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Design and Development of the B-pillar lower (Interior Trim)

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Abstract

The automotive interior trim plays a crucial role in passenger comfort, aesthetics, and safety. Among these, the B-pillar trim is essential for covering structural components, integrating safety features, and enhancing vehicle ergonomics. This paper discusses the design and development process of the B-pillar trim, considering material selection, manufacturing techniques, structural integrity, and compliance with OEM standards. Key aspects such as crashworthiness, weight reduction, and sustainability are also examined.

INTRODUCTION

Pillars are the vertical or near-vertical supports of a car's window area, designated as A, B, C, or Dpillars, from front to rear in profile view. The B-Pillar is the central pillar of the car, providing critical structural support to the roof by connecting the front and rear doors. The B-pillar is a critical structural component in automobiles, playing a vital role in safety and vehicle integrity. The interior trim for the B-pillar is designed to enhance aesthetics, provide occupant protection, and improve NVH (Noise, Vibration, and Harshness) characteristics. This paper explores the systematic approach to designing a robust and cost-effective B-pillar trim while meeting OEM requirements and regulatory standards.

FUNCTIONS OF THE B PILLAR TRIM

The B-pillar trim in a car interior serves as a protective and aesthetic cover for the structural Bpillar, concealing the body panel, wire harness, and electrical components while ensuring proper gap and flushness with surrounding interior parts for a seamless look. It also integrates a seatbelt cutout for occupant safety and contributes to the overall aesthetic appeal of the vehicle's cabin.

MATERIAL, FINISH, MANUFACTURING FEASIBILITY

Plastics such as Polypropylene (PP), Acrylonitrile Butadiene Styrene (ABS), and Polycarbonate (PC) are commonly used due to their lightweight nature, impact resistance, and cost-effectiveness. Tata Motors' guidelines emphasize the use of recyclable and sustainable materials. Additionally, dual-tone materials and soft-touch finishes are incorporated to enhance the premium feel of higher-end models.

METHODOLOGY OVERVIEW

This explains the methodology followed in designing the B-Pillar trim, including tooling axis creation, Class B and C surface generation, and integration into a closed body.
The primary steps involved are:

- Checking for defects in the Class A surface.
- Creating the tooling axis.
- Performing a preliminary draft analysis.
- Understanding the master section.
- Creating flanges on both sides.
- Developing Class B and Class C surfaces.
- Integrating all surfaces into a complete model.
- Adding B-side features.
- Conducting a final draft analysis.

Fig.1. Location of B Pillar trim

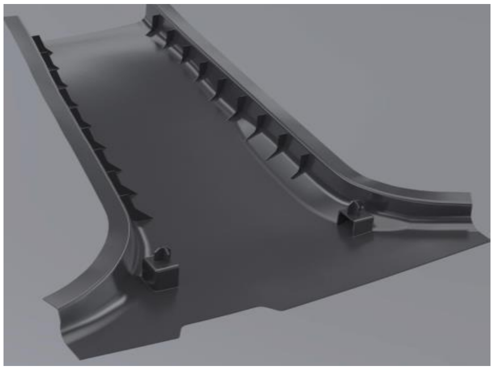

Fig.2. B Pillar trim

OBJECTIVES

1. To create a closed body of the given B pillar trim CAS.
2. To create tooling axis and follow design rules.
3. To follow the Master section to create a flange
4. To follow the master section for thickness and to create the Closed volume.
5. To follow the master section with attachment features.

Given (Inputs required):

1. A-surface
2. Master-sections
3. Distance between ribs should be 50mm.

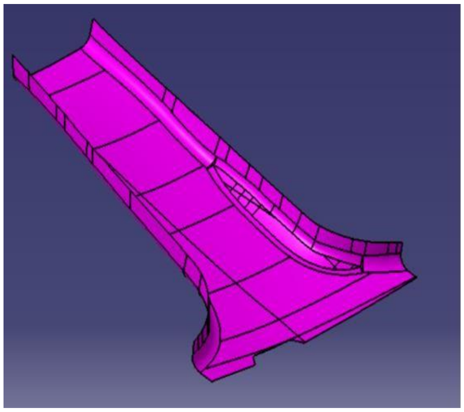

Fig.3. B Pillar trim styling surface (CAS)

