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Determination of span rating for natural fibre-reinforced plastic composite (NFC) deck boards

Détermination de la portée nominale des lames de platelage en composite plastique renforcé de fibres naturelles (NFC)

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Contents

Page

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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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

This document was prepared by Technical Committee ISO/TC 61, *Plastics*, Subcommittee SC 11, *Products*.

Introduction

Natural fibre-reinforced plastic composites (NFC) are made of one or several cellulosic materials combined with one or several thermoplastics. Currently, cellulosic materials mainly come from different natural plant sources and the most common thermoplastics, including virgin and recycled forms, are polyethylene, polypropylene and polyvinyl chloride. In the past, these composites used to be called wood plastic composites (WPC). In this document, NFC is used instead of WPC, in line with the terminology used in ISO 16616.

The production of NFC in the thermoplastics industry has gained much acceptance in recent years and is expected to keep growing rapidly. This type of composite material has become an important family of engineering materials due to the increasing need for sustainable and biodegradable renewable materials, which are known as “green composites.” NFC has sustainable character due to the presence of wood as a natural component, which enables environmental protection and minimization of waste formation. Such materials offer significant advantages which justify their use.

NFC has recently found wide applications in construction and decoration areas including decking, fencing, flooring, landscaping, railings, window framing, and roof tiles. Meanwhile it is also applied for packaging, automotive industries, furniture and other items.

For deck boards used in outdoor environments, some performance measurements, such as temperature and moisture effects, ultraviolet resistance, freeze-thaw resistance, etc., are used in the determination of the span rating in order to assist in the proper installation and using. However, due to the lack of a unified testing method to evaluate a span rating indicating the board’s ability to comply with functions identified for its specific end use, therefore, it would be required to establish an ISO standard for removing the barriers of deck boards in the application and sales, and encouraging technology development in the NFC production field.

Determination of span rating for natural fibre-reinforced plastic composite (NFC) deck boards

1 Scope

This document specifies the procedures to establish a span rating for natural fibre-reinforced plastic composite (NFC) deck boards and deck boards used as stair treads, provided that the stair treads are produced from the same materials and processing techniques as the deck boards. This document covers test methods of performance, acceptance criteria and determination of span rating. It is intended to establish the basis for code recognition of deck boards used in exterior applications where combustible construction is allowed.

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 291, *Plastics — Standard atmospheres for conditioning and testing*

ISO 4892-2:2013, *Plastics — Methods of exposure to laboratory light sources — Part 2: Xenon-arc lamps*

ISO 16616:2015, *Test methods for natural fibre-reinforced plastic composite (NFC) deck boards*

EN 15534-1:2014, *Composites made from cellulose-based materials and thermoplastics (usually called wood-polymer composites (WPC) or natural fibre composites (NFC)) — Part 1: Test methods for characterization of compounds and products*

ASTM D7032-17, *Standard Specification for Establishing Performance Ratings for Wood-Plastic Composite and Plastic Lumber Deck Boards, Stair Treads, Guards, and Handrails*

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
natural fibre-reinforced plastic composite
NFC
product made thereof being the result of the combination of one or several cellulosic materials with one or several thermoplastics

3.2
flexural strength
maximum load achieved by the test specimen during flexural test, and reported as modulus of rupture (MOR)

3.3
flexural stiffness
value calculated from a linear least squares fit of the stress-strain curve over the range of 10 % to 40 % of ultimate stress, and reported as either modulus of elastic (MOE) or MOE × moment of inertia (EI)

Note 1 to entry: If the cross-section of deck boards is complicated to calculate moment of inertia, it is better to use EI to indicate flexural stiffness.

3.4
span rating
maximum centre-to-centre support spacing for the specified end use

4 Test specimen

Test specimens with the original thickness and width of the product are used in the tests unless otherwise specified. In general, test specimens of the product are rectangular in cross-section for deck boards and stair treads.

5 Sampling

It is important to select test specimens that reflect the variability of the population. It is essential to consider batch-to-batch and shift-to-shift variability when sampling actual production. Test specimens shall be selected from several production runs of a given item.

