

Innovative Use of IMC Process and Laminate Thermoforming Process 'LIGHT WEIGHTING'

AutoDynamic Technologies & Solutions Pvt Ltd
“Delivering Ideas to Products”



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IMC PROCESS

IMC / LFT Principle

Get the Benefit together

Injection Molded Composite Process - Principle

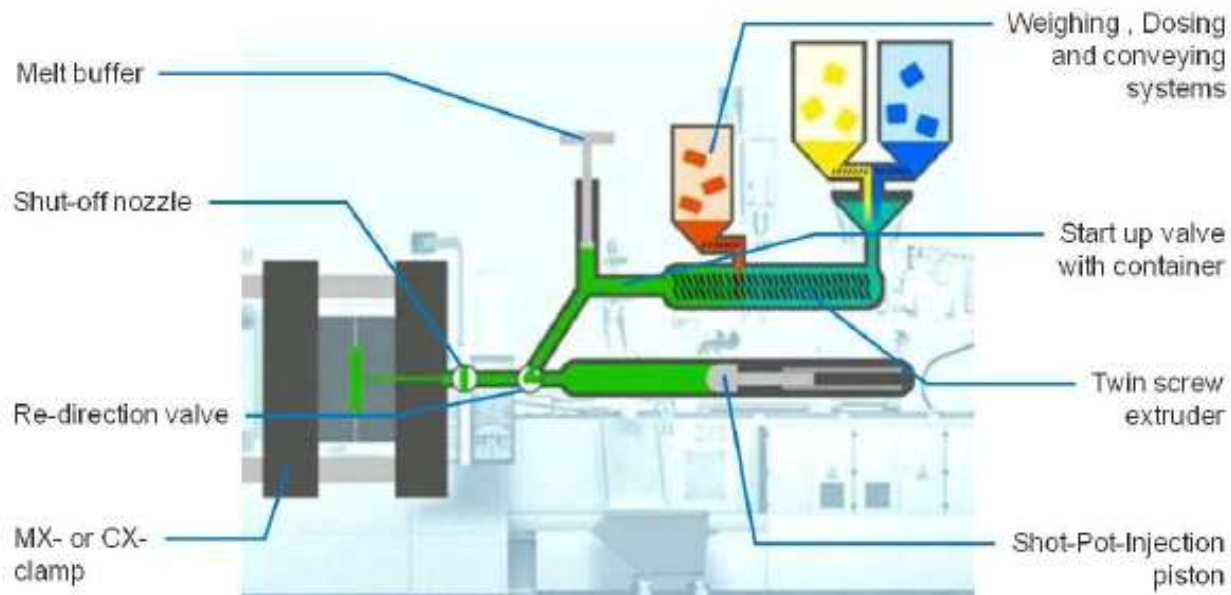
Injection Molding:

Single screw
Material processing
Discontinuous process

Extrusion:

Twin screw
Material compounding
Continuous process

Continuous and discontinuous – Two in One

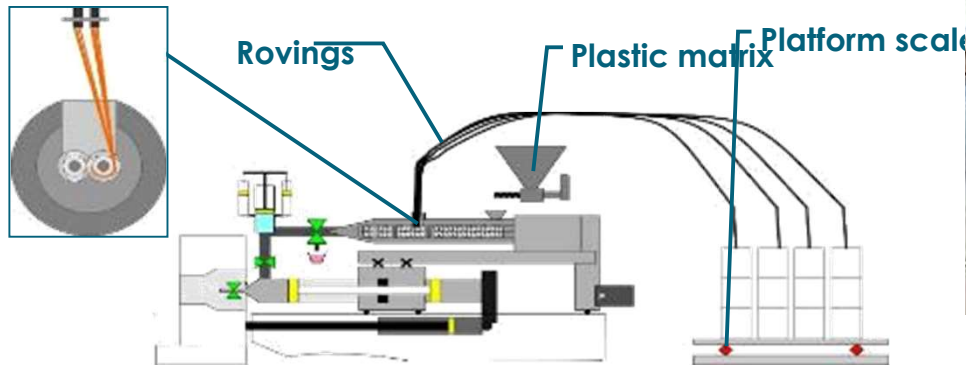


IMC PRINCIPLE

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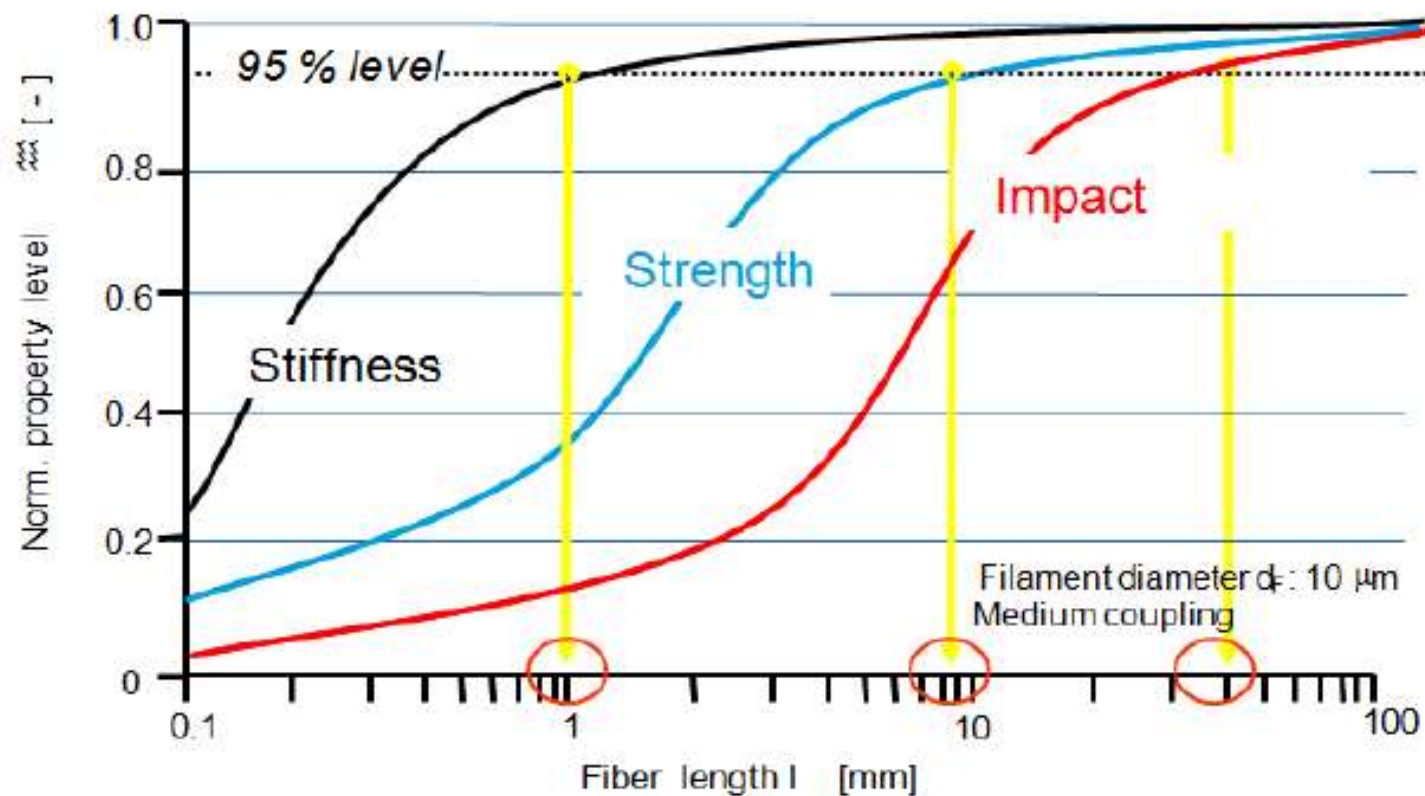
What makes an IMC suitable for long glass fiber applications?

