Technical Report

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Design examples of concrete-filled steel tubular (CFST) hybrid structures in accordance with ISO 16521

Exemples de conception de structures hybrides en tubes d'acier remplis de béton (CFST) conformément à l'ISO 16521

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Foreword

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The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

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This document was prepared by Technical Committee ISO/TC 71, *Concrete, reinforced concrete and pre-stressed concrete*, Subcommittee SC 9, *Steel-concrete composite and hybrid structures*.

A list of all parts in the ISO/TR 25439 series can be found on the ISO website.

Any feedback or questions on this document should be directed to the user's national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

Introduction

This document provides informative design examples of concrete-filled steel tubular (CFST) hybrid structures in accordance with ISO 16521, *Design of concrete-filled steel tubular (CFST) hybrid structures*. ISO 16521 stipulates the conceptional design, refined analysis method, simplified design formulae based on refined analysis and experimental verifications, and detailing design of CFST hybrid structures. Detailed calculations are provided in the design examples and the corresponding reference subclauses in ISO 16521 are indicated.

For trussed CFST hybrid structures, four design examples are provided, which include a three-chord structure and two four-chord structures without concrete slab, and a four-chord structure with a concrete slab. General requirements are verified and indices for cross-sections are calculated. The resistances of the hybrid structures as well as the CFST chords in compression, bending, combined compression and bending, and shear, are calculated in accordance with ISO 16521:2024, Clause 11. The protective design of corrosion resistance and impact resistance is presented in accordance with ISO 16521:2024, Clause 14. The detailing requirements and the resistances of the joints are verified in accordance with ISO 16521:2024, Clause 15. Finally, the verification of the limiting value of the core concrete void in the steel tube is carried out in accordance with ISO 16521:2024, Clause 16.

For concrete-encased CFST hybrid structures, four design examples are presented, i.e., a single-chord structure, a six-chord structure, and a four-chord structure with circular CFST members and a four-chord structure with rectangular CFST members. General requirements are verified and indices for cross-sections are calculated. Resistances in compression, combined compression and bending, resistance considering long-term load effects, shear resistance, are verified in accordance with ISO 16521:2024, Clause 12. Fire resistance is calculated in accordance with ISO 16521:2024, Clause 14.

Clause 6 of this document presents a global structural analysis example. A concrete-encased CFST hybrid arch structure is analysed in accordance with ISO 16521:2024, Clause 10, which employs a fibre-based model. It includes the determination of load, model establishment, load-displacement relationship analysis, deformation analysis, and stress and strain analysis.

Annex A is provided in this document to present some experimental data on CFST hybrid structures. These published experimental data serve as an important basis for the development of ISO 16521. Furthermore, they provide verifications of the design methods of CFST hybrid structures and examples for design of the structures based on experimental data, as stipulated in the standard.

It is worth pointing out that the design examples are only provided to help readers in using ISO 16521 and they are not based on any specific engineering projects.

Design examples of concrete-filled steel tubular (CFST) hybrid structures in accordance with ISO 16521

1 Scope

This document provides design examples of concrete-filled steel tubular (CFST) hybrid structures in accordance with ISO 16521.

This document includes the design calculation of major structural types in ISO 16521, i.e., trussed CFST hybrid structures, concrete-encased CFST hybrid structures. The design examples cover the major loading cases for the structures and follow the design procedure presented in ISO 16521:2024, Clause 6.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 16521, *Design of concrete-filled steel tubular (CFST) hybrid structures*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 16521 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 Design examples of trussed CFST hybrid structures

In this clause, the design of four examples of trussed concrete-filled steel tubular (CFST) hybrid structures with and without a concrete slab are conducted in accordance with the corresponding clauses of ISO 16521. The general design and construction procedure in ISO 16521:2024, 6.1, is followed, and the correspondence between this clause and the detailed clauses of ISO 16521:2024 are shown in Table 1.

Table 1 — Design and construction procedure of trussed CFST hybrid structures

Procedure	Clause in ISO 16521:2024	Subclause in this document
Preliminary structural design	Clauses 5 to 8	4.1
Definition of actions (loads)	Clause 9	/
Structural analysis	Clause 10	4.2
Ultimate limit states design	Clause 11	4.3
Serviceability limit states design	Clause 13	/
Protective design	Clause 14	4.4
Detailing design	Clause 15	4.1 and 4.5
Construction and acceptance	Clause 16	4.6