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Mobile elevating work platforms — Design calculations — Stability criteria — Construction — Safety — Examinations and tests

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National foreword

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The UK participation in its preparation was entrusted to Technical Committee MHE/12, Lifting Platforms.

A list of organizations represented on this committee can be obtained on request to its secretary.

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English Version

Mobile elevating work platforms - Design calculations - Stability
criteria - Construction - Safety - Examinations and tests

Plates-formes élévatrices mobiles de personnel - Calculs de
conception - Critères de stabilité - Construction - Sécurité -
Examens et essais

Fahrbare Hubarbeitsbühnen - Berechnung - Standsicherheit
- Bau - Sicherheit - Prüfungen

This European Standard was approved by CEN on 21 May 2013 and includes Amendment 1 approved by CEN on 27 June 2015.

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Foreword

This document (EN 280:2013+A1:2015) has been prepared by Technical Committee CEN/TC 98 “Lifting platforms”, the secretariat of which is held by DIN.

This European Standard shall be given the status of a national standard, either by publication of an identical text or by endorsement, at the latest by February 2016, and conflicting national standards shall be withdrawn at the latest by February 2017.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. CEN [and/or CENELEC] shall not be held responsible for identifying any or all such patent rights.

This document includes Amendment 1 approved by CEN on 27 June 2015.

This document supersedes A1 EN 280:2013 A1.

The start and finish of text introduced or altered by amendment is indicated in the text by tags A1 A1.

This document has been prepared under a mandate given to CEN by the European Commission and the European Free Trade Association, and supports essential requirements of EU Directive.

For relationship with EU Directive, see informative Annex ZA, which is an integral part of this document.

A1 *deleted text* A1

According to the CEN/CENELEC Internal Regulations, the national standards organizations of the following countries are bound to implement this European Standard: Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, Former Yugoslav Republic of Macedonia, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, Turkey and the United Kingdom.

Introduction

This standard is a type C standard as stated in EN ISO 12100:2010.

The machinery concerned and the extent to which hazards, hazardous situations and hazardous events are covered are indicated in the scope of this document.

When provisions of this type C standard are different from those which are stated in type A or B standards, the provisions of this type C standard take precedence over the provisions of the other standards, for machines that have been designed and built according to the provisions of this type C standard.

The object of this European Standard is to define rules for safeguarding persons and objects against the risk of accidents associated with the operation of Mobile Elevating Work Platforms (MEWPs).

- This European Standard does not repeat all the general technical rules applicable to every electrical, mechanical or structural component.
- The safety requirements of this European Standard have been drawn up on the basis that MEWPs are periodically maintained according to manufacturers' instructions, working conditions, frequency of use and national regulations.

It is also assumed that MEWPs are checked for function daily before start of work and are not put into operation unless all required control and safety devices are available and in working order.

If a MEWP is seldom used, the checks may be made before start of work.

Furthermore it is assumed that persons on the work platform in case of power supply failure are not incapacitated and can assist in the emergency lowering.

- As far as possible this European Standard sets out only the requirements that materials and equipment need to meet in the interest of safety, and it is assumed that persons operating MEWPs are adequately trained.
- Where for clarity an example of a safety measure is given in the text, this does not need to be considered as the only possible solution. Any other solution leading to the same risk reduction is permissible if an equivalent level of safety is achieved.
- As no satisfactory explanation could be found for the dynamic factors used for stability calculations in previous national standards, the results of the tests carried out by the former CEN/TC 98/WG 1 to determine a suitable factor and stability calculation method for MEWPs have been adopted. The test method is described in Annex B (informative) as a guide for manufacturers wishing to use higher or lower operating speeds and to take advantage of developments in control systems.

Similarly, to avoid the unexplained inconsistencies in coefficients of utilisation for wire ropes found in other standards for lifting devices, appropriate extracts of the widely accepted standard DIN 15020-1 have been taken into 5.5.2 and Annex C (normative) with a worked example in Annex D (informative).

1 Scope

1.1 This European Standard specifies safety requirements and measures for all types and sizes of Mobile Elevating Work Platform (MEWP, see 3.1) intended to move persons to working positions where they are carrying out work from the work platform (WP) with the intention that persons are getting on and off the work platform only at access positions at ground level or on the chassis.

NOTE Machines designed for the handling of goods which are equipped with work platforms as interchangeable equipment are regarded as MEWPs.

1.2 This European Standard is applicable to the structural design calculations and stability criteria, construction, safety examinations and tests before MEWPs are first put into service. It identifies the hazards arising from the use of MEWPs and describes methods for the elimination or reduction of these hazards.

It does not cover the hazards arising from:

- a) use in potentially explosive atmospheres;
- b) electromagnetic incompatibility;
- c) work from the platform on external live electric systems;
- d) use of compressed gases for load bearing components;
- e) getting on and off the work platform at changing levels;
- f) specific applications (e.g. railway, ships) covered by National or local regulations.

1.3 This European Standard does not apply to:

- a) machinery serving fixed landings (see e.g. EN 81-1 and EN 81-2, EN 12159);
- b) fire-fighting and fire rescue appliances (see e.g. EN 1777);
- c) unguided work cages suspended from lifting appliances (see e.g. EN 1808);
- d) elevating operator position on rail dependent storage and retrieval equipment (see EN 528);
- e) tail lifts (see EN 1756-1 and EN 1756-2);
- f) mast climbing work platforms (see EN 1495);
- g) fairground equipment;
- h) lifting tables (see EN 1570-1);
- i) aircraft ground support equipment (see e.g. EN 1915-1 and EN 1915-2);
- j) elevating operator positions on industrial trucks (see EN 1726-2).

1.4 Classification:

MEWPs are divided into two main groups:

- a) 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.

b) Group B: All other MEWPs.

Relating to travelling, MEWPs are divided into three types:

- 1) Type 1: Travelling is only allowed with the MEWP in its transport configuration;
- 2) Type 2: Travelling with raised work platform is controlled from a point of control at the chassis;
- 3) Type 3: Travelling with raised work platform is controlled from a point of control at the work platform.

NOTE Type 2 and type 3 can be combined.

2 Normative references

The following documents, in whole or in part, are normatively referenced in this document and are indispensable for its application. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 349, *Safety of machinery — Minimum gaps to avoid crushing of parts of the human body*

EN 12385-4, *Steel wire ropes — Safety — Part 4: Stranded ropes for general lifting applications*

EN 13001-3-1:2012+A1:2013, *Cranes — General Design — Part 3-1: Limit States and proof competence of steel structure* ^(A1)

EN 14033-1, *Railway applications — Track — Railbound construction and maintenance machines — Part 1: Technical requirements for running*

EN 14033-2:2008+A1:2011, *Railway applications — Track — Railbound construction and maintenance machines — Part 2: Technical requirements for working*

EN 15746-1:2010+A1:2011, *Railway applications — Track — Road-rail machines and associated equipment — Part 1: Technical requirements for running and working*

EN 15954-1:2013, *Railway applications — Track — Trailers and associated equipment — Part 1: Technical requirements for running and working*

EN 15955-1:2013, *Railway applications — Track — Demountable machines and associated equipment — Part 1: Technical requirements for running and working*