IMC with platform scale



Influence of fiber length on mechanical properties

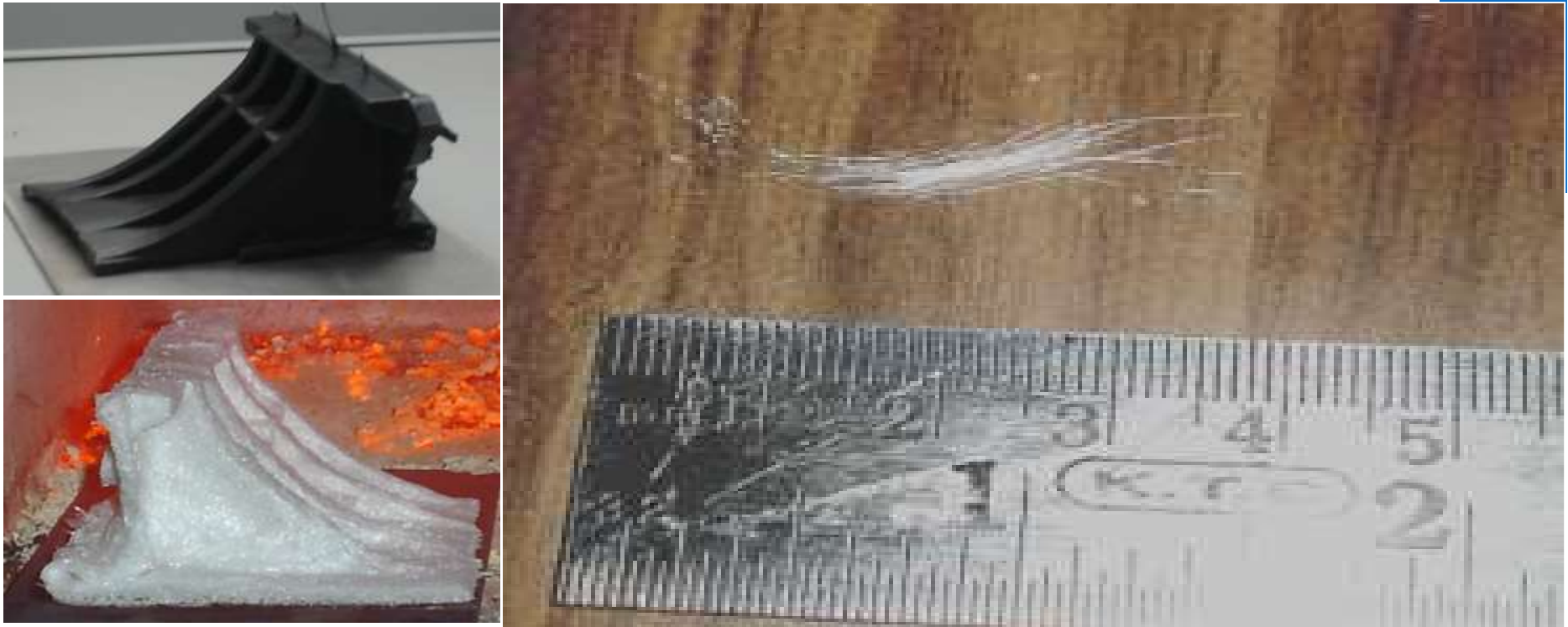
Long glass fiber – PP/GF (qualitative)



Source: FH Rosenheim, Prof. Schemma, based on Thomason & Vlugs

ACTUAL FIBER LENGTH

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Note - Testing done on part level, test specimens cut from the actual molded part.

Part thickness was in the range of 2.5 to 2.7 mm.

Fiber length - GF Injection molding = < 0.5 mm

- LFT / LGF Injection Molding = < 1mm

- IMC = minimum 5mm & even more than 30mm in MANY areas



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ACTUAL RESULTS ON PART

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Sr. No	Property	Specification	Condition	Unit	Conventional Injection molded part	IMC molded part				
1	MATERIAL				PP GF 20 (APPCOM G2CC BK UV)	PP GF 20	PP GF 15	PP GF 10	PP GF 5	PP MFGF 1010
2	FILLER CONTENT	ASTM D 5630	800 °C	%	20	20.7	15.82	11.25	5.54	19.46
3	IMPACT STRENGTH	ASTM D 256	23 °C	kg.cm/cm	3.98	10.95	7.91	6.41	4.72	6.69
4	TENSILE STRENGTH	ASTM D 638	23 °C	kgf/cm ²	109.5	480	475	453	375	439
5	ELONG. At Break	ASTM D 638	23 °C	%		4.9	6.03	6.24	8.11	6.69
6	FLEXURAL MODULUS	ASTM D 790	23 °C	kgf/cm ²	6075	34785	22370	21648		23746
7	FLE. Strength	ASTM D 790	23 °C	kgf/cm ²		855	753	623		584
8	SPECIFIC GRAVITY	ASTM D 792	23 °C	gm/cc		1.037	1.014	0.984	0.942	1.029
9	HDT AT 4.6 Kg/cm2	ASTM D 648	23 °c	°C						

Note - Testing done on part level, test specimens cut from the actual molded part.

Part thickness was in the range of 2.5 to 2.7 mm.



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Sustainable Long Term Benefits- IMC

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Weight reduction of 30% to 50% - Impact due to

➤ **Specific gravity difference between metal & plastics.**

Cost reduction of 10% to 20% - Impact due to

➤ **Process cost** - Combination of 2 process of extrusion & injection molding to 1 process of IMC.

➤ **Raw Material Cost** - Elimination of RM cooling, drying, packing, transport and then re-melting granules in injection molding to make parts. Can select RM ingredients and compound & injection in 1 shot.

➤ **Quality improvement** – Better Retention of Polymer properties by reducing one melting cycle