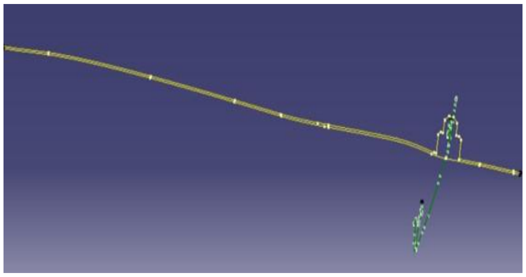

Fig.4. Master section

DESIGN METHODOLOGY

A-surface improvement

Before we start creating the closed body for the B-pillar we need to check the quality of the given Asurface. The A-surface needs to be free of all the patches or error elements. For this first, we need to disassemble the given styling surface and join it with the merging distance of 0.001mm.

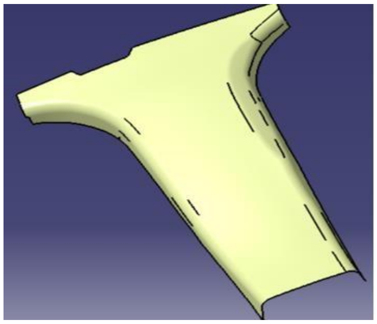

Fig.5. Surface quality of the surfaces

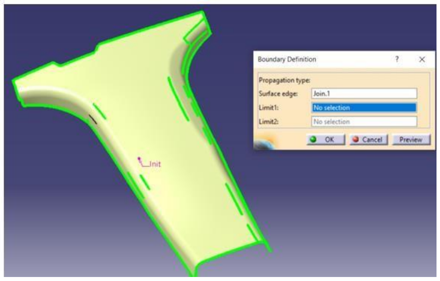

Fig.6. Style check

Flange creation

According to the master section, the B-pillar has flanges on both sides. The flanges have to be included in the design and the A and B surface has to be modified. The surfaces should match the master section.

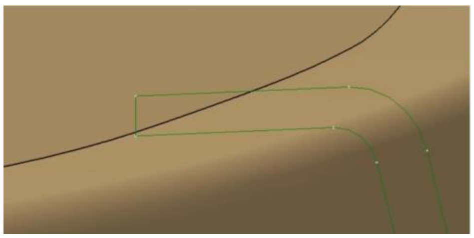

Fig.7. A-Surface flange creation as per master section

Main Tooling Axis Creation

The tooling axis is the direction in which the core moves. During injection molding the core is moved into the cavity and molten plastic is injected. When this molten plastic is cooled down then the core is moved away from the cavity. The direction in which the core moves is the tooling direction for the part. To find the tooling direction we use the master section for the engineering feature. Here we take the two boundaries and find a bisecting line between them.

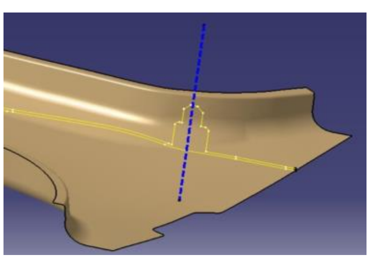

Fig.8. Main tooling direction (MTD)

Manufacturing Feasibility of the A-surface (Draft analysis)

Draft analysis is used to check the A-surface manufacturing feasibility. The tooling axis is used as a reference. Draft analysis checks the angle at which the surface is with respect to the tooling axis. As we know for injection molding the draft on the surface should be positive and greater or equal to 3 degrees. Areas with the draft less than 3 degrees are a bit difficult and costly to manufacture.

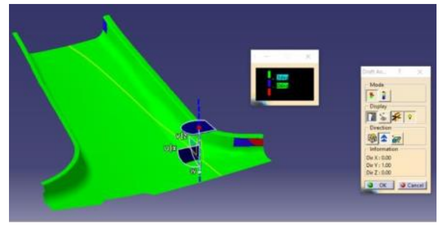

Fig.9. Draft analysis on A-Surface

B-surface creation

According to the master section the offset value for the B-surface is 2mm. We offset the A-surface and create the B-surface at 2mm offset. The offset will result in some areas having a problem. We need to rectify the patches and create a smooth surface.

