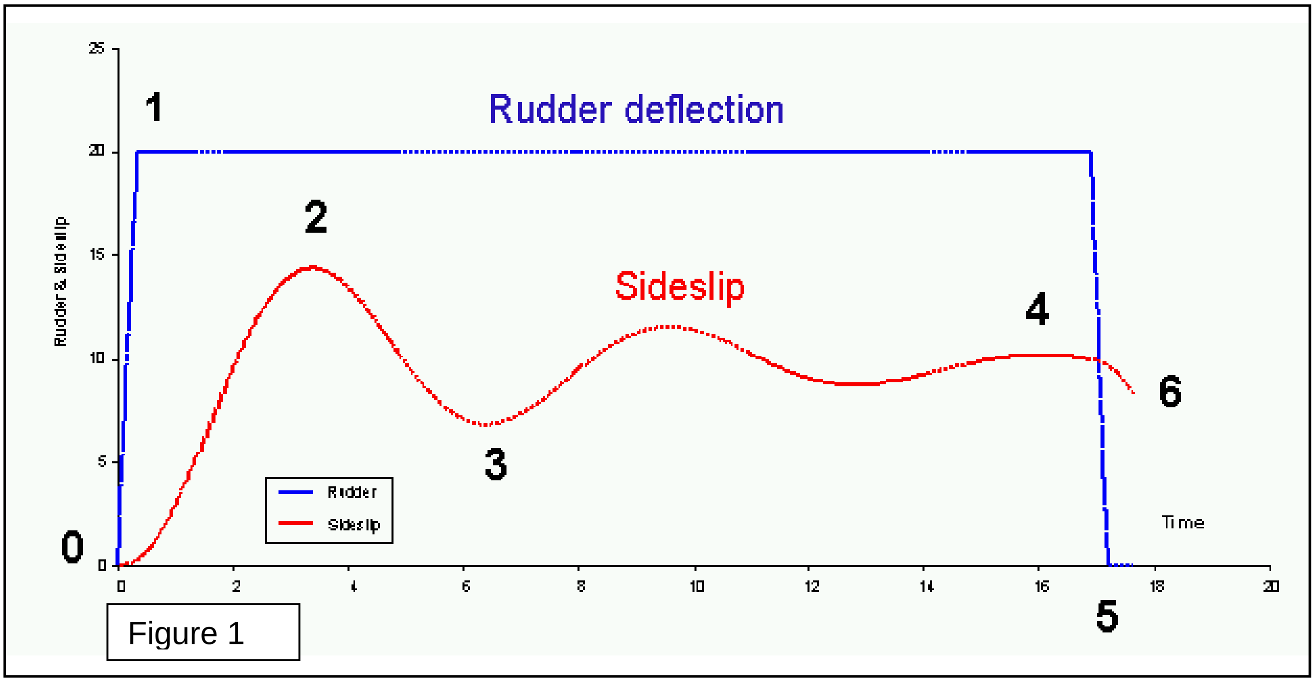
2. Principle

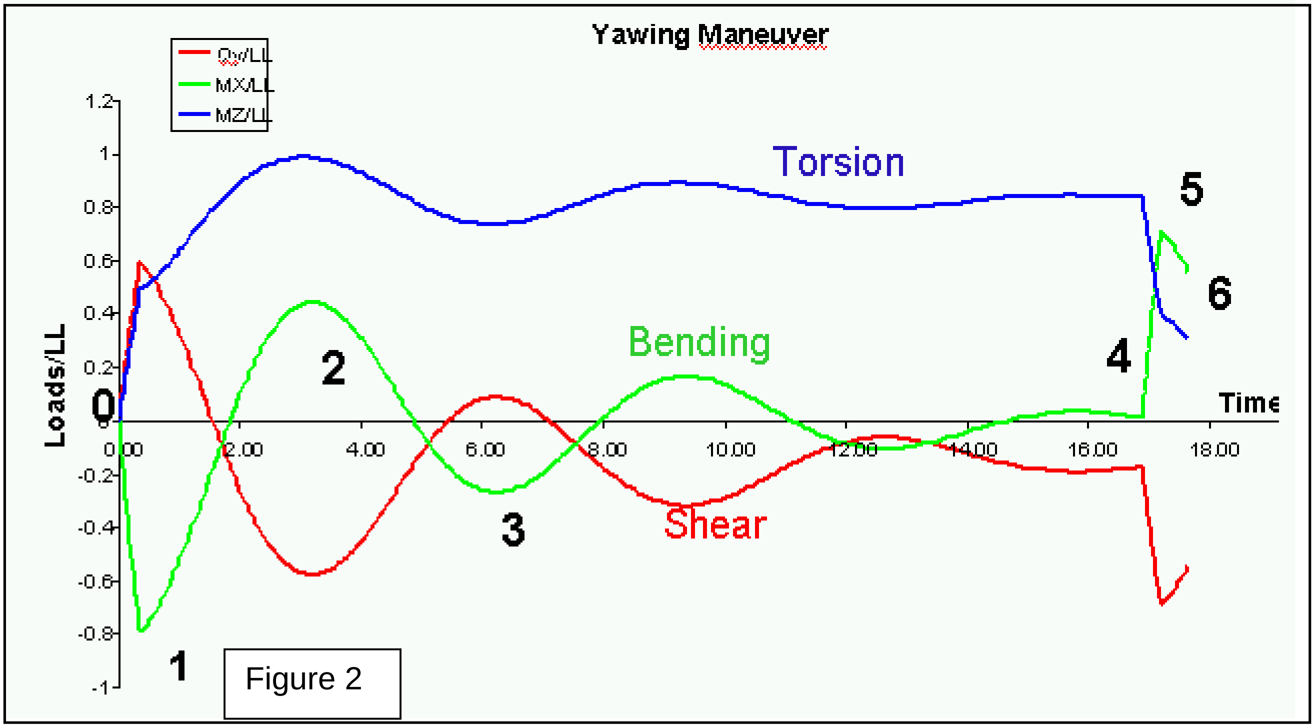
The general principle can be seen from figures 1-5, given below:

Figure 1 shows a typical time history of rudder deflection and associated resulting side-slip in case of a design yawing maneuver type calculation according to FAR25 §351.

Starting a time=0 (point 0) the rudder is deflected suddenly (but limited by control system characteristics) (point 1) associated to FAR25 §351(a). The maximum resulting sideslip conditions is achieved in point 2 as one condition as defined in FAR25 §351(b). Finally the steady sideslip condition as given in FAR25 §351(c) is defined by point 4, and the return of the rudder to neutral is reached at point 5. The other points are intermediate time-step for which the significance can be seen in the next figures.

Figure 2 represents the resulting shear, bending and torque values at the fin root for the above given kind of maneuver. It can be seen that high values of shear and bending are resulting in this calculation at points 1 and 5, whereas the maximum torque is achieved at point 2.


Rudder deflection
Sideslip
Rudder & Sideslip
Rudder
Sideslip
Time
0
1
2
3
4
5
6
Figure 1


Yawing Maneuver
Qy/LL
MX/LL
MZ/LL
Torsion
Bending
Shear
Loads/LL
Time
0
1
2
3
4
5
6
Figure 2

If the time-correlated values for two loads items are plotted now against each other in one diagram (as given in Figure 3 as an example for the Fin Root Torsion against Fin Root bending) it leads to a CSF-diagram for this case, whereby the time history can still be recognized.

