

Australian/New Zealand Standard™

Cranes, hoists and winches

Part 10: Mobile elevating work platforms



AS/NZS 1418.10:2011

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Australian/New Zealand Standard™

Cranes, hoists and winches

Part 10: Mobile elevating work platforms

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PREFACE

This Standard was prepared by the Joint Standards Australia/Standards New Zealand Committee ME-005 Cranes, to supersede AS 1418.10(Int)—2004, *Cranes, hoists and winches*, Part 10: *Elevating work platforms*.

This Standard incorporates Amendment No. 1 (September 2017). The changes required by the Amendment are indicated in the text by a marginal bar and amendment number against the clause, note, table, figure or part thereof affected.

The objective of this Standard is to address the requirements for mobile elevating work platforms (MEWPs) in general and, in addition, those intended for specific applications such as use near live electrical conductors, or operation in orchards where specific design requirements are necessary to address the risks associated with the intended use. Additional requirements are also specified for portable MEWPs.

In the preparation of this Standard cognizance was taken of ISO 16368, *Mobile Elevating Work Platforms—Design, Calculations, Safety Requirements and Test Methods*.

This revision includes the following significant changes:

- (a) Sections 1 to 4 follow largely the requirements specified in ISO 16368. However, the reader is cautioned that some significant deviations from that Standard have been incorporated.
- (b) The introduction of specific requirements for safety devices taking cognizance of the requirements in EN 280, *Mobile Elevating Work Platforms—Design Calculations—Stability Criteria—Construction—Safety—Examinations and Tests*.
- (c) The introduction of load- and moment-sensing systems.
- (d) Requirements for insulated MEWPs have been combined into a separate section.
- (e) Revision to the ‘ring test’ used to verify the extent of low-voltage cover insulation on insulated MEWPs.
- (f) Clarification of requirements relating to basket insulation.
- (g) Clarification of insulation classes and marking.
- (h) The requirement for insulation test procedures to be developed in accordance with this Standard and documented by the manufacturer.
- (i) The introduction of requirements for MEWPs intended for exclusive use in orchards.
- (j) The introduction of requirements for portable MEWPs.
- (k) Explanatory notes on the changes for electrically insulated MEWP appear in Appendix B.

The terms ‘normative’ and ‘informative’ have been used in this Standard to define the application of the appendix to which they apply. A ‘normative’ appendix is an integral part of a Standard, whereas an ‘informative’ appendix is only for information and guidance.

Statements expressed in mandatory terms in notes to tables and figures are deemed to be requirements of this Standard.

At the time of publication of this Standard technical solutions to meet the requirements of Clauses 2.3.1.2, 2.3.1.4 and 2.3.4 may not be available for certain classes of MEWP.

The respective jurisdictional authority may specify the requirements of Clauses 2.3.1.2, 2.3.1.4 and 2.3.4 for uninsulated/insulated MEWPS including effective dates.

Australia and New Zealand have different requirements for insulated MEWPs (see Section 7).

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Australian/New Zealand Standard

Cranes, hoists and winches

Part 10: Mobile elevating work platforms

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

A1 | This Standard specifies requirements for mobile elevating work platforms (MEWPs), as defined in Clause 1.3. It does not apply to passenger and goods lifts, hoists, fixed elevating work platforms, suspended scaffolding or mast climbing platforms.

Section 5 of this Standard provides variation of requirements for MEWPs that are specifically designed for use in orchards.

Section 6 of this Standard provides variations of requirements for portable MEWPs.

Section 7 of this Standard provides additional requirements for insulated MEWPs.

This Standard does not apply to any matter relating to firefighting equipment or to any matter relating to the vehicles upon which elevating work platforms are mounted, except to a vehicle which, while stationary, is a stable support for the extending structure.

NOTES:

- 1 Appendix A provides a list of typical hazards associated with MEWPs.
- 2 Appendix B provides explanatory notes on the changes to MEWP insulation that have been introduced in this revision.

1.2 REFERENCED DOCUMENTS

The following documents are referred to in this Standard:

AS

1319 Safety signs for the occupational environment

1418 Cranes, hoists and winches

1418.1 Part 1: General requirements

Text deleted.

1824 Insulation coordination

1824.1 Part 1: Definitions, principles and rules

1824.2 Part 2: Application guide

1931 High-voltage test techniques

1931.1 Part 1: General definitions and test requirements

2067 Substations and high voltage installations exceeding 1 kV a.c.

2549 Cranes (including hoists and winches)—Glossary of terms

2550 Cranes, hoists and winches—Safe use

2550.10 Part 10: Mobile elevating work platforms

2700 Colour Standards for general purposes

AS

- 4024 Safety of machinery
- 4024.1301 Part 1301: Risk assessment—Principles of risk assessment
- 4024.1501 Part 1501: Design of safety related parts of control systems—General principles for design
- 4024.1502 Part 1502: Design of safety related parts of control system—Validation
- 4024.1601 Part 1601: Design of controls, interlocks and guarding—Guards—General requirements for the design and construction of fixed and movable guards
- 4024.1604 Part 1604: Design of controls, interlocks and guarding—Emergency stop—Principles for design
- 4024.1801 Part 1801: Safety distances to prevent danger zones being reached by the upper limbs
- 4024.1802 Part 1802: Safety distances and safety gaps—Safety distances to prevent danger zones being reached by the lower limbs
- 4024.1803 Part 1803: Safety distances and safety gaps—Minimum gaps to prevent crushing of parts of the human body
- 60068 Environmental testing
- 60068.2.64 Part 2.64: Tests—Test Fh: Vibration. broad-band random (digital control) and guidance
- 60204 Safety of machinery
- 60204.1 Part 1: Electrical equipment of machines—General requirements (IEC 60204-1, Ed. 5 (FDIS) MOD)
- 60417 Graphical symbols for use on equipment
- 60417.1 Part 1: Overview and application
- 60529 Degrees of protection provided by enclosures (IP Code)
- 62061 Safety of machinery—Functional safety of safety-related electrical, electronic and programmable electronic control systems

AS/NZS

- 60479 Effects of current on human beings and livestock
- 60479.1 Part 1: General aspects

ISO

- 2408 Steel wire ropes for general purposes—Minimum requirements
- 3864 Graphical symbols—Safety colours and safety signs
- 3864-1 Part 1: Design principles for safety signs in workplaces and public areas
- 4302 Cranes—Wind load assessment
- 4309 Cranes—Wire ropes—Care and maintenance, inspection and discard
- 13849 Safety of machinery—Safety-related parts of control systems
- 13849-1 Part 1: General principles for design
- 13849-2 Part 2: Validation
- 13850 Safety of Machinery—Emergency Stop—Principles for Design
- 16368 Mobile elevating work platforms—Design, calculations, safety requirements and test methods

ISO	
18893	Mobile elevating work platforms—Safety principles, inspection, maintenance and operation
20381	Mobile elevating work platforms—Symbols for operator controls and other displays
BS	
2573	Rules for the design of cranes
2573-2	Part 2: Specification for classification, stress calculations and design of mechanisms
IEC	
61057	Aerial devices with insulating boom used for live working
ASTM	
D635	Standard test method for rate of burning and/or extent and time of burning of plastics in a horizontal position
ANSI/SIA	
A92.2	Vehicle-mounted elevating and rotating aerial devices
EN	
280	Mobile elevating work platforms—Design calculations—Stability criteria—Construction—Safety—Examinations and tests
954-1	Safety of machinery—Safety related parts of control systems—General principles for design
IEC/TS	
62073	Guidance on the measurement of wettability of insulator surfaces
UL	
94	Tests for flammability of plastic materials for parts in devices and appliances

1.3 DEFINITIONS

For the purposes of this Standard, the terms and definitions given in ISO 18893, AS 2549 and those below apply.

1.3.1 Access position

Configuration of the MEWP for access to and from the work platform.

NOTE: The access, stowed, lowered travel and transport positions can be identical.

1.3.2 Boom insulation/Insert

A dielectric component consisting of an insulated insert designed to electrically insulate the platform from all portions of the extending structure lying below the insert.

1.3.3 Basket

An enclosed work platform made from dielectric materials used on insulated MEWPs.

1.3.4 Brittle (non-ductile) material

A material that is not ductile as defined by Clause 1.3.11.

1.3.5 Chain-drive system

System that comprises one or more chain(s) running on chain sprockets and on or over chain sheaves as well as any associated chain sprockets, chain sheaves and compensating sheaves.

A1

1.3.6 Chassis

Base of the MEWP (see Figure 1.3).

NOTE: The chassis may be pulled, pushed, self-propelled, etc.

1.3.7 Chassis insulation

A dielectric component consisting of an insert or cover or both, positioned between the chassis and the extending structure, designed to electrically insulate the chassis should any portion of the extending structure below the boom insert contact energized electrical apparatus.

1.3.8 Critical component

Load-supporting element that supports or stabilizes the work platform or the extending structure.

NOTE: Critical components are usually subject to fatigue or wear and normally require routine inspection and/or replacement during the service life of the MEWP.

1.3.9 Competent person

A person who has acquired through training, qualification, experience or a combination of these, the knowledge and skill enabling that person to correctly perform the required task.

NOTE: Different types of MEWP (e.g. self-propelled boom lift, scissor lift, vehicle-mounted or insulated-vehicle-mounted MEWPs) require different competencies. Appropriate training and qualifications should demonstrate competencies in the applicable type of MEWP under consideration.

1.3.10 Disruptive discharge

Phenomena associated with the failure of insulation under electric stress, in which the discharge completely bridges the insulation under test, reducing the voltage between the electrodes to zero or nearly to zero.

NOTES:

- 1 The term applies to discharges in solid, liquid and gaseous dielectrics and to combinations of these.
- 2 A disruptive discharge in a solid dielectric produces permanent loss of dielectric strength (non-self-restoring insulation); in a liquid or gaseous dielectric, the loss may be only temporary (self-restoring insulation).
- 3 The term 'sparkover' is used when a disruptive discharge occurs in a gaseous or liquid dielectric.
- 4 The term 'flashover' is used when a disruptive discharge occurs over the surface of a solid dielectric in a gaseous or liquid medium.
- 5 The term 'puncture' is used when a disruptive discharge occurs through a solid dielectric.

1.3.11 Ductile material

A material that has a minimum elongation before failure of 10% and has adequate notch impact strength at the lowest operating temperature for which the MEWP is rated.

1.3.12 Electrical apparatus

Electrical apparatus, including overhead lines and underground cables, the conductors of which are live or can be made live.

1.3.13 Elevated travel position

Configuration of the MEWP for travel on a work site outside of the lowered travel position.

1.3.14 Extending structure

A structure that is connected to the chassis to support the work platform and allow movement of the work platform to its required position (see Figure 1.3).

NOTE: It may be, for example, a single or a telescoping or an articulating boom or ladder, or a scissor mechanism or any combination of them, and may or may not slew on the base.

1.3.15 Fall-arrest system

A system designed to arrest a fall by a person.

1.3.16 Fall-restraint system

A fall protection system that restrains or prevents a worker from being exposed to a fall from the work platform.

1.3.17 Finite element analysis model (FEA model)

Computerized method of idealizing a real model for the purposes of performing structural analysis.

1.3.18 Height

The distance measured from the supporting surface to the floor of the work platform.

1.3.19 Instability

Condition of a MEWP in which the sum of the moments tending to overturn the unit exceeds the sum of the moments tending to resist overturning.

1.3.20 Insulated line maintenance MEWP

A vehicle-mounted MEWP used by or for an electricity utility in the construction, operation and maintenance of the electricity distribution network, and where the equipment and stores associated with the work are carried on the vehicle body.

1.3.21 Load cycle

Cycle starting from a position, carrying out work and returning to the same position.

1.3.22 Load-sensing system

System of monitoring the vertical load and vertical forces on the work platform.

A1 | NOTE: The system includes the measuring device(s), the method of mounting the measuring device(s), the signal processing systems, indicators, displays and warning systems.

1.3.23 Lowered travel position

A1 | Configuration(s) of the MEWP for travel on the work site where the chassis inclination limits and maximum travel speeds associated with the elevated travel position do not apply.

1.3.24 MEWP classifications

1.3.24.1 Group A

MEWPs where the vertical projection of the centre of the area of the platform, in all platform configurations at the maximum chassis inclination specified by the manufacturer, is always inside the tipping lines.

1.3.24.2 Group B

All MEWPs that are not in Group A.

1.3.25 MEWP types

- 1 *Type 1* MEWP for which travelling is only allowed with the MEWP in its stowed position.
- 2 *Type 2* MEWP for which travelling with work platform in elevated travel position is controlled from a point on the chassis.
- 3 *Type 3* MEWP for which travelling with work platform in elevated travel position is controlled from a point on the work platform.

NOTE: Types 2 and 3 may be combined.

1.3.26 Mobile elevating work platform (MEWP)

A1 | A mobile machine (device) that is intended to move persons, tools and material to working positions and consists of at least a work platform with controls, an extending structure and a chassis.

1.3.27 Moment-sensing system

System of monitoring the moment acting about the tipping line tending to overturn the MEWP.

NOTE: The system includes the measuring device(s), the method of mounting the measuring devices and the signal processing system.

1.3.28 Operating modes

- 1 *Mode 1* The normal operating mode usually under the control of the operator.
- 2 *Mode 2* An operating mode employed in the event of failure of the main power supply to retrieve the elevated MEWP.
NOTE: This mode is usually under the control of the operator or ground personnel and is the primary emergency recovery mode (see Clause 2.6.10).
- 3 *Mode 3* An operating mode intended to be employed by trained personnel for the purpose of maintenance, testing or as a secondary emergency recovery mode.

1.3.29 Orchard

Text deleted.

1.3.30 Orchard MEWP

A1 | A MEWP intended to raise workers to a position to maintain and harvest trees, vines on trellises or other plants cultivated for the production of fruit, nuts, seeds, flowers or plant extracts.

1.3.31 Oscillating axle

Supporting structure that allows mainly vertical movement of the end wheel assemblies independently or in relation to each other.

1.3.32 Pedestrian-controlled MEWP

MEWP whose controls for powered travel can be operated by a person walking close to the MEWP.

1.3.33 Rail-mounted MEWP

MEWP whose travel is guided by rails.

1.3.34 Rated capacity

The maximum load, expressed in kilograms, for which the MEWP has been designed for normal operation, and includes persons, tools and material acting vertically on the work platform.

NOTE: A MEWP can have more than one rated capacity depending on different configurations.

1.3.35 Reach

The distance measured from a plumbline at the outer extremity of the work platform to the centre of slew.

1.3.36 Rotation

Circular movement of the work platform about a vertical axis (see Figure 1.3).

1.3.37 Secondary work platform

Platform attached to the work platform or the extending structure, and able to be moved separately.

1.3.38 Self-propelled MEWP

MEWP whose travelling controls are located on the work platform.

1.3.39 Slab-type MEWP

MEWP intended only for use on a substantially level hard surface.