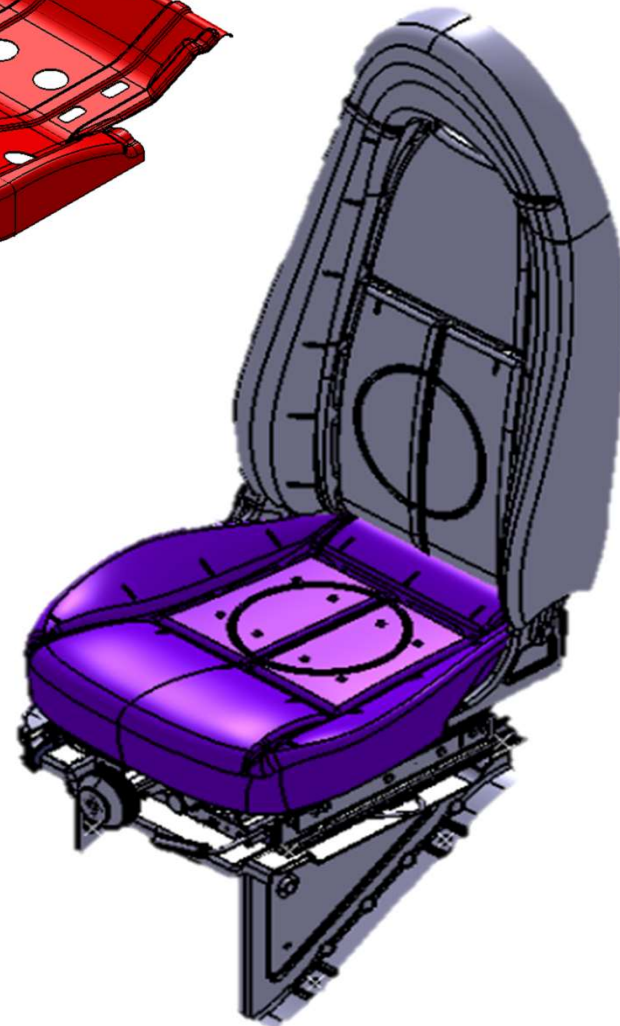
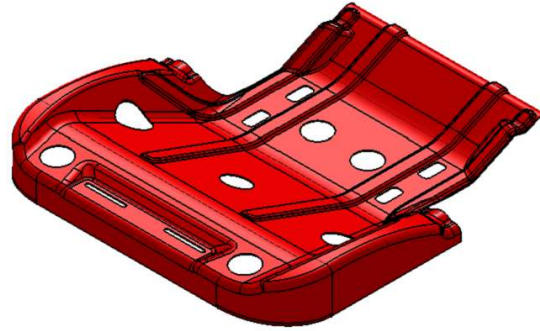


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Innovation in IMC Process (Fabric Lamination) Eg of Seat Pan

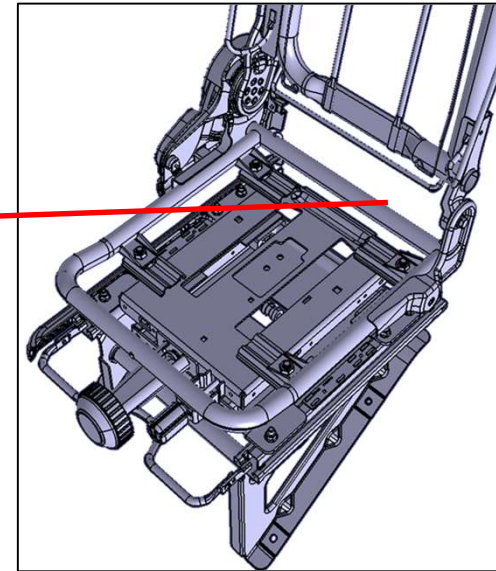
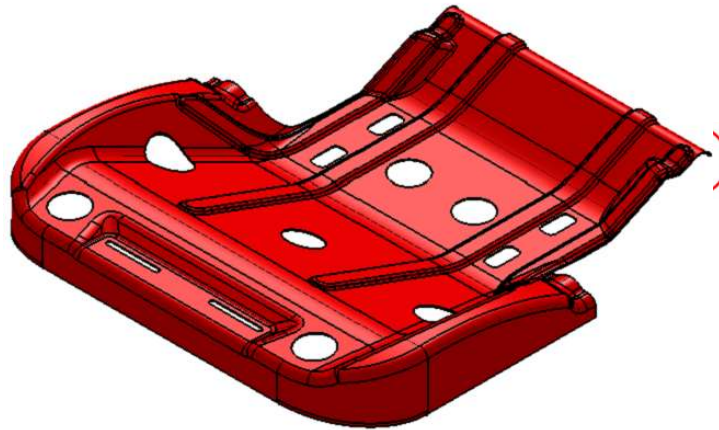
Product – Seat Pan

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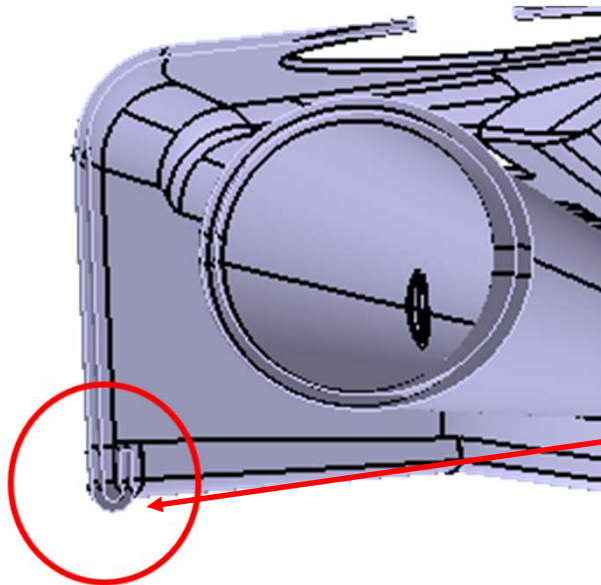


Metal Seat Pan - Mounting & Fixing

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Base Structure & Pipe Frame Assly mounting 4 location Welding Operation to be done to Fix Metal Seat pan with Base Frame Structure and also as shown in fig Metal Curve Will be Welded on the Metal pipe.



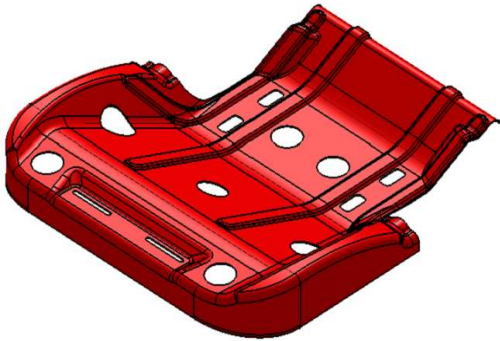
U type feature for fabric hooking is Provided in Metal part, As shown Above With this U type Structure Fabric Hooking Can be Fixed.

Objective

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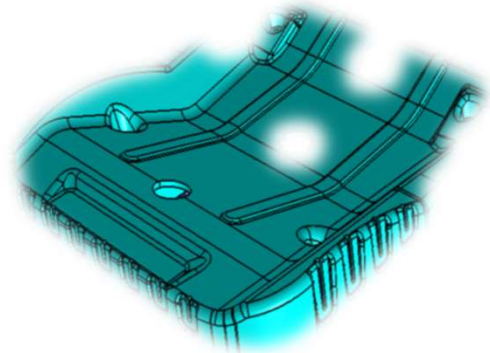
Objective :- Weight reduction of seat structure through conversion of metal seat pan to plastic composite seat pan.

