

Structural Analysis of a Plastic-Lidded Food Box

Mergon International were asked by their client, PPS, to design and manufacture reusable plastic-lidded food-use boxes for the temporary storage and transportation of fresh fish. Mergon in collaboration with LBM Innovations on design required Wilde to assess the structural performance of the lidded boxes when subject to worst-case stacking loads. The results of the analysis enabled the design to be optimised and Mergon to proceed with confidence to manufacturing the reusable fish box and lid tooling.

Companies

Mergon are innovators in technical plastic moulding solutions for the automotive, industrial and healthcare sectors in Europe and North America. Established in 1981, the company is headquartered in Ireland with major facilities in the USA and Czech Republic. With over 500 employees worldwide, Mergon is one of the leading providers of blow-moulded and injection-moulded products in the world. Clients include BMW, Toyota, Bosch, Abbott, Xerox and many other leading global corporations.

PPS as a group have been providing returnable plastic packaging and container solutions for more than a decade. PPS East Ltd, established in 1986 and based in Grimsby, supplied and washed plastic fish boxes for the Humber fish auction markets and the trawlers which landed fish there. Since then, it has relocated from the fish dock area and grown



Fig. 2: Reusable lidded box for the temporary storage and transportation of fish. (Courtesy: PPS)

into an integral part of the local seafood processing community by renting reusable fish and salmon boxes, bins, pallets and tubs to customers. The company's two BRC-accredited wash plants, one in the Midlands and the other in North East Lincolnshire, are used for cleaning all their returnable packaging. PPS continue in their mission to help clients replace one-trip solutions such as cardboard and polystyrene boxes.

Challenge

Mergon's main requirement was for Wilde to rapidly assess the structural performance of a 139 mm-deep reusable plastic-lidded food box when subject to storage loads. This included calculation of the stress and displacement distributions, assuming that a maximum worst case of 19 x 68 mm-deep boxes would be stacked vertically above it, each with a product weight of 4 kg and a box weight of 1kg. An assessment of the maximum load capacity of the design was also required.

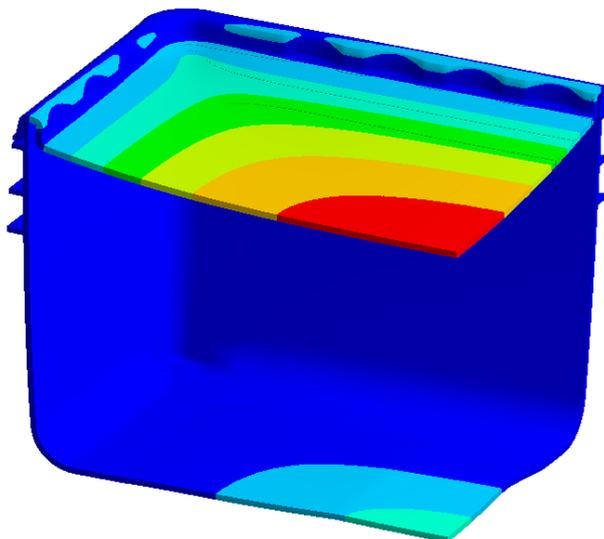


Fig. 1: Stacking load results – total deformation. (Courtesy: Mergon)

Solution

Under compressive loading, buckling due to structural instability is often a significant engineering concern. To capture potential buckling effects in this design, a bi-linear elastic-perfectly-plastic material model was developed. This model used an assumed tangent modulus so that plasticised regions strain indefinitely unless limited through redistribution of load into surrounding non-plasticised regions. This analysis method allows for an efficient assessment of the structure's theoretical buckling capacity. The **ANSYS Suite** of software was used throughout the project, including **ANSYS Professional NLS** and **ANSYS Design Modeller**.

Frequent communication was maintained during the project, with Mergon attending on-site meetings at Wilde Analysis to discuss the results just a week after work on it began. There was further regular contact by phone, email and web conferencing as appropriate.

Business Benefits

The structural assessment by Wilde using FEA enabled Mergon to confirm that:

- When subjected to the worst case stacking load, the calculated peak stress value was below the documented yield stress and localised to a small region of the lid.
- Observed deflections under the specified stacking loads were considered to be acceptable. The deflections were not anticipated to present a sealing issue, as the lid remained in close contact with the rim of the box.
- The maximum load/buckling capacity factor of 7.5 obtained for the outlined loading conditions represented a significant margin of safety for the design, therefore buckling failure was not expected under the assumed loading and material conditions.

Following the consultancy work, Mergon were pleased that subsequent independent product validation testing gave close correlation to the analysis results. Only the expected minor

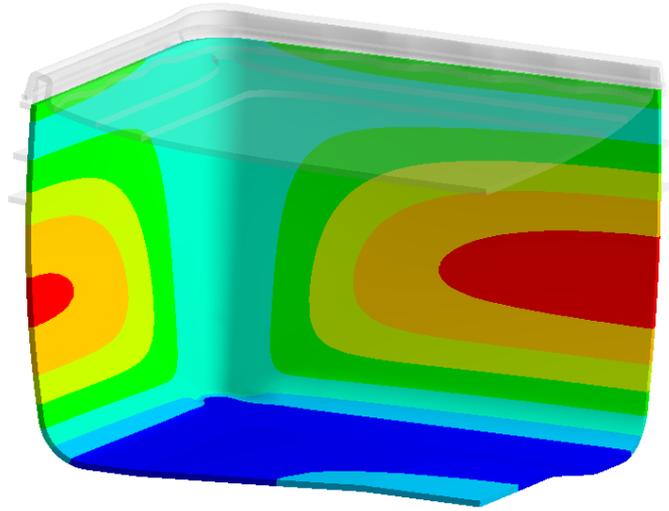


Fig. 3: Maximum load capacity results – total deformation.
(Courtesy: Mergon)

adjustments to the tooling to optimise the lid sealing were required. The product is now tested, approved and available either as a fully-managed returnable food box through PPS or for direct purchase from them. This project has given Mergon confidence in the capabilities of **ANSYS** software to efficiently and accurately analyse their designs.



“““ We currently have limited in-house resources available for design analysis work, and so **Wilde's help** in assessing the **complex structural performance** of these boxes was **essential**. We were **very impressed** with **how well the process** went. Compared to our previous experience of product development / FEA with a prior company, we felt that **the process with Wilde was much faster**, with **results expertly presented** and **proven to be accurate**.