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Additive manufacturing of metals — Test artefacts — Compression validation specimens for lattice designs

Fabrication additive de métaux — Pièces types d'essai — Éprouvettes de validation de compression pour les conceptions de treillis

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Foreword

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Introduction

Validation and verification activities to support the manufacture of components are critical quality requirements to ensure reliable production of consistent parts. Additive manufacturing (AM) offers the opportunity to seamlessly incorporate computationally designed, high resolution, lattice structures into components. On the other hand, AM systems can have different capabilities in terms of feature resolution, therefore impacting physical properties of lattice structures. In order to ensure quality requirements, there is a need to develop standardized lattice specimen geometries that can be used as surrogates in destructive evaluations. Specifically, components incorporating lattice structures can be placed under compressive loads. Since lattice designs, including, beam, gyroid or schwartz, can be unique to manufacturers, a standardized approach is needed to ensure that the lattice design is adequately represented and can be consistently assessed. This can allow for the evaluation of the compressive mechanical strength with adequate representation of the manufacturing of the lattice design.

This document provides the lattice compression specimen and other AM specific considerations for using the specimen per an existing compression test method like ASTM E9 or ISO 13314. Although ASTM E9 and ISO 13314 provide standard methods of compression testing for metallic materials, in this document specific considerations for lattice structures, such as the minimum number of unit cells, ductile and brittle material considerations, the option for building specimens with endplates, and differences between regular and non-regular lattices are included along with reporting requirements of AM build parameters.

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Additive manufacturing of metals — Test artefacts — Compression validation specimens for lattice designs

1 Scope

This document specifies requirements and provides guidance for the preparation for axial force compression testing of additively manufactured (AM) metallic lattice specimens for validation purposes.

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/ASTM 52900, *Additive manufacturing — General principles — Fundamentals and vocabulary*

ISO/ASTM 52931, *Additive manufacturing of metals — Environment, health and safety — General principles for use of metallic materials*

ASTM E9, *Standard Test Methods of Compression Testing of Metallic Materials at Room Temperature*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO/ASTM 52900 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 Values

The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems can result in nonconformance with this document.

5 Significance and use

5.1 Significance

This document provides a compression specimen design for AM metallic lattice structures to be used with existing compression test methods. As such, it is expected to be better suited for AM metallic lattices than the specimen designs found in ISO 13314 or ASTM E9. The optional endplates incorporated in this document can assist in protecting the compression plates as well as ensuring a more uniform load across the lattice structure.

The data obtained from a compression test of a lattice structure typically includes the test time, force and displacement. Additional calculations can be made based on the compression test method being used; it is up to the user to determine what data are most important for their validation process.

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