# SLIM A-PILLAR: BETTER VISIBILITY, LESS WEIGHT

The new InCar plus A-pillar offers numerous advantages in comparison with conventional A-pillars: a significantly larger field of vision, high passive crash safety and around 10 % less weight. Use of less material and innovative manufacturing technologies enable increased efficiency at very moderate lightweight design costs of € 1.57/kg. Cost advantages arise on integration of the A-pillar concept into a cross-model common parts strategy.

High structural mechanical requirements and the vehicle design are causing the A-pillars of current vehicle generations to become significantly wider. As a result of this, larger areas of the field of vision are being obstructed, leading to an increased risk of not seeing other road users or not seeing them in time, ❶. The vastly reduced cross-section of the A-pillar developed as part of the InCar plus project enlarges the free field of vision and therefore makes a significant contribution to accident prevention.

Together with the resulting increase in driving comfort, this creates an additional customer benefit which may positively affect the purchase decision.

Lower weight is a second, by no means less important, objective.

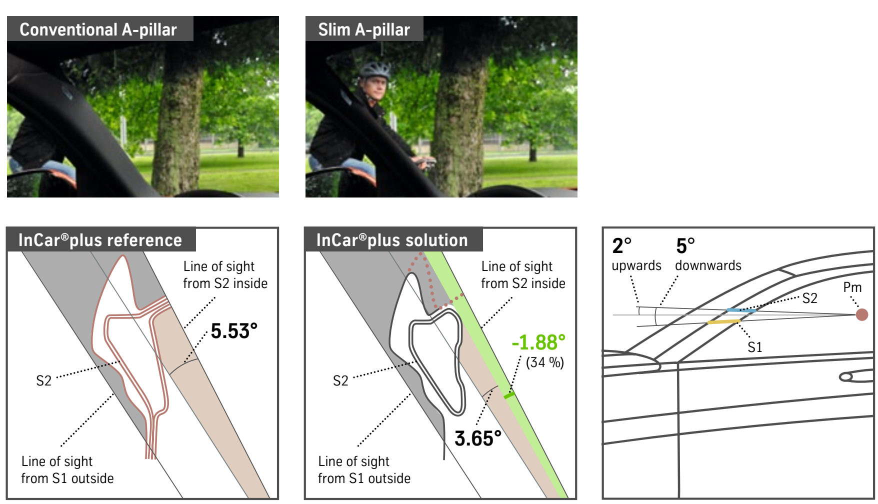
However, optimizing the field of vision and reducing weight conflict with the requirements of crash safety. In addition, the complex geometry of typical A-pillars makes high demands on the materials and manufacturing processes which are used. A multi-part shell design, which meets all current, crucial structural mechanical requirements and therefore represents the state of the art in 2014, serves as the reference for assessing the new A-pillar concept, ❷.

Within InCar plus, the objectives are achieved with a hot-formed, closed profile with integrated window flange which optimally exploits the reference's available package, ❸. This new A-pillar concept reduces the obstruction angle by a significant 34 % and the weight by 10 % or 3.22 kg per vehicle.

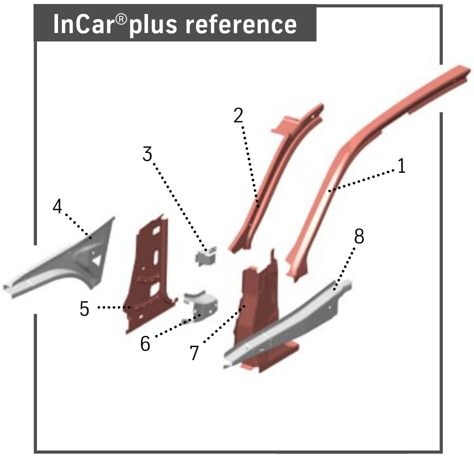
Structural mechanical validation of the A-pillar is based on the specifications of the Euro NCAP, Euro NCAP pole and IIHS small overlap tests as well as the FMVSS 216a roof intrusion test. On the whole, the A-pillar attains the target values of the relevant crash load cases and offers crash behavior comparable with that of the reference structure. The same applies to the torsional and bending stiffnesses which are achieved. In combination with an optimal restraint system design, the risk of injury can be reduced to such an extent that the prerequisites for scoring five stars in the Euro NCAP test are created.

## NEW PROCESSES OPTIMIZE MANUFACTURING

The investigation is focused on implementation of the complex A-pillar geometry in manufacturing. The component

