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DESIGN AND ANALYSIS OF EXTERIOR GRILLE

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Abstract— In an automobile engineering, a grille covers an opening in the body of a vehicle to allow air to enter. Most vehicle feature, a grille at the front of the vehicle is to protect the radiator and engine. Merriam-Webster describes grille as "a grating forming a barrier or screen; especially: an ornamental one at the front end of an automobile. The grille on the car or truck is its most distinctive signature, and it's one of the first things people notice about a ride. A well-designed grille can make it easy for those with even a passing interest in cars to recognize the type of vehicle you drive. The objective of our project is to design the vertical and horizontal billet grille by using CREO PARAMETRIC, study and analyze the structural ability by varying the material. The materials using for analyse the grille are ABS PLASTIC,ABS/PC ALLOY. The flow from outside to the inside of a car bonnet for vertical and horizontal type of billet grille also studied and compared using UG-NX NASTRAN. Along with this, tool design also done using CREO PARAMETRIC.

Keywords — Creo, Nastran, ABS Plastic, Grille.

I. INTRODUCTION

In automotive lingo, a grille is an opening in the bodywork that allows air to enter. Usually, there is a large, prominent grille in the front of vehicles for cooling off the radiator and engine compartment. Also, most cars, trucks, SUVs and vans have secondary grilles on their bumpers.

BMW exterior grille

Necessity of design:

The front fascia of a motor vehicle has an important role in attracting buyers. The principal function of the grille is to admit cooling air to the car's radiator. However, the look of the vehicle "matters a great deal more than whether the design features actually serve any function". As one of the main visual components on the front of vehicles, "an inspired grille design makes a car attractive and shapes its identity by tying it to the carmaker's history and reputation". Rolls-Royce is known for arranging its grille bars by hand to ensure that they appear perfectly vertical. Other makers known for their grille styling 3 include Bugatti's horse-collar, BMW's split kidney, Rover's chrome "teeth", Mitsubishi's forward swept, fighter aircraft-style grilles for their cars 2008 A billet grille is an aftermarket part that is used to enhance the style or function of the original OEM grille.

II. TYPES OF GRILLE

A. Mesh grille:

Mesh grilles are simple, yet elegant. They're original equipment on some of the finest sports and luxury cars in the world, and are very popular in the aftermarket. Mesh patterns are either cast in one piece, or created by bonding or weaving separate strands of material together. Whether crafted from ALUMINIUM, stainless steel, or ABS plastic, mesh grilles will come with a finish of polished metal, chrome plating, or powder coat (usually black). Depending on the closeness of the weave pattern or openings, mesh grilles can be

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described as "fine mesh" or "heavy mesh".

B. Billet grilles:

Billet is a term you'll see frequently, and in some places it's become so synonymous with the aftermarket that all such grilles are referred to as "billet" grilles. However, for our purposes billet refers to a grille style consisting of a series of vertically or horizontally stacked bars. The term may have originated because such bars look like billets, which are square section castings or extrusions created when steel or ALUMINIUM is formed. There are billet grilles with many thin bars stacked closely together and grilles with only a few thick bars. Billet grilles are made from ALUMINIUM or stainless steel and they can be polished, chrome plated or powder coated in the choice of colour.

C. CNC type manufactured grille:

CNC (Computer Numerical Control) manufacturing means virtually all steps of the grille-making process are performed by machines controlled solely by computers. This allows precision shaping of metal, cutting of intricate patterns and shapes, and machining of irregular edges to smooth perfection. Grilles with complex customized patterns such as perforated holes seen on "punch" style grilles, spider webs, and flames require this higher level of precision and accuracy that wasn't possible before CNC processes existed. Without computer controls relentlessly performing all legs of the manufacturing process flawlessly, finished parts could not be produced in quantity, nor would it be possible to maintain consistent quality control or ease of interchangeability.

