INTERNATIONAL STANDARD

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Steel structures —

Part 1:
Materials and design

Structures en acier —

Partie 1: Matériaux et conception

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CONTENTS

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

International Standard ISO 10721-1 was prepared by Technical Committee ISO/TC 167, *Steel and aluminium structures*, Subcommittee SC 1, *Steel: Material and design*.

ISO 10721 consists of the following parts under the general title *Steel and aluminium structures*:

— Part 1: Materials and design

— Part 2: Fabrication and erection

Annexes A and B of this part of ISO 10721 are for information only.

Introduction

This part of ISO 10721 establishes a common basis for drafting national standards for the use of materials in steel structures and for their design, in order to ensure adequate and consistent measures regarding safety and serviceability.

Annex A of this part of ISO 10721 contains noncompulsory recommendations which may be used as guidelines for practical design.

The specific and numerical requirements for the completion of structures which are optimal with respect to the state of a country's economy, development and general values should be given in the national codes of the country.

The design rules given concern limit-state verifications for comparing the effects of actions or combinations of actions with the strength (resistance) of the structure and its components.

Steel structures —

Part 1:
Materials and design

1 Scope

This part of ISO 10721 establishes the principles and general rules for the use of steel materials and design of steel structures in buildings.

NOTE 1 The degree of reliability should be as specified in national codes. In the establishment of design safety factors, due consideration should also be given to ISO 10721-2 for fabrication of steel structures.

This part of ISO 10721 is also applicable to bridges, off-shore and other civil engineering and related structures, but for such structures it may be necessary to consider other requirements.

This part of ISO 10721 does not cover the special requirements for steel structures in corrosive environments beyond normal atmospheric conditions and corrosion protection with regard to fatigue design.

This part of ISO 10721 does not cover the special requirements of seismic design.

For welded connections and for structures subject to fatigue, special considerations regarding the scope of this document are presented in 8.9 and 10.1 respectively.

NOTE 2 Rules and recommendations regarding composite steel and concrete structures and fire safety of steel structures will subsequently be issued as separate International Standards.

2 Normative references

The following standards contain provisions which, through reference in this text, constitute provisions of this part of ISO 10721. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this part of ISO 10721 are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below. Members of IEC and ISO maintain registers of currently valid International Standards.

ISO 630:1995, *Structural steel — Plates, wide flats, bars, sections and profiles.*

ISO 898:1988–1994, *Mechanical properties of fasteners* (all parts).

ISO 2394: –[1], *General principles on reliability of structures.*

ISO 3989: –[2], *Bases for design of structures — Notations — General symbols.*

ISO 4753:1983, *Fasteners — Ends of parts with external metric ISO thread.*

ISO 4951:1979, *High yield strength steel bars and sections*

ISO 6892: –[3], *Metallic materials — Tensile testing at ambient temperature.*

1) To be published. (Revision of ISO 2394:1986)

2) To be published. (Revision of ISO 3898:1987)

3) To be published. (Revision of ISO 6892:1984, replacing ISO 82:1974)

3 DEFINITIONS AND SYMBOLS

For the purposes of this part of ISO 10721, the following definitions and symbols apply.

3.1 Definitions

Limit states:	The states beyond which the structure no longer satisfies the design requirements.
Ultimate limit state:	The limit states corresponding to the maximum load carrying resistance (safety related).
Serviceability limit state:	The limit states related to normal use (often related to function).
Specified life:	The time the structure is to be used under the given design assumptions.
Direct action:	One or a set of concentrated or distributed forces acting on the structure, such as selfweight, imposed specified actions, wind, etc.
Indirect action:	The cause of imposed or constrained deformations in the structure, such as temperature effects, settlements, creep etc.
Nominal action:	The numerical value of an action either defined by the authorities or by the contract documents. When this value corresponds to a specified probability to be exceeded within a specified reference time, it is called characteristic action, and it is calculated in accordance with ISO 2394.
Design action:	Actions used in calculations. The design action is the nominal action multiplied by its partial safety factor γ_f, or it is the combination of nominal actions, each multiplied by its partial safety factor γ_f for the relevant limit state.