1.3.40 Slewing

Circular movement of the extending structure about a vertical axis (see Figure 1.3).

1.3.41 Stability

A condition of a MEWP in which the sum of the moments that tend to overturn the unit is equal to or less than the sum of the moments that tend to resist overturning.

1.3.42 Stowed position

Configuration of the MEWP in which the extending structure is lowered and retracted and stabilizers/outriggers are retracted.

NOTE: The access, stowed, lowered travel, and transport, positions can be identical.

A1

1.3.43 Totally manually powered MEWP

MEWP whose movement is powered only by manual effort.

1.3.44 Transport position

Configuration of the MEWP for transport.

NOTE: The access, stowed, lowered travel, and transport, positions can be identical.

1.3.45 Transporting

Delivery of the MEWP to or from the work site.

1.3.46 Travelling

Any movement of the chassis except transporting (see Figure 1.3).

1.3.47 Type test

Test on a representative model of a new design or one incorporating significant changes to an existing design.

1.3.48 Vehicle-mounted MEWP

MEWP installed on a vehicle chassis that is not expressly designed and manufactured as part of the MEWP.

1.3.49 Wire rope drive system

System that comprises one or more wire rope(s) running on rope drums and on or over rope sheaves as well as any associated rope drums, rope sheaves and compensating sheaves.

1.3.50 Working envelope

Space in which the work platform is designed to work, under normal operating conditions.

NOTE: MEWPS can have more than one working envelope.

1.3.51 Work platform

Movable component of the MEWP, other than the chassis, intended for carrying personnel (with or without material), e.g. cages, buckets and baskets.

1.3.52 Working coefficient

The ratio of the minimum breaking load to the working load.

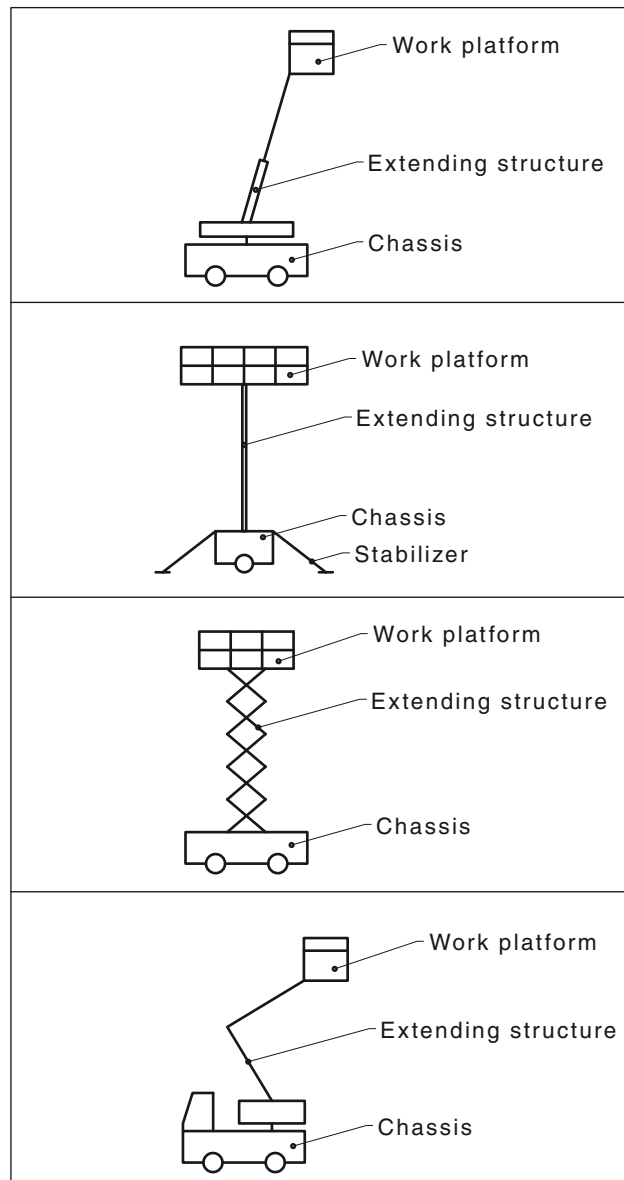


FIGURE 1.3 (in part) ILLUSTRATION OF SOME DEFINITIONS

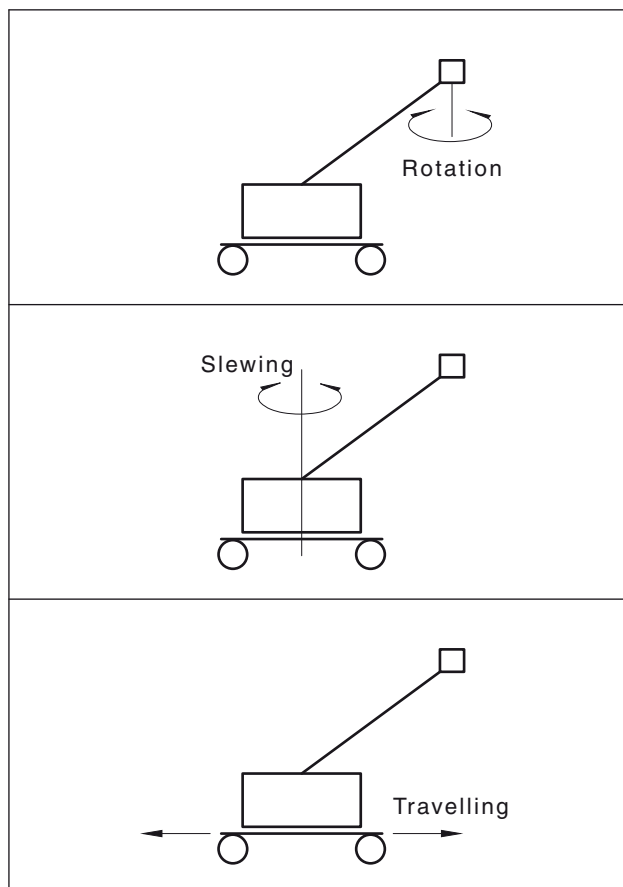


FIGURE 1.3 (in part) ILLUSTRATION OF SOME DEFINITIONS

1.4 NEW DESIGNS, INNOVATIONS AND DESIGN METHODS

This Standard does not preclude the use of materials, designs, methods of assembly, procedures, and the like, that do not comply with a specific requirement of this Standard, or are not mentioned in it, but which can be shown to give equivalent or superior results to those specified.

NOTE: Where an example of a safety measure has been given in this Standard, it should not be considered as the only possible solution. Any other solution leading to an equivalent level of safety is permissible.

SECTION 2 DESIGN REQUIREMENTS

2.1 STRUCTURAL AND STABILITY CALCULATIONS

2.1.1 Calculations

The following shall be performed:

- (a) Structural calculations to evaluate the individual loads and forces in their positions, directions and combinations that produce the highest stresses in the components.
- (b) Stability calculations to identify the various positions of the MEWP and combinations of loads and forces, which together create conditions of minimum stability.

Verification of the requirements of Clause 2.1 shall be carried out by design check, static tests and overload tests.

2.1.2 Rated capacity

The rated capacity [equivalent to a mass (m)] shall be determined from the following equation:

$$m = (n \times m_p) + m_e$$

where

m_p = 80 kg (mass of a person)

m_e = ≥ 40 kg (minimum mass of tools and materials)

n = the permitted number of persons on the work platform

The minimum capacity shall be no less than 120 kg.

2.1.3 Forces acting on the MEWP structure

The following loads and forces shall be taken into account:

- (a) Forces created by rated capacity and structural masses (see Clause 2.1.4.1).
- (b) Wind forces (see Clause 2.1.4.2).
- (c) Manual force (see Clause 2.1.4.3).
- (d) Special loads and forces (see Clause 2.1.4.4).

2.1.4 Determination of forces acting on the MEWPs structure

2.1.4.1 Forces created by rated capacity and structural masses

2.1.4.1.1 Gravitational and dynamic forces

Gravitational forces created by the rated capacity (mass) and structural masses shall be taken to act vertically downwards at the component centres of mass. The forces shall be calculated by multiplying the component masses by $1.0g$. The factor g represents the acceleration due to gravity (9.81 m/s^2).

Dynamic forces created by acceleration and deceleration of structural masses and rated capacity (mass) shall be represented by forces acting in the line of motion of the component centres of mass:

- (a) The dynamic forces created by extension or retraction of the extending structure shall be calculated by multiplying the structural masses by $0.1g$.

NOTE: For information on dynamic factors in stability and structural calculations, see Appendix C.

- (b) The dynamic forces created by travelling movements of Types 2 and 3 MEWPs shall be calculated by multiplying the component masses by z times g . The product of z and g represents the acceleration/ deceleration of the MEWP due to travel and the angular acceleration/deceleration of the MEWP due to travel over ground obstacles such as occurs during the kerb test (see Clause 3.6.3.2.2). The factor z shall be a minimum of 0.1 unless determined by calculation or tests.

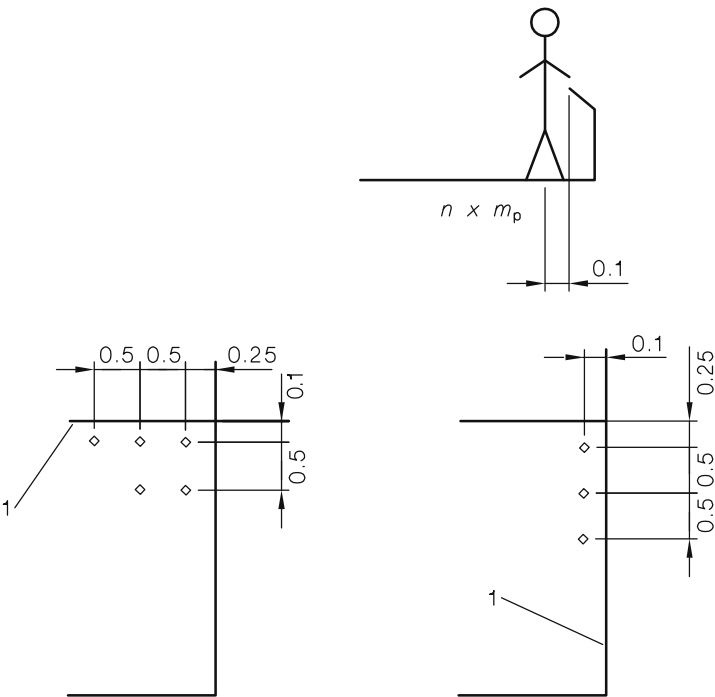
NOTE: For information on dynamic factors in stability and structural calculations, see Appendix C.

2.1.4.1.2 Load distribution on the work platform

Each person is assumed to act as a point load on the work platform and any platform extension at a horizontal distance of 100 mm from the upper inside edge of the top rail. The distance between the point loads shall be 500 mm. The width of a person shall be taken to be 500 mm (see Figure 2.1.4.1).

Equipment is assumed to act as an evenly distributed load on 25% of the floor of the work platform. If the resulting pressure exceeds 3 kN/m², the value of 25% may be increased to give a pressure of 3 kN/m².

All these loads are assumed to be located in the positions giving the worst-case results.



Legend:
1 Inside handrail

DIMENSIONS IN METRES

FIGURE 2.1.4.1 RATED CAPACITY—PERSON

2.1.4.2 *Wind forces*

2.1.4.2.1 *Outdoor MEWPs*

All MEWPs that may be exposed to wind shall be regarded as being affected by wind at a pressure of 100 N/m^2 , equivalent to a wind speed of 12.5 m/s (Beaufort Scale 6).

Wind forces are assumed to act horizontally at the centre of surface of the parts of the MEWP, of persons and equipment on the work platform, and shall be taken to be dynamic forces.

This does not apply to MEWPs intended for non-wind conditions only [see Clause 4.2.2(d)].

2.1.4.2.2 *Shape factors applied to surfaces exposed to wind*

The following shape factors are applicable to surfaces exposed to wind:

- (a) L-, U-, T-, I-sections 1.6.
- (b) Box sections 1.4.
- (c) Large flat areas 1.2.
- (d) Circular sections, according to size 0.8 to 1.2.
- (e) Persons directly exposed 1.0.

NOTE: If additional information is needed, especially concerning shielded structural areas, see ISO 4302 (see also Clause 2.1.4.2.3).

2.1.4.2.3 *Surface area of persons on a work platform exposed to wind*

The full surface area of one person shall be 0.7 m^2 (0.4 m average width $\times$ 1.75 m height) with the centre of area 1.0 m above the work platform floor.

The exposed surface area of one person standing on a work platform behind an imperforate (not perforated) section of fencing 1.1 m high shall be 0.35 m^2 , with the centre of area 1.45 m above the work platform floor.

The number of persons directly exposed to wind shall be calculated as—

- (a) the length of the side of the work platform exposed to wind, rounded to the nearest 0.5 m , and divided by 0.5 m ; or
- (b) the number of persons allowed on the work platform, if less than the number calculated in Item (a) above.

If the number of persons allowed on the work platform is greater than in Item (a) above, a shape factor of 0.6 shall be applied to the extra number of persons.

2.1.4.2.4 *Tools and equipment on the platform exposed to wind*

The wind force on exposed tools and materials on the work platform shall be calculated as 3% of their mass, acting horizontally at a height of 0.5 m above the work platform floor.

2.1.4.3 *Manual force*

The minimum value for the manual force (M) shall be taken as 200 N for MEWPs designed to carry only one person, and 400 N for MEWPs designed to carry more than one person, applied at a height of 1.1 m above the work platform floor. Any greater force permitted shall be specified in the operator's manual.

2.1.4.4 *Special loads and forces*

Special loads and forces are created by special working methods and conditions of use of the MEWP, such as objects carried on the outside of the work platform, wind forces on large objects carried on the work platform and forces imposed by winches or material handling devices.

NOTE: Information on the use of MEWPS in wind speeds greater than 12.5 m/s, see Appendix E.

If a user asks for such special working methods and/or conditions of use, the resulting loads and forces shall be taken into consideration as a modification to the rated capacity, structural load, wind load and/or manual forces, as appropriate.

2.1.5 *Stability calculations*

2.1.5.1 *Forces created by structural masses and rated capacity*

The MEWP shall be taken to be operating in the most adverse stability condition with respect to the combination of chassis inclination, structural configuration, position, structural motions, and vehicle travel motion.

A1 | NOTE: See examples in Figures 2.1.5.1 and 2.1.5.2.

The maximum allowable inclination of the chassis, as defined by the manufacturer, shall be increased by 0.5 degrees to allow for inaccuracy in setting up the MEWP.

2.1.5.2 *Wind forces*

Wind forces shall be multiplied by a factor of 1.1 and taken to be acting horizontally.

2.1.5.3 *Manual forces*

Manual forces applied by persons on the work platform shall be multiplied by a factor of 1.1 and taken to be acting in the direction creating the greatest overturning moment.

