Handbook

for scaffolders

SfS
Samarbeid for Sikkerhet

SfS Recommendation 048E/2021

1.0 Foreword

The main purpose of this handbook is to highlight the quality and standards that are expected within the petroleum industry. The handbook was originally created by Equinor, but has now been taken over and further developed by a Working Together for Safety (SfS) working group. Thank you to Equinor for sharing the handbook, and to the members of the working group who have updated it.

The handbook shall also:

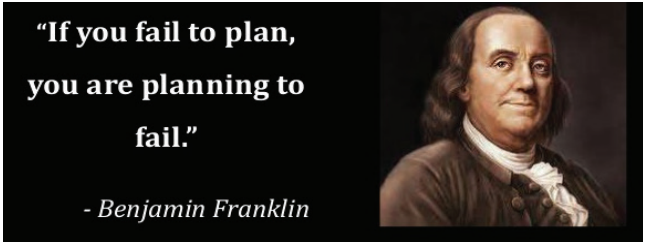
- Help to increase the safety of scaffolders
- Contribute to a shared understanding of the desired scaffolding standards
- Contribute to increased safety during the assembly, dismantling and altering of scaffolds
- Be an aid for scaffolders who perform work for the company

Be aware that if there are differences between the descriptions provided in the company's work processes and associated management elements and this handbook, the text of the management elements shall always apply.

Hugo Halvorsen
General manager, Working Together for Safety (SfS)

2.0 Contents

3.0 Planning



Scaffolding shall be erected and approved in accordance with national standards and regulations, as well as the company's work processes for the assembly, dismantling and covering of scaffolds and work at height.
The planning of scaffolds shall be jointly carried out by the orderer of the scaffold and the executing personnel who will be involved in the scaffolding's construction.
The manufacturer's assembly instructions, material specification and work description shall be available at the operation site.
Scaffolds shall be designed and situated so that they satisfy the needs of users and ensure a good working environment.
Obstacles such as pipes, railings and beams that may hinder workers in reaching the worksite shall be taken into consideration when assessing the scaffold's location and the need for appropriate safety measures.
If physical limitations result in the erected scaffold not having satisfactory collective fall protection, the scaffold shall be clearly labelled with the text 'use harness'. The inspection card / tag holder shall be labelled, or a 'Use harness' tag may be used.
In this case, the scaffold is only approved for use when fall arrest equipment is used. If in doubt, check with the relevant scaffolder.

3.0 Planning

Scaffolding shall be designed and situated in such a way that it does not reduce the facility's safety level by blocking access to safety and rescue equipment or important processing equipment. Any questions relating to this shall be clarified with the area technician.

Specialist competence and composition of scaffolding team:

A scaffolding team may consist of 1-4 workers, and must feature a minimum of one qualified scaffolder. Further competence requirements can be found in the Norwegian Oil and Gas Association's Guideline 105.

Remember that all work at height shall be risk assessed

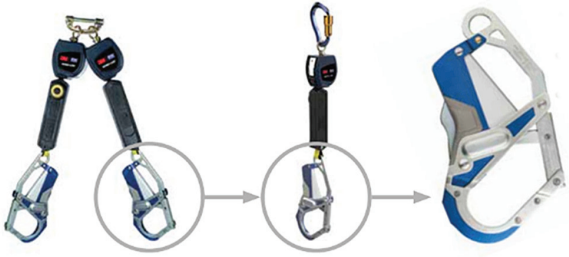
4.0 Fall protection

a. Personal fall protection shall always be incorporated. Fall protection and rescue methods shall always be clarified and planned before the work is started. Rescue equipment should be selected on the basis of a risk assessment. Use of a fall arrest block with recovery winch shall be considered.
b. Collective fall protection shall be prioritised over personal fall arrest equipment.
c. Consider the fall factor when selecting fall protection, and consider the use of a fall arrest block instead of a fall line. A fall line does not become effective until the line is taut.
d. As a main rule, fall arrest equipment shall always be attached to the structure above the user, and extension over long horizontal distances must be avoided. When working using secondary retention, the carabiners must not be connected to the same anchor point.
e. When using a fall arrest harness with a line, ensure that the harness is equipped with a Y-line and consider the need for trauma relief straps.
f. When using fall arrest equipment, the work team shall consist of at least two persons due to rescue considerations.
g. Fall arrest equipment shall be checked by the user both prior to and after use. In the event of defects, wear or other damage, the equipment shall be replaced. Check the date of the last inspection and remember to perform buddy checks!
h The manufacturer's specifications for the relevant fall arrest equipment shall be followed.

4.0 Fall protection

Tip: Carry slings/suspension slings and carabiners in order to be able to find good anchor points more easily. The scaffolding assembly instructions will show where carabiners can be attached.

Carabiners must always be used in accordance with usage instructions. Be aware that not all carabiners are dimensioned for vertical attachment points (e.g. standards). Use carabiners that tolerate loads at all angles:



4.1 Fall factor

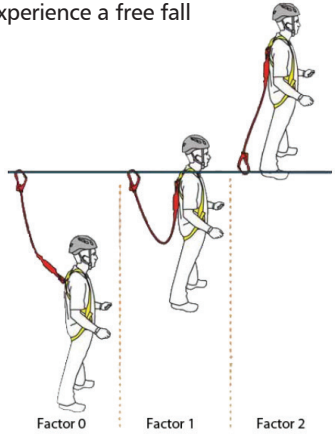
The fall factor is the length of the fall divided by the length of the securing device that absorbs the fall energy. This means that the length of the fall depends on where you are anchored in relation to where you are working. The fall factor should therefore be as low as possible, especially in the event of horizontal extension! Use a fall line that can be shortened.

Example of fall factor if using fall arrest equipment with a 2 m line:

Fall factor 0: Anchor point is 2 m above you – you avoid free fall.

Fall factor 1: Anchor point is at the same height as the attachment point on your harness – you can experience a free fall of 2 m

Fall factor 2: Anchor point is 2 m below you – you can experience a free fall of 4 m.



4.1 Fall factor

In addition to the fall factor, the force to which a person is subjected will also depend on the energy-absorbing properties of the securing device (the device's ability to extend without failing). Fall energy absorbers are therefore important, especially in the event of a fall factor of 1 or more. Select a harness with front or rear attachment based on the work situation. Front attachment will ensure free airways in the event of a fall.

