PD CEN/TR 17603-32-02:2022

BSI Standards Publication

Space engineering — Structural materials handbook

Part 2: Design calculation methods and general design aspects

bsi.

National foreword

This British Standard is the UK implementation of CEN/TR 17603-32-02:2022.

The UK participation in its preparation was entrusted to Technical Committee ACE/68, Space systems and operations.

A list of organizations represented on this committee can be obtained on request to its committee manager.

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Published by BSI Standards Limited 2022

ISBN 978 0 539 17715 9

ICS 49.140

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This British Standard was published under the authority of the Standards Policy and Strategy Committee on 31 March 2022.

Amendments/corrigenda issued since publication

Date	Text affected

TECHNICAL REPORT

RAPPORT TECHNIQUE

TECHNISCHER BERICHT

CEN/TR 17603-32-02

January 2022

ICS 49.140

English version

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

Ingénierie spatiale - Manuel des matériaux structuraux - Partie 2 : Méthodes de calculs de conception et aspects généraux de conception

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

This Technical Report was approved by CEN on 22 November 2021. It has been drawn up by the Technical Committee CEN/CLC/JTC 5.

CEN and CENELEC members are the national standards bodies and national electrotechnical committees of Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Republic of North Macedonia, Romania, Serbia, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and United Kingdom.

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

Ref. No. CEN/TR 17603-32-02:2022 E

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European Foreword

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.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association.

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

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 nanotechnoligies	Clauses 82 - 107
TR 17603-32-08	Part 8	Glossary	

10 Stress-strain relationships

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 homoginisation 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.