A1 | NOTE: See examples in Figures 2.1.5.1 and 2.1.5.2.

2.1.5.4 *Special loads and forces*

Special loads and forces shall be included in the calculation.

2.1.5.5 *Calculation of overturning and stabilizing moments*

The maximum overturning and corresponding stabilizing moments shall be calculated about the most unfavourable tipping lines.

Tipping lines shall be determined as shown in Appendix F. For solid and foam-filled tyres, the tipping lines may be taken at a distance from the outside edge of quarter of the ground contact width.

All forces shall be taken to act in the allowable direction that will produce the least stable outcome. Forces that can act simultaneously shall be taken into account in their least favourable combinations.

When the load has a stabilizing effect, additional stability calculations shall be made assuming the least favourable load combination on the work platform.

A1 | NOTE: Examples are shown in Tables 2.1.5.5.1 and 2.1.5.5.2, and in Figures 2.1.5.1 and 2.1.5.2.

In each case, the calculated stabilizing moment shall be greater than the calculated overturning moment.

In the calculation, the following influences shall be taken into account:

- (a) Tolerances in the manufacture of the components.
- (b) Play in the connections of the extending structure.
- (c) Elastic deformations due to the effects of forces.

- (d) Failure of any one tyre in the case of MEWPs supported by pneumatic tyres in the working position.
- (e) Performance characteristics (accuracy) of the load-sensing system, moment-sensing system and position control; these may be affected by, for example—
 - (i) peaks caused by short-term dynamic effects;
 - (ii) hysteresis;
 - (iii) slope of the MEWP;
 - (iv) ambient temperature; and
 - (v) different positions and distribution of load on work platform (see Clause 2.1.3).

The determination of elastic deformations shall be obtained by experiment or by calculation.

2.1.5.6 *Dynamic stability*

The MEWP shall remain stable when subjected to the braking tests (Clause 3.6.3.2.3) and the kerb and depression tests (Clause 3.6.3.2.2).

NOTE: For a calculation example, see Appendix D.

A1

TABLE 2.1.5.5.1

EXAMPLES OF LOAD AND FORCE DIRECTIONS AND COMBINATIONS FOR STABILITY CALCULATIONS—LOAD SENSING (see Figure 2.1.5.1)

Example	Working condition	Rated capacity		Structural force S_n		Manual force M		Wind force W		Diagram
		× 1.0	× 0.1	× 1.0	× 0.1	× 1.0	× 0.1	× 1.0	× 0.1	
1	Raising (lowering)	V	A	V	A	—	—	H	H	
2	Travelling	V	S	V	S	—	—	H	H	
3	Travelling	V	S	V	S	—	—	H	H	
4	Forwards stability, stationary on slope	V	—	V	—	A	A	H	H	
5	Backwards stability, stationary on slope	80 kg V	—	V	—	A	A	H	H	
		0 kg	—	V	—	—	—	H	H	
6	With limited reach, forward stability, stationary on slope, lowering	V	A	V	A	—	—	H	H	
7	On slope, stationary	V	—	V	—	A	A	H	H	
8	Level ground, stationary. (Load always inside the tipping line)	80 kg V	—	V	—	—	—	H	H	
		0 kg V	—	V	—	—	—	H	H	

LEGEND:

V = vertical

H = horizontal

A = angular

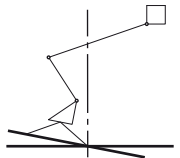
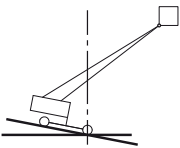
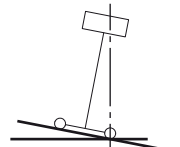
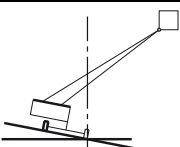
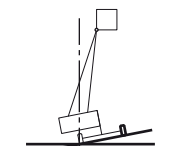
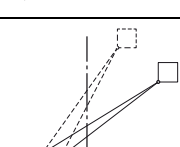
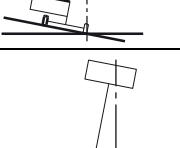
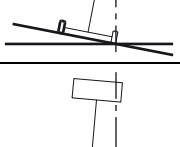
S = at slope angle; S represents the mass of the structural component n

NOTE: This Table is not exhaustive.

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TABLE 2.1.5.5.2

EXAMPLES OF LOAD AND FORCE DIRECTIONS AND COMBINATIONS FOR STABILITY CALCULATIONS—USING ENHANCED OVERLOAD & STABILITY CRITERIA (see Figure 2.1.5.2)

Example	Working condition	Rated capacity		Structural force S_n		Manual force M		Wind force W		Diagram
		× 1.5	× 0.15	× 1.0	× 0.1	× 1.0	× 0.1	× 1.0	× 0.1	
1	Raising (lowering)	V	A	V	A	—	—	H	H	
2	Travelling	V	S	V	S	—	—	H	H	
3	Travelling	V	S	V	S	—	—	H	H	
4	Forwards stability, stationary on slope	V	—	V	—	A	A	H	H	
5	Backwards stability, stationary on slope	80 kg V	—	V	—	A	A	H	H	
		0 kg	—	V	—	—	—	H	H	
6	With limited reach, forward stability, stationary on slope, lowering	V	A	V	A	—	—	H	H	
7	On slope, stationary	V	—	V	—	A	A	H	H	
8	Level ground, stationary. (Load always inside the tipping line)	80 kg V	—	V	—	—	—	H	H	
		0 kg V	—	V	—	—	—	H	H	

LEGEND:

V = vertical

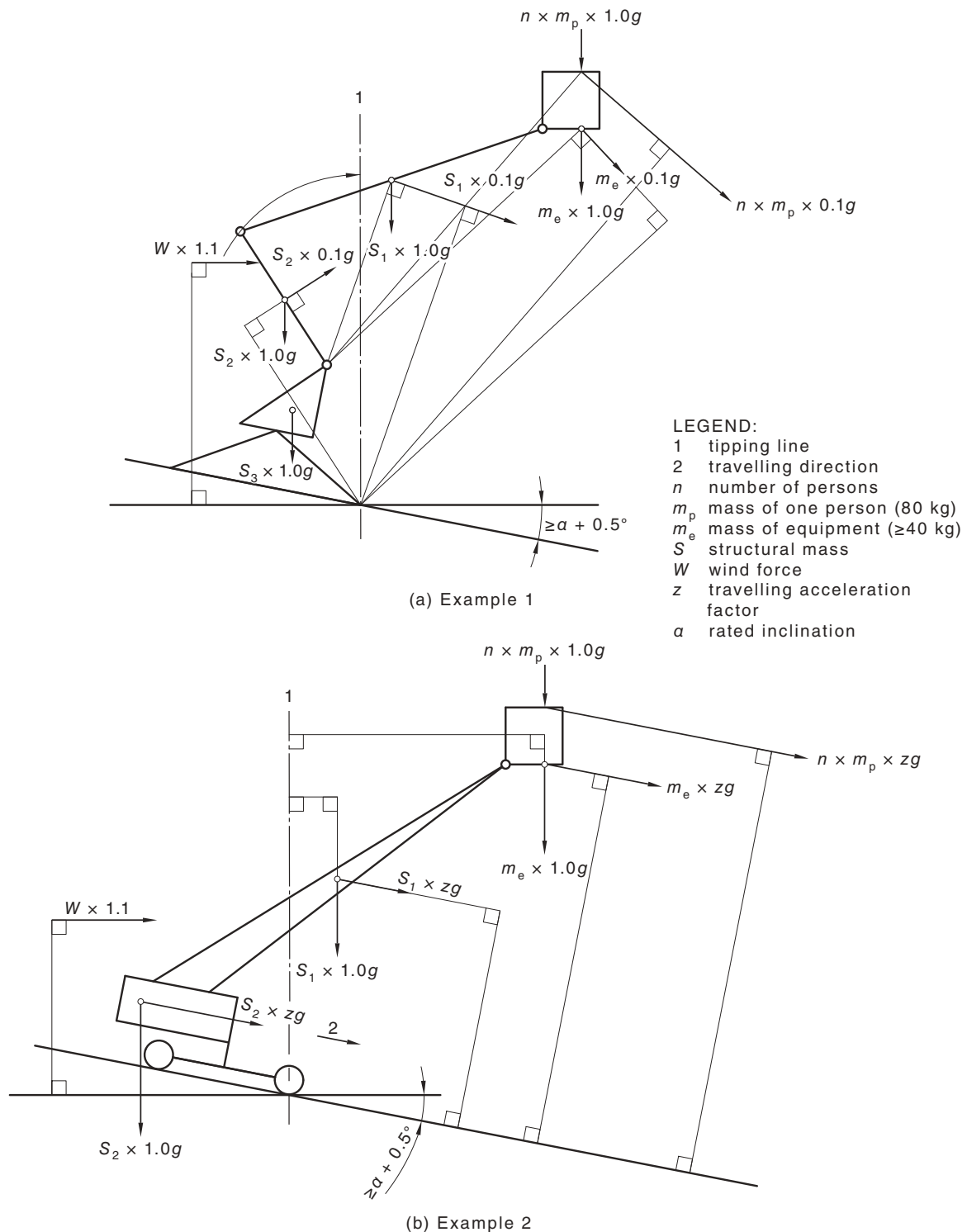
H = horizontal

A = angular

S = at slope angle; S represents the mass of the structural component n

NOTE: This Table is not exhaustive.

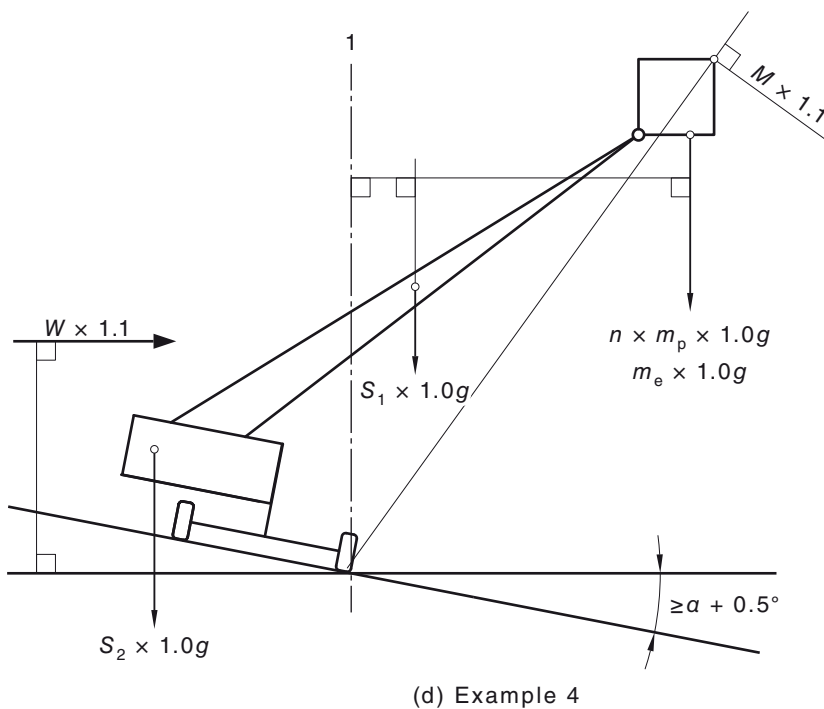
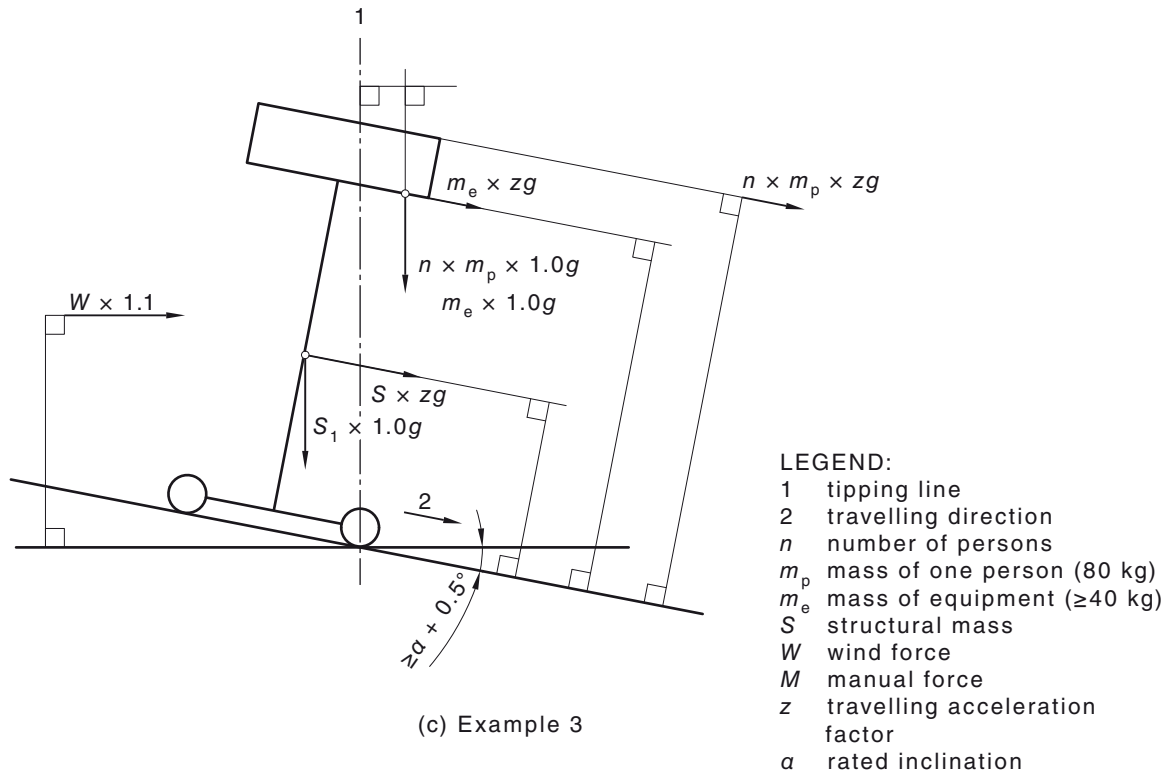
A1



NOTE: For number of persons (n) see Clause 2.1.2; mass of one person (m_p) see Clause 2.1.2; mass of equipment (m_e) see Clause 2.1.2; wind force, see Clause 2.1.4.2; manual force, see Clause 2.1.4.3; and travelling acceleration factor, see Clause 2.1.4.1.1.