A fall energy absorber extends during a fall (usually by around 1.75 m), so there must be adequate headroom beneath the worksite.

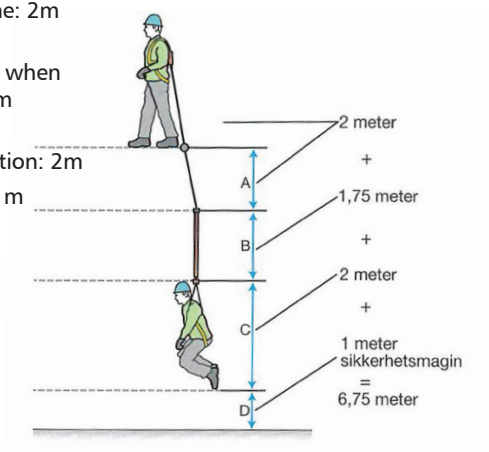
For a fall factor of 1, the distance from the fall arrest anchor point to the next obstacle must be at least 5.25 m when using a 2 m line. For a fall factor of 2 (which should be avoided), there should be more than 6.75 m.

A: Length of fall line: 2m

B: Length of fall energy absorber when extended: 1,75 m

C: Your length + harness extention: 2m

D: Safety margin: 1m



5.0 Protective equipment

Section 15 of the Regulations concerning organisation, management and employee participation requires the employer to supply appropriate protective equipment.

The scaffolder's helmet shall provide protection against dropped objects and head injuries in the event of a fall. Whenever there is a risk of falling, the scaffolder shall use a helmet that fulfils the requirements regarding protection against dropped objects and falls (ref. Standard NS-EN 12492).

Scaffolders often walk long distances on hard surfaces, and carry heavy scaffolding materials. It is therefore particularly important to ensure use of the correct footwear with adequate cushioning.

6.0 Erection of scaffolding – General tips

a. Stepladders/rope ladders shall only be used where it is not possible to use stairs to access the scaffold.
b. Stair towers should permit evacuation using a stretcher.
c. Stair towers in access roads/walkways shall be of an even height, and no higher than 225 mm. The first and last step may be adjusted, but should not exceed 250 mm in height.
d. Entrances to work platforms shall be safe and convenient. Avoid obstacles that the user must bend under. Use a single ledger beam if possible – this provides maximum height.
e. The size/height of the work platform must be adapted to the work. Remember to ensure good ergonomic conditions for the user.
f. There must be good access to the scaffold, including a dedicated external walkway if necessary. The minimum height for the walkway is 190cm.
g. The scaffold shall be situated so that it does not block escape routes or obstruct access to emergency or operative equipment.
h. If scaffolding shall be erected in the vicinity of vents and exhaust ducts, this should be emphasised in the risk assessment. Be aware of heat and exposure to hazardous chemicals during assembly/dismantling.
i. Remember to perform a visual inspection of the scaffolding components before, during and after assembly/dismantling of the scaffold.
j. Avoid the interim storage of scaffolding materials during assembly and dismantling.
k. Check that the assembly guide applies to the relevant equipment.

6.1 Securing of items

In the event of work at height, the executing worker shall undertake a pre-job discussion (TA-TO or equivalent) before starting the activity, and if necessary after breaks before the activity is resumed. In addition, the following points shall be adhered to:

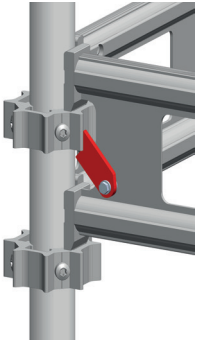
a. Consider your own activity in the context of other ongoing activities.
b. Ensure order, cleanliness and control of all loose components during the course of the activity.
c. Stop the activity in the event of changes and assess the need for new compensating measures.

All tools and equipment used during work at height shall be secured at all times (ref. SfS Handbook: Prevention of dropped objects)

Standard bolts shall always be used and secured regardless of whether the scaffold is assembled from ground level or as a suspended scaffold.

6.1 Securing of items

All ledgers and transoms shall be in the locked position at all times when the scaffold is erected.



The area shall be cordoned off and measures to prevent dropped objects implemented during the erection of the scaffolding. An example of such measures is the covering of processing equipment. Tarpaulins must always be secured against strong winds.

Before dismantling:

Re-check/obtain an overview in order to ensure that all components are in place and secured. Others may have loosened scaffolding components, which may pose a risk to scaffolders.

In connection with the dismantling of scaffolding, be aware that tools and equipment may have been left behind on the scaffold. Such items shall be removed or secured before the dismantling of the scaffold begins. Also check that there are no forgotten objects at height, such as on beams/pipes/cabinets etc.

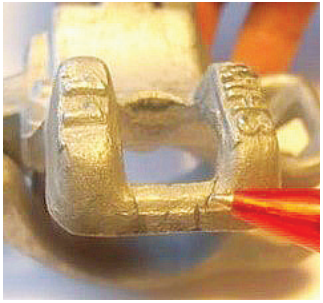
6.2 Defective scaffolding materials

Damaged scaffolding materials shall be labelled with the colour white (spray-paint or paint) and set in a suitable location (dedicated basket or fenced-off area), to ensure that they will not be used. The fenced-off area or basket shall be marked with a sign for discarded scaffolding materials.