III. TYPES OF MATERIAL USED:

- ✓ **Aluminum**
- ✓ **Stainless Steel**
- ✓ **ABS Plastic**

1) Aluminium:

The material most widely used in the billet grille industry is ALUMINIUM—for good reasons, too. ALUMINIUM is known for its strength, versatility, low-density, durability and resistance to corrosion. Because of its malleability, ALUMINIUM can easily be rolled, stamped, drawn, spun, hammered or forged into almost any shape, making it the ideal metal for the automotive and aero space industries.

2) Stainless steel:

Known the world over for its strength and corrosion resistance, stainless steel is a popular metal used for crafting billet grilles. The reason that it resists rust so successfully is that it has a high chromium content. In fact, for steel to be considered stainless, it needs to have at least a 10.5% chromium content. Plus, stainless steel is incredibly tough, resilient and easily fashioned into a multitude of forms and shapes.

3) ABS plastics:

The most cost effective billet grille material available is the ABS Plastic. Widely used across the entire automobile accessories spectrum, ABS Plastic is a lightweight, rigid and durable thermoplastic material. While it is not as strong as stainless steel or ALUMINIUM, ABS Plastic still makes an excellent medium for building billet grilles because the plastic is impervious to rust and quite durable. For added customization, it can usually be painted to match or accent stock paint. For high quality ABS billet grilles, turn to RDX, Street Scene and Stull Industries.

IV. MATERIAL DESCRIPTION

1) ABS PLASTIC:

Acrylonitrile butadiene styrene (ABS) is a common thermoplastic used to make light, rigid, moulded products such as automotive body parts, wheel covers, enclosures, protective headgear, and buffer edging for furniture and joinery panels, and many other applications where cost is an issue. The final properties will be influenced to some extent by the conditions under which the material is processed to the final product; for example, moulding at a high temperature improves the gloss and heat resistance of the product whereas the highest impact resistance and strength are obtained by moulding at lower temperature.

PHYSICAL PROPERTIES:

Description	
Polymer type	ABS
Grade name	STAREX NH-0825 S
Producer	CHEIL
Melt flow index	MFI (200,5)=6.5g/10min
Process condition	
Melt temperature (minimum)	220.0 °c
Melt temperature (normal)	240.0 °c
Melt temperature (maximum)	260.0 °c
Mold temperature (minimum)	20.0 °c
Mold temperature (normal)	40.0 °c
Mold temperature (maximum)	60 °c
Ejection temperature	89.85 °c
Freeze temperature	110 °c

Even though ABS plastics are used largely for mechanical purposes, they also have electrical properties that are fairly constant over a wide range of frequencies. These properties are little affected by temperature and atmospheric humidity in the acceptable operating range of temperatures.

2)ABS/PC ALLOY:

Polycarbonate/Acrylonitrile-Butadiene-Styrene (PC-ABS) blends are an amorphous engineering thermoplastic alloy based on the melt blending of specific grades of polycarbonate and ABS.

The blend technology employed supplies products with an attractive combination of mechanical, thermal and rheological properties. This leads to materials with ease of processing combined with low temperature ductility, excellent impact resistance, good heat resistance and outstanding aesthetics.

PHYSICAL PROPERTIES:

Description	
Polymer type	PC+ABS
Grade name	BAYBLEND T90 MF_20
Producer	Bayer
Melt flow index	Unavailable
Process condition	
Melt temperature (minimum)	240.0 °c
Melt temperature (normal)	260.0 °c
Melt temperature (maximum)	280.0 °c
Mold temperature (minimum)	60.0 °c
Mold temperature (normal)	80.0 °c
Mold temperature (maximum)	100.0 °c
Ejection temperature	126.85 °c
Freeze temperature	147 °c

V. COMPONENT DESIGN

PTC creo parametric, developed by Parametric technology corporation, is a new technology in the series of Pro/ENGINEER. It provides a broad range of powerful and flexible CAD capabilities that can address even the most tedious design challenges. Being a parametric feature-based solid modelling tool, it not only integrates the 3D parametric features with 2D tools, but also assists in every design-through-manufacturing process.