FIGURE 2.1.5.1 (in part) EXAMPLES OF MAXIMUM OVERTURNING LOAD AND FORCE MOMENT COMBINATION—LOAD SENSING (see Table 2.1.5.5.1)

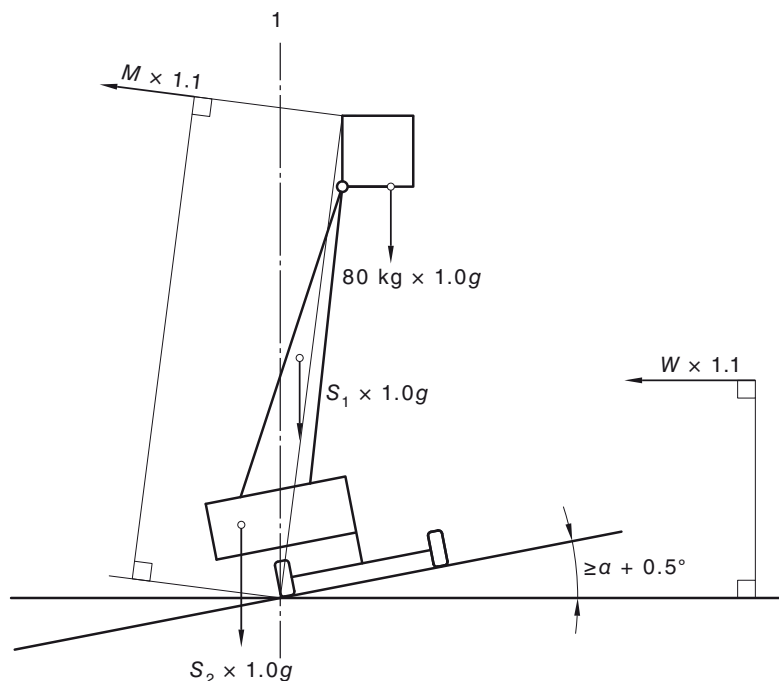
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NOTE: For number of persons (n) see Clause 2.1.2; mass of one person (m_p) see Clause 2.1.2; mass of equipment (m_e) see Clause 2.1.2; wind force, see Clause 2.1.4.2; manual force, see Clause 2.1.4.3; and travelling acceleration factor, see Clause 2.1.4.1.1.

FIGURE 2.1.5.1 (in part) EXAMPLES OF MAXIMUM OVERTURNING LOAD AND FORCE MOMENT COMBINATION—LOAD SENSING (see Table 2.1.5.5.1)

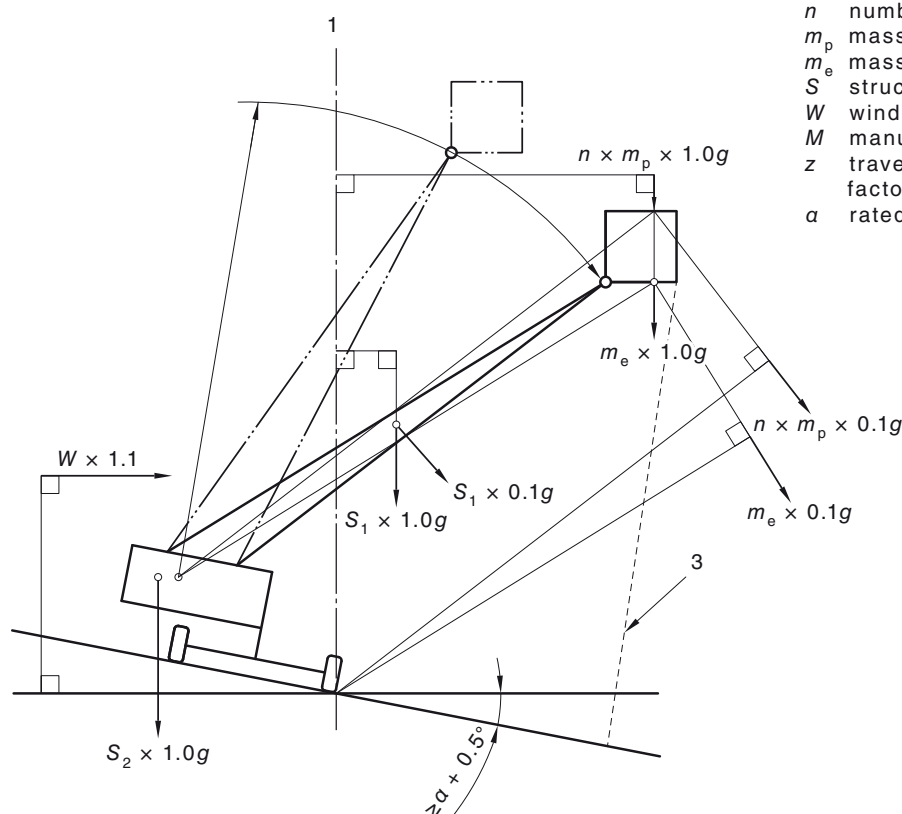
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(e) Example 5

LEGEND:

- 1 tipping line
- 2 travelling direction
- n number of persons
- m_p mass of one person (80 kg)
- m_e mass of equipment (≥ 40 kg)
- S structural mass
- W wind force
- M manual force
- z travelling acceleration factor
- α rated inclination

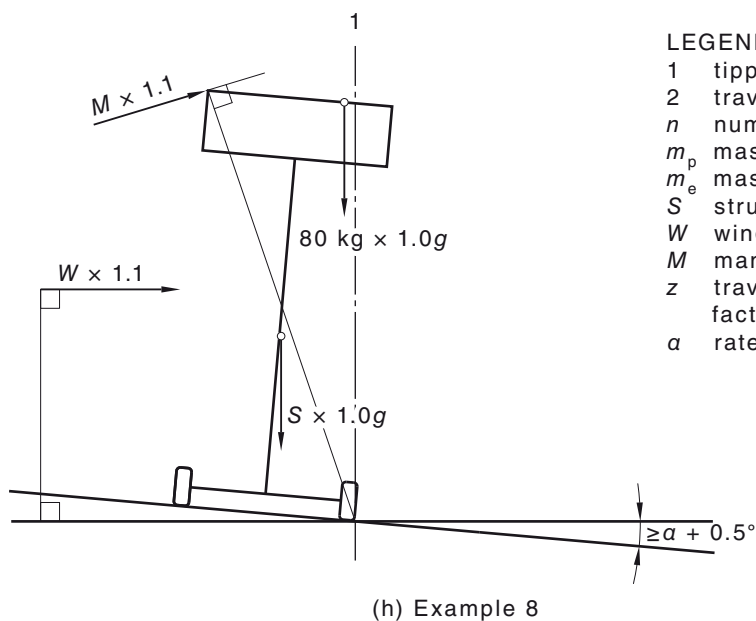
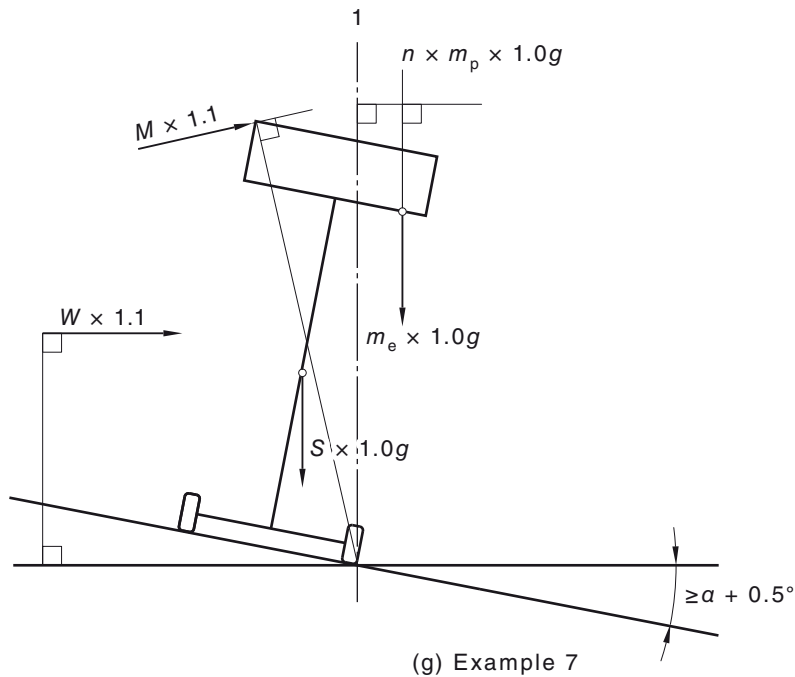


(f) Example 6

NOTE: For number of persons (n) see Clause 2.1.2; mass of one person (m_p) see Clause 2.1.2; mass of equipment (m_e) see Clause 2.1.2; wind force, see Clause 2.1.4.2; manual force, see Clause 2.1.4.3; and travelling acceleration factor, see Clause 2.1.4.1.1.

FIGURE 2.1.5.1 (in part) EXAMPLES OF MAXIMUM OVERTURNING LOAD AND FORCE MOMENT COMBINATION—LOAD SENSING (see Table 2.1.5.5.1)

A1



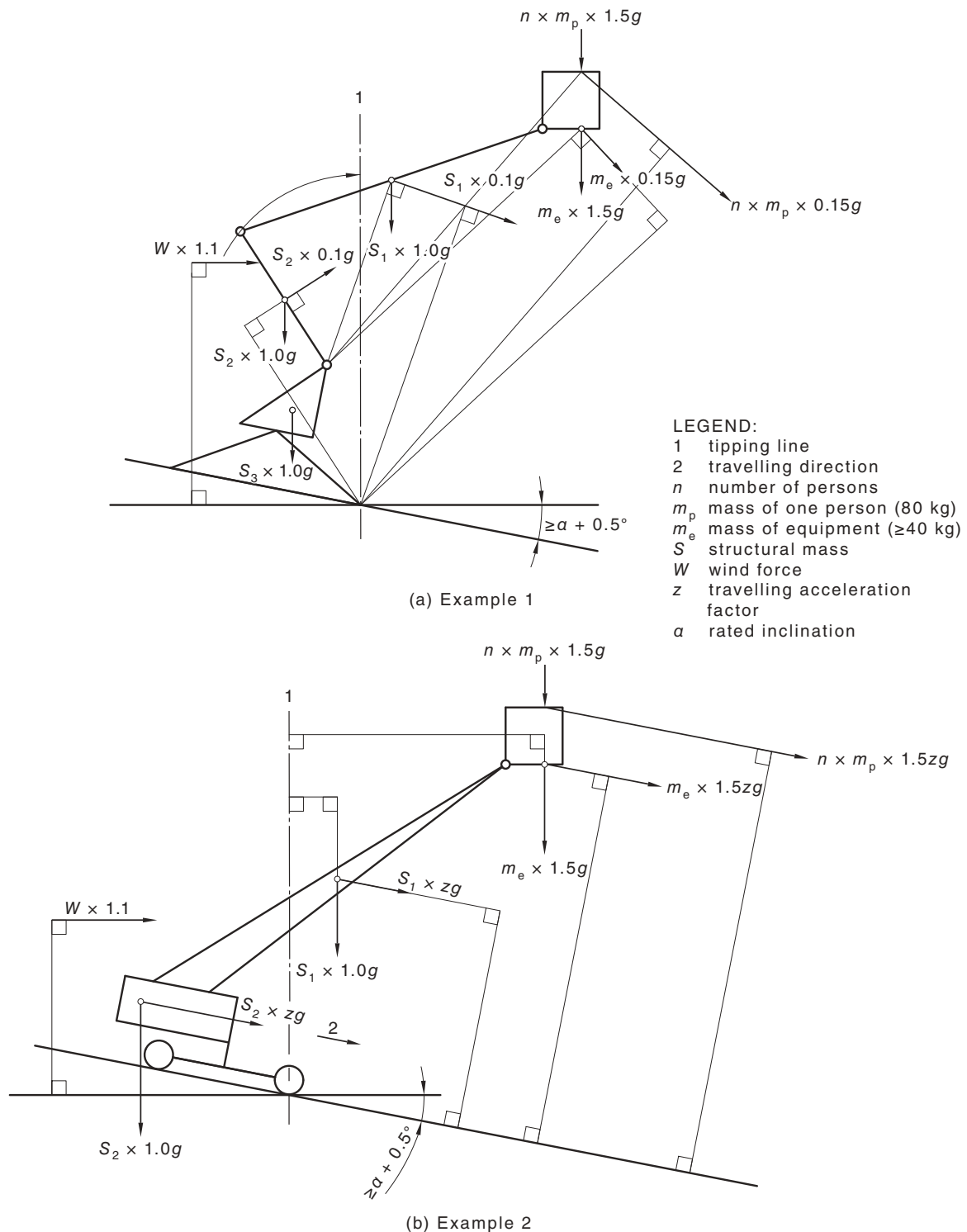
LEGEND:

- 1 tipping line
- 2 travelling direction
- n number of persons
- m_p mass of one person (80 kg)
- m_e mass of equipment (≥ 40 kg)
- S structural mass
- W wind force
- M manual force
- z travelling acceleration factor
- a rated inclination

NOTE: For number of persons (n) see Clause 2.1.2; mass of one person (m_p) see Clause 2.1.2; mass of equipment (m_e) see Clause 2.1.2; wind force, see Clause 2.1.4.2; manual force, see Clause 2.1.4.3; and travelling acceleration factor, see Clause 2.1.4.1.1.