The scrapping criteria and focus areas when performing visual checks of the equipment include (see relevant assembly and user instructions):

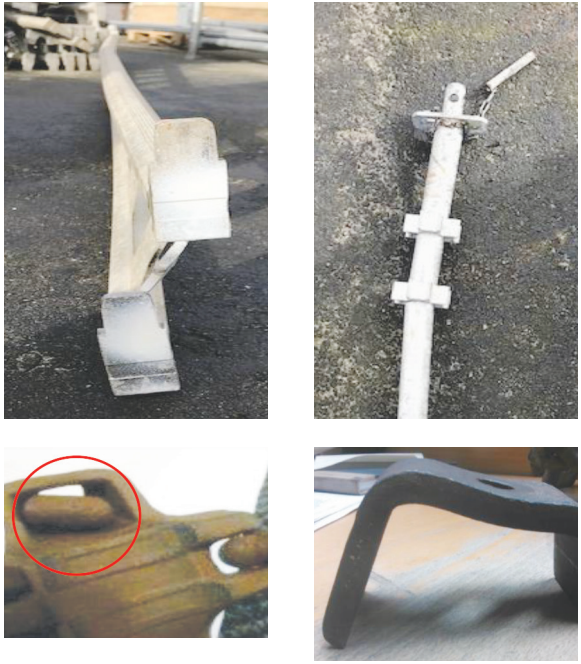
a. igns of deformation
b. Possible impact damage
c. Formation of cracks
d. Signs of corrosion
e. Signs of overloaded components

Examples of defective materials:



Formation of visible cracks

6.2 Defective scaffolding materials



Deformation/overloaded components

7.0 Construction

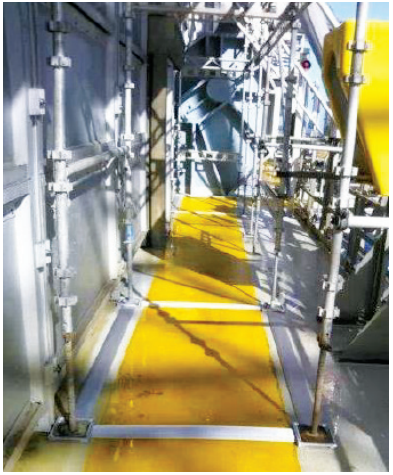
a. All scaffolding shall be assembled and anchored in accordance with the requirements given in the individual manufacturer's assembly instructions, standards and regulatory requirements.

b. The buckling length of standards is from node point to node point in accordance with the load tables given in the assembly instructions.

c. The scaffold shall be stable, and its supporting elements shall be secured against side slippage. This can be done in many ways, for example using locking lists.

d. If there is a risk of personnel falling, railings shall be installed on the scaffold regardless of its height. If this is not possible, other safety measures shall be implemented (e.g. use of fall arrest harness).

e. A minimum of 25% of the length of the base plate (minimum 150 mm) shall insert into the standard, and it is recommended that a maximum of 250 mm is unscrewed.



7.0 Construction

Good assembly practice for consoles and brackets

a. Recommended assembly of 1.20 consoles:
Attach the ledger beams to the console and affix a connector/clip over this to secure it, or use a wire around the lock in order to secure the ledger beam against being dropped before assembling the console at the desired height.

b. When assembling brackets/consoles, there should only be one floor per bracket/console. If erecting more than one floor, the horizontal and vertical pressure load on the standard and brace must be calculated in order to find the correct load.

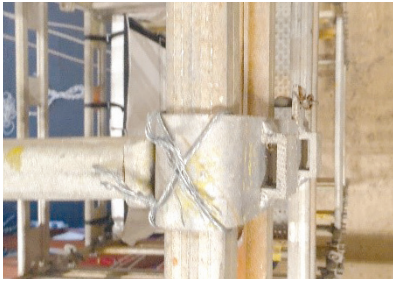
Good assembly practice for beam riders and puncheon units

a. When installing beam riders, these shall be secured.

b. If the beam riders have bolts, these shall be used.

c. For beam riders without bolts, or to prevent them from moving, the beam riders should be tied down using wire by making a cross over the top.

d. The use of beam riders should not be excessive, see the assembly instructions for how much the ledger beams are able to tolerate in pressure and point loads



7.1 Rolling scaffolds

Calculations for rolling scaffolds shall always be performed if these are not provided in the assembly instructions (usually for outdoor use)

a. Width of at least 1.0 m. Remember to lock castor brakes before use

b. Internal access wherever possible

c. All castors shall feature brakes

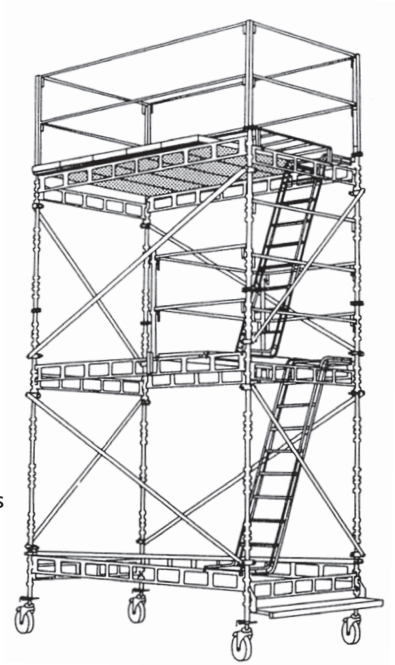
d. Toe boards shall be installed

e. Ballast shall be evenly distributed as low as possible

f. Rolling scaffolds that are not in use shall be secured

g. Safety factor against tipping shall be 1.5

h. Rolling scaffolds shall be re-checked in the same way as all other scaffolds (every 7 days offshore and every 14 days onshore).



7.2 Bracing – Diagonals

a. All braces shall tolerate both tension and compression. Bracing must be considered together with the anchoring of the scaffold.

b. The bracing shall be continuous from the surface on which the scaffold stands to the uppermost floor level. In order for the bracing to provide the maximum effect, the diagonals shall be connected at the node point or as close to the node point as possible.

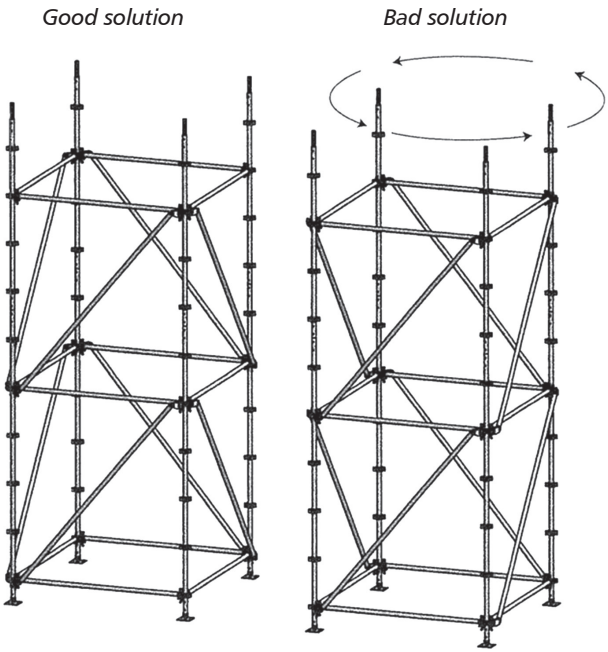
c. It is extremely important to install the diagonal braces as the scaffold is erected, and to stay within the requirements of the assembly instructions.

