



BSI Standards Publication

## Space engineering — Structural materials handbook

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Part 2: Design calculation methods and general design aspects

## National foreword

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## Space engineering - Structural materials handbook - Part 2: Design calculation methods and general design aspects

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- Partie 2 : Méthodes de calculs de conception et  
aspects généraux de conception

Raumfahrttechnik - Handbuch  
Konstruktionswerkstoffe - Teil 2:  
Konstruktionsberechnungsverfahren und allgemeine  
Konstruktionsaspekte

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**CEN-CENELEC Management Centre:  
Rue de la Science 23, B-1040 Brussels**

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## European Foreword

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This document (CEN/TR 17603-32-02:2022) has been prepared by Technical Committee CEN/CLC/JTC 5 "Space", the secretariat of which is held by DIN.

It is highlighted that this technical report does not contain any requirement but only collection of data or descriptions and guidelines about how to organize and perform the work in support of EN 16603-32.

This Technical report (CEN/TR 17603-32-02:2022) originates from ECSS-E-HB-32-20 Part 2A.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

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This document has been developed to cover specifically space systems and has therefore precedence over any TR covering the same scope but with a wider domain of applicability (e.g.: aerospace).

## Introduction

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The Structural materials handbook is published in 8 Parts.

A glossary of terms, definitions and abbreviated terms for these handbooks is contained in Part 8.

The parts are as follows:

|                |        |   |                  |
|----------------|--------|---|------------------|
| TR 17603-32-01 | Part 1 | Overview and material properties and applications   | Clauses 1 - 9    |
| TR 17603-32-02 | Part 2 | Design calculation methods and general design aspects   | Clauses 10 - 22  |
| TR 17603-32-03 | Part 3 | Load transfer and design of joints and design of structures   | Clauses 23 - 32  |
| TR 17603-32-04 | Part 4 | Integrity control, verification guidelines and manufacturing  | Clauses 33 - 45  |
| TR 17603-32-05 | Part 5 | New advanced materials, advanced metallic materials, general design aspects and load transfer and design of joints                                | Clauses 46 - 63  |
| TR 17603-32-06 | Part 6 | Fracture and material modelling, case studies and design and integrity control and inspection   | Clauses 64 - 81  |
| TR 17603-32-07 | Part 7 | Thermal and environmental integrity, manufacturing aspects, in-orbit and health monitoring, soft materials, hybrid materials and nanotechnologies | Clauses 82 - 107 |
| TR 17603-32-08 | Part 8 | Glossary  |                  |

# 10

## Stress-strain relationships

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### 10.1 Introduction

The many analytical and practically derived methods developed for predicting the stress-strain behaviour of composite materials are reviewed.

Calculation methods are given for:

- Behaviour prediction from constituent properties, [See:10.2].
- The calculation of intra-ply, [See: 10.10].
- Interlaminar stress-strains, [See: 16.16].

### 10.2 Elastic property prediction for UD ply from constituent properties

UD ply properties can be predicted by the procedures of micro-mechanics and be measured by physical means. These can then be used in a macro-mechanical analysis of the structure.

Micro-mechanical analysis has inherent limitations. Fibre properties cannot easily be measured, so they are determined from measurements of UD by applying inverse homogenisation formulae. The transverse and shear properties are particularly inaccurate.

In addition, a perfect bond between fibres and matrix is a common assumption for analysis, which is not always true for some composites. Imperfect bonds give a material with poorer properties than those of the micro-mechanical analysis. So, the analysis should be proven by careful experimental work. The derivation of macro-mechanical properties is summarised in Figure 10.2-1.