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Inland navigation vessels — Floating landing stages and floating equipment on inland waters — Requirements, tests

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National foreword

This British Standard is the UK implementation of EN 14504:2016. It supersedes BS EN 14504:2009 which is withdrawn.

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European Foreword

This document (EN 14504:2016) has been prepared by Technical Committee CEN/TC 15 “Inland navigation vessels”, 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of an identical text or by endorsement, at the latest by January 2017, and conflicting national standards shall be withdrawn at the latest by January 2017.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 supersedes EN 14504:2009.

The following changes have been made to EN 14504:2009:

a) Title changed;

b) Floating civil engineering works subdivided into floating landing stages according to function;

c) Adaptation of technical requirements to take into consideration the materials used to make floating civil engineering works;

d) Adaptation of the design situations to take into consideration the function of floating civil engineering works;

e) Incorporation of metacentre commonly used in shipbuilding as a criteria for assessing floating stability;

f) Text and drawings have been revised.

According to the CEN-CENELEC Internal Regulations, the national standards organisations 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.

1 Scope

This European Standard specifies safety requirements for floating landing stages and floating systems for passenger transport and their equipment.

Requirements relating to supplies to disposals of berthing vessels are not governed by this Standard.

It is not applicable to:

— floating landing stages for motor vehicle traffic;

— floating landing stages for recreational craft and for vehicles of inland navigation vessels which are not berthing vessels, e.g. floating equipment;

— more severe requirements for floating landing stages used for the transhipment of dangerous goods;

— any landing stages required between vessel and floating landing stage;

— specialised floating structures which are not used for passenger traffic or the berthing of vessels.

2 Normative references

The following documents, which are cited either partially or wholly in this document, are required for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

EN 711, *Inland navigation vessels — Railings for decks and side decks — Requirements, designs and types*

EN 790, *Inland navigation vessels — Stairs with inclination angles of 45° to 60° — Requirements, types*

EN 1492-4, *Textile slings — Safety — Part 4: Lifting slings for general service made from natural and man-made fibre ropes*

EN 13056, *Inland navigation vessels — Stairs with inclination angles of 30° to < 45° — Requirements, types*

EN 13281, *Inland navigation vessels — Safety requirements for walkways and working places*

EN 13411-2, *Terminations for steel wire ropes — Safety — Part 2: Splicing of eyes for wire rope slings*

EN 13574, *Inland navigation vessels — Permanently installed climbing devices with a length not exceeding 5 m*

EN 14144, *Lifebuoys — Requirements, tests*

EN 14145, *Holders for lifebuoys*

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

EN ISO 1140, *Fibre ropes — Polyamide — 3-, 4-, 8- and 12-strand ropes (ISO 1140)*

EN ISO 1346, *Fibre ropes — Polypropylene split film, monofilament and multifilament (PP2) and polypropylene high tenacity multifilament (PP3) — 3-, 4-, 8- and 12-strand ropes (ISO 1346)*

ISO 8793, *Steel wire ropes — Ferrule-secured eye terminations*

ISO 18421, *Ships and marine technology — Inland navigation vessels — Lifebuoy housings*

ISO 18422, *Ships and marine technology — Inland navigation vessels — Plate with instructions for rescue, resuscitation and first aid for drowning persons*

3 Terms and definitions

For the purposes of this document, the following terms and definitions apply.

3.1
floating construction
a floating structure for passenger traffic on inland waters

3.1.1
floating landing stage
a floating structure used exclusively for berthing and mooring of vessels and as a connection between vessel and shore

3.1.2
floating equipment
a floating structure with or without a berth

3.1.2.1
floating landing stage
floating equipment with a berth, for combined use for passenger traffic, berthing and mooring ships and as a transportation link between the ship and land

3.1.2.2
floating landing bridge
floating equipment with no berth, used solely for passenger traffic and not for berthing or mooring ships

3.2
floating body
one or more fixed buoyancy bodies with a traffic area and/or a connecting bridge support

3.3
buoyancy body
body capable of floating that either:

— consists of waterproof air chambers or

— is completely filled with a closed-pore material

3.4
connecting bridge
movable walkway between floating body and shore

3.5
Anchorage for the floating structure
Device by which the floating structure is secured to its berth

3.6
shore boom
spacer for floating body

3.7
freeboard
distance between water level and top of the buoyancy body

3.8
residual freeboard
distance between the waterline and the upper edge of the buoyancy body in the event of a leak

3.9
safety distance
distance between water level and lowest point of buoyancy body with air chambers that is no longer watertight

3.10
residual safety distance
distance between the waterline and the lowest point of a buoyancy body with air chambers that is no longer watertight in the event of a leak

4 General requirements

4.1 Components

The floating structure consists of floating body, connecting bridge and anchorage.

4.2 Strength

The strength of the components of floating structures shall be fixed taking into account the actions described in Annex A.

Test as specified in 7.2.

4.3 Buoyancy and stability

4.3.1 General

In combination with the following proof of buoyancy and stability, for floating structures the effects in accordance with Annex A shall have a partial safety coefficient of $\gamma F = 1{,}0$.

4.3.2 Intact stability

A

— freeboard of at least 0,15 m;

— safety clearance of at least 0,30 m and

— heeling angle of no more than 10°

shall be maintained.

