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ESDU Automotive Design Methods

Validated Methodologies for Enhanced Automotive Engineering and Compliance

The future of automotive design will be built on light-weight composites and aluminum. Start building the future today using independently validated design methods from ESDU, a unique collection of more than 80 years of engineering excellence

Solving Complex Automotive Engineering Problems

> The ESDU Automotive Collection consists of a group of design methods, best practices, data and software tools for solving complex Automotive Engineering problems and enabling faster and more reliable decision making during vehicle design.
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> The ESDU Automotive Collection is structured to complement your internal design practices, address gaps in information and provide access to best-in-class industry expertise.

Meeting New Efficiency Standards

On 28 August 2012, the Obama administration, as part of the revised Corporate Average Fuel Economy (CAFE) regulations, finalized a historic fuel efficiency standard for cars and light-duty trucks requiring a fuel efficiency rating of 54.5 miles per gallon by the year 2025. As automotive OEMs strive to meet the higher fuel efficiency standards, extensive research and development efforts will be required during new automotive product design programs.

The proven ESDU design methods are widely used in aircraft and aerospace design and many of the tools and data can be used to speed up the design process while assuring the reliability of new vehicle designs. Reducing the weight of body, frame and engine components should translate to fuel economy improvements. As light-weight materials with better strength and stiffness to weight ratios, such as composites, aluminum, titanium and magnesium alloys, are more widely adopted in automotive designs, the knowledge, tools and data required to design with these different materials becomes increasingly crucial to engineers.

Data Items within ESDU such as those in the section on Design for Minimum Weight and the ESDU validated Metallic Material Data Handbook (MMDH) provide the design methods and resources required for designing vehicles with light-weight materials.

Reliable Engineering Design Methods with ESDU

Applications

- Reduce the weight of body, frame and engine components
- Fracture mechanics, stress intensity factors

Reliability

- Accurate engineering data and assurance of data validation
- Up-to-date methodologies that can be incorporated into the design and safety assessment processes
- Methods developed by experts under the guidance of independent technical committees

Comprehensive Information for Automotive Design

Optimizing the flow of fuel and air into the engine, turbocharging, supercharging and increasing engine speeds are all potential methods to improve fuel efficiency.

As engine speeds or torque increases and component sections decrease, fatigue from rotational and vibrational stresses become an increasing concern during design.

ESDU Fatigue - Endurance Data and Fracture Mechanics modules will provide automotive design engineers a solid foundation of design methods to handle these problems.

Trusted and Validated Design Methods

The information available in the ESDU Automotive Collection complements the highly conservative design and operating standards and codes used in the automotive industry.

The ESDU validated methodologies provide a reliable source of engineering knowledge for design within the targets set by international standards and codes.

These methodologies are based on experimental data, analytical methods and computational techniques, such as Computation Fluid Dynamics (CFD) and Finite Element Analysis (FEA), and represent industry best practices and validated design methods.

Specific Sections Included with ESDU Automotive Package

Composites

These Sections provide a rapidly growing collection of data for use in the design of fibre-reinforced laminated composite materials. The information has wide application to design engineering areas where composite materials offer benefits.

The Sections contain the solutions to many strength analysis problems met in the design of fibre-reinforced laminated composite structures. These include failure criteria, plate vibration and buckling, analysis of bonded joints, and stress concentrations, in addition to the calculation of basic stiffnesses and stresses including built-in thermal stresses.

