Loads

- **LE5 - Flexibility**

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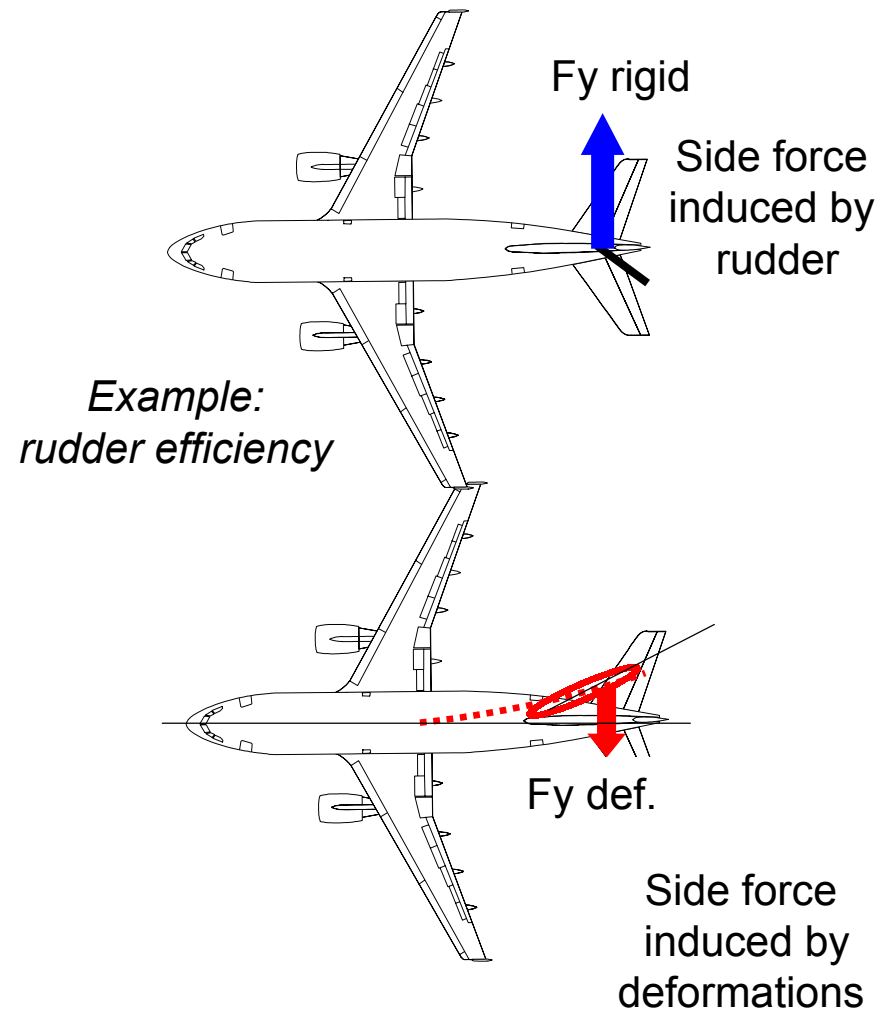# *Loads*

- **LE5 - Flexibility**

  - Large transport airplanes are not rigid, their structure is flexible.

  - Under aerodynamic forces, the airplane structure deforms.

  - These deformations develop themselves new aerodynamic forces which added to the primary aerodynamic forces.

  - This leads to a modification of:
    - the aerodynamic distribution along the airplane components,
   - the airplane aerodynamic derivatives.

Fy rigid

Side force induced by rudder

Example: rudder efficiency

Fy def.

Side force induced by deformations

Fy flexible= Fy rigid + Fy def.

Flexible factor= Fy flex / Fy rigid

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Loads

- **LE5 - Flexibility**

  - Elastic deformations:

    - Calculation of the elastic deformations of the vertical tail is performed by taking into account the fuselage stiffness, the vertical tail stiffness and the vertical tail-fuselage local attachment flexibility.

