NORDIC 2010 CONFERENCE

NAFEMS

IMPACT SIMULATION ON THE REAL PART OF AIRCRAFT STRUCTURES

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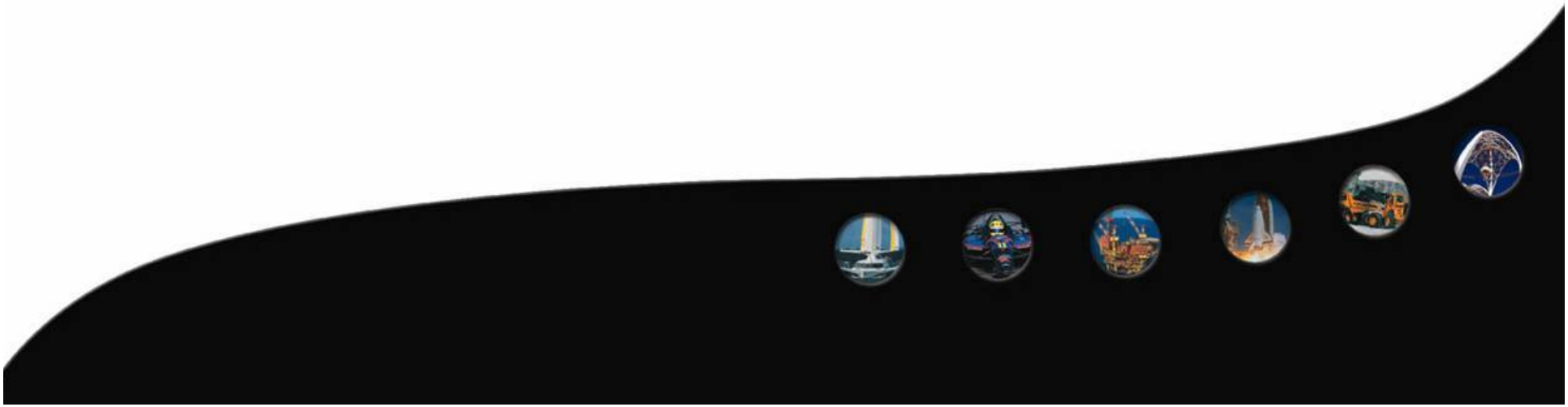
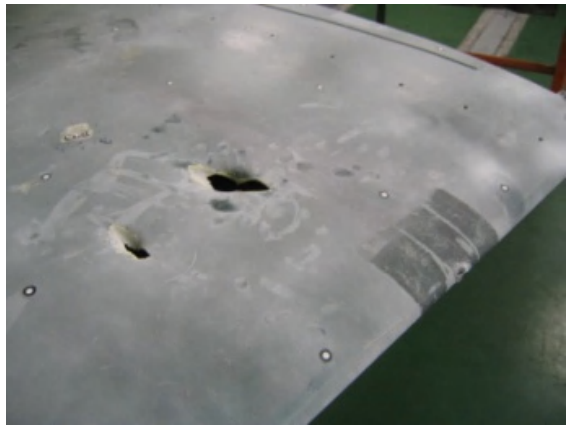


Aim: prediction of the impact behavior of hard and soft body immediately after the impact to part of aircraft structures.

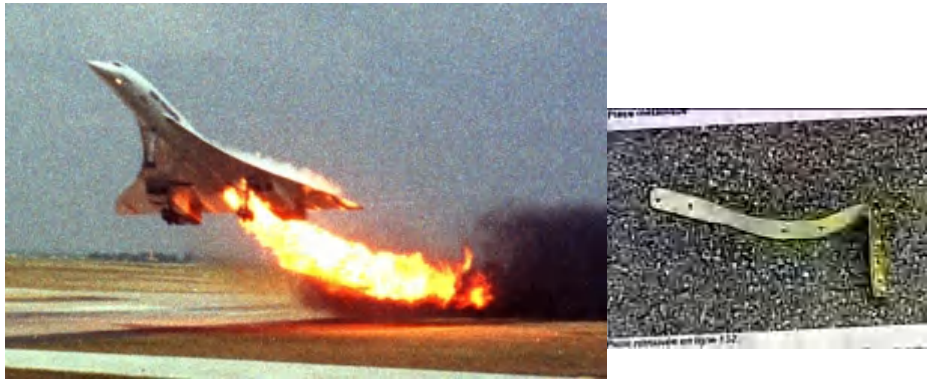
- Description of problem
- Projectile impact
  - Measurement
  - FE simulation
  - Comparison between measurement and FE simulation
- Bird strike
  - Measurement
  - FE simulation
  - Comparison between measurement and FE simulation
- Conclusions

