BRITISH STANDARD

BS 7905-2:2000

Incorporating Corrigendum No. 1

Lifting equipment for performance, broadcast and similar applications —

Part 2: Specification for design and manufacture of aluminium and steel trusses and towers

ICS 53.020.99; 91.080.10; 97.200.10

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by Technical Committee MHE/3, Cranes and derricks, to Subcommittee MHE/3/13, Lifting equipment for performance, broadcast and similar applications, upon which the following bodies were represented:

Association of British Theatre Technicians
Broadcasting Entertainment Cinematograph and Theatre Union
H.S.E
ITV Association (ITVA)
Lifting Equipment Engineers Association
Professional Lighting and Sound Association
Safety Assessment Federation Ltd
Theatres Advisory Council

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The following BSI references relate to the work on this standard:
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11027 Corrigendum No. 1	July 2000	Corrections to inside front cover. Other corrections indicated by a sideline in the margin.

Contents

Foreword

This British Standard has been prepared by Subcommittee MHE/3/13, Lifting equipment for performance, broadcast and similar applications.

There are no specific British Standards that cover the design, manufacture and use of aluminium or steel trusses in the entertainment industry. It should be noted that other British Standards may be relevant, depending on the application and intended use.

In an attempt to improve safety and standards in the entertainment industry, the Entertainment Services and Technology Association (ESTA) of New York, USA, convened a series of meetings to prepare a draft standard for the American National Standards Institute. The preparation of the draft standard was entrusted to the Truss Team working as part of the Rigging Work Group for the Technical Standards Committee (TSC) of ESTA. The Truss Team generally consisted of manufacturers and their structural engineering advisors.

This British Standard is based on the American draft standard.

It has been assumed in the drafting of this British Standard that execution of its design provisions is entrusted to appropriately qualified and experienced people, and that the fabrication is carried out by qualified and suitably experienced people and organizations.

This British Standard specifies a coordinated set of requirements that can also be a guide to government and other regulatory bodies and municipal authorities responsible for guarding and inspection of the equipment falling within its scope. The requirements concerning accident prevention are given both as mandatory and advisory provisions; compliance with both types may be required by employers of their employees.

Safety codes and standards are intended to enhance public safety. Revisions result from committee consideration of factors such as technology advances, new data, and changing environmental and industry needs. Revisions do not imply that previous editions were not adequate.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

Compliance with a British Standard does not of itself confer immunity from legal obligations.

Summary of pages

This document comprises a front cover, an inside front cover, pages i and ii, pages 1 to 5 and a back cover.

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1 Scope

This British Standard covers design and manufacture of aluminium and steel trusses, towers and associated structural components such as tower head blocks, sleeve blocks, bases, and corner blocks in the entertainment industry. This British Standard covers truss beams and two dimensional ladder beams but does not cover individual, separate rigging hardware (half couplers, shackles, wire ropes, etc.).

This British Standard covers a variety of uses that are confined to the entertainment industry and applies to a range of structures subjected to normal atmospheric conditions.

This British Standard does not cover aerospace aluminium alloys, detailed design of castings, curved shell structures or structures subjected to severe thermal or chemical conditions. This British Standard is not intended to be used for the design of containment vessels, airborne structures, or vessels, or for any application covered by another standard.

Guidance on use of the equipment covered by this British Standard is given in BS 7906-2.

Wherever "truss" is referred to in this British Standard, it equally applies to "tower" and vice versa. "Truss" also applies to associated structural components.

2 Normative references

The following normative documents contain provisions that, through reference in this text, constitute provisions of this British Standard. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated references, the latest edition of the publication referred to applies.

