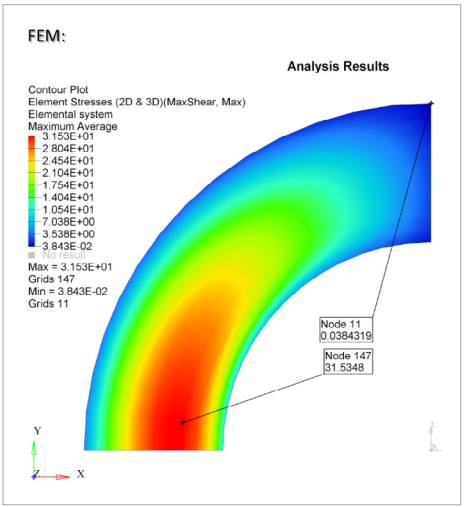
Advanced Composite Material Calculations with HyperWorks, LAP and CoDA



eStress
SUSTAINABLE • RENEWABLE • ENGINEERING

Key Highlights

Industry
Engineering Consultancy

Challenge
Develop practical and generalised approach to assess the behaviour of curved composite beams under corner unfolding loading for design sizing

Altair Solution
Access to all Altair and partner software via the Altair Partner Alliance

Benefits
- Access to latest software versions
- Quick software benchmarking
- Comparison of different processes
- FEA sanity checks
- Establishment of standard workflows

Customer Profile

UK-based eStress Ltd. primarily specialises in providing engineering analysis and software consultancy services to the aerospace and high-tech manufacturing industries, but also has a growing portfolio of innovative lightweight-structural products. The company combines extensive practical experience with advanced computer technology and software to assess and optimise new product designs, investigate the structural integrity of existing products and components, undertake failure analysis (F&DT), perform thermo-fluid behaviour, and assess the impact of modifications on a product's life expectancy and structural performance. With many of Europe's largest companies as customers, including Airbus, BAE Systems, Rolls Royce, and British Energy, eStress takes great pains to fully understand each company's workflow, design development process, and niche consultancy needs.

To handle the myriad facets of their projects, eStress engineers employ a comprehensive suite of design and engineering software, including Altair Engineering's HyperWorks suite of tools. Several specific products – HyperMesh (meshing), OptiStruct (FE solver for structural analysis and optimisation), and HyperView (post-processing) – have become standard tools in eStress' analysis workflow.

In 2014, eStress learned about the Altair Partner Alliance (APA), which offers third-party software under the same flexible license structure applied to Altair's own products. Because of the wide variety of projects eStress takes on, from design and structural analysis to fatigue or stress analysis, the engineering team is always looking for the best approach to tackle challenges. In early 2015, eStress took advantage of APA offerings to successfully and pragmatically solve a complex engineering issue.

Keywords: HyperWorks, LAP, CoDA, APA, CAE, Composite Beams

eStress Success Story

“We were already familiar with Anaglyph's LAP and CoDA solutions and had used them on previous projects, but since we always want to make sure we work with the latest and best version of each tool available, we were happy to see that they were available through the Altair Partner Alliance. This program provides us the unique opportunity to immediately access the latest software versions of these products with our HyperWorks units at no incremental cost.”

Tim Evans
Managing Director,
eStress Ltd.

The Challenge:

Calculating the corner unfolding behaviour of a curved beam made of composite material is not straightforward. Typically, in real engineering structures, curved composite beams never demonstrate an exactly circular arc. Moreover, available data sheets cover only limited geometrical configurations, boundary conditions and specially-orthotropic lay-ups, and the eStress engineers needed to look beyond these closed-form theoretical solutions to provide customers with appropriate design recommendations. Because simple linear isotropic FE analysis would not accurately predict the critical through-the-thickness stress tensors, the eStress engineers wanted to create a practical generalised orthotropic FE idealisation of the problem, which would deliver fast, reliable results for design sizing purposes.

Hoping to set up a practical approach and robust design development path, the engineers turned to the Altair Partner Alliance and found two products from Anaglyph Ltd, a UK-based software provider specialising in composite materials, that would help them meet their goal.

Anaglyph’s Laminate Analysis Program (LAP) can be used to analyse any type of composite laminate subjected to in-plane loads and out-of-plane moments. The flat laminate has no fixed size apart from its thickness, so that the analysis can be applied to any element of a composite component, at a location where loadings or deformations are known. Typically, the software is used in preliminary designs for tailoring a stacking sequence, then analysing the composite component with other methods such as finite element, and finally optimising the design by inspecting the laminate behaviour layer by layer.