Description of problem

In the service of an aircraft has been possibility risk of emergency cases from point of view unforeseeable circumstances (e.g. bird strike, sucked impurities to the engine etc.), or owing to human factor (e.g. projectile, missiles etc).



http://en.wikipedia.org/wiki/Bird_strike

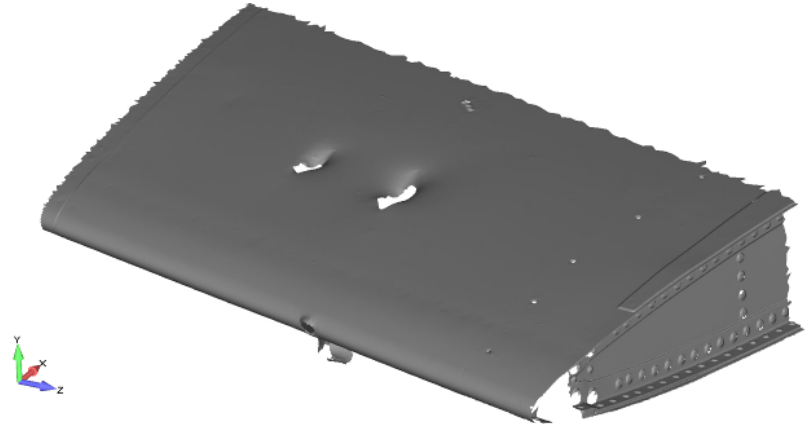


http://en.wikipedia.org/wiki/File:Air_France_Flight_4590.jpg

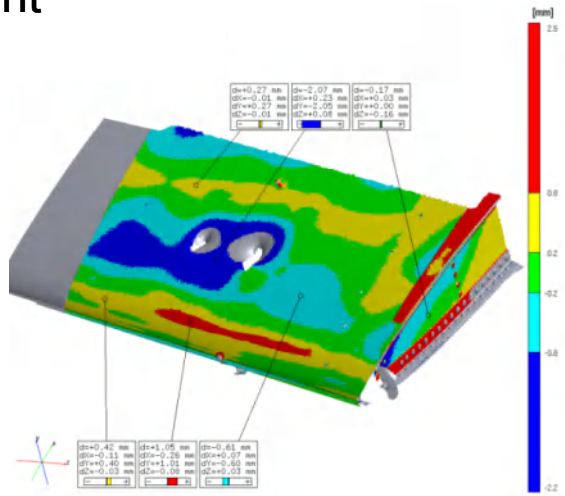
Projectile Impact

Aircraft surface scanning

ATOS measurement



Result of scanning



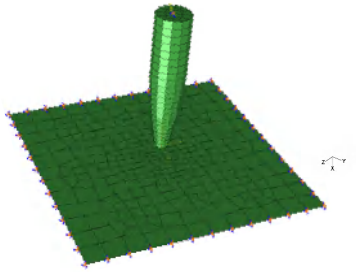
Comparison between real damage and non-damage (CAD) surface

