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Atmospheric icing of structures

Charges sur les structures dues à la glace

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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.

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).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www. iso. org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation on the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT) see the following URL: www.iso. org/iso/foreword. html.

The committee responsible for this document is ISO/TC 98, *Bases for design of structures*, Subcommittee SC 3, *Loads, forces and other actions*.

This second edition cancels and replaces the first edition (ISO 12494:2001), of which it constitutes a minor revision. The changes made are the following:

— 8.1, line 2, replaced "ISO 4355" by "ISO 4354";

— 8.3, Figure 7, revised the right figure;

— 9.1, line 2 ,9.2, line 2 to 4, replaced "exceedence" by "exceedance";

— 9.2, line 11, replaced "to day's" by "today's";

— Clause 10, line 15, replaced "5.3" by "5.4";

— A.2, Table 3, line 1, replaced "the glaze mass" by "the mass of the ice, glaze or rime";

— A.2, Table 3, line 2, replaced "the glaze thickness" by "the thickness of the ice, glaze or rime";

— A.2, Table 3, line 4, replaced "the glaze density" by "the density of the ice, glaze or rime";

— A.2, Table 3, line 4, replaced "r" by "γ";

— A.2, Table 3, line 1 to 4, moved before Table 3,

— B.3.2, c), replaced "see Table 2 and 2.3" by "see Table 1 in 6.2.1";

— B.3.3, line 5, replaced "definitions 3.1 and 3.2" by "definitions B.3.1 and B.3.2";

— B.3.3, line 6, replaced "Table 4 or 5" by "Table 3 or 4";

— C.3, paragraph 6, line 4, replaced "0,7 cm^{-3}" by "0,7 g cm^{-3}";

— E.4, b), line1, replaced "ICGx" by "ICRx".

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Annexes A to E of this document are for information only.

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Introduction

This document describes ice actions and can be used in the design of certain types of structures.

It should be used in conjunction with ISO 2394 and also in conjunction with relevant CEN standards.

This document differs in some aspects from other International Standards, because the topic is poorly known and available information is inadequate. Therefore, it contains more explanations than usual, as well as supplementary descriptions and recommendations in the annexes.

Designers might find that they have better information on some specific topics than those available from this document. This may be true, especially in the future. They should, however, be very careful not to use only parts of this document partly, but only as a whole.

The main purpose of this document is to encourage designers to think about the possibility of ice accretions on a structure and to act thereafter.

As more information about the nature of atmospheric icing becomes available during the coming years, the need for updating this document is expected to be more urgent than usual.

Guidance is given as a NOTE, after the text for which it is a supplement. It is distinguished from the text by being in smaller typeface. This guidance includes some information and values which might be useful during practical design work, and which represents results that are not certain enough for this document, but may be useful in many cases until better information becomes available in the future.

Designers are therefore welcome to use information from the guidance notes, but they should be aware of the intention of the use and also forthcoming results of new investigations and/or measurements.

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Atmospheric icing of structures

1 Scope

This document describes the general principles of determining ice load on structures of the types listed in this clause.

In cases where a certain structure is not directly covered by this or another standard or recommendation, designers can use the intentions of this document. However, it is the user's responsibility to carefully consider the applicability of this document to the structure in question.

The practical use of all data in this document is based upon certain knowledge of the site of the structure. Information about the degree of "normal" icing amounts (= ice classes) for the site in question is used. For many areas, however, no information is available.

Even in such cases, this document can be useful because local meteorologists or other experienced persons should be able to, on the safe side, estimate a proper ice class. Using such an estimate in the structural design will result in a much safer structure than designing without any considerations for problems due to ice.

CAUTION — It is extremely important to design for some ice instead of no ice, and then the question of whether the amount of ice was correct is of less importance. In particular, the action of wind can be increased considerably due to both increased exposed area and increased drag coefficient.

This document is intended for use in determining ice mass and wind load on the iced structure for the following types of structure:

— masts;

— towers;

— antennas and antenna structures;

— cables, stays, guy ropes, etc.;

— rope ways (cable railways);

— structures for ski-lifts;

— buildings or parts of them exposed to potential icing;

— towers for special types of construction such as transmission lines, wind turbines, etc.

Atmospheric icing on electrical overhead lines is covered by IEC (International Electrotechnical Commission) standards.

This document is intended to be used in conjunction with ISO 2394.

NOTE Some typical types of structure are mentioned, but other types can also be considered by designers by thinking in terms of which type of structure is sensitive to unforeseen ice, and act thereafter.

Also, in many cases, only parts of structures are to be designed for ice loads because they are more vulnerable to unforeseen ice than is the whole structure.

Even if electrical overhead lines are covered by IEC standards, designers can use this document for the mast structures to overhead lines (which are not covered by IEC standards) if they so wish.

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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 2394:2015, *General principles on reliability for structures*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

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

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

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

3.1
accretion
process of building up ice on the surface of an object, resulting in the different types of icing on structures

3.2
drag coefficient
shape factor for an object to be used for the calculation of wind forces in the along-wind direction

3.3
glaze
clear, high-density ice

3.4
ice action
effect of accreted ice on a structure, both as gravity load (= self-weight of ice) and as wind action on the iced structure

3.5
ice class
IC
classification of the characteristic ice load that is expected to occur within a mean return period of 50 years on a reference ice collector situated in a particular location

3.6
in-cloud icing
icing due to super-cooled water droplets in a cloud or fog

3.7
precipitation icing
icing due to either

a) freezing rain or drizzle, or

b) accumulation of wet snow

3.8
return period
average number of years in which a stated action statistically is exceeded once

Note 1 to entry: A long return period means low transgression intensity (occurring rarely) and a short return period means high transgression intensity (occurring often).

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3.9
rime
white ice with in-trapped air

4 Symbols

C_i	drag coefficient of an iced object	1
$C_{0,3}$	drag coefficient for large objects (width >0,3 m)	1
C_0	drag coefficient of an object without ice	1
D	diameter of accreted ice or total width of object including ice	mm
F_w	wind force	N/m
H	height above terrain	m
k	factor for velocity pressure from wind action	1
K_h	height factor	1
L	length of ice vane measured in windward direction	mm
m	mass of accreted ice per meter unit length	kg/m
m_W	ice mass for ice on large objects	kg
T	return period	year
t	ice thickness	mm
t_a	air temperature	°C
W	width of object (excluding ice) perpendicular to wind direction	mm
α	angle of incidence between wind direction and the objects longitudinal axis	°
γ	density of ice	kg/m^3
θ	angle of wind incidence in a vertical plane	°
τ	solidity ratio: $\frac{\text{exposed panel area}}{\text{total panel area within outside boundaries}}$	1
τ'	increased value of τ caused by icing to be used in calculations	1
ϕ	factor of combination	1

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