Code of practice for

Access and working scaffolds and special scaffold structures in steel

Committees responsible for this British Standard

The preparation of this British Standard was entrusted by Technical Committee B/514, Access and support equipment, to Subcommittee B/514/21, Access and working scaffolds, upon which the following bodies were represented:

Building Employers' Confederation
Concrete Society
Federation of Civil Engineering Contractors
Health and Safety Executive
House Builders' Federation
Institution of Structural Engineers
National Association of Scaffolding Contractors
Suspended Access Equipment Manfacturers' Association

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Contents

Foreword

This British Standard has been prepared under the direction of Technical Committee B/514, Access and support equipment. It supersedes BS 5973:1990 which is withdrawn. This edition introduces technical changes but it does not reflect a full review or revision of the standard which will be undertaken in due course to make the standard compatible with the forthcoming European Standard for scaffolds, expected to be published in 1995 by the European Committee for Standardization (CEN).

The principal changes from the 1990 edition are as follows:

a) revised advice is given on temporary roofs;

b) dimensions not strictly in accordance with the Construction (Working Places) Regulations have been brought into line;

c) information on lip ties has been improved;

d) better information is provided on fans;

e) account has been taken of the revised standards for steel tube and fittings which are in accordance with published CEN documents;

f) a comprehensive index to the code has been added.

Changes from the 1990 edition are indicated by a vertical rule in the margin.

The requirements for tube specified in BS 1139-1.1:1990 are marginally higher than those specified in BS 1139-1:1982[1], which was the basis of the information in BS 5973:1990. Because scaffold tube has a long life, this edition of BS 5973 contains information on both qualities of tube. Where no specific reference is given to the type of tube, the advice given is applicable to both types.

BS 1139-2.1:1991 assesses right angle, swivel and parallel couplers much more rigorously than BS 1139-2:1982[2] Analysis of tests carried out to date shows that right angle couplers complying with the 1982 standard also comply with the 1991 standard. Thus though the reference level is lower, no change in safe working load is proposed. This implies a factor of safety of 1.6, and this figure has been applied to the two other types of coupler similarly assessed (swivel and parallel). In other cases the value of 2.0 should be used. Swivel couplers complying with the 1982 standard may be used in accordance with this standard but for those complying with the 1991 standard there is a reduction in capacity.

Attention is drawn both to the wider range of fittings and to some properties specified or examined in BS 1139-2.1, but not normally used in scaffold design in the UK.

This code has been prepared on a broad interpretation of the rules for design and construction, so that they can be applied to the very numerous variations of scaffolds which inevitably occur. It includes guidance on procedures for construction and dismantling, on the stability of scaffolds during various stages of these operations and on the responsibilities of users of scaffolding. Recomendations are included for the inspection of scaffolds and some guidance is given on prefabricated scaffold systems.

While dealing with many common applications this code does not cover all the innumerable circumstances resulting from the diversity of building facades and variety of purposes for which scaffolding is required.

A limit of application for clause **36**, Temporary buildings and temporary roofs, has been identified and for the larger structures specialist advice should be sought.

[1] BS 1139-1:1982, Specification for tubes for use in scaffolding (withdrawn).
[2] BS 1139-2:1982, Specification for couplers and fittings for use in tubular scaffolding (withdrawn).

Effective training of scaffolders is possibly the most essential factor in preventing accidents amongst both scaffolders and those who use scaffolds. The Construction Industry Training Board (CITB), many firms in the industry and several safety groups organize a wide range of training courses, not only for scaffolders, but for chargehand scaffolders, site supervisors who may have to inspect scaffolds, general foremen and safety officers.

The importance of training was recognized in the report of a Subcommittee of the Joint Advisory Committee on Safety and Health in the Construction Industries entitled "Safety in Scaffolding"[3)], which made recommendations for the training of scaffolders and for the issue of certificates of competence.

Such a certification scheme has been developed and adopted by the large part of the industry covered by the agreements of the National Joint Council for the Building Industry, and the Civil Engineering Construction Conciliation Board. The scheme, known as the Construction Industry Scaffolders Record Scheme, is organized by the CITB, who run training courses in basic and advanced scaffolding and issue and control individual training record cards. Scaffolders are grouped into three categories, trainee, basic scaffolder and advanced scaffolder and before scaffolders can be classed as basic or advanced they should have completed the appropriate courses and have had specific minimum experience.

The scheme applies, at present, only to scaffolders who work on scaffolding more than 5 m (16.5 ft) high.

Participation in this scheme is not a legal requirement, but the scheme should lead to a general raising of the level of expertise throughout the industry. It is important to note that the legal requirements relating to the training of workers in the Health and Safety at Work etc. Act 1974 and to the competence and experience of scaffolders in the Construction (Working Places) Regulations 1966 apply to *all* scaffolding work.

A British Standard does not purport to include all the necessary provisions of a contract. Users of British Standards are responsible for their correct application.

This code of practice represents a standard of good practice. Compliance with it does not confer immunity from relevant legal requirements, including regulations and byelaws.

Summary of pages

This document comprises a front cover, an inside front cover, pages i to x, pages 1 to 104, an inside back cover and a back cover.

This standard has been updated (see copyright date) and may have had amendments incorporated. This will be indicated in the amendment table on the inside front cover.

[3)] Obtainable from HMSO.

Section 1. General

1 Scope

This code of practice gives recommendations and includes some guidance for the design, construction and use of common scaffolds in steel, normally used in construction, maintenance, repair, and demolition work, excepting those for the support of permanent work, commonly referred to as temporary works or falsework, and suspended scaffolds. Recommendations for falsework may be found in BS 5975 and recommendations for suspended scaffolds may be found in BS 5974.

The recommendations of this code relate to steel scaffold tube of steel with a yield stress not less than 235 N/mm^2, an outside diameter of 48.3 mm and a wall thickness of 4 mm. This code is only applicable to scaffold made from tube and scaffold fittings which when new complied with one of the following standards:

BS 1139-1:1982

BS 1139-2:1982

BS 1139-1.1:1990

BS 1139-2.1:1991

BS 1139-2.2:1991

However, the use in access scaffolding of tubes of other dimensions and strengths is not precluded by this code and appendix D provides a limited amount of data on aluminium tube complying with the requirements of BS 1139. When other tubes are used, the structural calculations should be carried out using the properties of the tubes used and the structures, when assembled, should have similar characteristics to scaffolding constructed with the tube recommended in this code. Section 6 provides some technical data and guidance on calculations.

2 References

The titles of the standards publications referred to in this standard are listed on the inside back cover.

3 Definitions

For the purposes of this British Standard, the following definitions apply (see Figure 1 and Figure 2).

3.1 Types and dimensions of scaffolds and buildings

3.1.1
base lift

see foot lift (**3.1.8**)

3.1.2
bay

the space between the centre lines of two adjacent standards along the face of a scaffold

3.1.3
bay length

the distance between the centres of two adjacent standards, measured horizontally

3.1.4
building

a building or structure or other facade against which the scaffold is constructed

3.1.5
height

the height measured from the foundation to the top assembly of ledgers and transoms (cf. lift height)

3.1.6
length

the length of a scaffold between its extreme standards, sometimes designated by the number of bays (cf. bay length)

3.1.7
lift

the assembly of ledgers and transoms forming each horizontal level of a scaffold

3.1.8
foot lift

a lift erected near to the ground

3.1.9
lift height

the vertical distance between two lifts, measured centre to centre

3.1.10
lift head room

the clear distance between a platform and the tubular assembly of the lift above

3.1.11
pair of standards

the standards forming the frame at right angles to the building

3.1.12
normal facade

a facade which permits the fixing of through ties or non-movable ties

3.1.13
abnormal facade

a facade which does not permit the fixing of through ties or non-movable ties

3.1.14
scaffold

a temporarily provided structure which provides access, or on or from which persons work or which is used to support materials, plant or equipment

3.1.15
free standing scaffold

a scaffold which is not attached to any other structure and is stable against overturning on its own account or, if necessary, assisted by guys or rakers and anchors

3.1.16
independent tied scaffold

a scaffold which has two lines of standards, one line supporting the outside of the deck and one the inside. The transoms are not built into the wall of the building. It is not free standing, being supported by the building (see Figure 2)

3.1.17
putlog scaffold

a scaffold which has one line of standards to support the outside edge of the deck and utilizes the wall being built or the building to support the inside edges (see Figure 1)

3.1.18
slung scaffold

a scaffold hanging on tubes, ropes or chains from a structure overhead. It is not capable of being moved or lowered

3.1.19
suspended scaffold

a scaffold hanging on ropes which is capable of being suspended or raised and lowered

3.1.20
width

the width of a scaffold measured at right angles to the ledgers from centre to centre of the uprights or interclear as stated. Sometimes designated by the number of boards within the uprights and the number beyond the uprights on extended transoms

3.2 Tubular members and beams

3.2.1
brace

a tube placed diagonally with respect to the vertical or horizontal members of a scaffold and fixed to them to afford stability

3.2.2
cross brace

see ledger brace (**3.2.6**)

3.2.3
facade brace

a brace parallel to the face of a building

3.2.4
face brace

see facade brace (**3.2.3**)

3.2.5
knee brace

a brace across the corner of an opening in a scaffold to stiffen the angles or to stiffen the end support of a beam

3.2.6
ledger brace

a brace at right angles to the building

3.2.7
longitudinal brace

a brace generally in the plane of the longer dimension of the scaffold, particularly in birdcages

3.2.8
plan brace

a brace in a horizontal plane

3.2.9
transverse brace

a brace generally in the plane of the shorter dimension of the scaffold

3.2.10
bridle

a horizontal tube fixed across an opening or parallel to the face of a building to support the inner end of a putlog transom or tie tube

3.2.11
vertical bridle

a vertical tube performing the same function as a bridle

3.2.12
inside or outside bridle

a bridle either inside or outside a building wall

3.2.13
butt tube

a short length of tube

3.2.14
butting tube

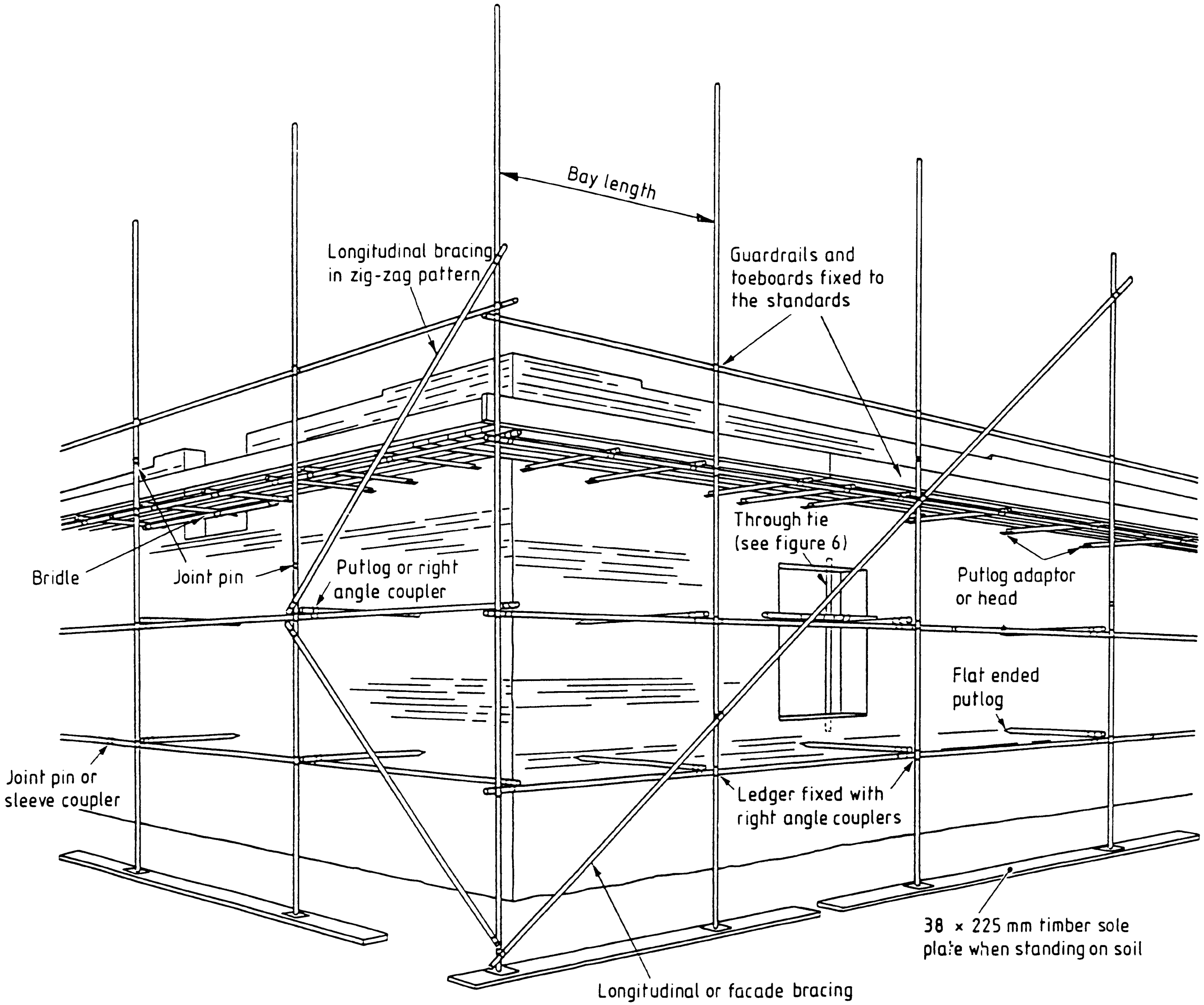
a tube which butts up against the facade of a building or other surface to prevent the scaffold moving towards that surface

3.2.15
chord

the principal longitudinal member(s) of a beam or truss

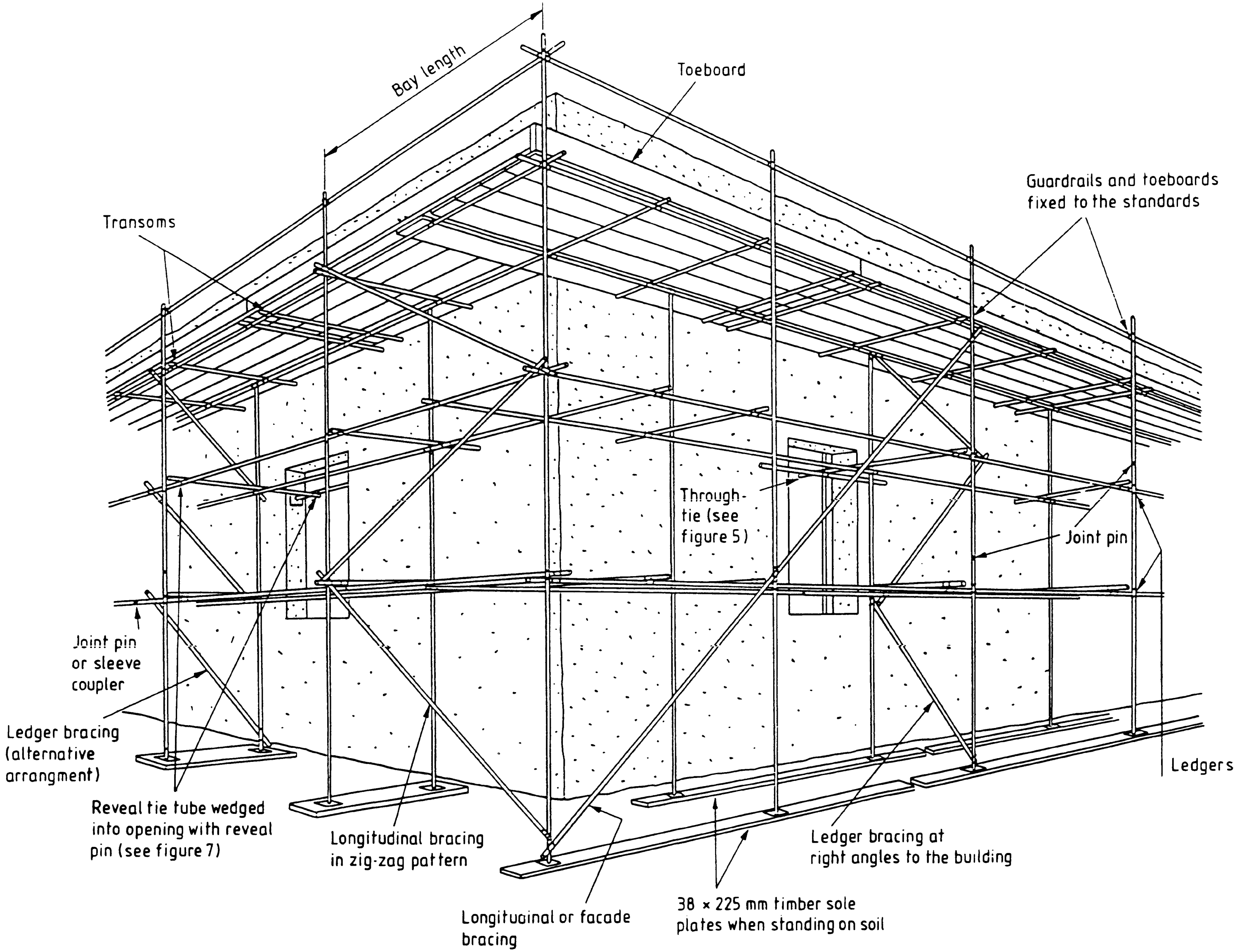
3.2.16
chord stiffener

a tube fixed at right angles to the chord of a prefabricated rafter, beam or truss for the purpose of preventing buckling



NOTE. This drawing should be read in conjunction with the text.