EN 60068-2-64, *Environmental testing — Part 2-64: Tests — Test Fh: Vibration, broadband random and guidance (IEC 60068-2-64)*

EN 60204-1:2006, *Safety of machinery — Electrical equipment of machines — Part 1: General requirements (IEC 60204-1:2005, modified)*

EN 60204-32:2008, *Safety of machinery — Electrical equipment of machines — Part 32: Requirements for hoisting machines (IEC 60204-32:2008)*

EN 60529, *Degrees of protection provided by enclosures (IP Code) (IEC 60529)*

EN 62061, *Safety of machinery — Functional safety of safety-related electrical, electronic and programmable electronic control systems (IEC 62061)* ^(A1)

EN ISO 12100:2010, *Safety of machinery — General principles for design — Risk assessment and risk reduction (ISO 12100:2010)*

EN ISO 13849-1:2008, *Safety of machinery — Safety-related parts of control systems — Part 1: General principles for design (ISO 13849-1:2006)*

EN ISO 13849-2, *Safety of machinery — Safety related parts of control systems — Part 2: Validation (ISO 13849-2)*

EN ISO 13850, *Safety of machinery — Emergency stop — Principles for design (ISO 13850)*

EN ISO 13857, *Safety of machinery — Safety distances to prevent hazard zones being reached by upper and lower limbs (ISO 13857)*

ISO 3864-1, *Graphical symbols — Safety colours and safety signs — Part 1: Design principles for safety signs and safety markings*

ISO 4302, *Cranes — Wind load assessment*

ISO 4305, *Mobile cranes — Determination of stability*

ISO 4309, *Cranes — Wire ropes — Care and maintenance, inspection and discard*

ISO/TR 23849:2010, *Guidance on the application of ISO 13849-1 and IEC 62061 in the design of safety-related control systems for machinery*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in EN ISO 12100:2010 and the following apply.

3.1

mobile elevating work platform MEWP

mobile machine that is intended to move persons to working positions where they are carrying out work from the work platform with the intention that persons are getting on and off the work platform only at access positions at ground level or on the chassis and which consists as a minimum of a work platform with controls, an extending structure and a chassis

3.2

work platform

fenced platform or a cage which can be moved under load to the required working position and from which erection, repair, inspection or similar work can be carried out

Note 1 to entry: See Figure 1.

3.3

extending structure

structure which is connected to the chassis and supports the work platform and which allows movement of the work platform to its required position

Note 1 to entry: See Figure 1.

Note 2 to entry: It may, for example, be a single or a telescoping or an articulating boom or ladder, or a scissors mechanism or any combination of them, and may or may not slew on the base.

3.4

chassis

base of the MEWP, which may be pulled, pushed, self-propelled, etc.

Note 1 to entry: See Figure 1.

3.5

stabilisers

devices and systems used to stabilise MEWPs by supporting and/or levelling the complete MEWP or the extending structure, e.g. jacks, suspension locking devices, extending axles

Note 1 to entry: See Figure 1.

3.6

access position

position(s) to provide access to and from the work platform

Note 1 to entry: Access position and transport configuration can be identical.

3.7

transport configuration

configuration of the MEWP prescribed by the manufacturer in which the MEWP is intended to be delivered to the place of use

Note 1 to entry: Access position and transport configuration can be identical.

3.8

lowering

operations to move the work platform to a lower level

Note 1 to entry: See Figure 2.

3.9

raising

operations to move the work platform to a higher level

Note 1 to entry: See Figure 2.

3.10

rotating

circular movement of the work platform about a vertical axis

Note 1 to entry: See Figure 2.

3.11

slewing

circular movement of the extending structure about a vertical axis

Note 1 to entry: See Figure 2.

3.12

travelling

movements of the chassis with work platform out of transport configuration

Note 1 to entry: See Figure 2.

3.13

vehicle mounted MEWP

MEWP where the chassis is a vehicle and where travelling controls are located within the cab of the vehicle

3.14

pedestrian controlled MEWP

MEWP that has the controls for powered transport located so that they are capable of being operated by a person walking close to the MEWP

3.15

self-propelled MEWP

MEWP that has the travelling controls located at the work platform

3.16

rated load

load for which the MEWP has been designed for normal operation and which is composed of persons, tools and material acting vertically on the work platform

Note 1 to entry: A MEWP can have more than one rated load.

3.17

load cycle

cycle starting from the access position, carrying out work and returning to the access position

3.18

wire rope drive system

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

3.19

chain drive system

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

3.20

type test

test on the representative model of a new design or one incorporating significant changes to an existing design, carried out by or on behalf of the manufacturer or his authorised representative

3.21

totally manually operated MEWP

MEWP with movement powered only by manual effort

3.22

rail mounted MEWP

MEWP where travelling is guided by rails

3.23

load sensing system

system of monitoring the vertical load and vertical forces on the work platform

Note 1 to entry: See 3.2.

Note 2 to entry: The system includes the measuring device(s), the way the measuring devices are incorporated in the machinery and the signal processing system.

3.24

moment sensing system

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

Note 1 to entry: The system includes the measuring device(s), the way the measuring devices are incorporated in the machinery and the signal processing system.

3.25

wireless control

means by which the MEWP operator's commands are transmitted without any physical connection for at least part of the distance between the control console and the rest of the control system

3.26

self-revealing failure or fault

failure or fault of a component where the failure or fault is apparent to the MEWP operator and can be revealed without the use of monitoring services

Note 1 to entry: Failure or fault may be apparent to the MEWP operator through:

- changes of operating characteristics, and/or
- visual evidence, and/or
- audible evidence, and/or
- other evidence.

3.27

working envelope

space in which the work platform is designed to work within the specified loads and forces under normal operating conditions

Note 1 to entry: MEWPS can have more than one working envelope.

3.28

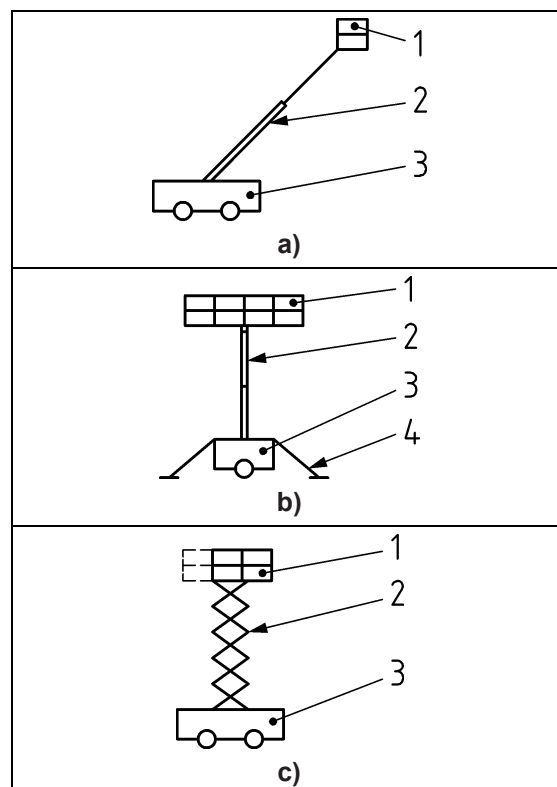
exchangeable work platform

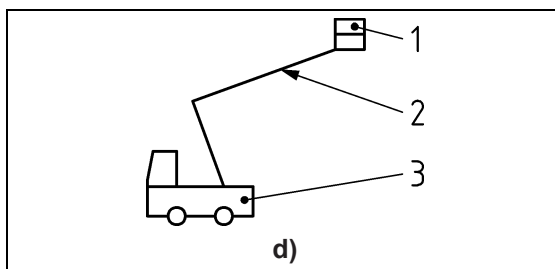
work platform according to 3.2 which is intended to be exchanged without using tools

Note 1 to entry: Such platforms may be of different sizes and/or capacities.