FIGURE 2.1.5.1 (in part) EXAMPLES OF MAXIMUM OVERTURNING LOAD AND FORCE MOMENT COMBINATION—LOAD SENSING (see Table 2.1.5.5.1)

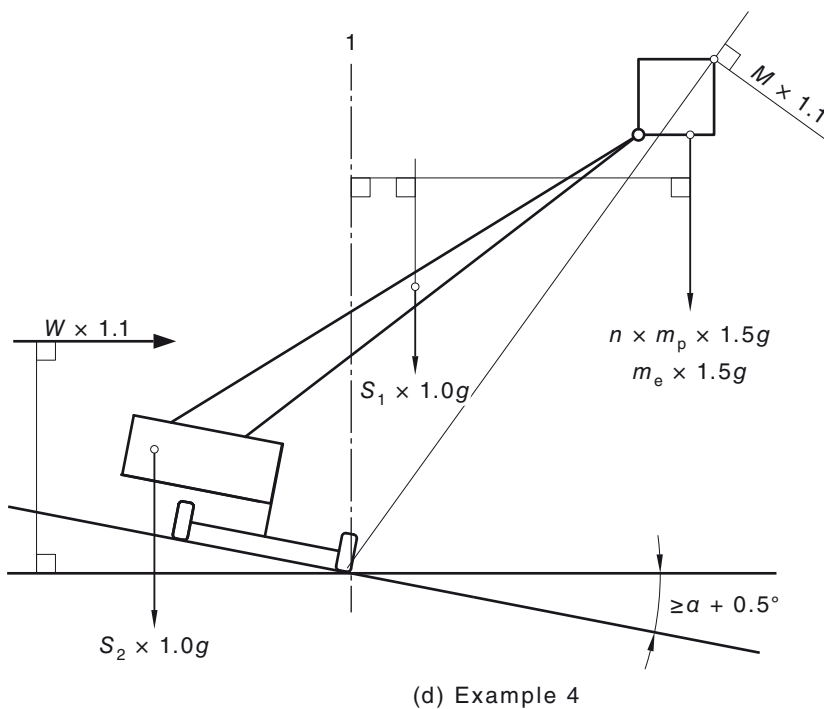
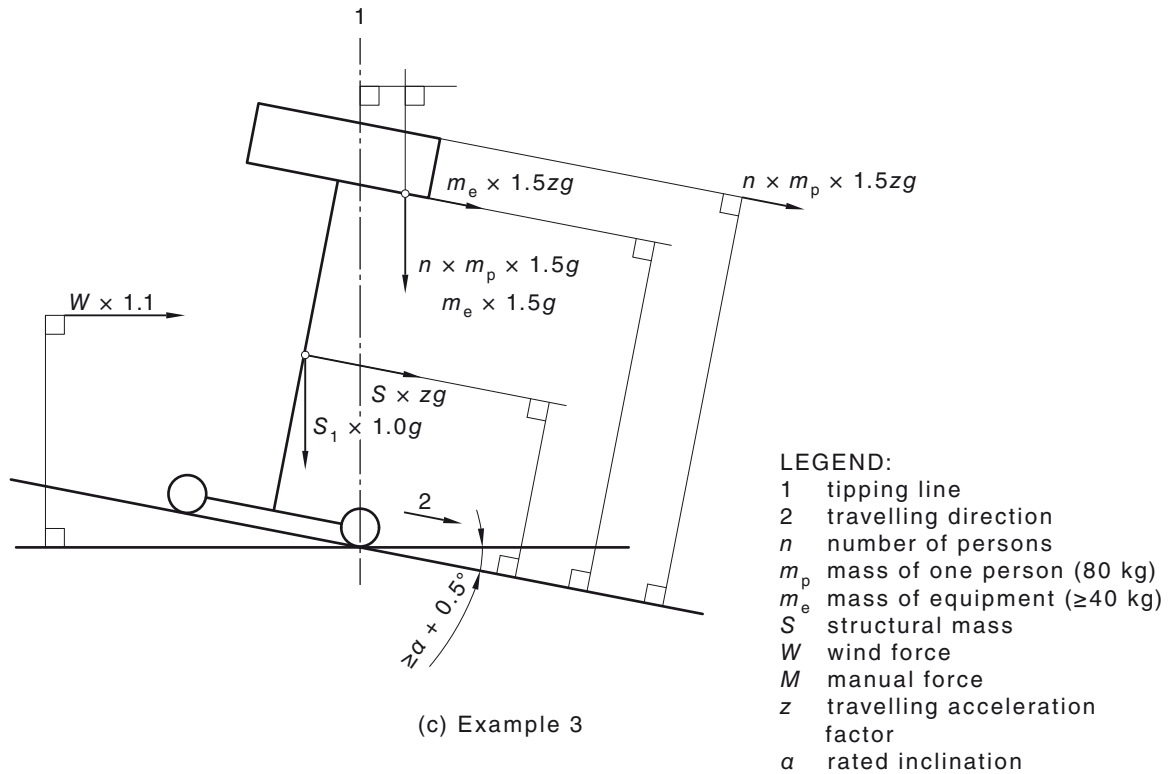
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NOTE: For number of persons (n) see Clause 2.1.2; mass of one person (m_p) see Clause 2.1.2; mass of equipment (m_e) see Clause 2.1.2; wind force, see Clause 2.1.4.2; manual force, see Clause 2.1.4.3; and travelling acceleration factor, see Clause 2.1.4.1.1.

FIGURE 2.1.5.2 (in part) EXAMPLES OF MAXIMUM OVERTURNING LOAD AND FORCE MOMENT COMBINATION—USING ENHANCED OVERLOAD AND STABILITY CRITERIA (see Table 2.1.5.5.2)

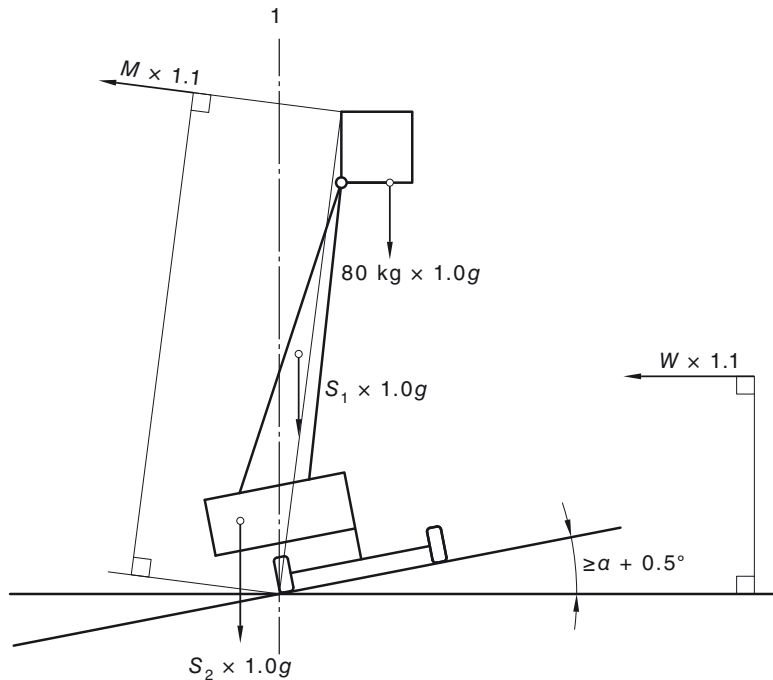
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NOTE: For number of persons (n) see Clause 2.1.2; mass of one person (m_p) see Clause 2.1.2; mass of equipment (m_e) see Clause 2.1.2; wind force, see Clause 2.1.4.2; manual force, see Clause 2.1.4.3; and travelling acceleration factor, see Clause 2.1.4.1.1.

FIGURE 2.1.5.2 (in part) EXAMPLES OF MAXIMUM OVERTURNING LOAD AND FORCE MOMENT COMBINATION—USING ENHANCED OVERLOAD AND STABILITY CRITERIA (see Table 2.1.5.5.2)

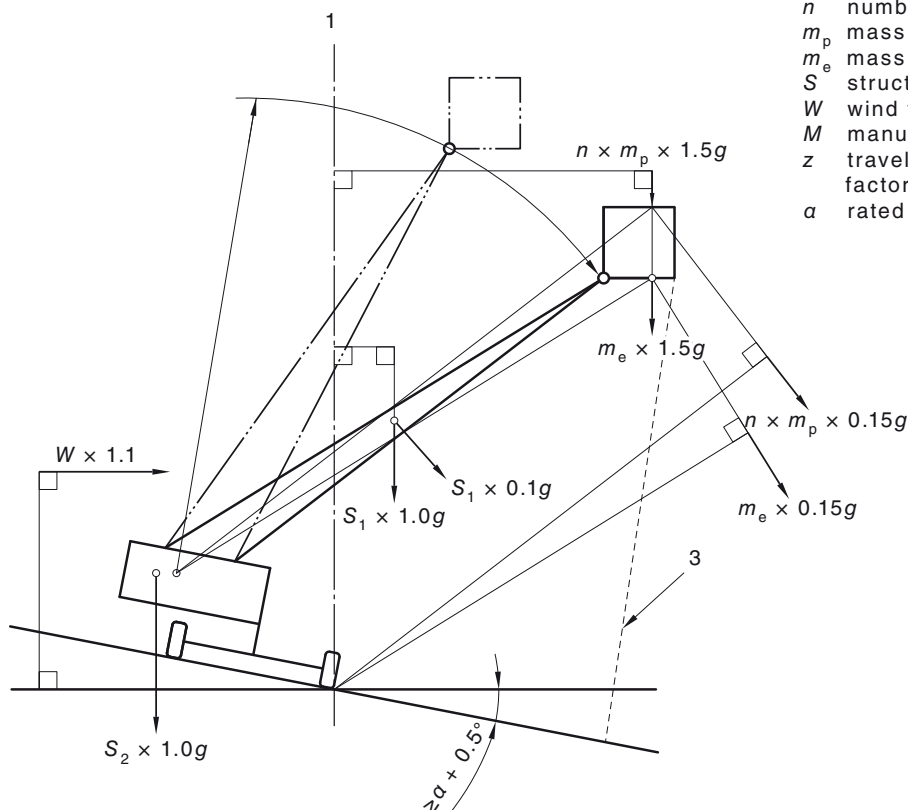
A1



(e) Example 5

LEGEND:

- 1 tipping line
- 2 travelling direction
- n number of persons
- m_p mass of one person (80 kg)
- m_e mass of equipment (≥ 40 kg)
- S structural mass
- W wind force
- M manual force
- z travelling acceleration factor
- α rated inclination



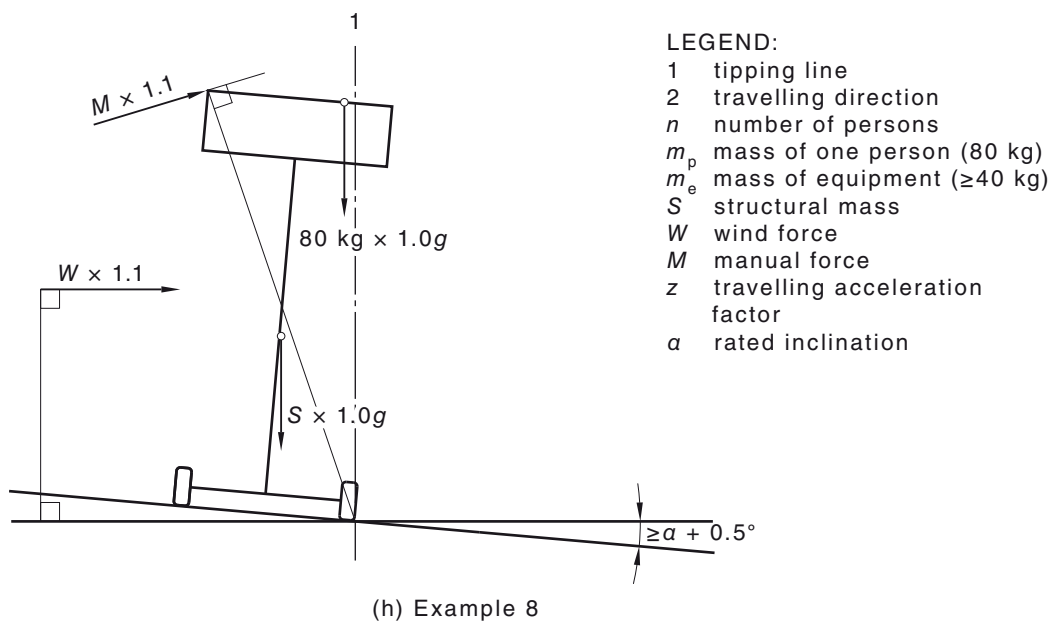
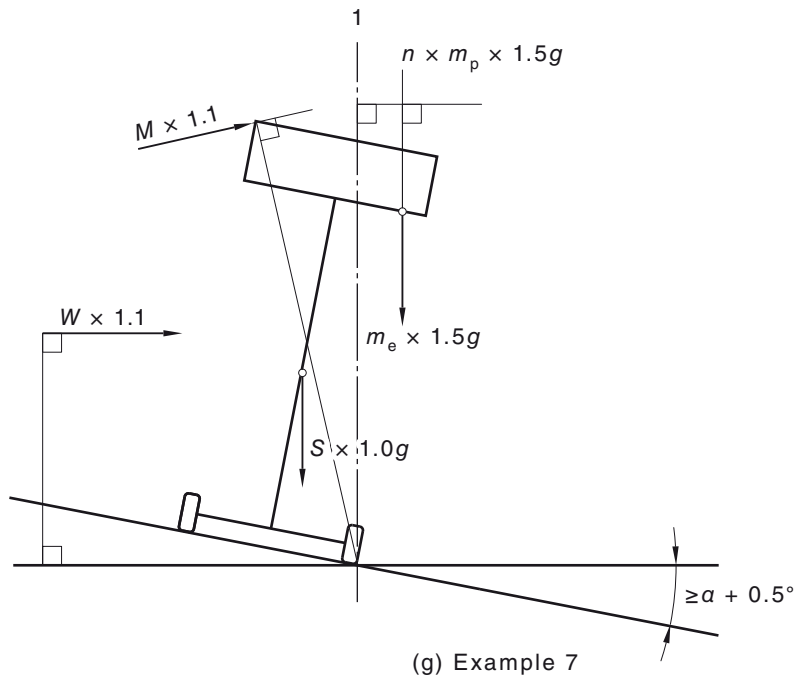
(f) Example 6

NOTE: For number of persons (n) see Clause 2.1.2; mass of one person (m_p) see Clause 2.1.2; mass of equipment (m_e) see Clause 2.1.2; wind force, see Clause 2.1.4.2; manual force, see Clause 2.1.4.3; and travelling acceleration factor, see Clause 2.1.4.1.1.

FIGURE 2.1.5.2 (in part) EXAMPLES OF MAXIMUM OVERTURNING LOAD AND FORCE MOMENT COMBINATION—USING ENHANCED OVERLOAD AND STABILITY CRITERIA (see Table 2.1.5.5.2)

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LEGEND:

- 1 tipping line
- 2 travelling direction
- n number of persons
- m_p mass of one person (80 kg)
- m_e mass of equipment (≥ 40 kg)
- S structural mass
- W wind force
- M manual force
- z travelling acceleration factor
- a rated inclination

NOTE: For number of persons (n) see Clause 2.1.2; mass of one person (m_p) see Clause 2.1.2; mass of equipment (m_e) see Clause 2.1.2; wind force, see Clause 2.1.4.2; manual force, see Clause 2.1.4.3; and travelling acceleration factor, see Clause 2.1.4.1.1.

FIGURE 2.1.5.2 (in part) EXAMPLES OF MAXIMUM OVERTURNING LOAD AND FORCE MOMENT COMBINATION—USING ENHANCED OVERLOAD AND STABILITY CRITERIA (see Table 2.1.5.5.2)

2.1.6 Structural calculations

2.1.6.1 General

The calculations shall conform to the laws and principles of applied mechanics and strength of materials. If special formulas are used, the sources shall be given; otherwise, the formulas shall be developed from first principles, so that their validity can be checked.

Requirements given in Clauses 2.1.3 and 2.1.5 above shall be considered for the determination of loads and forces to be used in the calculations.

Except where otherwise stated, the individual loads and forces shall be taken to act in the positions, directions and combinations that produce the least favourable conditions.

For all loadbearing components and joints, the required information on stresses or safety factors shall be included in the calculations in a clear and verifiable form. If necessary for checking the calculations, details of the main dimensions, cross-sections and materials for the individual components and joints shall be given.

2.1.6.2 *Calculation methods*

The method of calculation shall comply wherever possible with the requirements of structural Standards applicable to the materials used in the design. Calculations shall include fatigue-stress calculation methods and elastic buckling. The elastic deformations of slender components shall be taken into account.