Shake down:	The process of local yielding due to the initial applications of variable actions, leading to a condition of residual stress where all further applications can be sustained elastically (applies particularly to the formation of plastic hinges).
Variable action:	Action which is unlikely to act throughout a given design situation or for which the variation in magnitude with time is not monotonic nor negligible in relation to the mean value.
Repetetive action:	Design action which involves stress fluctuations leading to possible fatigue effects, i.e. it is the design action to be used for checking the fatique limit state.
Characteristic material property:	The value of material properties established by its specified occurrence taking account of control conditions and statistical variability.
Design material property:	The value of material properties obtained by dividing the characteristic property by a partial material safety factor.
Nominal strength or resistance:	The strength or resistance value based on specified characteristic material and geometric properties.
Design strength or resistance:	The nominal strength or resistance divided by the appropriate partial safety factor for resistance, γ_r.
Normal use:	Normal use is that which conforms to the loading and performance intended by the designer, or as specified in codes of practice, or by other relevant requirements.
Fatigue:	Damage, by gradual crack propagation in a stuctural part, caused by repeated stress fluctuations.
Fatigue loading:	A set of typical load events described by the position of loads, their intensities and their relative occurence.
Loading event:	A defined loading sequence applied to the structure and giving rise to a stress history variation.
Equivalent fatigue loading:	A simplified fatigue loading representing the fatigue effects of all loadings events.
Stress history:	A record or a calculation of the stress variation at a particular point of a structure during the load event.
Stress range:	The algebraic difference between two extrema of the stress history ($\Delta\sigma s = \sigma_{max} - \sigma_{min}$ or $\Delta\tau = \tau_{max} - \tau_{min}$). This difference is usually identified by a stress cycle counting method.
Nominal stress:	A fatigue design stress in the parent material adjacent to potential crack location calculated in accordance to simple elastic strength of materials theory. For the purpose of fatigue assessment of a particular class of constructional detail, the design stress is either the normal stress (axial and bending stress) or/and the shear stress. Where there is a geometric discontinuity, not taken into account in the classification of the constructional detail, the nominal stress shall be modified by the use of stress concentration factors.

Geometric stress:	A fatigue design stress, adjacent to the weld toe, defined as the extrapolation of the maximum principal stresses. The geometric stress takes into account the overall geometry of the constructional detail, excluding local stress concentration effects due to weld geometry and inherent defects in weld and adjacent parent metal. (The geometric stress is often referred in the litterature as the "hot spot stress").
Cycle counting:	A particular method used for counting the number of stress cycles and related stress ranges from a stress history.
Stress-range spectrum:	Histogram of the frequency of occurrence for all stress ranges of different magnitudes recorded or calculated for a particular loading event.
Design spectrum:	The total of all stress spectra relevant to the fatigue assessment.
Equivalent stress range:	The constant-amplitude stress range that would result in the same fatigue life (number of cycles of stress ranges) as for the spectrum of variable amplitude stress ranges based on a Miner's summation.
Miner's summation:	A cumulative linear damage calculation based on the Palmgren-Miner rule.
Constant amplitude fatigue limit:	The limiting stress range value above which a fatigue assessment is necessary.
Detail category:	The designation given to a particular welded or bolted detail, in order to indicate which fatigue strength curve is applicable for the fatigue assessment.
Fatigue strength curve:	The quantitative relationship between stress range and number of stress cycles to fatigue failure (selected on the basis of a statistical analysis of available test data of a constructional detail).
Design life:	The reference period of time for which a structure is required to perform safely with an acceptable probability that failure by fatigue or cracking will not occur.
Cut-off limit:	Limit below which stress ranges of the design spectrum do not contribute to fatigue damage.
Groove (butt) weld:	A weld made in a preparation to receive weld metal. (Also referred to as a butt weld).