d. On a facade scaffold, we usually only install diagonals on the outer row of standards, and usually on every fourth bay.

e. Tower scaffolds shall be braced on all four sides. If the tower scaffold stands against a wall or structure and is anchored to this, the other three sides shall be braced using diagonals. Remember to account for the tipping/ tilting of free-standing tower scaffolds and rolling scaffolds.

f. When all four sides shall have braces, the diagonals shall have the opposite orientation in pairs (east/west pair and north/south pair

7.2 Avstivning - Diagonaler



If the diagonals are installed in the same direction, the tower may screw itself out of alignment (no longer be perpendicular). Image from Stillasboka, used with permission.

7.3 Scaffolding floors

Example of correct work platform

Requirements for scaffold floors: (ref. NS9700).
Scaffold floors shall:

a. Be installed so that the individual components cannot shift during normal use.
b. Be appropriately affixed to the scaffold structure and be without ends that may tilt.
c. Be level, with a design and surface that prevents them from becoming slippery, and which prevents gaps greater than max. 25 mm.
d. End securely against the toe board.
e. Be stiff enough to ensure satisfactory working conditions and safety.

7.4 Grating boards

a. The grating's capacity must be checked before the scaffold is erected
b. The grating's capacity depends on its mesh size, the dimensions of the load bars and the span between the support beams to the grating
c. Toe boards shall always be used against the grating boards

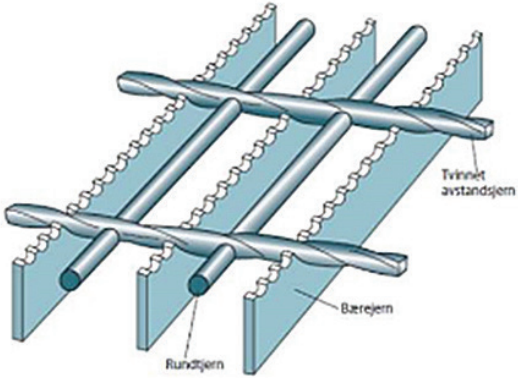


Table 3, page 52, shows the max load of S355 grating boards

7.5 Tying down of scaffolding boards

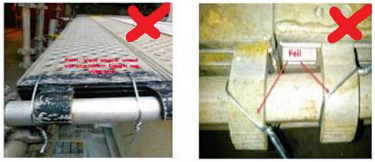
All scaffolding boards shall be affixed to the scaffold structure in such a way that they cannot move. Scaffolding boards without a dedicated locking device shall be tied down at both ends. The board shall lie flat against the surface without any form of vibration or movement, even in the event of strong winds or external influences.

a. When re-checking, ensure that the lashings are intact and that they have not worked loose or been damaged.

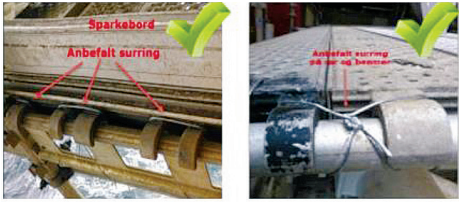
b. Toe boards shall be lashed to the standard and down to the platform.

c. All boards, whether finished or not, shall always be tied down in accordance with the recommended practice before leaving the workplace. This also applies in the event of brief interruptions and breaks.

d. In the event of predicted winds of over 20 m/s, measures shall be implemented to secure scaffolds exposed to adverse weather conditions.



Examples of incorrect lashings



Examples of recommended lashings

7.6 Example of safe assembly

According to Section 17-1 of the Regulations concerning the performance of work, collective fall prevention measures shall be prioritised over personal fall arrest equipment.
In order to adhere to the requirement in the regulations, an assembly method which protects the scaffolder during the work can be chosen. One way of doing this is assembly from the underside, e.g. using a 1-metre lift (there are also many manufacturers that supply telescopic guardrails).

The bottom of the scaffold is completed and external transoms and ledgers are installed on the outside of the scaffold at a height of 2 metres. The floors are then installed at a height of 1 metre. From here, the standards, transoms/ledgers and couplers are installed. Then the external transoms and ledgers are installed 2 metres above the floor. (There must be full fall protection on all sides of the scaffold).

The floor can now be lifted 1 metre – when using the extra assembly floor the uppermost external transoms/ledgers will act as a guardrail at the new scaffolding floor level.

When erecting standard scaffolding it is possible to provide full protection using a 1-metre lift.

8.1 Use of pulleys/gin wheels

a. The installation of a hoist post and gin wheel shall be performed in accordance with the manufacturer's assembly instructions.

b. The erection and use of gin wheels shall be approved by the scaffolding foreman/specialist, and labelled with a separate tag prior to use.

c. Gin wheels/hoist posts, ropes and load hooks shall be certified and labelled with their working load limit (WLL).

d. Scaffold pulleys/gin wheels are lifting equipment, and shall be inspected by a competent organisation a minimum of every 12 months.

e. Sufficient access control of the area that constitutes the drop zone must be implemented prior to use of the hoist.

f. The user and slinger shall have received training in the equipment's use, ref. the Regulations regarding the performance of work, section 10.4: Requirements relating to equipment-specific training.

g. All slinging and unslinging of equipment should occur on the inside of the scaffold. Only CE marked and approved gin wheels with brakes shall be used.

8.1 Use of pulleys/gin wheels

Always stand a safe distance from the drop zone!

8.2 Use of lifting rigs

A scaffolding lifting rig usually consists of a scaffold frame, which constitutes a foundation for a CE marked load-bearing beam. The scaffold frame shall be documented by the scaffolding foreman in accordance with the manufacturer's assembly instructions.