This solid modelling software allows you to easily import the standard format files with an amazing compatibility. The 2D drawing views of the components are automatically generated in the Drawing mode. The bidirectional associative nature of this software ensures that any modification made in the model is automatically reflected in the drawing views.

Introduction to the component:

According to the objective of the project, BOLREO SLX grille is taken as a reference and designed as per the dimensions. The BOLERO SLX exterior grille is the vertical type of billet grille .

In this exterior grille, there are five vents are with grille bar at the middle of each. The emblem mounting can be made at the middle of the vent. In order to enhance the efficient use of air flow with engine protection background mesh can be attach at the shell of the back of grille.

Modeling of grille:

- Vertical
- Horizontal

1) Vertical:

The designing of the vertical type grille of BOLERO SLX grille made by the software PTC CREO PARAMETRIC 3.0. In PTC CREO PARAMETRIC, the exterior grille is designed by using following drafting tools,

A. Sketch:

This tool is used to sketch the tool as per the geometrical dimensions.

B. Extrude:

This tool is used to specify the the thickness of the component.

C. Shell:

This tool is used to create the hollow cavity by providing the wall thickness.

D. Round:

This tool is used to make the edges to blend for providing the better aesthetic.

E. Warp:

This tool is used to bend the component to the required isometric shape.

Isometric view of vertical grille

2) Horizontal:

The horizontal grille for the BOLERO SLX is made by own idea & the geometrical dimensions of this horizontal grille is made with respect to the vertical grille dimensions. In PTC CREO PARAMETRIC the exterior grille is designed by using following drafting tools,

A. Sketch:

This tool is used to sketch the tool as per the geometrical dimensions.

B. Extrude:

This tool is used to specify the thickness of the component.

C. Shell:

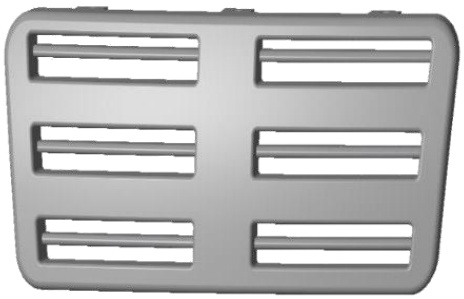
This tool is used to create the hollow cavity by providing the wall thickness.

D. Round:

This tool is used to make the edges to blend for providing the better aesthetic.

E. Warp:

This tool is used to bend the component to the required isometric shape.