Anaglyph’s Component Design Analysis (CoDA) solution provides preliminary design procedures to enable a first-pass analysis. For companies without sophisticated analysis capabilities, a CoDA analysis would be followed by build and test cycles. For those with techniques such as finite element analysis (FEA), the initial CoDA analysis allows potential materials, beam and plate sizes and thicknesses, and support conditions to be selected for further detailed investigation.

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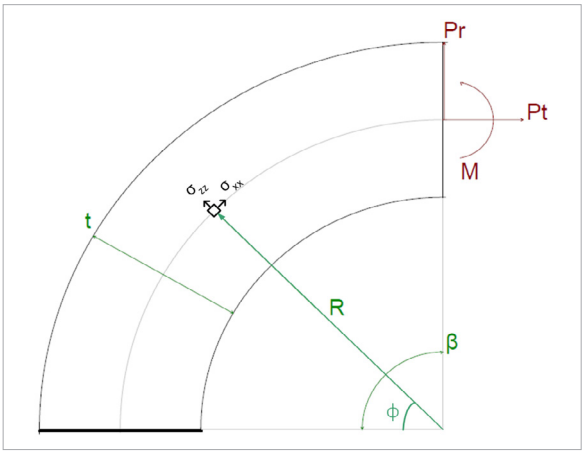


Figure 1: Curved Beam - Geometry, Loads and Stresses

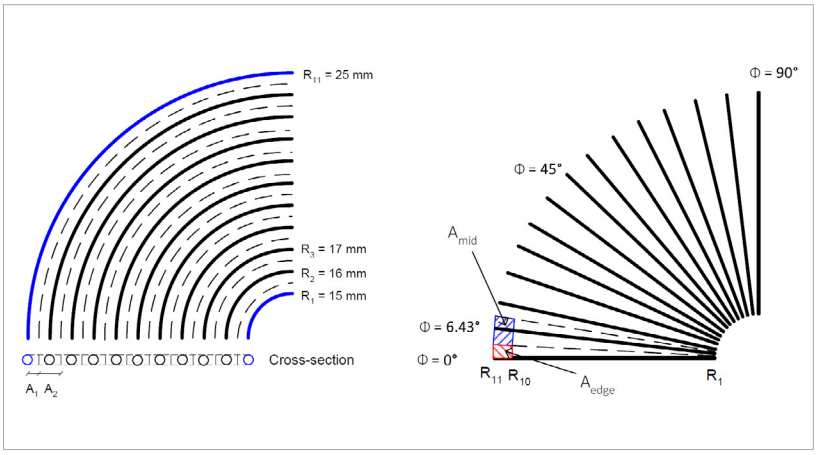
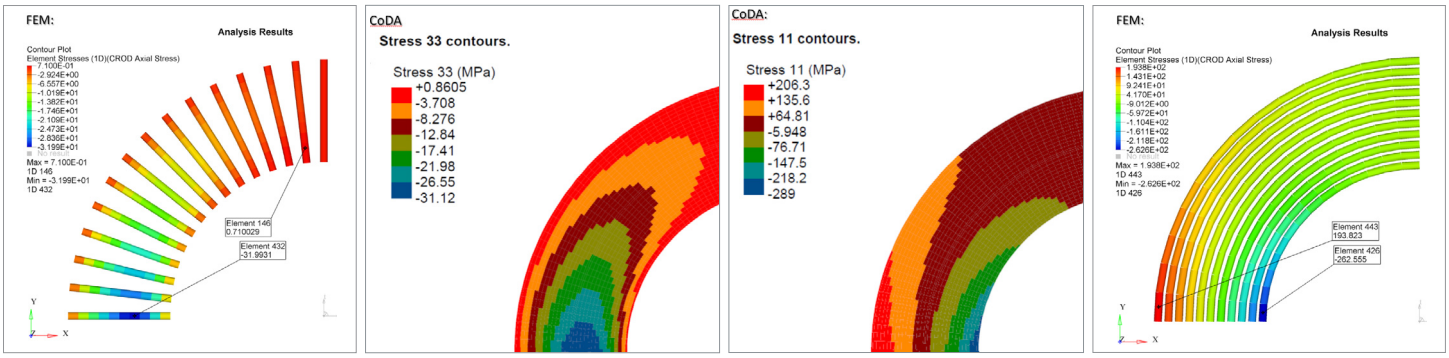


Figure 2: Idealisation of Curved Beam - Tangential Rods and Radial Springs



Figures 3-6: Applied Tangential Force

Anaglyph products were accessible through the APA offering," said Tim Evans, Managing Director of Engineering at eStress. "This program provides us the unique opportunity to take advantage of these products with our HyperWorks units at no incremental cost and immediate access to the latest software versions."