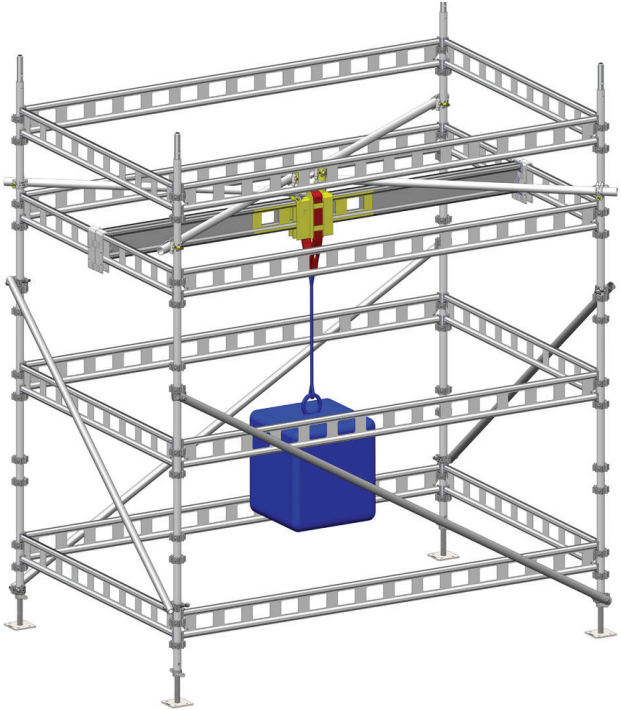
The load-bearing beam shall be marked/certified in accordance with the Regulations concerning machines and defined as lifting equipment. The load-bearing beam and suspended lifting device shall be approved by a rigger with the necessary competence for capacities of up to 2 tonnes, and a competent organisation for capacities of over 2 tonnes.

PS: A scaffolding lifting rig that solely consists of scaffolding materials requires individual calculations and documentation in accordance with NORSOK R-002 Annex H.

Lifting rigs shall be approved and labelled with a dedicated tag prior to use. User instructions and assembly instructions for the specific load-bearing beam must be followed.

NORSOK R-003N for the petroleum industry on the Norwegian continental shelf and NORSOK R-005N for onshore petroleum facilities should be used as the norm for approving lifting rigs.

8.2 Use of lifting rigs



8.3 Storage and transport of scaffolding equipment

a. All scaffolding equipment shall be secured against being dropped to a lower level at the worksite
b. All scaffolding equipment shall be stored horizontally during assembly and dismantling
c. Stored scaffolding equipment should be protected against adverse weather conditions
d. All scaffolding equipment that is transported on trolleys without side protection shall be attached using ratchet straps or another strap type. All other scaffolding equipment shall be transported on trolleys with full side protection
e. Fasteners shall never be thrown up or down – use a transport bag

8.4 Communication

When handling parts and equipment:

a. Ropes shall primarily be used when using wheels/hoists. Since it is the person at the bottom who controls the rope, it is important that the slinger gives a "thumbs up" signal before hoisting/lowering.
b. Involved personnel must remain focused and observant of what is happening at all times.
c. When hoisting, personnel shall remove themselves from the equipment's drop zone. Attention shall always be focused on the equipment when it is in motion. The cordoned-off area should be large enough that the sorting and storing of equipment can be performed safely within the cordoned-off area.
d. When scaffolding components are handled manually, the person receiving the component shall say 'yes' and/or give the component a brief lift to confirm that they have a firm grip on it.
e. When handling parts and equipment at height, the signal shall be agreed by the team before the work starts.

Remember affirmative communication!

9.0 Scaffolding over sea

Scaffolding erected over sea shall at a minimum be constructed at load class 3 and certified/approved at a load class lower than the class the scaffolding is intended for.

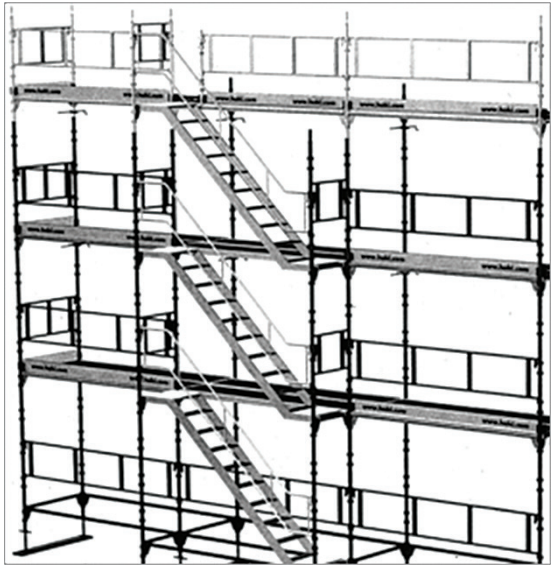
Scaffolding erected over sea shall have two knee boards in addition to a handrail; the minimum height shall be 145 cm.

All scaffolding erected over sea shall be re-certified weekly at a minimum, or following external influences such as strong winds, waves, vessels, etc. For scaffolding constructed under docks, or with a low height to sea, the scaffolding shall be re-certified daily before the work starts.

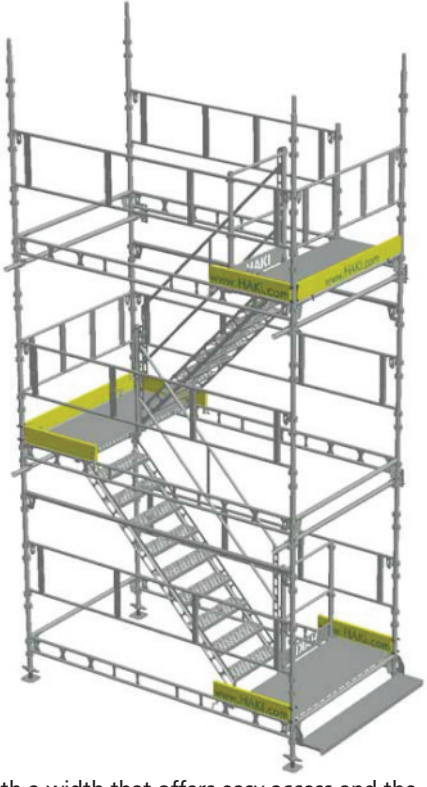
10.0 Access

Stairs for scaffolding access are approved for 100 kilos per m² in five flights above each other

Convenient access – simple assembly



Example of stair access to scaffolding



Example of stairs with a width that offers easy access and the possibility of evacuation via stretcher.