- Variants – Multiple Variants
- Volumes – ~1,00,000 Per Annum
- Tool – To prove out to meet all Testing Requirements



Sheet metal Seat Pan

**Weight Reduction by
30% -40% approx
Part thickness 2.8 to
3.0 mm.
Rib thickness can be
maintained 1.1mm**



Plastic IMC Seat Pan

Evaluating Material Options

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Sheet Metal

To

Plastic IMC

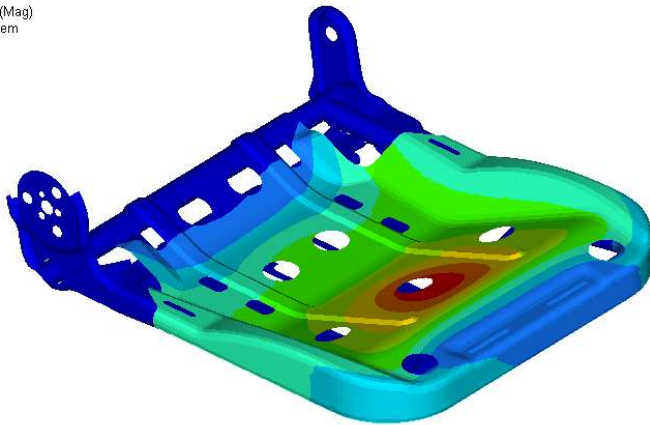


- Mfg. Process : Injection Moulding Composite
- Material : **PPCGF 30% OR PA6 CGF 30%**
- Material Thickness : 3 mm for PPCGF 30%
OR
2.2/2.5 for PA6 CGF 30%

Finalised Material Option

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Contour Plot
Displacement(Mag)
Analysis system
3.045
2.707
2.368
2.030
1.692
1.353
1.015
0.677
0.338
0.000
No result
Max = 3.045
Grids 1103
Min = 0.000
Grids 1490



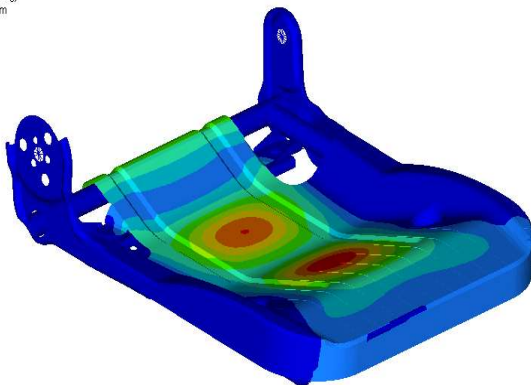
Weight: 3.218 kg
Thickness: 0.9 mm

Current design : Steel

Displacement: 3.045 mm

Proposed design: PP CGF 30 %

Contour Plot
Displacement(Mag)
Analysis system
3.959
3.519
3.079
2.639
2.199
1.759
1.320
0.880
0.440
0.000
No result
Max = 3.959
Grids 8177
Min = 0.000
Grids 11837

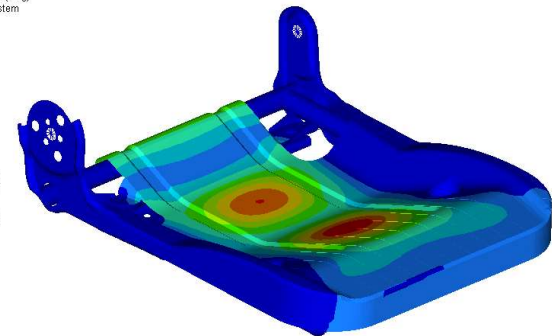


Displacement: 1.24 mm

Weight: 1.125 kg
Thickness: 3 mm

Proposed design: PA 6 CGF 30%

Contour Plot
Displacement(Mag)
Analysis system
3.959
3.519
3.079
2.639
2.199
1.759
1.320
0.880
0.440
0.000
No result
Max = 3.959
Grids 8177
Min = 0.000
Grids 11837

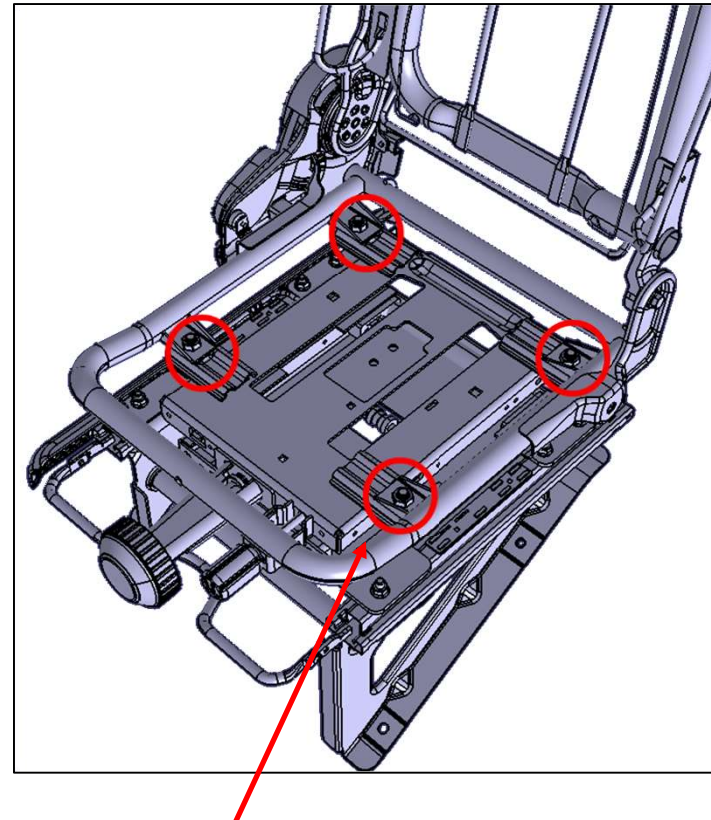
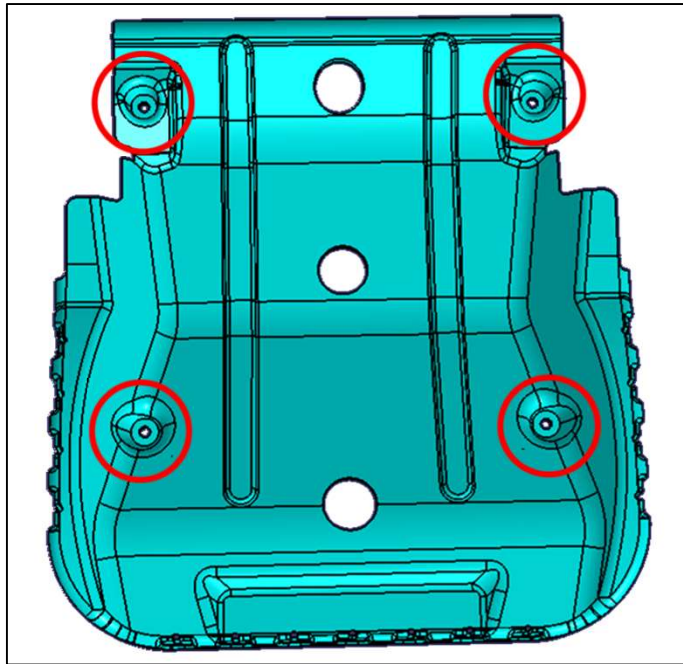


