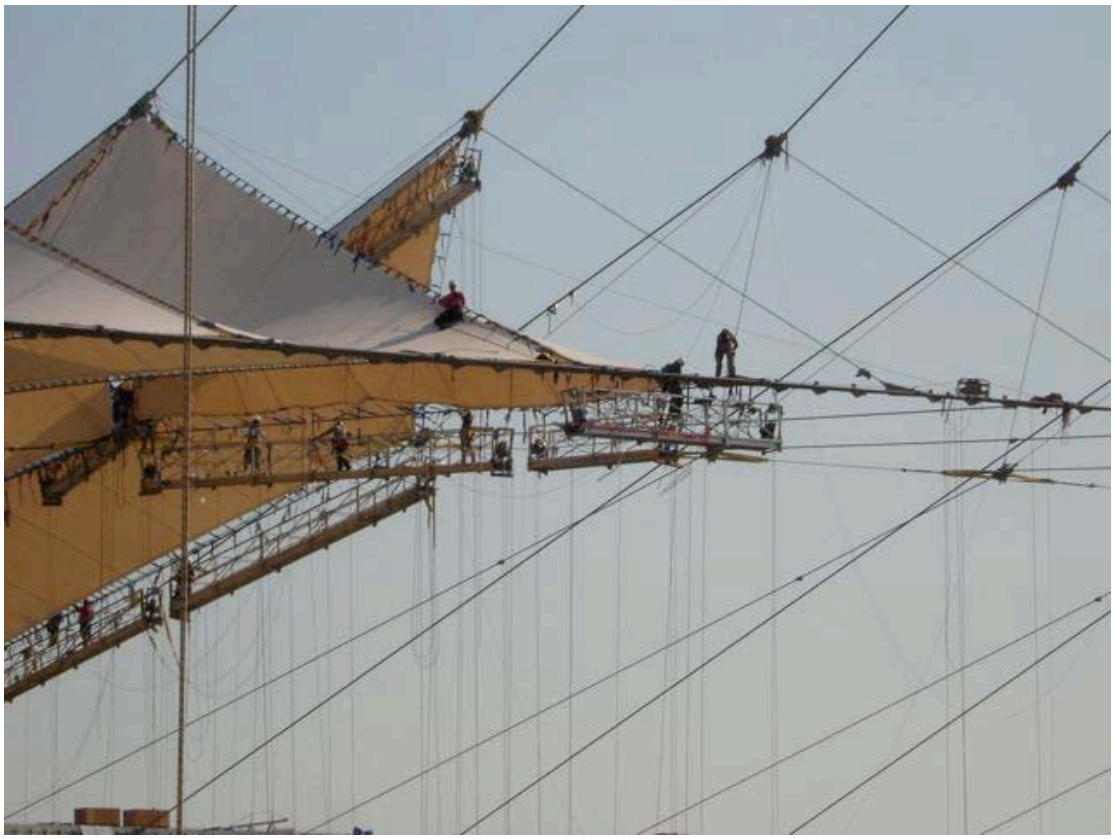
ILO CONSTRUCTION OS&H

A free, comprehensive, international, digital training package in occupational safety and health for the construction industry

THEME SUMMARY 14: WORKING AT HEIGHT



(Photo: Fiona Murie, BWI)

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1 PREFACE

This Theme Summary describes ways in which to work at height in ways that safeguard the people involved. The components, plant and equipment used are described in the Theme Summary 10: "General plant and equipment".

This Theme Summary follows the relevant structure and content of the "ILO Code of Practice: Safety & health in construction" (the "Code"). The following passage is taken from this Code:

1.1. Objective

1.1.1. The objective of this code is to provide practical guidance on a legal, administrative, technical and educational framework for safety and health in construction with a view to:

(a) preventing accidents and diseases and harmful effects on the health of workers arising from employment in construction;

(b) ensuring appropriate design and implementation of construction projects;

(c) providing means of analysing from the point of view of safety, health and working conditions, construction processes, activities, technologies and operations, and of taking appropriate measures of planning, control and enforcement.

1.1.2. This code also provides guidance in the implementation of the provisions of the ILO Safety and Health in Construction Convention, 1988 (No. 167), and the ILO Safety and Health in Construction Recommendation, 1988 (No. 175)."

Other passages from this Code are included in this Theme Summary, and they are shown in the same format as above.

This Theme Summary also includes extracts from the ILO's "Safety, health and welfare on construction sites: A training manual" (the "manual"). Further details of this manual and the Code are given in Section 8 below "Relevant elements of the Knowledge Base".

This Theme Summary follows the sections shown in the table above.

2 COMMON HAZARDS WITH WORKING AT HEIGHT

Although obviously hazardous, working at height should create no hazards for anyone on a construction project. Many of the hazards that do arise have the following causes:

- Poor conceptual design of the permanent works (designed with no thought or provision for how they will be built)
- Poor structural design (breaks under load, not strong enough, components fracture or malfunction)
- Poor functional design (not properly designed for the stated purpose)
- Inadequate planning and provision for weather
- Structural elements incorrectly erected or installed
- Poor (or perhaps no) workplace design (working platforms, access, egress)
- Signalling systems (manual, mechanical, electronic) malfunction
- Misuse (elements and equipment not used as designed or planned)
- Unprotected edges and openings
- Loads insecurely attached
- Release of pressure (concrete pumps)

These cause the following hazards:

- Workers put in dangerous positions
- Workers handling very heavy or awkward loads causing falls or injury
- Falls due to collapses of partly built permanent works
- Workers crushed by falling or otherwise moving elements or equipment
- Falling loads
- Crushing due to impact of moving or toppling plant and equipment
- Impact from release of pressure (e.g. concrete exploding from concrete pump hose failure)
- Falling from plant and equipment
- Falls caused by swinging loads, plant and equipment
- Limbs or bodies caught in parts of the permanent works or machinery
- Physiological damage through exposure to weather
- Poor ergonomics
- Physiological and psychological damage through stress of dangerous work
- Stress caused by poor environment (noise, heat, poor ventilation, chemicals, noxious gases)

(Photos: Richard Neale. Project in Dar es Salaam)

3 GENERAL OS&H REQUIREMENTS WHEN WORKING AT HEIGHT

Fall of materials

8.1.1. Where necessary to guard against danger, or where the height of a structure or its slope exceeds that prescribed by national laws or regulations, preventive measures should be taken against the fall of workers and tools or other objects or materials.

3.4.1. Adequate precautions should be taken such as the provision of fencing, look-out men or barriers to protect any person who might be injured by the fall of materials, or tools or equipment being raised or lowered.

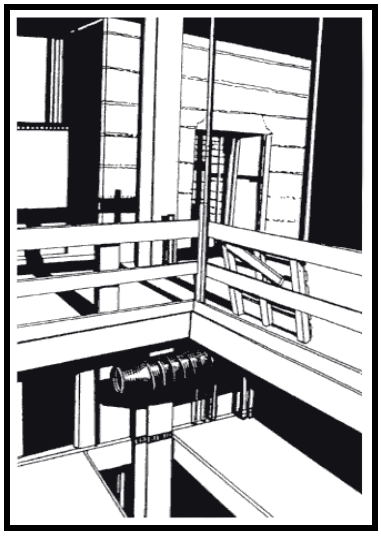
Openings

3.4.3. All openings through which workers are liable to fall should be kept effectively covered or fenced and indicated in the most appropriate manner.

3.4.4. As far as practicable, guard-rails and toe-boards in accordance with national laws and regulations should be provided to protect workers from falling from elevated work places. Wherever the guard-rails and toe-boards cannot be provided:

> *(a) adequate safety nets or safety sheets should be erected and maintained; or*
>
> *(b) adequate safety harnesses should be provided and used.*

8.1.2. Elevated workplaces, including roofs more than 2m or as prescribed, above the floor or ground should be protected on all open sides by guard-rails and toeboards complying with the relevant national laws and regulations. Wherever guard-rails and toe-boards cannot be provided, adequate safety harnesses should be provided and used.



Ladders

8.1.3. Elevated workplaces, including roofs, should be provided with safe means of access and egress such as stairs, ramps or ladders complying with the relevant national laws and regulations.

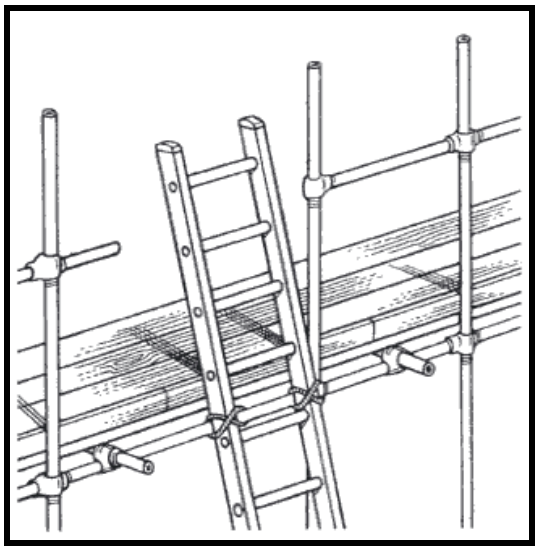
Every year many workers are killed or severely injured while using ladders of all types. Because a ladder is so readily available and inexpensive, its limitations are easily overlooked. So the first question to ask is – can the job be done more safely using other equipment? For example, a proper working platform can often ensure that the job is performed more quickly and efficiently.