10.0 Access

Example of installed stair tower

Access to scaffolding is provided by a dedicated stair tower where appropriate. For larger scaffolds, there shall be max. 25 metres of free walkway between each stair tower.
Access should be such that it also can be used as escape routes.

Sufficient space shall be allowed for users, tools and materials. The work shall be able to be performed in working positions that do not result in unfavourable physical strain.

11.0 Inspection cards

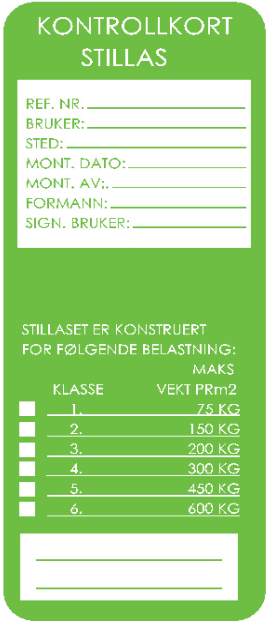
Use of inspection cards for scaffolding.

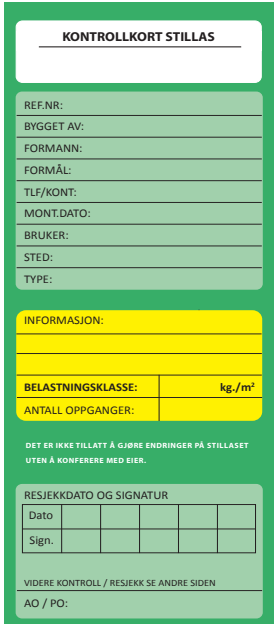
When assembling and dismantling scaffolding, the scaffold shall immediately be labelled “Danger – do not use scaffolding” at the entrances to the scaffold.

11.0 Inspection cards

The tag shall only be removed by the responsible scaffolding foreman/specialist scaffolder.

It is recommended that inspection cards with all information on the front of the tag are used, see examples below. Scaffolds that require the use of personal fall arrest equipment shall be marked with a ‘Use harness’ card. Equivalent cards can be used for hoists, tarpaulins and racks.





12.0 Access control

When implementing access control measures, only the necessary area shall be cordoned off. Access control measures that are no longer required shall be removed. Access control measures shall be clearly marked using signage or text with the following information:

a. Relevant hazard
b. Access type ("No access" or "Authorised personnel only")
c. Owner of the area
d. Channel or phone number on which the owner can be reached

The sign may also include information such as:

a. Reference to relevant work permit (if applicable)
b. When the cordon was established

FARE	STILLASBYGGING
ADGANG	KUN AUTORISERT PERSONELL
EIER	STILLASFORMANN, KANAL / TLF.
ARBEIDSTILLATELSE	AT 1234 / 08
SPERRING OPPRETTET	DATO / KLOKKEN

If the cordon constitutes a physical obstacle in an escape route, an alternative escape route shall be specified and clearly marked.

Existing guidelines for the use of access control measures shall be followed at all times. For more detailed information about the correct use of access control measures, see SfS Recommendation 026E: Access control.

13.0 Protection of equipment

Before starting work to erect the scaffold, safety critical equipment (e.g. pressure transmitters, instrument tubing, gas detectors and light fixtures) shall be identified together with the area operator. The equipment shall be protected/covered against dropped objects before work at height is carried out.

Trykktransmitter:

Instrumentrør:

Also remember to avoid personnel stepping on instrument tubing, insulated pipes, cable ducts, etc. (See image below)

14.0 References

Facade scaffolds made of prefabricated components – Part 1: Products specifications

NS-EN 12810-2 Facade scaffolds made of prefabricated components – Part 2: Particular methods of structural design

NS-EN 12811-1 Temporary works equipment – Part 1: Scaffolds – Performance requirements and general design

NS-EN 12811-2 Temporary works equipment – Part 2: Information on materials

NS-EN 12811-4 Temporary works equipment – Part 4: Protection fans for scaffolds – Performance requirements and product design

NS-EN 1004-1 Mobile access and working towers made of prefabricated elements — Part 1: Materials, dimensions, design loads, safety and performance requirements

NS-EN 74-1 Couplers, spigot pins and baseplates for use in falsework and scaffolds – Part 1: Couplers for tubes – Requirements and test procedures

NS-EN 74-2 Couplers, spigot pins and baseplates for use in falsework and scaffolds – Part 2: Special couplers – Requirements and test procedures

NS 9610 Fall protection — Work at height — Training and execution

NS 9700 Training system for personnel who shall work on or with scaffolding

Regulations concerning organisation, management and employee participation (section 15)

Regulations concerning the execution of work (section 10.4)

Regulations concerning the construction, design and production of work equipment and chemicals (the Producer Responsibility Regulations)

15.0 Suspension devices

The capacities of the most commonly used clamps are shown below, but remember to check the equipment's labels and assembly instructions. The capacity of the grating may take precedence.

HAKI Clamp L-beam

Weight: 5.3 kg
Permitted load: 20.0 kN

Designed for
L-beam from 60-120 mm.

HAKI Clamp bulb

Weight: 1.6 kg
Permitted load: 12.0 kN

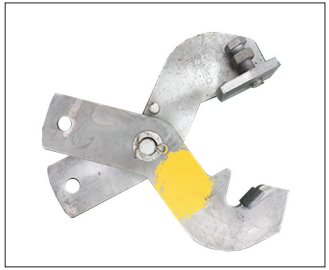
Specially designed for
bulb 160x8.

NB: Other producers can have almost identical clamps with lower permitted load.

Solideq Clamp bulb

Weight: 3.8 kg
Permitted load:
20.0 kN

Specially designed for bulb 160-240.



HAKI Clamp H-beam

Weight: 6.8 kg and
5.1 kg
Permitted load: 20.0 kN

Designed for H-beam 150-300 and 80-180

HAKI Suspension device grating

Weight: 2.4 kg
Permitted load: 20.0 kN

NB! Check grating type prior to suspension.

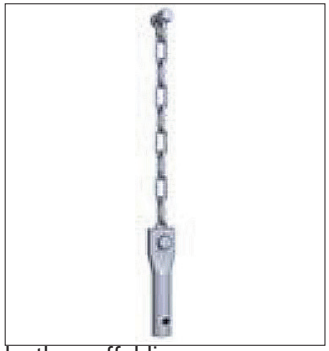
15.0 Suspension devices

HAKI Suspension device chain

Weight: 4.3 kg and
3.0 kg
Permitted load: 20.0 kN

Suspension device chain 1362 and 850.

