Topology optimisation improves rail component

When Alstom, Spain, wanted to improve the design of an existing cast rail component, the company employed HyperWorks as well as solidThinking Inspire® and Evolve® for design optimisation. The company then turned its attention to exploring additive manufacturing as an alternative manufacturing technique.

While investigation a component used in Alstom's Metropolis train bogies to support the anti-roll system, it was found that the first design of the part seemed much too strong for the occurring workloads, and the finite element (FE) model revealed that the safety factor was high.

As a first step, an analysis with solidThinking Inspire was carried out, providing the same results. To improve the overall design while at the same time optimising material use, the optimisation options were extended by increasing the design volume of the part, followed by a topology optimisation.

As a result of several iterations with Inspire, a customised solution was found; the exterior shape was refined and fixed with solidThinking Evolve.

The final geometry was then again verified with a detailed FE analysis. For this Alstom collaborated with local 3D printing companies.

Alstom a world leader in integrated railway systems

As a promoter of sustainable mobility, Alstom develops and markets systems, equipment and services for the railway sector. The company manages the widest range of solutions in the market – from high-speed trains to metros and tramways – offering customised services such as maintenance, modernisation, infrastructure and signalling solutions.

Alstom recorded sales of €6.9-billion and booked €10.6-billion in orders in the 2015/16 fiscal year. Headquartered in France, Alstom is present in over 60 countries and employs 31 000 people.

The component optimisation project described here was carried out by the Bodyshell and Calculation department in Barcelona, which is regularly designing and verifying the different train structures Alstom develops as the consultant to other Alstom departments on technical matters.

“We are very satisfied with the results achieved since we have realised better designs that fulfil all structural requirements in the shorter term. Currently HyperWorks is our main tool for structural studies as well as for the development of the best possible solutions, and we plan on using it for a long time”: Juan Manuel Romero a structures and calculation lead engineer at Alstom, Barcelona.

The challenge

In every industry development engineers strive for the best manufacturing and development processes in order to create the finest possible products. When searching for the perfect structural design solutions, they have to consider technical and economical aspects. Simulation enables them to achieve their goal and supports them in the entire product creation process. At Alstom in Barcelona the engineers usually receive several inputs, (strength, volume constraints, thermal, and others) to study the geometry, the material, and the mountings.

Then they check the solutions they came up with and generate graphical representations. Usually, the Alstom engineers handle several simulations per week, helping them to overcome any development obstacles that might occur. To address these challenges Alstom has to use sophisticated software tools allowing them to handle all related development tasks and to support the product creation process as a whole.

The solution

To handle their simulation tasks, Alstom Barcelona applies HyperWorks for meshing tasks and to perform static FE analyses. For optimisation and design tasks the engineers rely on solidThinking’s products, Inspire and Evolve, in particular. These tools allow them to address issues such as material questions, geometries and compatibilities between manufacturing processes and the designs.

Before the engineers started with the re-design of the component to support the anti-roll system, the existing design had been analysed. Since the FEM model showed that the safety factor was a too high, an analysis with solidThinking
Altair for synthesis and optimisation

Altair is focused on the development and broad application of simulation technology to synthesise and optimise designs, processes and decisions for improved business performance. Privately held with more than 2,000 employees, Altair is headquartered in Troy, Michigan, USA and operates more than 45 offices throughout 22 countries. Today, Altair serves more than 5,000 corporate clients across broad industry segments.

Alstom optimisation highlights

**Industry:** Transportation/railway.

**Challenge:** Optimisation of an existing component design to be manufactured using casting or, alternatively, using additive manufacturing technologies.

**Altair solution:** Simulation driven design approach with solidThinking Inspire for topology optimisation; Evolve for shape refinements; and HyperWorks for FE analysis.

**Benefits**
- Reduced development time.
- Improved components with less weight and increased stiffness.
- Detailed insights into new additive manufacturing production options.