In addition, the metacentric height for floating structures under option A (see 4.4) under impacts as per A.5 to A.7 and A.11 shall be at least 0,15 m. For these structures, heeling motions caused by the vessel´s movement or by the mooring equipment as well as open areas of liquid, which occur during the operation of the structure, shall also be taken into consideration.

Test as specified in 7.3.1.

4.3.3 Damaged stability

If an air chamber is damaged, the watertight integrity and stability shall be ensured. In this case, a residual freeboard and a residual safety distance each of not less than 10 cm shall be maintained; if greater safety clearances or residual freeboards are required, these shall be taken into account.

Free surfaces of liquids that can occur during operation shall also be taken into account.

If all buoyancy bodies are completely filled with a material according to 4.5.4, proof of leak stability may be omitted.

Test as specified in 7.3.2.

4.4 Anchorages for floating structures

Floating structures shall be anchored in their positions to prevent them from being torn loose or being displaced by currents, wind, waves, fluctuations in water level or the draught or wash of passing vessels or possible special loads. In the case of floating landing stages and floating landing bridges, the influence of berthing ships shall also be taken into consideration. The functioning capability of the anchoring shall also be documented for the case that the floating body of the floating structure springs a leak.

Anchorage for the floating stages shall comply with one of the following two options:

a) Option A:

The floating stage shall be secured to the land by means of

1) Chains,

2) Cables

3) Synthetic ropes as per EN ISO 1140 or EN ISO 1346

4) A pier anchor of appropriate strength and length or

5) the connecting bridge.

The fastenings shall be secured against deliberate undoing. This requirement is considered to be met if it is not possible to undo the fastenings without the use of a tool.

Rope end connections shall be designed as splicers according to EN 13411-2 or by means of aluminium ferrules according to ISO 8793. Plastic rope end connections shall be designed according to EN 1492-4.

b) Option B:

The floating structure shall be attached to guides or dolphins in accordance with 4.5.3.

4.5 Structural requirements

4.5.1 General

The floating structure shall be designed so that it can follow all changes in water level during operation.

4.5.2 Freeboard

Taking into account 4.3, for floating landing stages and floating landing bridges the freeboard of the floating body shall be selected so that the height difference between the traffic areas of the floating body and the deck of the vessel is as small as possible for the berthing vessels expected.

For floating jetties, the freeboard of the floating body should be selected taking 4.3 into account, so that no waves enter the traffic areas under predictable wind and wave conditions.

4.5.3 Floating bodies

Floating bodies using option B (see 4.4) anchorages shall be fixed so that they cannot tilt. The height of the guides or dolphins shall be measured so that the floating body is not flooded at the maximum water level to be expected or the floating body shall be secured against floating away.

Floating bodies shall have one or more buoyancy bodies, which

— comprise a total of at least three watertight air chambers or

— are completely filled with a material according to 4.5.4.

It shall be possible to seal the openings in the air chambers so that they are waterproof.

4.5.4 Materials for filled buoyancy bodies

Materials used to fill the filled buoyancy body shall have closed pores.

The water absorption characteristics of the material shall be taken into consideration during proving.

For buoyancy elements made of expanded polystyrene according to EN 13163, water absorption characteristics according to EN 12087 of max. 5% by volume are recommended.

These materials shall be protected against external influences or against such influences.

5 Equipment

5.1 Railings, barrier

5.1.1 The walkways on floating landing stages shall be fitted with fixed railings as specified in EN 711 at points where it is possible to fall into the water or to lower-lying levels. Types PF or PG shall be selected for floating landing stages or floating landing bridges used for passenger traffic.

5.1.2 There shall be a barrier at the shore-side access point to the connecting bridge of the floating landing stage if the design of the landing stage does not prevent persons being subjected to any hazards when the vessel is going alongside.

5.1.3 Where a fall into the water or onto lower levels is possible, the traffic areas of floating equipment shall be fitted with Type PF or PG fixed railings according to EN 711. In areas provided for the berthing of ships, the distance between the railings and the outer edge of the floating landing stage shall be at least 0,70 m.

5.2 Life-saving equipment

The floating structures shall have at least one information sign providing information on rescuing, reviving and first aid for a drowning person in accordance with ISO 18422 and at least one lifebuoy every 100 m as specified in EN 14144 with a 30-m long floating line and holder as specified in EN 14145 or housing according to ISO 18421.

5.3 Device for mooring vessels

There shall be at least two bollards on the landing stage side of the floating landing stages and floating landing bridges. Each bollard shall withstand a vessel static pull as specified in A.9. The tops of the bollards shall be of anti-slip design and be permanently marked with signal paint.

5.4 Lighting

Lights attached to floating structures may not mislead or hinder shipping through dazzling effects or reflections, nor give rise to confusion with shipping signs or impair their effect.

5.5 Electrical equipment

On the exposed deck, the electrical equipment shall have at least IP55 degree of protection and in moist rooms at least IP44 according to EN 60529.

5.6 Storage spaces

The relevant places for storing loads which can be influenced by lack of stability on the deck of the floating bodies shall be marked, and this shall be taken into consideration and the respective areas marked accordingly.

Suitable devices shall be provided to secure the objects against falling over, slipping or rolling away.

6 Walkways

6.1 General

Walkways shall meet the requirements of EN 13281.

Floating structures constructed for public traffic shall be suitable for use by people with restricted mobility.

If there are accesses to the air chambers of the floating body, they shall have stairs according to EN 790 or EN 13056 or permanently installed climbing devices as specified in EN 13574.