Displacement: 0.95 mm

Challenges in Assembly of Plastic Seat Pan

Mounting Strategy

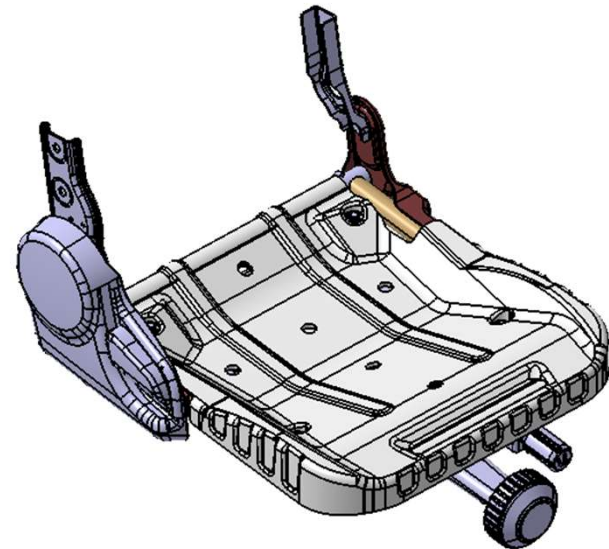
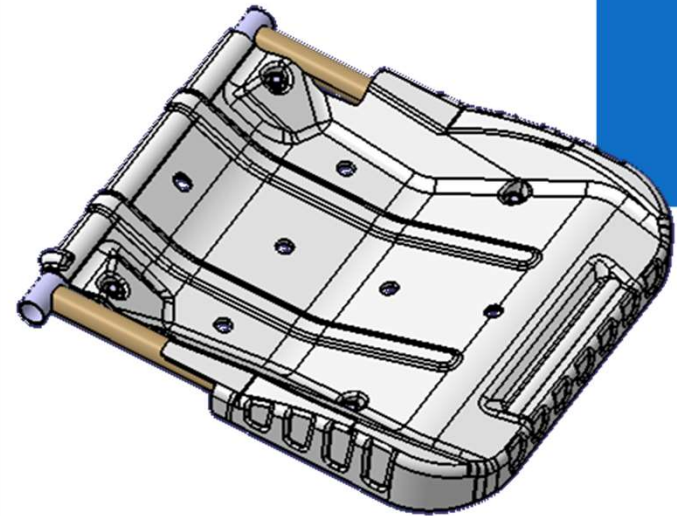
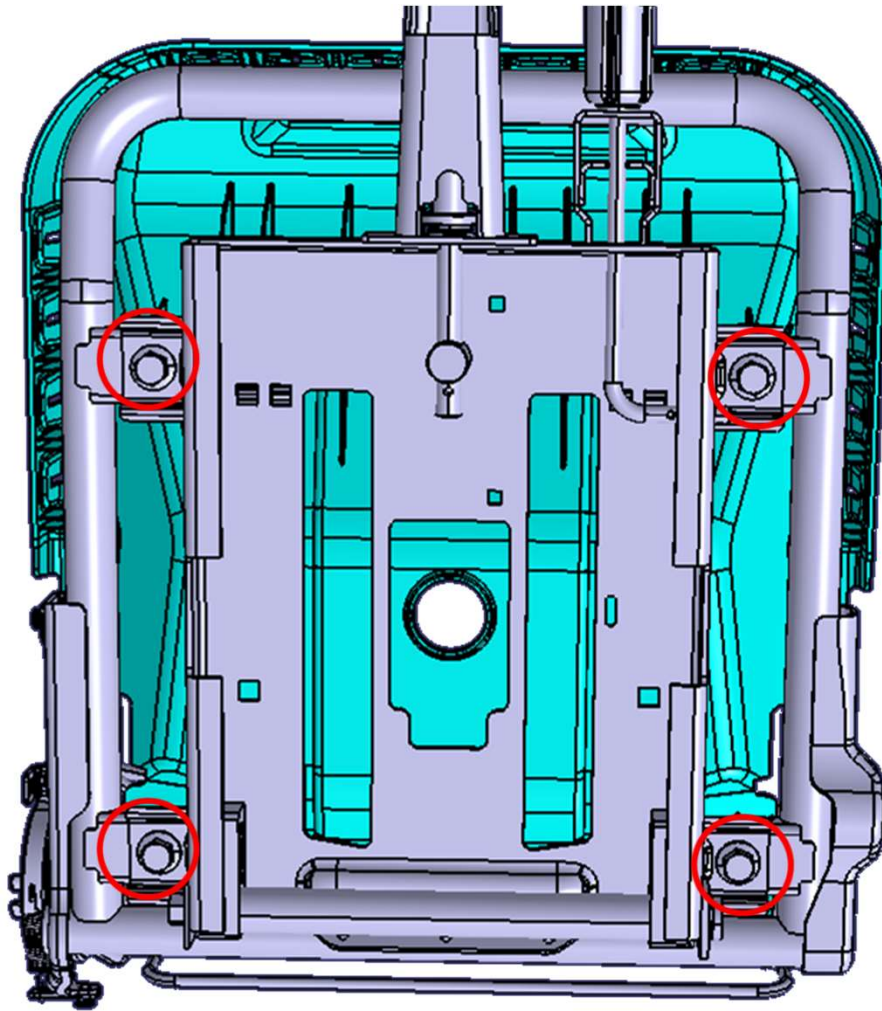
- ▶ Sheet Metal Seat Pan to be converted in the Plastic IMC.
- ▶ IMC Seat Pan with 04 Mountings for Fixing on Base structure



Base Structure & Pipe Frame Assly mounting 4 locations can be used for Plastic IMC Seat Pan Mounting in Seat Structure.
Welding operation will remove, due to integration of plastic IMC seat pan mountings with Base structure.

Part Fixing strategy

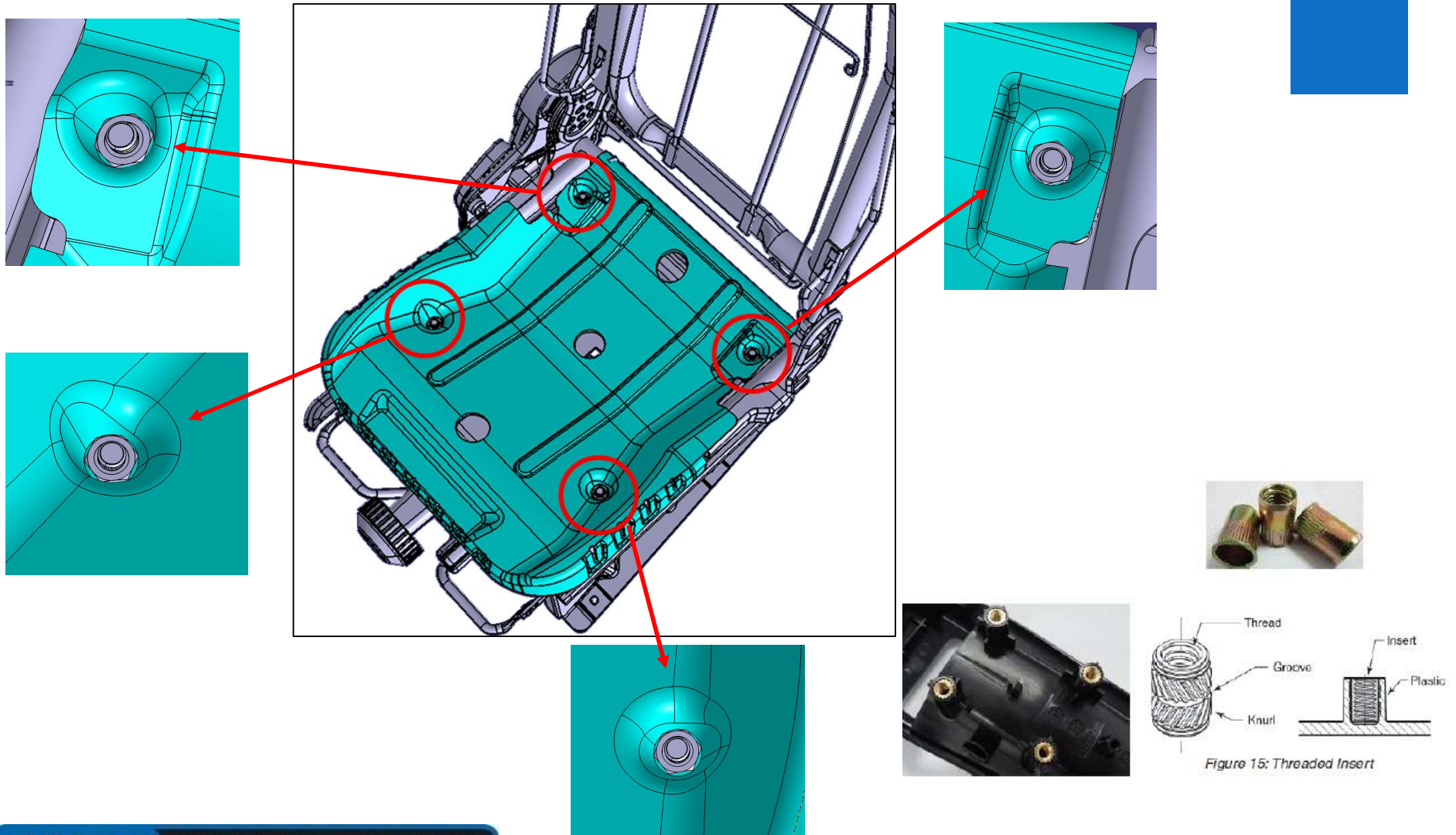
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Part Fixing strategy – Top View