Projectile Impact

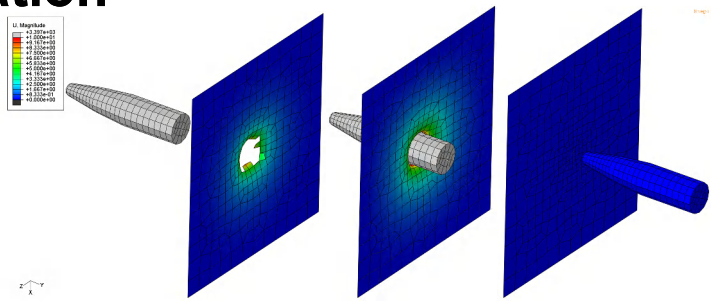
Numerical simulation

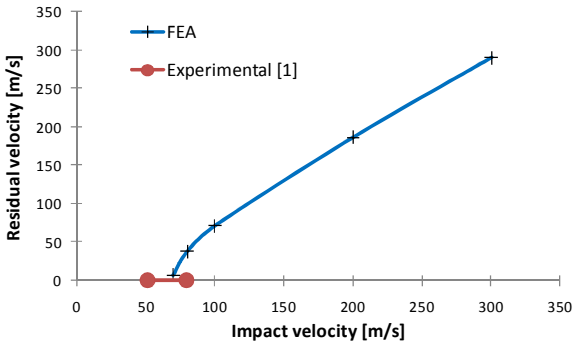
material:	2024-T3		
Elastic	E=	74000	MPa
	ν=	0,33	
	ρ=	2,77E-09	t/mm^3
Johnson-Cook constants	A=	368,9	MPa
	B=	683,9	MPa
	C=	0,0083	
	m=	1,7	
	n=	0,73	
Johnson-Cook failure	D_1=	0,112	
	D_2=	0,123	
	D_3=	1,5	
	D_4=	0,007	
	D_5=	0	

