

Australian Standard<sup>®</sup>

## Shackles



This Australian Standard® was prepared by Committee ME-025, Lifting Tackle. It was approved on behalf of the Council of Standards Australia on 29 March 2002. This Standard was published on 2 May 2002.

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- 

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Standards Australia wishes to acknowledge the participation of the expert individuals that contributed to the development of this Standard through their representation on the Committee and through the public comment period.

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**STANDARDS AUSTRALIA**

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**RECONFIRMATION**

**OF**  
**AS 2741—2002**  
**Shackles**

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Technical Committee ME-025 has reviewed the content of this publication and in accordance with Standards Australia procedures for reconfirmation, it has been determined that the publication is still valid and does not require change.

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## NOTES

# Australian Standard<sup>®</sup>

## Shackles

Originated as AS B278—1968.  
Previous edition AS 2741—1992.  
Third edition 2002.  
Reissued incorporating Amendment No. 1 (July 2002).  
Reissued incorporating Amendment No. 2 (November 2008).

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## PREFACE

This Standard was prepared by the Standards Australia Committee ME-025, Lifting Tackle, to supersede AS 2741—1992.

*This Standard incorporates Amendment No. 1 (July 2002) and Amendment No. 2 (November 2008). The changes required by the Amendments are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.*

The purpose of this Standard is to promote the safety of shackles.

This edition includes the following technical changes:

- (a) In Clause 2, the list of referenced documents has been brought up to date.
- (b) In Clause 3, the definitions for ‘production batch’ and ‘safe working load’ have been deleted, and definitions for ‘competent person’ and ‘nominal size’ have been added. The term ‘safe working load (SWL)’ is not used, to align with international practice.
- (c) In Clause 4, Quality Grades L, P and T have been deleted.
- (d) In Clauses 6, 8 and 9, the requirements for mechanical properties and proof testing are set out in a new format, including the deletion of production destructive tests.
- (e) Requirements for quality control have been included in Clause 9.
- (f) The note in Clause 9.4 recommends that the original test certificate be retained for 10 years.
- (g) In Appendix D, the dimension ‘E’ was changed from lower case to upper case.
- (h) Previous Figures 7 to 10 for pins for Quality Grade P shackles have been deleted.
- (i) Appendix F specifies conditions for application of test forces.

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## FOREWORD

Shackles are used in lifting, tensioning and staying systems as removable links to interconnect other components.

In any lifting, tensioning or staying system, the working load of each component has to take account of the conditions (such as the classification of load application as specified by AS 1418.1) and be compatible with any loads inherent in and applied to the system, and each component has to readily connect with each adjacent component. Therefore, it is important that components of lifting, tensioning or staying systems be quickly and positively identified in service for size, lifting capacity and quality grade.

The same quality grading system is used by other Australian Standards covering components in lifting, tensioning and staying systems. It allows for positive identification and easy selection and matching, and relates to the mechanical properties of the finished product and not simply to the strength of the material.

# STANDARDS AUSTRALIA

## Australian Standard Shackles

### 1 SCOPE

This Standard specifies requirements for forged shackles of Quality Grades M or 4 and S or 6.

#### NOTES:

- 1 Guidance on information that should be supplied with inquiries and orders is given in Appendix A.
- 2 Guidance on the care and use of shackles is given in Appendix B.
- 3 Standards for components used in lifting systems are listed in Appendix C.

### 2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

#### AS

- |        |                                                                                                                       |
|--------|-----------------------------------------------------------------------------------------------------------------------|
| 1065   | Non-destructive testing—Ultrasonic testing of carbon and low alloy steel forgings                                     |
| 1171   | Non-destructive testing—Magnetic particle testing of ferromagnetic products, components and structures                |
| 1199   | Sampling procedures and tables for inspection by attributes                                                           |
| 1399   | Guide to AS 1199—Sampling procedures and tables for inspection by attributes                                          |
| 1418   | Cranes, hoists and winches                                                                                            |
| 1418.1 | Part 1: General requirements                                                                                          |
| 1442   | Carbon steels and carbon-manganese steels—Hot-rolled bars and semifinished products                                   |
| 1444   | Wrought alloy steels—Standard, hardenability (H) series and hardened and tempered to designated mechanical properties |
| 1627   | Metal finishing—Preparation and pretreatment of surfaces                                                              |
| 1627.6 | Part 6: Chemical conversion treatment of metals                                                                       |
| 1721   | General purpose metric screw threads                                                                                  |
| 1789   | Electroplated coatings—Zinc on iron or steel                                                                          |
| 1816   | Metallic materials—Brinell hardness test                                                                              |
| 2062   | Non-destructive testing—Penetrant testing of products and components                                                  |
| 2193   | Methods for calibration and grading of force-measuring systems of testing machines                                    |