Unavoidable tripping hazards, such as edges of steps, hatch covers etc. shall be marked with signal paint.

6.2 Connecting bridge

6.2.1 The connecting bridge shall have a minimum clear width of at least 0,90 m and at least 1,50 m for the public passenger traffic.

6.2.2 Nip and shear points shall be covered. The floor covering of connecting bridges shall be provided with additional anti-slip measures in line with the gradient angle.

6.2.3 The floating structures shall be designed so that the gradient of the connecting bridge is as small as possible at mean water level. The maximum inclination angle for connecting bridges shall not exceed 20°; for connecting bridges constructed for public traffic, an inclination angle of 6° shall not be exceeded. Where suitable technical equipment exists, e.g. inclined lifts, stair lifts, these inclination angles need not be adhered to.

6.2.4 Connecting bridges supported on wheels on the shore-side, see Figure A.6, shall be secured against displacement by vessel berthing impact. Spring travel shall not exceed 65 cm. Safety measures shall be taken for spring travel values from 20 cm upwards.

7 Testing

7.1 General

The following tests shall be carried out by an expert for the particular application and the results documented.

7.2 Strength

The calculation of compliance with strength requirements shall be verified under the conditions specified in Annex A.

7.3 Stability

7.3.1 Intact stability

Intact stability shall be verified by calculation or by a loading test.

7.3.2 Damaged stability

The damaged stability shall be verified by calculation; in this case, one air chamber of the floating landing stage shall be considered to be damaged.

8 Marking

8.1 Maximum draught

A readily visible mark shall be applied to all four corners of the floating body at the maximum draught height according to 4.3.2.

8.2 Manufacturer's mark

At least the following marking shall appear permanently and legibly on the floating structure:

— manufacturer;

— year of manufacture;

— EN 14504;

— floating landing stage for vessels up to ____ m^3 displacement with/without bow rudder (not applicable for floating bridges).

9 Instructions for use

The manufacturer shall supply instructions for use, containing at least:

— conditions for the proper use of the floating structure, e.g. prevention of access to the construction under certain weather conditions;

— conditions for storing dangerous or combustible materials;

— information on regular checking by the user;

— information on the necessary regular testing by the expert (e.g. mooring equipment, material strengths) and the intervals between tests.

Annex A
(normative)

Design situations for floating structures on inland waters

A.1 General

Table A.1 of this annex lists the design situations to be used as a simplification when planning, designing and constructing floating structures if the permanent and additional actions cannot be determined individually or only at great expense. If more unfavourable actions or special loads indicated in A.12 are to be reckoned with in individual cases for structural or operational reasons, these shall be taken into consideration for the designs.

A.2 Design situations for floating landing stages and floating landing bridges

a) Combined actions

1) persons, no vessel;

2) persons, vessel alongside;

3) persons, vessel not yet moored/vessel already unmoored;

4) no persons, no vessel;

5) no persons, vessel alongside;

6) no persons, vessel not yet moored/vessel already unmoored;

7) persons, vessel moored;

b) continuous actions and an additional action in each case according to Table A.1, design situation b 1 to b 6.

As a result of the different movements involved, only one action shall normally to be taken into account from the load variables of the vessel berthing manoeuver (see clause A.8 to A.10) in the combination b 3 to b 5 in Table A.1.

The case of simultaneous friction in the event of vessel berthing impact and a wind load as a line load on the floating landing stage/floating landing bridge is not covered by Table A.1.

Table A.1 — Combination matrix and partial safety coefficients γ_F for floating landing stages and floating landing bridges

Design situation[a]	A.5 Permanent action (dead load) G_K	Additional actions Q_{ik}					
		A.6 Live load p_v	A.7 Hydro-dynamic action W_h	A.8 Vessel berthing impact F	A.9 Vessel static pull T_z	A.10 Vessel friction R	A.11 Wind load w
a 1	1,35	1,5	1,5	-	-	-	1,5
a 2	1,35	1,5	1,5	1,5	-	-	1,5
a 3	1,35	1,5	1,5	-	-	1,5	1,5
a 4	1,35	-	1,5	-	-	-	1,5
a 5	1,35	-	1,5	1,5	-	-	1,5
a 6	1,35	-	1,5	-	-	1,5	1,5
a 7	1,35	1,5	1,5	-	1,5	-	1,5
b 1	1,35	1,5	-	-	-	-	-
b 2	1,35	-	1,5	-	-	-	-
b 3	1,35	-	-	1,5		-	-
b 4	1,35	-	-	-	1,5	-	-
b 5	1,35	-	-	-	-	1,5	-
b 6	1,35	-	-	-	-	-	1,5

[a] In design situations with more than one additional action, the sum of the additional actions Q_{ik} including their associated partial safety coefficients γ_F is multiplied by the combination coefficient ψ_i = 0,9.

A.3 Design situations for floating jetties

a) Combined actions

1) Persons on the floating bridge subjected to wind load and hydrodynamic actions for which the equipment has been approved;
2) No person on the floating bridge subjected to the maximum occurring wind load and maximum hydrodynamic action.

b) Permanent action and one additional action, respectively, according to Table A.2, design situation a 1 to b 3.