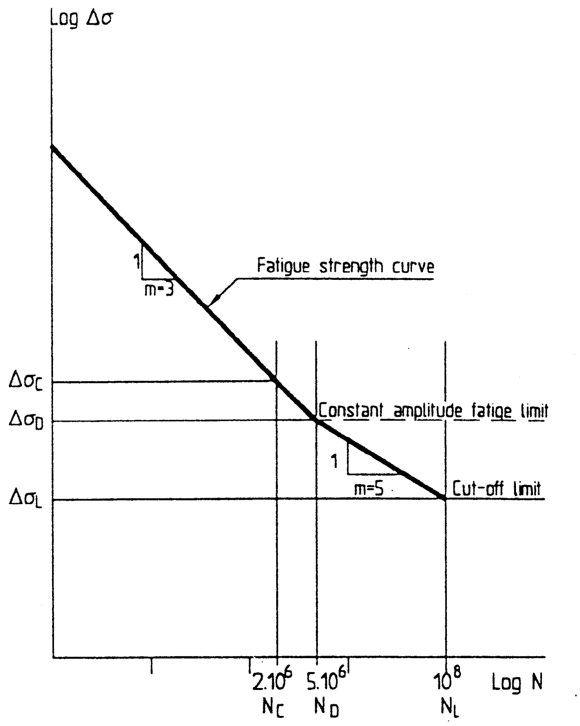

Fig. 3.1 Fatigue strength curve definitions

3.2 List of symbols
(see also ISO 3898)

LATIN UPPER CASE LETTERS:

A	Cross-sectional area
A_e	Effective cross-section area
A_g	Gross section area
A_L	Cross-sectional area of longitudinal stiffener
A_{Le}	Effective area of longitudinal stiffener
A_m	For fillet welds, A_m = effective size multiplied by its length. For butt joints, A_m = thickness of base metal multiplied by its length. For T-joints, A_m = size of fusion face in base metal multiplied by the length of the weld
A_n	Net section area
A_s	Cross-sectional area of a stiffener
A_{sp}	Nominal area of the threaded part of a bolt
A_t	Cross-sectional area of transverse stiffener
A_v	Effective shear area of bolts
A_w	Cross-sectional area of web
A_W	Effective area of weld (effective throat of weld multiplied by its length). For plug or slot welds, A_w = area of faying surface

B	Coefficient
C_w	Warping constant of torsion for the cross-section
E	Modulus of elasticity (Young's modulus)
E_T	Tangent modulus
F	Force, action
F_b	Bearing resistance of bolts
F_k	Characteristic action
F_d	Design force, action
F_p	Preloading force in bolts
F_s	Slip resistance of bolts
F_t	Tensile force resistance of bolts
F_v	Shear force resistance of bolts
G	Modulus of shear = $E/(2(1+\upsilon))$
I, I_y, I_z	Moment of inertia (about y- and z-axis, respectively)
I_s	Moment of inertia of a stiffener
I_p	Polar moment of inertia
I_t	St. Venant torsion constant of the cross-section
K_E	Coefficient for buckling length
K_i	Coefficients ($i = 1$-5)
L	Length
L_E	Effective length (in buckling)
L_o	Laterally unsupported length
L_s	Load distribution length
M, M_y, M_z	Bending moment (about y- and z-axis, respectively)
M_{rd}, M_{dy}, M_{dz}	Moment resistance (about y and z-axis, respectively)
M_{dr}	Reduced moment resistance
M_{EL}	Elastic lateral torsional buckling moment
M_f	Plastic moment of flanges
M_{Ld}	Moment resistance in lateral torsional buckling
M_p	Plastic moment = $f_y W_p$

M_T	Torsional moment
M_w	Plastic moment of web
M_y	Yield moment $= f_y W$
M_1, M_2	The larger and the smaller moments at the supported ends of a member
N	Normal force (chapt. 8)
N	Number of fatigue strength cycles (chapt 10)
N_{cd}	Buckling resistance (chapt. 8)
N_c	Number of cycles ($2 \cdot 10^6$) at which the reference value of the fatigue strength curve is defined (chapt. 10)
N_{cy}, N_{cz}	Buckling resistance about y- and z- axis, respectively
N_D	Number of cycles for which the constant amplitude fatigue limit is defined ($= 5 \cdot 10^6$)
N_r	Normal force resistance
N_{rd}	Normal force design resistance
N_E, N_{Ey}, N_{Ez}	Elastic buckling force of a pinned column $= \frac{\pi^2 EI}{L^2}$ (about the y- and z-axis, respectively).
N_{Ecr}	Elastic buckling load of a structure $= \frac{\pi^2 EI}{L_k^2}$
N_{ET}	Elastic torsional buckling load
N_i	Number of cycles of stress $\Delta\sigma_i$ to cause failure
N_L	Number of cycles for which the cut-off limit is defined ($= 10^8$)
N_p	Plastic normal force resistance
N_{Td}	Torsional buckling resistance
N_{yd}	Ultimate tensile yield force resistance
N_{ud}	Ultimate tensile strength
P	Concentrated force
P_d	Concentrated force resistance
R	Resistance
S	Static moment of area
T	Tensile force (in a bolt)
V	Shear force
V_{cd}	Shear resistance