If a ladder is properly used it:

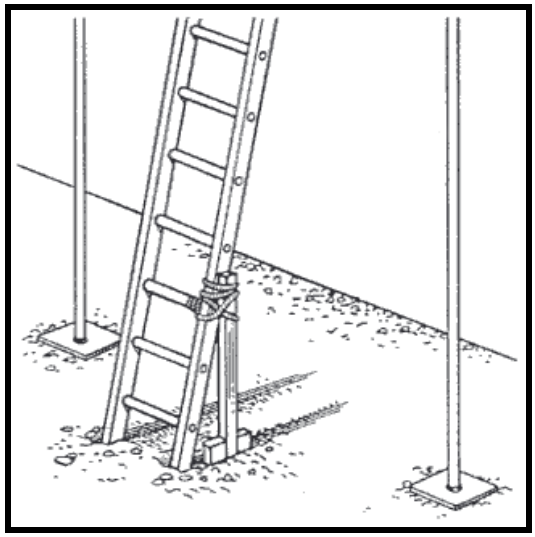
- Enables only one person to climb or descend at any one time.
- Enables only one person to work from it at any one time.
- If not lashed at the top, it requires two workers for use – one on the ladder and the other at the bottom.
- Leaves only one hand free; carrying tools or loads up a ladder is difficult and dangerous and the weight which can be carried is severely limited; there is also the risk of dropping items on passers-by.
- Restricts movement.
- Has to be safely situated and secured.
- Has a limitation on heights at which it can be used.

More than half of ladder accidents are caused by the ladder slipping at the base or at the top. The foot of a ladder should be on a firm and level base. If possible, the ground should be levelled or the foot of the ladder buried. If the ground is soft, the ladder should stand on a board. The ladder should never be supported by carrying its total weight on the bottom rung – only the stiles or side members are meant for this.

The head of the ladder should rest against a solid surface able to withstand the loads imposed on it; otherwise a ladder stay should be used. Ladders should be tied or otherwise fixed at the top – someone should hold the ladder at the foot while this is done.



If this is impracticable, the ladder must be secured at the bottom by tying it to stakes in the ground or by using sandbags.



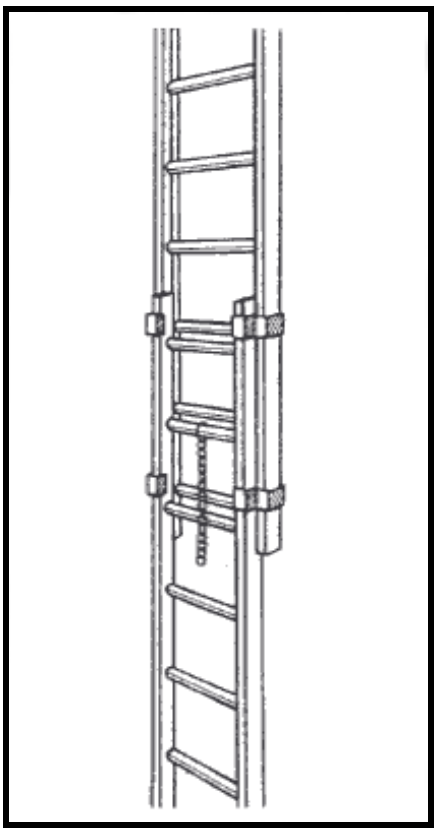
If neither is practicable, a worker should be at the foot of the ladder to prevent it slipping while someone is working from it, but this precaution is only effective if the ladder is not more than 5m in length. The fellow worker should face the ladder with a hand on each stile and with one foot resting on the bottom rung. The use of non-slip pads on ladder feet helps to prevent ladders slipping at the base.

Using ladders safely means observing the following precautions:

- Make sure there are no overhead power lines with which the ladder might make contact.
- Wooden ladders with wire-reinforced stiles should be used with the wired side facing away from you. Wire tie rods should be beneath and not above the rungs.
- The ladder should extend at least 1m above the landing place, or above the highest rung on which the worker has to stand, unless there is a

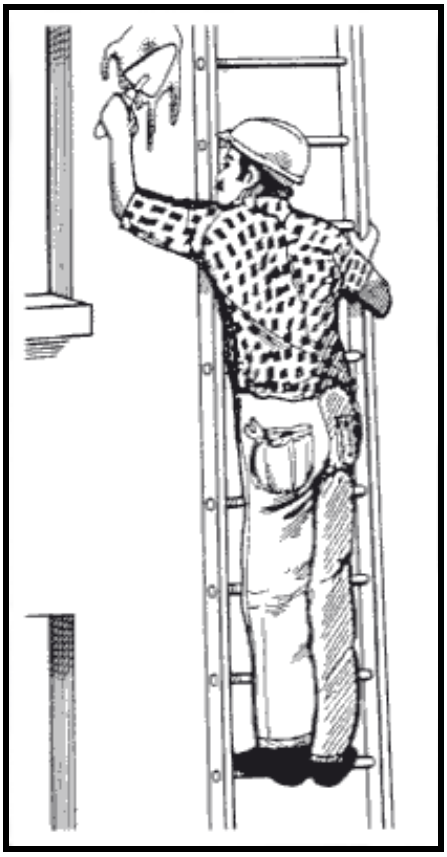
suitable handhold to provide equivalent support; this is to stop the risk of over-balancing when stepping off and on at the top.

- Workers should be able to step off the ladder at the working place without being required to climb over or under guard-rails or over toe boards; the gaps in guard-rails and toe boards must as small as possible.
- Ladders which are too short should never be used. And they should never be stood on something such as a box, bricks or an oil drum to gain extra height.
- The ladder should be placed at a safe angle of about 75° to the horizontal, that is about 1 m out at the base for every 4m in height.
- Workers must face the ladder when climbing or descending and ensure that there is sufficient space behind the rungs to provide a proper footing.
- On extension ladders, there must be an overlap of at least two rungs for sections up to about 5m in length and at least three rungs for sections of more than 5m in length.



- Extension ladders must always be raised and lowered from the ground and hooks or locks must be properly engaged before use.
- Workers should make sure that their footwear is free from mud or grease before they begin to climb a ladder.
- Ideally, tools should be carried in pockets or a holster or bag when climbing ladders so as to leave both hands free to grip the stiles.

- It is better not to carry materials while climbing ladders – a hoist line should be used instead.



- A common cause of accidents is overbalancing or overreaching; instead move the ladder.

Points to remember

Make sure that the ladder is long enough for the job

Avoid carrying tools or materials in your hand while you are climbing ladders

Don't over-reach

Clean your footwear before climbing

Care of ladders:

- Ladders need to be inspected regularly by a competent person and damaged ladders removed from service.
- Timber ladders should be checked for splits or cracks, splintering or warping, and metal ladders for mechanical damage. Both should be checked for missing, loose or worn rungs.
- Ladders should be capable of being individually identified, e.g. by some form of marking.
- Ladders not in use should not be left on the ground so that they are exposed to weather water and impact damage. They should be properly stored on racks under cover and above ground, and ladders over 6 m in length should have at least three support points to avoid sagging.
- A ladder should not be hung from its rungs or from one stile as this tends to pull out the rungs.
- Timber ladders should be kept in areas with good ventilation which are free from excessive heat or dampness.
- Timber ladders and equipment may be coated with transparent varnish or preservative, but should not be painted as paint conceals defects.
- Aluminium ladders should be given an adequate protective coating when they are likely to be subject to acids, alkalis or other corrosive substances.

Points to remember

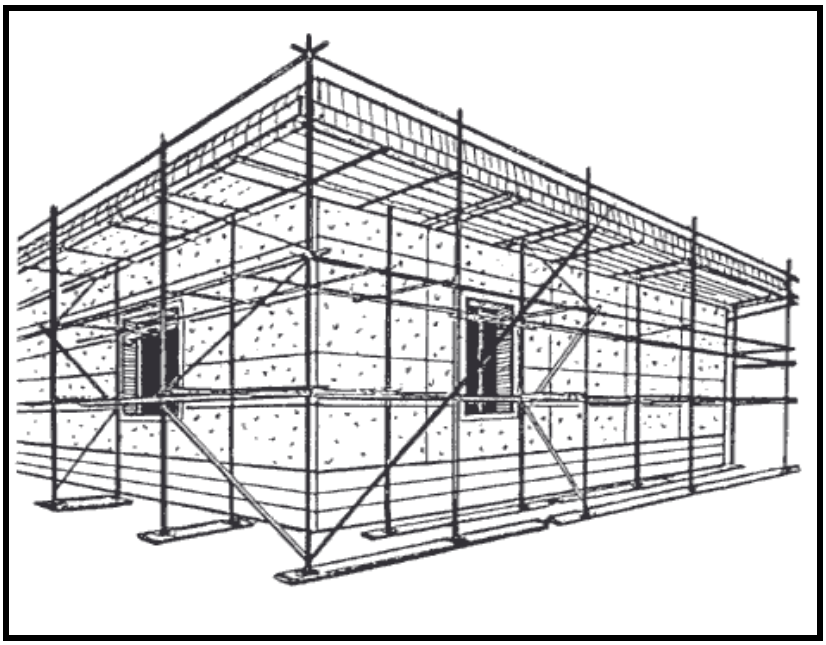
Always inspect your ladder before you use it

Remove damaged ladders from use and make sure that they are properly repaired. If they cannot be properly repaired, they must be destroyed

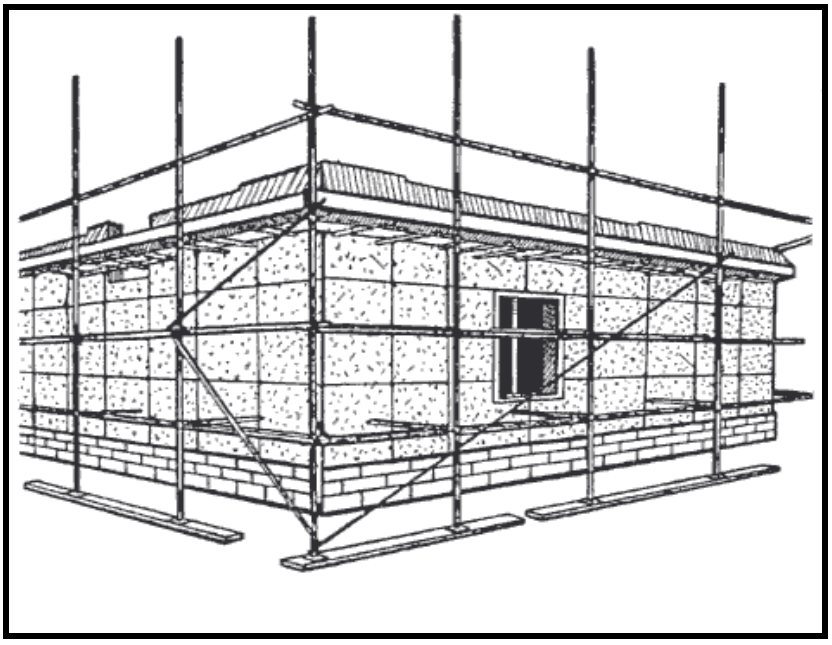
4 SCAFFOLDING

General requirements

4.1.1. Where work cannot safely be done on or from the ground or from part of a building or other permanent structure, a safe and suitable scaffold should be provided and maintained or other equally safe and suitable provision should be made.