Note 2 to entry: Such platforms do not modify the original function of the MEWP.

Note 3 to entry: Work platforms which are interchangeable equipment intended to be fitted on machines other than MEWPs are not covered by this definition.





Key

- 1 work platform (see 3.2)
- 2 extending structure (see 3.3)
- 3 chassis (see 3.4)
- 4 stabilisers (see 3.5)

Figure 1 — Illustration of some definitions (1)

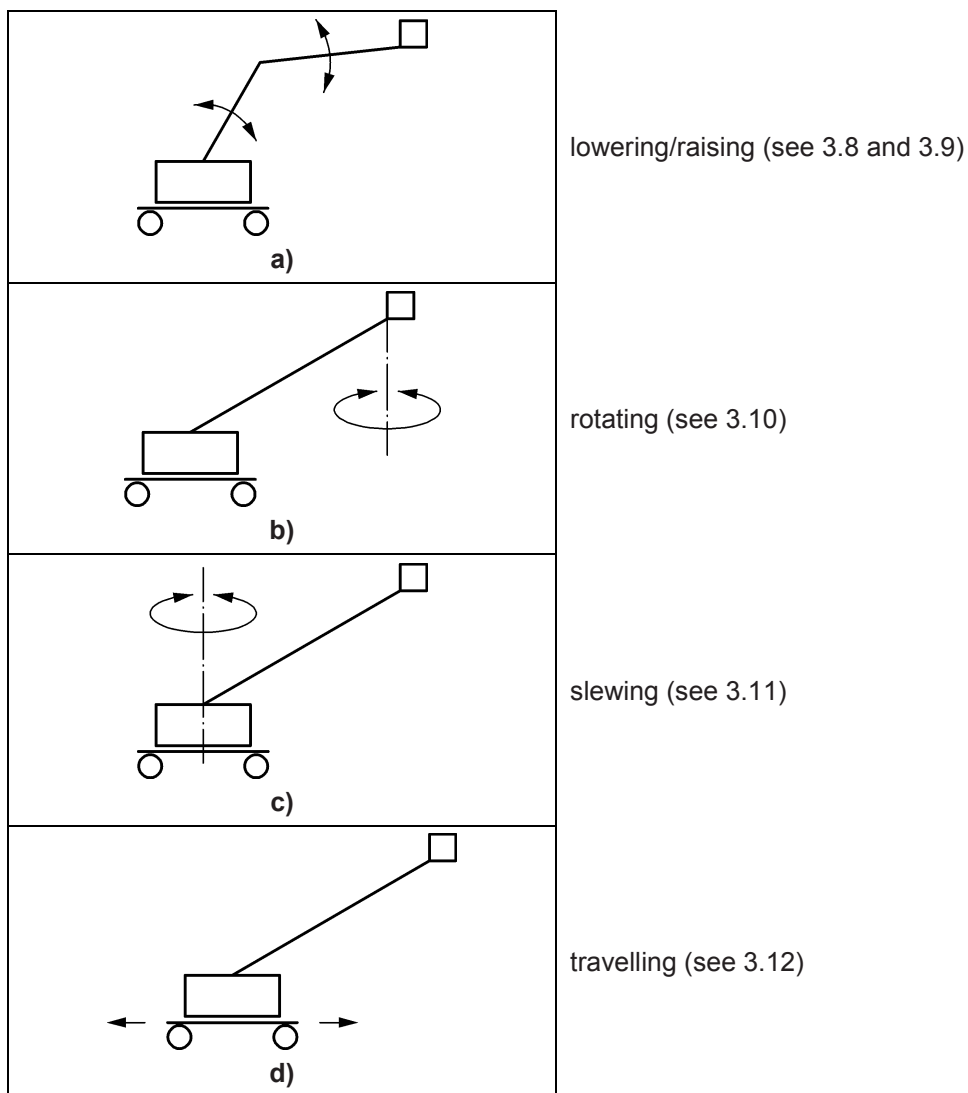


Figure 2 — Illustration of some definitions (2)

4 List of hazards

The hazards have been identified by the risk assessment procedure and the corresponding requirements formulated.

A hazard which is not significant and for which, therefore, no requirements are formulated, is shown in the Corresponding Requirements column as NS (not significant).

Table 1 — List of significant hazards

Significant hazards		Relevant clauses in this standard
1	Mechanical hazards	-
1.1	Crushing hazard	5.3.1.4, 5.3.1.5, 5.3.1.15, 5.6.9, 5.7.1, 7.2.15
1.2	Shearing hazard	5.4.3, 5.7.1, 7.2.15
1.3	Cutting or severing hazard	NS
1.4	Entanglement hazard	5.3.1.4, 5.3.1.15, 7.2.15
1.5	Drawing-in or trapping hazard	5.3.1.4, 5.3.1.15, 5.6.8, 7.2.15
1.6	Impact hazard	5.3.1.5, 5.3.1.7, 5.3.1.10, 5.3.1.17, 7.1.1.2 h)
1.7	Stabbing or puncture hazard	NS
1.8	Friction or abrasion hazard	7.1.1.7 e)
1.9	High pressure fluid injection hazard	5.9.1, 5.9.2, 5.9.3, 5.9.4, 5.9.5, 5.9.10
1.10	Ejection of parts	NS
1.11	Loss of stability (of machinery and machine parts)	5.2, 5.3.1.2, 5.3.2.1, 5.3.2.2, 7.2.1 k)
1.12	Slip, trip and fall hazards	5.6.2, 5.6.3, 5.6.4, 5.6.5, 5.6.6, 5.6.7, 7.2.15
2	Electrical hazards, caused for example by:	-
2.1	Electrical contact (direct or indirect)	5.8, 7.1.1.2 g)
2.2	Electrostatic phenomena	NS
2.3	Thermal radiation	NS
2.4	External influences on electrical equipment	5.8.1
3	Thermal hazards for example resulting in:	-
3.1	Burns, scalds and other injuries by a possible contact of persons with objects or materials with an extreme high or low temperature, by flames or explosions and also by the radiation of heat sources	5.3.1.12
3.2	Health-damaging effects by hot or cold work environment	5.3.1.12
4	Hazards generated by noise, resulting for example in:	-
4.1	Hearing losses (deafness), other physiological disorders (e.g. loss of balance, loss of awareness etc.)	7.1.1.2 v)
4.2	Interference with speech communication, acoustic signals, etc.	7.1.1.2 v)

Table 1 — List of significant hazards (continued)