6 Conditioning

Prior to testing, all specimens shall be conditioned to environmental conditions appropriate for the intended end-use of the product. Alternatively, the test specimens used for the determination of the product performance shall be conditioned for a minimum of 72 h and testing shall be carried out at the standard atmosphere 23/50 (23 °C ± 2 °C, 50 % ± 5 % RH) in accordance with ISO 291. When the product is to be subjected to a water soak environment, the test specimens shall be tested within 30 min upon removal from the treatment.

7 Evaluation methods of performance

7.1 General

Deck boards and stair treads are structural elements and shall be tested in flexure to establish a span rating. For products often used in diverse outdoor environments, the temperature and moisture effects (see 7.2) shall be used in the determination of the span rating. In addition, several other performance measures shall be evaluated and used to adjust the span rating in order to assist in the proper installation and using, including tests on ultraviolet resistance (see 7.3), freeze-thaw resistance (see 7.4), biodeterioration effects (see 7.5), creep-recovery (see 7.6), and creep-rupture (see 7.7), mechanical fastener holding capacity (see 7.8), and slip resistance (see 7.9).

7.2 Temperature and moisture effects

7.2.1 Temperature effect

Testing shall be conducted to verify that allowable span and load ratings are applicable at a range of temperatures expected in service. For the purposes of this document, the lower and upper temperatures shall be −30 °C ± 2 °C and 55 °C ± 2 °C, respectively. Flexure tests shall be conducted to failure at the desired span. A minimum of 10 specimens shall be tested at each temperature. The flexural strength and flexural stiffness shall be determined in accordance with ISO 16616:2015, 6.2.

The average change in properties between the flexural strength and stiffness of the standard control flexural specimens and the specimens tested at low and high temperatures shall be calculated as a percentage and reported. The average change shall be calculated by determining the difference between the standard control and temperature conditioned values and dividing that difference by the control value.

7.2.2 Moisture effect

Testing shall be conducted to verify that allowable span and load ratings are applicable at moisture conditions expected in service. Flexural tests shall be conducted to failure at the desired span. A minimum of 10 specimens shall be tested at moisture conditions potentially experienced in service (for example, high humidity, submerged), or under standard condition which is submersion in water for 14 d. The average maximum flexural strength and stiffness shall be determined in accordance with ISO 16616:2015, 6.2.

The average change in properties between the standard control specimens and those tested at the in-service moisture condition of interest shall be calculated as a percentage and reported. The average change shall be calculated by determining the difference between the control and moisture conditioned values and dividing that difference by the standard control value.

7.2.3 Acceptance criteria

The most restrictive effect (either temperature or moisture) shall be used to adjust the performance rating of deck boards and stair treads. The span rating shall be reduced by the most restrictive effect determined from 7.2.1 or 7.2.2.

7.3 Weatherproofing

7.3.1 Test method

To determine the mechanical property degradation after xenon lamp exposure, a minimum of five full-size or full-thickness specimens shall be tested for up to 2 000 h (340 nm, 0,51 w/m^2) in the direction of the exposed side as specified in Method A of ISO 4892-2:2013, Table 3.

A minimum of five exposed and five unexposed test specimens shall be tested in accordance with ISO 16616:2015, 6.2. The surface intended for exposure in service shall be exposed to the xenon lamp source. The flexure test shall be conducted with the exposed surface in tension.

When testing equipment does not allow either full-size or full-thickness test specimens, coupon specimens removed from the surface of the full-size cross-section shall be used. However, when using data generated from coupon specimens, the user shall justify the estimation of the impact on the full-size product.

7.3.2 Acceptance criteria

The average percent change in properties between the exposed and unexposed specimens shall be calculated and reported. The average change shall be calculated by determining the difference between the unexposed and exposed values and dividing that difference by the unexposed value. For acceptance, the average flexural strength of exposed test specimens shall be within 10 % of the average flexural strength of unexposed specimens. If the decrease exceeds 10 %, the span shall be reduced by the amount in excess of 10 %.