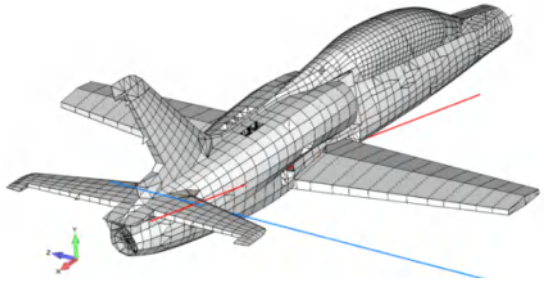
Model of real projectile

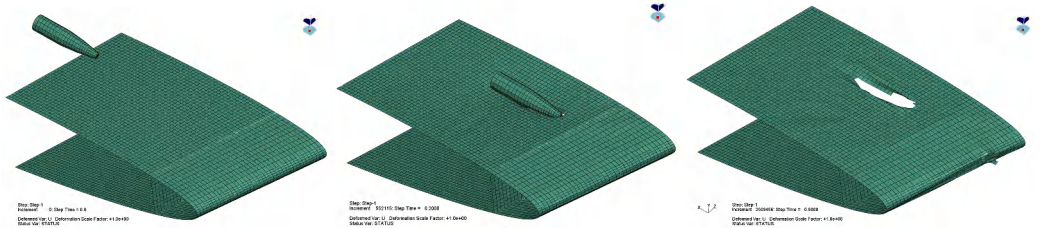


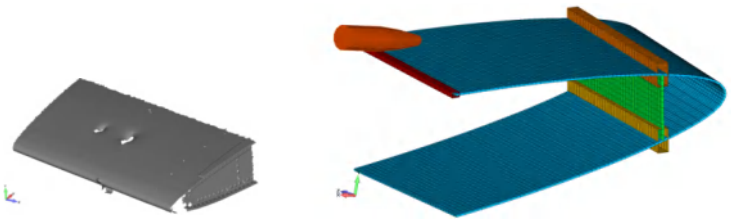
FE model

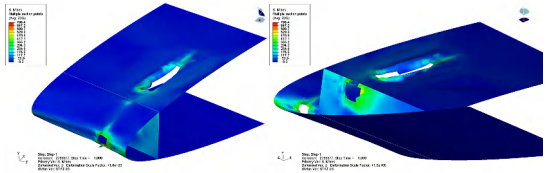




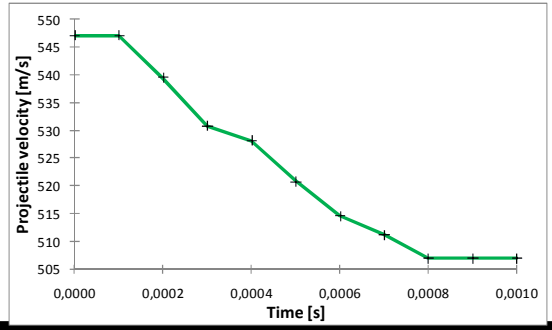








Results of FE simulation

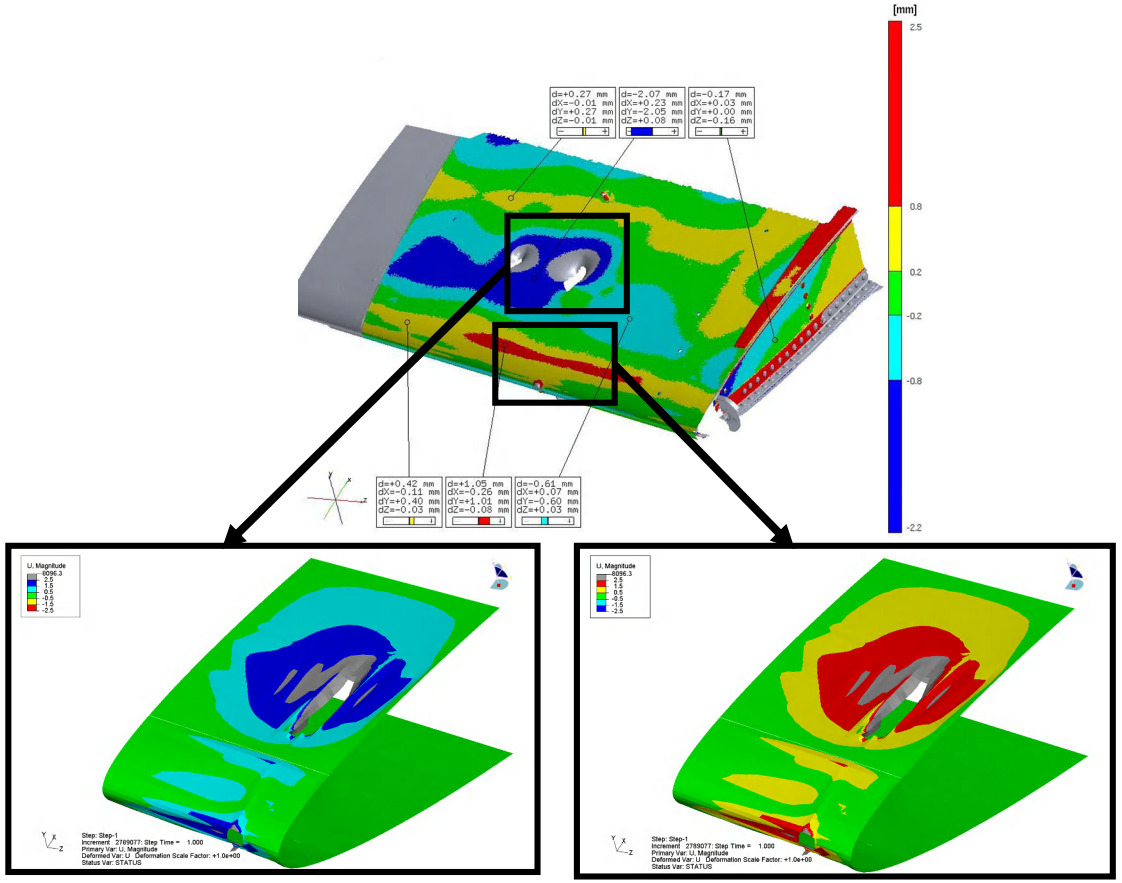


Projectile Impact

Comparison between measurement and FE simulation

Measurement

FE simulation

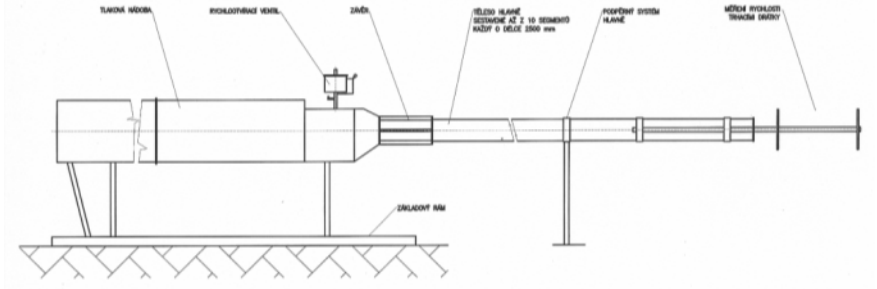


Skin results between ribs.