**‘Not applicable’**

#### ISO/IEC

- |       |                                                                                 |
|-------|---------------------------------------------------------------------------------|
| 17025 | General requirements for the competence of testing and calibration laboratories |
|-------|---------------------------------------------------------------------------------|

#### AS/NZS

- |      |                                                                   |
|------|-------------------------------------------------------------------|
| 4680 | Hot-dip galvanized (zinc) coatings on fabricated ferrous articles |
|------|-------------------------------------------------------------------|

AS/NZS

ISO 9001 Quality management systems—Requirements

ISO 9004 Quality management systems—Guidelines for performance improvements

HB [Standards Australia Handbook]

18 Guidelines for third-party certification and accreditation

18.28 Guide 28: General rules for a model third-party certification system for products

### 3 DEFINITIONS

For the purpose of this Standard, the definitions below apply.

#### 3.1 Competent person

A person having practical and theoretical knowledge and relevant experience, sufficient to enable that person to detect and evaluate any defects and any weaknesses that may affect the intended performance of the equipment.

#### 3.2 Finished condition

The condition after completion of processing and proof loading.

#### 3.3 Nominal size

The nominal diameter of the shackle body.

#### 3.4 Processing

Any treatment subsequent to forging, including heat treatment and application of surface finish coatings, but excluding proof loading and application of temporary protective coatings for storage purposes.

#### 3.5 Self-coloured

A surface finish arising from essential manufacturing processes, without additional surface treatment.

#### 3.6 Shackle

An assembly for interconnecting components in lifting, tensioning and staying systems, consisting of a body, a removable pin and any applicable locking devices.

#### 3.7 Shall

Indicates a statement is mandatory.

#### 3.8 Should

Indicates a recommendation.

#### 3.9 Working load limit (WLL)

The maximum load that may be applied to the shackle, which may be re-rated for particular conditions of use.

### 4 MATERIAL

Shackles shall be of—

- (a) heat-treated fully killed fine-grained steel complying with the relevant requirements of Table 1;
- (b) suitable materials complying with AS 1442 or AS 1444; or
- (c) steels not complying with AS 1442 or AS 1444, provided they meet the intent of this Standard.

Tramp elements such as tin, antimony and arsenic can increase the susceptibility of steel to temper embrittlement. Care should be taken to ensure temper embrittlement has not occurred.

To protect against strain-age embrittlement during service, the steel shall contain sufficient aluminium, subject to a minimum of 0.025%.

**TABLE 1**  
**MATERIAL AND HEAT TREATMENT**

| Quality Grade | Product analysis of elements, maximum allowable percentage |            |        | Heat treatment (see Clause 5.5)       |
|---------------|------------------------------------------------------------|------------|--------|---------------------------------------|
|               | Carbon                                                     | Phosphorus | Sulfur |                                       |
| M             | 0.45                                                       | 0.045      | 0.045  | Either harden and temper or normalize |
| S             | 0.45                                                       | 0.030      | 0.030  | Harden and temper                     |

## 5 DESIGN AND MANUFACTURE

### 5.1 Type

Shackles shall be of the following types, each of which is illustrated in Appendix D:

- (a) Quality Grade M or 4 dee.
- (b) Quality Grade S or 6 dee.
- (c) Quality Grade S or 6 bow.

### 5.2 Dimensions and tolerances

#### 5.2.1 Dimensions

Shackles shall conform to the relevant dimensions specified in Appendix D, within the tolerances and clearances specified in Clause 5.2.

#### 5.2.2 Tolerances

Dimensions  $B$ ,  $D$ ,  $d$ ,  $E$ ,  $L$  and  $W$ , as specified in Appendix D, shall be within a tolerance of +8% –5% of the specified dimension.

NOTE: Only indicative values are given for the other dimensions in Appendix E.