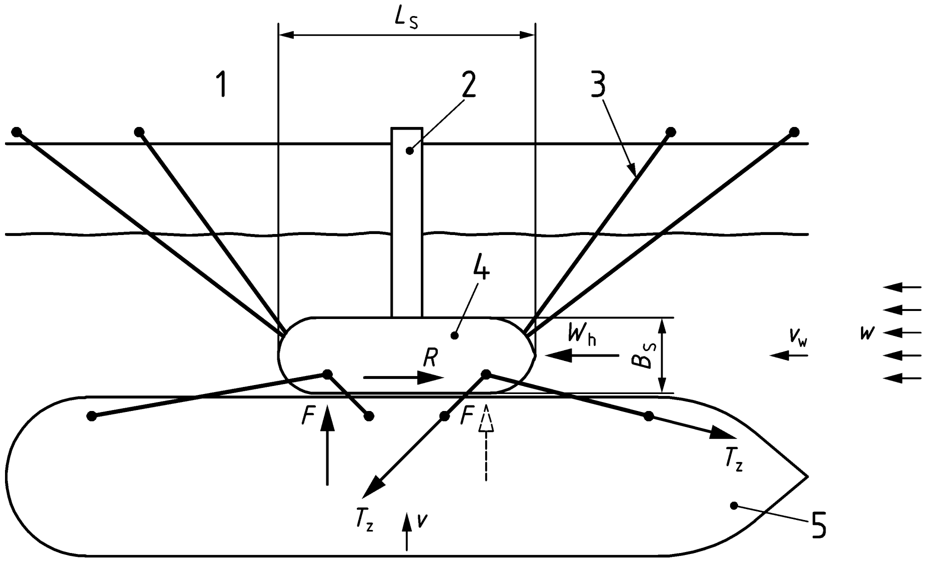
Table A.2 — Combination matrix and partial safety coefficients γ_F for floating jetties

Design situation	**A.5**	**Additional action Q_{ik}**		
		A.6	**A.7**	**A.11**
	Permanent action (dead load) G_K	**Live load** p_v	**Hydrodynamic action** W_h	**Wind load** w
a 1	1,35	1,5	1,5	1,5
a 2	1,35	–	1,5	1,5
b 1	1,35	1,5	–	–
b 2	1,35	–	1,5	–
b 3	1,35	–	–	1,5
NOTE In design situations with more than one additional action, the sum of the additional actions Qik including their associated partial safety coefficients γ_F is multiplied by the combination coefficient ψ_i = 0,9				

A.4 Effect on floating constructions

For floating landing stages and floating landing jetties, the actions as shown in Figure A.1 shall be applied. For floating jetties, the actions as shown in Figure A.1 shall be applied, but without F, T_Z and R.

The effects on floating structures are shown in Figure A.1 with an example of a floating landing stage.



Key

1 Quay
2 Connecting Bridge
3 Anchorage for the floating structure
4 Floating landing stage
5 Ship
W_h Hydrodynamic effect, see A.7
F Vessel berthing impact, see A.8
T_z Vessel static pull, see A.9
R Vessel friction, see A.10
w Wind load acting on the floating construction, see A.11
v Berthing velocity
v_w Maximum flow velocity of the water around the floating construction
B_S Width of the floating body at water level, see A.7
L_S Length of the floating body at water level, see A.7

Figure A.1 — Actions on floating landing stages

The bearing loads of the connecting bridge shall be taken into consideration. The loadings given in this annex also apply to the connecting bridge. It shall be ensured that the actual load of the connecting bridge causes neither heeling nor trim of the floating structure.

A.5 Permanent actions

Permanent actions on the components shall be determined according to the relevant standards and regulations. Actions of supply lines and other dead loads shall be taken into account.

A.6 Live load

The following values shall be inserted as uniformly-distributed vertical live loads for all the walkways:

— for public passenger traffic areas: $p_V = 5{,}0\ \text{kN/m}^2$.

If the walkway is used exclusively by pedestrians, unless otherwise specified, the live load for walkways over 10 m long may be reduced using the following equation:

$$2{,}5 \leq p_v = 2{,}0 + \frac{120}{L_b + 30} \tag{A.1}$$

— for all other areas: p_V = 2,5 kN/m^2.

Where:

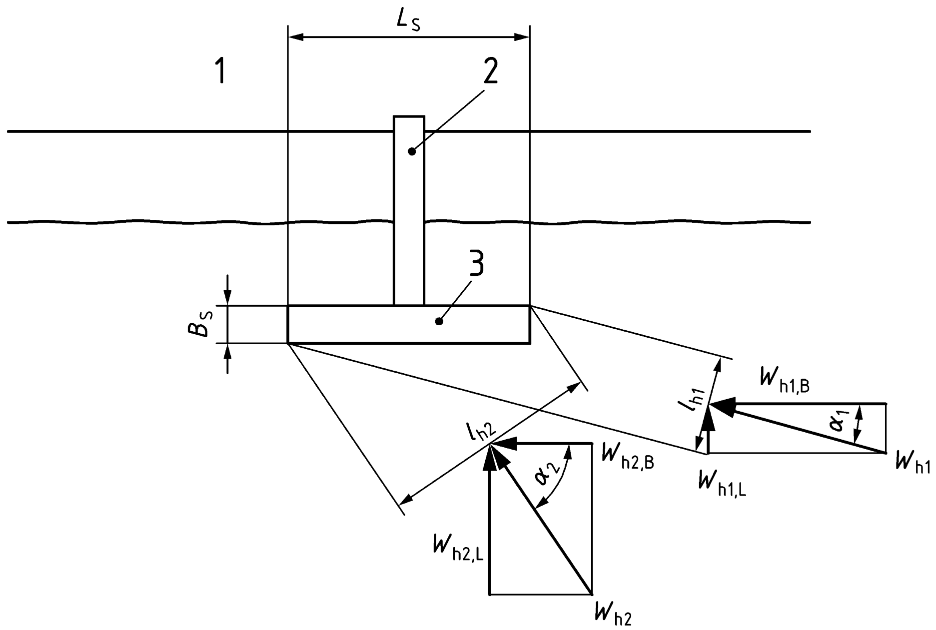
p_V vertical live load, in kilonewtons per square metre (kN/m^2);

L_b length of the connecting bridge and/or length of the floating equipment, in metres (m).