Figure 1 — Typical putlog scaffold



NOTE. This drawing should be read in conjunction with the text.

Figure 2 — Typical independent tied scaffold

3.2.17
guardrail

a member incorporated in a structure to prevent the fall of a person from a platform or access way

3.2.18
end guardrail

a guardrail placed across the end of a scaffold or used to isolate an unboarded part

3.2.19
guardrail post

a puncheon supporting a guardrail

3.2.20
ledger

a longitudinal tube normally fixed parallel to the face of a building in the direction of the larger dimensions of the scaffold. It acts as a support for the putlogs and transoms and frequently for the tie tubes and ledger braces and is usually joined to the adjacent standards

3.2.21
puncheon

a vertical tube supported at its lower end by another scaffold tube or beam and not by the ground or on a deck

3.2.22
purlin

a tube secured to the rafters of a building and parallel to the ridge for the purpose of attaching the roof covering and to act as a top chord stiffener for the rafter beams

3.2.23
putlog

a tube with a flattened end, to rest in or on part of the brickwork or structure

3.2.24
rafter and rafter beam

a transverse tube, beam, or truss in a building spanning across a roof or from the eaves to the ridge

3.2.25
raker

an inclined load-bearing tube

3.2.26
reveal tube

a tube fixed by means of a threaded fitting or by wedging between two opposing surfaces of a structure, e.g. between two window reveals, to form an anchor to which the scaffold may be tied

3.2.27
sheeting rail

a horizontal tube fixed to the verticals of a scaffold to support the sheeting

3.2.28
spine beam

a longitudinal main beam spanning from end to end of a roof at the ridge or eaves

3.2.29
standard

a vertical or near vertical tube

3.2.30
tie or tie assembly

the components attached to an anchorage or the building or framed around a part of it or wedged or screwed into it with a tie tube. Used to secure the scaffold to the structure

3.2.31
bolted tie

an assembly of nuts, bolts, anchors, rings or tubes fixed into the surface of a building

3.2.32
box tie

an assembly of tubes and couplers forming a frame round a part of a building

3.2.33
lip tie

an assembly of tubes forming an L or J shaped hook round an inside surface of a building

3.2.34
double lip tie

a lip tie which is a push/pull tie, i.e. has a cross tube on the back and front of the wall

3.2.35
prop tie

an assembly of telescopic props and/or scaffold tube jacked or wedged between the floors of a storey inside a building and including a tie tube

3.2.36
push/pull tie

a tie which only acts to prevent the scaffold moving either towards or away from the building, e.g. a reveal tie, a box tie, a double lip tie, a bolted tie with a tie tube

3.2.37
movable tie

a tie which may be temporarily moved for the execution of work (see **9.1.2**)

3.2.38
non-movable tie

a tie which will not be moved during the life of a scaffold, as agreed between the user and the scaffold erector (see **9.1.2**)

3.2.39
reveal tie
the assembly of a reveal tube with wedges or screwed fittings, and pads, if required, fixed between opposing faces of an opening in a wall together with the tie tube

3.2.40
through tie
a tie assembly through a window or other opening in a wall

3.2.41
wire tie or band tie
an assembly of a ring anchor and wire or steel banding used to tie the scaffold to the building

3.2.42
tie tube
a tube used to connect a scaffold to an anchorage

3.2.43
transom
a tube spanning across ledgers to form the support for boards or units forming the working platform or to connect the outer standards to the inner standards

3.2.44
butting transom
a transom extended inwards to butt the building to prevent the scaffolding moving towards the building

3.2.45
needle transom
a transom extending from or into a building

3.2.46
sway transom
a transom extended inwards in contact with a reveal or the side of a column to prevent the scaffold moving sideways (see Figure 4)

3.2.47
trapeze tube
a horizontal tube used to assist in erection and dismantling

3.3 Scaffold couplers and fittings

3.3.1
base plate
a metal plate with a spigot for distributing the load from a standard or raker or other load-bearing tube

3.3.2
adjustable base plate
a metal base plate embodying a screwjack

3.3.3
board-clip
a clip for fixing a board to a scaffold tube

3.3.4
toeboard clip
a clip used for attaching toeboards to tubes

3.3.5
end toeboard clip
a similar device for use on end toeboards

3.3.6
coupler
a component used to fix scaffold tubes together

3.3.7
check coupler or safety coupler
a coupler added to a joint under load to give security to the coupler(s) carrying the load

3.3.8
fixed finial coupler
a coupler to fix a tube across the end of another at right angles in the same plane, as in the handrail

3.3.9
parallel coupler
a coupler used to join two tubes in parallel

3.3.10
purlin, rafter or ridge coupler
special angle or variable angle couplers for joining members in sheeted buildings and roofs

3.3.11
putlog coupler
a coupler used for fixing a putlog or transom to a ledger, or to connect a tube used only as a guardrail to a standard

3.3.12
right angle coupler
a coupler used to join tubes at right angles

3.3.13
sleeve coupler
an external coupler used to join one tube to another coaxially

3.3.14
supplementary coupler
coupler(s) added to a joint to back up the main coupler taking the load when the estimated load on the joint is in excess of the safe working load of the main coupler

3.3.15
swivel coupler
a coupler used for joining tubes at an angle other than a right angle

3.3.16
swivel finial coupler
a coupler to fix a tube across the end of another in the same plane but at an angle, as the handrail to a staircase

3.3.17
dowel pin

see spigot pin (**3.3.34**)

3.3.18
fittings

a general term embracing components other than couplers

3.3.19
forkhead

a U-shaped housing for assembly on the end of a tube to accept bearers

3.3.20
adjustable forkhead

a forkhead fitted with a threaded spindle and nut to give adjustable height

3.3.21
rocking forkhead or swivel forkhead

a forkhead to accept bearers at a range of angles

3.3.22
hop up bracket or extension bracket

a bracket to attach usually to the inside of a scaffold to enable boards to be placed between the scaffold and the building

3.3.23
interlock pin

see spigot pin (**3.3.34**)

3.3.24
joint pin

an expanding fitting placed in the bore of a tube to connect one tube to another coaxially (see spigot)

3.3.25
putlog adaptor

a fitting to provide a putlog blade on the end of scaffold tube

3.3.26
retaining bar

a strip or device fixed across the top of the decking to hold it down

3.3.27
reveal pin

a fitting used for tightening a reveal tube between two opposing surfaces

3.3.28
roofing clip or sheeting clip

a fitting for fixing roof or wall sheeting to tubes in structures without the need for holes in the sheeting

3.3.29
sheeting hook

a threaded rod hook with a washer and a nut used for attaching sheeting to tubes

3.3.30
sole plate

a timber, concrete or metal spreader used to distribute the load from a standard or base plate to the ground

3.3.31
spigot

an internal fitting to join one tube to another coaxially (see joint pin)

3.3.32
expanding spigot

a spigot incorporating an expanding device (see joint pin)

3.3.33
fixed spigot

a spigot permanently fixed to the end of a scaffold tube

3.3.34
spigot pin

a pin placed transversely through the spigot and the scaffold tube to prevent the two from coming apart

3.3.35
sill

see sole plate (**3.3.30**)

3.3.36
tension pin

see spigot pin (**3.3.34**)

3.4 Other terms in general use

3.4.1
anchorage

component cast or fixed into the building for the purpose of attaching a tie

3.4.2
brick guard

a metal or other fender filling the gap between the guardrail and toeboard, and sometimes incorporating one or both of these components

3.4.3
castor

a swivelling wheel secured to the base of a vertical member for the purpose of mobilizing the scaffold

3.4.4
gin wheel or block

a single pulley for fibre ropes attached to a scaffold for raising or lowering materials

3.4.5
going

the horizontal distance between the nosings of two consecutive steps of a stair or terrace, measured in a horizontal line

3.4.6
guy anchor

a pin or tube driven into the ground at approximately 45° to the horizontal to provide an anchorage for a rope

3.4.7
inside board

a board placed between the scaffold and the building on extended transoms, or a hop-up bracket

3.4.8
jib crane

a small crane specially adapted for pivotal mounting to a scaffold tube

3.4.9
kentledge

dead weight, built-in or added to a structure to ensure adequate stability

3.4.10
retaining boards

see brick guard (**3.4.2**)

3.4.11
rise

the vertical distance between two steps of a stair or terrace

3.4.12
scaffold board

a softwood board generally used with similar boards to provide access, working platforms and protective components such as toeboards on a scaffold (cf. scaffold unit)

3.4.13
scaffold or decking unit

the board(s) or unit forming the working platform

3.4.14
sheeting

horizontal, vertical or inclined sheets of material, such as corrugated metal or plastics sheet, attached to a scaffold in order to provide protection from the effects of weather or alternatively to protect the surrounding area from the effects of works being carried out from the scaffold structure

3.4.15
skirt

a short portion of vertical sheeting usually adjacent to the edge of a roof to give extra protection to the area enclosed immediately under the roof

3.4.16
toeboard

an upstand at the edge of a platform, intended to prevent materials or operatives' feet from slipping off the platform

3.4.17
end toeboard

a toeboard at the end of a scaffold or at the end of a boarded portion of it

3.4.18
working platform

the deck from which building operations are carried out

4 Units

The standard units of measurement used in this code are those of the International System of Units (SI).

For further information reference should be made to BS 5555.

In this code the term "weight" has only been used to describe the gravitational or downward force exerted by a body which is given in newtons[4)]. In the past the term "weight" has also been used to describe the "mass" of a body which is given in kilograms.

5 Statutory requirements

Attention is directed to Acts, Byelaws, Regulations and any other Statutory Requirements relating to matters dealt with in this code. The equipment should comply with these regulations and requirements. Its performance, use, inspection, testing and maintenance should also be in accordance with the appropriate regulations.

Amongst others, the following requirements, current at the date of publication of this code, relate to access and working scaffolds and special scaffold structures in steel:

a) Health and Safety at Work etc. Act 1974;

b) Factories Act 1961;

c) SI 94 The Construction (Working Places) Regulations 1966;

d) SI 1580 Construction (General Provisions) Regulations 1961;

e) Construction (General Provisions) Regulations (NI) 1963;

f) Construction (Lifting Operations) Regulations (NI) 1963;

4) 1 KN = 101.972 kgf = 224.809 lbf.

g) Construction (Working Places) Regulations (NI) 1963;

h) Highway Act 1971;

i) Public Health Act 1930;

j) London Building (Amendment) Act 1939;

k) Building (Scotland) Act 1959.

6 Equipment

6.1 General

All materials should, when new, comply with the requirements of the appropriate British Standards. Used materials which are in satisfactory condition may not always comply with the requirements of these standards. Due allowance has been made for this fact in this code.

The materials and components and their method of assembly should comply with the relevant statutory regulations. A list of the other British Standards which give details of materials and components which will satisfy the recommendations of this code are given in appendix A.

Section 2 makes recommendations on the care of the materials and on the degree of wear and tear which should not be exceeded if the materials are to be included in a structure which is intended to be in accordance with this code.

6.2 Steel tubes

Tubes are normally supplied with a maximum length of 6.40 m and are available in shorter lengths by request. New tubes should comply with BS 1139-1.1:1991; the marking on such tubes is "39"; "A" or "B" and "4". Alternatively tubes which when new complied with the withdrawn BS 1139-1:1982 may be used. These documents specify the minimum properties, dimensions and tolerances (see **39.5**). Used tubes should be free from cracks, splits and excessive corrosion and be straight to the eye. The ends of load-bearing tubes should be cut cleanly and squarely with the axis of the tube and should not show excessive wear.

6.3 Couplers and fittings

Scaffold couplers and other fittings should, when new, comply with the requirements of the relevant British Standard. If they have characteristics which do not comply with the relevant British Standard, then account should be taken of this in the design and construction of the scaffolding. Fittings for which there is no standard should be used in accordance with the recommendations and data provided by the manufacturer or supplier.

6.4 Decking units

6.4.1 *General*

There are four groups of decking units, used to construct working platforms, as follows.

a) Timber scaffold boards of nominal cross sections 38 mm × 225 mm. (For strength data, see **39.6**.)

b) Components of similar width to those in a), but fabricated, for example, of laminated timber or metal, with equal or greater strength.

c) Timber boards of other thicknesses or greater width than those in a).

d) Components of greater width than those in a) and fabricated in various ways, such as platforms or lightweight staging.

All decking should have adequate strength to meet the recommendations for the appropriate duty of Table 1. To ensure this, timber scaffold boards should comply with the requirements of BS 2482.

NOTE Unless otherwise indicated, the use of the word "board" in this document implies the decking described in a) but the principles apply to all types.

6.5 Other equipment

It is recommended that all other equipment should, when new, comply with the requirements of the appropriate British Standard. Where there is no appropriate British Standard, the strength of materials used should comply with the recommendations and data supplied by the manufacturer.

Table 1 — Access and working scaffolds of tube and couplers

Duty	Use of platform	Distributed load on platforms	Max. number of platforms	Commonly used widths using 225 mm boards	Max. bay length
		kN/m²			m
Inspection and very light duty	Inspection, painting, stone cleaning, light cleaning and access.	0.75	1 working platform	3 boards	2.7
Light duty	Plastering, painting, stone cleaning, glazing and pointing.	1.50	2 working platforms	4 boards	2.4
General purpose	General building work including brickwork, window and mullion fixing, rendering, plastering.	2.00	2 working platforms + 1 at very light duty	5 boards or 4 boards + 1 inside	2.1
Heavy duty	Blockwork, brickwork, heavy cladding.	2.50	2 working platforms + 1 at very light duty	5 boards or 5 boards + 1 inside or 4 boards + 1 inside	2.0
Masonry or special duty	Masonry work, concrete blockwork, and very heavy cladding.	3.00	1 working platform + 1 at very light duty	6 to 8 boards	1.8

NOTE 1 This table should be read in conjunction with the remainder of the code and **8.4.3** and **8.5.1** in particular.
NOTE 2 The loads and number of loaded platforms and widths of scaffold from this table have been used in the calculations given in appendix B.

7 Care of equipment

7.1 General

When not in use, equipment should be cleaned and protected from deterioration.

Materials which show excessive corrosion or deterioration should be discarded.

7.2 Tube

Hot dipped galvanized, painted or unprotected tube may be used in scaffolding structures. Unprotected steel tube should generally not be used in water and particularly not in marine structures. If used in such conditions, tubes should be thoroughly cleaned afterwards, carefully inspected, e.g. for signs of excessive corrosion, and only returned to stock if suitable.

Before painted tubes are used, the paint should be firm and dry.

Bent steel tube may be straightened by using a crow or a reeling machine. This operation should be carried out under competent supervision. Sections of tube which have been seriously deformed or creased by abuse should be cut out and discarded. Where tubes have become thin or split at the ends, then these should be cut off, all such cuts being at right angles to the axis of the tube.

Corroded tube should be wire brushed and the extent of the corrosion assessed by an expert examiner. This examination may be carried out by eye and should have as its basis the observation of the surface characteristic of a tube which has lost about 10 % of its original minimum specified weight. All tubes failing this examination should be rejected.

7.3 Couplers and fittings

All couplers and fittings should be properly maintained and examined before use. The nuts should be run on their bolts to ascertain that they have a free-running fit.

Heat should not be applied to couplers and fittings, free parts, nuts or bolts.

Spanners and podgers should have lengths as recommended by the coupler manufacturer. Torque should not be applied to a coupler through an ill-fitting spanner.

7.4 Gin wheels and gin wheel ropes

Gin wheels should be maintained in a free-running condition with the shaft not turning in the side plates.

All ropes for use with gin wheels should be inspected at every change of job and, in any event, every six working months.

The identification tag and SWL (safe working load) tag should be replaced where necessary.

Ropes which have been used on stone cleaning contracts or in any location where there are aggressive chemicals, should be carefully inspected for deterioration.

7.5 Scaffold boards

Boards should be inspected after each job. Any which show signs of ill-treatment, abuse or decay should be discarded, as should boards which are excessively warped. Damaged or suspect sections should be cut off and destroyed.

The end hoops or other means of end protection should be replaced or refixed as necessary.

Where boards have split ends which do not exceed the limits given in **7.2.2.1** of BS 2482:1981 nail plates may be used to close them in accordance with clause **6**(b) of that specification. No other repair should be used.

Scaffold boards should be cleaned on return from a construction site prior to stacking. They should be stacked flat and raised from the ground by cross battens.

Care should be taken of boards in use. Any over stressing, e.g. that caused by impact loading, is likely to cause unseen damage. They should not be used as ramps or platforms over long spans, nor should they be put on the ground where vehicles or other loads can be put on them.

The detection of compression creases which cause a weakness in boards is very difficult. Such damage is likely to result from over loading, particularly impact loading caused by dropping on the end. In any case of doubt, destroy the board. Boards which show evidence of vehicle tyre marks should be destroyed.

Both high temperatures and chemicals can result in permanent loss of strength. Where boards are treated for fire retardent purposes, care should be taken to select a process which minimizes the loss of board strength.

Section 2. Standard scaffolds

8 Description of access scaffolding

8.1 General

Putlog and independent tied scaffolds are generally as defined in **3.1** and shown in Figure 1 and Figure 2. They are constructed in tubes and couplers for the purpose of providing working platforms adjacent to the surfaces of buildings. Guardrails and toeboards should be provided on all working platforms on a scaffold.

8.2 Putlog scaffolds

A putlog scaffold consists of a single row of uprights parallel to the face of the building and set as far away from it as is necessary to accommodate a platform of four or five boards with the inner edge of the platform as close to the wall as is practicable.

The standards are connected with a ledger fixed with right angle couplers and the putlogs are fixed to the ledgers with right angle or putlog couplers.