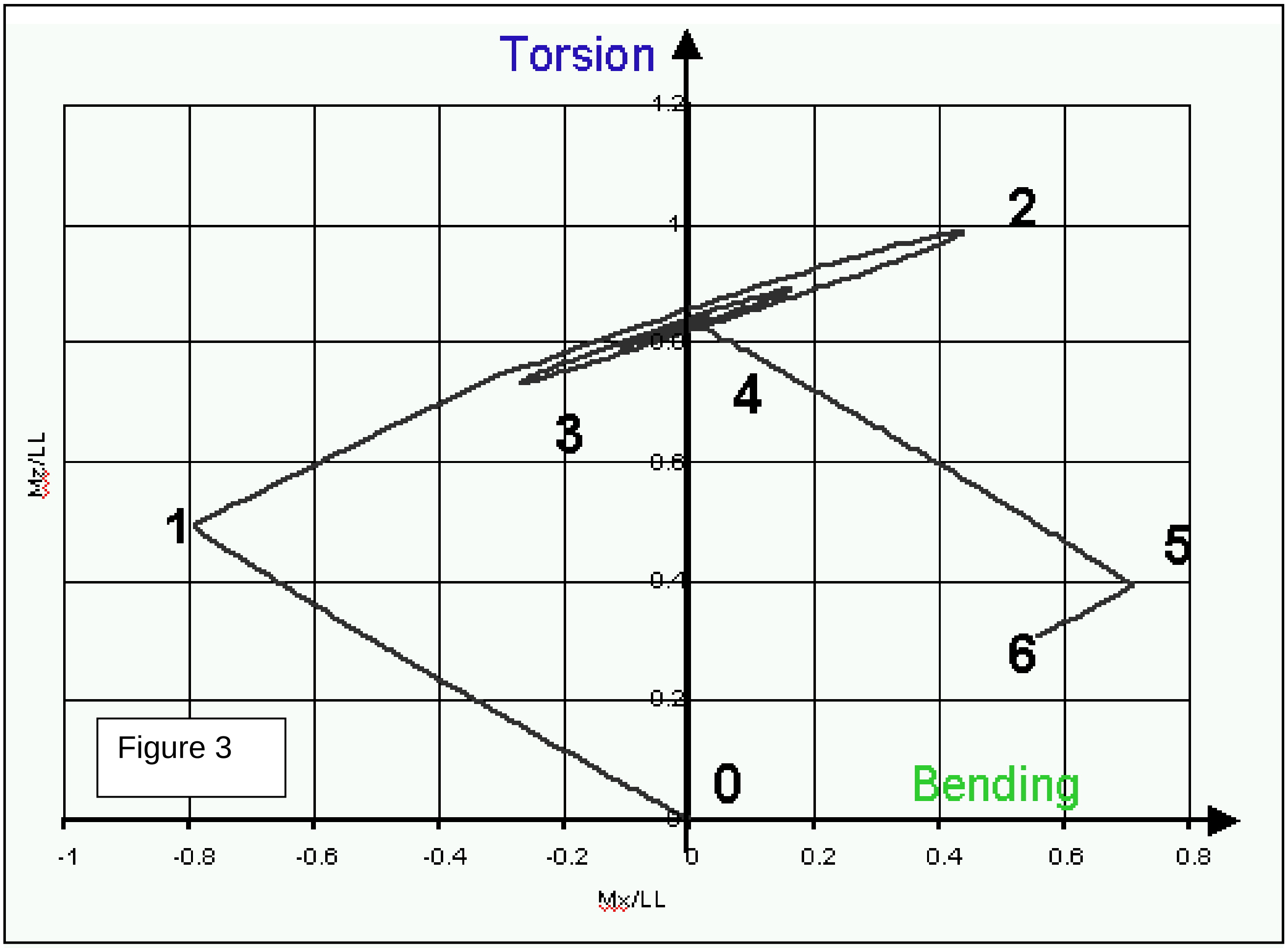


Figure 3

Points 1-6 are the same as in the figure before. Now the significance of all the points can be seen better than before. For simplification it is common engineering praxis to construct out of such information, which are available for a lot of loadcases a convex hull in the manner given in figure 4. It should be noticed, that in this example the convex hull is just constructed for a single loadcase, but this is just for simplification - the principle is the same also when more loadcases are involved.

