TOA Industries successfully controls springback in thin ultra-high strength steel stamping parts using PAM-STAMP 2G

THE CHALLENGE

There is a strong pressure to reduce CO_2 emissions in vehicles, one way being to cut their weight. At the same time, crash performance must not be sacrificed. The usage of thin ultra-high strength steel can solve both these problems. One of the complexities that arises when using ultra-high strength steel is the high risk of springback during stamping.

Traditional simulation methods for mild steel show their limitations here, so the Yoshida-Uemori model has to be used to control the springback.

THE BENEFITS

TOA Industries has found that by using PAM-STAMP 2G in combination with the Yoshida-Uemori model, the springback for thin ultra-high strength steel parts can be controlled within the normal time frame and at a low cost. They now mass-produce 980MPa-class ultra-high strength steel components used in current vehicles.

"To develop Ultra-High Strength Steel automotive components in a short period of time, early assessment by digital simulation is essential and its accuracy is crucial. PAM-STAMP 2G, which is highly accurate in springback analysis, can be used to combine the Yoshida-Uemori material model with the Bauschinger effect in order to further improve springback prediction accuracy."

Mr. Masuyoshi Ueda
General Manager
1st Product Engineering Department
TOA Industries Co., Ltd.

The Automotive Division of TOA Industries Co., Ltd. manufactures vehicle body and suspension parts. There is strong pressure to reduce the weight of these components in order to cut CO_2 emissions without sacrificing safety performance. A solution is to use ultra-high strength steel, but this technological shift mustn't lead suppliers to overlook automobile OEMs' constant demand for the reduction of both development lead time and cost.

The most difficult problem in the manufacture of ultra-high strength steel components, given their exceptional yield stress, is dimensional deviation due to springback. To create dies for use with high strength materials in a short time frame and at low cost, springback must be prevented in the die from the design stage to minimize trial-and-error correction once the die is made.

Boasting a strong experience with PAM-STAMP 2G for crack/wrinkle prevention, TOA Industries has recently been analyzing springback and has found that on many components, conventional analytical methods are unable to predict springback accurately when ultra-high strength materials are used.

Figure 1 compares a physical test to PAM-STAMP 2G prediction results, when a 2.0mm thick 980MPa-class material is used for a Central Pillar. Analysis reveals a suitable correlation.

However, as shown in **Figure 2**, when a 1.2mm thick 980MPa-class material was used for a B-Pillar Inner, considerable gaps were observed.

Analysis of the behavior of blanks during the stamping process revealed that the B-Pillar Inner was subject to greater unbending deformation than the Central Pillar.

Figure 1: Central Pillar: PAM-STAMP 2G results compared to physical testing

"PAM-STAMP 2G, which provides high accuracy in springback analysis, has become an essential tool for us to achieve early delivery at low cost. To develop ultra-high strength steel automotive parts into mass production in a short period of time, accurate early assessment is very important. By using the Yoshida-Uemori material model and taking into account the Bauschinger effect, we improved springback prediction accuracy on 980MPa level parts. As a result, we succeeded in reducing the amount of physical trial and error cycles."

Mr. Nobuyuki Seki
Subsection Manager
1st Production Engineering Department
Stamping Engineering Section
TOA Industries Co., Ltd.

It is known that the stress-strain relation during unbending deformation is different from that during bending deformation, owing to the Bauschinger effect.

However, the Isotropic Hardening Material Model generally used in existing forming simulation is unable to take the Bauschinger effect into account. This impacted on the accuracy of springback prediction in the B-Pillar Inner.

TOA Industries therefore decided to apply the Yoshida-Uemori model, which makes it possible to take the Bauschinger effect into account.

As shown in **Figure 3**, the PAM-STAMP 2G predictions displayed appropriate correlation with the physically stamped panel, confirming that springback prediction could be accurate enough to be of practical use.

From the results of these initiatives TOA Industries concluded that mass production of components using ultra-high strength steel would be possible. Drawing on its technical expertise, components made of 980MPa-class ultra-high strength materials are now in mass production and being used in vehicles available on the market.

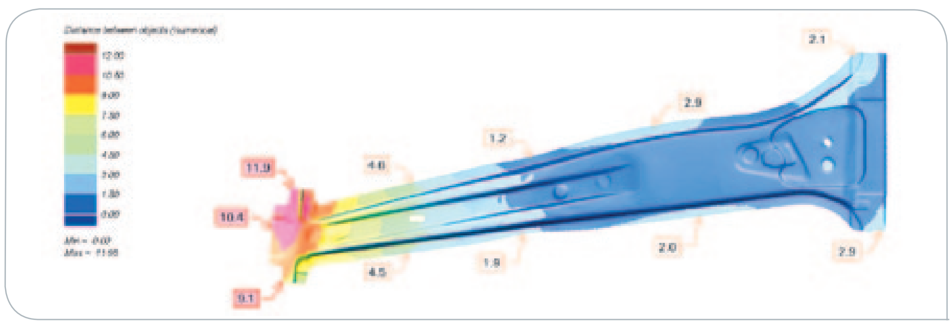

Figure 2: B-Pillar Inner: PAM-STAMP 2G results compared to physical testing, Isotropic Hardening Model, 52.3 % of the points within +/- 1mm

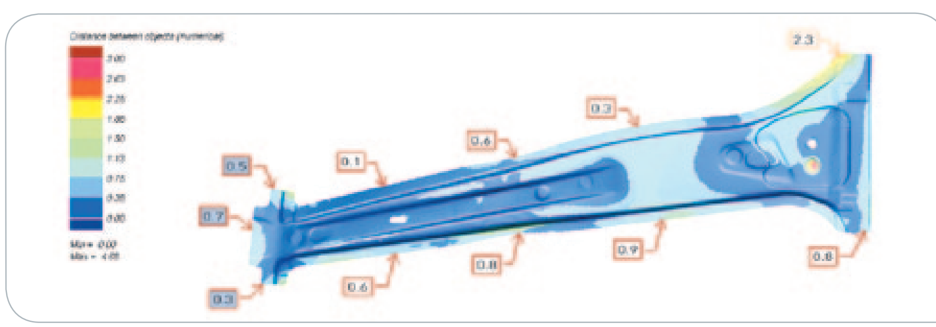

Figure 3: B-Pillar inner: PAM-STAMP 2G results with the Yoshida-Uemori model compare to physical testing, 95.8 % of the points within +/- 1mm

ABOUT TOA INDUSTRIES CO., LTD.

TOA Industries Co., Ltd. (based in Ota City, Gunma Prefecture; "TOA") manufactures components and materials for the automotive and housing industries. The company's automotive business centers on body and suspension parts. Since its establishment in 1949, TOA's business has grown to the point that it now has a total of six manufacturing facilities in Japan, including the head office and main factory. TOA is expanding its automotive components business, and regarding suspension parts it not only deals with domestic car makers but also with car makers overseas. In 2000, TOA built an automotive parts factory in Indiana, USA as part of a strategy geared to taking on the global market.

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