The blade end of the putlog tube or putlog adaptor is normally placed horizontally on the brickwork being built. However, where putlog scaffolds are erected against an existing brick wall for repointing, the old putlog holes may be reused or others raked out. In this case the putlog blades may be inserted vertically.

Sole plates and base plates are usually used under each standard. Tying recommendations are detailed in clause **9**.

Where a putlog is required for a board support and it is opposite an opening in the building such as a window or doorway, the inside end of the putlog should be supported on an underslung bridle tube spacing between adjacent putlogs, as shown in Figure 6, which also shows a method of tying through these openings.

Longitudinal bracing is required, at intervals not exceeding 30 m but, unlike independent tied scaffolds, ledger bracing is not required in the finished structure.

For brickwork, the lift height should be about 1.35 m, although for certain types of masonry a lower lift height may be necessary.

8.3 Independent tied scaffolds

An independent scaffold consists of a double row of uprights, with each row parallel to the building. The inner row is set as close to the building as is practicable. The distance between the lines of uprights should be the minimum necessary to accommodate the required number of boards and toeboards.

A variation may be adopted in which the row of standards nearest to the building can be set back about 300 mm from the building face so that one of the boards of the platform can be laid between the inside row of standards and the building face.

The uprights should be connected with ledgers parallel to the building and fixed with right angle couplers and with transoms fixed to the ledgers with putlog couplers to give platform widths as given in **15.1** and Table 2.

Sole plates and base plates should be used under each standard when so recommended by clause **11**.

The scaffold should be tied into the building at the frequency detailed in clause **9**.

Longitudinal bracing is required at intervals not exceeding 30 m. Ledger bracing is generally fixed to alternate pairs of standards.

8.4 Duty of scaffolds

8.4.1 *Loading*

Access and working scaffolds may be specifically designed and constructed for any particular distributed or point load and for a variety of purposes. If no load rating is quoted by the specifier, it is recommended that the selection is made from Table 1. For platform loadings on access towers and other types of scaffold, reference should be made to the relevant clause in section 5.

8.4.2 *Maximum bay lengths*

The bay lengths depend on the height and loading of the scaffold. Table 1 gives maximum bay lengths of scaffolds with single standards (see Figure 1 and Figure 2).

8.4.3 *Lift heights*

The normal lift height for brickwork is 1.35 m, and for walk-through scaffolds is 2.0 m. In certain circumstances lifts greater than 2.7 m are required and are admissible provided the load applied to the standard is not greater than the value given in Table 14 for the appropriate height.

8.5 Calculations required for the construction of access scaffolding

8.5.1 *General*

Unsheeted access and working scaffolds may be constructed up to a height of 50 m without calculations provided that they are constructed in accordance with the recommendations of sections 2 and 3, and that they do not carry greater loads nor have greater bay lengths than those given in Table 1. A further recommendation is that they are not subjected to loading of materials by mechanical means, such as by rough terrain fork lift trucks.

All other forms of scaffold should be subject to design and calculation. Section 5 details special scaffolds which are the subject of calculation, section 6 gives technical data for calculations of scaffolding heights and appendix B gives examples of the calculations.

8.5.2 ***Sheeted scaffolds***

Where sheets are added to scaffold, for instance for the protection of the public or where weather protection sheeting is attached to part of it for the benefit of the workmen using the scaffold, special consideration should be given to tie spacing. The scaffold may also need to be specially designed with consideration given to the additional wind forces (cf. **9.3**).

When a temporary roof is to be fixed to the top of an access scaffold, the scaffold and its attachments to the building should be specially designed.

9 Tying scaffolding to building facades

9.1 General

9.1.1 ***Basic requirements***

Means of resisting inward and outward movement should be provided for both independent and putlog scaffolds. This will normally be by attachment with ties to the facade at a number of points. Where the structure and its components are strong enough, in the interests of safety and economy, permission should be sought to use ties. A tie to the facade consists of a tie member, normally a tube, and an anchorage. Various types are described in **9.4**. Where the recommendations of **9.1.2** to **9.8** cannot be followed, the facade should be considered abnormal, and the scaffold should be specially designed (see **9.9**).

See **9.7** for alternatives to ties.

9.1.2 ***Building structure***

It should be established, by test if necessary, that the strength of the building structure at the location of a tie is adequate to sustain the loads which will be transferred to it. This applies particularly to any proposed use of parapets or architectural features such as balustrades as it is frequently found that the anchorage value of such features is negligible. Where required, packing should be provided to protect the structure or to spread the load away from edges or corners. Examples of packing are timber packs, wedges or plastics caps. Packing should be secured to prevent it from falling.

9.1.3 ***Movable and non-movable ties***

A scaffold should be erected, adequately tied, and wherever practical these ties left undisturbed until the scaffold is dismantled. The choice of appropriate ties and their positioning should make this possible. Such ties are referred to as non-movable and they are provided at an agreed regular spacing.

Where it is necessary to remove a tie, however temporarily, the scaffold will be less secure, and accordingly a higher provision of ties will be appropriate. The actual calculation of area should be made with any one tie removed. Ties which it may be necessary to remove temporarily are referred to as movable.

9.2 Layout of ties

Ties should be evenly distributed over the scaffold, both horizontally and vertically. The spacing of lines of ties should not exceed 8.5 m, either vertically or horizontally, but individual ties should still be within the area rule (see Table 1(a)). Where the building surface permits a staggered arrangement of ties, this should be adopted in preference to a rectangular pattern.

Where the capacity of individual anchorages is less than 6.25 kN, either a tie should be attached to two or more, or additional ties should be used, so that adequate capacity is provided.

The friction of the foundation of a scaffold can be regarded as providing adequate tying of the lower 3 m of the scaffold.

9.3 Frequency of tie points on the scaffold

9.3.1 ***General***

At least the number of ties recommended in Table 1(a) should be installed. The frequencies in the table do not apply where the design wind speed is greater than 39 m/s (see **39.10**). Recommendations of frequency are based on a minimum tie and anchorage safe working capacity of 6.25 kN each, and the majority of ties will be of this capacity. For reveal ties (see **9.7.1** b)) the capacity is less, and their security is less assured, so a smaller area per tie is appropriate. This has been taken into account in Table 1(a). No scaffold should rely only on reveal ties, and every attempt should be made to keep them below 50 % (see also **9.9**). Some cast-in and drilled anchors do not have the standard capacity of 6.25 kN because of the weakness of the material into which they are fixed, and in such cases the number of anchors to be provided should be calculated by proportion. This also applies to any other case when a tie capacity of 6.25 kN cannot be made available.

Table 1(a) — Frequency of ties in square metres per tie

This table should be read in conjunction with **9.3**				
	Ties 12.5 kN[a]	**Ties 6.25 kN[a]**	**Up to 50 % reveal ties 3.5 kN[a]**	**Over 50 % reveal ties 3.5 kN[a]**
Unsheeted scaffolds				
Independent scaffolds				
with movable ties	32	32	25	[b]
with non-movable ties	40	40	31	22
Putlog scaffolds				
with non-movable ties	32	32	25	[b]
Sheeted scaffolds				
with movable ties	25	12.5		
with non-movable ties	32	16		

NOTE 1 Where tie capacities are less than those stated, appropriate frequencies should be calculated by proportion.
NOTE 2 For tie capactity see **9.7**.
NOTE 3 The height of the scaffold has been assumed to be:
for unsheeted scaffolds less than 50 m;
for sheeted scaffolds less than 25 m, but see also **9.3.3**.

[a] Safe working capacity.
[b] Not recommended.

9.3.2 ***Unsheeted scaffolds***

The recommendations given in Table 1(a) are for scaffolds less than 50 m high. If scaffolds are higher they should be specially designed.

9.3.3 ***Sheeted scaffolds***

The recommendations given in Table 1(a) are for scaffolds less than 25 m high in England and Wales on sites other than open country and where there is a tie capacity of 12.5 kN at each tie position. If any of these conditions are not met the scaffold should be specially calculated.

9.4 Ties

9.4.1 ***Selection of ties***

The type of tie and anchorage should be selected from those given in **9.4.2** to **9.4.5** to suit the tying requirements and the nature of the facade.

9.4.2 ***Box ties***

Box ties consist of an assembly of tubes and couplers arranged in the form of a square fixed around columns or other elements of the building, being wedged, where necessary, to resist both the inwards and outwards movement and to give some degree of lateral restraint. Details (ii) and (iii) of Figure 3 are typical examples.

They should be at the level of the scaffold lift and be joined to both the inside and the outside ledgers or standards. If this impedes free access through the scaffold, then it is permissible for them to be fixed to the inside standard. In this case they should be adequately attached to resist the loading.

9.4.3 ***Lip ties***

Where it is not possible to use box ties, lip ties may be used (see Figure 4). These consist of an L-shaped arrangement of tubes and couplers to hook the scaffold behind elements of the building. They do not resist inward movement of the scaffold and should be accompanied by an adjacent butting transom or have two cross tubes, nor do they resist sway. They are improved in performance by the use of a sway transom as shown in detail (iv) of Figure 4(a). Sway transoms should not be regarded as a substitute for facade bracing. They should be coupled to the ledger with load bearing couplers. Care should be taken to ensure that the strength of any building feature utilized is adequate, particularly if this is a parapet or similar structure.

Lip ties may also be used over sills and under lintels. In these cases, it will be infrequent that the sill or lintel tie is on a level with a lift of the scaffold and they may be fixed to the inside uprights only or to a bridle tube fixed to two inside uprights. They should be accompanied by adjacent butting transoms and sway transoms.

In certain circumstances it may not be possible to fit butt tubes at right angles to the transom to form lip ties. Right angle couplers may be used as stops, provided there is at least a 25 mm lap onto a suitable part of the building.

9.4.4 ***Through ties***

9.4.4.1 *Through ties for independent tied scaffolds* Through ties (see Figure 5) rely on a tube across the inside of an opening such as a window in a building.

The inside tube should be placed vertically and rest on the floor so that it cannot slip downward, but it may be placed horizontally.

The tie tube should rest on the sill for the same reason but it may be placed under the lintel. Tie tubes attached to a tube across the inside of the window or opening should be as close to one of the edges of the opening as possible.

Where it is not possible to fix an outside tube, the adjacent transoms should butt against the outside surface of the wall.

9.4.4.2 *Through ties for putlog scaffolds*

When a putlog is required to support boards and it is opposite a window opening, a bridle tube is frequently placed near the wall across the adjacent putlogs on either side of the window. The putlog opposite to the window is fixed to this.

A similar arrangement may be used to form a through tie.

Figure 6 shows an arrangement in which a tie tube is underslung and attached to both ledger and bridle.

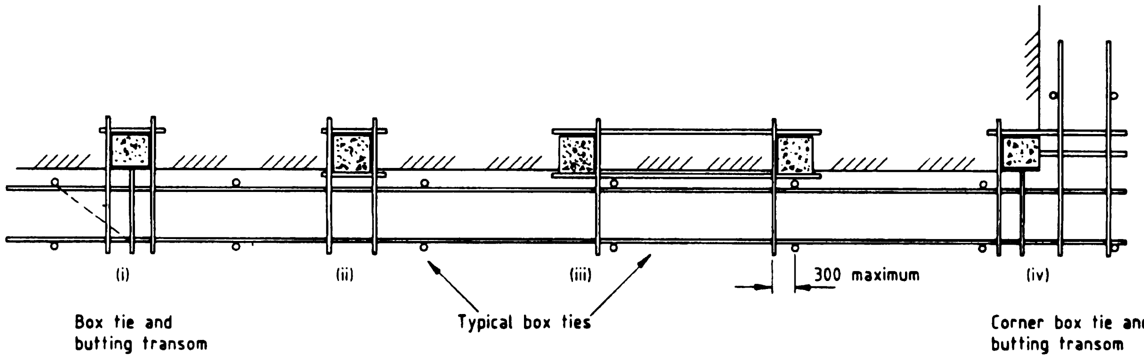


Figure 3 — Plan of typical box ties

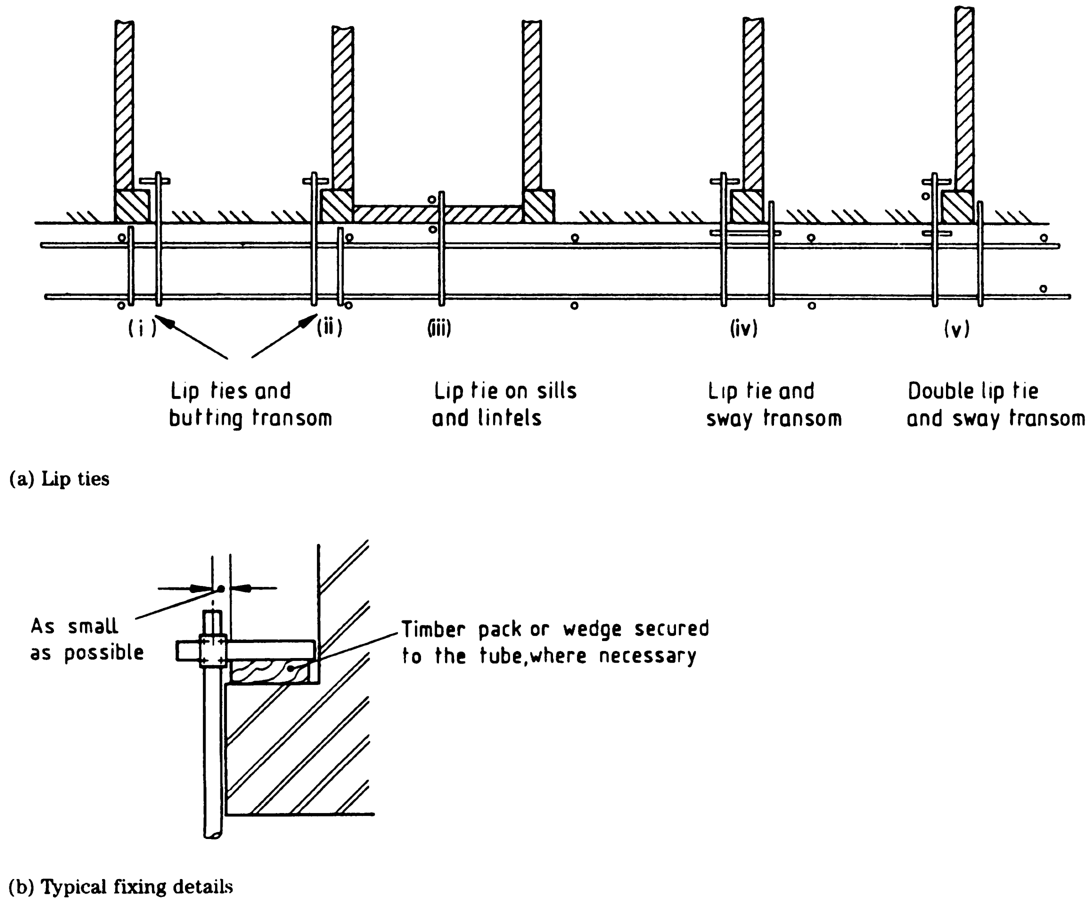
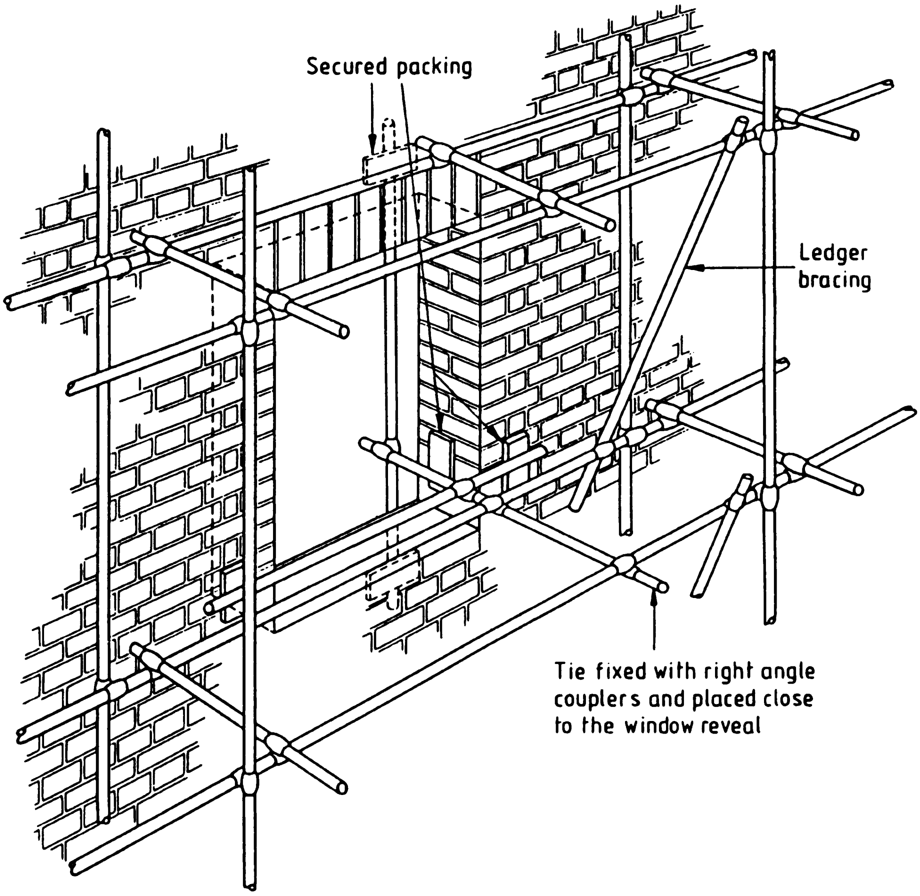


Figure 4 — Arrangement of lip ties and sway transoms



NOTE. This drawing should be read in conjunction with the text.