Closing surface

The closing surface of the plastic part should be created in such a way that it follows the draft of the A-surface. This is necessary to maintain the A-surface finish in the injection molded part.

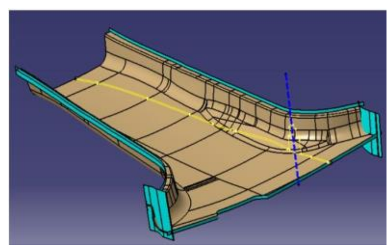

Fig.10. Closing surface at an angle w.r.t. tooling direction

Closed body and Draft analysis

A closed body is developed from the above surfaces and a check was performed on the body to find any openings in the surfaces.

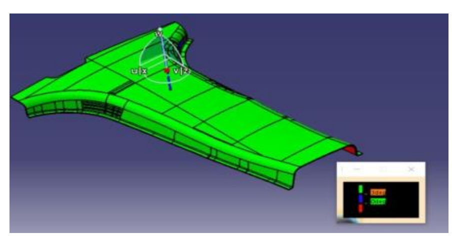

Fig.11. Draft analysis on the final body

Parting Line

The parting line is created when the core and cavity meet, the space between the junction where the plastic flow which create the parting line.

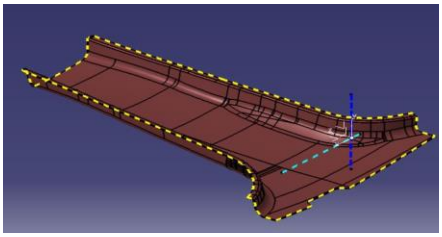

Fig.12. Parting line

Attachment feature creation

The attachment features will be created according to the input given to us. According to the master section, we have a dog-house and a 4-way locator on top. First, we need to create the dog house. The dimensions of the dog house and the four-way locator are taken from the master section.

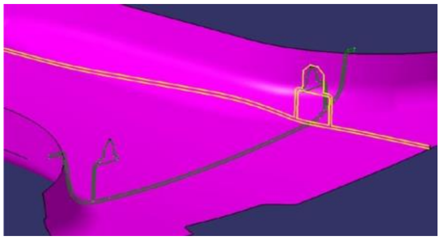

Fig.13. Assembly fixation as per Master section

ENGINEERING TERMINOLOGY

Master Section

These are the guidelines provided to a design engineer which describe how a component would look like once it is modeled into a solid component from the class-A surface. For example, in this model, we have received a master-section as an input which tells us out the thickness the component and dimensions & type of the engineering features on the component.

Dog house & Four-way locator

Dog house is an engineering feature used in plastic trim design. The primary function of a dog house is to avoid sink marks on the class A surface which may occur due to features such as a thick screw boss or rib on the back side of Class A. So, the best possible solution is to increase the height and decrease the cross-sectional thickness of the 'legs' by using a dog house. We can also use them for solving the necessity of large length features such as a screw boss which may require a large length sometimes. We can use a dog house and make a screw boss above it in such situations. We can also use them for making features that are perpendicular to the main tooling direction.

Ribs

Ribs provide a means to economical stiffness and strength in molded parts without increasing overall wall thickness. They also facilitate: 1) Locating & arresting components of an assembly.
2)Providing alignment in mating parts.
3)Acting as stops or guides for mechanisms.

SUSTAINABILITY & FUTURE TRENDS

Eco-friendly materials, lightweight composite alternatives, and advanced surface treatments are being explored to enhance durability and environmental impact reduction. The integration of smart materials for noise absorption, self-healing coatings, and bio-based polymers is an emerging trend. Additionally, 3D-printed tooling and digital twin simulations are being used to reduce development time and cost.

CONCLUSION

- The B-Pillar trim was successfully designed using CATIA V5's generative shape design workbench.
- A nominal draft angle of 3degrees was maintained for the component and 0.5 degrees for engineering features.
- A closed body was achieved using the 'Close Body' command in the part design workbench.
- Engineering features were designed following standard industry design rules.

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