TATA STEEL

TATA

HyperForm® offers affordable weight saving steels for the entire car body

Extra formability tackling weight, costs and performance simultaneously

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Thanks to major efforts, and the development of various technologies that contribute to the reduction of CO_2 tailpipe emissions, car manufacturers are currently doing well in complying with international regulations. One of the key technologies supporting the reduction is material light weighting. Here, the focus shifts from the mere reduction of CO_2 to also lower the related costs, and considers manufacturing process efficiency as well as the end application performance. High-strength steels present a light and affordable solution with good crash performance for the car body. With considerable improvements in their formability over recent years, the latest generation of these types of steels can be applied to almost all areas of modern Body-in-White (BIW) structures and are easy to process at the same time.

Tata Steel was the first to start developing these formable, high-strength steels in 2008, with DP800-GI HyperForm®, the first grade of an entire product family, launched in 2011. Compared to conventional products, these special grades offer better stretchability at the same strength level and are easy to process due to the optimised chemistries. Today, the innovative concept behind HyperForm offers huge potential to be used for Body-in-White applications. In addition to building lighter cars, the use of this new generation of high-strength steels allows more innovative BIW designs and helps to substantially reduce scrap rates in the stamping process of difficult parts. This subsequently has a significant positive impact on sustainability and costs.

Revised norms broaden use of extra formable steels

Since 2009, various advanced and ultra high-strength steels have been incorporated to EuroNorm and VDA norms. In 2016, the new extra-formable steels were adopted into VDA 239-100 under the DH classification. Formerly seen as mere problem solvers for difficult parts, the acceptance of these steels in the standards allows their use in broader applications and enables car manufacturers to review the whole Body-in-White design with regards to further lightweighting potential right from the start of new car development. With four to five percent better elongation, compared to conventional dual phase steels of the same strength level, the HyperForm family facilitates downgauging of about 35 structural parts in the Body-in-White. Related cost implications are neutral, or even positive, as the higher material price is compensated by lower weight, a reduced material need, an improved press shop yield, and the opportunity to replace more expensive process solutions.

To assess the potential of extra formable steels for broader applications in the Body-In-White, Tata Steel supports customers with its technical service, TCO (total cost of ownership) scan. The service analyses further lightweight potential of high-strength steels, by calculating the maximum thickness reduction at the required strength level, taking into account the application and then quantifying the cost benefits, CO_2 impact, lightweighting and performance. To do this for the new HyperForm grades, these steels are checked in a four-phase process in the table shown on page 2.

In the part selection phase, potential parts in the entire car body are identified and assessed with regards to their weight optimisation. In the Forming to Crash (F2C®) phase, the possible gauge reduction at an equal crash performance is determined. This is followed by the forming analysis, where the forming and stamping is simulated to assess the processing and manufacturing feasibility of the parts. In the final phase, the weight and cost impact of the chosen solution is calculated.