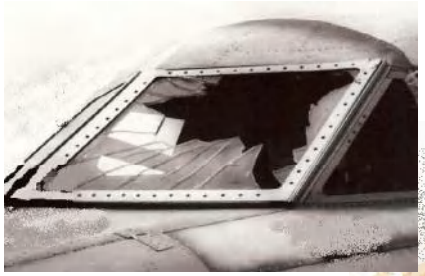
Leading edge results.

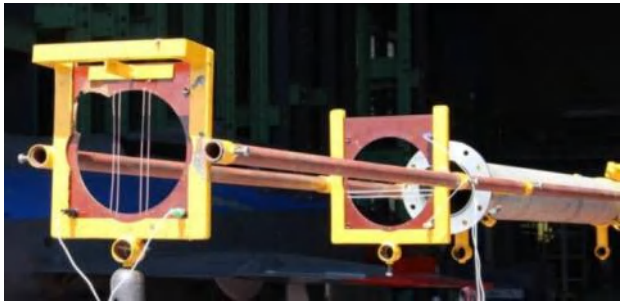
Bird strike

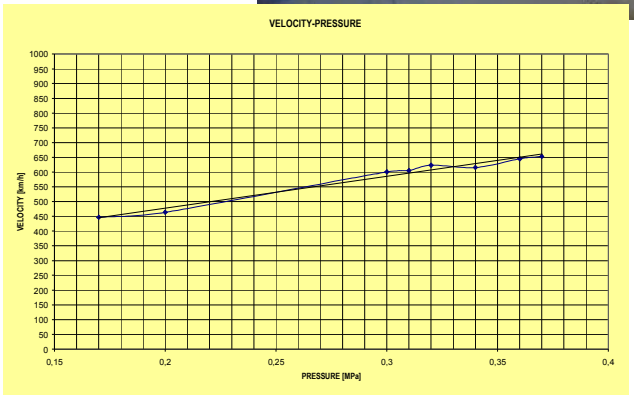
Test Method and Facility



Diametr of muzzle [mm]	length of muzzle [m]	weight of bird	velocity of bird [km/h]
125	25	2lb (0,91kg)	650
125	25	4lb (1,81kg)	450





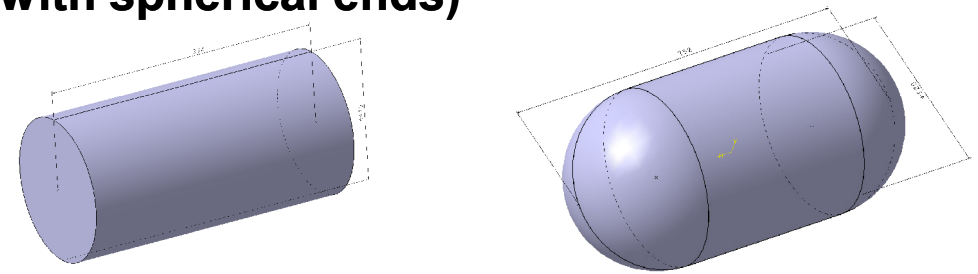


Bird strike

FE simulation

- **The ABAQUS/Explicit has been used for impact simulation onto the part of aircraft structure**

- **the bird for sharp parts such as pitot probe was modeled as a cylinder with refine mesh on the contact surface for point of view some numerical singularities elimination. For oblique parts has been used standard bird model (cylinder with spherical ends)**



- **In the simulation, the bird adopts an elastic-plastic model with shear and tensile failure**

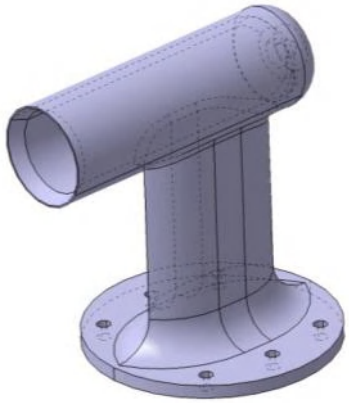
  *TENSILE FAILURE

  *SHEAR FAILURE

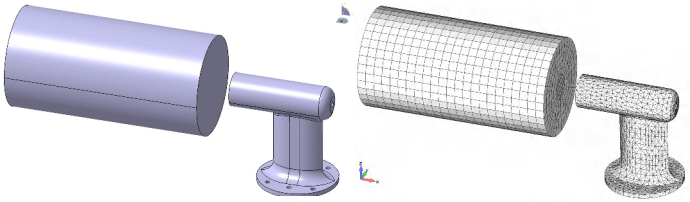
- **The bird nodes are charged with an initial velocity**