  - Aerodynamic derivatives

    - Aeroelastic effects are provided through corrective factors, called "flexible factors", to be applied to the "rigid" aerodynamic derivatives to obtain the flexible aerodynamic derivatives.

    - Those factors are dependant of flight conditions: the mach number and the dynamic pressure.

flexible factors - Mach=0.4

EGLC - 2002

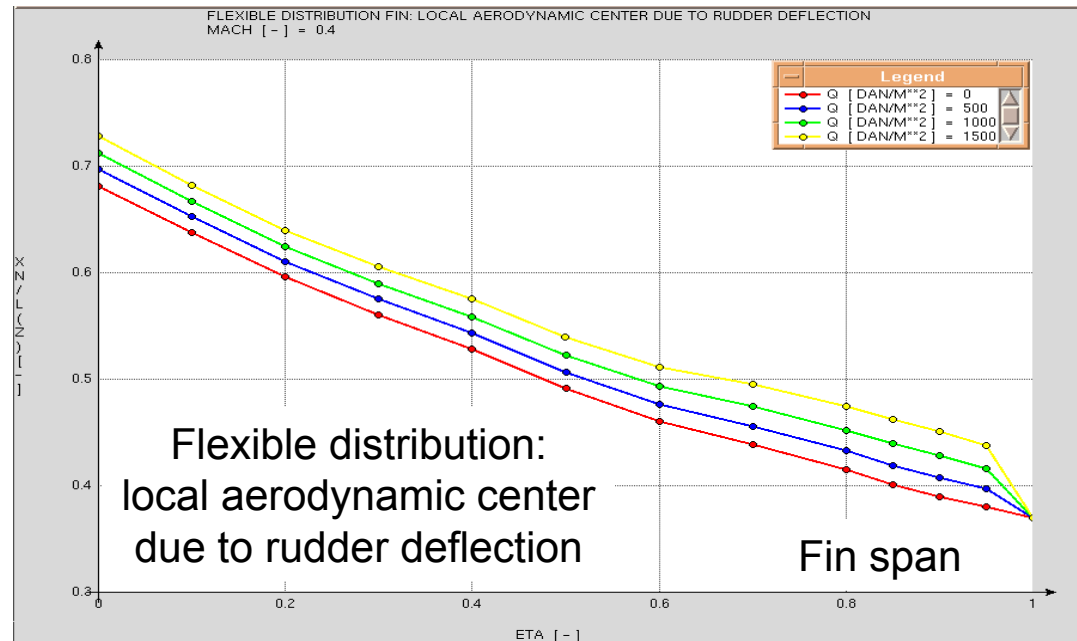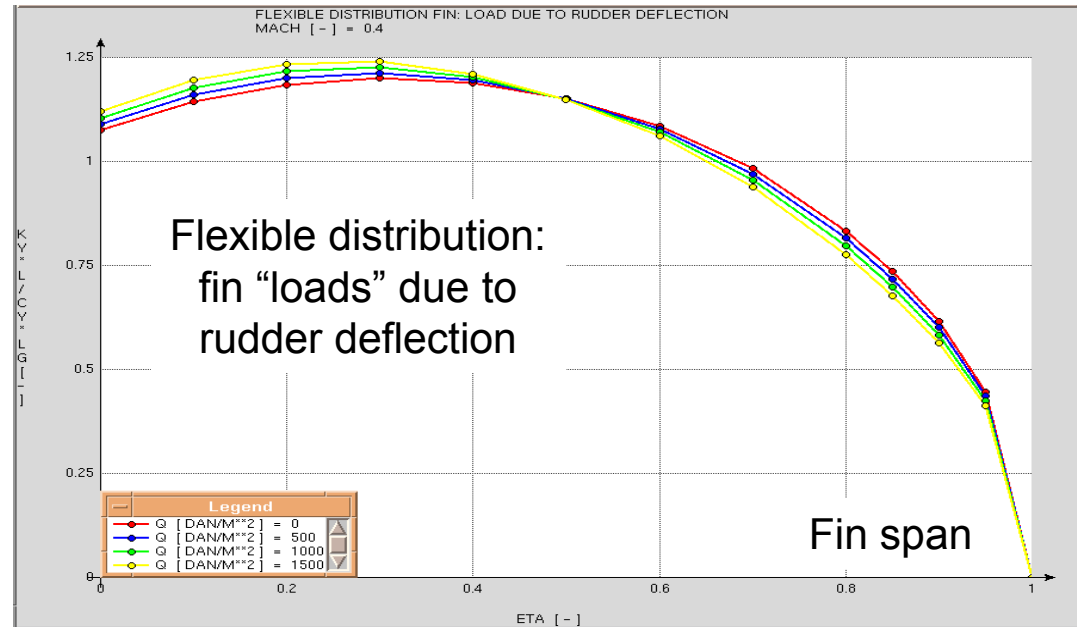*AIRBUS*
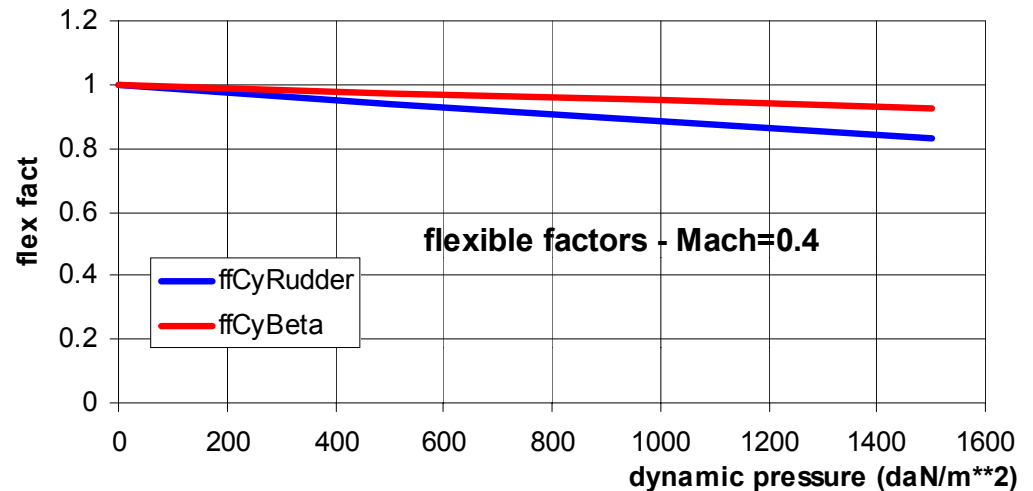
Loads