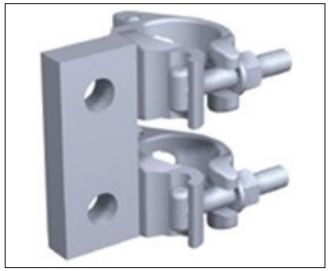
NB: Only short-link chain should be used around beams and tubes in order to avoid damaging the links.



Chain shall be approved for use by the scaffolding manufacturer and certified in accordance with the Producer Responsibility Regulations.

HAKI Suspension device double

Weight: 2.1 kg
Permitted load: 20kN

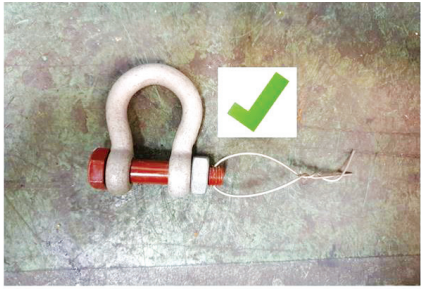


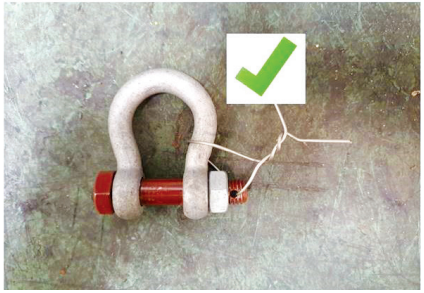
When using H-beam or L-beam clamps, wire/string can be used around the ‘neck’ of the H-beam or L-beam clamp in order to secure it before attaching the shackle and chain.

15.0 Suspension devices

Securing of shackles

Only shackles with double retention shall be used. Generally this will be shackles with split pins, but on scaffolds wire may also be used **as long as the shackle is not used as lifting equipment.** Be aware that the hole for the wire must be far enough down the bolt that it ensures the nut cannot unscrew over the wire.



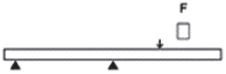


16.0 Formulae and tables

NB: All tables are typical values based on the Stillasboka (Scaffolding Book) and previous handbook from Equinor. Use the assembly instructions/user guide for the actual equipment you are using!

The formula for the calculation of aluminium tubes is the same as for steel, but different types of aluminium tube may have differing bending moments. The bending moment for the aluminium shall be specified by each individual manufacturer or supplier.

Point load on tube supported at one end.
Applies to steel tubes in accordance with NS-EN 39 and aluminium tubes in accordance with NS-EN 12811-2.



F = 0,93/L

Tube length	Max. permitted point load F
0,1 m	930 kg
0,2 m	465 kg
0,3 m	310 kg
0,4 m	232 kg
0,5 m	186 kg

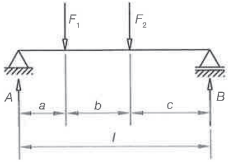
Point load on tube supported at both ends.
Applies to steel tubes in accordance with NS-EN 39 and aluminium tubes in accordance with NS-EN 12811-2.

F = 0,93 x 4/L

Tube length	Max. permitted point load F
0,2 m	1860 kg*
0,4 m	930 kg
0,6 m	620kg
0,8 m	465 kg
1,0 m	372 kg
1,2 m	310 kg
1,4 m	265 kg
1,6 m	232 kg
1,8 m	206 kg
2,0 m	186 kg

* This load must not exceed 1220 kg when using A couplers and 1820 kg when using B couplers

Acentric point loads on freely supported lattice beams.

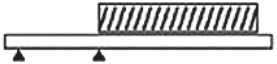


$$\text{Opplagringskraft i } A = \frac{F_2 \cdot c + F_1(b + c)}{l}$$

$$\text{Opplagringskraft i } B = \frac{F_1 \cdot a + F_2(a + b)}{l}$$

Bending moment at F1 = Force (A) x distance (a)
Bending moment at F2 = Force (B) x distance (c).

Evenly distributed load on tube, free end.
Applies to steel tubes in accordance with NS-EN 39 and aluminium tubes in accordance with NS-EN 12811-1.

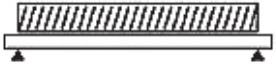


F = 0,93 x 2/L

Tube length	Max. evenly distributed load Q
0,1 m	1860 kg *
0,3 m	620 kg**
0,5 m	372 kg
0,7 m	265 kg
1,0 m	186 kg

* This load must not exceed 610 kg when using A couplers and 910 kg when using B couplers
** This load must not exceed 610 kg when using A couplers

Evenly distributed load on tube, supported at both ends.
Applies to steel tubes in accordance with NS-EN 39 and aluminium tubes in accordance with NS-EN 12811-2.



F = 0,93 x 8/L

Tube length	Max. evenly distributed load Q
1,0 m	744 kg
1,2 m	620 kg
1,5 m	496 kg
1,8 m	414 kg
2,0 m	372 kg

16.0 Formulae and tables

Examples of couplers:

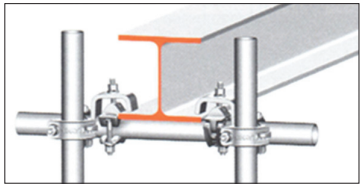


Fig 1
Beam couplers (SK)
– max. load 3.6 kN
(must be used in pairs)

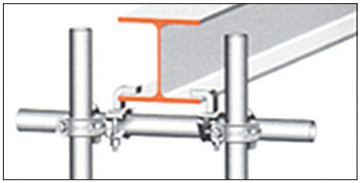


Fig 2
Beam couplers –
max. load 9.0 kN
(must be used in pairs)

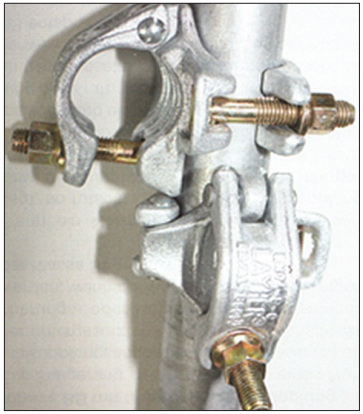


Fig 3. Example of doubling

Tillatt last på klips/kobling::