Figure 5 — Through tie for independent tied scaffold

9.4.5 *Reveal ties*

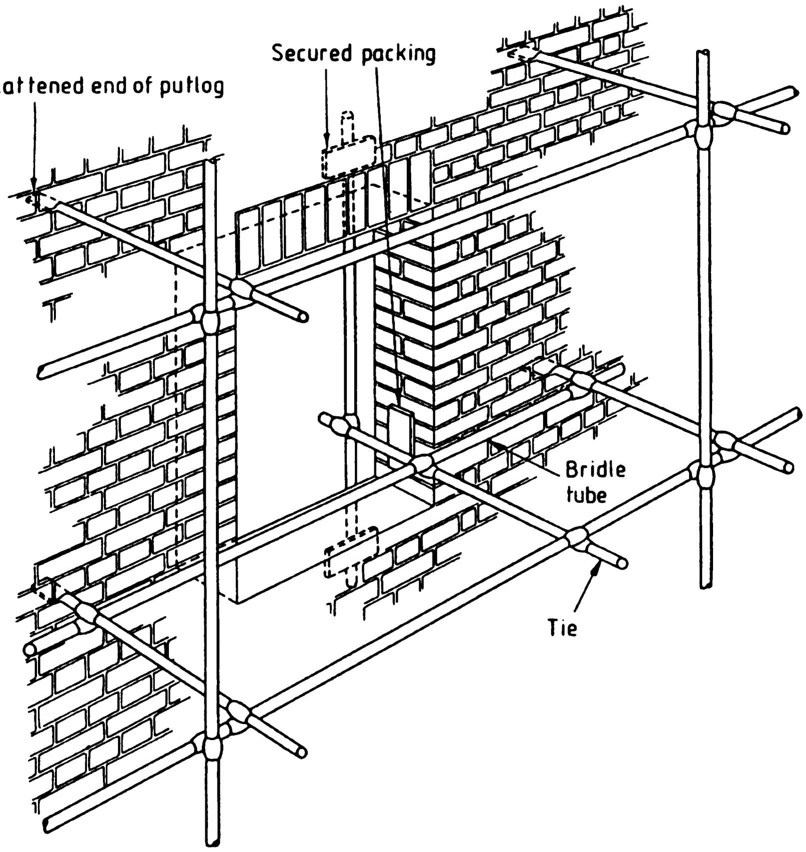
In cases where it is impracticable to drill into the surface of a building for screw or anchor ties, or where the quality of the fabric of the building is not known, or where it is impracticable to open windows for tube and coupler ties, the attachment of the scaffold should be made by reveal ties which rely on friction (see **9.3.1** and Figure 7).

Opposing faces of a building surface, such as the two opposing sides of a window opening or alternatively the underside of the lintel beam and the sill if this is not sloping, may be used to make an attachment of the scaffold to the building by means of a tube, wedged or jacked tight between the opposing faces.

It is essential that the manner of wedging the reveal tube into the opening be firm, reliable and, if possible, positive rather than by friction, i.e. if the reveal tube can be fixed behind indentations or masonry features advantage should be taken of this (see **9.4.3**).

For most building surfaces, the reveals are plain and parallel and should not be marked or damaged. For these, it is frequently necessary to place a packing between the end of the reveal tube and the surface so that damage does not occur. Timber packs should be thin so as to reduce shrinkage (a thickness of 10 mm is recommended). It is not expected that they should spread the load over the surface of the reveal but that they should grip it and protect it at the same time.

The preferred method is to use a reveal pin at one end of the reveal tube. This consists of a small plate on which is mounted a threaded bar and nut. The assembly should be placed inside the bore of the reveal tube and the nut adjusted until the reveal tube is expanded into the opening, gripping it with considerable force.



NOTE. This drawing should be read in conjunction with the text.

Figure 6 — Through tie for a putlog scaffold on a bridle tube

The tie tube should be fixed to the reveal tube with a right angle coupler as near as possible to the end opposite to the reveal pin and in all cases within 150 mm of the face of the opening. It should also be fixed to the scaffold in two places with right angle couplers (see Figure 7) but other arrangements may also be satisfactory.

For a putlog scaffold, a bridle tube attached to two putlog tubes can provide a second fixing point. There are other methods of providing reveal ties, for instance by utilizing props and struts.

Because reveal ties rely on friction and are usually packed with timber, they should be frequently checked for tightness during the life of the scaffold.

9.5 Anchorages and allied components

9.5.1 *Selection*

An anchorage can be provided by casting in or subsequently fixing something, normally a threaded socket, into a part of the structure itself. Various components are then used to attach the scaffold. The appropriate anchorage and tie should be selected from the principal types described in **9.5.2** to **9.5.5**. Anchorages and allied components should have a safe working capacity of 6.25 kN in tension and compression.

9.5.2 *Cast-in and drilled anchorages*

A variety of screwed plates, sockets and nuts are available for setting into the concrete during pouring, in a similar manner to formwork anchors, for subsequent use as scaffold ties. The attachment of the tie to the anchorage should be either by bolts welded to scaffold tubes or by use of special scaffold fittings (see Figure 8). Ring bolts may also be used.

A variety of anchor sockets are available intended for fixing into holes drilled into hardened concrete or sound brickwork. The attachments are similar to cast-in anchors. Specialist advice should be sought before using resin anchors. When drilling into brickwork, the anchor should be placed in the solid portion of the brick.

If the brickwork has been rendered, the location of the centre of the bricks should be found by drilling test holes and inspecting the location of the courses and brick ends through the holes. Care should be taken that the facade material is an integral structural material and not a surface cladding.

Holes for anchor sockets should be drilled to the correct depth and diameter as recommended by the manufacturer and be clean and normal to the surface. Some cavity walls and thin cladding panels may be unsuitable for supporting tie loads in which case other tying methods should be used. When intending to fix anchorages, data provided by manufacturers and based on tests carried out with substrates comparable to that of the structure may be used, applying a minimum factor of safety of 2.0 on the failure load quoted to determine the safe working load.

The capacity of the anchorages should be established either by a proof load test or by test to failure on a representative sample chosen on an acceptable statistical basis. The manufacturer's recommendations in this respect should normally be adopted.

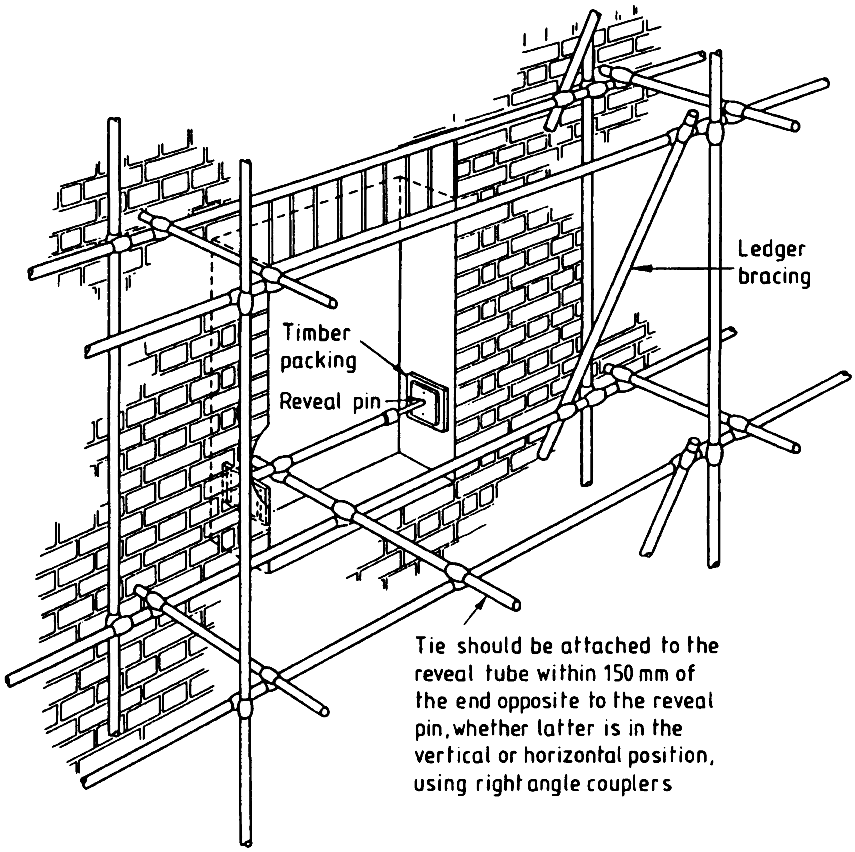
9.5.3 ***Tie tube adaptors***

Tubes fitted with end plates (see Figure 8) can be used when it is possible to drill the element of the building to which the tie is to be attached and fix the end plate to it with expanding bolts. On new work, cast-in sockets can be used.

The tube welded to the drilled end plate can be standard scaffold tube, or tube of 60.3 mm external diameter able to receive standard scaffold tube inside it, the two tubes being fixed together with friction bolts.

Offset ties (such as shown in Figure 8(d)) enable fixing of the scaffolding to the building so that the window frames can be placed between the tie tube and the column.

A variety of scaffold fittings and half fittings may be adapted, by securely welding on bolts or drilling bolt holes, to become satisfactory tie fittings.



NOTE 1. This drawing should be read in conjunction with the text.
NOTE 2. The tube in the reveal can be in the vertical or horizontal position.

Figure 7 — Reveal tie

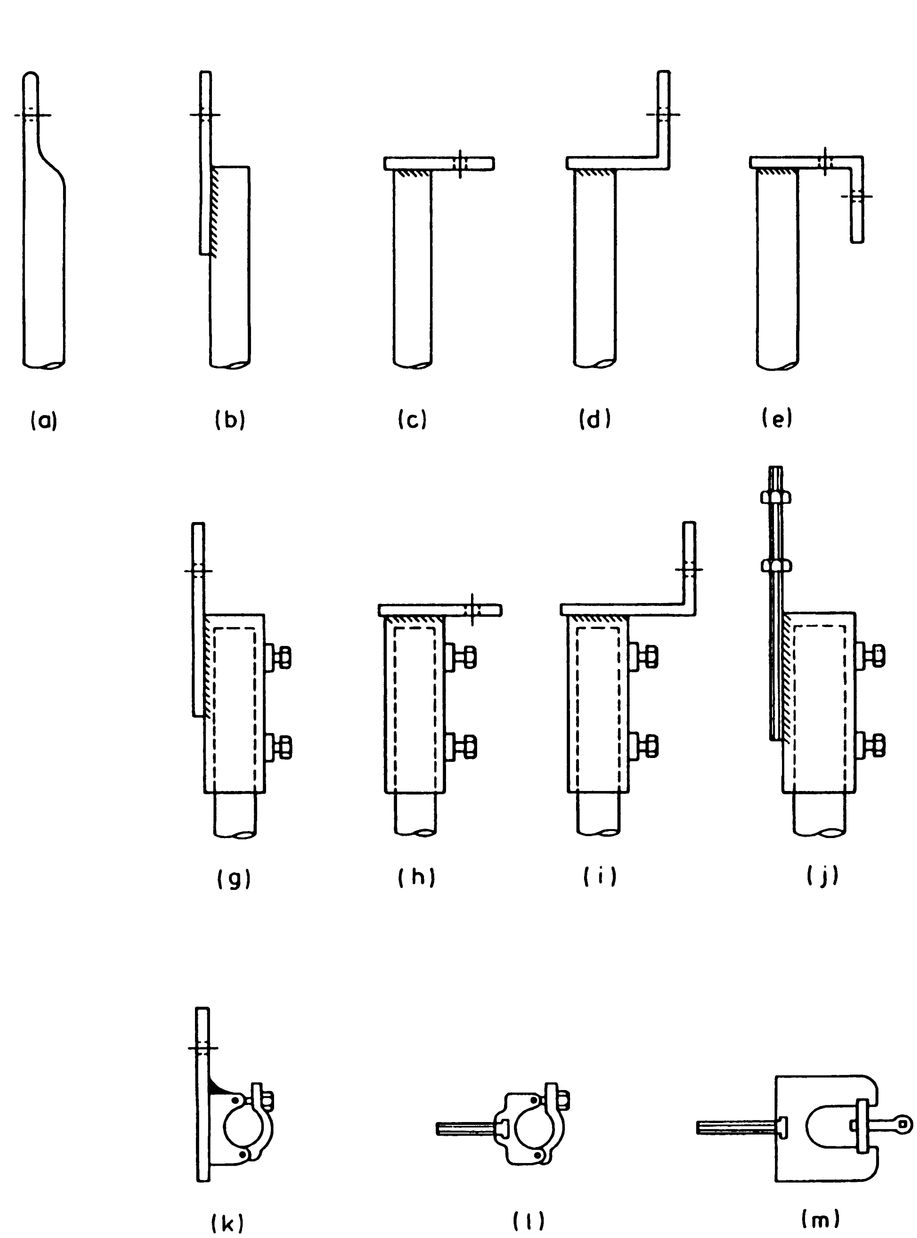


Figure 8 — Typical end details for tie tubes

9.5.4 ***Ring bolts***

Typical ring bolts are shown in Figure 9 and Figure 10. They may be of two sizes:

a) with rings of between 50 mm and 55 mm internal diameter through which scaffold tube may be passed to form a tie assembly;

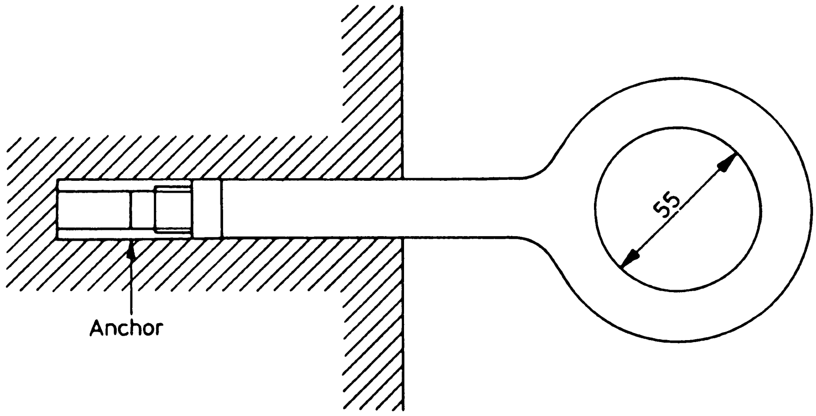
b) with smaller rings for use with wire or steel banding ties.

In case b), the tube and fittings assembly should be such that it prevents the scaffold from moving inwards or outwards.

9.5.5 ***Wire and steel banding ties***

Where the small ring anchorages shown in Figure 10 are used, the scaffold may be attached to the building or structure with 6 mm wire rope threaded through the ring and round a member of the scaffold with a minimum of three turns. Steel banding of equivalent strength may also be used.

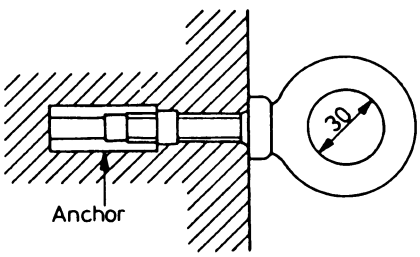
When wire or banding is used, the tie does not prevent the scaffold from moving inwards to the building and accordingly such ties should be accompanied by adjacent butting and sway transoms.



The dimension is in millimetres.

Figure 9 — Typical ring bolt tie

Many elements of a building may afford opportunities for the attachment of wire ties and may be used provided they are of adequate strength. However, it should be realized that the anchorage value of these elements is frequently negligible. The strength and pull-out capabilities of these elements, which will include rainwater pipes, parapets and other architectural features should be verified before any use is made of them. Where there is any doubt as to the suitability of such features, alternative attachment points should be found. Rainwater guttering should never be used for the attachment of ties.



The dimension is in millimetres.

Figure 10 — Typical wire or band tie anchorage

9.6 Attachment of the scaffold to the anchorage point

In plan, tie tubes, wire or banding ties should be set at right angles to the building unless they are intended to plan brace the scaffold against lateral movement. In the latter case, they may be set at an angle to the plan perpendicular to the building but should be fixed in pairs at opposing angles so as to afford lateral stability in both directions and should be accompanied by ties at right angles to the building to prevent outward movement.

In elevation, tie tubes should be horizontal or sloping downwards away from the building. They should not slope upwards away from the building.

Ties should be attached to both the inside and outside ledgers or standards at a point not more than 300 mm from a ledger braced standard, and as near to a node point as possible. Where this hinders access along a platform, attachment to the inside ledger or upright only is permissible.

The couplers for ties set horizontally and at right angles to the building should be right angle couplers or another such arrangement of couplers which gives similar or adequate strength.

The couplers for ties set at an angle to the building may be swivels.

Where wire or bonding ties are used, they should be turned round a node point of the scaffold or otherwise prevented from slipping along the ledger or upright by fixing safety couplers. A tube butting against the structure will be required in order to provide inwards strength.

9.7 Capacity of tie systems and alternatives

9.7.1 *Inwards/outwards capacity*

The safe working capacities of a tie system may be calculated in accordance with section 6 of this standard having regard to the geometry of the arrangements and the capacities of the individual elements of both the tie and scaffold within such an arrangement.

In the absence of such calculations and providing that the recommendations of **9.4** and **9.5** are followed, each tie assembly should be considered as having the following safe working capacity.

a) *Box ties, lip ties and through ties*

All the ties shown in Figure 3(iv), Figure 4, Figure 5 and Figure 6: 6.25 kN.

For the ties in Figure 3 which have two tubes and a butt tube connected with two couplers: 12.5 kN.

b) *Reveal ties*

Where these rely solely on friction there is no mechanical interlock and construction is in accordance with Figure 7: 3.5 kN inwards and outwards.

