AFRC
ADVANCED FORMING RESEARCH CENTRE
UNIVERSITY OF STRATHCLYDE

University of Strathclyde Glasgow

Rolls-Royce

AFRC demonstrates >15% improvement in material fatigue strength for candidate materials on UltraFan® Power Gearbox

Background

Rolls-Royce is developing its new UltraFan® engine design, which is set to deliver a 25% fuel efficiency improvement over the first generation of its original Trent engine.

The Innovate UK funded programme, MAMOTH PGB, has been set up to support the development of the gearbox for this new Rolls-Royce application.

With Rolls-Royce as lead partner, the project consortium also includes the AFRC, McLaren Racing, University of Newcastle, University of Nottingham, Swansea University, the MTC and the AMRC.

Customer challenge

The gearbox is a vital component of the UltraFan® engine design, providing power to the engine over a wide range of take-off thrusts, along with a reduction in overall engine weight.

With the gearbox design aimed at achieving 100,000 horsepower, this massive leap in power, compared to a traditional gas turbine engine, requires a robust gearbox that can support extremely high operating loads.

Consequently, it was necessary to analyse the candidate materials and manufacturing processes involved in future production of the gearbox in order to demonstrate the materials and mechanical integrity necessary for the UltraFan® application.

"The AFRC has made a hugely significant contribution to our understanding of gear manufacturing processes and provided a sound foundation on which we can develop improved methods of manufacture for gearbox components."

Peter Dixon, Rolls-Royce

How did the AFRC help?

We brought a blend of expertise in forging and incremental technologies, modelling, materials characterisation and residual stress to the project.

Through forging and forming investigations, we developed a deep understanding of methods and materials that would support development of the product application.

We analysed five gear steels across four different manufacturing routes, including machined from bar, pancake forging, near net shape forging and cold rolling, before testing them to failure.

We investigated manufacturing techniques, heat treatments, post-processing, metallurgical analysis and residual stress measurement, all aimed at enhancing and understanding the performance and fatigue strength of the gearbox.

Business impact

Based on the selected baseline material and utilising a developed manufacturing process, we demonstrated an improvement in fatigue strength (inclusive of standard deviation) of 19.7 % compared to gears that had been machined from bar.

Near net shape forged gears of within 0.4 mm of rough machine condition were also designed and successfully manufactured, providing opportunities for raw material reduction compared to conventional oversize forged gear manufacturing routes.

The work undertaken and technologies demonstrated and developed through the project have provided the foundations on which Rolls-Royce can build its manufacturing route for the UltraFan® Power Gearbox.

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