The diagram above shows an independent tied scaffold which does not rely on the building for its strength. It has inner and outer rows of uprights or standards.



The above shows a single pole or putlog scaffold, with a single outer row of uprights or standards and which is partly supported by the building which consists of a platform resting on horizontal putlogs (called transoms in independent scaffolds) fixed at 90° to the face of the building. The outer ends of the putlogs are supported on horizontal ledgers fixed parallel to the face of the building and secured to a single row of uprights or standards, also parallel to the wall. The flattened inner end of the putlogs rests flat on the wall, or in holes in the wall, rather than on ledgers. It follows that the scaffold cannot stand without the support of the structure. Putlog scaffolds are mostly used where brick structures are being built. The same principles of good construction as for independent scaffolds are generally applicable.

A good base for the single row of uprights is essential and the base plates for each upright should again rest on a timber sole board – a sole board should be long enough to support at least two uprights. The uprights should be not more than 2m apart and set at 1.3m from the wall to allow for a five-board platform. Ledgers should be connected on the inside of the uprights, at a vertical distance of not more than 2m – a lesser distance may be necessary for some types of work – and left in position as the scaffold rises.

Putlogs should rest on and be secured to the ledgers at horizontal gaps depending on the thickness of the boards used – of not more than 1.5m for boards of 38mm – while their flattened, or spade, ends should lie on the brickwork, or enter the wall to a depth of at least 75mm. For repointing old brickwork, the spade ends can rest vertically in joints in the brickwork. Tying into the building is of even greater importance than with independent scaffolds, as putlogs can easily work loose in brickwork. In this type of scaffold, bracing along the face and to the full height of the scaffold is required. Bracing should be at an angle of about 45° to the horizontal and at 30metre intervals. The requirements already described for the construction of working platforms and gangways and for the erection of guard-rails and toe boards apply equally to putlog scaffolds.

4.1.2. Scaffolds should be provided with safe means of access, such as stairs, ladders or ramps. Ladders should be secured against inadvertent movement.

(Photo: Richard Neale, permission granted by the scaffolders)

The photo shows ladder leading from one secure platform to another, securely tied at top and midway.

4.1.3. All scaffolds and ladders should be constructed, erected and used in accordance with national laws and regulations.

4.1.4. Every scaffold should be properly designed, constructed, erected and maintained so as to prevent collapse or accidental displacement when properly used.

4.1.5. Every scaffold and part thereof should be:

(a) designed so as to prevent hazards for workers during erection and dismantling;

(b) designed so that guard rails and other protective devices, platforms, putlogs, rakers, transoms, ladders, stairs or ramps can be easily put together;

(c) of suitable and sound material and of adequate size and strength for the purpose for which it is to be used and maintained in a proper condition.

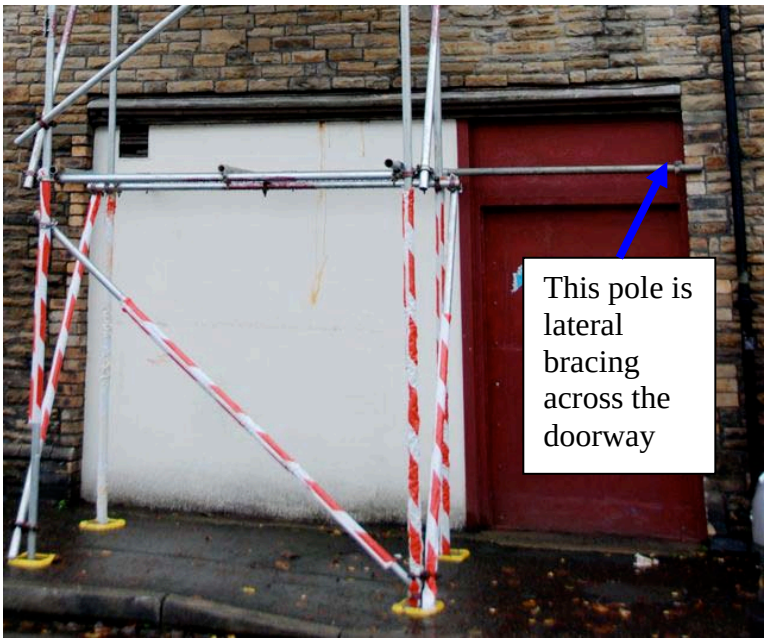
4.1.6. The competent authority should establish and enforce laws, regulations or standards covering detailed technical provisions for the design, construction, erection, use, maintenance, dismantling and inspection of the different kinds of scaffolds and ladders used in construction work.

Design and construction

4.3.1. Scaffolds should be designed for their maximum load and with a safety factor of at least 4, or as prescribed by the competent authority.

4.3.2. Scaffolds should be adequately braced.

(Photo: Richard Neale, permission granted by the scaffolders)



(Photo: Richard Neale, permission granted by the scaffolders)

The main photo shows good diagonal bracing in two directions. The detailed photo shows additional lateral bracing between reveals of an old doorway in the building.

4.3.3. Scaffolds which are not designed to be independent should be rigidly connected to the building at suitable vertical and horizontal distances.

(Photo: Richard Neale, permission granted by the scaffolders)

This detail of the main photo shows how the top of the scaffold has been taken over the ridge of the roof to anchor the scaffold to the building.

4.3.4. A scaffold should never extend above the highest anchorage to an extent which it might endanger its stability and strength.

4.3.5. Sufficient putlogs and transoms should remain in position and securely fastened to the ledgers, uprights or standards, as the case may be, to ensure the stability of the scaffold until it is finally dismantled.

4.3.6. All scaffolds and appliances used as supports for working platforms should be of sound construction, have a firm footing, and be adequately strutted and braced to maintain their stability.

4.3.7. Loose bricks, drainpipes, chimney-pots or other unsuitable material should not be used for the construction or support of any part of a scaffold.

4.3.8. When necessary to prevent danger from falling objects, working platforms, gangways and stairways of scaffolds should be provided with overhead screens of adequate strength and dimensions.

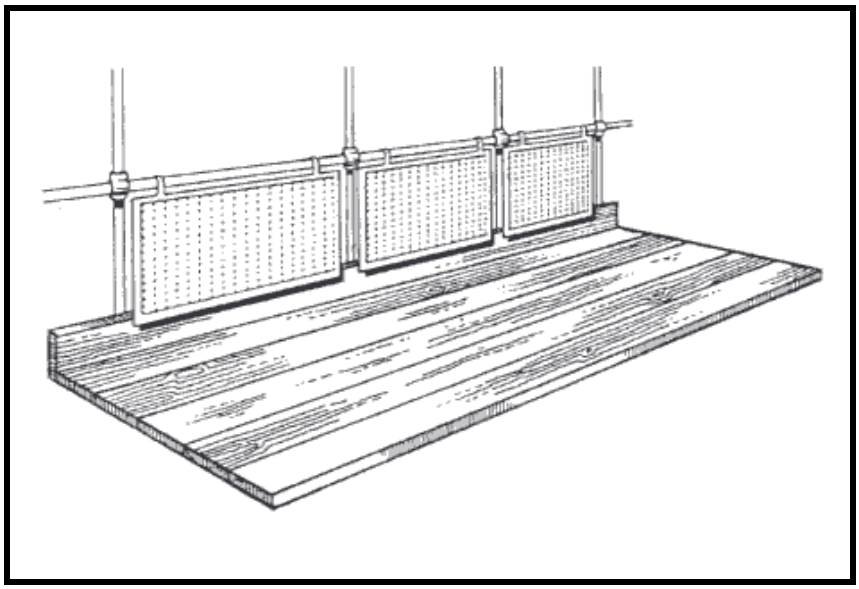
4.3.9. Nails should be driven full length, and not driven part way and then bent over, and should not be subject to direct pull.

4.3.10. Scaffolding materials should not be thrown from scaffolds or from heights. Other materials should only be thrown from scaffolds or heights where the landing area has been designated, protected, appropriate notices displayed, and is under the supervision of a person on the landing level.

4.3.11. Metal scaffolds should not be erected in closer proximity than 5m to overhead electricity transmission lines equipment except in accordance with safety distances laid down by the competent authority or after the electrical transmission line or equipment has been rendered electrically dead.

4.3.12. As far as practicable, every part of a working platform, gangway or stairway of a scaffold from which a person is liable to fall a distance of 2m or as prescribed in the national laws or regulations, should be provided with guard-rails and toe-boards complying with the relevant national standards.