Where the reveal tube goes behind a load-bearing feature and the tie tube is tight to that feature, and there is a butt tube: 6.25 kN outwards.

c) *Cast-in and drilled anchorages*

In accordance with **9.5.2**, i.e. the manufacturer's stated safe working load with an appropriate factor of safety or a value determined by site tests inwards and outwards.

d) *Tie tube adaptors*

6.25 kN inwards and outwards.

e) *Ring bolts*

6.25 kN inwards and outwards.

f) *Wires and steel bands*

6.25 kN outwards.

9.7.2 *Lateral and vertical capacity*

Except in special cases, the design should not call for vertical or lateral capacity. But in the event of damage to the scaffold below, some vertical or lateral strength will prove advantageous.

9.7.3 *Equivalent tying value of scaffold returns, buttresses and rakers*

The stability of a scaffold can be achieved by means other than ties fixed to the surface of the building. Returns of scaffolds which are themselves effectively tied round the ends of building facades should be regarded as providing an adequate attachment of the scaffold to the facade for a 3 m length of the scaffold, measured from the end of the building.

Specially designed buttresses, either side of a scaffold, should be regarded as providing adequate stability for a 3 m length of the scaffold on either side of the buttress.

Single unjointed raking tubes of up to 6 m in length, at 6 m centres coupled at the top to the ledger at the second lift and tied back to the scaffold at the foot, should be considered as providing adequate stability for scaffolds up to 6 m high. The raking tube should be external to the scaffold and at an angle of not more than 2 vertical to 1 horizontal.

For other applications they should be designed in accordance with Table 14 taking the self weight into account.

9.8 Special details

9.8.1 *First working lift*

When a working lift is required at 1.35 m height, as in a putlog scaffold, or at 2 m height, as in an independent tied scaffold, and no firm part of the building has been constructed to attach a tie, a scaffold should be temporarily stabilized by raking tubes or other means. Such tubes should also be fixed during dismantling if low level ties are impracticable. Movement of the lower end should be prevented by a foot tie to the main scaffold or other suitable means.

9.8.2 *Ties for small scaffolds without returns*

When only two ties are required, it is preferable to place the ties towards the ends of a straight run of scaffold.

9.9 Abnormal facades

9.9.1 *General*

Where the tying arrangements of the previous clauses are inapplicable, the facade is considered abnormal and any such scaffold requires special consideration. Such facades will have no holes or possibilities for making them. Even if reveal ties are possible tying should not be reliant on such ties and they should not exceed 50 % of the total (see Table 1(a)). Where tying can only be provided by reveal ties these should only be adopted after careful consideration of their ability to carry the load and where their physical condition will be regularly maintained.

9.9.2 *Weak structure*

If the material is too weak to support an anchor, or if the structure as a whole is too weak, other means of access should be considered. These include tower mounted scaffolds, and hydraulic platforms.

9.9.3 *Limited facade size*

Where the facade concerned is not large, suitable methods of restraint include the use of raking tubes, buttresses, wire ties over the roof or round the sides, struts from other buildings and additional width of the scaffold.

If the ends of buildings are without windows and are unsuitable for fixing ties, consideration should be given to return scaffolds at the front and the back, or to wire ties along the front and the back. Where the untied facade is longer than 6 m, plan bracing across the corners of the scaffold and its front and back returns should be fixed at intervals of height not more than 8.50 m. Where the untied facade is longer than 10 m, additional plan bracing should be fixed across the full length of the untied structure at intervals of height of not more than 8.50 m. For lengths greater than 15 m, other methods should be considered.

Where a complete hollow structure is fully scaffolded internally or a structure of small plan area is completely surrounded outside by scaffolding, consideration should be given to dispensing with ties and placing reliance on butting transoms. In this case the lateral stability of the scaffold should be ensured by face bracing.

10 Bracing

10.1 General

Bracing should be provided to stiffen the scaffold. The plane to be braced should, wherever practicable, be divided into a complete series of triangles by braces. These should be fixed as close as possible to intersections. A check should be made on the reduction in strength of the scaffold where a brace has to be omitted or where it cannot be fixed within 300 mm of an intersection. For special scaffolds refer also to **39.9**.

10.2 Ledger bracing

Independent tied access scaffolding should contain ledger bracing which should generally be on alternate pairs of standards. Any pair of standards which are ledger braced should be made into a complete series of triangles.

When the bay length is 1.5 m or less, the ledger bracing may be fixed to every third pair of standards.

The ledger bracing should preferably be fixed from ledger to ledger with right angle couplers when the lift is not to be boarded but may be fixed to the standards using swivel couplers.

The bracing on boarded lifts should be from under the outside ledger of a boarded lift down to the inside ledger of the lift below so as to avoid the toeboard. This arrangement may require an extra width on the scaffold to accommodate the brace.

Ledger bracing from the inside ledger to the guardrail level of the lift below may be used provided that every pair of standards is so braced instead of every alternate pair.

The direction of ledger bracing is immaterial for the structural stability of the scaffold but it should be pre-planned to take account of the intended use of the scaffold.

In scaffolding over footpaths, it may not be possible to ledger brace the lowest lift. Ledger bracing may be omitted from this lift provided the lengths of the standards in the lift area are not in excess of 2.7 m. In this case account should be taken of the reduced loading capacity of this lift.

When the height of the lowest lift is in excess of 2.7 m, a knee brace should be inserted across the top corner of the lower lift, commencing at approximately 1.8 m from the ground.

One such knee brace should occur on every pair of standards and be fixed with alternate slopes. On large scaffolds it is sometimes desirable to insert cross knee braces on every pair of standards. To be effective, a ledger should be fixed adjacent to where the knee brace meets the standard.

10.3 Facade bracing

Longitudinal bracing should be provided to all scaffolds in which the movement along the facade of the building is not prevented by other means. It need not be fixed where the scaffold is securely butted between opposing outside or inside faces of returns or recesses, provided that no length greater than 10 m is so fixed against movement in both directions.

When longitudinal bracing is omitted, the lateral movement of both the inside and outside lines of the standard at every lift should be prevented either by both lines being adequately butted or by adequate plan bracing onto firm points inserted at every level.

Longitudinal bracing should be achieved by tubes set at between 35° and 55° to the horizontal, reaching from bottom to top of the facade. The principal forms are:

a) individual tubes set in zig zag pattern, the top of a tube and the bottom of the next preferably being attached to the same transom;

b) a continous tube, extended as necessary to cover the whole facade, only possible for wider facades;

c) individual tubes as in a), but all sloping the same way; the top of one is connected at a ledger/standard intersection, and the bottom of the next is attached to the same pairs of standards.

A combination of these may be appropriate.

In all cases, the bracing tubes should be connected either:

1) to every lift of the extended transoms with right angle couplers; or

2) to every standard with swivel couplers.

Arrangement (1) is to be preferred.

One such brace assembly should be provided at intervals along the scaffold not exceeding 30 m.

The longitudinal bracing should be fixed as near to the standards as possible. When the brace is fixed to extended transoms, the latter should be fixed to the outside ledgers with right angle couplers.

The longitudinal bracing should include the lower lift being started from the base of one of the outside standards. In the lower lift, when the bracing is started a guardrail should be placed through the braced bay to prevent people passing.

The joints in continuous diagonal bracing should be made by overlapping the two lengths of the tube by a distance of at least 300 mm and joining them together with two parallel couplers. Alternatively, the two tubes may be joined by a sleeve coupler or other coupler capable of sustaining the applied load or by an expanding joint pin lapped with a butt tube with one fitting either side of the joint.

10.4 Plan bracing

Plan bracing should be provided to all portions of an access scaffold which are not otherwise stabilized against lateral distortion. It may be joined by the same type of couplers used for longitudinal bracing and the same rules with regard to strength apply.

10.5 Couplers for fixing braces

Right angle couplers should be used to fix braces to ledgers or transoms and swivel couplers should be used for the attachment to standards. Other couplers may be used provided that they are capable of sustaining a safe working load of 5 kN.

11 Foundations

11.1 General

The foundations for a scaffold should be adequate to carry and dispose the load imposed both locally at each standard and, in general, to carry the whole weight of the scaffold.

The foundation for a scaffold should be maintained in an adequate condition during the life of the scaffold.

11.2 Hard surfaces

On surfaces such as steel and concrete which are even and level and where there is adequate hardness and thickness to prevent the scaffold tube penetrating into the surface, the uprights of a scaffold may be placed directly on the surface, although it is generally preferable to use a base plate.

11.3 Pavements and other surfaces of intermediate hardness

On surfaces such as hard asphalt, timber and flooring, where there is a possibility of the standards deforming the surface, base plates or metal packing plates should be used at the bottom of the standards.

11.4 Other surfaces

On soil, ash, hoggin, gravel, soft asphalt and any type of flooring or paving which would be penetrated by a standard with a base plate beneath it or if there is doubt about the surface, there should be a further spreading of the load by a sole plate of timber or other suitable material.

11.5 Sole plate area

When a sole plate is used, the sole plate area beneath any one standard should be at least 1 000 cm^2, with a least dimension of 219 mm, and if the sole plate is of timber, it should be not less then 35 mm thick. On sites where the ground is soft, or has been disturbed, the sole plate area should be not less than 1 700 cm^2 when individual sole plates are used, e.g. under hoist towers, and not less than 3 400 cm^2 when two are combined together under two standards. In this case, if the sole plate is of timber, it may be necessary to use one with a total thickness in excess of 35 mm. Sole plates should support two standards.

11.6 Soil compaction

The soil or ground beneath the sole plate should be well compacted and free from irregularities which would make the sole plate unstable or poorly bedded.

11.7 Sloping foundations

On slopes exceeding 1 vertical to 10 horizontal, a check may have to be made on the foundations to ensure the stability of the scaffold.

12 Standards

12.1 Foundations

Standards should be founded as detailed in clause **11**.

12.2 Erection tolerances

Erection tolerances should not exceed the figures detailed in **18.1**.

12.3 Joints

The joints in standards should be staggered. Joints in standards of access scaffolds tied to a building may be made with either joint pins or sleeve couplers. Sleeve couplers are preferred. As these types of couplers have limited load capacity in tension, in scaffolds which are free standing or projecting above the level of a building or otherwise subject to forces which would produce tension in the uprights, the standards should be joined in a manner capable of resisting the applied tension.

No more than three out of the four standards at the corner of any bay should have joints in the same lift except in the case of the bottom 6.5 m of a scaffold where an extended base life is necessary for pedestrian access or other reason, when a joint in all four of the standards at the corner of any one bay is permissible provided that one of the joints is lapped with a short length of tube.

12.4 Lift heights

The vertical intervals at which standards are linked to one another, i.e. the lift height, is the most important dimension in scaffolding. This dimension should be measured on site and maintained in accordance with the requirements of the design.

Where any of the standards in a scaffold are founded in a light well or at a level lower than the remainder of the standards, the extension downwards should be stiffened by horizontal tubes, in two directions at right angles and fixed at lift heights not greater than that of the foot lift of the remaining scaffold. Where access for the public is required under the first lift, a height of up to 2.7 m is permissible, provided that the load in the standards does not exceed those given in Table 14.

13 Ledgers

13.1 Attachment

Ledgers should be fixed to standards with right angle couplers, except in the case referred to in **13.3**, and should be horizontal except that a foot lift may follow the slope of the ground at the base of a scaffold. In this case, the transoms may be attached to the standards and the ledgers to the transoms.

13.2 Joints

Joints in ledgers may be made with sleeve couplers or expanding joint pins. Where tension is likely to occur, only sleeve couplers should be used. Joints in ledgers on the same lift and in adjacent lifts should not normally occur in the same bay. However, when guardrails are to remain permanently in place, the absence of a joint in the guardrail in any bay may be accepted as giving sufficient continuity to the scaffold to permit joints in the ledgers above and below it in the same bay. Where joints are necessary they should be positioned at a distance not greater than $\frac{1}{3}$ of the span between adjacent standards.

13.3 Curved building surfaces

In the case of curved scaffolds, fittings other than right angle couplers may be used to join the ledgers to the standards, provided that they are of adequate strength or otherwise supplemented by a right angle check coupler. If underslung transoms are used to modify the height of one platform, these transoms should be joined to the ledgers with right angle couplers. For large radius curves, separate scaffolds with platforms of the same height may be used.

14 Transoms and putlogs

14.1 Length of transoms and putlogs

The length of transoms and putlogs will vary according to the intended use of the scaffold and should be such that the widths of scaffolds given in Table 2 are obtained.

Transoms should be extended inwards and outwards, as necessary, for the purpose of butting the face of the building and fixing the longitudinal bracing.

14.2 Couplers

Transoms may be fixed to the inside and outside ledgers with right angle or putlog couplers, except in the cases referred to in **10.3** and **13.1**, when only right angle couplers should be used. Attachment to braces should be in accordance with clause **10**.

14.3 Spacing

14.3.1 *Boarded lifts*

The spacing of transoms and putlogs for boarded lifts should be in accordance with Table 3, except that the distance between transoms should not result in bay lengths greater than those given in Table 1. Board end transoms should be fixed so that the end overhang of a board does not exceed that given in Table 3. In no case should the overhang be less than 50 mm.

14.3.2 ***Non-boarded lifts***

Transoms and putlogs for non-boarded lifts should be fixed at one per pair of standards, including the pair at each end of the scaffold, and should be fixed within 300 mm of the standard.

On scaffolds of a height greater than 50 m, the transoms on unboarded lifts, when fixed at the frequency of one transom per pair of standards, should be fixed to the ledgers or uprights with right angle or other suitable couplers provided they are capable of sustaining a safe working slip load of 5 kN.

When a boarded platform is moved to a new level, the transoms on the lift from which the boards have been taken may be re-arranged to comply with the requirements for a non-boarded lift.

14.4 Putlog blades

A putlog should generally be fixed with its blade horizontal (but see **8.2**).

15 Working platforms and decking

15.1 General

Scaffold platforms should be of the widths given in Table 2 for the purposes given.

Table 2 — Widths of access scaffold platforms

Purpose	Minimum widths	Minimum number of 225 mm nominal width boards
	mm	
For access, inspection, gangways and runs	430	2 boards
Working platforms for men without materials or only for the passage of materials	600	3 boards
For men and materials provided there is 430 mm left clear for the passage of men or 600 mm if barrows are used	800	4 boards
For carrying trestles or other similar higher platforms	1 050	5 boards
For use in dressing or roughly shaping stone[a]	1 300	6 boards
For use to support a higher platform where the supporting scaffold is also used for dressing and roughly shaping stone[a]	1 500	7 boards

[a] These scaffolds should be specially designed.

15.2 Decking

Any group of boards across the width of the scaffold should be of the same length, with all boards of the same thickness.

Table 3 — Maximum span of scaffold boards

Nominal thickness of board	Maximum span between transoms	Minimum overhang	maximum overhang
mm	m	mm	mm
38	1.5	50	150
50	2.6	50	200
63	3.25	50	250

15.3 Supports

The spacing of the transoms to support the boards should vary according to the thickness and length of the boards as given in Table 3.

The overhang of the boards of any thickness should not exceed four times their thickness and should not be less than 50 mm (see Table 3).

Boards which are nominally 38 mm thick are the most commonly used and are customarily supplied in lengths of 3.90 m. When these are used, there should be four transoms to each board. Boards which are nominally 38 mm thick and less than 3.35 m long may be supported on three transoms. Boards which are nominally 38 mm thick and less than 2.13 m long should not be used unless they are fixed down to prevent tipping.

Boards which are less than 1.80 m long may be supported on two transoms, but should be fixed down at both ends. Such boards occur adjacent to ladder openings and provision should be made to prevent them from moving under impact and vibration. Boards which are used on small static and mobile access towers and on other small platforms, where the platform is surrounded by a guardrail and posts and there are no end joints in the boards, need not be fixed down but should be prevented from moving.

15.4 Gaps in decking

Gaps between boards should be as small as is reasonably practicable. Scaffolds should be erected as near to the building as is reasonably practicable, except when it is required for workmen to sit on the edge of the boarded deck in which case the gap should not exceed 300 mm.

15.5 Toeboards

Toeboards and end toeboards should be suitably fixed to all working platforms where a person may fall more than 2.0 m. They should be of such a height that the gap between the top of the toeboard and the guardrail does not exceed 765 mm and have a minimum height of 150 mm. They should be placed inside the standards.

15.6 Guardrails

Working platforms from which a person may fall more than 2.0 m should have a guardrail and end guardrails fixed inside the standards at a height of between 910 mm and 1 150 mm above the level of the decking.

If the guardrails are set higher than 915 mm, a second lower guardrail or higher toeboard should be provided to limit the gap to 765 mm. Suitably added brick guards or retaining boards are an acceptable alternative for a second or intermediate guardrail.

15.7 Brick guards

Brick guards or other suitable vertical protection are desirable in cases where materials may fall from the scaffold. These screens can be hung from the guardrails and should be prevented from outward movement. Toeboards may be incorporated within the screen and the screens should be capable of preventing the materials being used passing through.

15.8 Length of decking

The ends of a working platform should, where possible, extend beyond the end of the wall or working face by a distance of 600 mm when work is to be carried out up to the end of the wall.

15.9 Slope of decking

Gangways and working platforms should preferably be horizontal but may slope at an inclination of up to 1 vertical to 4 horizontal without stepping laths. At slopes steeper than this they should be provided with stepping laths to provide a firm foothold. These may incorporate gaps not exceeding 100 mm in width for wheels of barrows.

16 Ladder access to and in scaffolds

16.1 General

Every sloping ladder should stand on a firm and level base and be supported only by the stiles. Where practicable, it should be set at an angle of 4 vertical to 1 horizontal. The stiles should be securely fixed to the scaffold at the top by lashings, as shown in Figure 11, or by other attachments.