Requirements given in Clauses 2.1.4 and 2.1.5 above shall be considered for the determination of loads and forces to be used in the calculations.

The analysis shall be made for the worst-case load combinations. The calculated stresses shall not exceed the permissible values.

NOTES:

- 1 For typical load combinations, see AS 1418.1.
- 2 The permissible values of stresses and the required values of safety factors depend on the material, the load combination and the calculation method.

2.1.6.3 *Analysis*

2.1.6.3.1 *General stress analysis*

The general stress analysis is the proof against failure by yielding or fracturing.

General stress analysis shall be made for all loadbearing components and joints.

The required information on stresses or safety factors shall be included in the analysis in a clear and easily verifiable form. Details of the main dimensions, cross-sections and materials for the individual components and joints shall be given.

Finite element analysis (FEA) modelling may be used to meet this requirement. The FEA model shall be specified and include an explanation of the loading areas, load types, constraint areas and constraint types.

Stresses imposed by the static test (see Clause 3.6.3.1) and the overload test (see Clause 3.6.4) shall not exceed 90% of the elastic limit of ductile materials or 30% of the ultimate limit of brittle materials.

Dynamic forces imposed on critical components, during frequently occurring load combinations shall not exceed the following:

- (a) For ductile materials, 66.7% of the minimum elastic limit of the material.
- (b) For brittle (non-ductile materials), 20% of the minimum ultimate tensile strength of the material.

NOTE: The allowable design stress may need to be decreased based on the evaluation given in Clauses 2.1.6.3.2 and 2.1.6.3.3.

2.1.6.3.2 *Elastic stability analysis*

Elastic stability analysis is the proof against failure by elastic instability (e.g. buckling, crippling). This analysis shall be made for all loadbearing components subject to compressive stress.

2.1.6.3.3 *Fatigue-stress analysis*

Fatigue-stress analysis is the proof against failure by fatigue due to stress fluctuations. This analysis shall be made for all loadbearing components and joints that are critical to fatigue, taking into account the construction details, the degree of stress fluctuation and the number of stress cycles. The number of stress cycles may be a multiple of the number of load cycles.

As the number of stress fluctuations during transport cannot be calculated with any degree of accuracy, the stress in the transport position in components subject to vibration during transport shall be low enough to provide virtually infinite fatigue life (see also Clauses 2.3.7 and 2.5.14).

2.1.6.4 *Classification*

A MEWP shall be classified in accordance with AS 1418.1.

NOTE: The number of load cycles for a MEWP is normally the following:

- (a) Light intermittent duty (group classification corresponding to C1 to C3, e.g. 10 years, 40 weeks per year, 20 h per week, 5 load cycles per hour): 4×10^4 cycles.
- (b) Heavy duty (group classification corresponding to C2 to C5, e.g. 10 years, 50 weeks per year, 40 h per week, 5 load cycles per hour): 10^5 cycles.

2.1.6.5 *Effects of ambient temperature*

The analysis shall consider the effects of ambient temperature in the range for which the MEWP has been designed.

2.2 CHASSIS AND STABILIZERS/OUTRIGGERS

2.2.1 *Automatic safety device*

An automatic safety device, in accordance with Clause 2.10, shall be fitted to prevent the travel of pedestrian-controlled MEWPs and power-driven Type 1 MEWPs when the work platform is out of the transport or stowed position.

All travel speed restrictions for self-propelled MEWPs, when the work platform is out of the lowered travel position, shall be automatic.

Verification shall be carried out by design check and functional test.

2.2.2 *Chassis inclination*

Every MEWP shall have a device to indicate when the inclination of the chassis has reached or exceeded maximum permissible limits when out of the transport, stowed or lowered travel position. This device shall be automatic, in accordance with Clause 2.10, and shall minimize the potential for damage, accidental change of its setting and unauthorized operation (e.g. be sealed or locked).

For MEWPs of Type 1 with a manually controlled chassis levelling system, the device may be replaced by a spirit level that clearly indicates the permissible limits of inclination.

For MEWPs with power-driven stabilizers/outriggers, the indication shall be able to be monitored from each stabilizer/outrigger control position.

For vehicle-mounted MEWPs supported entirely or partly on pneumatic tyres when elevated, an inclination-indicating device shall be fitted to each end of the vehicle in close proximity to the points of support.

A1 For MEWPs of Type 2 and Type 3, while travelling out of the transport configuration, the device shall prevent the chassis exceeding the limits of inclination permitted by the manufacturer. When the chassis has reached the limits of inclination and the safety device according to Clause 2.10 has been triggered, the safety device shall prevent continuation of travel in the selected direction. For vehicle-mounted MEWPs of Type 2, the cut-out function of the safety device may be replaced by an audible alarm.

When the safety device is triggered, controls used for emergency retrieval may remain active.

Verification shall be carried out by functional test.

2.2.3 Locking pins

Locking pins shall be secured against unintentional disengagement (e.g. spring pin) and loss (e.g. chain).

Verification shall be carried out by visual examination.

2.2.4 Control bars

Control bars of pedestrian-controlled MEWPs and tow bars shall be securely fastened to the chassis.

Verification shall be carried out by visual examination and test.

2.2.5 Control bars held in vertical position

If control bars and tow bars, when not in use, are raised to the vertical position, an automatic device (i.e. self-latching) shall be provided to hold the bars in this position.

For multi-axle chassis, the minimum clearance between the fully lowered control bar or tow bar and the ground shall be 120 mm.

Verification shall be carried out by visual examination, test and measurement.

2.2.6 Stabilizer/outrigger feet

Stabilizer/outrigger feet shall be constructed to accommodate ground unevenness of at least 10 degrees.

Verification shall be carried out by visual examination and measurement.

2.2.7 Permitted work platform positions

A1 2.2.7.1 MEWPs with stabilizing devices or systems

Except for totally manually operated MEWPs (see Clause 2.2.8) every MEWP with devices/systems that are required to be deployed to satisfy the stability tests specified in Clause 3.6.3 shall be fitted with a safety device in accordance with Clause 2.10, which shall prevent the work platform operating outside permitted positions unless the devices/systems are set in accordance with the operating instructions. The safety system shall function without the need for operator intervention or connection.

NOTE: Stabilizing devices or systems include stabilizers, outriggers, extendible axles, axle lockouts and pothole protection.

Verification shall be carried out by design check and functional test.

2.2.7.2 MEWPs that operate in a limited range with alternate stabilizing devices

MEWPs that are constructed for operation without stabilizers/outriggers, or with alternate stabilizing devices in a limited range of operation, shall be equipped with safety devices in accordance with Clause 2.10, which shall prevent operation outside that limited range.

The safety device shall operate without the need for operator intervention or connection.

Verification shall be carried out by design check and functional test.

2.2.8 Totally manually operated MEWP

The requirements of Clause 2.2.7 are not mandatory for MEWPs that are totally manually operated and have a work platform floor height not exceeding 5 m above base level.

Totally manually operated MEWPs are also exempted from all safety requirements that cannot be met without power supply.

Verification shall be carried out by design check.

2.2.9 Oscillating axle lock or control systems

MEWPs equipped with one or more oscillating axles, in systems that lock or control the oscillating axle(s) to maintain stability, shall satisfy the following requirements:

- (a) On Type 1 MEWPs, a safety device in accordance with Clause 2.10, which shall prevent deployment of the extending structure until oscillation of the axle(s) is locked or controlled.
- (b) On Type 2 and Type 3 MEWPs that have a means of locking or control of the oscillating axle(s), except mechanical hydraulic locking mechanisms, safety devices in accordance with Clause 2.10 shall be incorporated.

Where hydraulic cylinders are used as positional locking or control devices, these shall comply with Clause 2.9.

2.2.10 Prevention of powered stabilizer/outrigger or chassis levelling system movement

- A1 | MEWPs with powered stabilizers/outriggers or a chassis levelling system shall be fitted with a safety device in accordance with Clause 2.10, to prevent movements of the stabilizers/outriggers or chassis levelling system, unless the extending structure and the work platform are in the stowed or transport position or within the limited range specified in Clause 2.2.7.

When the extended structure and the work platform are inside the limited range, as specified in Clause 2.2.7, the operation of the stabilizers/outriggers or chassis levelling system shall not create an unstable situation.

Verification shall be carried out by design check and functional test.

2.2.11 Manually operated stabilizers/outriggers

Manually operated stabilizers/outriggers shall be designed to prevent unintentional movement.

Verification shall be carried out by design check and functional test.

2.2.12 Self-propelled MEWP brakes

- A1 | Self-propelled MEWPs shall be equipped with brakes on at least two wheels on the same axis, which shall engage automatically when power or signal to the brakes is removed or fails, and shall be able to stop the MEWP in accordance with Clause 2.2.16 and keep it in the stopped position. Such brakes shall not rely on hydraulic or pneumatic pressure or electrical power to remain engaged.

Verification shall be carried out by design check and functional test.

2.2.13 Movement of stabilizers/outriggers

The movements of stabilizers/outriggers shall be limited by mechanical stops that include hydraulic cylinders if designed for that purpose.

Mechanical means shall be provided to prevent uncontrolled movements of stabilizers/outriggers from the transport position.

Powered stabilizers/outriggers meeting the requirements of Clauses 2.2.10 and 2.9 are deemed to meet the above requirement. This requirement applies to MEWPs with permanently attached stabilizers/outriggers that increase the width or length of the MEWP and to all vehicle-mounted and trailer-mounted MEWPs.

Manually operated stabilizers/outriggers shall be locked in the transport position by two separate locking devices for each stabilizer/outrigger, at least one of which operates automatically (e.g. a gravity-locking pin plus a detent). Removable stabilizers/outriggers (vertical lifts) have exemption from mechanical stops, as these types need to be removed and stowed to transport the MEWP.

Verification shall be carried out by design check.

2.2.14 Unauthorized use

MEWPs shall be equipped with a device to prevent unauthorized use (e.g. lockable switch).

Verification shall be carried out by functional test.

2.2.15 Maximum travel speeds in elevated travel position

Type 3 MEWPs shall be fitted with a safety device in accordance with Clause 2.10, to prevent the travel speed in the elevated travel position exceeding the following values:

- (a) 1.5 m/s for vehicle-mounted MEWPs.
- (b) 3.0 m/s for rail-mounted MEWPs.
- (c) 0.7 m/s for all other Type 3 MEWPs.

Verification shall be carried out by design check and functional test.

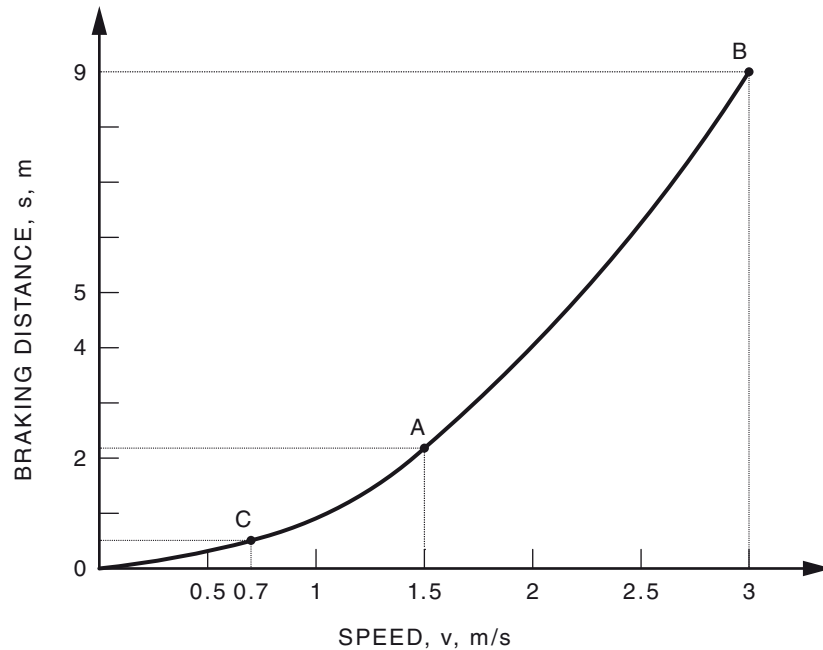
2.2.16 Stopping distances

MEWPs travelling at the maximum speeds given in Clause 2.2.15 on the maximum specified slope shall be capable of being stopped at distances not greater than those given in Figure 2.2.16.

NOTES:

- 1 Figure 2.2.16 is based on an average deceleration of 0.5 m/s^2 and does not include the operator's reaction time.
- 2 Minimum braking distances depend on factor z (see Clause 2.1.4.1.1).

Verification shall be carried out by functional test.



Key:

A For vehicle-mounted MEWPs

B For rail-mounted MEWPs

C For all other MEWPs

FIGURE 2.2.16 MAXIMUM BRAKING DISTANCE FOR TYPES 2 AND 3 MEWPs

2.2.17 Maximum travel speed of pedestrian-controlled MEWPs

Maximum travel speed of pedestrian-controlled MEWPs with the work platform in the transport or stowed position shall not exceed 1.7 m/s.

Verification shall be carried out by measurement.

2.2.18 Guards to protect persons at control positions

A1

Except for Group A MEWPs (see Clause 2.3.4) guards shall be provided to prevent persons at control positions, or standing adjacent to the MEWP at ground level or at other points of access from touching hot parts or dangerous parts of drive systems. Opening or removal of these guards shall only be possible by devices located in fully enclosed and lockable enclosures (e.g. cabs, compartments) or by the use of tools or keys provided with the MEWP. When it is foreseen that the fixed guards will be removed regularly (e.g. for routine maintenance) then the fastenings shall remain attached to the guards or to the MEWP.

This requirement does not apply to the exhaust systems of vehicles conforming to road traffic regulations unless they are located near the control or access position.

Verification shall be carried out by visual examination.

2.2.19 Engine exhaust

The exhaust from internal combustion engines shall be directed away from control positions and from all electrical insulation.

Verification shall be carried out by visual examination.

2.2.20 Filling points for fluids

The filling points for flammable fluids shall be positioned to minimize the risk of fire from spillage onto hot parts (e.g. engine exhausts).

Verification shall be carried out by visual examination.

2.2.21 Battery constraint

Batteries and battery containers of all MEWPs shall be constrained to prevent displacement. Means shall be provided so that, in the event of overturning, the battery assembly will be constrained to avoid the risk of injury to the operator by the battery being displaced or electrolyte being ejected.

Suitable ventilation holes shall be provided in the battery container, compartment or cover, to prevent dangerous accumulation of gases in places occupied by operators.

NOTE: Experience has indicated that when openings are positioned such that gases can escape freely, ventilation apertures are usually satisfactory if they provide a cross-section (in square millimetres) of $(0.5 \times \text{the number of cells} \times \text{the 5 h rated capacity, in ampere-hours})$. This level is not intended to cover the charging condition.

Verification shall be carried out by visual examination.