Guard-rails and toe-boards should be fitted on the inside of the uprights. Guard-rails should be between 90cm and 115m above the platform to prevent workers from easily falling over or under the rail. Toe boards, which are also intended to prevent material being knocked over the edge of the platform, must rise at least 15cm above the working platform to achieve this, and if materials are stored to greater than this height then additional boards may be necessary or the space filled in with wire mesh.



Working platform showing guard-rail and toe board with wire mesh filling between them and the closely boarded platform.

(Photo: Richard Neale. St David's 2, Cardiff, UK)

The photo shows propriety safety barriers, scaffolding safety barriers, 'fans' to catch falling materials and other items, and some protective netting.

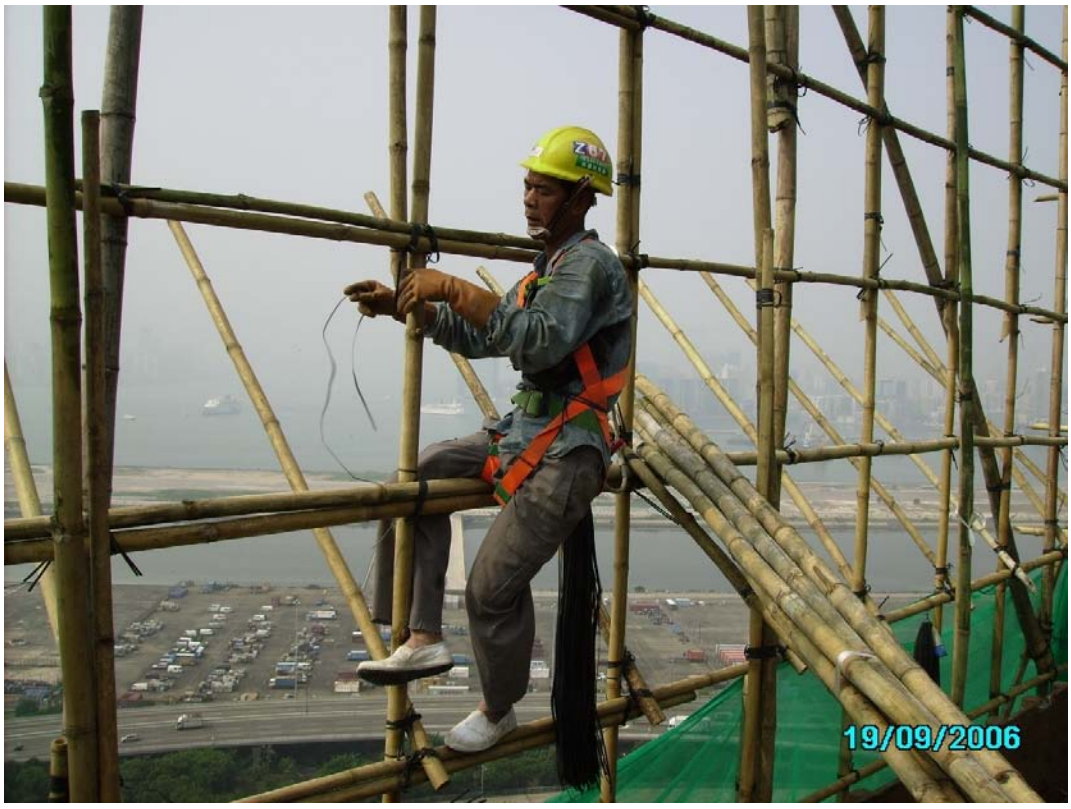
4.3.13. Platforms on scaffolds should be of adequate dimension, especially in width, for the tasks performed from the scaffold.

Bamboo scaffolding

This is widely used in parts of Asia. It has been the subject of a research study in Hong Kong, published by the Institution of Civil Engineers (See Section 8: Relevant elements of the Knowledge Base, below), which concluded:

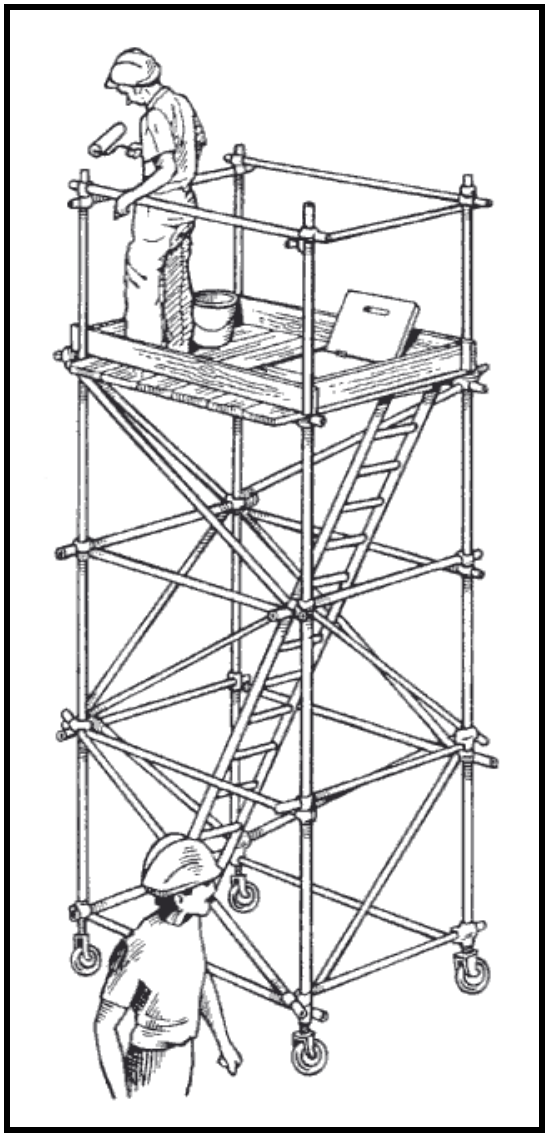
Hong Kong's skyline is dominated by some of the world's tallest buildings. Nevertheless, the city still uses bamboo scaffolding for much of its construction work – a traditional skill passed down over 5000 years. Bamboo is sustainable, lightweight and cheap and, as long as it remains fairly dry, a good construction material with significant mechanical properties. Researchers, engineers, environmentalists and bureaucrats have taken an increasing interest in the craft, such that regulations and practice continue to be improved and refined. However, to alleviate remaining design and safety concerns a structural design code is needed.

One of the important findings was the increased use of personal protective equipment, although being a bamboo scaffolder remains a dangerous occupation.



[From the paper "Hong Kong-bastion of bamboo scaffolding", by M Ramanathan, Proceedings of ICE- Civil Engineering, Volume: 161, Issue: 4, November 2008.
Photograph by the author of the paper, Muthukaruppan Ramanathan}

Tower scaffolds



A tower scaffold consists of a platform resting on horizontal ledgers connected to four uprights, supported on base plates if static or on castor wheels if mobile. It is devised for painters and others who do lightweight work of limited duration mainly in one place.

The first precaution with tower scaffolds is to achieve stability. For this the ratio of height to base width should not be more than 4:1 for a static tower used indoors. For a static tower used outdoors the ratio is reduced to 3.5:1, while for a mobile tower used outdoors it should not be more than 3:1. Any loading on the platform will raise the centre of gravity of the tower and too great a load will endanger its stability.

Static towers should not exceed 12m in height when free-standing, and above this height they should be tied. Mobile towers should not exceed 9.6m in height when free-standing or 12m when tied to a structure.

Towers should be vertical, have a single platform and be used only on a firm and level base, with the uprights of static towers on adequate base plates.

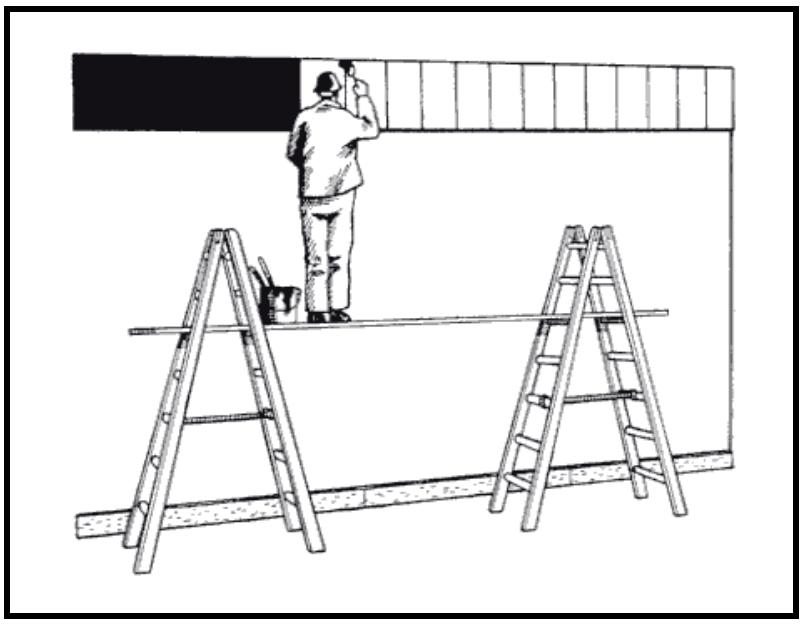
Dimensions will vary according to need but corner standards should never be less than 1.2m apart. The uprights of mobile towers should have castor wheels of not less than 125mm in diameter which are locked into the base of the uprights. The castor wheels should be fitted with locks or brakes which cannot be accidentally released, and you should ensure that the brakes are applied whenever the tower is stationary.

The platform should be equipped with a cover for the ladder access opening which is able to be fixed in both open and closed positions with a latch. This prevents an accidental step into the opening. The cover should be provided with a suitable handhold to provide support when climbing through the opening. Guard-rails and toe boards will be necessary for the sides of the working platform, erected as for independent scaffolds. The ladder provided for access to the working platform should be positioned inside the tower as a precaution against overturning.

