Square Grid Analysis for Intraply Shear in Thermoformed Thermoplastic Composites

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Abstract

A Square Grid Analysis (SGA) measurement system has been developed in order to study intraply shear deformation in thermoformed thermoplastic composite parts. The system allows the user to take two or more pictures, calibrates the camera and performs a 3D geometry reconstruction of the region of interest using perspective projections. The software integrates the drapability calculations and allows an automatic comparison between the experimental tests and the simulation tools. In addition, the software is used to study the behavior of foils for diaphragm forming process.

1 Thermoforming

Thermoplastic composites can be used to quickly produce parts using thermoforming techniques during which a laminate is heated and deformed into a mold. Here, the intraply shear is the most important deformation mechanism involved.

Excessive shearing angles imply manufacturing difficulties, and the fibers may not keep the desired orientations.

The study of intraply shearing is therefore necessary to reduce the cost of development associated with the trial-and-error approach commonly used.

2 Square Grid

The classical SGA used in metal forming for surface strain measurements uses an array attached to the sample prior to the forming. Afterwards, the user selects a region of interest and analyze that deformed pattern.

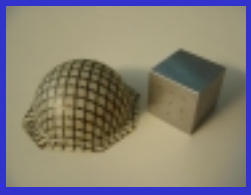
The attachment of an array to composite thermoplastics is not a feasible approach because the matrix is melted during the thermoforming and the pattern would be distorted.

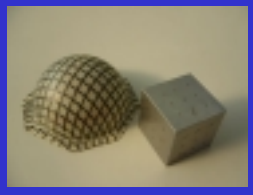
Hence, an **SGA tool for thermoplastic composites** was developed using two kinds of fibers (carbon and glass) that are incorporated in the fabric style.

For **high temperature diaphragm foils**, special inks are used in order to warranty their geometrical stability and adherence to the foil.

3 The Pictures

At least two pictures of the same object are taken from 2 different perspective views including a target. The acquisition is performed via *firewire* or *USB* port.

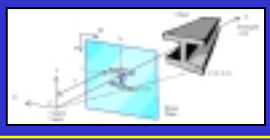


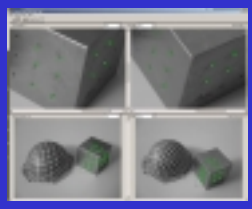


Since the image noise and the light affect the results of analysis; the picture is processed to improve its quality.

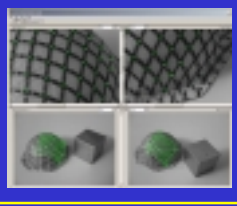
4 Calibration

The relationship between the global and the pixel coordinate systems is obtained by calibrating the camera using perspective projection geometry and the known target.





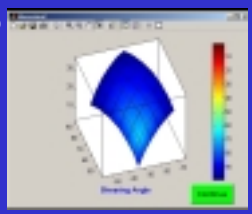
5 3D Reconstruction



Then, the user selects some points of interest and their global coordinates are computed. With these information, a 3D stereo reconstruction is performed and the shearing angles calculated.

6 Postprocessing

Finally, a matching process is done to couple the reconstructed region and the drapability simulation obtained with Drape.



7 Conclusions

- A computer-based measurement method has been developed using the SGA technique in order to evaluate the intraply shear deformation of thermoformed thermoplastic composites.
- The SGA software helps the designer in the identification of critical deformation areas and reduces considerably the time required to evaluate a thermoformed component.
- The tool can be integrated easily in a concurrent manufacturing and design environment for composite materials and it allows a quick verification of numerical calculations.

References

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