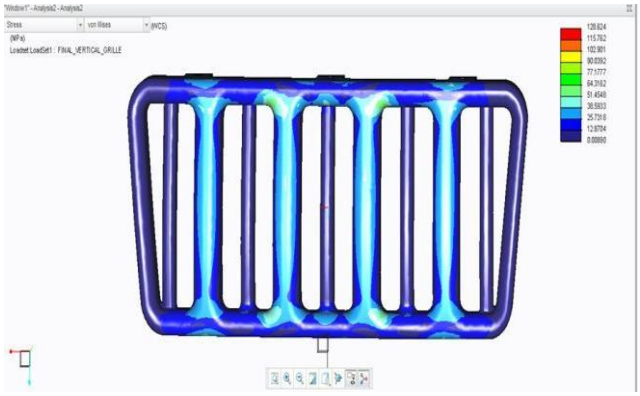
Isometric view of horizontal grille

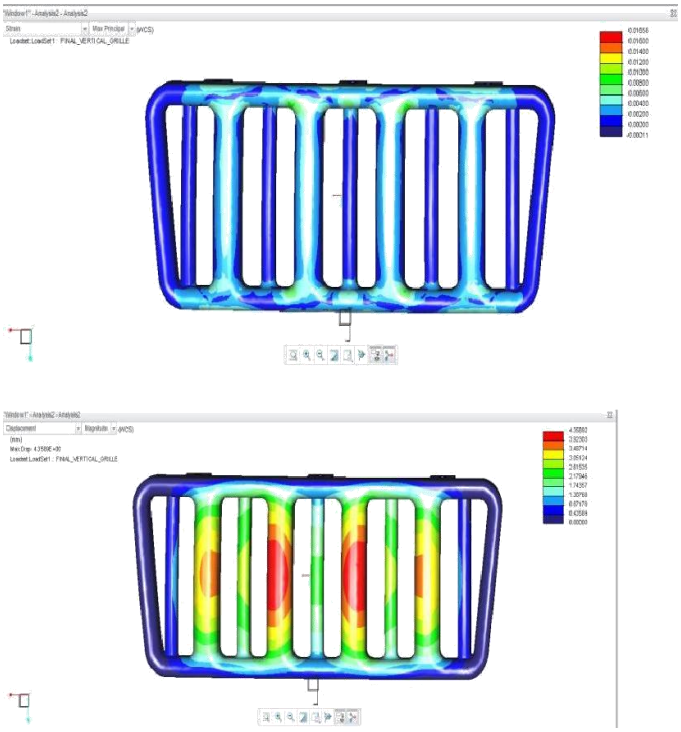
VI. ANALYSIS OF THE COMPONENT STRUCTURAL ANALYSIS:

Structural analysis is the determination of the effects of loads on physical structures and their components. Structures subject to this type of analysis include all that must withstand loads, such as buildings, bridges, vehicles, machinery, furniture, attire, soil strata, prostheses and biological tissue.

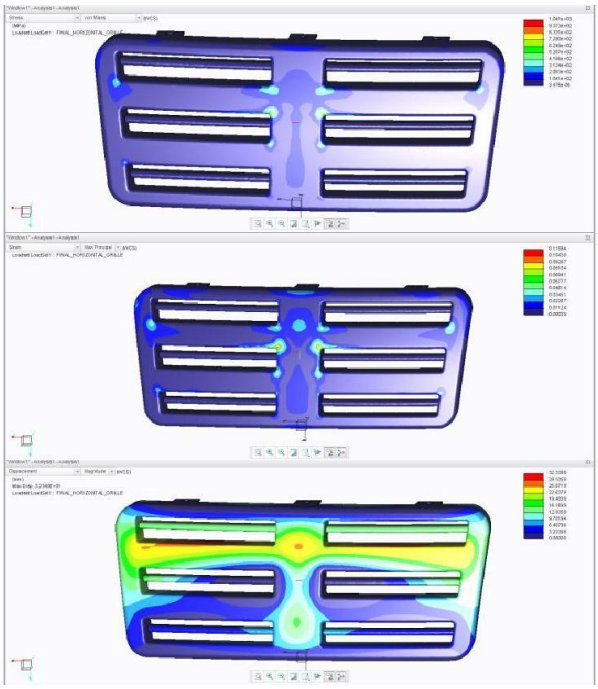
The results of the analysis are used to verify a structure's fitness for use, often precluding physical tests. Structural analysis is thus a key part of the engineering design of structures.

Vertical Grille of ABS/PC alloy:





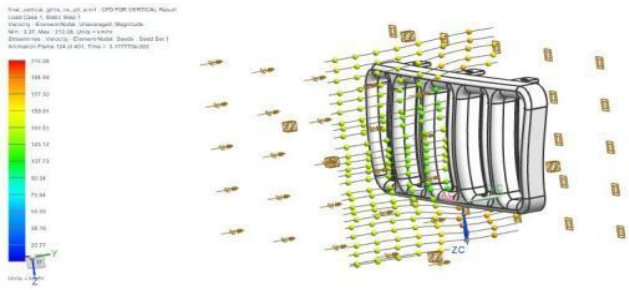
Horizontal Grille of ABS/PC alloy:



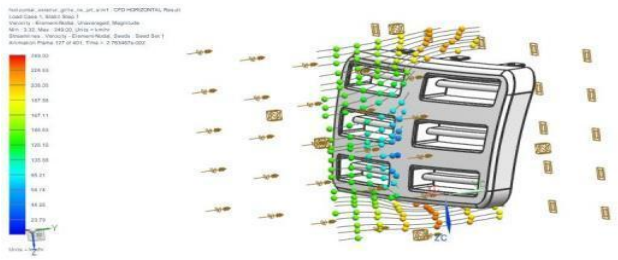
FLOW ANALYSIS:

Software Description:

NX from Siemens PLM software delivers next-generation design tools and techniques that help companies transform product development. With industries broadest suite of integrated, fully associative CAD/CAM/CAE applications, NX touches the full range of development processes in product design, manufacturing and simulation.



Flow analysis of vertical grille



Flow analysis of horizontal grille

VII. TOOL DESIGN

Injection moulding is a manufacturing process for producing parts by injecting material into a mould. Injection moulding can be performed with a host of materials mainly including metals, (for which the process is called die-casting), glasses, elastomers, confections, and most commonly thermoplastic and thermosetting polymers. Material for the part is fed into a heated barrel, mixed, and forced into a mould cavity, where it cools and hardens to the configuration of the cavity.

Parts to be injection moulded must be very carefully designed to facilitate the moulding process; the material used for the part, the desired shape and features of the part, the material of the mould, and the properties of the moulding machine must all be taken into account. The versatility of injection moulding is facilitated by this breadth of design considerations and possibilities.

A. TOOL DESIGN FOR VERTCAL GRILLE:

The tool for the vertical component is manufactured by mold cavity manufacturing process in CREO PARAMETRIC. This is done by following process,

1) Reference model:

This step is used to import the model into the mold cavity window and the work piece for the model is generated by the work piece option.

2) Mold volume:

This step is used to create the slider for the fastener hole.

3) Parting surface:

In this step, the parting surface is created which separates the mold core and mold cavity.

4) Volume split:

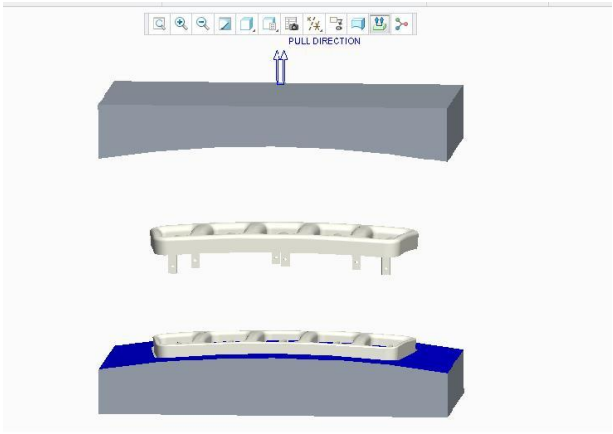
This step is used to split the mold core and mold cavity

5) Cavity insert:

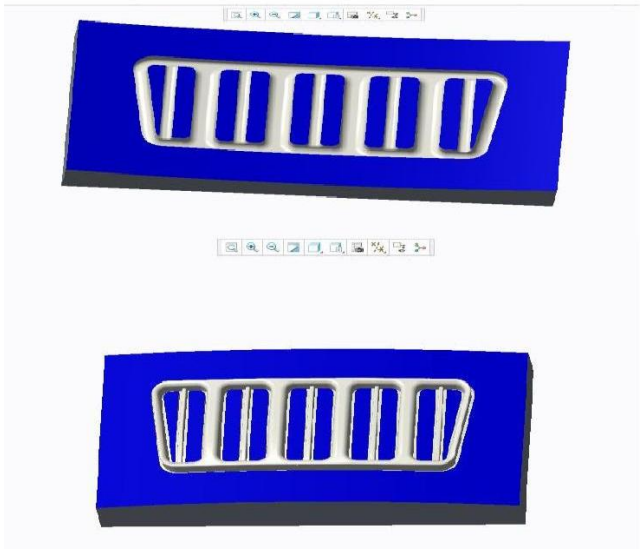
This step is used to the make the core and cavity as a model in a working directory.