BS 4-1:1993, *Structural steel sections — Specification for hot rolled sections.*

BS 1139-1.2:1990, *Metal scaffolding — Part 1: Tubes — Section 1.2: Specification for aluminium tube.*

BS 5950 (all parts), *Structural use of steelwork in building.*

BS 6399 (all parts), *Loading for buildings.*

BS 8118 (all parts), *The structural use of aluminium.*

BS EN 287-1:1992, *Approval testing of welders for fusion welding — Steels.*

BS EN 287-2:1992, *Approval testing of welders for fusion welding — Aluminium and aluminium alloys.*

BS EN 754 (all parts), *Aluminium and aluminium alloys — Cold drawn rod/bar and tube.*

BS EN 755 (all parts), *Aluminium and aluminium alloys — Extruded rod/bar, tube and profiles.*

BS EN 30042:1994, *Arc welded joints in aluminium and its weldable alloys — Guidance on quality levels for imperfections.*

BS EN 10056-1:1999, *Specification for structural steel equal and unequal angles — Dimensions.*

BS EN 10067:1997, *Hot rolled bulb flats — Dimensions and tolerances on shape, dimensions and mass.*

BS EN 10210-2:1997, *Hot finished structural hollow sections of non-alloy and fine grain structural steels — Tolerances, dimensions and sectional properties.*

BS EN 25817:1992, *Arc-welded joints in steel — Guidance on quality levels for imperfections.*

3 Definitions

For the purposes of this British Standard, the following definitions apply.

NOTE Figure 1 shows some components of a typical truss or tower module.

3.1

abrasion

loss of material due to wear

3.2

allowable load

maximum permitted static equivalent load imposed on truss/tower in addition to the self-weight

3.3

camber

intended vertical deviation of a truss, usually radiused

3.4

central point load (CPL)

load applied at mid-span of the truss

3.5

chord

element of a truss module that carries axial forces associated with flexure or axial loading

3.6

competent person

person with sufficient practical and theoretical knowledge and experience to carry out the person's duties, and who is aware of the limits of the person's competency, expertise and knowledge

3.7

connecting plates

plates welded to the end frames of a truss or tower module, used to connect adjacent modules together

3.8

consumable

item that requires regular replacement with use

3.9

crack

crevice type discontinuity in a material

3.10

damage

condition that adversely affects the intended use of a truss module (usually the load carrying capacity)