Significant hazards		Relevant clauses in this standard
5	Hazards generated by vibration (resulting in a variety of neurological and vascular disorders)	5.3.1.16, 7.1.1.2 l)
6	Hazards generated by radiation, especially by:	-
6.1	Electrical arcs	7.1.1.2 g)
6.2	Lasers	NS
6.3	Ionising radiation sources	NS
6.4	Machine making use of high frequency electromagnetic fields	5.8.1
7	Hazards generated by materials and substances processed, used or exhausted by machinery for example:	-
7.1	Hazards resulting from contact with or inhalation of harmful fluids, gases, mists, dusts and fumes	5.3.1.13, 5.3.1.17
7.2	Fire or explosion hazard	5.3.1.14
7.3	Biological and microbiological (viral or bacterial) hazards	NS
8	Hazards generated by neglecting ergonomic principles in machine design (mismatch of machinery with human characteristics and abilities) caused for example by:	-
8.1	Unhealthy postures or excessive efforts	5.6.6, 5.6.7
8.2	Inadequate consideration of human hand-arm or foot-leg anatomy	NS
8.3	Neglected use of personal protection equipment	NS
8.4	Inadequate area lighting	NS
8.5	Mental overload or underload, stress, etc.	NS
8.6	Human error	5.7.1, 5.7.3
9	Hazard combinations	-
10	Hazards caused by failure of energy supply, breaking down of machinery parts, and other functional disorders, for example:	-
10.1	Failure of energy supply (of energy and/or control circuits)	5.3.1.6, 5.7.6, 5.7.7, 5.7.8, 5.9.6, 5.9.7, 5.9.8, 5.9.9, 5.11.3
10.2	Unexpected ejection of machine parts or fluids	NS
10.3	Failure/malfunction of control system	5.3.1.19, 5.7.7
10.4	Errors of fitting	5.8.1, 5.9.11
10.5	Overturn, unexpected loss of machine stability	5.2, 5.3.1.2, 5.3.2.1.2, 5.3.2.1.3, 5.3.2.1.4, 5.3.2.2.1, 5.3.2.2.2, 5.3.2.2.3, 5.3.2.3, 7.2.1 k)

Table 1 — List of significant hazards *(continued)*

Significant hazards		Relevant clauses in this standard
11	Hazards caused by (temporary) missing and/or incorrectly positioned safety-related measures/means, for example:	
11.1	All kinds of guard	5.3.1.12
11.2	All kinds of safety related (protection) devices	5.3.2.1.4, 5.11
11.3	Starting and stopping devices	5.3.1.1, 5.4.4, 5.5.2.7, 5.5.3.7, 5.5.5.2, 5.6.3, 5.7.1, 5.7.2, 5.7.4, 5.7.5, 5.7.7, 5.7.8, 5.11
11.4	Safety signs and signals	5.3.1.2, 5.4.1, 5.4.3, 5.6.10, 5.7.3, 5.9.10
11.5	All kinds of information or warning devices	5.3.1.2, 5.3.1.7, 5.6.11, 7.1.1.2 c), 7.2
11.6	Energy supply disconnecting devices	5.3.1.19
11.7	Emergency devices	5.7.5
11.8	Feeding/removal means of work pieces	NS
11.9	Essential equipment and accessories for safe adjusting and/or maintaining	5.4.4, 5.9.1, 7.1.1.7 d), 7.1.1.7 i)
11.10	Equipment evacuating gases, etc.	5.3.1.13
12	Inadequate lighting of moving/working area	NS
13	Hazards due to sudden movement/instability during handling	5.1.2, 5.2, 5.3.1.2, 5.3.1.3, 5.3.2.1.5, 5.3.2.1.6, 5.3.2.2.1, 5.3.2.2.2, 5.3.2.3, 5.6.1, 5.7.1, 5.7.4, 5.7.5, 5.7.10
14	Inadequate/inergonomic design of driving/operating position	5.6.9
14.1	Hazards due to dangerous environments (contact with moving parts, exhaust gases, etc.)	5.3.1.12, 5.3.1.13
14.2	Inadequate visibility from driver's/operator's position	5.3.1.15, 5.3.2.1.1
14.3	Inadequate seat/seating (seat index point)	5.3.1.16
14.4	Inadequate/non-ergonomic design/positioning of controls	5.6.9
14.5	Starting/moving of self-propelled machinery	5.3.1.7, 5.3.1.8, 5.3.1.9, 5.3.1.10, 5.3.1.11, 5.3.1.15, 5.7.1, 5.7.2, 5.7.4
14.6	Road traffic of self-propelled machinery	5.3.1.6, 5.3.1.9, 5.3.1.10
14.7	Movement of pedestrian controlled machinery	5.3.1.11, 5.7.2
15	Mechanical hazards	-
15.1	Hazards to exposed persons due to uncontrolled movement	5.4.2, 5.4.4, 5.7.1
15.2	Hazards due to break-up and/or ejection of parts	NS
15.3	Hazards due to rolling over (ROPs)	NS
15.4	Hazards due to falling objects (FOPs)	NS

Table 1 — List of significant hazards (continued)

Significant hazards		Relevant clauses in this standard
15.5	Inadequate means of access	5.6.6, 5.6.7
15.6	Hazards caused due to towing, coupling, connecting, transmission	NS
15.7	Hazards due to batteries, fire, emissions etc.	5.3.1.13, 5.3.1.14, 5.3.1.17
16	Hazards due to lifting operation	-
16.1	Lack of stability	5.2, 5.3.1.2, 5.3.2.1.2, 5.3.2.1.3, 5.3.2.1.4, 5.3.2.1.5, 5.3.2.1.6, 5.3.2.2.1, 5.3.2.2.2, 5.3.2.2.3, 5.3.2.3, 5.4.1, 7.2.1 k)
16.2	Derailment of machinery	5.3.1.18
16.3	Loss of mechanical strength of machinery and lifting accessories	5.2.5, 5.4.1, 5.4.6, 5.6.13, 7.1.1.3 a), 7.1.1.3 b)
16.4	Uncontrolled movements	5.3.1.3, 5.3.1.4, 5.3.1.5, 5.4, 5.5, 5.6.1
17	Inadequate view of trajectories of the moving parts	5.3.1.15
18	Hazards caused by lightning	NS
19	Hazards due to loading/overloading	5.4.1
20	Hazards due to lifting persons	-
20.1	Mechanical strength	5.5.2, 5.5.3
20.2	Loading control	5.4.1
21	Controls	-
21.1	Movement of work platform	5.4, 5.6.1, 5.7.1, 5.7.4, 5.7.5, 5.7.10, Annex C
21.2	Safe travel control	5.7.1, 5.7.2, 5.7.4, 5.7.5
21.3	Safe speed control	5.3.1.1, 5.3.1.9, 5.3.1.10, 5.3.1.11, 5.4.5
22	Falling of persons	-
22.1	Personal protective equipment	5.6.2, 5.6.14
22.2	Trapdoors	5.6.8
22.3	Work platform tilt control	5.6.1
23	Work platform falling/overturning	-
23.1	Falling/overturning	5.2, 5.3.1.2, 5.3.1.3, 5.3.2, 5.4.1, 5.4.2, 5.6.12, 5.9, 5.10
23.2	Acceleration/braking	5.3.1.6, 5.3.1.10, 5.4.5, 5.5.1.6
24	Markings	7.2
25	Hazards of trapping, shearing or crushing generated by the triggering of safety devices that cause the stopping of the machine's movements	5.7.8, 5.7.9

5 Safety requirements and/or measures

5.1 General

5.1.1 Machinery shall comply with the safety requirements and/or protective measures of this clause. In addition, the machine shall be designed according to the principles of EN ISO 12100:2010 for relevant but not significant hazards, which are not dealt with by this document.