When calculating in tax stability, the centre of gravity of the live load should be assumed to be 1 m respectively above the traffic area.

A.7 Hydrodynamic actions

Hydrodynamic actions on floating constructions are comprised of the effects of flow and waves. The impacts therefrom are illustrated in Figure A.2.



Key

1	Quay
2	Connecting Bridge
3	Floating Landing Stage
B_S	Width of the floating body at water level, in metres (m)
L_S	Length of the floating body at water level, in metres (m)
W_{h1}	Hydrodynamic effect of flow, in kilonewtons (kN)
W_{h2}	Hydrodynamic effect of waves, in kilonewtons (kN)
α_1	Angle between the line of action of the flow and the longitudinal axis of the floating body, in degrees (°)
α_2	Angle between the line of action of the waves and the longitudinal axis of the floating body, in degrees (°)
l_{h1}	Projected length of the floating body perpendicular to the direction of action of the flow, in metres (m)
l_{h2}	Projected length of the floating body perpendicular to the line of action of the waves, in metres (m)
$W_{h1,B}$; $W_{h2,B}$	Force components relative to the width of the floating body, in kilonewtons (kN)
$W_{h1,L}$; $W_{h2,L}$	Force components relative to the length of the floating body, in kilonewtons (kN)

Figure A.2 — Hydrodynamic action on floating constructions

The hydrodynamic effect of flow is calculated as follows:

$$W_{h1} = c_w \times \frac{\rho_w}{2} \times v_w^{\ 2} \times A_q \qquad \text{(A.2)}$$

Where

c_W The resistance coefficient:

For rectangular floating bodies with no end tapering			For designs with tapered ends
$L_S/B_S \leq 2$	$2 < L_S/B_S \leq 3$	$L_S/B_S > 3$	
$c_W = 2{,}0$	$c_W = 1{,}5$	$c_W = 1{,}0$	$c_W = 1{,}0$

ρ_W The density of the water = 1 tonne per cubic metre (t/m^3);

v_W The maximum flow velocity, in meters per second (m/s), of the water around the floating construction (as specified by the local authority);

A_q The cross-sectional area of the floating body, taken from the product of the projected length and depth, in square metres (m^2).

If parts of the connecting bridge also are submerged in flowing water when there are extreme water levels, an additional resistance force with the coefficient c_w = 2,0 shall be calculated for the submerged cross-section.

If the direction of flow does not solely act on the broadside of the floating body, the force components relative to the width and length of the floating body according to Figure A.2 shall be calculated as follows:

$$W_{h1,B} = W_{h1} \times \cos \alpha_2 \qquad \text{(A.3)}$$

$$W_{h1,L} = W_{h1} \times \sin \alpha_2 \qquad \text{(A.4)}$$

If significant wave action is expected, the effect of waves shall be calculated as follows:

$$W_{h2} = 2 \text{ kN/m} \times l_{h_2} \qquad \text{(A.5)}$$

$$W_{h2,B} = W_{h2} \times \cos \alpha_2 \qquad \text{(A.6)}$$

$$W_{h2,L} = W_{h2} \times \sin \alpha_2 \qquad \text{(A.7)}$$

The linear load of 2 kN/m shall be adjusted if a more accurate determination of the wave forces results in different values.

The resulting force components of the hydrodynamic action of the flow and waves relative to the length and width of the floating body are derived from the following sums:

$$W_{h,B} = W_{h1,B} + W_{h2,B} \qquad \text{(A.8)}$$

$$W_{h,L} = W_{h1,L} + W_{h2,L} \qquad \text{(A.9)}$$

The resulting load from the effect of the flow and waves shall be calculated as follows:

$$W_h = \sqrt{W_{h,B}^2 + W_{h,L}^2} \quad \text{(A.10)}$$

The direction of action of the resulting forces shall be calculated as follows:

$$\sin \alpha_h = \frac{W_{h,L}}{W_h} \quad \text{(A.11)}$$

Where:

α_h The angle between the longitudinal axis of the floating body and line of action of the resulting forces W_h in degrees (°).

A.8 Vessel berthing impact

A.8.1 General

The impact load of the floating landing stage/floating landing bridge shall be determined as a function of the mass of the largest berthing vessel, its berthing velocity and the spring properties of the floating landing stage/floating landing bridge.

The impact force is the force component of the berthing impact acting at right angles on the floating body of the floating landing stage/floating landing bridge. The force component acting in the longitudinal direction of the floating landing stage/floating landing bridge is transmitted to the floating landing stage/floating landing bridge by friction forces and the vessel static pull.

The vessel berthing impact *F* is calculated differently according to the spring systems provided, and the impact force shall be calculated only for one system in the event of a simultaneous effect of several systems.