2.2.22 Derailment prevention

Rail-mounted MEWPs shall be provided with devices that act on the rails to prevent derailment and devices to remove obstacles on the rails, which might cause derailment (e.g. track clearers).

Verification shall be carried out by functional test.

2.2.23 Vehicle-mounted MEWP chassis selection

For vehicle-mounted MEWPs, the vehicle shall be selected to meet the design specifications. Installation criteria shall meet the vehicle chassis manufacturer's specifications and the specifications for mounted sub-assemblies.

2.3 EXTENDING STRUCTURE

2.3.1 Methods to avoid overturning and exceeding permissible stresses

2.3.1.1 General

In addition to the provisions of Clause 2.1.5.5, the MEWP shall be provided with control devices or comply with the methods outlined in this Clause, which reduce the risk of overturning and the risk of exceeding permissible stresses by one of the equivalent solutions indicated in Table 2.3.1.1 by a cross.

Verification of all requirements of Clause 2.3.1 shall be carried out by design check and tests (see Clauses 3.4 and 3.6).

NOTE: Load or moment controls are not able to protect against an overload that grossly exceeds the rated capacity.

TABLE 2.3.1.1
CONTROL DEVICES

Group	Load-sensing system and position control	Load- and moment-sensing system	Moment-sensing system with enhanced overload criteria	Position control with enhanced overload and stability criteria
(see Clause 1.3.19)	(see Clauses 2.3.1.2 and 2.3.1.3)	(see Clauses 2.3.1.2 and 2.3.1.4)	(see Clauses 2.3.1.4 and 2.3.1.6)	(see Clauses 2.3.1.3, 2.3.1.5 and 2.3.1.6)
A	X			X
B	X	X	X	X

2.3.1.2 Load-sensing system

Where provided, the load-sensing system shall operate in the following way:

- (a) It shall trigger after the rated capacity is reached and before 120% of the rated capacity is exceeded.
- (b) When the load-sensing system is triggered, a warning, consisting of a flashing red light at each control position together with an acoustic signal audible at each control position, shall be activated. The light shall continue to flash all the time the overload prevails and the acoustic alarm shall sound for a period of at least 5 s and shall be repeated every minute.
- (c) If the load-sensing system is triggered while the work platform is stationary, it shall prevent all movement of the work platform. Movement shall only restart if the overload is removed.

NOTE: If the load-sensing system is triggered during normal movement of the work platform, the possibility of normal movement may remain.

For Type 1 MEWPs in Group A, it is permitted for the load-sensing system to be effective only when raising the extending structure from the lowest position. In this case, for the overload test specified in Clause 3.6.4, the test load shall be 150% of the rated load.

For Group A MEWPs in general, the load-sensing system need not be activated until the work platform is elevated more than 1 m or 10% of lift height, whichever is the greater, above the lowest position. If an overload condition is sensed at or above this height, further elevation shall be prevented.

The load-sensing system shall be in accordance with Clause 2.10.

The emergency override system shall remain active at all times, including those times when the load-sensing system is activated.

2.3.1.3 Position control

2.3.1.3.1 General

To avoid overturning of the MEWP or exceeding the permissible stresses in the structure of the MEWP, the permissible positions of the extending structure shall be limited automatically by mechanical stops (see Clause 2.3.1.3.2), non-mechanical limiting devices (see Clause 2.3.1.3.3) or electrical safety devices (see Clause 2.10).

2.3.1.3.2 Mechanical limiting devices

Where permissible positions are limited by mechanical stops, these shall be designed to resist without permanent deformation the maximum forces exerted.

NOTE: Hydraulic cylinders fulfil this requirement if designed for that purpose.

2.3.1.3.3 Non-mechanical limiting devices

Where non-mechanical limiting devices are used, permissible positions of the extending structure shall be limited by a device that measures positions of the extending structure, and is operated through the control systems to limit movements to the working envelope. This device shall be backed up by a safety device in accordance with Clause 2.10.

2.3.1.4 Moment-sensing system

Where provided, the moment-sensing system shall operate such that when the permissible overturning moment (see Clause 2.1.5.5) is reached, a visual and audible warning shall be given and further movements shall be prevented, except those movements that reduce the overturning moment.

The control system for the moment-sensing system shall comply with the requirements of Clause 2.10.

2.3.1.5 *Criteria for enhanced stability for limited work platform dimensions*

As an alternative to a load- and moment-sensing system, MEWPs for up to two persons may follow 'enhanced stability requirements'.

To meet the requirement of enhanced stability, the MEWP shall be designed according to the following criteria:

- (a) Inside dimensions of the work platform at any horizontal section shall be as follows:
 - (i) For one person, sectional area not more than 0.6 m^2 with no side more than 0.85 m.
 - (ii) For two persons, sectional area not more than 1.1 m^2 with no side more than 1.5 m.
- (b) For the static stability test described in Clause 3.6.3.1, the test loads shall be calculated using 150% of the rated capacity as identified in Clause 2.1.2. The other load and force combinations specified in Clauses 2.1.4.1, 2.1.4.2, 2.1.4.3, and 2.1.4.4 shall remain as specified.

2.3.1.6 *Criteria for enhanced overload for limited work platform dimensions*

As an alternative to a load-sensing system, MEWPs for up to two persons may follow 'enhanced overload requirements'.

To meet the requirements of enhanced overload, the MEWP shall be designed according to the following criteria:

- (a) Inside dimensions of the work platform at any horizontal section shall be as follows:
 - (i) For one person, sectional area not more than 0.6 m^2 with no side more than 0.85 m.
 - (ii) For two persons, sectional area not more than 1.1 m^2 with no side more than 1.5 m.
- (b) For the overload test described in Clause 3.6.4, the test load shall be 150% of the rated capacity.

2.3.1.7 *Variable working envelope with more than one rated capacity*

MEWPs with more than one rated capacity and more than one working envelope shall have an indicator of the selected combination that is visible at the work platform. The indicator may be a physical change (e.g. platform extension) to the configuration of the platform that affects its rated capacity. An indicator is not required for MEWPs on which the working envelope is limited by a moment-sensing system.

The MEWP shall be fitted with load- and moment-sensing systems or load-sensing system and position control.

MEWPs with enhanced stability for two persons shall require activation of a load-sensing system when selecting the extended working envelope(s).

2.3.1.8 *Variable working envelope with one rated capacity*

For MEWPs with one rated capacity and a variable working envelope (e.g. MEWPs with variable positions of stabilizers/outriggers) where selection is by manual means, selection shall only be possible with the extending structure in the access position (see Clause 2.2.10).

2.3.2 Sequencing of the extending structure

When a telescopic structure needs to be extended or retracted in a specific sequence, this sequence shall be automatic.

Verification shall be carried out by design check and functional test.

2.3.3 Tilting chassis or superstructure

MEWPs equipped with tilting chassis and/or superstructure in which the stability of the machine, when operating, is dependent on control or locking of the tilting mechanism, shall satisfy the following requirements:

- (a) On Type 1 MEWPs, a safety device in accordance with Clause 2.10 shall prevent deployment of the extending structure until tilting of the chassis and/or superstructure is positively controlled or locked.
- (b) On Types 2 and 3 MEWPs, it shall be shown by demonstration that the inclinations of the superstructure remain within the limits specified by the manufacturer when the inclination of the chassis is at the maximum permitted value.

Safety devices that control or lock the tilting shall be in accordance with Clause 2.10. Hydraulic cylinders shall comply with Clause 2.9.

2.3.4 Trapping and shearing

Trapping and shearing points between moving parts that are within reach of persons on the work platform or standing adjacent to the MEWP at ground level shall be avoided by providing safe clearances in accordance with AS 4024.1801, AS 4024.1802 or AS 4024.1803, or guarding in accordance with AS 4024.1601 as applicable.

For Group A MEWPs, when this is not practicable, clearly visible warnings, with instructions to keep clear, shall be permanently attached in the area of the hazard. Motion (lowering) alarms shall sound over at least the last 2 m of lowering to warn persons in the vicinity of a lowering platform.

Verification shall be carried out by measurement and visual examination.

2.3.5 Supporting the extending structure for routine maintenance

When the work platform of a MEWP needs to be raised for routine servicing purposes, a means shall be provided to enable the extending structure to be held in the required position. This means shall be capable of supporting an unloaded work platform and of being operated from a safe position; it shall not cause damage to any part of the MEWP (see Clause 4.2.13).

Verification shall be carried out by visual examination and functional test.

2.3.6 Speeds of the extending structure

MEWPs shall not exceed the following speeds:

- (a) For raising and lowering the work platform 0.8 m/s.
- (b) For telescoping the boom..... 0.8 m/s.
- (c) For slewing or rotation (horizontal speed at the outer edge of the work platform, measured at maximum range) 1.4 m/s.

If accelerations or decelerations are greater than 0.25g, then the following speeds shall not be exceeded:

- (i) For raising and lowering the work platform 0.4 m/s.
- (ii) For telescoping the boom..... 0.4 m/s.
- (iii) For slewing or rotation (horizontal speed at the outer edge of the work platform, measured at maximum range) 0.7 m/s.

Deceleration caused by an emergency stop shall not be considered during measurement of g forces. Accelerations and decelerations, including emergency stops, shall be taken into account in accordance with Clause 2.1.

Verification shall be carried out by functional test.

2.3.7 Support in the transport position

Provision shall be made to enable the extending structure to be supported in the transport position to limit vibrations during transport.

Verification shall be carried out by design check and visual examination.

2.4 EXTENDING STRUCTURE DRIVE SYSTEMS

2.4.1 General

2.4.1.1 *Inadvertent movements*

Drive systems shall be designed and constructed to prevent any inadvertent movements of the extending structure.

Verification shall be carried out by design check and functional test.

2.4.1.2 *Protection of the extending structure from power sources*

If the power source is capable of producing greater power than the extending structure and/or work platform drive system requires, protection shall be provided to the extending structure and/or work platform drive system to prevent damage.

NOTE: Protection may be achieved by using a pressure-limiting device.

The use of friction couplings does not fulfil this requirement.

Verification shall be carried out by design check.

2.4.1.3 *Failure of transmission chain or belt*

Transmission chains or belts shall be used only in drive systems if inadvertent movements of the work platform are automatically prevented in the event of failure of a chain or belt.

NOTE: This may be achieved by using a self-sustaining gearbox or by monitoring the chain/belt by a safety device in accordance with Clause 2.10.

Flat belts shall not be used.

Verification shall be carried out by design check and functional test.

2.4.1.4 *Kickback of handles*

Manual drive systems shall be designed and constructed to prevent kickback of handles.

Verification shall be carried out by design check and visual examination.

2.4.1.5 *Powered and manual drive systems for the same function*

If both powered and manual drive systems are provided for the same function (e.g. to override an emergency system) and if there is a risk of injury from engaging both systems at the same time, this shall be prevented.

NOTE: **Text deleted.**

Verification shall be carried out by design check and functional test.

2.4.1.6 *Braking system for all drives*

A braking system shall be provided on all drives. For raising movements, this system shall be an automatic lock or self-sustaining device. The braking system shall be automatically applied when the drive is no longer energized.

A1

The braking system shall ensure that the work platform, loaded with 1.1 times the rated capacity, can be stopped and held at any position in all configurations of operation. The braking system shall be protected against inadvertent release.

Verification shall be carried out by design check and functional test.

2.4.2 Wire rope drive systems

2.4.2.1 Wire rope drive system safety

2.4.2.1.1 General

Wire rope, drum and sheave diameters shall be calculated according to AS 1418.1, assuming that the entire load is taken on one wire rope system. Traction drive systems shall not be used.

Wire rope drive systems shall have a device or system that, in the event of a wire rope drive system failure, limits the vertical movement of the fully loaded work platform to 200 mm. This requirement shall be met by either a mechanical safety device (see Clause 2.4.2.1.2) or an additional wire-rope drive system (see Clause 2.4.2.1.3).

2.4.2.1.2 Mechanical safety device

Mechanical safety devices shall operate by engaging with the extending structure. This safety device shall gradually bring the work platform plus the rated load to a stop and hold it in the event of the wire rope drive system failure. The average deceleration shall not exceed 1.0g. Any spring operating this device shall be a guided compression spring with secured ends, or shall have a wire diameter of more than half the pitch in the operating condition, to limit the shortening of the spring should it fail.

2.4.2.1.3 An additional wire rope drive system

Where an additional wire rope drive system is used, it shall be one of the following:

- (a) A wire rope drive system designed according to the first system, with a device to give approximately equal tension in the two wire rope systems, thus doubling the working coefficient.
- (b) A wire rope drive system designed according to the first system, with a device to ensure that the second system takes less than half of the load in the operating condition, but is able to take the full load if the first system fails.
- (c) A wire rope drive system designed according to Item (a), with larger drum and sheave diameters to increase the fatigue life of the second system to at least twice the calculated lifetime of the first system.

Failure of the first system shall be self-revealing.

Verification shall be carried out by design check and visual examination.

2.4.2.2 Load-carrying wire ropes

Load-carrying wire ropes (see ISO 2408) shall be made from galvanized steel wires or equivalent and shall have the following characteristics:

- (a) Minimum diameter, 8 mm.
- (b) Minimum number of wires, 114. Tensile grade of the wires, minimum 1570 MPa, and maximum 2160 MPa.
- (c) Fatigue life suitable for the application.
- (d) Corrosion resistance equivalent to galvanized steel.
- (e) Ratio of sheave diameter to wire diameter meeting requirements of AS 1418.1, appropriate to the design classification.

The minimum breaking load of the wire ropes shall be shown on a certificate.

Wire ropes that are used directly for lifting or supporting the work platform shall not include any splicing, except at their ends.

Wire ropes with other characteristics may be used if they provide equivalent safety.

Verification shall be carried out by design and visual examination.

2.4.2.3 *System of multiple wire ropes*

If more than one wire rope is attached at one point, a device shall be provided for approximately equalizing the tension of the wire ropes.

Verification shall be carried out by design check and visual examination.

2.4.2.4 *Re-tensioning wire ropes*

It shall be possible to re-tension wire ropes.

Verification shall be carried out by design check and visual examination.

2.4.2.5 *Terminations of wire ropes*

For the terminations of wire ropes, only the following shall be used:

- (a) Splices.
- (b) Aluminium pressed ferrules.
- (c) Non-ageing steel pressed ferrules.
- (d) Wedge-socket anchorages.

U-bolt grips shall not be used as wire rope terminations for load-carrying wire ropes.

The junction between the wire rope and the wire rope termination shall be able to resist at least 80% of the minimum breaking load of the wire rope.

Verification shall be carried out by design check and visual examination.

2.4.2.6 *Visual examination of wire rope terminations*

Visual examination of wire rope terminations shall be possible.

NOTE: The visual examination should not require the removal of the wire ropes or major disassembly of the structural components of the MEWP.

If it is not practicable to use inspection openings, means for examination shall be specified in the manufacturer's instructions.

Verification shall be carried out by design check and visual examination.