Accidents can happen when a tower topples over. This is likely to happen in any of the following cases:

- The ratio of the height of the tower to the width of the base is excessive
- The top working platform is overloaded causing the tower to become unstable
- Mobile tower scaffold-wheels not locked when in use
- A ladder is placed on the top platform to extend the height of the tower
- Work involving percussion tools produces an outward horizontal or lateral force at the top of the tower
- A mobile tower is moved with persons or materials carried on the top platform
- The tower is used on sloping or uneven ground
- The tower is not tied to the building or structure where this is necessary
- Access to the platform is via the outside of the tower

Trestle scaffolds



Trestle scaffolds are simply working platforms supported on “A” frames or a similar type of folding support.

Trestle scaffolds, whether the trestles be fixed or folding in type, should be used only for light work of comparatively short duration. Folding trestles should be used only for scaffolds of one tier in height, and the working platform should be at least 430mm (two scaffold boards) wide. One-third of the height of the trestles should be above the working platform. Fixed trestles should not be used for scaffolds of more than two tiers in height, and where the working platform is more than 2m high guard-rails and toe boards should be provided.

Mobile platforms

In many applications, mobile towers, as shown in the photo below, are superseding tower and trestle scaffolds. These offer a more flexible and safe alternative.

(Photo: Richard Neale. St David’s 2, Cardiff, UK)

Inspection and maintenance

4.4.1. Scaffolds as prescribed by national laws or regulations should be inspected, and the results recorded by a competent person:

(a) before being taken into use;

(b) at periodic intervals thereafter as prescribed for different types of scaffolds;

(c) after any alteration, interruption in use, exposure to weather or seismic conditions or any other occurrence likely to have affected their strength or stability.

4.4.2. Inspection by the competent person should more particularly ascertain that:

(a) the scaffold is of suitable type and adequate for the job;

(b) materials used in its construction are sound and of sufficient strength;

(c) it is of sound construction and stable;

(d) that the required safeguards are in position.

4.4.3. A scaffold should not be erected, substantially altered or dismantled except by or under the supervision of a competent person.

4.4.4. Every scaffold should be maintained in good and proper condition, and every part should be kept fixed or secured so that no part can be displaced in consequence of normal use.

4.4.5. No scaffold should be partly dismantled and left so that it is capable of being used, unless it continues to be safe for use.

Use of scaffolds

4.7.1. The employer should provide competent supervision to ensure that all scaffolds are used appropriately and only for the purpose for which they are designed or erected. In transferring heavy loads on or to a scaffold a sudden shock should not be transmitted to the scaffold.

4.7.2. When necessary to prevent danger, loads being hoisted on or to scaffolds should be controlled, e.g. by a hand rope (tag line), so that they cannot strike against the scaffold.

4.7.3. The load on the scaffold should be evenly distributed, as far as practicable, and in any case should be so distributed as to avoid disturbance of the stability of the scaffold.

4.7.4. During the use of a scaffold care should constantly be taken that it is not overloaded or otherwise misused.

4.7.5. Scaffolds should not be used for the storage of material except that required for immediate use.

4.7.6. Workers should not be employed on external scaffolds in weather conditions that threaten their safety.

Suspended scaffolds

4.8.1. In addition to the requirements for scaffolds in general as regards soundness, stability and protection against the risk of falls, suspended scaffolds should meet the following specific requirements in so far as such requirements are applicable:

(a) platforms should be designed and built with dimensions that are compatible with the stability of the structure as a whole, especially the length;

(b) the number of anchorages should be compatible with the dimensions of the platform;

(c) the safety of workers should be safeguarded by an extra rope having a point of attachment independent of the anchorage arrangements of the scaffold;

(d) the anchorages and other elements of support of the scaffold should be designed and built in such a way as to ensure sufficient strength;

(e) the ropes, winches, pulleys or pulley blocks should be designed, assembled, used and maintained according to the requirements established for lifting gear adapted to the lifting of persons according to national laws and regulations;

(f) before use, the whole structure should be checked by a competent person.

5 STRUCTURAL FRAMES

General

3.4.2. Where necessary to prevent danger, guys, stays or supports should be used or other effective precautions should be taken to prevent the collapse of structures or parts of structures that are being erected, maintained, repaired, dismantled or demolished.

11.1.1. The erection or dismantling of buildings, structures, civil engineering works, formwork, falsework and shoring should be carried out by trained workers only under the supervision of a competent person.

11.1.2. Adequate precautions should be taken to guard against danger to workers arising from any temporary state of weakness or instability of a structure.

Provision of temporary floors

11.4.1. All tiers of open joists and girders on which workers are employed should be securely covered with close planking or any other effective covering until the permanent floor is installed.

11.4.2. Parts of the protection should only be removed to the extent required for the continuation of the work.

11.4.3. In halls and similar buildings without intermediate walls, columns or chimneys, close planking may be replaced by working platforms with adequate safeguards.

11.4.4. In buildings or structures of skeleton steel construction, permanent floor filling should as far as practicable be installed as the erection progresses.

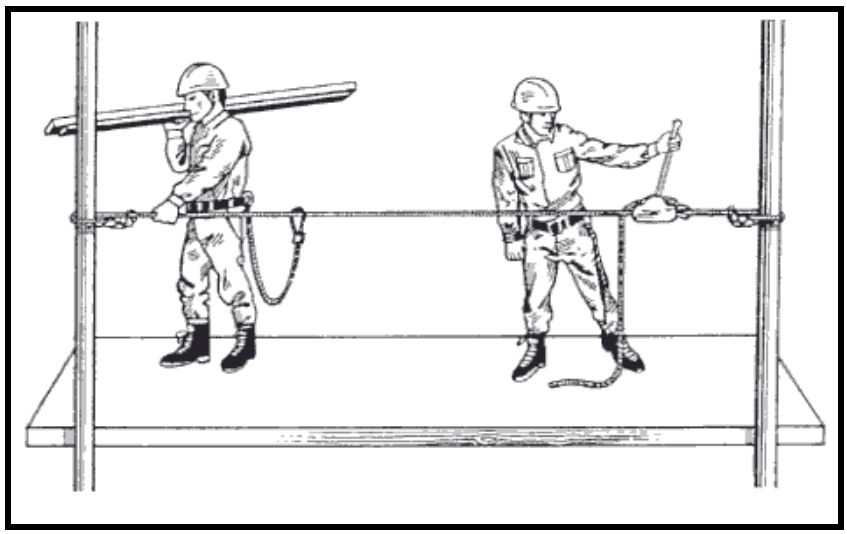
Erection and dismantling of steel and prefabricated structures

11.2.1. As far as practicable the safety of workers employed on the erection and dismantling of steel and prefabricated structures should be ensured by appropriate means, such as provision and use of:

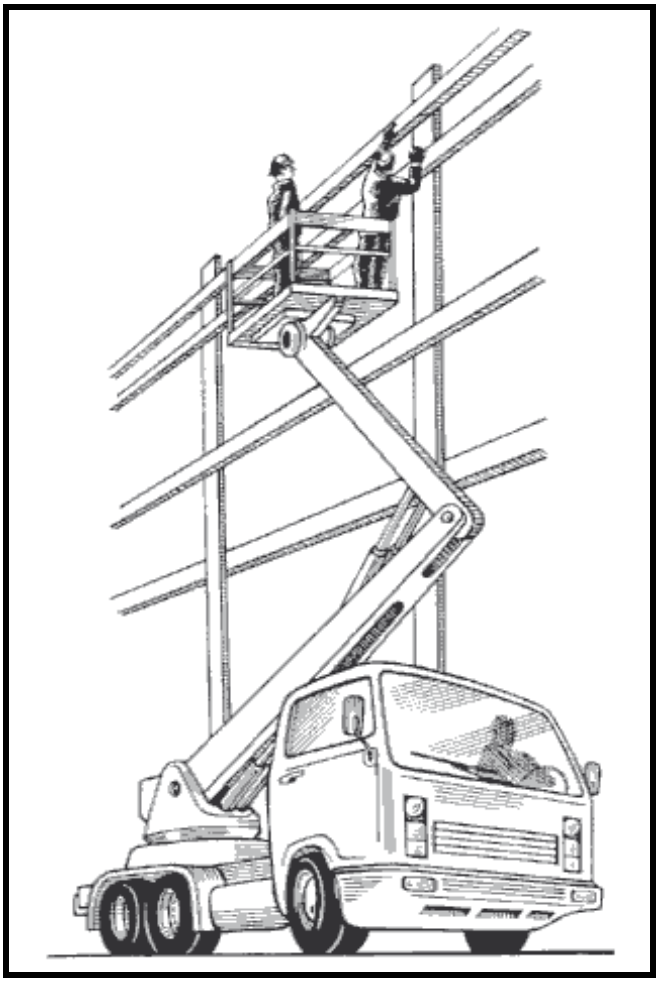
(a) ladders, gangways or fixed platforms;

(b) platforms, buckets, boatswain's chairs or other appropriate means suspended from lifting appliances;

(c) safety harnesses and lifelines, catch nets or catch platforms;



(d) power-operated mobile working platforms.



Mobile hydraulic platforms provide safe means of access for steel erectors

11.2.2. Steel and prefabricated structures should be so designed and made that they can be safely transported and erected, and if required by national laws and regulations each unit should be clearly marked with its own weight.

11.2.3. In addition to the need for the stability of the part when erected, when necessary to prevent danger the design should explicitly take into account:

(a) the conditions and methods of attachment in the operations of transport, storing and temporary support during erection or dismantling as applicable;

(b) methods for the provision of safeguards such as railings and working platforms, and, when necessary, for mounting them easily on the structural steel or prefabricated parts.