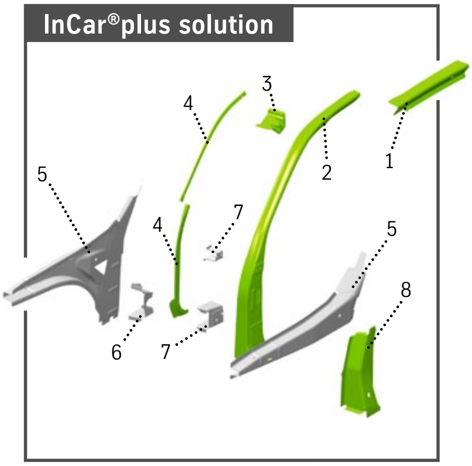



❶ Reduction of the obstruction angle




❷ Reference A-pillar components

| No. | Part | Material | Coating | Thickness | Weight |
|---|---|---|---|---|---|
| 1 | A-pillar upper outer left | CP-W® 660Y760T | GI40 | 1.80 mm | 4.40 kg |
| 2 | A-pillar upper inner left | MBW® 1500 | AS150 | 1.15 mm | 1.29 kg |
| 3 | Bracket cockpit beam left | CR300LA | GI40 | 1.50 mm | 0.25 kg |
| 4 | Longitudinal member upper inner left | DP-K® 440Y780T | GI40 | 1.10 mm | 2.07 kg |
| 5 | A-pillar lower inner left | RA-K® 400Y690T | GI40 | 1.10 mm | 1.79 kg |
| 6 | Reinforcement A-pillar lower left | CR210IF | GI40 | 1.20 mm | 0.64 kg |
| 7 | A-pillar lower outer left | MBW® 1500 | AS150 | 1.20 mm | 2.53 kg |
| 8 | Longitudinal member upper outer left | DP-K® 440Y780T | GI40 | 1.10 mm | 2.04 kg |
| | Total weight per vehicle | | | | 30.02 kg |




❸ InCar plus A-pillar components

| No. | Part | Material | Coating | Thickness | Weight |
|---|---|---|---|---|---|
| 1 | Roof frame side outer left | DP-K® 590Y980T | GI40 | 1.30 mm | 1.00 kg |
| 2 | A-pillar profile left | MBW® 1500 | AS150/U | 1.25 mm | 4.95 kg |
| 3 | Bracket roof cross member front left | CR240LA | GI40 | 1.15 mm | 0.20 kg |
| 4 | Flange support upper/lower left | CR240LA | GI40 | 0.90 mm | 0.36 kg |
| 5 | Longitudinal member upper inner/outer left | DP-K® 440Y780T | GI40 | 1.10 mm | 5.08 kg |
| 6 | Bulkhead A-pillar lower | DP-K® 590Y980T | GI40 | 1.20 mm | 0.31 kg |
| 7 | Reinforcement A-pillar upper/lower left | CR380LA | GI40 | 1.20 mm | 0.50 kg |
| 8 | A-pillar lower outer | DP-K® 590Y980T | GI40 | 1.20 mm | 1.01 kg |
| | Total weight per vehicle | | | | 26.82 kg |

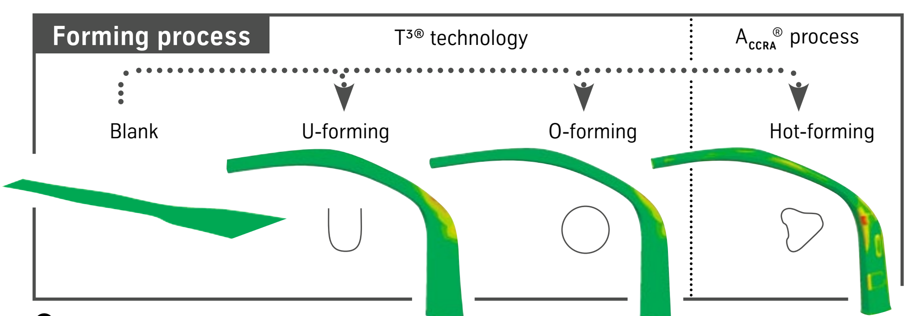
starts at the sill, proceeds along the hinge pillar, the windshield inclination, over the roof frame area and ends at the B-pillar connection. The ultra high-strength steel profile reveals all of the reference design's connection surfaces and follows the three-dimensional structure specified by the package.

Necessary reinforcements are integrated into the closed profile with conventional body-in-white (BIW) methods.

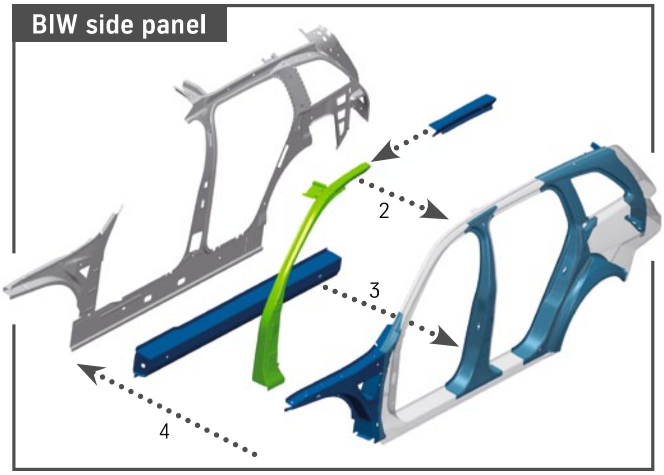
Two forming techniques which supplement each other are used for manufacturing, ❹. The T³ technology is a production process for manufacturing thin-walled, closed or open profiles with a flexible cross-section. First, the T³ technology is used to produce a curved, tubular semi-finished product with varying cross-sections. This semi-finished product obtains its final geometry in a further hot-forming operation, the Accra process developed by Linde + Wiemann.