Ladders should preferably project at least 1.05 m above the top landing place with the landing rung level with or slightly above the level of the landing platform.

Ladders should not be extended by lashing two lengths together.

16.2 Landings

The vertical distance between two successive landing places should not exceed 9.0 m.

The landing places should be provided, where necessary, with access holes for the user which should not exceed 500 mm in width and should be as small as practicable in the other direction.

The landing places should be kept clear of all material and should be provided with guardrails and toeboards.

16.3 Ladder towers

Where practicable, the ladder access to the scaffold should be with its own ladder tower fixed to the outside of the main scaffold. Figure 26 is a typical example of such a tower. For the constructional details of ladder towers see **30.2**.

On large construction sites consideration should be given to the use of staircase towers and ramps. (See clauses **30** and **33**).

17 Raising and lowering material

17.1 Gin wheels

Gin wheels may be fixed to scaffolding for the purposes of raising and lowering materials during the construction of the scaffold and for the user of the completed scaffold.

The gin wheel should be mounted on a cantilever tube projecting outwards from the scaffold to a suitable distance, which should be kept to a minimum and preferably not greater than 750 mm.

The horizontal tube holding the gin wheel should be fixed with right angle couplers to two uprights in the case of an independent tied scaffold. In the case of a putlog scaffold, a puncheon should be fixed near to the wall from a suitable putlog at a lower level to a putlog at the working level and extending upwards. The gin wheel tube should be fixed to this and to the outer standard. A diagonal brace from the gin wheel tube to the outer end of a lower putlog may alternatively be used to brace the standard carrying the gin wheel.

A ring type gin wheel is preferable (see Figure 12(a)). If a hook type gin wheel is used it should not be hooked through a coupler but, it should be lashed to the supporting tube and the hook moused (see Figure 12(b)) unless it is provided with a safety catch. In either case the gin wheel fixing to the tube should be prevented from slipping towards or from the building by one fitting mounted on either side of the fixing.

Materials should be firmly attached to the gin wheel rope and should not exceed 50 kg in mass.

Gin wheel ropes should be of the correct size to suit the gin wheel (usually 18 mm) and should comply with the requirements of the appropriate British Standard and be marked with an identification tag and the safe working load.

17.2 Scaffold jib cranes and hoists

Scaffold jib cranes should be attached to a standard in a scaffold by the means recommended by the manufacturer. Special consideration should be given to the strengthening of the scaffold in the location of the crane and its attachment to the building at this point.

17.3 Hoist towers

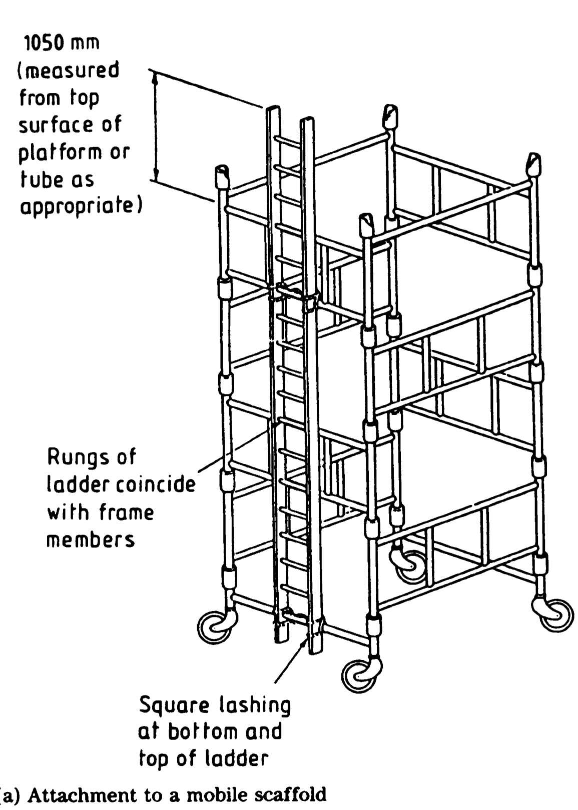
When a hoist is used, it is usual to construct a special hoist tower. This may be attached to the outside of a scaffold and may also utilize one of two of the standards of the scaffold as corners of the hoist tower. A hoist tower should be constructed in accordance with **30.1**.

17.4 Multiple rope blocks

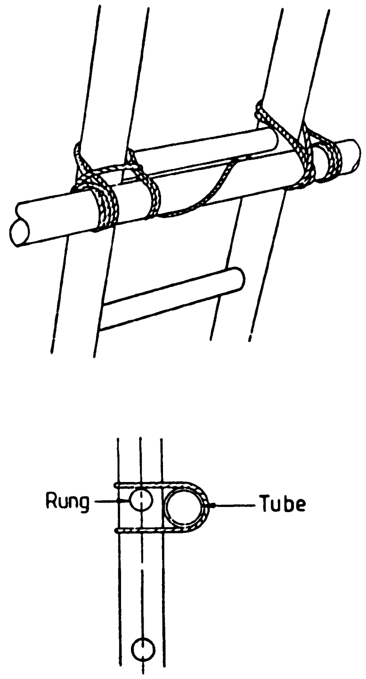
The attachment of multiple rope blocks to scaffolding should be made the subject of special design in respect of the scaffold itself and its attachment to the building in the location of the upper block.

17.5 Impact loading

Where mechanical handling is used, special allowance should be made in the design of the loading area for the additional loads due to the impact of placing (see clauses **23** and **24**).

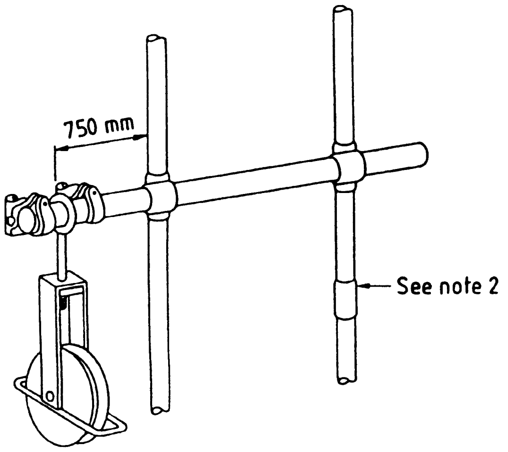


(a) Attachment to a mobile scaffold

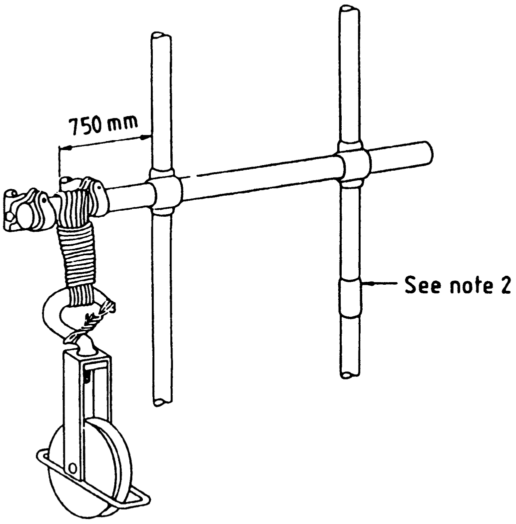


(b) Preferred method of attachment by means of square lashing to horizontal tube

Figure 11 — Ladder fixings



(a) Ring type



(b) Hook type

NOTE 1. This drawing should be read in conjunction with the text

NOTE 2. If there is a joint in the inner standard of a lift, a sleeve coupler should be used in order to resist uplift.

Figure 12 — Gin wheel fixings

Section 3. Work on site

18 Erection, alteration and dismantling

18.1 Erection

The procedure for erection should be such that an unstable condition is not reached at any time. This recommendation is as important in low scaffolds as in taller ones.

When built into an assembly, other than one requiring curved members, the erection tolerances given in Table 4 should not generally be exceeded. However in some instances, such as hoist towers, tighter tolerances may be required and should be used in preference to those given in Table 4.

The ties for the scaffold should be fixed in place as the scaffold is erected and reaches each tie position.

Single lift putlog scaffolds may be in use for bricklaying when the wall has not reached sufficient height to give an effective tie point. In this case, the scaffold should be stabilized by rakers and, if necessary, foot ties to them, until ties can be inserted in the wall.

No portion of the scaffold should be used unless that portion is fully decked, braced and tied. Warning notices should be fixed to draw attention to those parts of a scaffold which are incomplete and should not be used.

18.2 Modifications

18.2.1 *General*

All modifications to existing scaffolds should be carried out in such a way that the stability of the scaffold is not impaired. As a general rule, supplementary components should be added before those which have to be removed are uncoupled and taken away.

18.2.2 *Access ways through scaffolding*

If access ways through scaffolding are required, the number of standards removed should be as few as possible and these should be replaced on either side of the gap so the total number of standards is not reduced.

Table 4 — Erection tolerances

Feature	Erection tolerances
Standards	Vertical to within ± 20 mm in 2 m (subject to max. deviation of 50 mm)
Bay length and width	± 200 mm on designated lengths Level to within ± 20 mm in 2 m (subject to a max. total deviation of 50 mm)[a]
Lift height	± 150 mm on the designated height
Nodes	⩽ 150 mm between coupler centres

[a] Foot ties may follow the general slope of the ground on which the scaffold is founded.

The ledger across the top of the gap should be further supported either by a V frame or an A frame of scaffold tubes above it, transferring the load over it to the standards at the sides of the gap. Bracing should be inserted across the top corners of the gap if extra support to the ledgers is required.

18.3 Dismantling

During dismantling, no component which endangers the stability of the remaining structure should be removed.

If dismantling has reached the stage at which a critical member has to be removed, e.g. a tie or a brace, the stability of the structure should be assured by fixing a similar or otherwise adequate member in place lower down before the member to be taken out is removed.

Because of the changes which are made in a scaffold structure during its working life, it is not safe to assume that dismantling can be carried out in the reverse order to the erection. The scaffold, especially its tying and bracing, should be inspected prior to dismantling.

If the scaffold is defective, it should be made good before dismantling commences.

The procedure of dismantling should be orderly and planned and should proceed generally from the top in horizontal sections.

Scaffolds should not be dismantled in vertical sections from one end towards the other, especially in cases where a hoist tower, which apparently gives support to the scaffold, is to be left standing, unless special consideration is given to ties and bracings.

The following precautions should be observed.

a) DO NOT remove all the ties.

b) DO NOT remove all the bracing first.

c) DO NOT remove all the intermediate and board end transoms.

d) DO NOT remove all intermediate guardrails.

An access scaffold may have been temporarily stabilized during construction by rakers that have been subsequently removed. If the level of the lowest tie point is high, e.g. over entrance halls or above tall shop windows, temporary rakers, constructed and attached in accordance with **9.5**, or other structurally adequate means of support should be built up from the ground to achieve stability of the part-dismantled scaffold.

18.4 Lowering materials

Materials should be lowered to the ground and not stored on the scaffold. In the case where a pavement is not to be obstructed and scaffolding materials have to be stored on the lowest lift awaiting collection, this lift should be stiffened and fully braced or propped by rakers, using materials recovered from the upper lifts.

Components should not be thrown on the ground; they should be lowered hand to hand in an orderly fashion or brought down by crane, gin wheel or other suitable means.

18.5 Progressive dismantling

Scaffolds which are to be progressively dismantled during the demolition of a building should not be left projecting above the residual height of the walls more than is necessary. Stabilizing ties should be maintained, especially with sheeted scaffolds.

Scaffolds which are to remain in use while partly dismantled should be fitted with end guardrails and toeboards at the end of the portion in use.

If access is possible on to a partly dismantled scaffold, warning notices should be fixed.

19 Duties of erectors and users of scaffolds

19.1 General

This clause has been compiled to act as a guide to persons concerned with scaffolds.

Persons directly responsible for, and working on or employing persons to work on scaffolds should familiarize themselves with the contents of the relevant documents listed in appendix A and clause **5**.

The statutory regulations and codes of practice detail commonsense requirements and recommendations and accordingly any method of construction or use which is seen to be inadequate or dangerous is likely to be a contravention of one of the documented requirements or recommendations and should be reported to a person in authority on the site for appropriate action to be taken.

It should be ensured that the lower portions of the scaffold are adequately protected against damage through interference, accident, traffic or any other cause. Similarly, the scaffold should comply with the requirements of the local authority as regards lighting, hoarding, and the provision of fenders.

19.2 Scaffold constructors

Persons constructing scaffolding should ensure that at the time of handing over to the user, it is adequate for the purpose for which it is intended and that it is stable and in a safe condition. Persons constructing any type of scaffolding should employ people with the necessary experience and competence to erect scaffolds of that type.

They should employ operatives to construct the scaffold who have the physical, mental and character fitness to carry out the work safely and to leave it in a safe condition.

19.3 Training

Training forms a critical part of the make up of a person whose duty it is to construct working platforms for others to use. It is recommended that scaffolders and others concerned in the construction and use of scaffolds have formal training in their specific jobs which should include familiarization with the statutory requirements and codes of practice (see also the foreword).

19.4 Communication

In modern construction works, the segregation of the specialist occupations from each other requires a high degree of cooperation which should be maintained between all concerned to avoid the creation of hazards and the consequences thereof. Any special requirements by the user should be included in a brief to the scaffold contractor.

Where the design depends on special materials, the designer should ensure that this information is adequately conveyed to stockholders and to the erectors, e.g. where the design is based on tube conforming to BS 1139-1.1:1990 instead of BS 1139-1:1982.

19.5 Persons using scaffolds

19.5.1 *General*

Persons using scaffolds and particularly subsequent users, both employers and operatives, should ensure that the scaffolds are properly constructed and suitable for the purpose for which they require them. They should ensure that the scaffolds are maintained in the relevant condition throughout their use. It is essential that they should not interfere with the scaffold structure or platforms or ties or braces in any way whilst using it and should not leave it in a hazardous condition for others to use. They should ensure that all the necessary safeguards have been provided and maintained and are used.

19.5.2 *Inspections*

Attention is drawn to the user's obligation to ensure that inspections are made (see clause **20**).

19.5.3 ***Loading***

Users of the scaffold should be aware of the loading capacity and see that it is not overloaded. It is preferable to distribute materials adjacent to the scaffold standards.

19.5.4 ***Mechanical handling***

It is recommended that users should specify a loading tower, or specially strengthened portion of the scaffold, to receive loads which are placed by mechanical handling equipment or consist of packaged materials. Persons using scaffolds on which loads are to be so placed should ensure that the scaffold is not overloaded, either locally or in general, by excessive imposed loads.

19.6 Protection of the public

Scaffolding is frequently erected in areas to which members of the public have access, such as streets, courtyards, halls and gardens. The precautions which need to be taken to protect the public during the erection, modification and dismantling of scaffolds are similar to those which need to be taken to protect other workpeople on an enclosed site but, because of the public's unfamiliarity with the dangers and curiosity about the work and because there may be a large number of people at risk, high standards of physical protection and more effective systems of work and supervision will generally be needed.

During erection, modification and dismantling, care should be taken to exclude the public from the area of the work and a sufficient area around the work. In confined areas it may be necessary to provide an adequately protected thoroughfare while the scaffold is in use. Effective steps should be taken to prevent persons being struck by falling objects and again the provision of a protected thoroughfare, suitable brick guards, facade nets, sheeting or fans may be necessary.

In general, care should be taken that, at the lower levels of a completed scaffold, there are no protruding tubes, low headroom, etc. that could cause damage or injury to members of the general public or their property, e.g. clothing. Where access through parts of the base of a scaffold structure might prove hazardous, entrance to such areas should be barred by means of a horizontal tube or other suitable obstruction.

Children pose a special problem; many have been injured either through falling or causing the scaffold to collapse after climbing up scaffolding, either by the standards or by ladders left at ground level. It is essential to remove and secure all ground level ladders whenever scaffolds are left unattended, and it is also advisable to board in the bottom lift of such scaffolds.

In addition to the general duties to the public under the Health and Safety at Work etc. Act 1974 outlined above, persons erecting or using scaffolding in or near public places may also have specific duties under other legislation, such as the Highway Act 1971, the Public Health Act 1930, the London Building (Amendment) Act 1939 and the Building (Scotland) Act 1959, and advice in such cases should be sought from the appropriate local or highway authority.

20 Inspection of scaffolds

20.1 Compliance with statutory regulations

When completed, scaffolds should be left in a condition suitable to perform the duty for which they were intended and they should comply with the requirements for the statutory regulations and any local authority requirements (see clause **5**).

Scaffolds should be inspected by the constructor before they are handed over for use. The user should inspect them weekly to see that they remain in compliance with the statutory regulations and should sign the Reports of Weekly Inspections[5)] to record his findings.

When equipment other than scaffolding materials is attached to the scaffold, which is subject to statutory inspections, this equipment should be inspected and the appropriate certification made.

Such additional inspections may include the following:

a) lighting;

b) lifting gear and lifting appliances;

c) electrical supplies;

d) hoist ways;

e) ropes.

[5)] Department of Employment, Factories Act 1961. Building Operations and Works of Engineering Construction. Records of Weekly Inspections, Examinations and Special Tests Form F 91 (Part 1).

20.2 Inspection

The inspector should ascertain what duties have to be carried out from the working platforms. He should then assure himself that the scaffold is properly constructed, that it is the right type for the planned duty, that it is of the correct height, width and length and that the working platforms are correctly positioned.

He should check that these working platforms comply with the various requirements of the statutory regulations and the recommendations of this code and that access and egress are suitable and safe.

He should then satisfy himself that the foundations are adequate, that they are not likely to be disturbed and that they and the lower portion of the scaffold are not liable to damage by interference, accident, traffic or any other cause.

