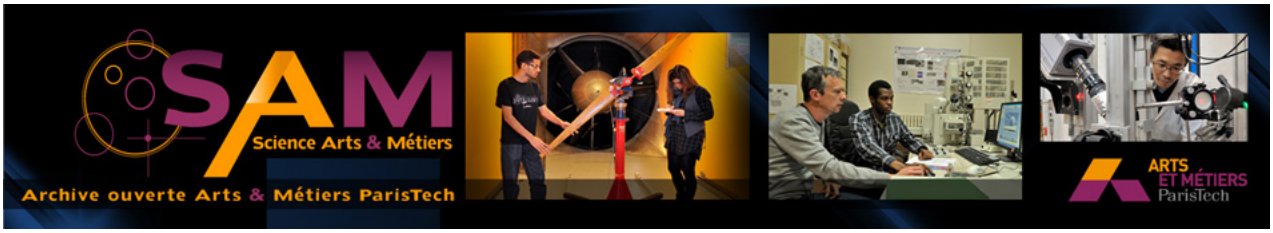

Numerical simulation of peen forming induced deformations: modeling and experimental validation

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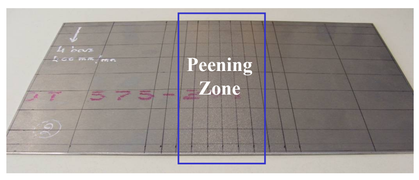
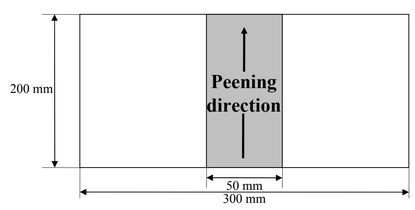
CONTEXT

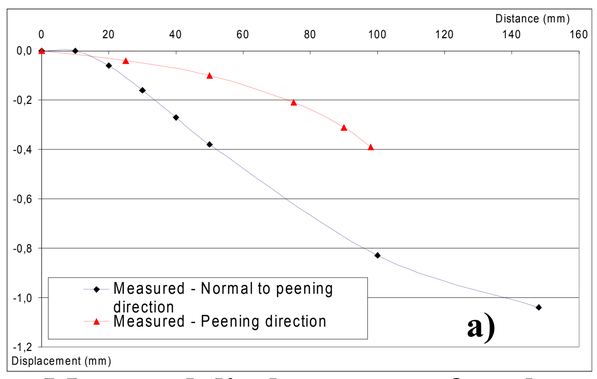
- *Experimental and numerical study of the peen forming process:* ***study of the deformation mechanisms involved in shot-peening****.*
- *The scope of the work is to identify data that permit to* ***simulate the peen forming*** *process.*
- *The choice of* ***plastic strains as process data*** *is made. The plastic strains induced by the impacts are identified on simple cases and then numerically introduced in a Finite Element program to predict the deformation of more complex parts.*

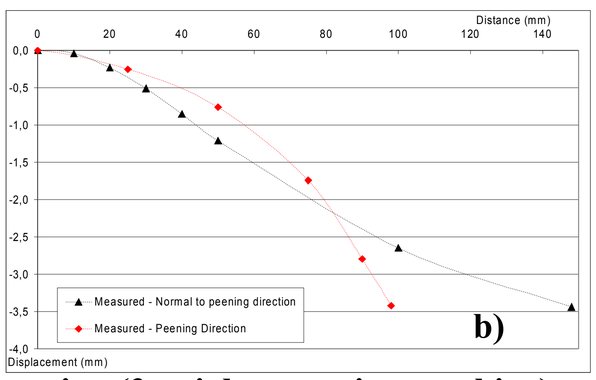
EXPERIMENTAL CASES

Partially shot-peened aluminum 2024T3 alloy plates





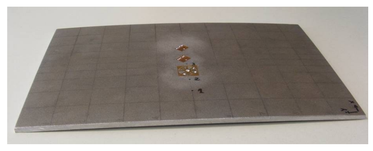


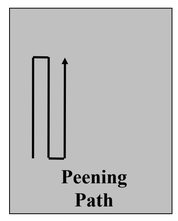


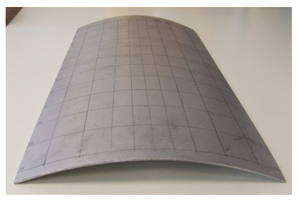
Measured displacements after shot-peening (3-axial measuring machine)