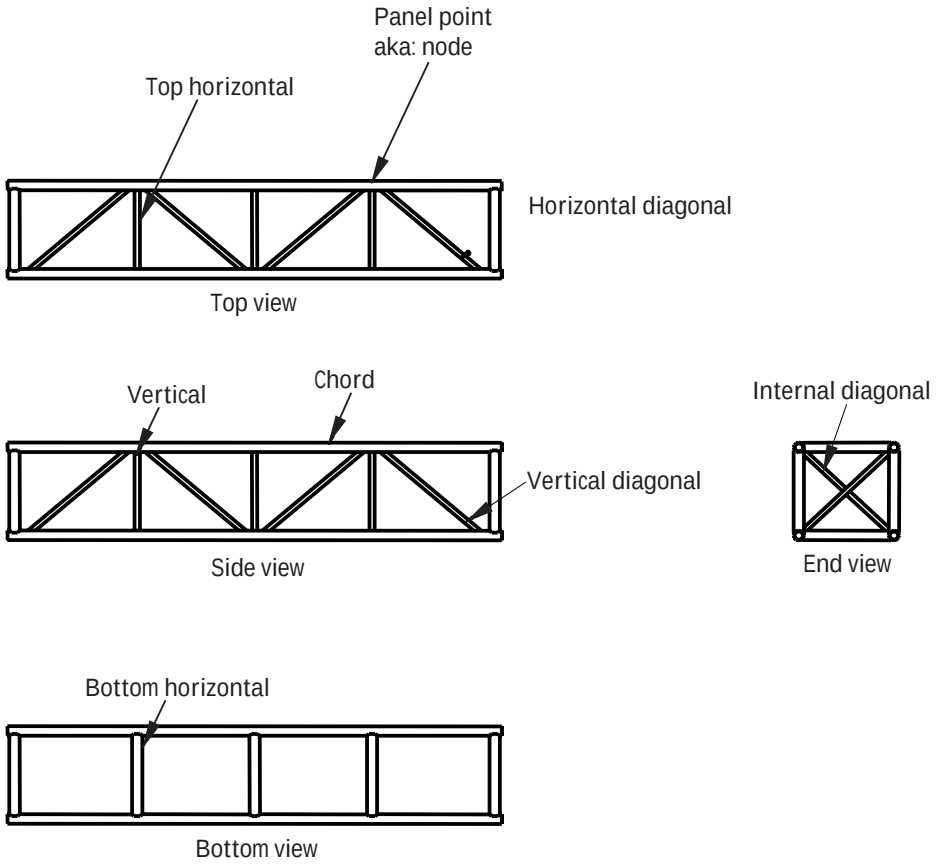

Figure 1 — Components of a typical truss or tower module

3.11
dent
local deformation resulting in measurable change in cross section of member or element

3.12
design strength
capacity of the elements of the structure to withstand normal design loading

3.13
diagonal
elements of the truss or tower module that are at an angle to the main chords

3.14
drift test
standard test carried out on aluminium tubing to check structural integrity of the tube walls

NOTE Drift testing highlights splits in the tube that can occur in the extrusion process.

3.15
dye penetrant test
standard non-destructive test that highlights cracks in welds

3.16
dynamic load
load that moves or vibrates

3.17
end plate
plate on end of a truss module that allows connection to adjacent truss module(s)

3.18
incident
occurrence in which damage to one or more truss modules can be sustained

3.19
module
singular framed structure built up entirely from tension and compression members, arranged in panels to be stable under load

3.20
pinned connection
end tube connection that uses a removable pin to form a connection between truss modules

3.21

qualified person

person who, by possession of a recognized degree or certificate of professional standing, or who by extensive knowledge, training, and experience, has demonstrated the ability to solve problems relating to the subject matter and work

3.22

regular service

normal use with repetitive assembling and dismantling

3.23

skin

material cover to a truss structure

NOTE A skin is normally used on a roof system.

3.24

span

distance between support points

3.25

static load

load that is not moving

3.26

sweep

intended lateral deviation of a truss, usually radiused

3.27

tower

one or more modules, usually square or triangular, assembled vertically to carry primarily axial load

3.28

truss

one or more modules, generally horizontal, assembled to carry load over a distance, primarily in flexure

3.29

user

person or company who assembles or uses truss or tower modules or systems

3.30

uniformly distributed load (UDL)

load that is evenly spread over the length of a truss

4 Engineering

4.1 General

Aluminium and steel trusses and towers shall be designed in accordance with this clause.

4.2 Design

Aluminium trusses shall be designed in accordance with BS 8118.

Steel trusses shall be designed in accordance with BS 5950.

The design of either aluminium and steel trusses shall also conform to any other relevant standard for the intended conditions of use.

Welds shall be designed and detailed in accordance with the appropriate material standard (i.e. BS 8118 or BS 5950).

Fasteners and other components of materials other than aluminium and steel shall be designed in accordance with standards relevant to the material.

Design loading, including wind, shall be determined in accordance with BS 6399.

All conditions of use considered in design shall be explicitly outlined in the engineering documentation provided by the manufacturer.

Strength shall be established using design methods and/or by physical testing. If testing is used to determine the strength of an element or structure, the test procedures shall conform to the appropriate material standard (i.e. BS 8118 or BS 5950).

Truss structures shall conform to the following:

— Design of truss structures for single use: these structures shall be designed in accordance with either BS 8118 or BS 5950 as appropriate.

— Design of truss modules for repetitive use: the design strength determined in accordance with BS 8118 or BS 5950 shall be reduced by multiplying the strength by a factor of 0.85. The reduced design strength shall be greater than or equal to the allowable load for intended loading conditions.

Steel connectors for joining pieces of trussing together shall be either nut and bolt fasteners of minimum strength grade 8.8 throughout, or other fasteners of appropriate strength and design, that require at least two deliberate manual actions to release (e.g. pin and clip).

Quarter turn fasteners or other types of connector that require only a single action shall not be used.

4.3 Analysis

4.3.1 Analysis of the truss or tower structures for the intended load conditions shall be performed by calculation, modelling, physical testing, or a combination of these methods.