He should then check that the scaffold is sufficiently strongly designed and well enough constructed to carry the loads and that it is correctly tied, anchored and braced to have and maintain stability under load and environmental influences.

He should see that it complies with the requirements of the local authority for lighting, hoarding and fenders and in general that it is not constructed in a way which can cause damage or injury to persons near the base of it by protruding tubes, low head room etc.

He should see that any attachments such as fans, loading bays, hoists and hoist towers and lifting tackle are properly constructed and in compliance with the statutory regulations.

Section 4. Prefabricated components

21 Proprietary equipment

21.1 Instructions

Where equipment comprises a complete set of components of unique design, capable of erection without any other equipment, it will be necessary for the supplier of the system to provide a complete set of instructions, compatible with this code and sufficient to ensure the safe erection and use of the scaffold. These should be related to the requirements of the user, given for example in this code. Most of the content of the instructions is likely to be drawn from this code, especially as standard scaffold tube and couplers will frequently be used as an adjunct to the proprietary sections. When using proprietary equipment, the supplier's instructions for use should always be followed.

Particular attention is drawn to the following:

a) the need to seek and obtain instructions when deviating from the standard scaffold, or when sheeting or fans are added or other changes are made which will vary the structural loading or arrangement;

b) the fact that many vertical joints have a minimal tensile capacity and may not be staggered;

c) the need for fully tying and its attachment to appropriate points on the scaffold;

d) the need for adequate foundations as outlined in clause **11**.

Because of different materials and jointing systems, characteristics and spacings of proprietary scaffolds will frequently differ from tube and fittings scaffolds. Their accuracy will be better and construction less difficult for all straightforward applications.

21.2 Proprietary components

21.2.1 *General*

Certain components are available for use with tube and fittings, and their use is discussed in **21.2.2** and **21.2.3**.

21.2.2 *Transoms with couplers attached (sometimes referred to as mobile transoms)*

Four couplers, which would be used to connect a transom and two standards, are replaced by two half couplers fixed to each of the ends of a transom member.

Intermediate transom members are also available without connections for standards.

Provided that the couplers have equivalent strength to the couplers they replace, a direct substitution may be made. The resulting connections are usually more rigid than those provided by ordinary couplers and some reduction in bracing may be possible.

21.2.3 *Other equipment*

Where other equipment for use in conjunction with tube and fittings is supplied, the supplier should provide the guidance recommended in **21.1**. Some guidance on the use of prefabricated beams is given in clause **22**.

22 Use of prefabricated beams in scaffolds

22.1 Description

Prefabricated beams of a variety of types are available to increase the strength and simplify the construction of beams and trusses in scaffolding materials.

These beams may be fully welded lattice structures or fabricated in separate parts or units for assembly on site.

22.2 Loading

The loading on a beam is determined from the requirements of the structure and the size and type of beam should be chosen accordingly.

The safe working load of prefabricated beams for various methods of erection should be available from the supplier.

22.3 Components

Any additional components required should be properly designed and fabricated by a competent manufacturer.

Where splices are used to join units together, the forces within the beam, especially in the chords, should be calculated and catered for by specially designed splices.

When bolts are used, they should be of the size, type and grade of steel specified by the manufacturer of the beam.

22.4 Inspection

All the components in a beam system should be inspected before assembly. Defective parts and components with defective welds should be discarded.

22.5 Method of applying the load and end reactions to beams

The loads and end reactions should be applied to the beam by the method and in the position prescribed by the manufacturer.

Attachments should be made as close as practicable to the node points.

22.6 Assembly

Where beams have chords of different sizes, reference should be made to the supplier for the rules of correct application.

22.7 Lateral stiffeners

The load carrying capacity of a beam is dependent on both its chords being laterally restrained at the intervals laid down by the manufacturer. Stiffeners or other lateral restraint should be inserted at these intervals, which may be different for the compression and tension chords.

The lateral rigidity of the beam at its supports should be adequate.

22.8 Knee bracing

Consideration should be given to improving the performance of a beam by the use of knee bracing below it or V bracing above it. Where knee bracing, V bracing, standards and puncheons are used to improve a beam's stability, they should be coupled to the beam twice, i.e. to both chords or to a chord and a cross-member.

22.9 Beams as columns

When prefabricated beams, such as ladder beams, are coupled together as columns, the spacing of the couplers should be designed so as to ensure adequate strength.

22.10 Spine beams

When large beams are used as spine beams in roofs, the bottom chord should be stiffened by V bracing to the rafters.

22.11 Attaching guys

Guys should not be attached to prefabricated beams as a means of providing lateral support, except where provision has been made in the design.

Section 5. Special scaffolds

23 Loading bays founded on the ground

23.1 Loads and general arrangement

When materials are to be stored on a scaffold, the weight of these will probably be in excess of the access scaffold ratings given in Table 1.

An impact load of at least 25 % of the largest load should also be included in the design.

Weights of materials which give a distributed load of not more than 4 kN/m^2 may be catered for by cantilevered loading platforms of the type described in clause **24**. Platforms with larger distributed loads, or when several storage platforms are required above one another, should be arranged in a special loading bay with its own standards founded on the ground. This may be attached to the access scaffold but should be separately tied to the building from which it should take its rigidity.

Where loading bays form part of pavement gantries and carry further lifts of access scaffolding above, the extra loads should be taken into account.

The method normally used is to select the required length of the access scaffold to which the loading bay is to be attached and to reduce the spacing of the standards in this length to supplement their total load-carrying capacity to the required amount. The transoms are then extended outwards to the distance necessary to give the required storage area and a third line of standards is erected on the outside of the platform to carry a share of the load.

Alternatively, a separate tower may be constructed with the inside standards tied to the outside ledgers of the access scaffold, in which case the lift heights in these loading bays should be calculated for the loads in the appropriate standards and may not be the same as those in the access scaffold.

Guardrails on the access scaffold may be left in place at all lifts and utilized as lifts in the loading bay, ensuring that suitable load-bearing couplers are used.

A loading bay may form part of a hoist tower with access at its end and it may also form part of a ladder tower giving access to all levels of the access scaffold.

So that interference with crane operation will not occur, transoms should not project beyond the outside face of the loading bay.

23.2 Bracing

23.2.1 *Diagonal bracing*

The loading tower should be diagonally braced on all four sides and should be externally plan braced off the access scaffold. The internal facade bracing of the loading bay may hinder the access from the scaffold to and from the loading bay, and accordingly may be placed in the form of a zigzag longitudinal bracing system on the main scaffold outside the area of the loading bay. This bracing may also be considered as contributing to the longitudinal bracing of the access scaffold.

The external face of the loading bay may be modified to give easy crane access where needed.

23.2.2 *Wind bracing*

In addition to the external bracing in **23.2.1**, it is usually sufficient to place a diagonal plan brace either internally or externally from the outside corner of a loading bay to the main access scaffold on alternate sides at every lift level. The main scaffold should be tied to the building opposite these braces with ties supplementary to its own requirements at intervals not exceeding 3 m.

23.3 Lifts

The storage levels of a loading bay will usually be required at the levels of the floor of the building. When several such levels are required, care should be taken to restrict the lengths of the standards by supplementary lifts to give the necessary load-carrying capacity in the standards.

23.4 Decking

It is advantageous to choose a length for a loading bay in modules of board lengths so that short boards are not required, as movement of heavy materials about the platform may cause short boards to be dislodged. The platforms may be double boarded, if necessary, in which case the layers of boards should be parallel.

23.5 Guardrails and toeboards

The platforms should be provided with guardrails and toeboards on all the outside faces and on the inside as well, if this is not a boarded lift of the main access scaffold.

Where the materials to be stored are to be fed to the platform by mechanical means, removable lengths of guardrails on the outside face of the loading bay should be provided and replaced after loading has been completed.

23.6 Foundations

Consideration should be given to the adequacy of the sole plates and foundations of loading bays.

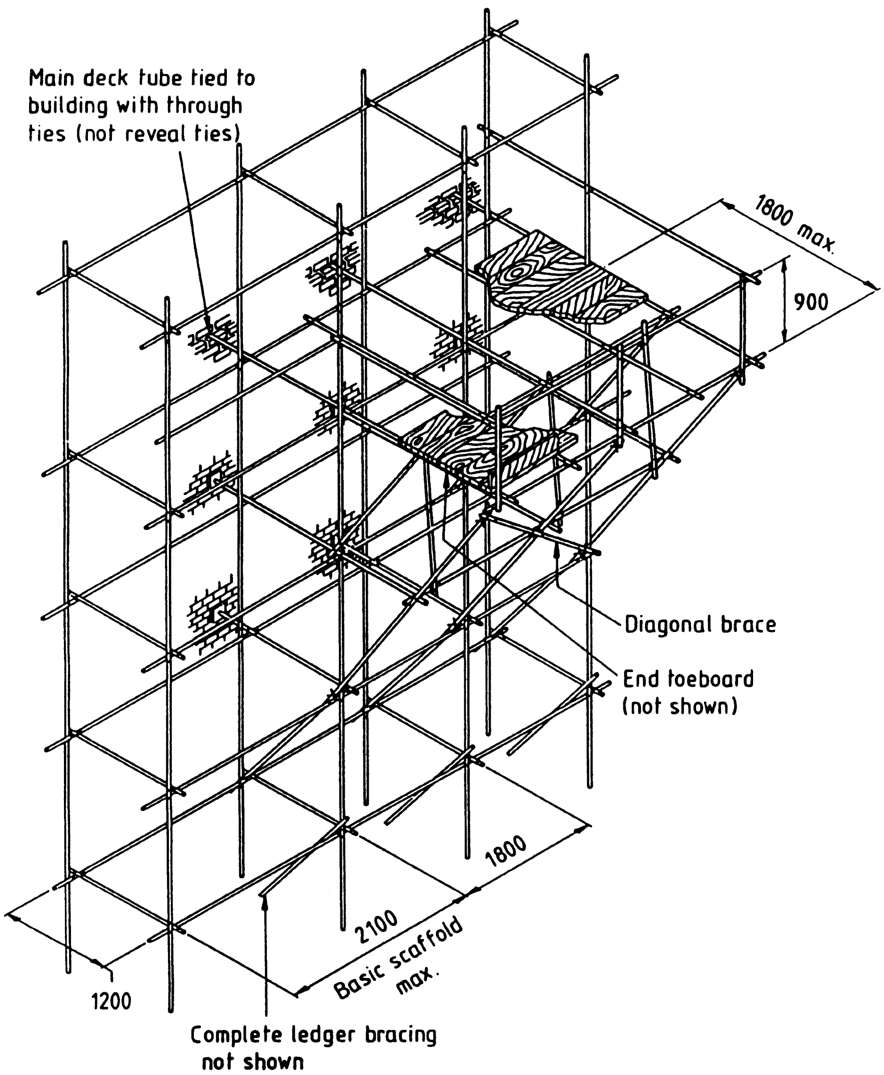
23.7 Notices

It is recommended that a notice should be erected showing the safe working load.

24 Cantilever loading bays attached to scaffold

24.1 Loads and general arrangement

For single lift loading bays carrying a loading not in excess of 4 kN/m^2, a cantilever structure can be erected from the main access scaffold. It is desirable to give consideration to the possible use of cantilever loading bays at the planning stage of the scaffold. Figure 13 shows details of this construction.



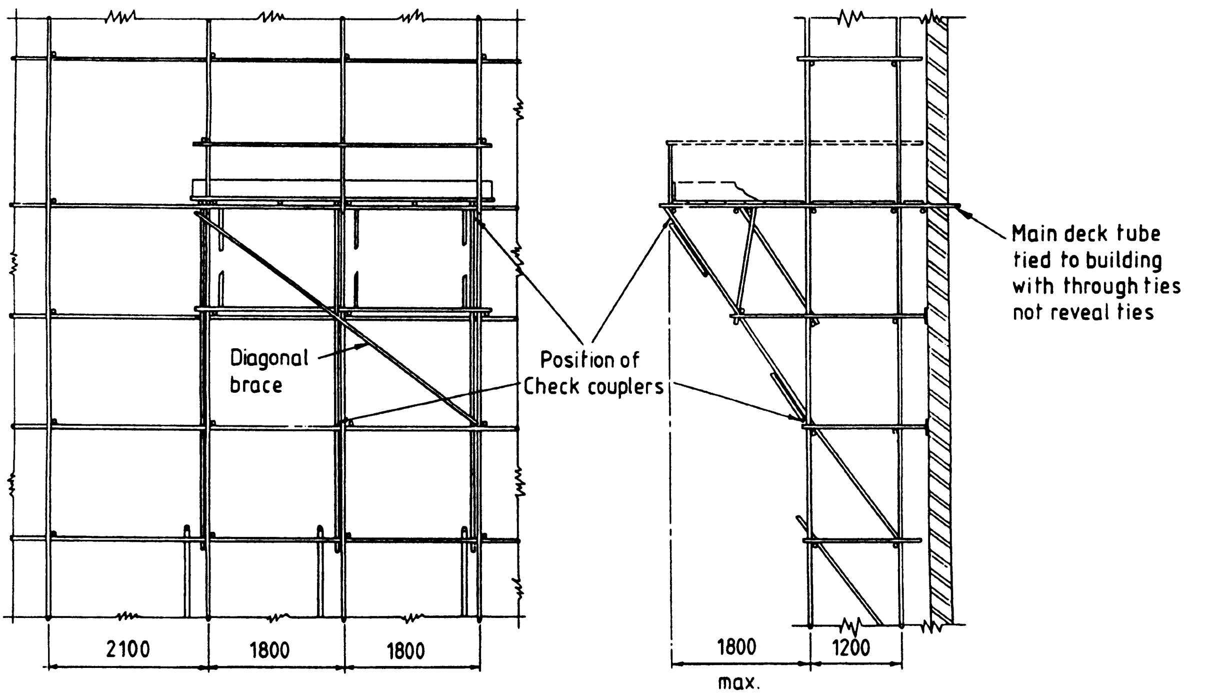
Dimensions are in millimetres.

NOTE 1. When more than one loading platform is required at various heights, they should not be one above the other but spaced horizontally, having a scaffold bay between them in plan.

NOTE 2. 'X' marks the position of check couplers.

(a) General arrangement

Figure 13 — Cantilever loading platform



Dimensions are in millimetres.

(b) Front elevation (c) Side elevation

Figure 13 — Cantilever loading platform *(concluded)*

The area and loading required should first be chosen, taking into account an impact factor of at least 25 % of the largest lifted load. The self weight of the cantilever structure and its decking should be assessed and added to its imposed load and impact. The main access scaffold should then be modified to accept safely this total load on its outside standards. It should also be fitted to the building with supplementary ties to cater for the outward forces resulting from the cantilever structure. The forces in the rakers and the couplers thereon should be estimated from the largest lifted load and its impact.

When several cantilever loading bays are required at different levels, they should not be under one another but attached to separate parts of the access scaffold with a free bay between them so that their load is not additive.

It may be necessary to reduce the bay length of the access scaffold to increase the number of standards carrying the load, or alternatively doubled standards may be used.

The transoms of the main scaffold should be extended into the area of the loading bay and may be required to be at closer centres than those of the main scaffold.

A ledger is required at the outer edge of these platforms. Additional ledgers may be required depending upon the design of the particular platform.

In the example shown in Figure 13, the intermediate transom has been extended to the raker to restrict the length.

Joints in ledgers should not be in the same bay and should be made with sleeve couplers.

The rakers should be set as close as possible to each standard in the access scaffold. They should be at an angle not greater than 35° to the vertical and fitted with the necessary check couplers. They should not have an unsupported length greater than that required to carry the load and in any event not greater than 3 m.

24.2 Bracing

The access scaffold supporting the cantilever loading bay should be fully ledger braced on every standard at the bottom of every raker.

24.3 Ties and butting transoms

The access scaffold should have supplementary ties fixed at the level of the cantilever loading platform, to cater for the outward forces resulting from the applied load and impact and the self weight of the platform.

At the level of the bottom of the rakers, the access scaffold should be adequately butted on to the building which should be checked for suitability and strength at this point.

24.4 Decking

It is advantageous to choose a length of cantilever loading bay that avoids the use of short boards (as in **23.4**). The platform may be double boarded, if necessary, with the layers parallel to one another.

24.5 Guardrails and toeboards

The platform should be fitted with toeboards and guardrails on three sides. The guardrail posts should be fixed to the transom with right angle couplers so as to avoid the outward rotation of the posts which might occur if they were fixed to the ledgers.

24.6 Notices

It is recommended that a notice should be erected showing the safe working load.

25 Protection fans, nets and pavement frames

25.1 Description and duty

Protection fans and nets are sometimes fixed to access scaffolding to intercept anything which may fall from the structure. Typical fan structures will only arrest small objects. Special consideration is required if heavy objects with a long free fall are to be catered for. These fans may be supported from the building or scaffold using wires or tubes.

It is not possible to state loadings for fans since it cannot be predicted what weight will fall and from what height. The recommendations set out in the following classifications have been found to be generally satisfactory in practice (see Figure 14).

a) *Class A.* A light duty fan with a maximum loading equivalent to 0.75 kN/m^2, for the protection of pedestrians from paint droppings from painters working in cradles or from droppings of mortar from the pointing of brickwork, etc. In some cases a sufficient level of protection can be afforded against fine dust or paint by containment nets and sheets. If this type of material is being considered reference should be made to BS 8093.

b) *Class B.* A medium duty fan with a maximum loading equivalent to 1 kN/m^2, for protection against falling aggregate, bricks and like weights from heights not exceeding 10 m overhead. Bricks falling from approximately 10 m can produce a large punching force in the fan, which should therefore be covered with a material able to cope with this.

c) *Class C.* Fans built to catch objects heavier and larger than bricks, or for bricks etc. falling more than 10 m, should be designed specifically for the application. These types of fans are not dealth with in this code but Figure 14(c) shows the type of additional strengthening which might well be required.

d) *Class D.* A fan for arresting the fall of persons or like weights, falling about 6 m or the distance of about two building storeys, which should be erected in accordance with BS 8093 (cf. **25.9**).