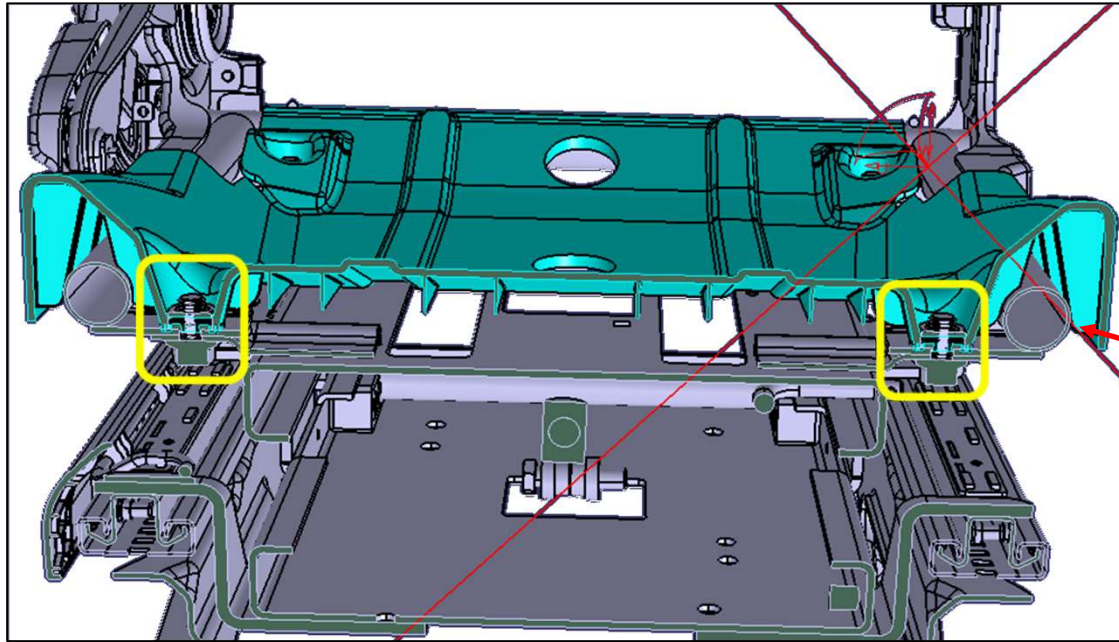
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- Mounting of IMC Seat Pan on Base Structure.
- Threaded insert can be proposed in Plastic IMC Seat Pan & removal of bolting.

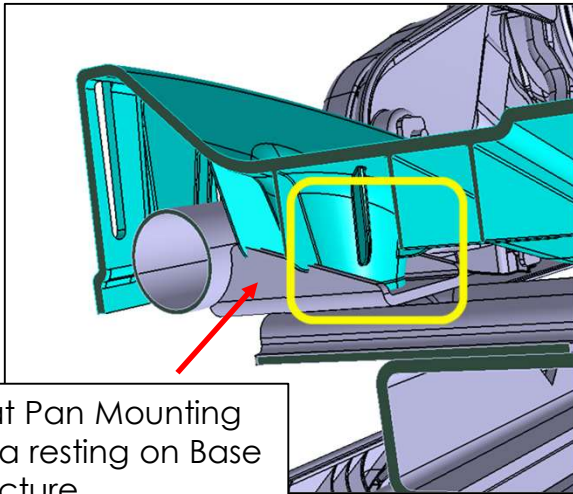


Sectional View of Mountings & Resting

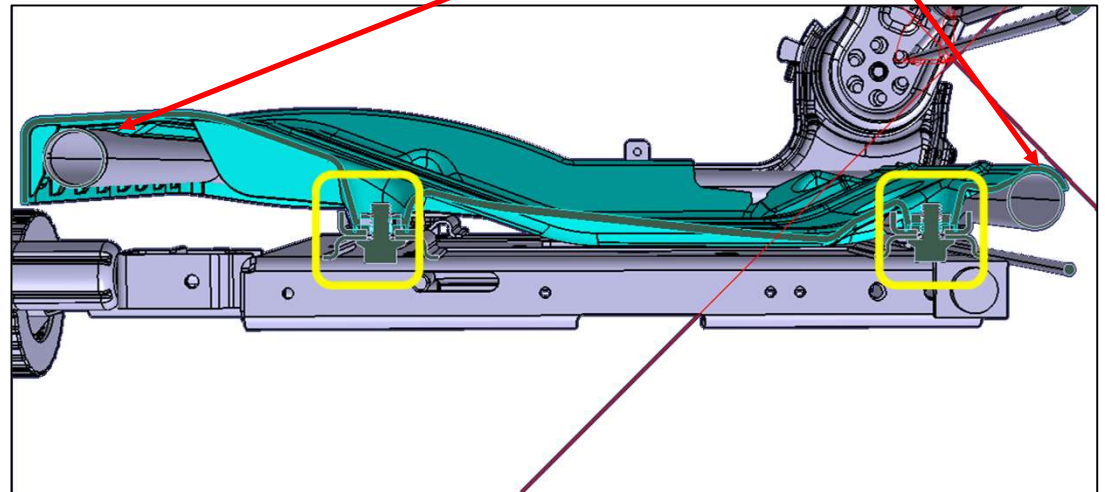
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Plastic IMC Seat Pan will be rested on Pipe frame structure. There will be no twisting of seat pan after mounting.