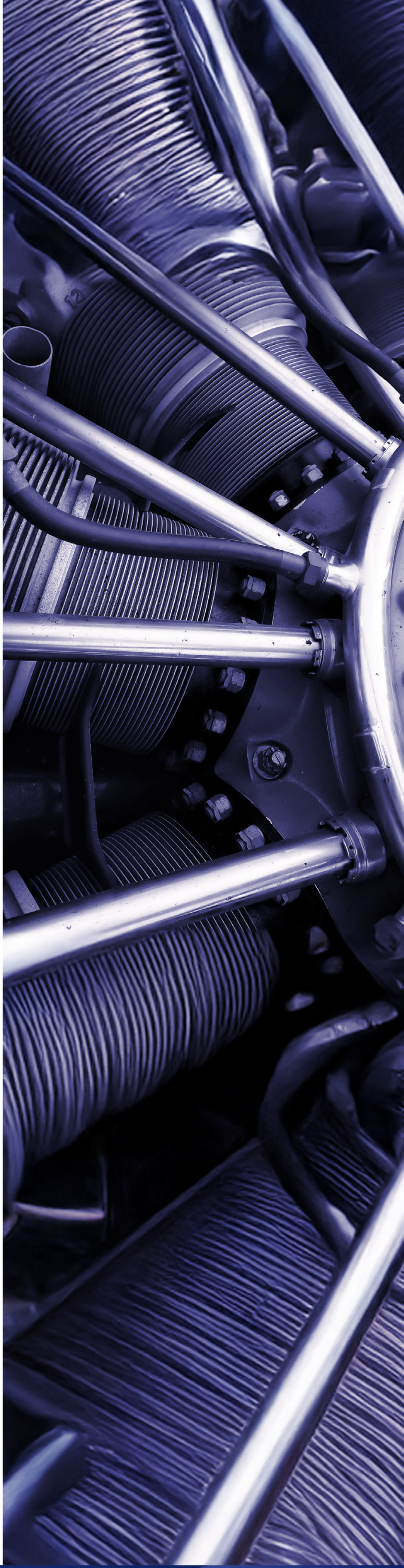
Laminated composites can be specified in very many forms and assembled in a multitude of lay-up arrangements. Because of this complexity the only practical form in which many of the solutions can be provided is as a computer program, and software programs are provided for many of the analysis methods. In addition to the freedom to change the overall geometry the designer in composites has the freedom to arrange the material strength and/or stiffness to meet the local loading. This complicates the design process and it is often difficult to select a route to the best combination of geometry and material. The Sections contain guidance on the factors influencing the design and suggest methods of achieving the desired solution.

Fatigue

Endurance Data

Methods and data are given for strength calculations primarily on thin-walled and light-weight structures. The data are principally for use when the design philosophy is one of "safe-life design", that is, the structure or component is required to be crack-free for the specified design life.

The major part of the data consists of constant amplitude stress-endurance curves (S-N curves) for light-weight materials (aluminium and titanium alloys), steel and structural joints (riveted, bolted or bonded). In addition, a large collection of stress concentration factors is included and the principles for designing against metal fatigue are explained and illustrated with worked examples. The necessary statistical methods for dealing with small samples in design are also included.



Fatigue

Fracture Mechanics

Methods and data are given for strength calculations primarily on vehicle structures. The principles of linear elastic fracture mechanics are employed to provide data for strength analysis of cracked or flawed structures or components. The information therefore relates to damage-tolerant design.

The major body of the data consists of curves of crack propagation rate versus stress intensity factor range under constant amplitude fatigue loading. These data are grouped according to material, aluminium or titanium alloys or steels, and for each material the curves are grouped according to alloy type and manufacturing process. The influence of the environment is included for many materials. Where possible, mean and upper bound curves are provided.

In addition, an introduction to the principles of fracture mechanics is included with example calculations. Methods of compounding, to obtain stress intensity factors for "real life" complex geometries from simple theoretical solutions, are also treated and, for the complex case of a pin loaded lug, data for stress intensity factors are given.

Stress and Strength

The strength analysis is treated of components used in general mechanical engineering. The information has been evaluated by engineers to ensure soundly based analysis leading to safe, cost-effective design.

The information is divided into three principal types. Firstly, the design of commonly used components is considered. The data include stiffnesses, static stresses and deflections, buckling loads and fatigue strengths. Design notes and methodology are covered. Secondly, data for certain stress intensity factors are given.