In the InCar plus project, the engineers have additionally developed an industrialization concept which enables the closed profiles to be manufactured under conventional production conditions and with standard cycle times. The A-pillar semi-finished product can be manufactured either on an individual press or conventional pressing lines. High material exploitation is achieved through the use of the blanks and optimal nesting.

Accra is an innovative manufacturing process for crash-optimized, ultra high-strength structural components consisting of closed hollow profiles (form blow




❹ Overall T³ and Accra process chain




| Scope of joints side panel/vehicle | InCar®plus reference | InCar®plus solution | Difference |
|---|---|---|---|
| No. of spot welds | 1,325 | 1,293 | -32 |
| MIG/MAG welding | 700 mm | 3,856 mm | +3,156 mm |
| Laser beam welding | 0 mm | 1,440 mm | +1,440 mm |
| Structural adhesive | 31,470 mm | 28,702 mm | -2,768 mm |

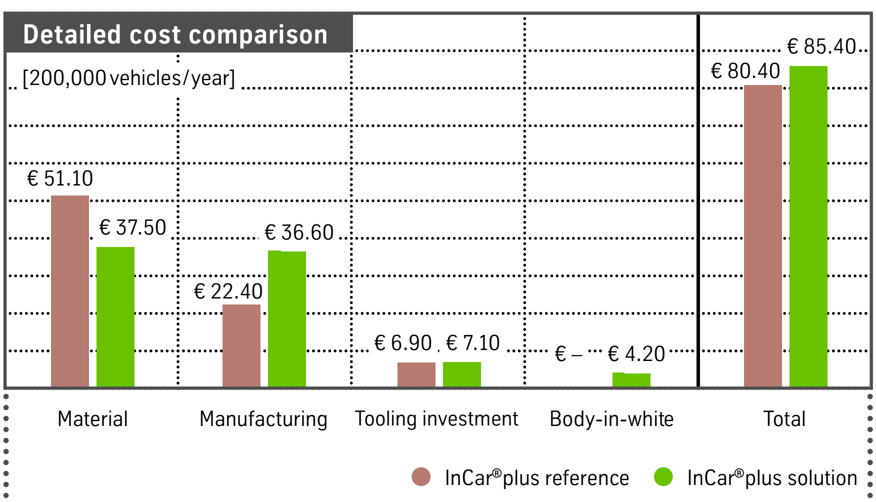
❺ Integration of the InCar plus A-pillar into the outer/inner side panel (left) with important joining parameters (right)

hardening) and combines the advantages of hydroforming and press hardening. In the Accra process, the semi-finished profiles manufactured using the T³ technology are heated to the austenitization temperature (880 to 950 °C) in a furnace and inserted fully automatically into a hot-forming tool. When the tool is closed, the semi-finished product is molded into the three-dimensional sheer line. Sealing elements seal the semi-finished product at the ends on both sides. The final component contour is then formed by means of internal high pressure (with compressed air in the simplest case) of up to 600 bar. After forming, the internal pressure is reduced and water flows through the component through the sealing elements. Depending on the material thickness, direct cooling leads to an extremely rapid and even cooling rate of up to 350 K/s. This guarantees process-consistent and reproducible phase transformation from austenite to martensite. The structure and therefore also the characteristics of the finished component are comparable with those of conventionally press-hardened shell components. After hot-forming, lasers trim the ends of the component and cut holes and cutouts. No springback is usually to be anticipated. The finished component's dimensional tolerances lie in the range of +/- 0.5 mm.

The combination of these two innovative manufacturing technologies enables extremely complex component geometries to be achieved which could not previously be manufactured with the familiar manufacturing techniques and comparable material strengths.

In interaction with the technical characteristics of hot-formed hollow profiles manufactured from MBW 1500, both techniques make a significant contribution towards optimizing the weight of structural components. The components manufactured in this way can usually be integrated into existing body-in-white systems with ease, e.g. through modified joining sequences and adapted joining techniques. ❺ shows an example of the joining sequence for the outer/inner side panel.

The concluding cost assessment gives consideration to the adapted body-in-white scopes. Attractive lightweight design costs of € 1.57/kg with a weight reduction of approximately 3.2 kg per vehicle arise in combination with the reduced use of material, ❻.




❻ Comparison of the InCar plus reference and InCar plus solution lightweight design costs

### COMMON PARTS STRATEGY POSSIBLE WITH SEMI-FINISHED AND FINISHED COMPONENT

The hot-formed A-pillar profile offers an additional advantage: it can be specifically adapted as required by the customer, e.g. with regard to a vehicle-based geometric modification. This means both that the length of the A-pillar can be varied and that the profile can be transferred to other models as part of a common parts strategy. The common parts strategy does not therefore merely refer to the use of the same semi-finished product. This may be a technically and economically interesting option for the final, formative manufacturing process. The manufacturing processes can also be transferred to other body, chassis or steering components.