6) Mold opening:

This step is used to animate how the core and cavity separate by create the model. The mold opening of the vertical grille is shown in below,



Mold opening of vertical grille



Core and cavity of vertical grille

B. TOOL DESIGN FOR HORIZONTAL GRILLE

The tool for the horizontal component is manufactured by mold cavity manufacturing process in CREO PARAMETRIC. This is done by following process,

1) Mold volume:

This step is used to create the slider for the fastener hole.

2) Parting surface:

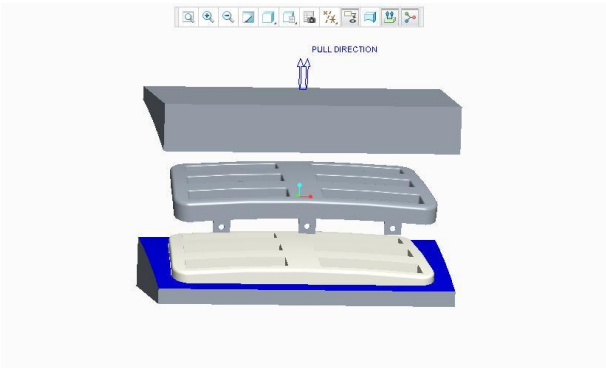
In this step, the parting surface is created which separates the mold core and mold cavity.

3) Volume split:

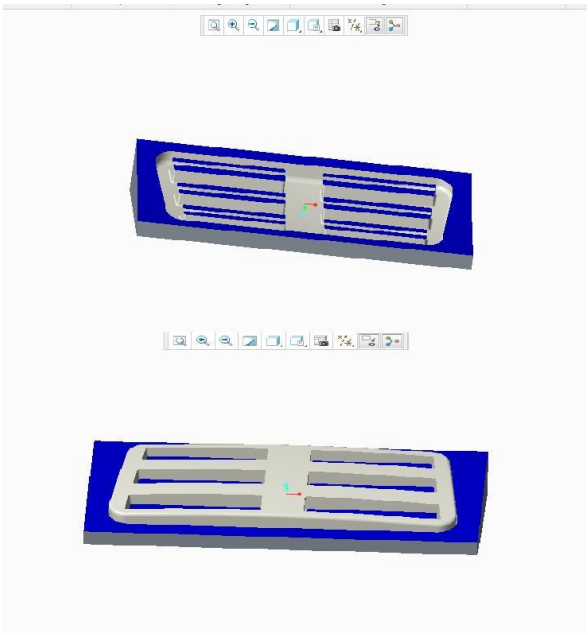
This step is used to split the mold core and mold cavity

4) Cavity insert:

This step is used to the make the core and cavity as a model in a working directory.