4.3.2 Analysis shall consider the worst combination, application, and configuration of loads and effects possible within the guidelines for use.

4.3.3 Consideration shall be given to overall structural stability and bracing requirements for all applications within the guidelines for use.

4.3.4 Consideration shall be given to the effects of eccentricities in element and module connections.

4.3.5 Deflections shall be calculated for the load conditions provided in the user information.

4.4 Engineering documentation

Engineering drawings of the truss or tower designs shall be developed and maintained by the manufacturer.

Engineering drawings shall include dimensions, components, subassemblies, material types, fastener types, and specifications, weld sizes and types, and welding consumables.

Engineering calculations, design notes and/or test results shall be developed and maintained to demonstrate conformity to this standard for the intended load conditions and uses.

If a statement about design factor (commonly known as the "factor of safety") is included in the information for use, then the manufacturer shall clearly state to what condition the design factor refers.

NOTE The design factor is usually defined as the ratio of the load required to cause failure to the allowable load on the structure or element.

5 Manufacture

5.1 General

A level of quality in accordance with acceptable standard shall be maintained throughout the manufacturing process.

Each truss shall have a mark so that it is traceable to the manufacturer if a defect occurs.

5.2 Materials

Aluminium alloy shall conform to BS EN 754 and BS EN 755.

Extruded aluminium alloy tubes shall be drift tested in accordance with BS 1139-1.2 to reduce the possibility of splitting.

Steelwork shall conform to BS 4 and/or BS 10210-2, BS EN 10056-1 and BS EN 10067, ensuring component dimensions are within set limits and tolerances.

5.3 Welding

Welders employed to manufacture aluminium truss or who are involved in producing the truss module through the welding process shall be certified in accordance with BS EN 287-2.

Welding processes for the manufacture of aluminium truss shall be carried out in accordance with BS 8118. Acceptance levels of defects in welds shall conform to BS EN 30042.

Welders employed to manufacture steel truss or who are involved in producing the truss module through the welding process shall be certified in accordance with BS EN 287-1.

Welding processes for the manufacture of steel truss shall be carried out in accordance with BS 5950. Acceptance levels of defects in welds shall conform to BS EN 25817.

5.4 Inspection

All welds shall be visually inspected after completing the welding process.

All welds that do not appear sound shall be tested using the dye penetrant test. Repairs shall be carried out as required.

All products shall be inspected during and after fabrication to ensure conformity to the design drawings.

5.5 Identification

5.5.1 Each truss module shall bear an identification mark unique to the manufacturer and to the module. The mark shall be easily recognizable, durable and difficult to remove. The mark shall include the manufacturer's name, type of truss and basic allowable load/span data.

5.5.2 The manufacturer shall be responsible for keeping appropriate records relating to the truss identification marks.

6 Care and use

6.1 General

Information shall be provided for the end-user to ensure that the individual truss modules can be handled correctly during storage, transportation, erection, and dismantling, and that the assembled truss systems can be used on site within the limitations of the manufacturer's loading tables.

6.2 User information

User information sheets or other documentation shall be provided with each type of truss in a consignment and shall include the following data:

a) the maximum span into which truss modules may be assembled and safely used;

b) the maximum load that can be applied to a truss, UDL and CPL for given spans;

c) theoretical deflection expected at given load and span;

d) the maximum height to which a tower can be erected;

e) the maximum load that can be supported by the tower;

f) details of the standards to which the truss or towers have been designed;

g) the extent of dynamic loading considered in the design;

h) the correct ways to store, handle, transport, and erect the trussing;

i) the correct method of making connections;

j) requirements for regular inspections of the trussing;

k) details of how to obtain full engineering documentation for the truss;

l) any additional information appropriate to the truss or assemblage of trussing.

Bibliography

BS 7905-1, *Design of lifting equipment for performance, broadcast and similar applications — Specification for above stage equipment (excluding towers and trusses)* (under preparation).

BS 7906-1, *Use of lifting equipment for performance, broadcast and similar applications — Code of practice for installation, use and removal of above stage equipment (excluding towers and trusses)* (under preparation).

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