5.1.2 Totally manually A_{11} powered A_{11} MEWPs having a height of the floor of the work platform above ground level not exceeding 5 m (see 7.2.17) are exempted from all safety requirements which cannot be met without power supply.

5.2 Structural and stability calculations

5.2.1 General

It is the manufacturer's responsibility:

- a) for structural calculations, to evaluate the individual loads and forces in their positions, directions and combinations producing the most unfavourable stresses in the components, and
- b) for stability calculations, to identify the various positions of the MEWP and combinations of loads and forces creating together conditions of minimum stability.

5.2.2 Loads and forces

The following loads and forces shall be taken into account:

- a) rated load (see 5.2.3.1);
- b) A_{11} dead weights (see 5.2.3.2) A_{11} ;
- c) wind loads (see 5.2.3.3);
- d) manual forces (see 5.2.3.4);
- e) special loads and forces (see 5.2.3.5).

5.2.3 Determination of loads and forces

5.2.3.1 Rated load

The rated load m is:

$$m = n \cdot m_p + m_e \quad (1)$$

where

m_p is 80 kg (mass of a person)

m_e is ≥ 40 kg (minimum mass of tools and material)

n is the permitted number of persons on the work platform

The mass of each person is assumed to act as a point load on the work platform and any platform extension at a horizontal distance of 0,1 m from the upper inside edge of the top rail. The distance between the point loads shall be 0,5 m (see Figure 3 as an example).

The mass of 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/m^2 the figure of 25 % may be increased to a figure giving a pressure of 3 kN/m^2 (see Figure 4 as an example).

All these loads are assumed to be located in the positions giving the most severe results.

The above rated load refers to the maximum people and materials loads that can be placed on the deck including any extension. Lower rated loads can be specified for extension(s) and under these circumstances the load distributions specified in 6.1.4.2.1, 6.1.4.2.2 and 6.1.4.3 will need to be taken into account.

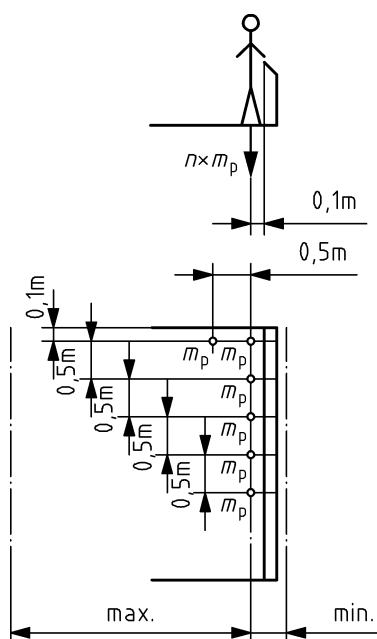
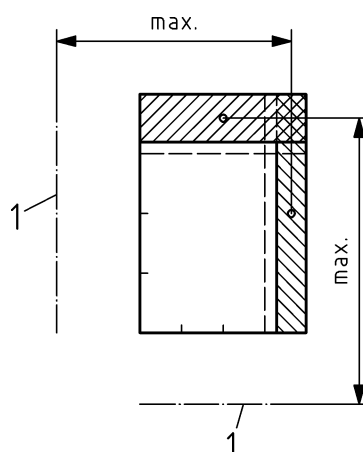


Figure 3 — Rated load – persons



Key

1 tipping line

Figure 4 — Rated load – equipment



5.2.3.2 Dead weights

The masses of the components of the MEWP when they are not moving shall be taken to be static dead weights.

The masses of the components of the MEWP when they are moving shall be taken to be dynamic dead weights.

5.2.3.3 Wind loads

5.2.3.3.1 All MEWPs used out-of-doors are regarded as being affected by wind at a pressure of 100 N/m^2 , equivalent to a wind speed of $12,5 \text{ m/s}$ (Beaufort Scale 6).

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

This does not apply to MEWPs intended for indoor use only (see 7.2.7).

5.2.3.3.2 Shape factors applied to areas 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: 0,8/1,2;
- e) persons directly exposed: 1,0.

If additional information is needed, especially concerning shielded structural areas, see ISO 4302. For shielded persons see 5.2.3.3.3.4.

5.2.3.3.3 Area of persons on a work platform exposed to wind:

5.2.3.3.3.1 The full area of one person shall be $0,7 \text{ m}^2$ ($0,4 \text{ m}$ average width $\times$ $1,75 \text{ m}$ height) with the centre of area $1,0 \text{ m}$ above the work platform floor.

5.2.3.3.3.2 The exposed area of one person standing on a work platform behind an imperforate section of fencing $1,1 \text{ m}$ high shall be $0,35 \text{ m}^2$ with the centre of area $1,45 \text{ m}$ above the work platform floor.

5.2.3.3.3.3 The number of persons directly exposed to the wind shall be calculated as:

- a) the length of the side of the work platform exposed to the wind, rounded to the nearest $0,5 \text{ m}$, and divided by $0,5 \text{ m}$, or
- b) the number of persons allowed on the work platform if less than the number calculated in a).

5.2.3.3.3.4 If the number of persons allowed on the work platform is greater than in 5.2.3.3.3.3 a) a shape factor of 0,6 shall be applied to the extra number of persons.

5.2.3.3.4 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 $0,5 \text{ m}$ above the work platform floor.

5.2.3.4 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 stated by the manufacturer.

5.2.3.5 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 and wind forces on large objects carried on the work platform.

If a MEWP is intended for such special working methods and/or conditions of use, the loads and forces resulting from that shall be taken into consideration as a modification to the rated load, $\square_{A1}$ dead weight $\square_{A1}$, wind load and/or hand forces as appropriate.

5.2.4 Stability calculations

5.2.4.1 Forces created by structural masses and rated load

Forces created by structural masses and rated load, causing overturning or stabilising moments, shall be multiplied by a factor of 1,0 and calculated as acting vertically downwards.

In the case of movement of the extending structure these forces shall be multiplied by a factor of 0,1 and applied as additional forces acting in the direction of movement creating the greatest overturning moment.

Manufacturers may use factors lower than 0,1 provided they have been proved by measurement of the effects of acceleration and deceleration.

For the travelling movements of MEWP of type 2 and type 3 the factor of 0,1 shall be replaced by a factor 'z' representing the forces produced by acceleration and deceleration or the kerb test (see 6.1.4.2.2.2). This factor shall be determined by calculation or tests (see Annex E (informative) for a calculation example).

5.2.4.2 Wind forces

Wind forces shall be multiplied by a factor of 1,1 and taken to be acting horizontally.

5.2.4.3 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.

NOTE Examples for forces are given in Figures 5, 6, 7, and 8.

5.2.4.4 Calculation of overturning and stabilising moments

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

Tipping lines shall be determined in accordance with ISO 4305 but for solid and foam-filled tyres the tipping lines may be taken at 1/4 of the tyre ground contact width from the outside of the ground contact width.