Lastly, data are presented on the fatigue strength of materials, both as constant amplitude stress versus endurance (S-N) curves and in terms of linear elastic fracture mechanics. The fatigue data are for many low and high alloy and stainless steels made to US, UK and European specifications, and the fracture mechanics data include both crack propagation rates, many down to threshold, and fracture toughness values.

Structures

These Sections give comprehensive and continually expanding, rigorously evaluated information for the strength analysis of light-weight structures.

Data are given on elastic or inelastic stresses, strains, displacements or buckling loads under static loading. They range from general data, with application regardless of component form, to the analysis of specific components in metallic, compound (sandwich) or composite structures. Examples of general data are metallic materials properties, principal stresses and strains, and failure criteria. Examples of specific components are, struts, panels, stress raisers (stress concentrations) and joints.

The range of components and geometries gives a comprehensive selection that will meet the structural analyst's idealization needs. Thus it will allow both detailed, accurate analyses of critical components, and initial estimates, with appropriate idealization, that will facilitate the economic use of finite element or other expensive computational techniques on problems where no specific analysis is currently available.

Vibration and Acoustic Fatigue

To design reliable structures for use in areas of intense sound, engineers need to investigate the possibility of acoustic fatigue failures. Failures during the service life of a structural component may lead to costly design modifications.

The ESDU Vibration and Acoustic Fatigue module provides simple and efficient methods for estimating the response and fatigue life of structures typical of those used in industry, including fibre-reinforced composites, when subjected to acoustic loading.

Although it is not possible to predict precisely the response of a structure under acoustic loading, the structural parameters of various designs can be compared and the design selected to give the best relative performance for a noisy environment.

Material Databases Included with ESDU Automotive Package

MMDH

Metallic Materials Data Handbook

Validated metallic materials properties database.

Design engineers can spend a great deal of time rigorously developing models, analyzing structures and simulating product performance and good reliable design data is critical to the design process.
The design engineer faces an ever-increasing demand for products with a performance that must be substantiated under stringent conditions of cost and environment. If invalid material property data are utilized, then valuable engineering time will be wasted. If the error is detected early during development or testing, then the design and structures will have to be re-analyzed with validated data and new prototypes built and tested.
In the worst case, field failures could result in costly corrective actions such as scrapping of raw materials, alternative materials selection, new supplier identification and approval, product redesign or retooling of production lines.

The output or results of structural design or finite element method (FEM) models are only as good as the design input data, which include physical or material properties. After the design is verified with prototyping and testing or virtual simulations, the design can be optimized by assessing alternative part geometries or new material selections from the MMDH materials database in the validated model and/or through additional prototyping and testing.

MMPDS

Metallic Materials Properties Development and Standardization Handbook

The primary purpose of this Handbook is to provide a source of statistically based design values for commonly used metallic materials and joints. Additionally, other mechanical and physical properties needed for the design of structures are included. The material properties and joint data used to derive values published in this Handbook were obtained from tests conducted by material and fastener producers, government agencies, and members of the airframe industry.
The data submitted to MMPDS are reviewed and analyzed per the methods detailed in this Handbook. Results of these analyses are submitted to the membership during coordination meetings and if determined to meet the documented standards set they are published in this Handbook.

About Accuris

Accuris is an engineering-focused technology company that delivers value through AI powered data and workflow solutions. For over **60 years**, engineers have relied on our data and technology to innovate and solve problems, reducing their ideation time by **70%** and eliminating product and process failures by **up to 5 times**.

We work with over **7,000** global customers and **950,000** engineering end users in **over 100** countries and dozens of industries – including aerospace and defense, energy, sustainability, construction, architecture and more.

Accuris partners with **450+** Standards Development Organizations to help streamline your access to **2.3 million** engineering standards to accelerate innovation and progress across the globe. Accuris unleashes builders so you can build a better world.

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