11.2.4. The hooks and other devices built in or provided on the structural steel or prefabricated parts that are required for lifting and transporting them should be so shaped, dimensioned and positioned as:

(a) to withstand, with a sufficient margin, the stresses to which they are subjected;

(b) not to set up stresses in the part that could cause failures, or stresses in the structure itself not provided for in the plans, and be designed to permit easy release from the lifting appliance. Lifting points for floor and staircase units should be located (recessed if necessary) so that they do not protrude above the surface;

(c) to avoid imbalance or distortion of the lifted load.

11.2.5. Prefabricated parts made of concrete should not be stripped or erected before the concrete has set and hardened sufficiently to the extent provided for in the plans, and before use should be examined for any sign of damage which may indicate weakness.

11.2.6. Storeplaces should be so constructed that:

(a) there is no risk of structural steel or prefabricated parts falling or overturning;

(b) storage conditions generally ensure stability and avoid damage having regard to the method of storage and atmospheric conditions;

(c) racks are set on firm ground and designed so that units cannot move accidentally.

11.2.7. While they are being stored, transported, raised or set down, structural steel or prefabricated parts should not be subjected to stresses prejudicial to their stability.

11.2.11. Structural steel or prefabricated parts should be lifted by methods or appliances that prevent them from spinning accidentally.

11.2.12. When necessary to prevent danger, before they are raised from the ground, structural steel or prefabricated parts should be provided with safety devices such as railings and working platforms to prevent falls of persons.

11.2.13. While structural steel or prefabricated parts are being erected the workers should be provided with and use appliances for guiding them as they are being lifted and set down, so as to avoid crushing of hands and to facilitate the operations.

11.2.14. Before it is released from the lifting appliance a raised structural steel or prefabricated part should be so secured and wall units so propped that their stability cannot be imperilled, even by external agencies such as wind and passing loads, in accordance with national laws and regulations.

11.2.15. At workplaces adequate instruction should be given to the workers on the methods, arrangements and means required for the storage, transport, lifting and erection of structural steel or prefabricated parts, and before erection starts a meeting of all those responsible should be held to discuss and confirm the requirements for safe erection.

11.2.16. During transport, attachments such as slings and stirrups mounted on structural steel or prefabricated parts should be securely fastened to the parts.

11.2.17. Structural steel or prefabricated parts should be so transported that the conditions do not affect the stability of the parts or the means of transport result in jolting, vibration or stresses due to blows, or loads of material or persons.

11.2.18. When the method of erection does not permit the provision of other means of protection against falls of persons, the workplaces should be protected by guard-rails, and, if appropriate, by toe-boards.

11.2.19. When adverse weather conditions such as snow, ice and wind or reduced visibility entail risks of accidents the work should be carried on with particular care, or, if necessary, interrupted.

11.2.20. Structures should not be worked on during violent storms or high winds, or when they are covered with ice or snow, or are slippery from other causes.

11.2.21. If necessary to prevent danger, structural steel parts should be equipped with attachments for suspended scaffolds, lifelines or safety harnesses and other means of protection.

11.2.22. The risks of falling, to which workers moving on high or sloping girders are exposed, should be limited by all means of adequate collective protection or, where this is impossible, by the use of a safety harness that is well secured to a sufficiently strong support.

11.2.23. Structural steel parts that are to be erected at a great height should as far as practicable be assembled on the ground.

11.2.24. When structural steel or prefabricated parts are being erected, a sufficiently extended area underneath the workplace should be barricaded or guarded.

11.2.25. Steel trusses that are being erected should be adequately shored, braced or guyed until they are permanently secured in position.

11.2.26. No load-bearing structural member should be dangerously weakened by cutting, holing or other means.

11.2.27. Structural members should not be forced into place by the hoisting machine while any worker is in such a position that he could be injured by the operation.

11.2.28. Open-web steel joists that are hoisted singly should be directly placed in position and secured against dislodgement.

Points to remember

Trying to save crane time by reducing the number of bolts used in connections is a dangerous practice

Do not work in high winds or on wet steelwork

Always wear suitable personal protective equipment

If you climb or walk on bare steel, sooner or later you will fall

Cast-in-situ concrete structures

11.3.1. The construction of cast-in-situ, large span and multi-storey concrete structures should be based on plans that:

> *(a) include specifications of the steel, concrete and other material to be used, including technical methods for safe placing and handling;*
>
> *(b) indicate clearly the position and arrangement of reinforcements in structural elements;*
>
> *(c) provide, if appropriate, calculations of the load-bearing capacity of the structure.*

11.3.2. During the construction of cast-in-situ, large span and multi-storey concrete structures, a daily record should be kept of the progress of the work, including indications of all data which could affect the curing of the concrete.

11.3.3. Precise procedures for all stages of erection should be prepared and a competent person appointed to co-ordinate the work and check procedures.

Formwork

11.1.3. Formwork, falsework and shoring should be so designed, constructed and maintained that it will safely support all loads that may be imposed on it.

11.1.4. Formwork should be so designed and erected that working platforms, means of access, bracing and means of handling and stabilising are easily fixed to the formwork structure.

11.3.4. During pouring, shuttering and its supports should be continuously watched for defects.

11.5.2. Clear and concise procedures to cover all stages of work should be prepared.

11.5.3. A competent person should be appointed to coordinate the work and check that the procedures are being followed.

11.5.4. No changes should be made without consulting the co-ordinator.

11.5.5. All materials and scaffolding should be carefully examined and checked with the drawings before being taken into use.

11.5.6. The foundations should be checked to see that the excavated ground conditions are as the original soil report suggested.

11.5.7. Shuttering should be examined, erected and dismantled under the supervision of qualified and experienced persons and, as far as practicable, by workers familiar with the work.

11.5.8. The necessary information for the erection of shuttering, including particulars of the spacing of stringers and props to stringers, should be provided for the workers in the form of sketches or scale drawings.

11.5.9. Lumber and supports for shuttering (forms) should be adequate, having regard to the loads to be borne, spans, setting temperature and rate of pour. Where necessary to prevent danger, adequate shoring should be provided to support slabs and beams as a protection against superimposed loads.

11.5.10. All adjustable shoring should be locked in position when adjusted.

11.5.11. Shoring should be so arranged that when it is being removed sufficient props can be left in place to afford the support necessary to prevent danger.

11.5.12. Shoring should be adequately protected from damage from moving vehicles, swinging loads, etc.

11.5.13. Shoring should be left in place until the concrete has acquired sufficient strength to support safely not only its own weight but also any imposed loads. It should not be removed until authorisation has been given by a competent person.

11.5.14. Shoring should be adequately braced or tied together to prevent deformation or displacement.

11.5.15. To prevent danger from falling parts when shuttering is being taken down, the shuttering should as far as practicable be taken down whole, or else remaining parts should be supported.

11.5.16. Mechanical, hydraulic or pneumatic lifting appliances for handling forms should be provided with automatic holding devices to prevent danger if the power of the lifting mechanism fails.

11.5.17. Vacuum-lifting appliances should only be applied to smooth, clean surfaces.

11.5.18. Vacuum-lifting devices should be provided with an automatic cut-off to prevent loss of suction in the event of a power or equipment failure.

6 DEMOLITION OF ABOVE GROUND STRUCTURES

Causes of incidents ('accidents')

The principal causes of incidents during demolition are:

- The choice of an incorrect method of demolition
- An unsafe place of work
- The unintentional collapse of the building being demolished, or of an adjoining structure, because of lack of temporary support
- Unexpected exposure to toxic substances

Planning and training

Demolition must be supervised by persons with a thorough knowledge not only of demolition processes but of the principles of building construction. First, a survey of the physical characteristics and design of the building to be demolished must be carried out in order to choose a safe method of work. Contained within the structure of buildings are various forces and stresses, whether the buildings be of concrete, brick, masonry, steel or timber. When the building is complete, these forces and reactions are in balance, and equilibrium and stability is achieved. The severance or removal of a load-carrying member may unbalance the forces, upset the equilibrium and cause collapse of the whole or that part of the building.

There are particular problems in some newer buildings which are post-tensioned or un-bonded stressed structures, or are structures which have been progressively stressed as construction proceeds. Preliminary inquiries of the client or local authority may reveal such problems. The proposals for demolition should be contained in a written method statement which should also include drawings or sketches showing the sequence of operations, and the machinery or equipment to be used, including personal protective equipment.

Demolition is an inherently dangerous process and everyone on site must wear personal protective equipment (PPE) including helmet, gloves and safety footwear. The presence of debris and dust, and such jobs as the cutting of bolts or rivets, call for the provision of eye protection such as goggles or visors.

Before demolition begins, all services to the building or structure must be disconnected. Failure to do this adequately can result in electric shock, gasing, fire, explosions or flooding. Arrangements should be made to keep the public as far away as possible from the site, and wherever practicable a fence not less than 2m high should be erected around it.

Points to remember

Plan before you demolish and demolish according to plan

Have a written method statement for your demolition site

The demolition process

The aim should be to adopt methods which do not expose persons to falls from heights. While in general it is a sound rule gradually to reduce the height of a building and to demolish in the reverse order to construction, a deliberately engineered collapse, the licensed use of explosives, a demolition ball on a crane, or a pusher arm may sometimes be the quickest and most economical method of demolition, leaving work to be completed at ground level. It is dangerous to leave isolated walls or parts of walls standing and liable to collapse from the effect of high winds. Whatever the process adopted, debris should not be allowed to build up against walls or on floors with the consequent risk of the structure being unintentionally overloaded.

Debris chutes should be used rather than throwing down material indiscriminately, even on isolated sites.

Wherever practicable, workers should avoid working directly from parts of the building or structure they are demolishing, such as standing on the top of a brick wall. This usually means that they have both poor handholds and poor footholds.