Coupler type:	*kN*	*Ca kg*
Fixed coupler A and swivel coupler	6.1	610
Fixed coupler B and beam coupler	9.1	910
Fixed coupler BB double (2pcs)	15	1500
Swivel coupler A (center bolt)	3.6*	360*
Swivel coupler B (center bolt)	5.5*	550*

* Estimated from test load in NS-EN 74-1

NB: This is what the coupler tolerates. Remember to check how much the scaffolding/standard itself will tolerate! Fixed and swivel couplers shall be tightened with 50 Nm. All couplers shall be approved and tested in accordance with NS-EN 74-1

16.0 Formulae and tables

Table 1: Buckling length and permitted compressive force

Permitted compressive force for steel and aluminium tubes as a function of buckling length:

Effective Buckling length lk (m)	Eccentricity e due to coupler (mm)	Steel tube Type 3 tube Permitted compressive force Fk Fk (kN)	Aluminium 4 mm Permitted Compressive force Fk (kN)
1,0	53,5	15,0*	12,0*
1,5	53,5	14,0*	8,9
2,0	53,5	12,2*	6,8
2,5	53,5	10,3*	5,3
3,0	53,5	8,5	4,2
3,5	53,5	7,1	3,3
4,0	53,5	5,9	2,7
4,5	53,5	5,0	2,2
5,0	53,5	4,3	1,9
5,5	53,5	3,7	1,6
6,0	53,5	3,2	1,4

*= Only with doubling coupler (BB)

Table 2: Scaffolding classes

	Evenly distributed load	Concentrated load on area 500x500mm	Load on a person on area 200x200mm	Load on sub-area		
						Sub-area
Klasse	kN/m² (kg/m²)	kN (kg)	kN (kg)	kN/m²	(kg/m²)	m²
1	0,75 (75)	1,50 (150)	1,0 (100)		Not permitted	
2	1,50 (150)	1,50 (150)	1,0 (100)		Not permitted	
3	2,00 (200)	1,50 (150)	1,0 (100)		Not permitted	
4	3,00 (300)	3,00 (300)	1,0 (100)	5,00	(500)	0,4A
5	4,50 (450)	3,00 (300)	1,0 (100)	7,50	(750)	0,4A
6	6,00 (600)	3,00 (300)	1,0 (100)	10,00	(1000)	0,5A

A = The area between two standard pairs.

Foundations: Before assembly of the scaffolding starts, the load-bearing capacity of the underlying surface must be assessed. We assume that the ground tolerates the following loads (ref. Stillasboka): Table 3, page 51.

16.0 Formulae and tables

Table 3: Load on different surface types

Surface	kN/m²	(kg/cm²)	Standard pressure * kN (kg)
Gravel and stone	500	(5)	11,25 (1125)
Asphalt (street)	500	(5)	11,25(1125)
Coarse sand, compacted	375	(3,75)	8,44 (840)
Asphalt (pavement, etc.)**	300	(3)	6,75 (675)
Fine sand, compacted	250	(2,5)	5,63 (563)
Fine sand, loosely packed	125	(1,25)	2,81 (281)
Clay, less firm***	80	(0,8)	1,80 (180)

* Assumed footplate is 15 x 15 cm when calculating max. standard pressure. Calculation of permitted standard pressure is the surface's tolerance times the area of the footplate (usually 15 x 15 cm = 0.0225 m²).

** The load-bearing capacity of asphalt is significantly reduced in sun/heat

*** Depending on dryness and firmness, the load-bearing capacity can vary from 80 kN/m² to 375 kN/m² in ground samples. The lowest figure is used here in order to be on the safe side.

Ground pressure = Force (F) /Area

The use of large, preferably rubberised, surfaces will provide an increased permitted standard pressure. It will also provide increased friction and a reduced buckling length.

Steel decks offshore tolerate standards with footplates.

Table 4: Grating loads

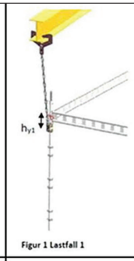
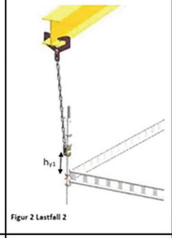
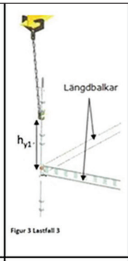
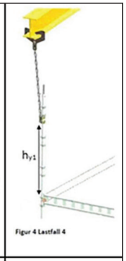
The table is based on suspension/ground plates of 150 x 150 mm, and that four load bars are loaded.
The table applies to S355-quality grating

Span (mm)	Max load Load bar 35x5 mm XSP-535-41/101-5 (kN)	Max load Load bar 30x5mm XSP-530-41/101-5 (kN)
300	18,7	13,4
400	12,9	9,3
500	9,9	7,1
600	8,0	5,8
700	6,7	4,8
800	5,8	4,2
900	5,1	3,7
1000	4,5	3,3
1100	4,1	3,0
1200	3,7	2,7
1300	3,4	2,5
1400	3,2	2,3
1500	3,0	2,2

NB!: If the scaffold shall be placed on composite grating, the load tables for the relevant grating type must be acquired.

16.0 Formulae and tables

Table 5: Reduction of capacity in relation to suspension attachment point (example from HAKI scaffolding)

	 Figur 1 Lastfall 1	 Figur 2 Lastfall 2	 Figur 3 Lastfall 3	 Figur 4 Lastfall 4
Vinkel	**kN**	**kN**	**kN**	**kN**
0	**11,8**	**11,8**	**11,8**	**11,8**
5	**11,2**	**13,2**	**13,2**	**13,2**
10	**10,6**	**14,9**	**10,8**	**5,4**
15	**10,1**	**17,3**	**5,8**	**3,2**
20	**9,6**	**15,2**	**3,9**	**2,2**
25	**9,1**	**9,8**	**2,9**	**1,7**
30	**8,7**	**7,1**	**2,2**	**1,3**
35	**8,2**	**5,4**	**1,8**	**1,1**
40	**7,7**	**4,3**	**1,5**	**0,9**
45	**7,5**	**3,4**	**1,2**	**0,7**