Application of Abaqus and Isight simulation on corrugated board and packaging

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***Abstract**: The presentation is about the application and impact of Abaqus and iSight simulations for corrugated board and packaging within Smurfit Kappa. Abaqus and Isightare used for the development of the prediction formulas, used in our prediction tool PaperToBox. PaperToBox is considered as industry leading. This tool is internally used by 1800 colleagues, resulting in >500 000 calculations per year. Also this tool provides the target values for the newly rolled-out quality measurement system, the "Board Referee".*

Smurfit Kappa is one of the leading providers of paper-based packaging solutions in the world, with around 42,000 employees in approximately 350 production sites across 32 countries and with revenue of €8.1 billion in 2014. We are located in 21 countries in Europe, and 11 in the Americas. We are the only large-scale pan-regional player in Latin America. With our pro-active team we relentlessly use our extensive experience and expertise, supported by our scale, to open up opportunities for our customers. We collaborate with forward thinking customers by sharing superior product knowledge, market understanding and insights in packaging trends to ensure business success in their markets. We have an unrivalled portfolio of paper-packaging solutions, which is constantly updated with our market-leading innovations. This is enhanced through the benefits of our integration, with optimal paper design, logistics, timeliness of service, and our packaging plants sourcing most of their raw materials from our own paper mills. Our products, which are 100% renewable and produced sustainably, improve the environmental footprint of our customers. Our headquarters are in Dublin with regional headquarters in Paris (Europe) and Miami (the Americas).

***Keywords**: Corrugated Board, Bending strength, Design Of Experiments, Response Surface Creation*

1. Introduction

The presentation is about the application and impact of Abaqus and iSight simulations for corrugated board and packaging within Smurfit Kappa.

The shown example is the use of Abaqus and Isight for the development of the prediction formulas, used in our prediction tool PaperToBox. PaperToBox is considered as industry leading. This tool is internally used by 1800 colleagues, resulting in >500 000 calculations per year. Also this tool provides the target values for the newly rolled-out quality measurement system, the "Board Referee".

2. Formula development for PaperToBox

The first example is the use of Abaqus and Isight for the development of the prediction formulas, used in our prediction tool PaperToBox. PaperToBox is considered as industry leading. This tool is internally used by >1800 colleagues, resulting in >500 000 calculations per year. Also this tool provides the target values for the newly rolled-out quality measurement system, the "Board Referee", which measures the bending strength of corrugated board.

2.1 Work flow

The complete work flow is starting with the FEA model and ends with business application, see picture 1.

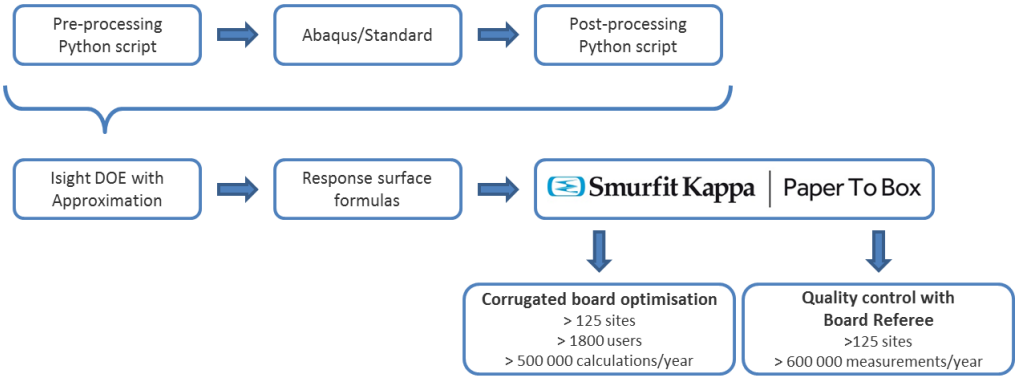

Figure 1. Work flow from FEA to the business.

2.2 Pre-processing and post-processing with Python

The use of Isight requires fully parametric FEA models. Using Python scripts for pre-processing and post-processing is needed, because the whole geometry of the corrugated board is dependent on complex formulas. Abaqus/CAE is used as the pre- and post-processor.

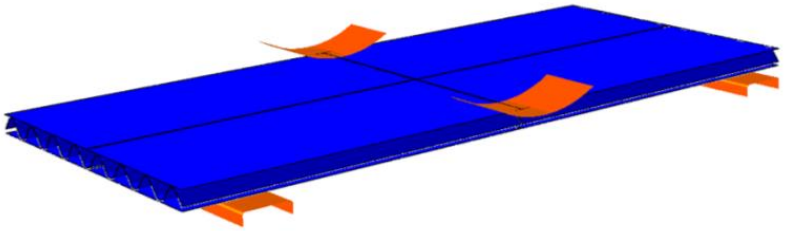

Figure 2. Bending strength model.

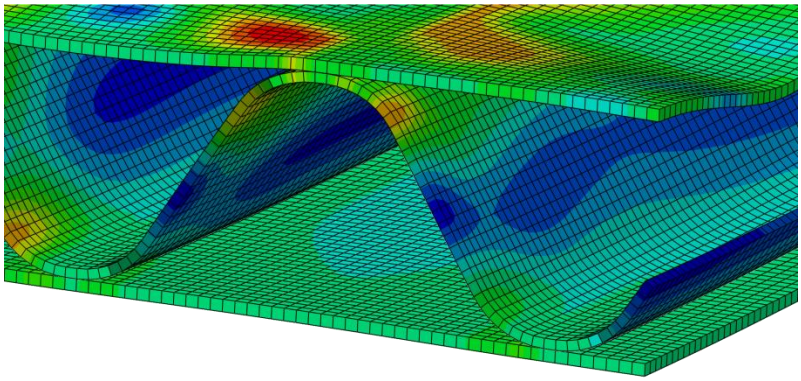

Figure 3. Detail of bending strength model.

2.3 Using Isight for generating response surface formulas.

With Isight a DOE is created based on the properties and value range of the PaperToBox input. For the different flute types, a full factorial DOE with selected parameters was run..

In Isight the DOE component in combination with simcode component is used. In the simcode component each FEA model is generated with a pre-processing Python script using Abaqus/CAE, run with Abaqus/Standard and post-processed with a post-processing Python script, again using Abaqus/CAE.

After the DOE has run, the approximation function with quartic polynomals is used to generate the response surface. The error using the approximation function was less than 1% for any sample point. These formulas can be directly copied into Excel with minor editing.

2.4 Implementation in PaperToBox and subsequent usage

The Excel file with the response surface formulas is embedded in PaperToBox, an in-house developed web-based application. This allows all the users (>1800) in the corrugated board and packaging plants (>125) to use PaperToBox and have instantaneous results for their calculations.

This allows the Smurfit Kappa plants to optimize the paper usage (> 3000 M€) in the corrugated board and packaging.

Also PaperToBox provides the target values for the newly rolled-out quality measurement system, the "Board Referee", which measures the bending strength of corrugated board. the corrugated board and packaging plants (>125) will measure more than 600 000 samples per year.

Figure 4. Board Referee, developed by Smurfit Kappa.

3. References

1. Abaqus Users Manual, Version 6.13-1, Dassault Systémes Simulia Corp., Providence, RI.