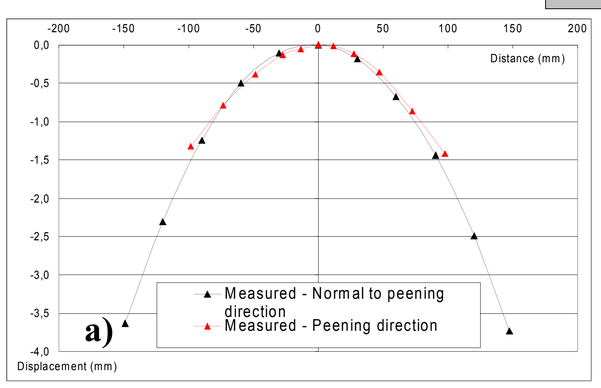
a) 5 mm thick specimen b) 2 mm thick specimen

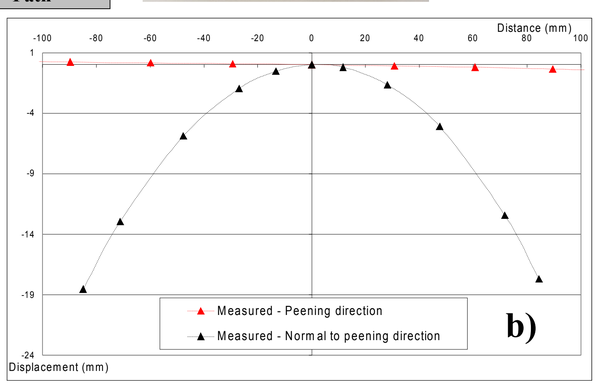
Totally shot-peened aluminum 2024T3 alloy plates











Measured displacements after shot-peening (3-axial measuring machine)

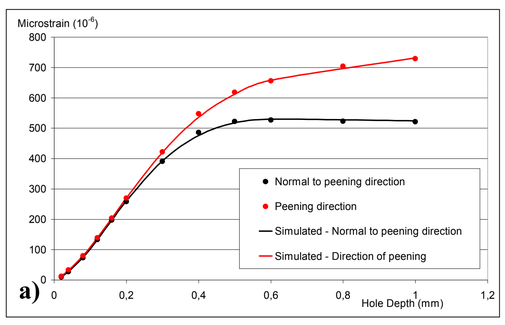
a) 5 mm thick specimen b) 2 mm thick specimen

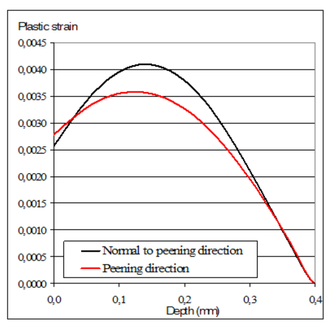
- *No influence of the peening path on global deformations for relatively thick specimens.*
- *Huge influence of the peening path on global deformations for thin specimens (cylindrical form depending on peening direction).*

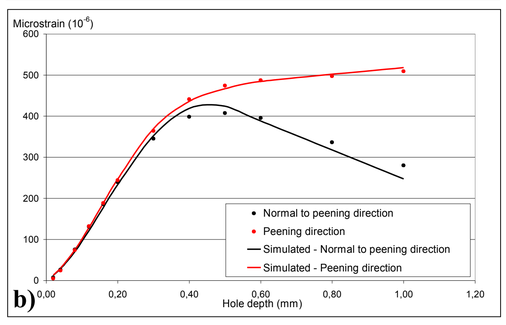
NUMERICAL SIMULATION

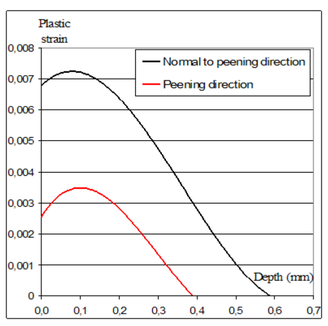
Incremental Hole Drilling results

- Classical method using strain gages.
- Model based on eigenstrains theories. Elastic FE problem with initial strains.
- Numerical model coupled to optimization program to identify plastic strains.
- Plates supposed to be free of external constraints during drilling.









