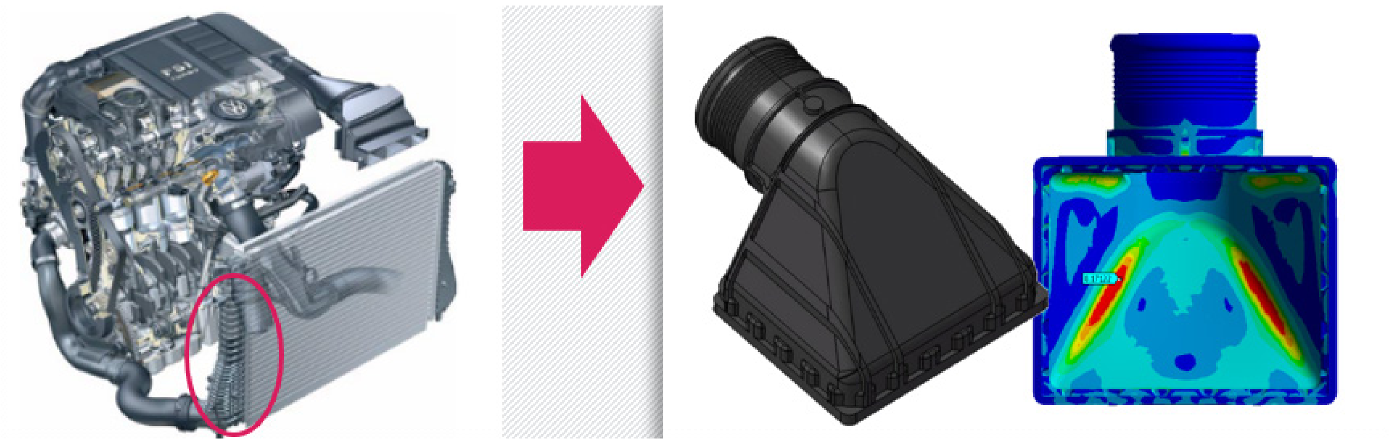
From material to part performance

HEXAGON | MSC Software



Email: info.es@mscsoftware.com | **Telf.**: +34 915 560 919 | **Web**: www.mscsoftware.com

Sector: Automotion

Challenge: The objective is to demonstrate that the intake manifold manufactured in SLS achieves the same performance; for tolerances and resistance compared to its injection counterpart.

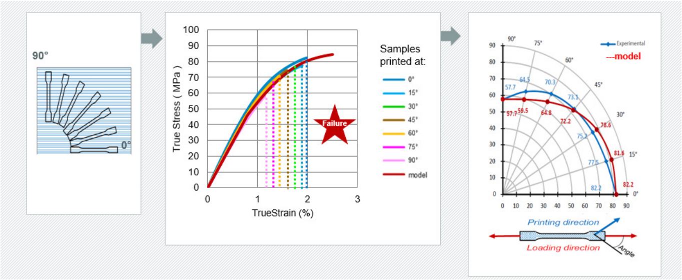
Solution: Solve the challenges associated with AM technology: orientation-dependent material properties, distortion compensation, and structural integrity.

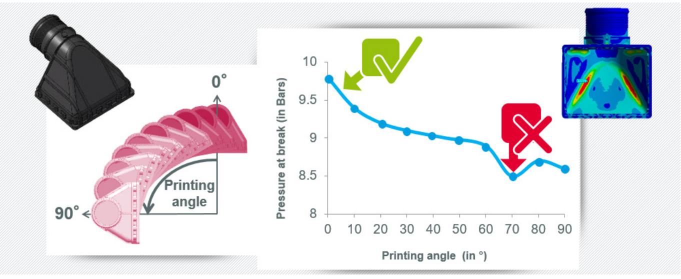
CHALLENGE

Due to the fact that parts are built of layer superposition, laser sintering can quickly produce components that integrate complex internal features and functions. However the direction in which the part is built greatly affect the printed part strength.

Although the printed material behavior is not highly affected by the building direction, its ultimate strength is reduced in the stacking direction. This issue is inherent to additive manufacturing processes, as successively deposited layers are not perfectly bounded together.

At the same time additive manufacturing processes are driven by a thermo-mechanical behavior which cause expansion and shrinkage deformations which results in a distorted shape from nominal dimensions. This could lead into part rejection or malfunctioning.



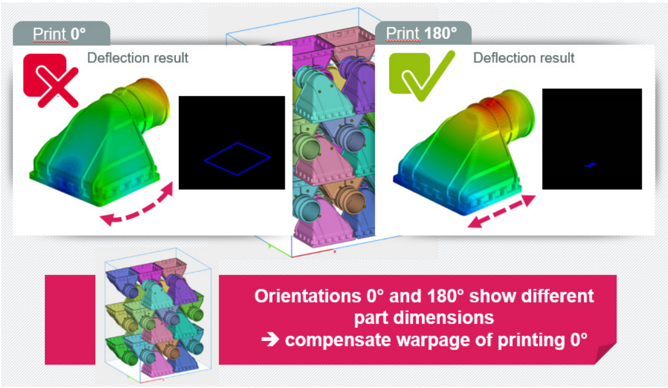


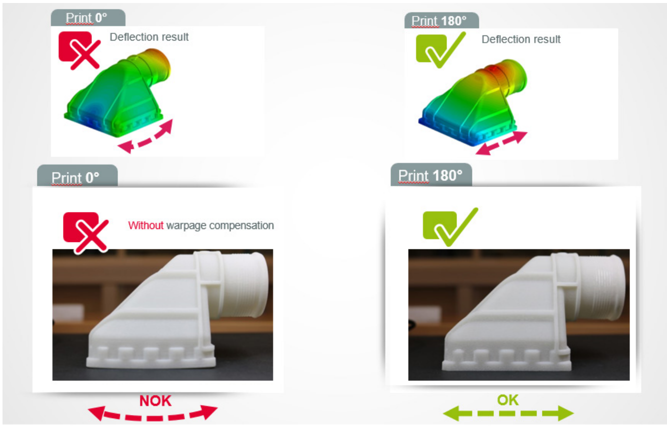
SOLUTION

First step would be to create and calibrate the material behavior using the appropriate constitutive law. The glass beads are modelled using an elastic law while the pressure-dependent Drucker-Prager model is well suited to catch the matrix behavior.

To fully characterize the failure surface using the appropriate failure criterion. The failure surface shape, specific to 3D printed material, can be well fitted with a generalized version of the Tsai-Wu transversely isotropic failure criterion.

Then the printing process would be simulated helping to identify part warpage and residual stresses as a function of the material and process parameters. Last a coupled calculation is performed taking in to account residual stresses and material behavior to establish the ultimate pressure loads the part is able to withstand depending on the printing orientation.





ADVANTAGES

By this way, manufactured parts optimal structural response can be observed for 0 and 180 degrees of orientation. With a maximum pressure values well above the requirements. However, for orientations between 45º-90º the component failure is below the minimum expected pressure.

Despite the fact that both 0º and 180º manufactured parts are valid from structural integrity point of view, the one manufactured at 0º presents a distortion in its shape due to the position it occupies within the powder chamber. Such distortion can prevent the correct functionality of the part in the form of refrigerant leaks.

For this reason, it is necessary to use the distortion compensation tool, so that the final part built at 0º be very close to the nominal geometry.

In short, MSC Software tools for additive manufacturing allow the use of simulation throughout the entire product design cycle, from creating and implementing the material model, simulating the manufacturing process, to finally check its mechanical performance.