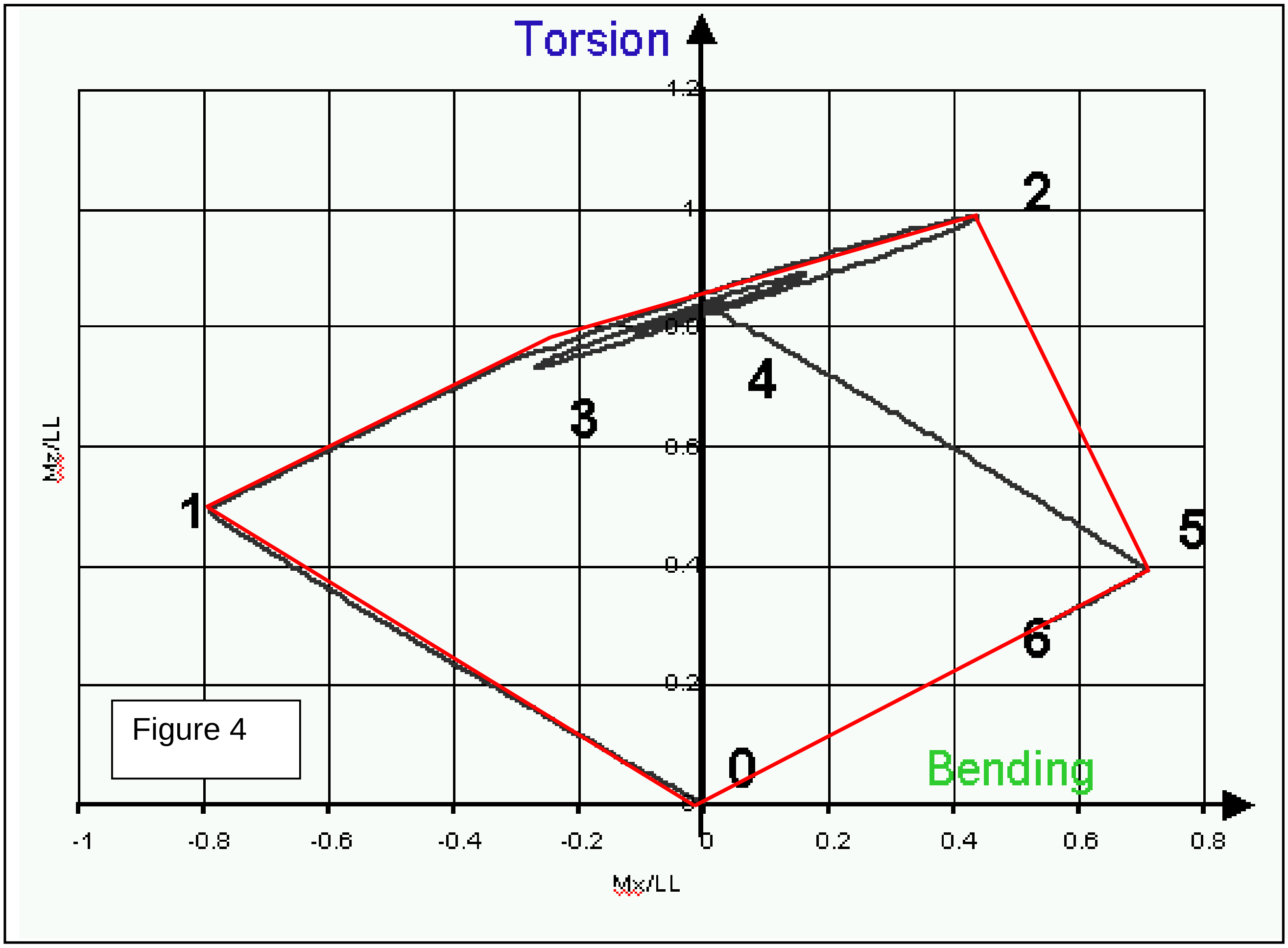


Figure 4

It can be seen, that there is a straight line connecting points 2 and 5, covering a triangle between the points 2,5 and 4, representing an area for which no direct loads results are available.

The same principle is applied also in cases in which a total CSF-diagram (convex hull about several conditions) should be established. As an example for the Fin Root the following correlation could be imagined: **Mz** vs. **Mx**
for

- Yawing maneuver
- One Engine Out maneuver
- Lateral Gust.

In principle a diagram as given in figure 5 (next page) will result from forming the convex hull (yellow line) about all the points given by calculation or by the points established by mirroring calculated points in order to cover as well right and left sided maneuver or gusts from left and right side. At the time of certification for A300-600R and A310-300 those detailed CSF-diagrams were established for yawing maneuver only. That means from the information available today only a few points for defining the One Engine Out and Lateral gust are available. Nevertheless the information can be used in order to extend the convex hull above the yawing maneuver curve.