The calculations shall be made with the MEWP in the most unfavourable extended and/or retracted positions with the maximum allowable inclination of the chassis defined by the manufacturer. All loads and forces, which can act simultaneously, shall be taken into account in their most unfavourable combinations. An allowance of 0,5° for inaccuracy in setting-up the MEWP shall be added to the maximum allowable inclination of the chassis permitted by the manufacturer. Examples are shown in Table 2 and Figure 5 to Figure 8. Graphical methods may be used.

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

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

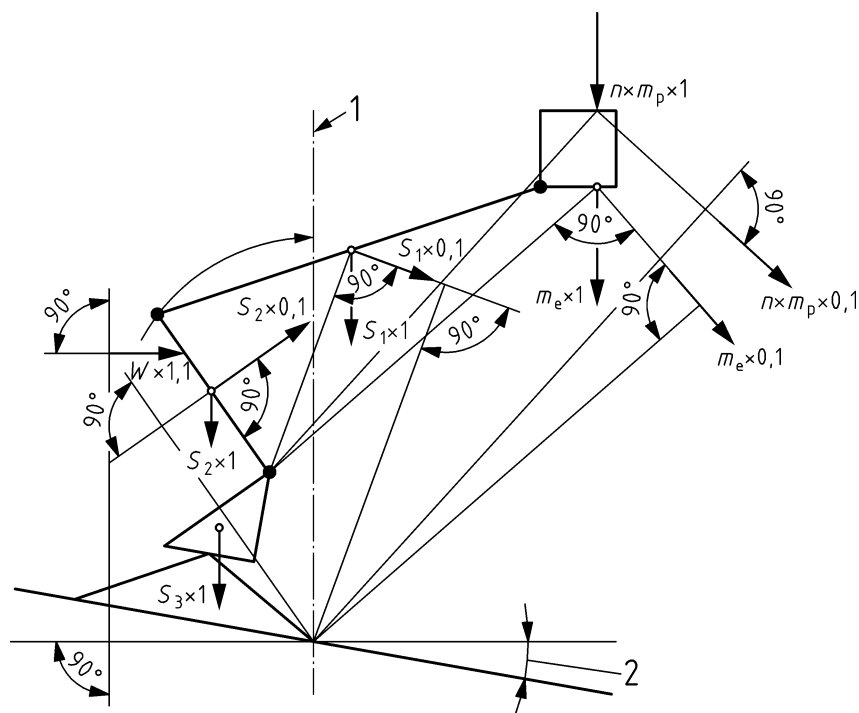
- a) tolerances in the manufacture of the components;
- b) play in the connections of the extending structure;
- c) elastic deformations due to the effects of forces;
- d) failure of any one tyre in the case of MEWPs supported by pneumatic tyres in the working position;
- e) performance characteristics of the load sensing system, moment sensing system and position control.
This shall include at least the following:
 - 1) transitory peaks caused by short term dynamic effects;
 - 2) hysteresis;
 - 3) chassis inclination;
 - 4) ambient temperature;
 - 5) different positions and distribution of load on work platform;
 - 6) accuracy of the system;
- f) effects of deflection of suspensions.

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



Table 2 — Examples of load and force directions and combinations for stability calculations
(see Figure 5 to Figure 8)

Example	Working condition	80 kg up to rated load		A1 Dead weights A1 (S _N)		Manual force (M)		Wind loads (W)		Diagram
		× 1,0 (1,5) ^a	× 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	V	-	V	-	A	A	H	H	
6	with limited reach, forwards 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	V	-	V	-	A	A	H	H	
Key V = vertical, H = horizontal, A = angular, S = at slope angle ^a 1,5 instead of 1,0 to be considered if enhanced stability criteria are applicable according to 5.4.1.5.										

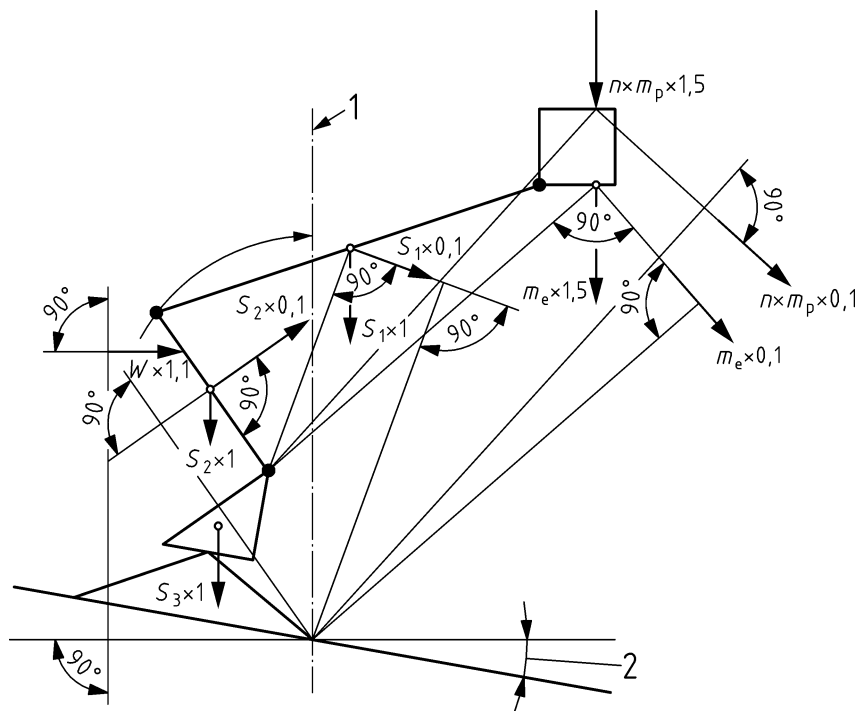


Key

- 1 tipping line
- 2 maximum slope +0,5°
- m_e 40 kg (min. mass of tools and material)
- m_p 80 kg (mass of a person)
- n permitted number of persons on the work platform
- S_n structural loads
- W wind loads

a) EXAMPLE 1a — Load sensing

Figure 5 — Examples 1a/1b and 2a/2b of maximum overturning load and force moment combinations
(see Table 2) (continued)