Mold opening of horizontal grille

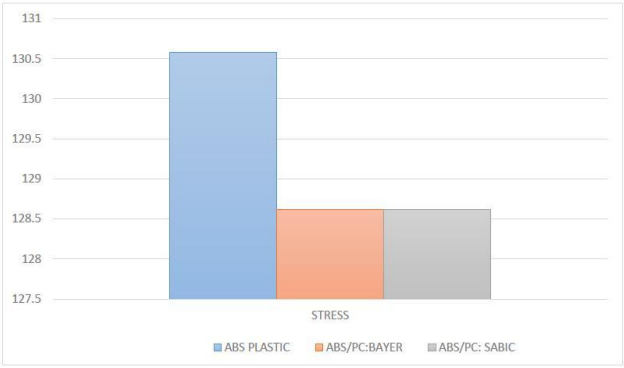


Core and cavity of horizontal gille

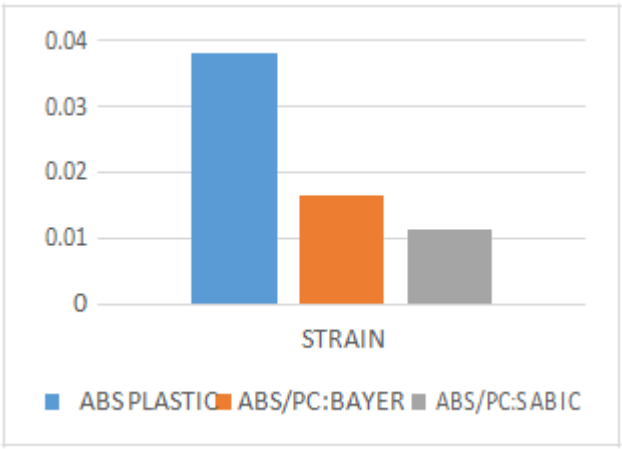
VIII. RESULT AND DISCUSSION

In this report the external grille of BOLERO SLX was discussed fully.

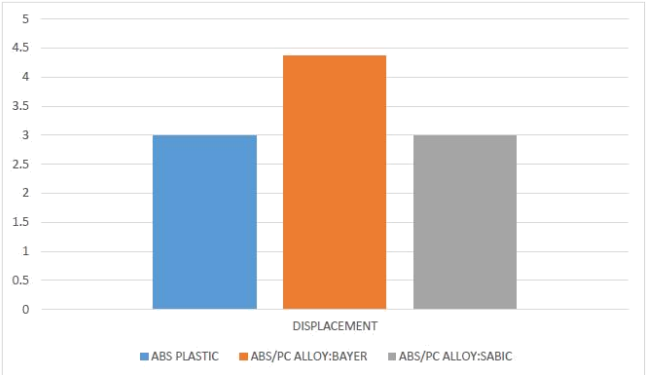
The structural analysis and flow analysis of billet grille's result is done and described below,



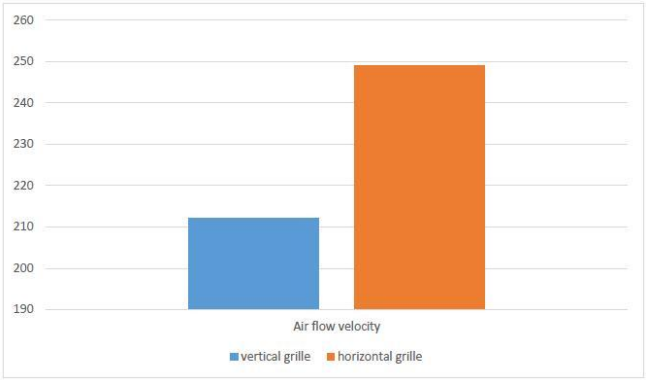
Stress of ABS PLASTIC, ABS/PC ALLOY of BAYER AND ABS/PC ALLOY of SABIC



Strain of ABS PLASTIC, ABS/PC ALLOY of BAYER AND ABS/PC ALLOY of SABIC



Displacement of ABS PLASTIC, ABS/PC ALLOY of BAYER and ABS/PC ALLOY of SABIC



Air flow velocity of vertical grille and horizontal grille

IX. CONCLUSION AND FUTURE WORK

Conclusion:

From the above result,

- As per the mechanical ability is concerned, the VERTCAL BILLET TYPE is suitable.
- As per the flow velocity is concerned, the HORIZONTAL BILLET TYPE is suitable.
- As per the material is concerned, the material ABS/PC alloy is suitable as it is higher cost than the ABS plastic because of their strength.

Future work:

This might be give a best result by using the MESH type of grille combined with BILLET type of grille in the name of cross grille. The advantage behind this combination of mesh grille with billet grille is the protection of the radiator and the surrounded part from stacking of external objects into external grille.

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