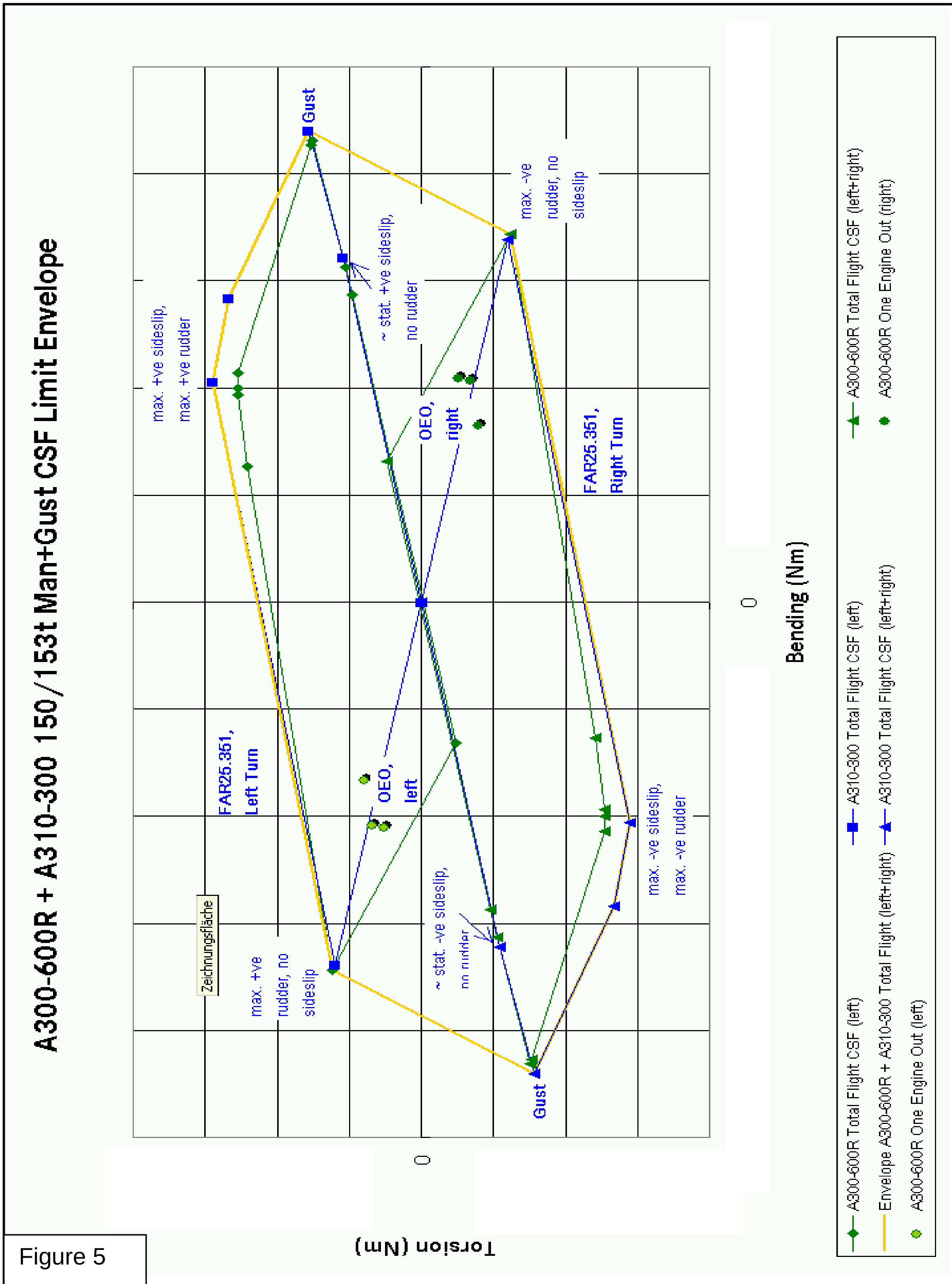

A300-600R + A310-300 150/153t Man+Gust CSF Limit Envelope
Gust
max. +ve sideslip,
max. +ve rudder
~ stat. +ve sideslip,
no rudder
max. -ve
rudder, no
sideslip
OEO,
right
FAR25.351,
Right Turn
FAR25.351,
Left Turn
OEO,
left
max. +ve
rudder, no
sideslip
~ stat. -ve sideslip,
no rudder
max. -ve sideslip,
max. -ve rudder
Zeichnungsfläche
0
Bending (Nm)
Torsion (Nm)
A300-600R Total Flight CSF (left)
A300-600R Total Flight CSF (left+right)
A310-300 Total Flight CSF (left)
Envelope A300-600R + A310-300 Total Flight (left+right)
A310-300 Total Flight CSF (left+right)
A300-600R One Engine Out (right)
A300-600R One Engine Out (left)

Figure 5

3. Summary

The process to establish so-called CSF-diagrams is explained by an example of the Fin Root station for the CFRP Vertical Tailplane of the A300-600R, which is common to that of the A310-300. The principle is always to construct a convex hull around points calculated. This common praxis in loads community is valid as well for a single loadcase as also in forming the total convex hull for all relevant flight-cases as shown in Figure 5.