2.4.2.7 *Safety device for MEWPs raised and lowered by wire ropes*

MEWPs with work platforms that are raised and lowered by means of wire ropes, and where a slack rope condition can develop, shall be equipped with a safety device in accordance with Clause 2.10 that interrupts movements causing slack rope conditions. Movements in the opposite direction shall be possible.

NOTE: For the purpose of this Clause, a slack rope condition can occur where a rope pulls a mechanism in one direction and the mechanism is returned by gravity or an external force. A slack rope condition does not occur with a double-acting system where a rope pulls the mechanism in both directions.

Verification shall be carried out by design check and functional test.

2.4.2.8 *Rope drum grooves and prevention of rope leaving the ends of drum*

Power-driven rope drums shall be grooved. Means shall be provided to prevent the wire rope from leaving the ends of the drum.

NOTE: Means of prevention may be by using flanges extending to a height of at least twice the wire rope diameter above the highest layer.

Verification shall be carried out by visual examination.

2.4.2.9 *Layers of rope*

Only one layer of wire rope shall be wound on the drum unless a special spooling system is used.

Verification shall be carried out by visual examination.

2.4.2.10 *Turns of rope*

At least two turns of wire rope shall remain on the drum when the extending structure and/or the work platform is in its most extreme position.

Verification shall be carried out by functional test and visual examination.

2.4.2.11 *Fastening rope to drum*

Each wire rope shall be properly fastened to the drum. The fastening shall be able to take 80% of the minimum breaking load of the wire rope.

Verification shall be carried out by design check and visual examination.

2.4.2.12 *Unintentional displacement of rope*

Means shall be provided to prevent unintentional displacement of wire ropes from sheaves, even under slack rope conditions.

Verification shall be carried out by design check and visual examination.

2.4.2.13 *Cross-section of drum grooves*

The cross-section of the bottom of the grooves in wire rope drums and sheaves shall be circular over an angle of not less than 120 degrees.

Verification shall be carried out by design check and visual examination.

2.4.3 Chain drive systems

2.4.3.1 *General*

Round-link chains shall not be used. Leaf chains may be used.

There shall be on record a certificate on chains from the chain manufacturer, showing the minimum design breaking load of chains.

2.4.3.2 *Limit of vertical movement in case of failure*

2.4.3.2.1 *General*

Chain drive systems shall have a device or system that limits the vertical movement of the fully loaded work platform to 200 mm in the event of a chain drive system failure. This requirement shall be met by either of the drive systems described in Clause 2.4.3.2.2 or Clause 2.4.3.2.3.

2.4.3.2.2 *Single-chain drive systems*

Single-chain drive systems shall have a working coefficient of at least 5, plus a mechanical safety device that operates by engaging with the extending structure. This safety device shall gradually bring the work platform plus the rated capacity to a stop and hold it in the event of a drive system failure. The average deceleration shall not exceed 1.0g. Any spring

operating this device shall be a guided compression spring with secured ends, or have a wire diameter of more than half the pitch in the operating condition, to limit the shortening of the spring if it should fail.

2.4.3.2.3 *Two-chain drive systems*

Two-chain drive systems shall meet either one of the following requirements:

- (a) *Equal tension* Each chain of a two-chain drive system shall have a working coefficient of at least 4 (a total minimum coefficient of 8) and be provided with a device to give approximately equal tension in the two chain systems, or comply with (b) below. Failure of a chain shall be self-revealing.
- (b) *Unequal tension* The first chain of a two-chain drive system shall have a working coefficient of at least 5 when carrying the full load, and the second chain shall have a working coefficient of at least 4 (a total minimum coefficient of 9 when carrying the full load) and be provided with a device to ensure that the second chain takes less than half the load in the operating condition, but is able to take the full load if the first chain fails. Failure of a chain shall be self-revealing.

Verification shall be carried out by design check and visual examination.

2.4.3.3 *Multiple chains attached to a point*

If more than one chain is attached at one point, a device shall be provided to equalize approximately the tension in the chains.

Verification shall be carried out by design check and visual examination.

2.4.3.4 *Tensioning chains*

It shall be possible to re-tension chains.

Verification shall be carried out by design check and visual examination.

2.4.3.5 *Strength of junction between chain and termination*

The junction between the chain and the chain termination shall be able to resist at least 100% of the minimum breaking load of the chain.

Verification shall be carried out by design check.

2.4.3.6 *Visual examination of chains and terminations*

Visual examination of chains and chain terminations shall be possible and should not require the removal of the chains or major disassembly of structural components of the MEWP.

If it is not possible to provide inspection openings, detailed instructions for examination shall be specified in the manufacturer's instructions.

NOTE: See Paragraph G2.5, Appendix G.

Verification shall be carried out by design check and visual examination.

2.4.3.7 *Safety device for MEWPs raised and lowered by chains*

MEWPs with work platforms that are raised and lowered by means of chains, and where a slack chain condition can develop, shall be equipped with a safety device, in accordance with Clause 2.10, that interrupts movements causing slack chain conditions. Movements in the opposite direction shall be possible.

NOTE: For the purpose of this Clause, a slack chain condition can occur where a chain pulls a mechanism in one direction and the mechanism is returned by gravity or an external force. A slack chain condition does not occur with a double-acting chain drive system where a chain pulls the mechanism in both directions.

Verification shall be carried out by design check and functional test.

2.4.3.8 *Unintentional displacement of chain*

Means shall be provided to prevent unintentional displacement of the chain from the sprockets or sheaves, even under slack conditions.

Verification shall be carried out by design check and visual examination.

2.4.4 **Lead-screw drive systems**

2.4.4.1 *Lead-screw and nut design stress and material*

The design stress of lead-screws and nuts shall not be more than one-sixth of the ultimate tensile stress of the material used. The lead-screw material shall have a higher abrasion resistance than the loadbearing nut.

Verification shall be carried out by design check.

2.4.4.2 *Separation of lead screw from work platform*

The lead-screw mechanism shall be designed to prevent separation of the work platform from the mechanism during normal use.

Verification shall be carried out by visual examination.

2.4.4.3 *Loadbearing nut and safety nut*

Each lead-screw shall have a loadbearing nut and an unloaded safety nut. The safety nut shall only be loaded if the loadbearing nut fails. It shall not be possible to raise the work platform when the safety nut is under load.

Verification shall be carried out by design check and visual examination.

2.4.4.4 *Detection of wear on loadbearing nuts*

It shall be possible to detect the wear of the loadbearing nuts without disassembly.

2.4.5 **Rack and pinion drive systems**

2.4.5.1 *Design stress of racks and pinions*

The design stress of racks and pinions shall be not greater than one-sixth of the ultimate tensile stress of the material used.

Verification shall be carried out by design check.

2.4.5.2 *Safety device and overspeed governor*

Rack and pinion drives shall have a safety device in accordance with Clause 2.10, actuated by an overspeed governor. This safety device shall gradually bring the work platform plus rated capacity to a stop and hold it in the event of the lifting mechanism failing. The average deceleration shall not exceed 1.0g. If this safety device is actuated, the power supply shall be interrupted automatically.

Verification shall be carried out by design check and functional test.

2.4.5.3 *Devices to prevent pinion disengagement*

In addition to the normal work platform guide rollers, positive and effective devices shall be provided to prevent any driving or safety-device pinion from coming out of engagement with the rack. These devices shall ensure that axial movement of the pinion is limited so that a minimum of two-thirds of the tooth width is always in engagement with the rack. They shall also restrain radial movement of the pinion from its normal meshing position to no more than one-third of the tooth depth.

Verification shall be carried out by visual examination.

2.4.5.4 *Visual examination of pinions*

Visual examination of the pinions shall be possible without the removal of the pinions or major disassembly of structural components of the MEWP.

Verification shall be carried out by visual examination.

2.5 WORK PLATFORM

2.5.1 Level of work platform

- A1 | After the initial levelling (if applicable) of the platform, the level of the work platform shall not vary by more than 5 degrees from the initial setting during movements of the extending structure.

The levelling system, except hydraulic levelling systems, shall incorporate a safety device complying with Clause 2.10 that, in the case of a failure within the system, will maintain the work platform level within a further 5 degrees.

Verification shall be carried out by means of a design check and functional test.

- A1 | NOTE: Mechanical levelling systems fulfil this requirement if designed to take at least twice the load imposed on them. For wire ropes and chains, see Clause 2.4.2 and Clause 2.4.3. For the purpose of this Clause, the enhanced overload criteria do not apply.

Verification shall be carried out by means of a design check.

Hydraulic cylinders in hydraulic levelling systems shall comply with Clause 2.9.2.

Verification shall be carried out by means of functional testing.

2.5.2 Platform level adjustment

- A1 | Manually controlled adjustment of the level of the platform is permissible in all positions of the work platform. When the work platform is not in the lowered travel position or transport position, the speed of the platform levelling shall not exceed 0.3 rad/s (17 degrees/s).

2.5.3 Work platform materials

The structural components of the work platform shall be made of non-flammable material(s); that is, materials that will not sustain a flame after the ignition source has been removed.

2.5.4 Guardrail (protection) systems

Protection shall be provided on all sides of each work platform to prevent the fall of persons and materials. Except for orchard MEWPs (see Section 5) and insulated MEWPs (see Section 7), the protection shall be securely fastened to the work platform and, as a minimum, shall consist of guardrails at least 950 mm high, toe guards at least 100 mm high and intermediate guardrails not further than 550 mm from either guardrails or toe guards.

NOTE: An additional grabrail should be provided on the interior on at least each side of the platform to prevent crushing of hands when the platform is moving.

Vertical posts may be used instead of an intermediate guardrail, provided the clear horizontal distance between those posts is no more than 180 mm. Clear space between guardrail segments shall not exceed 120 mm.

Clear horizontal space between toe guard segments shall not exceed 15 mm.

The guardrails shall be constructed to withstand concentrated forces of 500 N per person, applied at the least favourable positions in the least favourable direction at 500 mm intervals without causing permanent deformation of the guardrails.

NOTE: Folding guardrails satisfy this requirement provided they remain securely fastened to the work platform and are equipped with locking pins secured against unintentional disengagement and loss, or an equally effective means of locking.

Chains or ropes shall not be used as guardrails, midrails, or access gates. Verification shall be carried out by visual examination.

2.5.5 Anchorage(s)

Anchorage(s) for the connection of a fall-arrest system shall be provided for boom-supported MEWPs. MEWPs other than boom-supported MEWPs may be fitted with a fall-arrest or fall-restraint anchorage.

When fitted with a fall-arrest anchorage, each anchorage shall be capable of withstanding a static force of 15 kN without reaching ultimate strength. For anchorages rated for two people, the strength requirement shall be increased to 21 kN. This strength requirement shall only apply to the anchorage and its attachment to the MEWP in all possible load directions. When fitted, the number of anchorages shall equal or exceed the allowable number of persons. Any anchors defined as fall-arrest anchorages shall be tested to the requirements of Clause 3.6.2.

A1 | Fall arrest anchorages shall be marked to indicate the number of persons that can be attached—see Clause 4.2.2(j). Their capacity shall not be shown.

When fitted with a fall-restraint anchorage, each anchorage shall be capable of withstanding a static force of 6 kN without reaching ultimate strength and shall be located no more than 750 mm above the floor. For anchorages rated for more than one person, the strength requirements shall be multiplied by the number of persons. This strength requirement shall only apply to the anchorage and its attachment to the MEWP in all possible load directions.

Fall restraint anchorages shall be marked 'Restraint Only', with words or symbols, and shall indicate the number of persons that can be attached.

Verification shall be carried out by design check and visual examination.

2.5.6 Openings in guardrails for entrance and exit

A1 | Any part of the protection movable for the purpose of access to the work platform shall not fold or open outwards. The gate shall be designed to either return automatically to the closed and latched position, or be interlocked in accordance with Clause 2.10 to prevent operation of the MEWP until it is closed and latched. Inadvertent opening shall be prevented.

Sliding or vertically opening intermediate guardrails that return automatically to their protective position do not need to be latched or interlocked. Sliding or vertically opening intermediate guard-rails shall be capable of being held in the open position with one hand whilst a person enters or leaves the platform.

The minimum opening width for the purpose of access to the work platform shall be 420 mm.

On work platforms with fixed top guardrails, the opening shall be not less than 800 mm high and 420 mm wide.

NOTE: Wherever reasonably practicable, the minimum opening dimensions should be 920 mm high and 645 mm wide.

Verification shall be carried out by visual examination.

2.5.7 Floor of work platform

The floor of the work platform, including any trapdoor, shall be slip resistant and self-draining. Any opening in the floor or between the floor and toe guards or access gates shall be dimensioned so as to prevent the passage of a sphere of 15 mm diameter.

The floor of the work platform and any trapdoor shall be able to take the rated capacity distributed according to Clause 2.1.4.1.2.

Verification shall be carried out by design check.

NOTE: Except for insulated MEWPs (see Section 7), non-conductive work platforms may have drain holes and/or access openings.

2.5.8 Access ladder

When the distance between the access level and the upper edge of the toe guard in an access position exceeds 700 mm, the MEWP shall be equipped with an access ladder. The steps or rungs shall be not more than 300 mm apart and shall be spaced equally over the distance between the bottom step/rung and the floor of the work platform. The bottom step/rung shall be not more than 700 mm above the access level. Each step or rung shall be at least 300 mm wide, at least 25 mm deep, and shall be slip resistant. The front of the steps or rungs shall be a horizontal distance of at least 150 mm away from the supporting structure or any other components of the MEWP. The access ladder shall be symmetrical with the access gate.

Verification shall be carried out by design check and visual examination.

2.5.9 Handholds and handrails

Handholds, handrails or similar devices shall be provided for both hands while climbing or descending the access ladder to the work platform. They shall be arranged to avoid the use of controls and piping as handholds or footsteps.

Verification shall be carried out by visual examination.

2.5.10 Trapdoors

- A1 | Trapdoors in work platforms shall be designed so that inadvertent opening is not possible. It shall not be possible for trapdoors to open downward or to slide sideward.

Verification shall be carried out by visual examination.

2.5.11 Audible warning device

Type 3 MEWPs shall be equipped with an audible warning device (e.g. a horn) that is operated from the work platform.

Verification shall be carried out by functional test.

2.5.12 Means of communication

Type 2 MEWPs shall be provided with an appropriate means of communication between the persons on the work platform and the driver.

Verification shall be carried out by visual examination and functional test.

2.5.13 Mechanical stops

The movements of work platform(s) relative to the extending structure shall be limited by mechanical stops.

NOTE: Hydraulic cylinders fulfil this requirement if designed for that purpose.

Verification shall be carried out by design check and functional test.

2.5.14 Support in transport position

- A1 | The work platform of vehicle and trailer mounted MEWPs shall be supported in the transport position in such a way as to minimize the effects of harmful vibrations during transport (see Clause 2.1.6.3.3).

Verification shall be carried out by design check and visual examination.