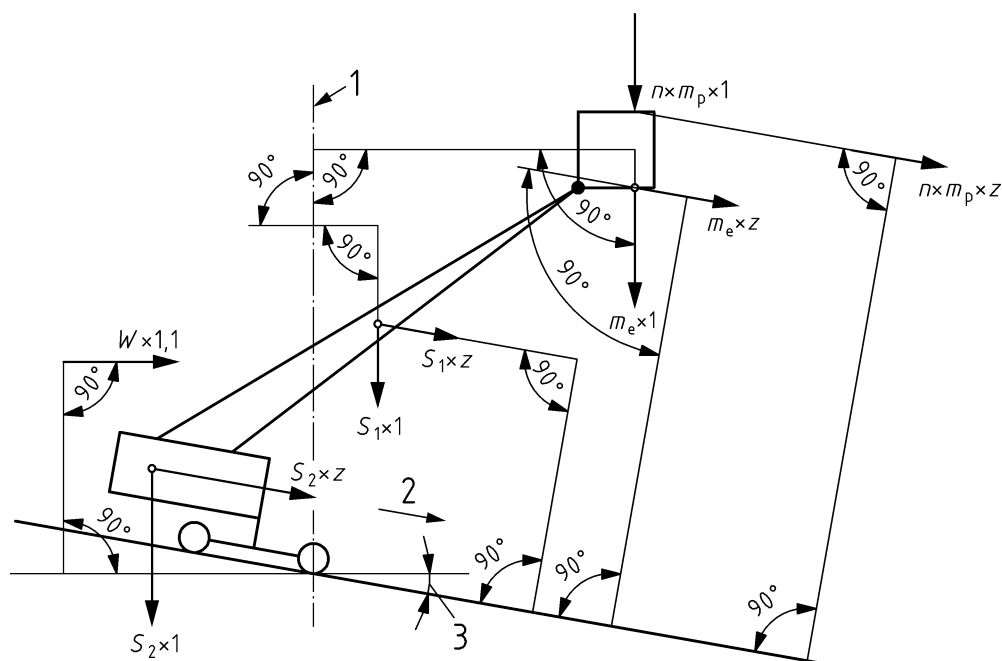


Key

- 1 tipping line
- 2 maximum slope +0,5°
- m_e 40 kg (min. mass of tools and material)
- m_p 80 kg (mass of a person)
- n permitted number of persons on the work platform
- S_n structural loads
- W wind loads

b) EXAMPLE 1b — Enhanced stability and overload criteria

Figure 5 — Examples 1a/1b and 2a/2b of maximum overturning load and force moment combinations
(see Table 2) (continued)

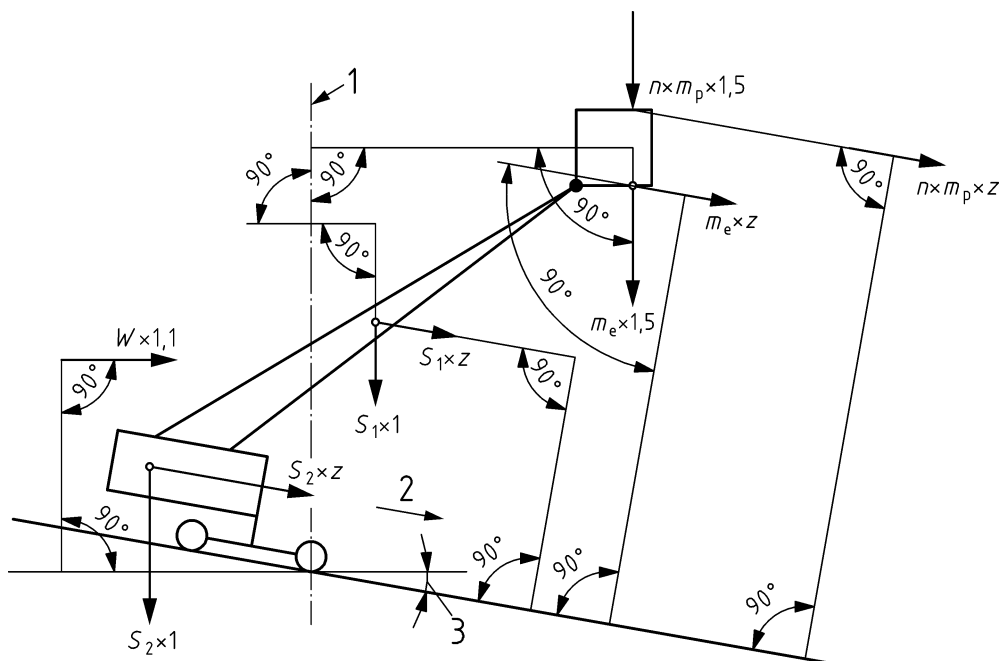


Key

- 1 tipping line
- 2 travelling direction
- 3 maximum slope +0,5°
- m_e 40 kg (min. mass of tools and material)
- m_p 80 kg (mass of a person)
- n permitted number of persons on the work platform
- S_n structural loads
- W wind loads
- z factor which represents the forces produced by acceleration and deceleration

c) EXAMPLE 2a — Load sensing

Figure 5 — Examples 1a/1b and 2a/2b of maximum overturning load and force moment combinations
(see Table 2) (*continued*)

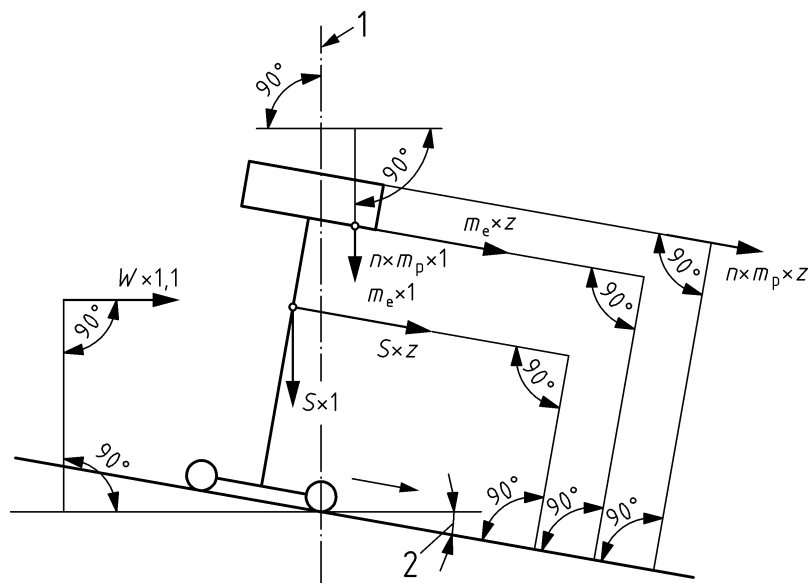


Key

- 1 tipping line
- 2 travelling direction
- 3 maximum slope +0,5°
- m_e 40 kg (min. mass of tools and material)
- m_p 80 kg (mass of a person)
- n permitted number of persons on the work platform
- S_n structural loads
- W wind loads
- z factor which represents the forces produced by acceleration and deceleration

d) EXAMPLE 2b — Enhanced stability and overload criteria

Figure 5 — Examples 1a/1b and 2a/2b of maximum overturning load and force moment combinations (see Table 2) (end)

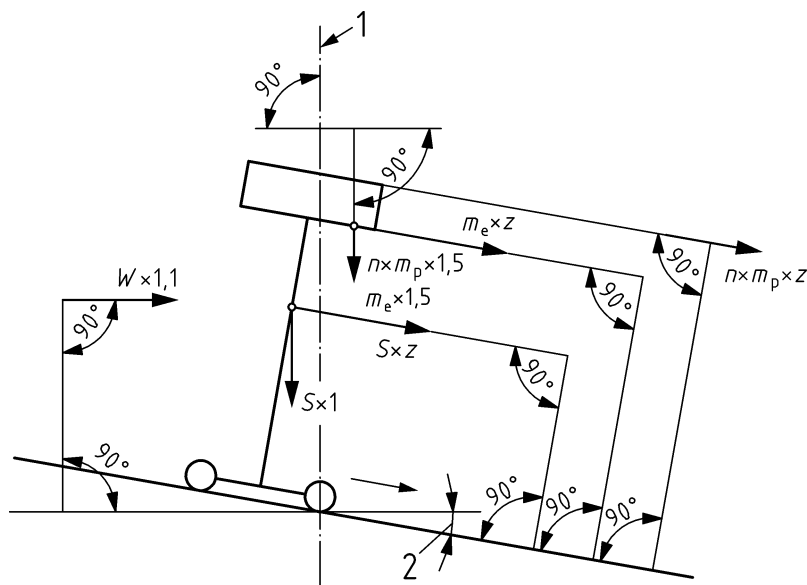


Key

- 1 tipping line
- 2 maximum slope +0,5°
- m_e 40 kg (min. mass of tools and material)
- m_p 80 kg (mass of a person)
- n permitted number of persons on the work platform
- S structural loads
- W wind loads
- z factor which represents the forces produced by acceleration and deceleration

a) EXAMPLE 3a — Load sensing

Figure 6 — Examples 3a/3b and 4a/4b of maximum overturning load and force moment combinations
(see Table 2) (continued)