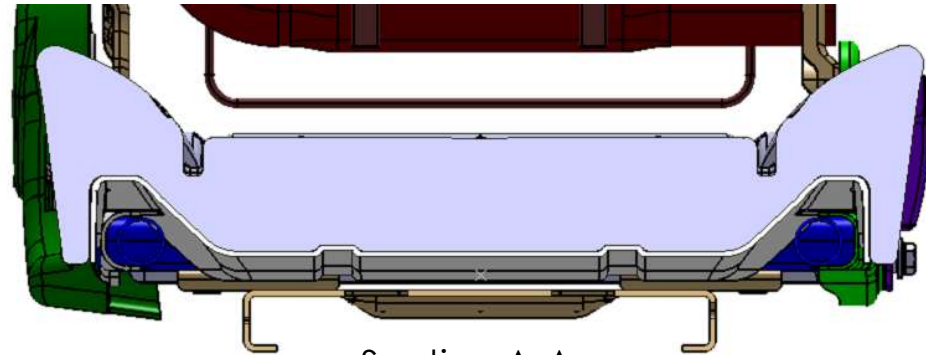
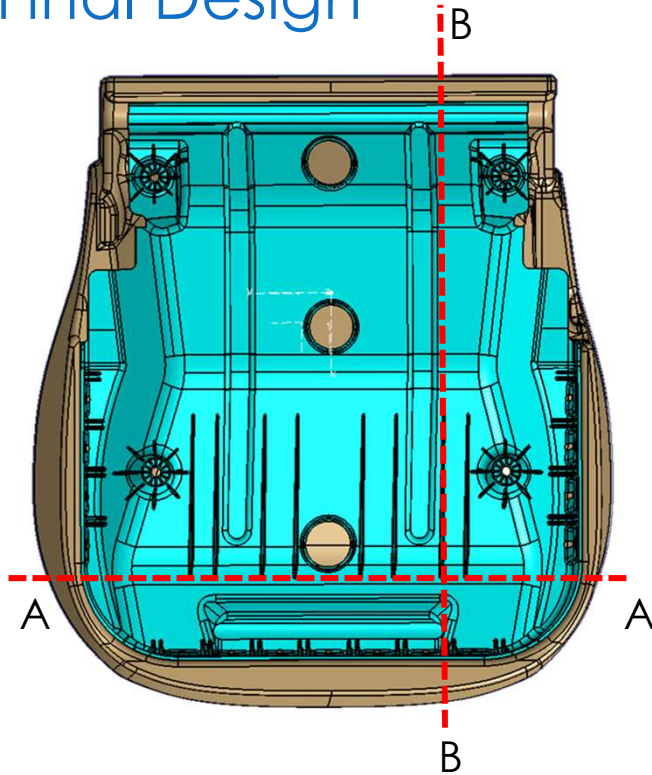


Seat Pan Mounting area resting on Base structure

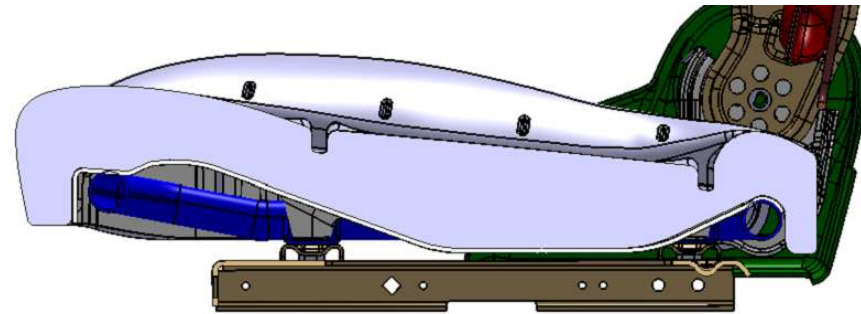


Final Design

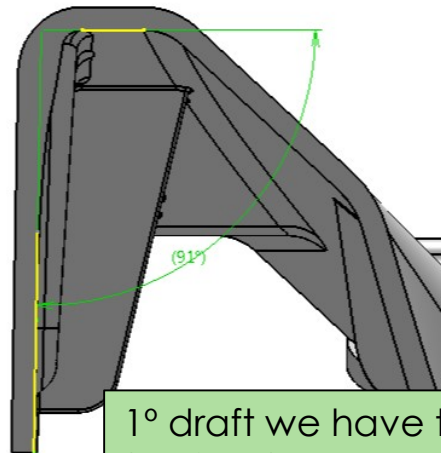
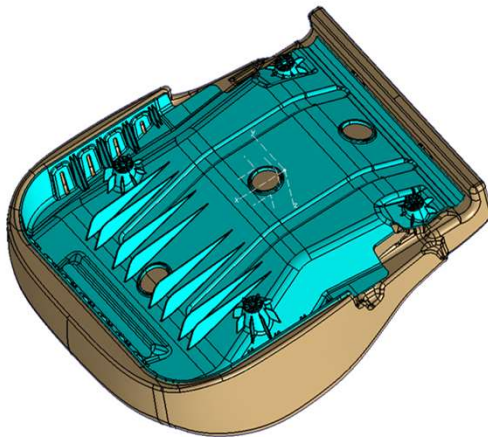
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Section A-A



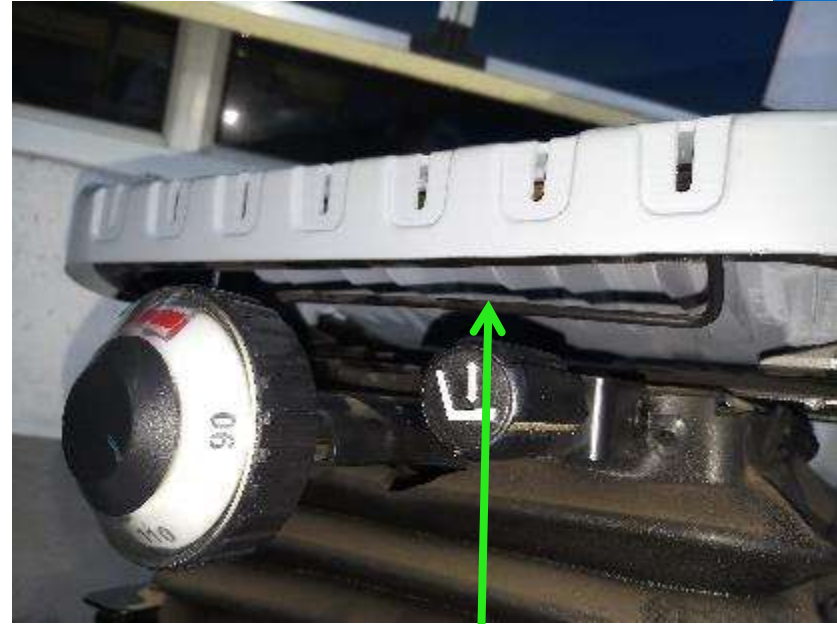
Section B-B



1° draft we have taken
for side flanges

We have considered Complete A surface of sheet metal seat as it is in plastic IMC seat pan concept, There is no change in profile in plastic IMC seat pan, **So it will not be affected on Foam profile.**

Seat Pan Assembly View on Structure

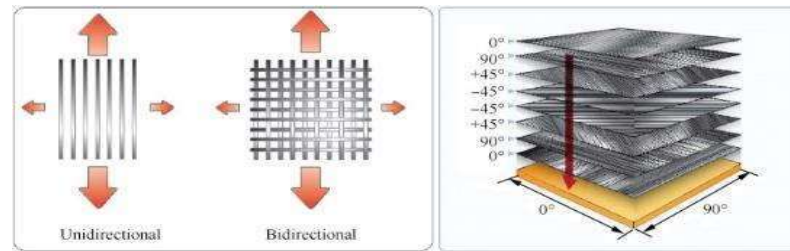
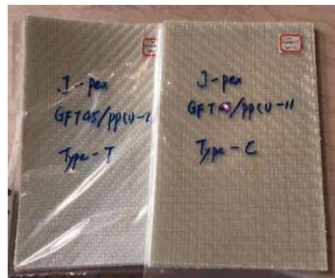
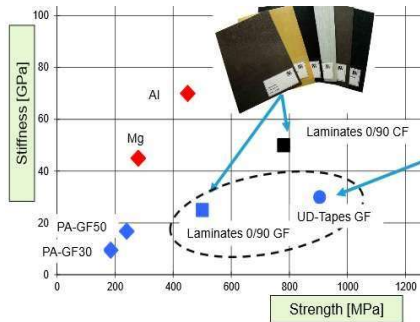