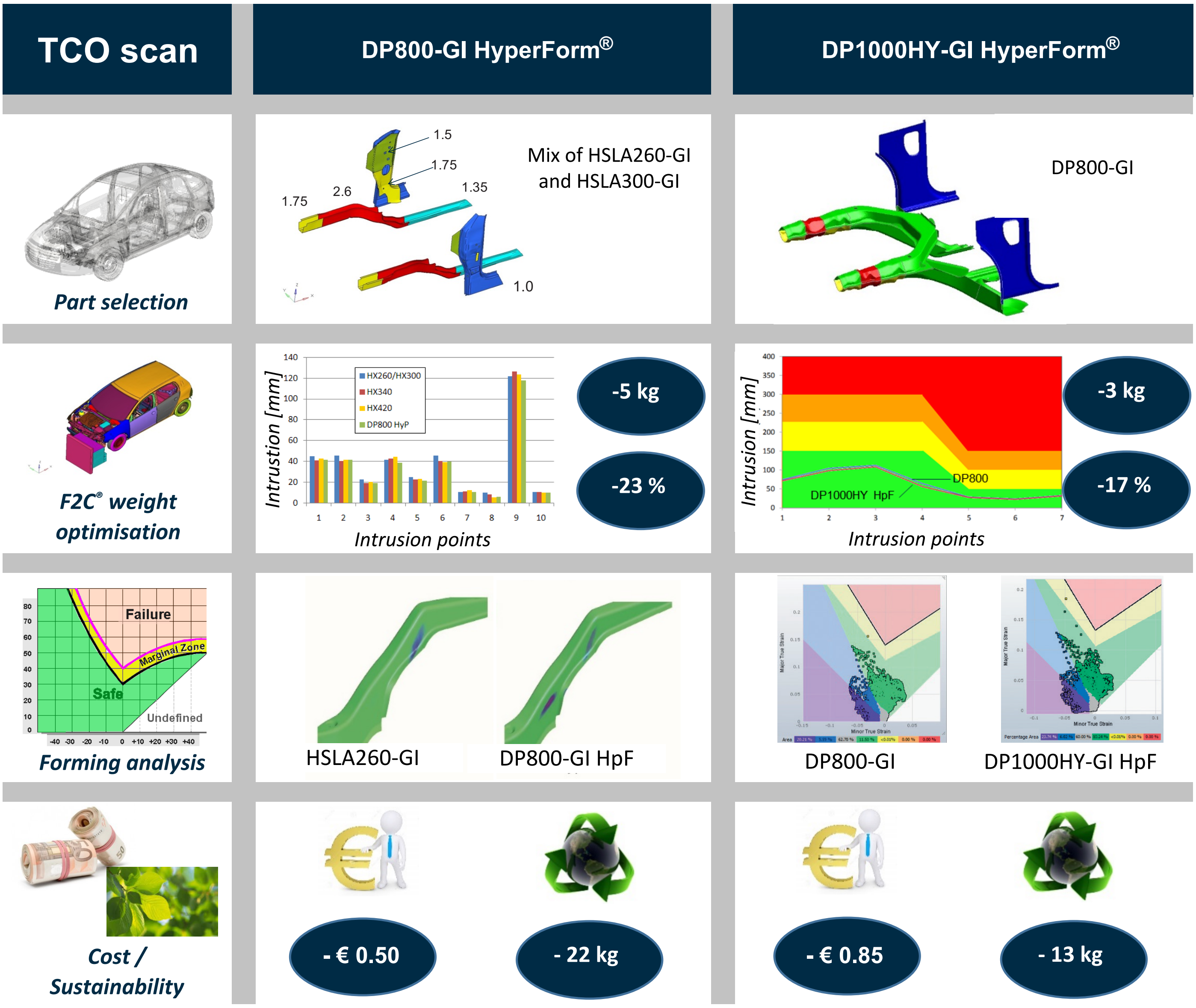
TCO scan on front structure parts

As representatives for numerous other parts in the car body structure, two front structure parts were chosen. For the front longitudinal, the base materials were HSLA260 and HSLA300, which were compared to DP600 and DP800-GI HyperForm. For another front structure based on higher strength, the A-pillar reinforcement, the base material, DP800, was compared to DP1000-GI HyperForm.

Initially, the formability benefits of the new high-strength steels were assessed compared to the conventional HSLAs. The DP800-GI HyperForm offered an up to 180 MPa higher yield strength than the HSLA260 and HSLA300 reference models. With a DP600 base with thicknesses from 0.9 to 2.0mm, the DP800-GI HyperForm still offered an up to 110 MPa higher yield strength. The DP1000HY-GI HyperForm presented an up to 160 MPa higher yield strength than its DP800 reference model.

In the second phase, the crash performance was calculated with the help of the Forming to Crash (F2C®) technology, which includes the increase in strength due to strain hardening by forming the part. The analysis determines the maximum possible gauge reduction to achieve an equal crash performance. For this, the reference model with HSLA was changed to DP800-GI HyperForm (DH800). The analysis showed a 23% downgauging potential per part without the loss of crash performance. For the other reference model, the DP800 baseline was replaced by DP1000-GI HyperForm (DH1000), the result of the analysis showed a downgauging potential of 17% per part.

The third phase of the TCO scan assessed the manufacturing feasibility of a specific part. Here, the outcome of the crash analysis with grades and thicknesses is checked regarding manufacturability. This stage demonstrates the benefits of the HyperForm grades: the extra formability that these grades offer result in an improved deep drawing capability which is necessary to obtain good parts at higher strength levels.
At the end, the weight and cost impact of the chosen solution is calculated. Comparing the reference models to DP800 HyperForm, the new steel showed a weight saving of up to 23%, which is approximately 5kg, with a similar crash performance and good feasibility. The lower weight of the parts resulted in reduced part cost of approximately 0.5 Euro. The DP1000HY-GI HyperForm when compared to DP800, achieved a weight saving of 17%, which is approximately 3kg and 0.85 Euro at a similar crash performance and good feasibility.



When analysing these results and translating to the entire Body-in-White, the potential weight savings – also considering the cost implications – of using HyperForm are significant. By replacing conventional HSLA steels with HyperForm, the reduction in weight of two separate front structure parts are 6.5kg (DP800) and 4.1kg (DP1000) respectively. Considering those results for the full range of Tata Steel's HyperForm products, applied to the whole BIW, impressive weight savings of 12.9kg can be achieved with a minimal cost penalty of just 0.13 Euro per car.

Conclusion

Although car manufacturers are making considerable progress in order to comply with international CO_2 regulations, they should look into further lightweighting options to improve affordability and processability aspects while also achieving 2020 targets. Extra formable high-strength steels offer a huge weight and cost saving potential for car manufacturers developing Body-in-White components. The improved formability of HyperForm steels enables the use of higher strength materials and facilitates lightweighting. The adoption of these steels in the DH classification of the VDA 239-100 norm paves the way for a broader application of these materials in the entire Body-in-White design, saving up to 23% weight at minimally higher costs. HyperForm is therefore an attractive lightweighting solution to reduce CO_2 emissions further to meet the requirements of the future.

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