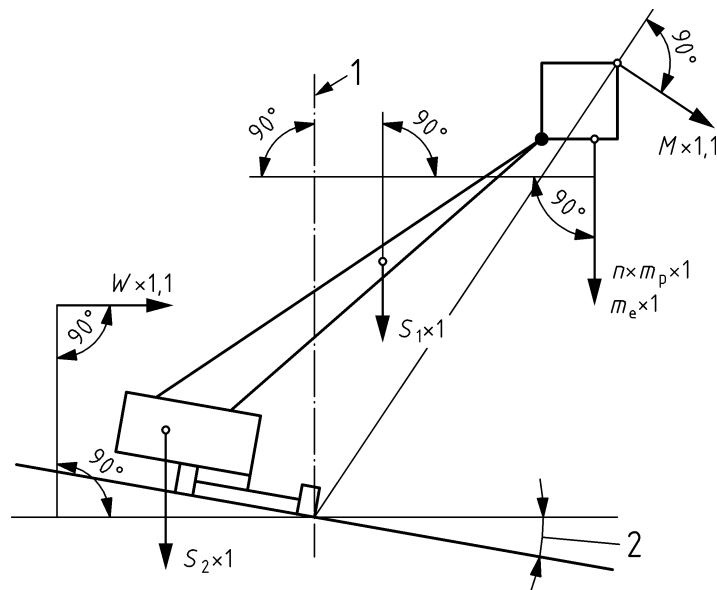


Key

- 1 tipping line
- 2 maximum slope +0,5°
- m_e 40 kg (min. mass of tools and material)
- m_p 80 kg (mass of a person)
- n permitted number of persons on the work platform
- S structural loads
- W wind loads
- z factor which represents the forces produced by acceleration and deceleration

b) EXAMPLE 3b — Enhanced stability and overload criteria

Figure 6 — Examples 3a/3b and 4a/4b of maximum overturning load and force moment combinations (see Table 2) (continued)

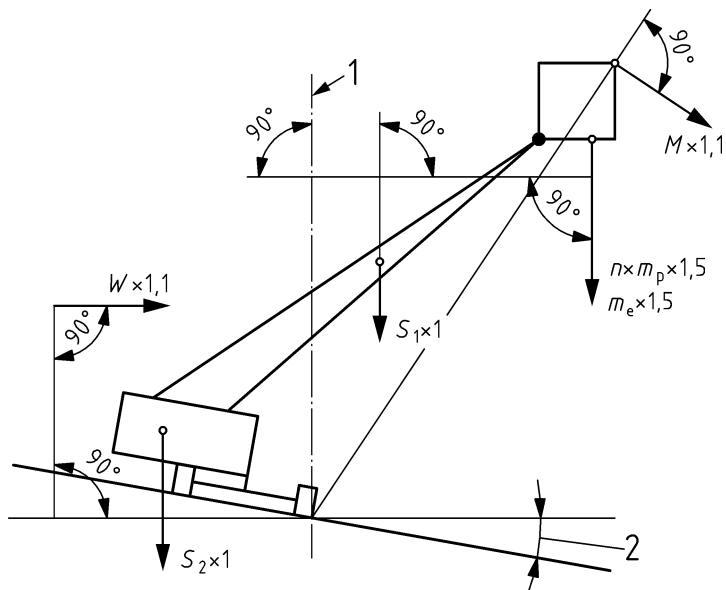


Key

- 1 tipping line
- 2 maximum slope +0,5°
- M $\overline{A_1}$ manual force $\overline{A_1}$
- m_e 40 kg (min. mass of tools and material)
- m_p 80 kg (mass of a person)
- n permitted number of persons on the work platform
- S_n structural loads
- W wind loads

c) EXAMPLE 4a — Load sensing

Figure 6 — Examples 3a/3b and 4a/4b of maximum overturning load and force moment combinations
(see Table 2) (continued)

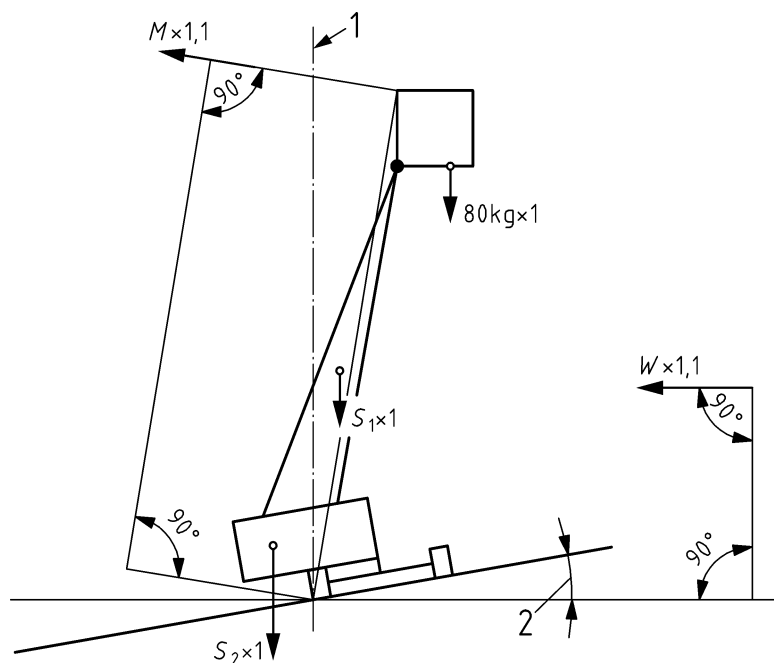


Key

- 1 tipping line
- 2 maximum slope +0,5°
- M $\boxed{A_1}$ manual force $\boxed{A_1}$
- m_e 40 kg (min. mass of tools and material)
- m_p 80 kg (mass of a person)
- n permitted number of persons on the work platform
- S_n structural loads
- W wind loads

d) EXAMPLE 4b — Enhanced stability and overload criteria

Figure 6 — Examples 3a/3b and 4a/4b of maximum overturning load and force moment combinations (see Table 2) (end)



Key

- 1 tipping line
- 2 max. slope + 0,5°
- M $\boxed{A_1}$ manual force $\boxed{A_1}$
- S_n structural loads
- W wind loads

a) EXAMPLE 5

Figure 7 — Examples 5 and 6 of overturning load and force moment combinations (see Table 2)
(continued)