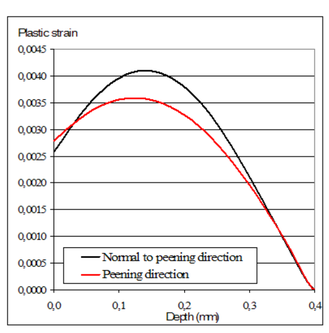
Numerical results – Partially shot-peened plates

a) 5 mm thick specimen b) 2 mm thick specimen

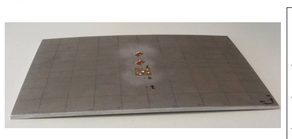
- **Nearly equi-biaxial plastic strain field** identified in **5 mm thick specimen**.
- **Plasticity oriented in the normal to peening direction** in **2 mm thick specimen**.
- **Non realistic modeling of the boundary conditions** of the **2 mm thick specimen**: measured microstrains evolution do not correspond to the theoretical one.

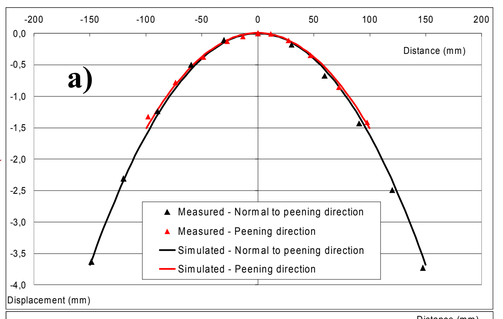
Application to peen forming simulation

- Identified plastic strains as process data.
- Simulation of the shot-peening of the same materials, with the same process parameters.

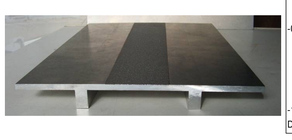


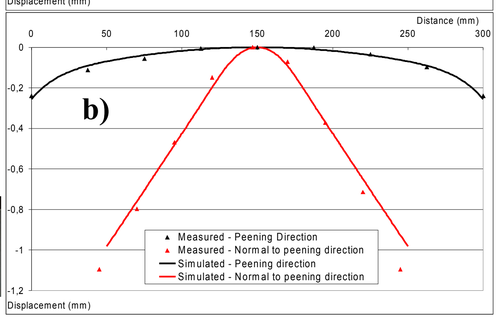
Finite Element calculation





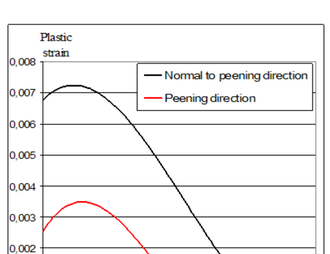
Finite Element calculation



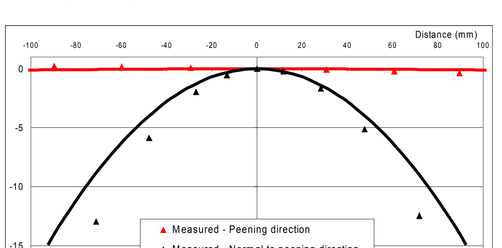


Numerical results – 5 mm thick specimens

a) totally shot-peened plate b) stiffened panel



Finite Element calculation



Numerical results – 2mm thick totally shot-peened plate

CONCLUSION

- Measurements show the influence of the shot-peening path on the global deformations.
  - Negligible for relatively thick specimens.
  - Appreciable for relatively thin specimens.
- Peen forming simulation gives good results for these first application cases.

FURTHER WORK

- Investigation of the deformation mechanisms of thin metallic parts.
  - To give a better understanding of the influence of the shot-peening path.
- Application to more complex geometries.
  - To fit the industrial needs (large aeronautical stiffened panels).

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