When work cannot safely be carried out from a building, a scaffold platform, self-supporting and independent of the part of the building being demolished, should be provided. On brick and masonry structures in particular, much of the work can be done from such scaffolding, the material being dropped to the interior of the building.

Person-carrying skips or power-operated mobile work platforms can also be used to work at heights. The use of safety nets or safety harnesses may sometimes be necessary

Tanks and vessels

The use of hot processes such as flame-cutting to demolish or dismantle plant which has contained flammable materials has caused many deaths and serious injuries. It is essential to make such tanks and vessels safe before work commences, and workers should always follow a written permit-to-work system. It is usually easier to ensure that a flammable concentration of vapour is not present in a tank than it is to remove residues. Residue fires during demolition are common. In the case of small vessels up to about 50 cubic metres capacity both vapours and residues can usually be removed by steaming out, but this is often impracticable for larger vessels. The nature and distribution of residues is thus a key factor in deciding on the techniques to be used. There are other ways of cutting tanks and drums by means of cold processes and these should be considered before you adopt a hot process.

Health hazards

Insidious and unexpected health hazards frequently arise during demolition on account of exposure to dust and fumes. Short-term effects of poisonous fumes, or acute gasing, arise when a plant is opened up without having first been properly isolated, purged or cleaned, or when a vessel is entered without taking precautions. Another cause is the flame-cutting of plant which has been painted with zinc or cadmium paint. Long-term or systemic poisonings arise from flame-cutting lead-painted steelwork, and from the inhalation of dust or fumes from chemical deposits. The site survey should have assessed the risk, and the method of work statement should set out permit-to-work systems, the use of breathing apparatus, approved respirators, and rescue equipment.

Exposure to asbestos-bearing materials is now a particular risk in demolition. Indeed, construction workers may be more at risk from the presence of asbestos than almost any other category of worker. This applies particularly to exposure to asbestos which was commonly used in sprayed insulation on columns and on the underside of ceilings and roofs for fire protection or for thermal insulation. Stringent precautions need to be taken to avoid contaminating the general atmosphere and to prevent breathing in of the dust. Material containing asbestos must be removed in isolation from other work, and workers must wear positive pressure breathing apparatus and protective clothing, and be trained in their use and the techniques of asbestos removal. Where possible, wet methods of asbestos removal should be adopted rather than dry methods. Special arrangements need to be made by management for the safe disposal of asbestos-contaminated debris. The best way to deal with asbestos is to employ a specialist company.

Points to remember

Never work on a tank or enclosed vessel without a written permit to work

Always check whether asbestos is present in the building to be demolished

7 ROOF-WORK

8.2.1. All roof-work operations should be pre-planned and properly supervised.

8.2.2. Roof work should only be undertaken by workers who are physically and psychologically fit and have the necessary knowledge and experience for such work.

8.2.3. Work on roofs should not be carried on in weather conditions that threaten the safety of workers.

8.2.4. Crawling boards, walkways and roof ladders should be securely fastened to a firm structure.

8.2.5. Roofing brackets should fit the slope of the roof and be securely supported.

8.2.6. Where it is necessary for a person to kneel or crouch near the edge of the roof an intermediate rail should be provided unless other precautions, such as the use of a safety harness, are taken.

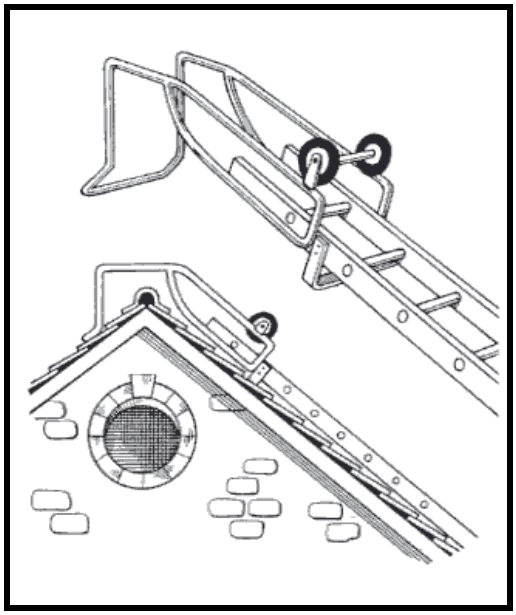
8.2.7. On a large roof where work does not have to be carried out at or near the edge, a simple barrier consisting of crossed scaffold tubes supporting a tubing guardrail may be provided. Such barriers should be positioned at least 2m from the edge.

8.2.8. All covers for openings in roofs should be of substantial construction and be secured in position.

8.2.9. Roofs with a pitch of more than 10 should be treated as sloping.

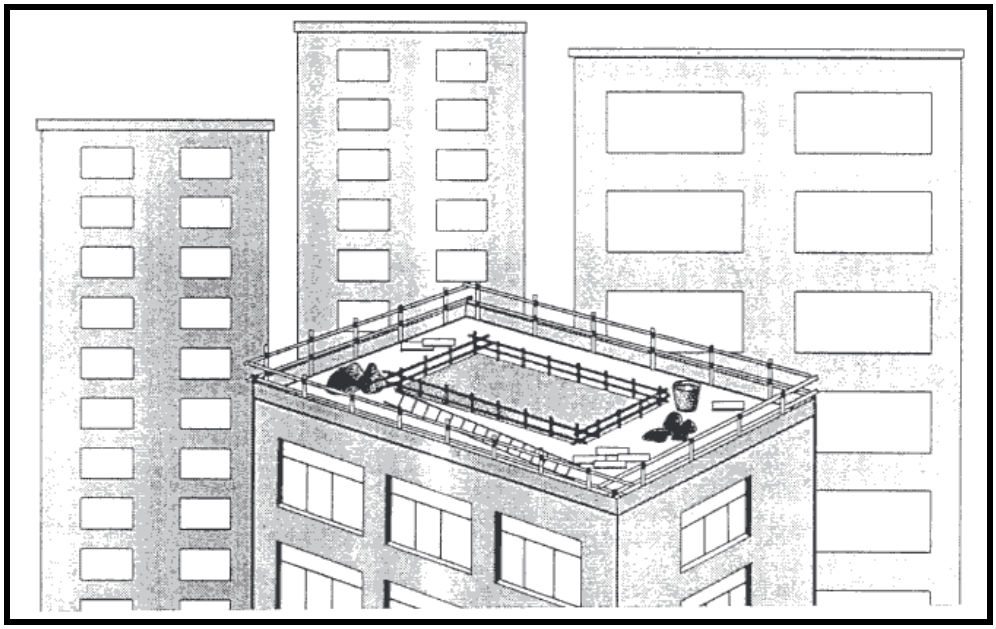
8.2.10. When work is being carried out on sloping roofs, sufficient and suitable crawling boards or roof ladders should be provided and firmly secured in position as soon as is practicable.

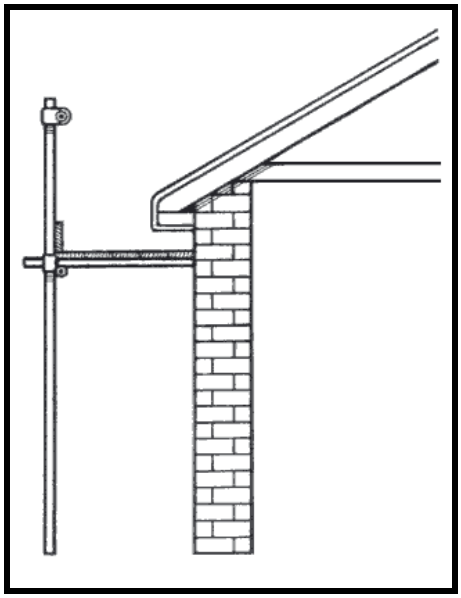
The picture below shows a ladder specially made for roof work.

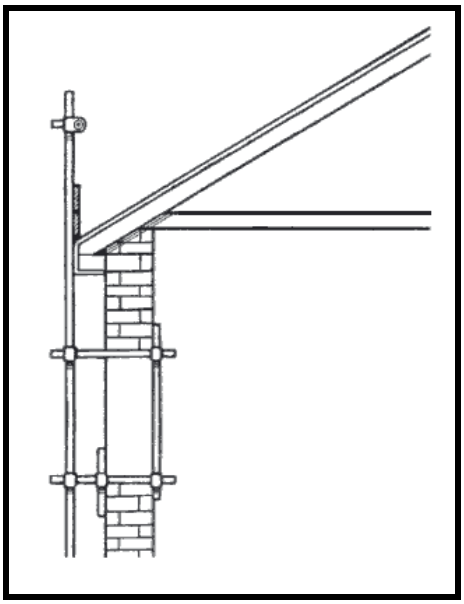


8.2.11. During extensive work on the roof, strong barriers or guard-rails and toeboards should be provided to stop a person from falling off the roof.

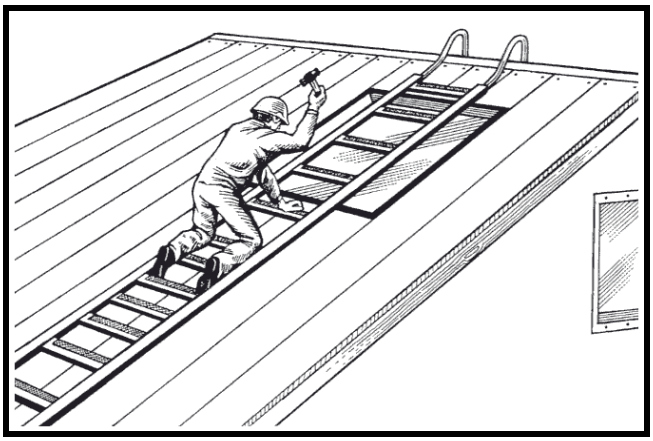
The three pictures below shows ways of protecting workers from falling from roofs.