#### 5.2.3 Clearances between pin and body

The diameter of unthreaded holes in the body of each shackle shall not exceed the following relevant values:

| Actual pin diameter ( $D$ ) mm | Maximum hole diameter mm                         |
|--------------------------------|--------------------------------------------------|
| $\leq 20$                      | The greater of $(1.07 \times D)$ and $(D + 1)$   |
| $> 20 \leq 45$                 | The greater of $(1.07 \times D)$ and $(D + 1.5)$ |
| $> 45$                         | The greater of $(1.07 \times D)$ and $(D + 2)$   |

#### 5.2.4 Geometry

Pin holes and bolt holes in the shackle body should be central to the outside shape of the eye and in axial alignment.

### 5.2.5 Threads

The screwed portion of shackle pins shall be concentric with the plain portion.

Metric threads shall comply with AS 1721, with a tolerance class of 6G/6e.

The tolerance for threads other than metric threads shall be similar to the tolerances for metric threads.

A2

Where an undercut is required at the end of the threaded portion of a shackle pin, the undercut shall be machined in a manner such as to minimize stress concentrations that could otherwise adversely affect the pin.

For bolts and nuts, the length of the plain portion of the bolt should be such that its nut will lock on the inner end of the thread or undercut and not on the face of the shackle body. When in this position, bolts shall be cross-drilled for the split cotter pin.

### 5.3 Shackle body

The shackle body shall be cleanly forged in one piece and, prior to machining, shall be free from apparent defects.

Where holes are machined, the diameter of any hot-pierced holes shall be not more than two-thirds of the finished diameter of the machined hole.

Where holes are produced by methods other than drilling, the resulting cut thread shall extend through the full depth of the eye.

Where plain punched holes are provided, the clearances between the body and the pin shall not exceed the limits specified in Clause 5.2.3.

Rounding of edges caused by punching shall be not more than 5% of the body diameter.

The screw thread shall be cleanly formed and free from imperfections.

### 5.4 Shackle pin

The shackle pin shall be either—

- (a) cleanly forged in one piece and threaded;
- (b) forged in one piece and machined;
- (c) machined from an appropriate grade of bar.

The finished pin shall be free from imperfections that are deleterious to the use of the product.

NOTE: Typical shackle pins are illustrated in Appendix E, in which the dimensions for pinheads are provided for guidance and may be varied.

### 5.5 Heat treatment

Shackles shall be heat treated in a manner that will achieve the mechanical properties required by Clause 6.

The body and the pin shall have a hardness of not more than 300 Brinell (equivalent to Rockwell 32RC), as well as complying with the requirements of Table 1.

### 5.6 Surface finish

Shackles should have a surface finish of one of the following:

- (a) Self-coloured.
- (b) Hot-dipped galvanized coating complying with AS/NZS 4680.
- (c) Class A1, Class A2 or Class B phosphate coating complying with AS 1627.6.
- (d) Fe/Zn 12c electroplated zinc coating complying with AS 1789.

- (e) Painted.
- (f) Mechanical plating.

NOTE: Hydrogen embrittlement can occur in shackles that had their thread rolled after being heat treated. It results from the absorption of atomic hydrogen generated at the steel surface by processes such as acid pickling or cathodic cleaning.

### 5.7 Visual examination

Shackles should be visually examined by a competent person, to look for faults, including the following:

- (a) Faults arising from the forging process, including overlaps, cavities and cracks.
- (b) Faults arising from the machining process.
- (c) Faults arising from the heat treatment process.
- (d) Faults arising from the surface finish or the surface finishing process.
- (e) Any indication of a possible crack.
- (f) The fit of the pin.

Visual defects are not permitted in areas of the shackle that may be subjected to tensile stresses under service conditions.

NOTE: Visual examinations may be performed on the finished shackle or progressively at the most convenient stages of the manufacturing process, by one or more competent persons, provided that all relevant features are examined.

## 6 MECHANICAL PROPERTIES

### 6.1 Quality control

Each shackle shall be subjected to a quality control process complying with Clause 9.

### 6.2 Strength

#### 6.2.1 General

Except where Clause 6.2.2(b) is applied, each shackle shall be capable of supporting a test load of 6 times the working load limit of the shackle under the conditions specified in Appendix F.