The Use Case: Unfolding Analysis of a Composite Beam

eStress used CoDA alongside FEA to investigate the accuracy of stress regime predictions from candidate FE idealisations of curved composite beams when subject to a variety of loading and constraint boundary conditions – see Figure 1. The engineers assessed the internal stresses due to tangential and radial forces, circumferential bending moments, and the combination of these using a variety of software tools: CoDA, HyperWorks (especially HyperMesh and OptiStruct), and a closed-form solution from ESDU, an engineering advisory organisation based in the United Kingdom. Background theoretical approaches from CoDA, ESDU, and Lekhnitskii (standard reference work) were also appraised to underpin the correct down-selection of FE approach - CoDA, ESDU, and Lekhnitskii solutions all produced comparable results, and the eStress engineers chose CoDA as the primary means of validation based on ease of use.

"We tried to reach a very simple way of creating an FE approach for this type of corner unfolding problem and finally chose to idealise the problem as a 'system model' using rods and springs," Evans explained – see Figure 2. "Once we got the results from the circumferential rods (composite ply tangential stress) and the radial springs (resin through-the-thickness stress) in the FE model, we compared those to the standalone results that we obtained from CoDA – see Figure 3 to Figure 6 (applied tangential force). A final check against ESDU was also performed. Once we were happy with the results, meaning when we received a good correlation between the FE approach and the theory, we were confident that this generalised approach would be appropriate for any other particular composite corner unfolding design development problem. The chosen approach represents a rapid and easily automated FEA solution to the unfolding problem particularly for design sizing and optimisation purposes - and by generating easily digestible results, offers a useful window into what is otherwise a complex stress regime."

The Solution:

This combined FEA and APA trade study has enabled eStress engineers to define a practical general approach for the unfolding of a curved composite beam that can be applied at the design sizing stage to a wide variety of similar problems in design development projects. For example, one in-house project which has benefited from the design tool is the optimisation of the leading edge and associated laminar flow seal of the HPC-Blade product (see cover images) which is an innovative composite wind turbine blade developed from expertise held within eStress.

eStress' initiative in investing in proactive investigation of solutions for complex challenges is critical to its continuing success. By employing the tools available within the HyperWorks suite as well as those from the Altair Partner Alliance, eStress is maximising its software investment and enhancing the expertise it offers the marketplace.

"Since we had used CoDA previously," Evans said, "we knew it had the needed functionality. But by the time we worked on this particular initiative, a newer version of the software was available, which may have corrected or enhanced our results. Although purchasing an upgrade of the software wasn't necessarily prohibitive, it was much more convenient to get it via the Altair Partner Alliance, since we also handle our HyperWorks licenses via Altair's flexible licensing system."

"As such we get more out of our software investments and always have access to the latest version of each tool," Evans concluded. "This helps validate both our internal product development projects and also the consultancy work we undertake for our customers - maintaining our market service track record and credibility, and contributes to satisfying our own continuous improvement quality objectives."

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About Altair

Altair is focused on the development and broad application of simulation technology to synthesize and optimize designs, processes and decisions for improved business performance. Privately held with more than 2,600 employees, Altair is headquartered in Troy, Michigan, USA and operates more than 45 offices throughout 24 countries. Today, Altair serves more than 5,000 corporate clients across broad industry segments.

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About Altair Partner Alliance

One Platform. One License. One Source. **All Access**.

Altair's HyperWorks platform applies a revolutionary subscription-based licensing model in which customers use floating licenses to access a broad suite of Altair-developed, as well as third-party, software applications on demand. The Altair Partner Alliance effectively extends the HyperWorks Platform from more than 20 internally developed solutions to upwards of 60 applications with the addition of new partner applications. Customers can invoke these third-party applications at no incremental cost using their existing HyperWorks licenses. Customers benefit from unmatched flexibility and access, resulting in maximum software utilization, productivity and ROI.

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Altair Engineering, Inc., World Headquarters: 1820 E. Big Beaver Rd., Troy, MI 48083-2031 USA
Phone: +1.248.614.2400 • Fax: +1.248.614.2411 • www.altair.com • info@altair.com