

# Practical Application Development of Headlining Press-Forming Simulation

Lihao Shu <sup>1)</sup> Tatsumi Onishi <sup>1)</sup>

*1) KASAI KOGYO CO., LTD.  
3316, Miyayama, Samukawa-machi, Koza-gun, Kanagawa, 253-0106, Japan*

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The press-forming of polymer material such as resin and cloth, which used in automotive interior, is different from metal material. The viscoelasticity of polymer material makes prediction and taking measures by simulation difficult.

Especially headlining is made by multi-layer of materials, that makes the influence and deformation between diefferent layers is complicated. As a result, analyzed by CAE is difficult, which makes the assessment is mainly made by actual trial, and that cause the problem of development efficiency.

Usually explicit dynamics solution and implicit static solution are used in press-simulation. But explicit dynamics solution needs a proper damping constant, which will significantly affect the outcome. On the other side, convergence is not always guaranteed in implicit static solution, so the stability of solution is not good enough.

Table1 Comparison of Solutions

| Solution                  | Explicit Dynamics | Implicit Static                      | Explicit Static      |
|---------------------------|-------------------|--------------------------------------|----------------------|
| Equation Type             | Motion Equation   | Statical Equilibrium                 | Statical Equilibrium |
| The Stability of Solution | Stable            | Convergence is not always Guaranteed | Stable               |
| Computational Speed       | Fast              | Slow                                 | Very Slow            |

This development use explicit static solution, which a proper damping constant is not required and the solution is stable. Although the computational speed is slow, but by the development of PC hardware, the computational time becomes acceptable.

The main problem of headlining press-forming is the crack of urethane, which is caused by over stretched, and the wrinkle of cloth, which is caused by compression, on front pillar. To reproduce these problems in simulation, the movement of the material and the interaction by multi-layers is the point. But simulation with multi-layer is unrealistic. So in the mean time, the phenomenon of multi-layer need to be reproduced by single-layer.

This development managed to forecast the crack and the wrinkle by input the proper parameter of material property and computational condition. And the reliability is verified through several models.

Except the appearance of the crack and the wrinkle, this development also managed to establish a technique to identify the cause and to consider the countermeasure. By analysis the outcome of simulation, such as thickness strain, displacement of XYZ directions, sheet thickness, temperature, the detail of sheet condition and press motion can be investigated. With those information, cause identification and countermeasure examination can be achieved.

With the forecasting and analyzation about headlining press-forming has been achieved by this development, problems can be found at early development phase, which enables early decision of modeling, production condition, mold structure, material property.

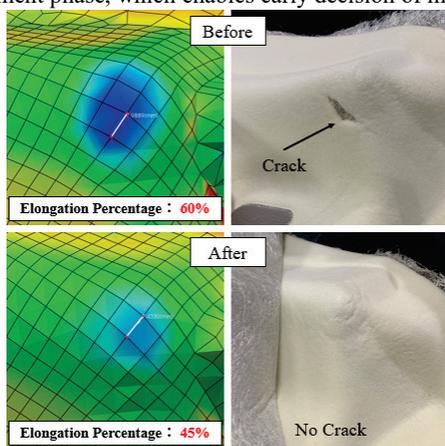


Fig.1 Effect of Countermeasure for Crack

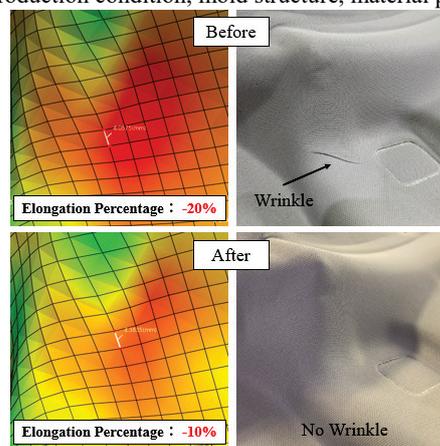


Fig.2 Effect of Countermeasure for Wrinkle