8.2.12. Where workers are required to work on or near roofs or other places covered with fragile material, through which they are liable to fall, they should be provided with sufficient suitable roof ladders or crawling boards strong enough, when spanning across the supports for the roof covering, to support those workers.



8.2.13. A minimum of two boards should be provided so that it is not necessary for a person to stand on a fragile roof to move a board or a ladder, or for any other reason.

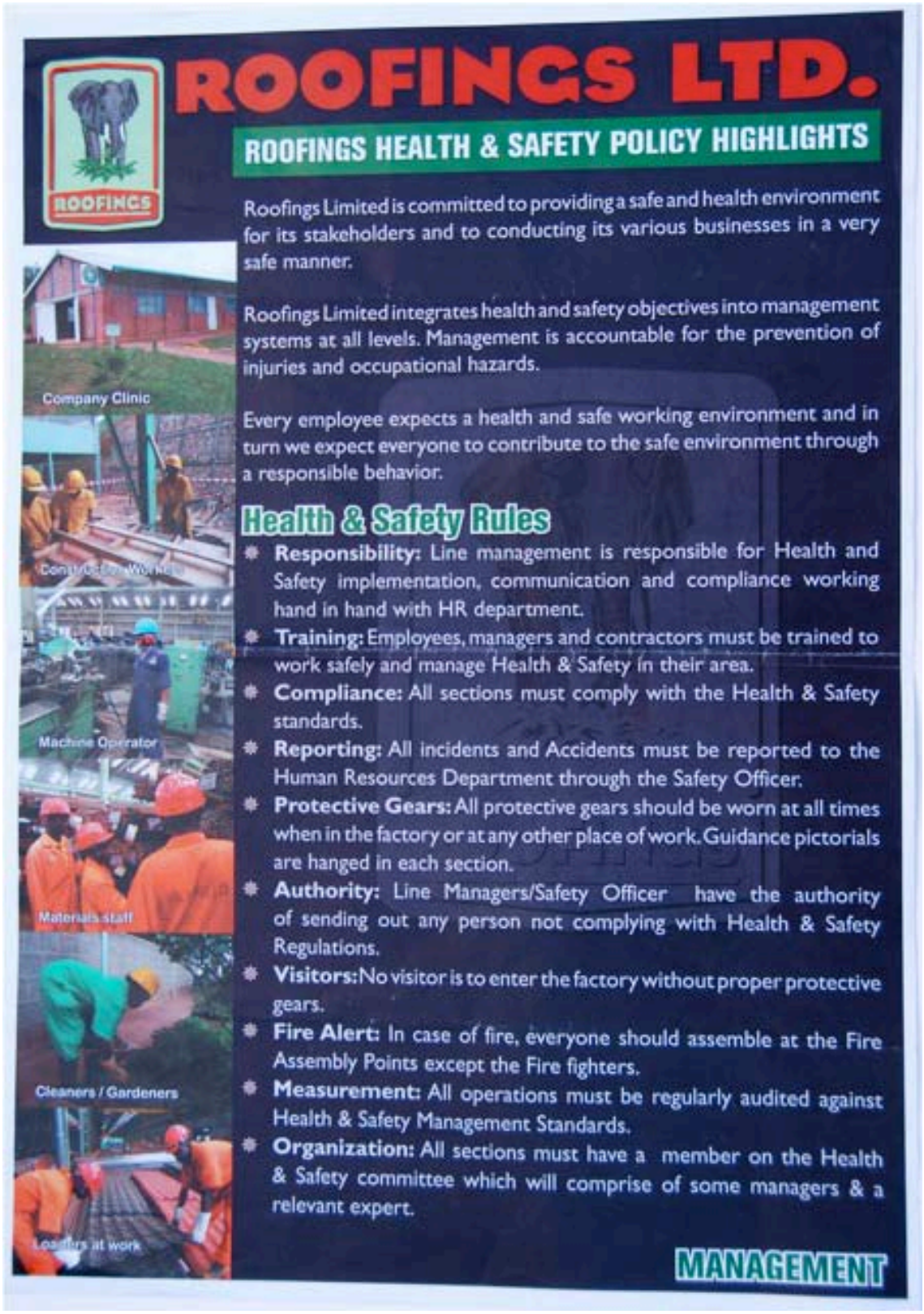
8.2.14. To prevent danger, suitable material such as steel wire mesh should be placed in position before any roof sheeting of asbestos cement or other fragile material is placed upon it.

8.2.15. Purlins or other intermediate supports for fragile roofing material should be sufficiently close together to prevent danger.

8.2.16. Where a valley or parapet gutter of a fragile roof is used for access, protection against falling through the fragile material should be provided by covering the adjacent fragile material to a minimum distance of 1m up the roof.

8.2.17. Buildings with fragile roofs should have a warning notice prominently displayed at the approaches to the roof.

EXAMPLE OF GOOD PRACTICE



(Poster provided by Charles Obongpiny, Uganda Building Worker's Union)

Finally

"Construction safety, roof construction, demolition: Three roofers at edge of roof, without fall protection, manhandle lifting and tying off flared top of trash chute with which to funnel old roofing material into dump truck for disposal. The crew is using two pitch forks (hand tools for roof demolition) to pry top flared part of chute over and above roof edge and gutter. Worker on right lost his balance an instant before this photo was taken, and in photo he is raising left arm and sitting back with grimace on his face, which saved him from pitching over roof edge and falling two floors. Of course, workers return next day to demolish roof, including near edge, and walk to edge of roof to drop debris into chute. They should all be wearing body harnesses, with lanyards tied back with safety line to a secure support near center of roof. California, 2006."

[Source of image & caption: Robert Carr, http://myconstructionphotos.smugmug.com)

8 RELEVANT ELEMENTS OF THE KNOWLEDGE BASE

Title	ILO Code of Practice: Safety & health in construction
Type of source	Code of practice, 174 pages
Publication or other source details	ILO Publications http://www.ilo.org/global/Publications
Date & ISBN/ISSN	1992. 92-2-107104-9
Summary of contents	*"It goes a long way in mapping out the agenda for health and safety professionals in this most dangerous and populous industry."* Content: 1. General provisions 2. General duties 3. Safety of workplaces 4. Scaffolds and ladders 5. Lifting appliances and gear 6. Transport, earth-moving and materials-handling equipment 7. Plant, machinery, equipment and hand tools 8. Work at heights including roof work 9. Excavations, shafts, earthworks, underground works and tunnels 10. Cofferdams and caissons and work in compressed air 11. Structural frames, formwork and concrete work 12. Pile-driving 13. Work over water 14. Demolition 15. Electricity 16. Explosives 17. Health hazards, first aid and occupational health services 18. Personal protective equipment and protective clothing 19. Welfare
Comments on relevance	This Code of Practice is fundamental to this training package. It has influenced the structure and informed the content.
Other information	Downloaded as "ILO Code of Practice"

Title	My construction photos
Author(s)	Dr Robert I Carr
Type of source	Web site
Publication or other source details	http://myconstructionphotos.smugmug.com/
Date & ISBN/ISSN	This site was accessed for **ILO Construction OS&H** in July 2009
Summary of contents	This is the personal site of Dr Robert I Carr, one of the most highly respected professors in the construction world. He has offered more than 2000 high quality photos, fully captioned, for free use. Here he is in person: http://myconstructionphotos.smugmug.com/gallery/2435976/ Although largely taken in the USA, there are photos taken in other countries.
Comments on relevance	This is a wonderful resource for trainers.
Other information	There are some superb photos of construction hazards

Title	ILO Safety, health and welfare on construction sites A training manual
Author(s)	ILO
Type of source	Training manual, 134 pages
Publication or other source details	ILO Geneva, International Labour Office Can be downloaded from: http://www.ilo.org/public/english/protection/safework/training/english/download/architecture.pdf
Date & ISBN/ISSN	1995. ISBN 92-2-109182-1
Summary of contents	Preface 1. Introduction 2. Safety organization and management 3. Site planning and layout 4. Excavations 5. Scaffolding 6. Ladders 7. Hazardous processes 8. Vehicles 9. Movement of materials 10. Working positions, tools and equipment 11. The working environment 12. Personal protective equipment (PPE) 13. Welfare facilities Annexes 1. Safety, health and welfare on construction sites: Check-list 2. The Safety and Health in Construction Convention, 1988 (No. 167), and Recommendation, 1988 (No175)
Comments on relevance	This is a comprehensive manual, which follows the contents of ILO C167 very closely. Extracts have been used in Construct OS&H, especially in the technical sections.
Other information	It has been Downloaded as ILO Safety, health and welfare on construction sites: A training manual

Title	Hong Kong – bastion of bamboo scaffolding
Type of source	Journal article
Publication or other source details	Journal name: Civil Engineering Author(s): Ramanathan DOI: 10.1680/cien.2008.161.4.177 Volume: 161 | Issue 4 Pages: 177 - 183
Date & ISBN/ISSN	01/11/2008. 0965-089X
Summary of contents	Hong Kong's skyline is dominated by some of the world's tallest buildings. Nevertheless, the city still uses bamboo scaffolding for much of its construction work – a traditional skill passed down over 5000 years. Bamboo is sustainable, lightweight and cheap and, as long as it remains fairly dry, a good construction material with significant mechanical properties. Researchers, engineers, environmentalists and bureaucrats have taken an increasing interest in the craft, such that regulations and practice continue to be improved and refined. However, to alleviate remaining design and safety concerns a structural design code is needed.
Comments on relevance	Generally relevant to the Themes 'General plant and equipment' and 'Working at height'.