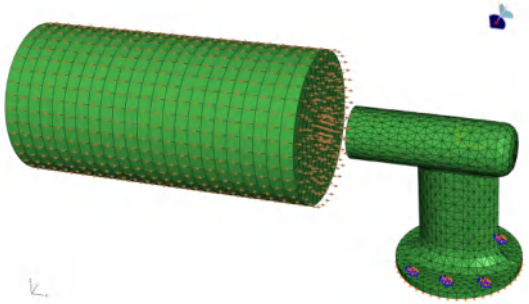
Bird strike

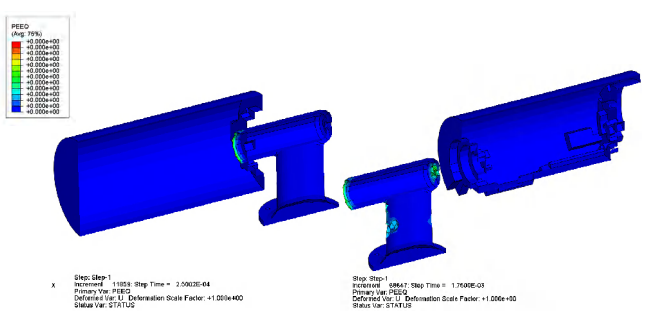
Pitot probe

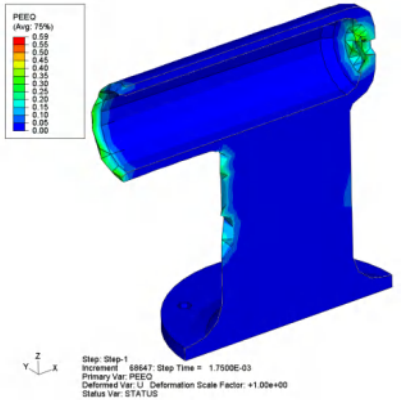


Bird mass =2lb (0,91kg)
Velocity = 180 m/s (648km/h)