**Wire Frame for Fabric
Hooking at Front
portion of Seat**

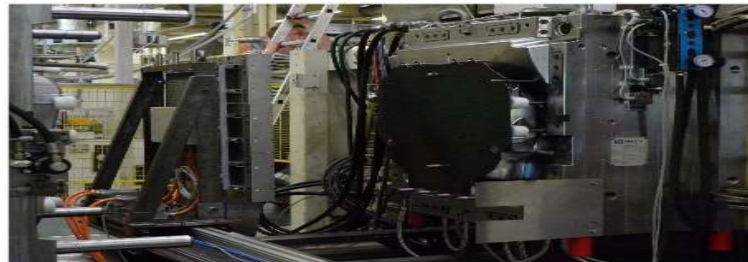
Combination of IMC Process and Reinforced Thermoplastics Laminates

Enhancing IMC Capability

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Items	unit	According to Standar	Value
Polymer	-	-	PP
Fiber	-	-	E-glass
Fiber content	vol.%	ISO 1172	45
Density	g/cm ³	ISO 1183-1	1.69
Thickness per layer	mm	-	0.5
Tensile strength	MPa	ISO 527-4	370
Tensile modulus	GPa	ISO 527-4	17
Flexural strength	MPa	ISO 14125	350
Flexural modulus	GPa	ISO 14125	16
Charpy notched impact strength	kJ/m ²	ISO 179	118



mold closing side

IR heater

laminate in open mold

mold injection side



Laminate

Laminate Heating

Injection Molding

FG Part



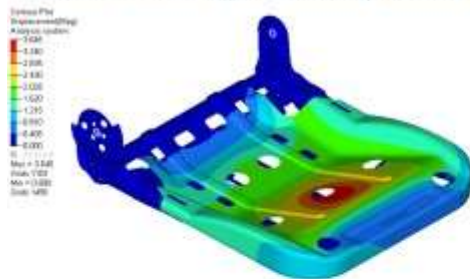
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Optimized design: PA 6 CGF 30% + PA Glass laminate

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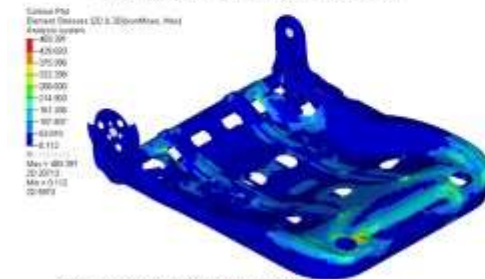
Weight: 0.9 kg
Thickness: 2.8 mm
(PA6 Thk : 2.3 mm & Laminate Thk: 0.5 mm)

Current design : Steel(Metal Seat Pan Part)



Weight: 1.40 kg
Thickness: 0.9 mm

Displacement: 3.645 mm



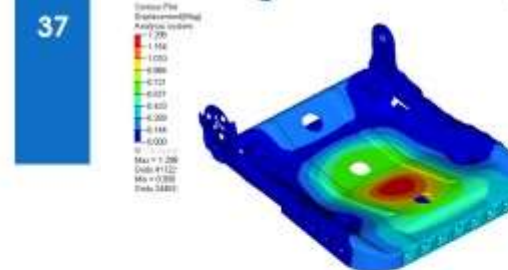
Stress: 483.391 MPa

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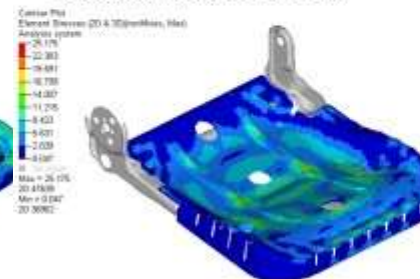
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IMC design: PA 6 CGF 30% + PA Glass laminate



Weight: 0.9 kg
Thickness: 2.8 mm
(PA6 Thk : 2.3 mm & Laminate Thk: 0.5 mm)

Displacement: 1.298 mm

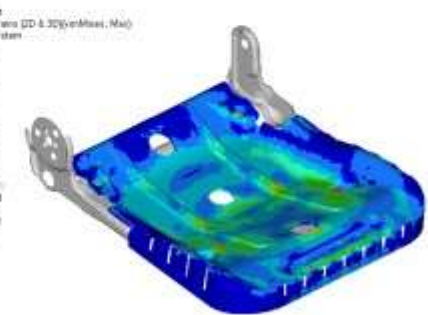


Stress: 25.175 MPa

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Strain: 0.001

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Introduced PA 6 Glass Laminate

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Molding in IMC with Glass Laminate

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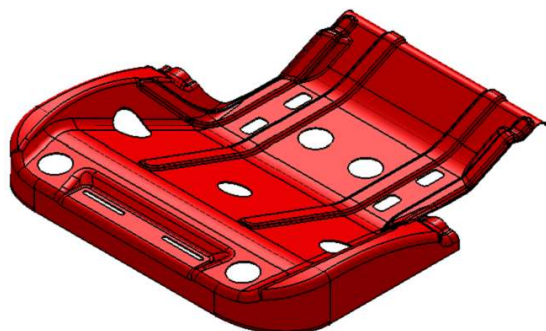


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Seat Pan – Weight Reduction

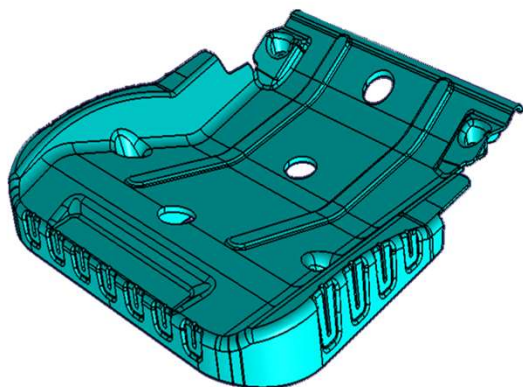
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Sheet Metal



WEIGHT 0.9 mm Thk. Sheet Metal = 1.40 kg

Plastic IMC



WEIGHT 2.8 mm Thk. (PA6 CGF 30% + PA GF Laminate) = 0.9 kg

**Weight Reduction in Plastic IMC
Seat Pan by 35-40%.**

New Parts Developed with IMC Process



Seat Pan



Material: PA 6 – 30% + Glass laminate
Thickness: 2.2 – 2.6 mm
Weight reduction: 40% - 48 %

Foot Step



WEIGHT =2.698 kg(27% weight savings)
DEFLECTION OF MODEL=9.68 mm
STRESSES OF MODEL=88.05 Mpa

Tailgate Inner



Material : PPCGF 30%
Weight of Plastic Part : ~8.2 kg
Weight Reduction : 30%

Steering Wheel



Material: PA 6 – 40% LFT
Weight reduction: 40% - 48 %
String Ribbing for better strength & durability

Bumper Beam



Weight: 1.05 kg

Weight Reduction: (52% Saving)

Battery rear Tub



Weight of Plastic Part : 4.47 kg

Weight Reduction : 33%

Battery Top Cover



Weight of Plastic Part : ~7.1 kg

Weight Reduction : 32%

Front End Carrier



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Thank You



Delivering Innovative solutions ahead of times to Automotive Industry

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