#### 6.2.2 WLL of more than 166 t

Shackles with a WLL of more than 166 t (which would require a test load of more than 1000 t to comply with Clause 6.2.1) shall be either—

- (a) tested in accordance with Clause 6.2.1; or
- (b) tested with a test load of not less than 1000 t in conjunction with other appropriate engineering verifications.

### 6.3 Ductility

#### 6.3.1 General

Where Clause 6.2.1 is applied, shackles shall be sufficiently ductile so that, in the event of being loaded to failure, the fractured member will show a permanent distortion before breaking. If the pin fractures, it shall show a permanent bend of not less than 20 degrees. If the body fractures, it shall show a permanent mid-shackle set of not less than 15% of the original width between the bows or legs (B or W in Appendix D).

#### 6.3.2 WLL of more than 166 t

Where Clause 6.2.2 is applied, the permanent distortion required by Clause 6.3.1 need not be demonstrated.

## 7 MARKING

### 7.1 General

Shackle bodies shall be permanently and legibly marked with the information required by Clause 7.2, the marking being either raised or indented. Where the marking is indented, the marks shall not have sharp edges nor reduce the strength of the shackle. The marking should be located in accordance with Figure 1.

### 7.2 Information

The following information shall be marked:

- Manufacturer's identification.
- Quality Grade, as M or 4, or S or 6.
- WLL.
- Identification marking to correlate the shackle to the test certificate.

NOTE: Manufacturers making a statement of compliance with this Australian Standard on a product, packaging or promotional material related to that product are advised to ensure that such compliance is capable of being verified.

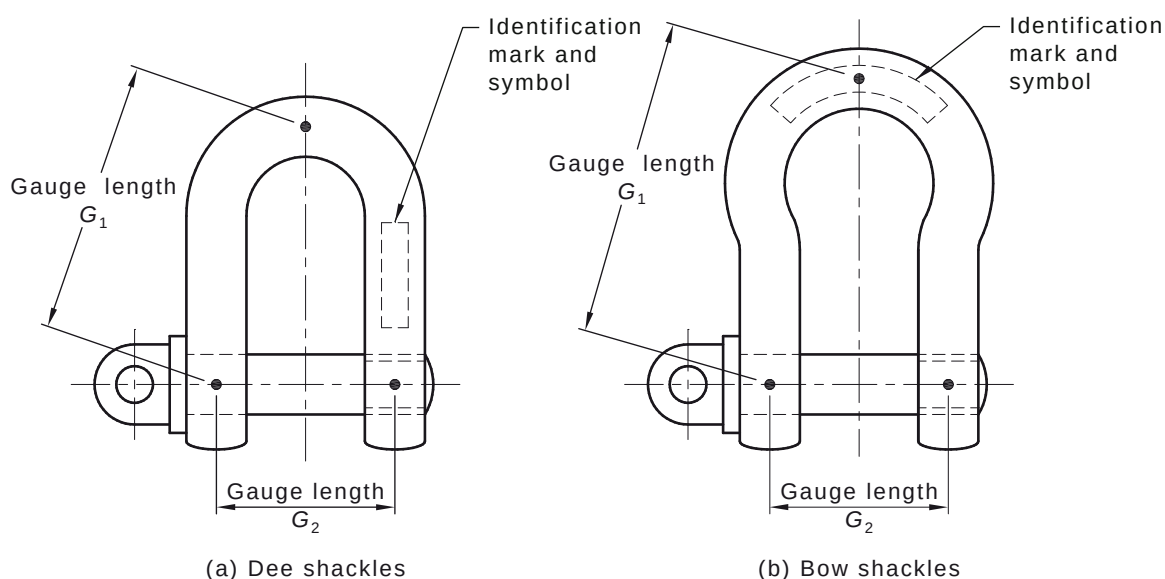


FIGURE 1 TYPICAL POSITIONS FOR MARKING SHACKLES

## 8 TESTING OF MECHANICAL PROPERTIES

Compliance of each design and each batch with the requirements of Clause 6 shall be demonstrated.

The test of each design is known as the type test, which determines the adequacy of the design for achieving the required performance.

Each change in manufacturing process (including heat treatment), grade of material, design and size shall necessitate separate type testing, to demonstrate compliance with the requirements of Clause 6.

NOTE: Means for demonstrating compliance with this Standard are given in Appendix G.