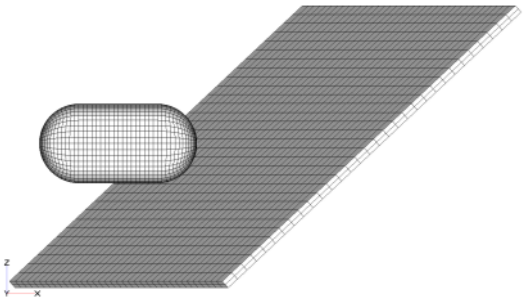


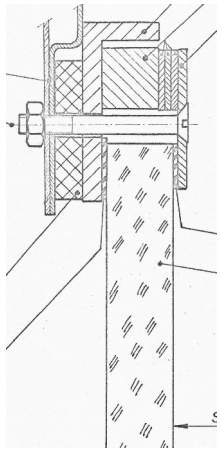




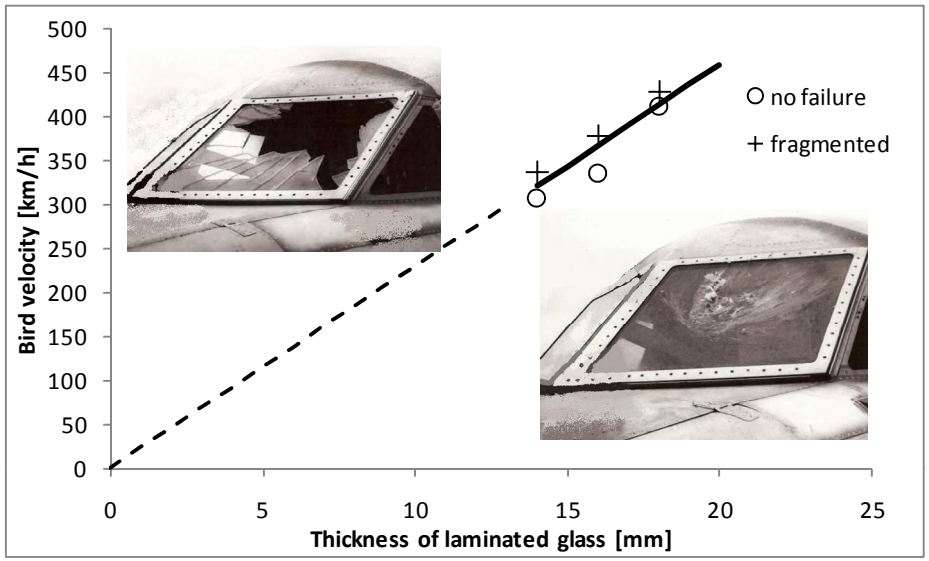
Bird strike

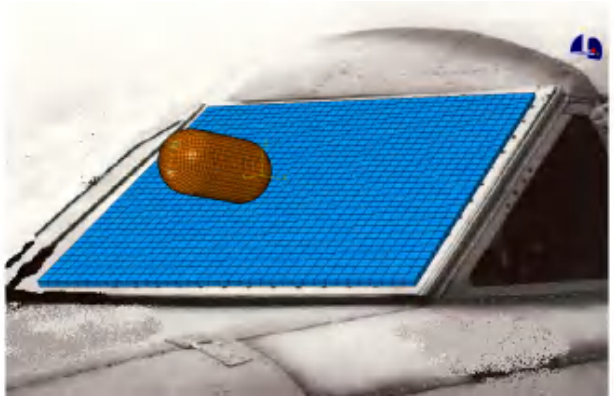
Windshield glass of civil aircraft

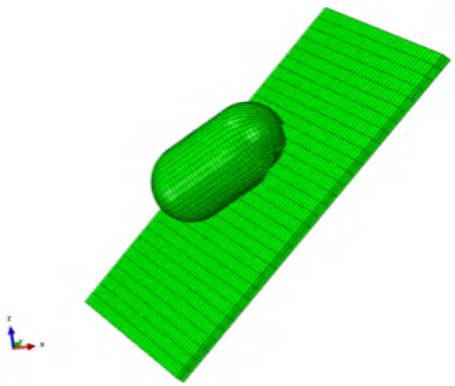


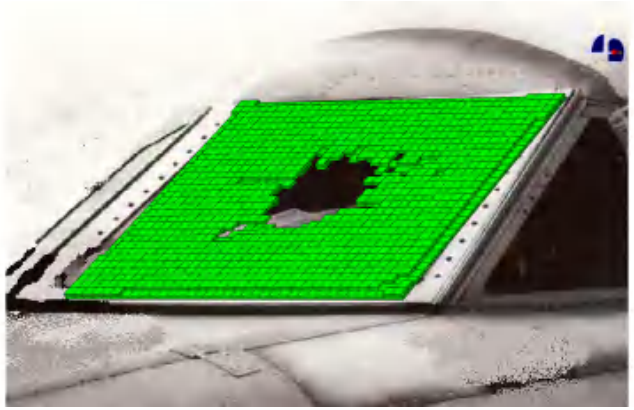


Bird mass = 4 lb (1,82 kg)
Velocity = 300 - 450 km/h

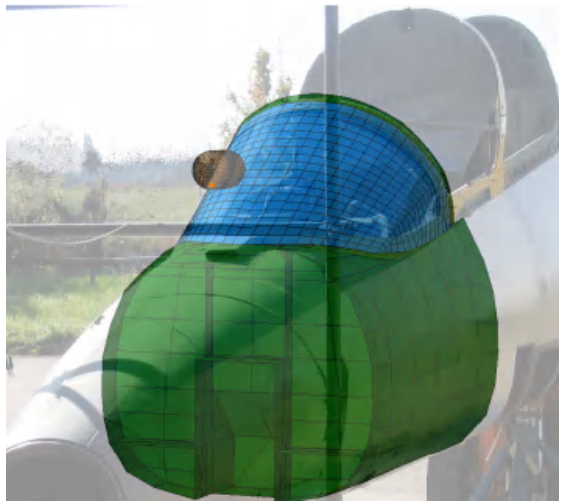








Bird strike
Windshield glass of military aircraft



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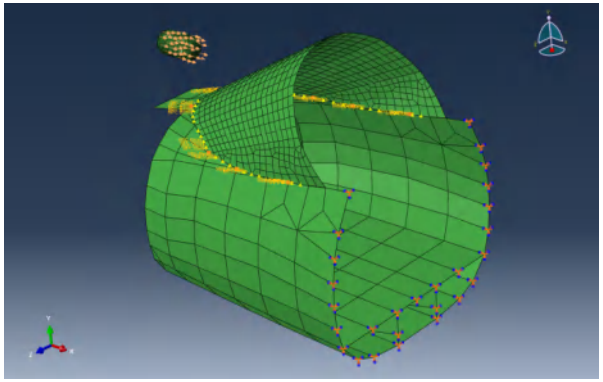
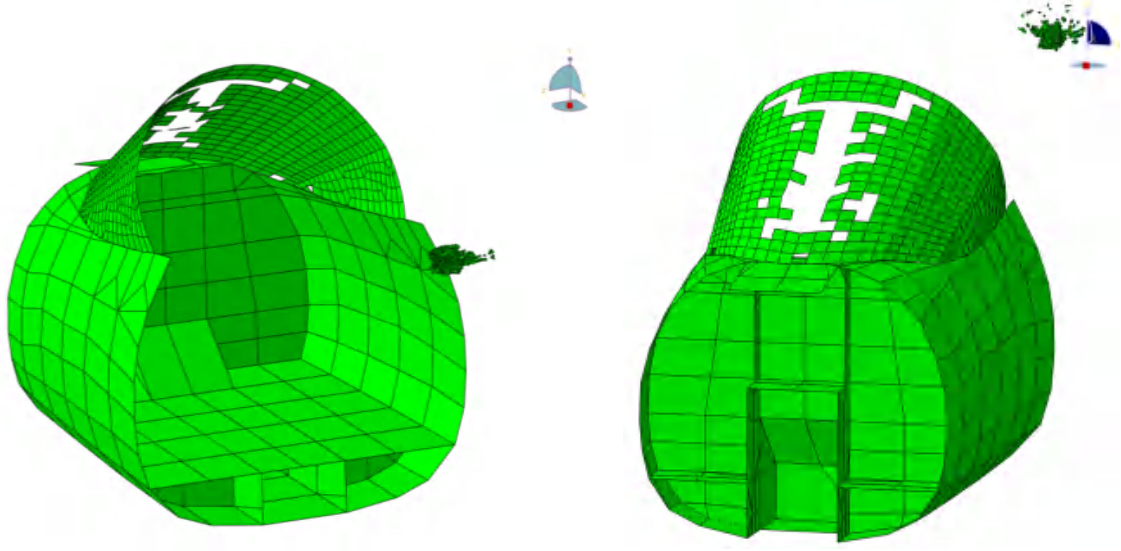
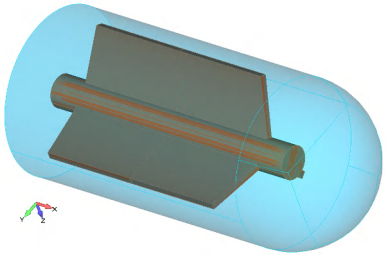
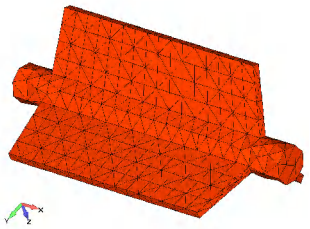
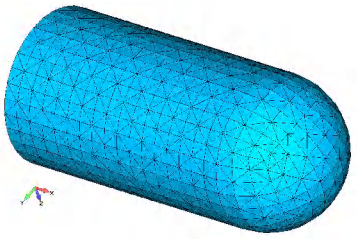




Future works

- development of the new synthetic model of bird with inner skeleton stiffness simulation



- simulations will be increased about CEL (Coupled Eulerian –Lagrangian) technique

- improve boundary conditions (frame, gasket etc.)

- improve material properties

Conclusions

The result shows good agreement between measurement and FE calculation. Although this work is only a first approximation, and implemented in relatively simplified terms, this method of finding damage propagation is applicable for:

- diagnostics of airframe damage - scanning of aircraft surface, photogrammetric system application etc.
- application for structure repair evaluation – damage of inner structure, composite path application etc.
- service operations – visual inspection
- performance of airworthiness from point of view bird strike


Thank you for your attention