Mooring equipment is not shown in Figures A.3 to A.6.

A.8.2 Vessel berthing impact according to Figure A.3

If there are explicit spring elements (compression springs in the mounting of the connecting bridge, fenders on the floating body) as shown in Figure A.3, the vessel berthing impact *F* is calculated as follows:

$$F = \frac{m \times v^2}{f} \text{ or} \quad \text{(A.12)}$$

$$F = v\sqrt{m \times c} \quad \text{(A.13)}$$

$$f = \frac{F}{c} \quad \text{(A.14)}$$

Where:

F is the vessel berthing impact, in kilonewtons (kN);

f is the spring travel, in metres (m);

m is the mass, in tonnes (t),

$m = m_S + m_H$; (A.15)

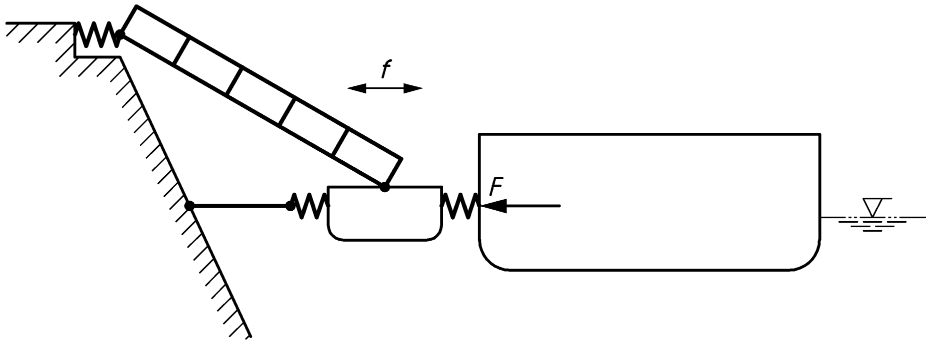
m_S is the mass of the vessel, in tonnes (t);

m_H is the hydrodynamic mass, in tonnes (t), with k_1 and k_2 according to Table A.3 and Table A.4:

$$m_H = m_S \times k_1 \times k_2; \quad \text{(A.16)}$$

v is the berthing velocity, in metres per second (m/s);

c is the linear spring constant of the springing, in kilonewtons per metre (kN/m).



Key

F vessel berthing impact, according to equation (A.12) or (A.13)

f spring travel, according to equation (A.14)

Figure A.3 — Springing by means of explicit spring elements

A.8.3 Vessel berthing impact according to Figure A.4

If there are fixed shore-side and floating-body-side bearings for the connecting bridge, the connecting bridge shall be inclined and springing of the floating landing stage/floating landing bridge operates exclusively by deeper immersion of the floating body (see Figure A.3). The vessel berthing impact F is calculated as follows:

$$F = v\sqrt{m \times A \times \rho_W \times g} \times \cos\alpha \quad \text{(A.17)}$$

Where:

F is the vessel berthing impact, in kilonewtons (kN);

m is the mass, in tonnes (t):

$$m = m_S + m_H; \quad \text{(A.15)}$$

m_S is the mass of the vessel, in tonnes (t);

m_H is the hydrodynamic mass, in tonnes (t), with k_1 and k_2 according to Table A.3 and Table A.4:

$$m_H = m_S \times k_1 \times k_2; \quad \text{(A.16)}$$

h is the minimum depth of water at the floating landing stage, in metres (m);

B is the maximum width of the vessel body, in metres (m);

T is the draught of the vessel, in metres (m);

A is the area of the vessel body at the water level, in square metres (m^2);

α is the inclination angle of the connecting bridge compared to the horizontal plane – clockwise, in degrees (°);

ρ_W is the density of the water = 1 tonne per cubic metre (t/m^3);

g is the acceleration due to gravity = 9,81 metres per second per second (m/s^2);

v is the berthing velocity, in metres per second (m/s), taking into account local conditions by means of factors b_1 and b_2 as shown in Table A.6:

$$v = v_0 \times b_1 \times b_2; \quad \text{(A.18)}$$

v_0 is the standard berthing velocity, in metres per second (m/s), at right angles to the longitudinal side of the floating body with the floating landing stage/floating landing bridge in an unprotected position, under unfavourable approach conditions, still waters and vessel without bow rudder as a function of the mass of the vessel according to Table A.5.

By selecting the spring travel f, the vessel berthing impact F and the spring constant required for it c can be determined.

$$f = L_b \times \cos\alpha - \sqrt{L_b^2 - (L_b \times \sin\alpha + \Delta T)^2} \quad \text{(A.19)}$$

Where:

f is the spring travel, in metres (m);

L_b is the length of the connecting bridge, in metres (m);

α is the inclination angle of the connecting bridge compared to the horizontal plane – clockwise, in degrees (°);

ΔT is the difference in floating body immersion, in metres (m):

$$\Delta T = v\sqrt{\frac{m}{A \times \rho_W \times g}} \quad \text{(A.20)}$$

Where:

v is the berthing velocity, in metres per second (m/s);

m is the mass, in tonnes (t):

$$m = m_S + m_H; \quad \text{(A.15)}$$

m_S is the mass of the vessel, in tonnes (t);

m_H is the hydrodynamic mass, in tonnes (t), with k_1 and k_2 according to Table A.3 and Table A.4:

$$m_H = m_S \times k_1 \times k_2; \quad \text{(A.16)}$$

A is the area of the floating body at the water level, in square metres (m^2);

ρ_W is the density of the water, in tonnes per cubic metre (t/m^3);

g is the acceleration due to gravity = 9,81 metres per second (m/s^2).