- **LE5 - Flexibility**
  - Flexible aerodynamic data distribution on vertical tail
    - The flexible aerodynamic data distribution are mach and dynamic pressure dependant
    - Example:
      - . flexibility effect linked with rudder deflection at mach=0.4
        - spanwise "loads" distribution
        - spanwise local aerodynamic center
        - distribution

FLEXIBLE DISTRIBUTION FIN: LOAD DUE TO RUDDER DEFLECTION
MACH [-] = 0.4

Flexible distribution: fin "loads" due to rudder deflection

Fin span

FLEXIBLE DISTRIBUTION FIN: LOCAL AERODYNAMIC CENTER DUE TO RUDDER DEFLECTION
MACH [-] = 0.4

Flexible distribution: local aerodynamic center due to rudder deflection

Fin span

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Loads

- **LE5 - Flexibility**
  - Influence of relative effect of vertical tail - fuselage deformations:
    - The flexible factors can be divided into two multiplicative parts:
      - . one containing the influence of the deformations of the vertical tail: **ffvt**
      - . one containing the influence of the fuselage deformations: **fffus**
      - . full flexible factor: **ff** = fffus*ffvt
    - Analysis of the above factors at Mach = 0.4 and a dynamic pressure = 1000 dan/m**2:

Input	ffvt	fffus	ff
Sideslip	0.971	0.97	0.942
Rudder deflection	0.919	0.97	0.891

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