Table A.3 — Factor k_1 as a function of the width-draught ratio B/T

B/T	14	12	10	8	6	4	2
k_1	0,22	0,26	0,30	0,38	0,48	0,66	1,20

Table A.4 — Factor k_2 as a function of the draught-water depth ratio T/h

T/h	0,1	0,2	0,3	0,5	0,6	0,7	0,8	0,85
k_2	1,05	1,1	1,2	1,5	1,8	2,3	3,2	4,0

Table A.5 — Standard berthing velocity v_0 as a function of the vessel mass m_S

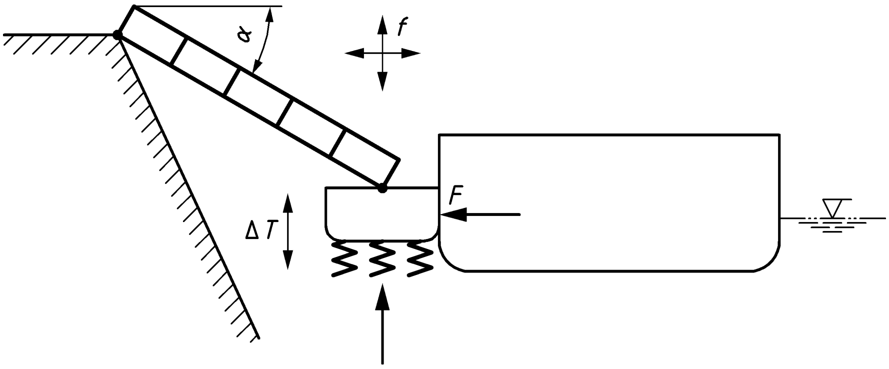
m_S (t)	100	200	500	1 000	1 500	2 000	3 000	4 000	≥ 5 000
V_0(m/s)	0,29	0,28	0,26	0,23	0,21	0,19	0,16	0,14	0,13

Table A.6 — Factors b_1 and b_2 for determining the berthing velocity v

Factor	Vessel with bow rudder		Vessel without bow rudder	
	Water		Water	
b_1	still	flowing	still	flowing
	0,6	0,5	1,0	0,8
Factor	Protected position[a]		Unprotected position	
	Approach		Approach	
b_2	favourable[b]	unfavourable	favourable	unfavourable
	0,8	0,9	0,9	1,0

[a] Protected position means: protected against wind by high bank, built-up surroundings or by trees and bushes.

[b] Favourable approach means: the vessel can be brought alongside without touching the floating landing stage/floating landing bridge.



Key

F vessel berthing impact, according to equation (A.17)

f spring travel, according to equation (A.19)

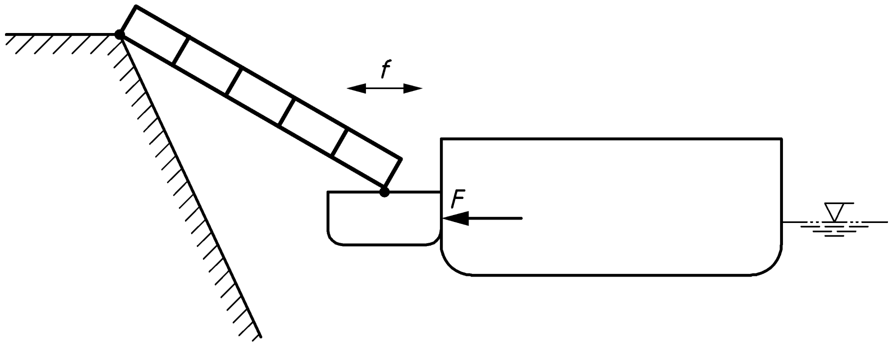
ΔT difference in floating body immersion, in metres (m), according to equation (A.20)

α inclination angle of connecting bridge compared to horizontal plane

Figure A.4 — Springing by immersion of floating body

A.8.4 Vessel berthing impact according to Figure A.5

If there are no explicit spring elements or structural springing available, spring travel of f = 0,05 m can be assumed for floating landing stages/floating landing bridges (see Figure A.5).



Key

F vessel berthing impact, according to equation (A.12)

f spring travel, *f* = 0,05 m

Figure A.5 — Rigid floating body - shore connection

A.8.5 Vessel berthing impact according to Figure A.6

With an inclined slideway for the connecting bridge, the vessel berthing impact F may be determined according to Figure A.6.

$$F = \frac{m_V \times g}{2(\tan\alpha + \tan\beta)}\left(1 + \frac{2{,}5 m_A}{(m - 2m_A)}\right) \tag{A.21}$$

$$f = \frac{m \times v^2}{F} \tag{A.22}$$

Where:

F is the vessel berthing impact, in kilonewtons (kN);

f is the spring travel, in metres (m);

m is the mass, in tonnes (t):

$m = m_S + m_H$; (A.15)

m_S is the mass of the vessel, in tonnes (t);

m_H is the hydrodynamic mass, in tonnes (t), with k_1 and k_2 according to Table A.3 and Table A.4:

$m_H = m_S \times k_1 \times k_2$; (A.16)

m_A is the mass of the whole floating landing stage/floating landing bridge, in tonnes (t);

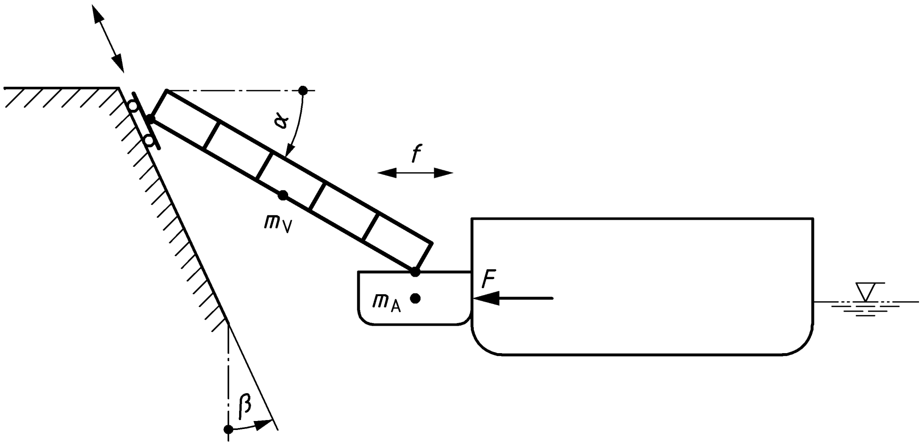
m_V is the mass of the connecting gangway, in tonnes (t);

g is the acceleration due to gravity = 9,81 metres per second per second (m/s²);

v is the berthing velocity, in metres per second (m/s), according to equation A.18;

α is the inclination angle of the connecting bridge, in degrees (°);

β is the inclination angle of the slideway, in degrees (°).



Key

F vessel berthing impact, according to equation (A.21)

f spring travel, according to equation (A.22)

m_V mass of the connecting bridge in tonnes (t)

m_A mass of the whole floating landing stage/floating landing bridge, in tonnes (t)

α inclination angle of the connecting bridge, in degrees (°)

β inclination angle of the slideway, in degrees (°)

Figure A.6 — Springing through inclination of slideway and connecting bridge

The impact force can be reduced (distributed) by means of fixed fenders or other structural reinforcements and specifying the resulting linear or surface load.

A.9 Vessel static pull of the moored vessel

If no other proof is provided, a vessel static pull T_Z shall be determined as follows for bollards or other mooring devices on the floating body of the floating landing stage/floating landing bridge:

for $L \times B \times T$ up to 1 000 m^3:

$$T_Z = 60 + \frac{L \times B \times T \times C_B}{10} \quad \text{(A.23)}$$

for $L \times B \times T$ over 1 000 m^3:

$$T_Z = 150 + \frac{L \times B \times T \times C_B}{100} \quad \text{(A.24)}$$

Where:

T_Z is the vessel static pull (characteristic value), in kilonewtons (kN);

L is the maximum length of the vessel, in metres (m);

B is the maximum width of the vessel, in metres (m);

T is the maximum draught of the vessel, in metres (m).

C_B the block coefficient of ship displacement.

If there are no concrete data, then it shall be assumed:

— for passenger ships C_B = 0,6;

— for cargo ships C_B = 0,9.

The vessel static pull T_Z determined may be reduced by 25 % for floating landing stages/floating landing bridges secured by wire ropes or chains.

If there are no concrete data regarding the direction of the vessel static pull T_Z, then this shall be assumed to be 10° and 45° to the longitudinal edge of the floating body, see Figure A.1, depending on the case.

This vessel static pull is to be specified as the characteristic value for the mooring equipment elements (bollards, foundations, dolphins, etc.) of the floating landing stage/floating landing bridge.

A.10 Vessel friction

The floating landing stage is subjected to a friction force R parallel to the landing edge, to be determined as follows:

$$R = \mu \times F \qquad \text{(A.25)}$$

Where:

R is the vessel friction, in kilonewtons (kN);

μ is the coefficient of friction between the vessel and landing edge;

— steel on steel: μ = 0,15,

— rubber on steel, dry: μ = 0,35,

— rubber on steel, wet: μ = 0,15,

— steel on wood or wood on wood: μ = 0,50;

F is the vessel berthing impact, in kilonewtons (kN) as per clause A.8.

A.11 Wind load

The following wind load w is to be inserted for the floating structure:

$$w = c_f \times q \qquad \text{(A.26)}$$

Where:

w is the wind load in kilonewtons per square metre (kN/m^2);

c_f is the compressive force coefficient = 1,3;

q is the dynamic wind pressure = 0,5 kilonewtons per square metre (kN/m^2).

NOTE The wind load on the moored vessel is contained in the static pull in the calculation as specified in A.9.

A.12 Special loads

Here, unfavourable loads acting on the floating structure, e.g. structural ice pressure, drifting material, ice pressure, jams, point loads of storage areas etc. shall be taken into consideration when calculating individual cases.

References

[1] EN 1992 (all parts), Eurocode 2 — Design of Concrete Structures

[2] EN 1993 (all parts), Eurocode 3: Design of Steel Structures

[3] EN 1995 (all parts), Eurocode 5: Design of Timber Structures

[4] EN 1999 (all parts), Eurocode 9: Design of Aluminium Structures

[5] EN 12087, *Thermal insulating materials for building applications — Determination of long-term water absorption by immersion*

[6] EN 13163, *Thermal insulation materials for buildings — Factory made products of expanded polystyrene (EPS) — Specification*

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