25.2 Effect of fans on the loads in standards of access scaffold

25.2.1 *Vertical loads*

A typical construction is to fix the transom of the fan above the outside ledgers of an access scaffold and below the inside ledgers, giving a minimum slope of 100 mm in 1.2 m (or 1 vertical to 12 horizontal).

This arrangement imposes additional loads on the ledgers and standards of the access scaffold. The inside standards may be subject to an uplift.

25.2.2 *Horizontal forces*

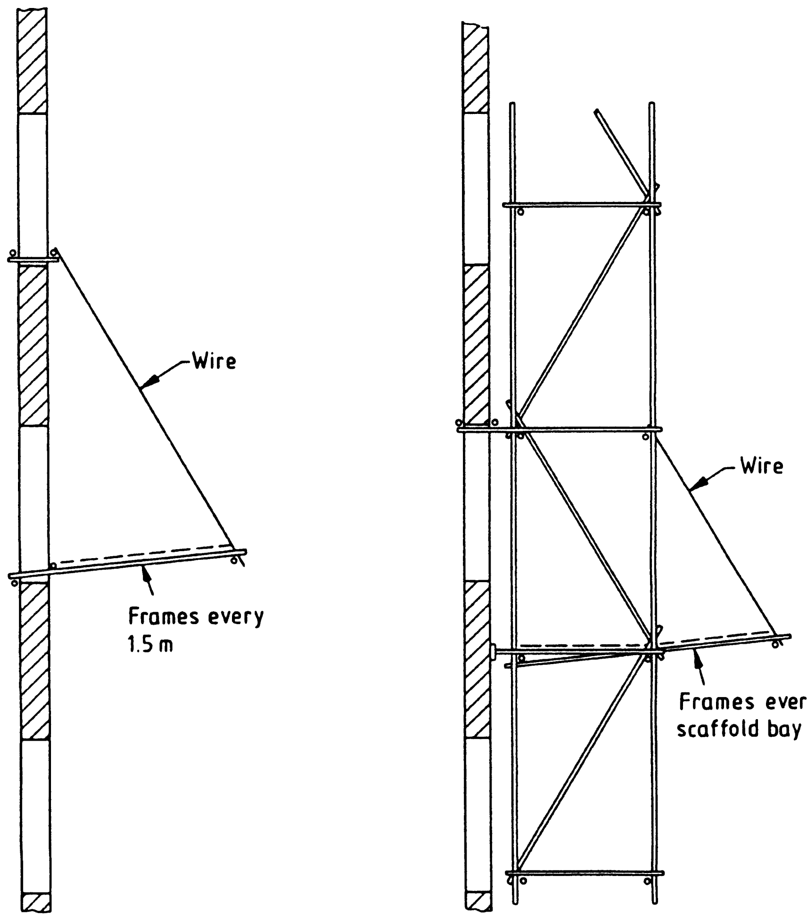
As the inwards and outwards forces acting at the points of attachment of the fan and its ties and struts may be large, account should be taken of this by the use of suitable attachments to the building. Care should be taken that the strength of the building is adequate to accept these forces, particularly if it is partially demolished.

25.3 Decking

The material of the decking, which may be agreed by the user, should be of waterproof sheeting, corrugated iron, boarding or netting. The decking material of the fan should be appropriate to the duty to be performed, with special reference to the closeness of the boarding or sheeting and the size of the mesh of nets.

The drainage arrangements of the fan should be agreed with the user.

The whole fan or net structure should be securely attached to the access or protection scaffold or to the building to resist the wind forces. Nets may be attached with cord. Corrugated sheeting should be attached with sheeting hooks or hook bolts. Boards should be laid and secured by wire, nails, or board clips.

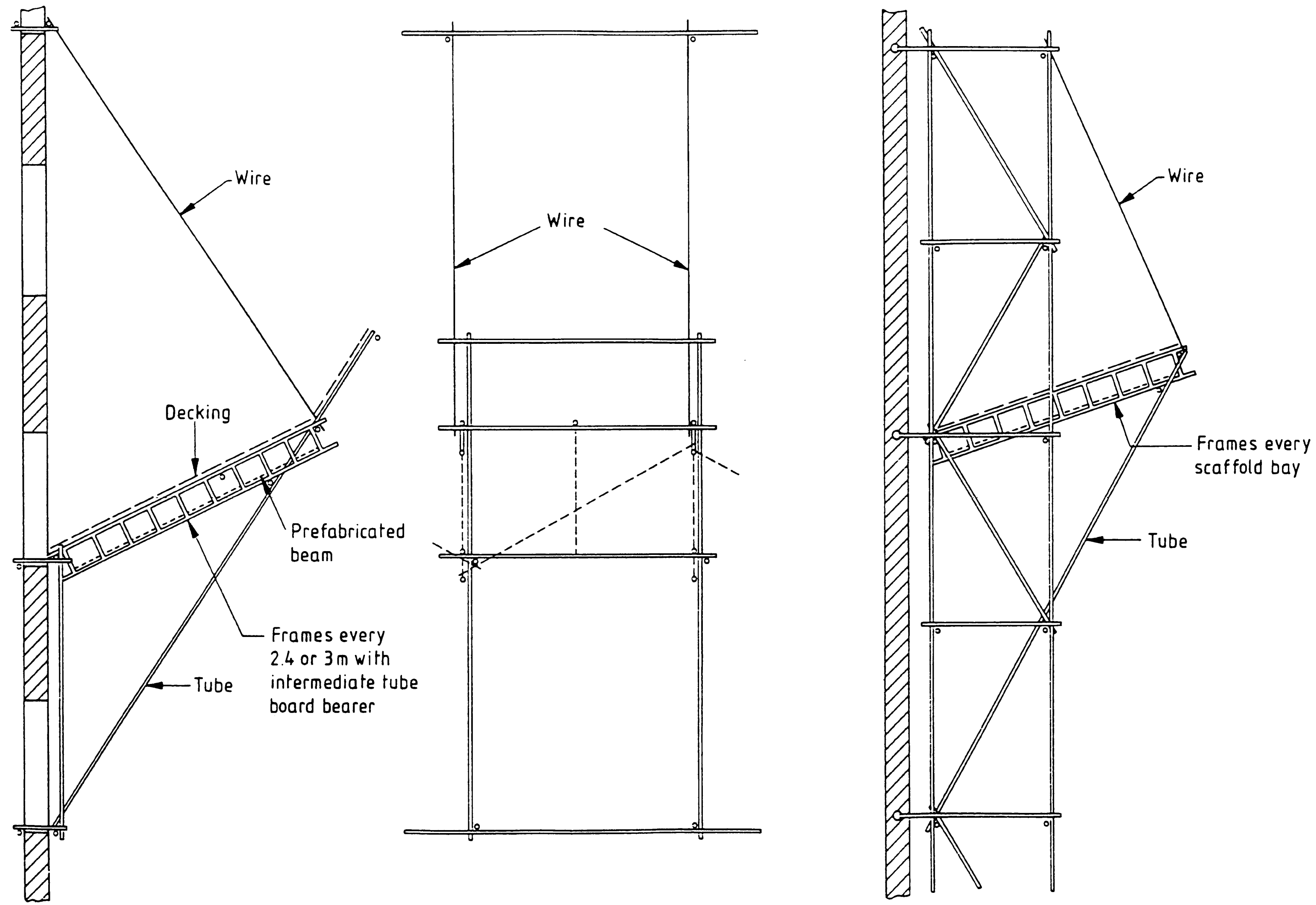


(i) Attached to building facade

(ii) Attached to scaffold

(a) Light duty (class A) fans suspended on wires

Figure 14 — Classes of fans for sheeting or netting

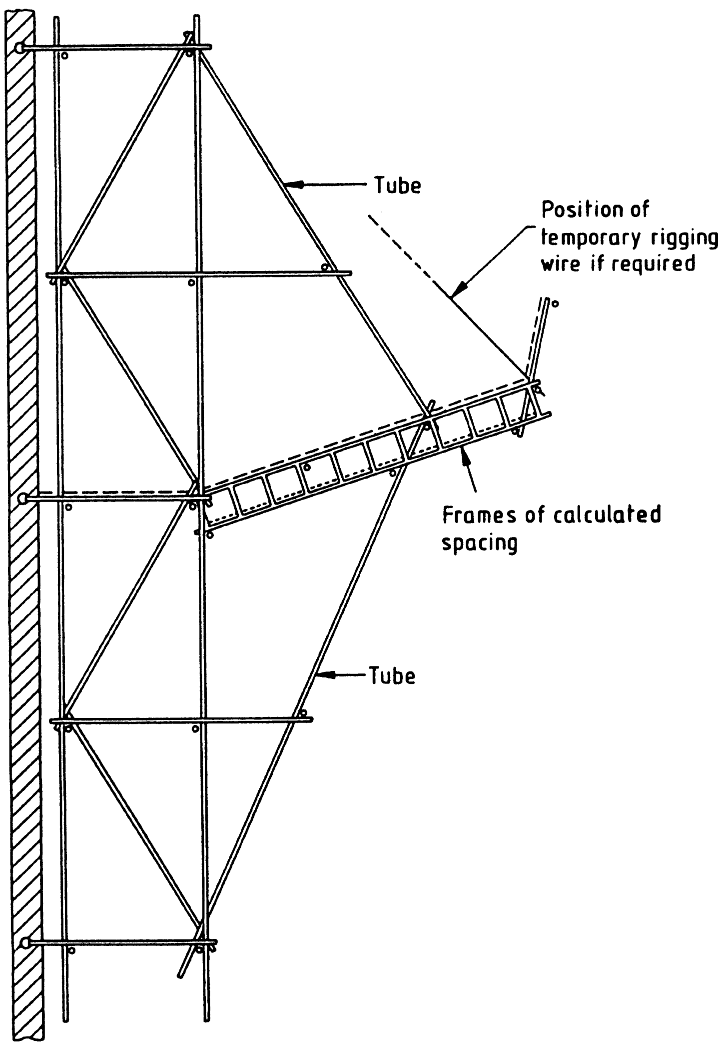


(i) Attached to building facade

(ii) Attached to scaffold

(b) Medium duty (class B) fans

Figure 14 — Classes of fans for sheeting or netting *(continued)*



(c) Heavy duty (class C) fans

Figure 14 — Classes of fans for sheeting or netting *(concluded)*

25.4 Wind forces

The wind forces on fans and nets can only be assessed approximately. The force may be upwards or downwards at various times, depending on the topography of the site and the degree of completion, size and shape of the building and adjacent structures (see **39.10.4**).

25.5 Precautions during erection and dismantling

The outside point of support of the fan structure should be in the outside third of its width, measured at right angles to the building or scaffold.

Because a typical fan structure has only two support points, the outside one of which sometimes may not be at the extreme outside edge, serious out of balance forces can occur during construction and dismantling.

Safe systems of construction and dismantling should be planned and adhered to on the site.

25.6 Light duty (class A) fans suspended on wires (see Figure 14(a))

This type of protection fan consits of two ledgers spaced apart with transoms to form a frame 1.2 m, 1.8 m or 2.4 m wide, according to the protection required.

The transoms should be spaced approximately 1.5 m apart and the suspension points are the nodes 3 m apart. When the suspended fan can be supported on a building feature the inboard suspension wire may be omitted as shown in Figure 14(a)(i).

One of each pair of suspension wires should be fixed near the surface of the building to the inside node and the other from the same suspension point on the building at an angle to the outside node. The fan is thus maintained against the building by its own weight and it may be further tied in at the decking level.

The suspension points may be the outriggers from the roof rig of a suspended platform, additionally counter-weighted, or may be screw-in or anchor tie points at a lower level.

The wires should be fixed to the tie points and the tubular framework by a round turn and two bulldog grips, a single turn and three bulldog grips or a round turn and two half hitches.

25.7 Medium duty (class B) fans fixed out from a building (see Figure 14(b))

This type of fan consists of beam struts projecting from the building to distances greater than 2.4 m and sometimes up to 5 m.

The inside ends of the beam struts should either rest on the building floors or on sills or be located on a bridle tube fixed to the building with ring bolts. The outside ends of the beams should be maintained at the desired angle by wires or tubes from or near the ends in an upwards or downwards direction attached to suitable tie points on the building.

The beams should be laced together with ledgers fixed below their top chords. Intermediate transoms are fixed between the beams so that the resulting framework can be boarded out.

A variety of prefabricated beams are suitable for this purpose but it should be ascertained that they are adequately strong in reverse bending if the point of suspension is not at their end.

Both ends of the beams should be stabilized against movement.

The decking may be of corrugated sheeting or scaffold boards and it should be fixed securely to the framework.

Under wind forces, the anchor points both above and below the fan frequently carry loads up to 2 t for every 3 m of length of fan supported and suitable means of attachment to suitable portions of the building or structure should be made.

The decking may be tightly lapped to draw the water to the inside edge or fixed with spacers so that the water drips through at other agreed locations.

The outboard end of the fan may be provided with a vertical or near vertical parapet to give further protection.

25.8 Medium duty (class B) fans built out from a scaffold (see Figure 14(b))

This type of fan is of similar construction to those described in **25.6** and **25.7**. The inside edge is coupled to both the inside and outside of an access scaffold to achieve a cantilever action which may be supplemented from below by tubular struts.

A medium duty fan is often used during the demolition of a building and may be structurally stable with only raker struts beneath it. It is frequently fitted with a parapet and boarded out closely with scaffold board. It is heavy and exerts considerable forces on the access scaffold which should be well tied in at the fan level and stiffened from the building at the bottom of the rakers.

For installations at high level, the fan may be subject to serious wind uplift. The propping rakers should be capable of tension as well as thrust and provided with safety couplers where necessary.

25.9 Safety net system (class D fans)

Safety nets should be in accordance with BS 3913 and be rigged in accordance with BS 8093. The larger mesh nets may be overlaid with a finer mesh to catch small debris.

The nets should be attached to a framework of tube as described in **25.8**. The framework should slope downwards towards the building and be maintained at a suitable angle of 10° to 30° to the horizontal by tension wires above. It should also be fitted with steadying wires beneath the net to resist wind uplift.

The framework may be made in small detachable units in order to be easily removed and refixed to the building so that it can be safely moved up the building as required.

The net should be attached to the framework with a winding of rope round the edge cord of the net or by the use of suitable clips. Where practicable, the net should be fixed clear from the framework of tubes.

25.10 Pavement frames or gantries

When a scaffold has to be in position over a pavement, it is frequently desirable to form a semi-permanent and fully boarded protection deck over the pavement.

Such a pavement gantry or framework should be carefully designed, especially if it has to carry the weight of an access scaffold or temporary office accommodation. Columns of grouped standards should be joined by transverse beams across and along the top. These columns should have small lifts with all faces of the columns zigzag braced.

The lateral stability of the system should be achieved by ensuring that the beam to column joints are rigid with at least two fittings and by providing cross bracing of tubes in both directions in all bays.

The assembly should comply with any local authority requirements for temporary works on pavements.

26 Cantilever scaffolds

26.1 General description

A cantilever scaffold is an independent tied scaffold constructed in accordance with this code but erected on beams cantilevering out from a building. It is used in cases where it is impracticable or undesirable to found the scaffold on the ground.

26.2 Loads

The cantilever beams should be spaced to suit the bay lengths of the scaffold to be built on them. They should be designed in accordance with BS 449 to support the self weight, the imposed load and the wind load resulting from the scaffold above.

The strength of the structure of the building should be checked to ensure that the loads applied by the scaffold can be safely resisted.

The strictest control should be exercised by the user on the loads transferred from cantilever scaffolds. There should be full liaison between the designer and the user on this matter and the drawings and calculations should state the load limitation clearly.

26.3 Fixing the beams to the structure

Figure 15 shows a typical beam assembly. There are two points on each beam which apply loads to the building:

a) the holding down position at a tailing end of the beam;

b) the supporting or fulcrum point at the edge of the slab or the edge beam of the building.

The forces at these points should be determined by the principle of leverage on the assumption that the applied weight from the scaffold acts between the inside and outside standards of the scaffold at a point $\frac{1}{3}$ of the width of the scaffold from the outside.

Where there are known impact loads they should be doubled and added to the dead load. Where this total force is catered for by steel bolts, a minimum factor of safety on ultimate failure of 3.3 should be adopted. Bolts should preferably be grade 4.6. The holding down arrangement should achieve torsional rigidity of the tailing end of the beam and have an adequate bridging plate.

The load on the structure at the fulcrum point should be calculated and it should be borne in mind that this is greater than the total load from the scaffold, being in fact the sum of this load and the tailing down force.

This reaction will impose considerable loads on the edge of the concrete slab or the edge beam of the building, which should be checked and approved by the building owner or his representative.

Where fulcrum load is to be spread on a concrete structure, it should be by packing along the slab edge if the load is to be resisted by an edge beam only, or at right angles to the slab edge if it is to be distributed over a wider edge strip of the slab. The packing should be of a defined size and shape which should be agreed with the building owner or his representative.

The packing should be of hard timber and should be of sufficient width and uniformity to ensure that the beam is squarely seated at its fulcrum point. A similar thickness of packing should be in place under the tailing edge of the beam so that the beam may be clamped firmly down at its tailing end but remain horizontal.

26.4 Scaffolding

The scaffold which is constructed on the cantilevered beams should be fixed in position and prevented from becoming dislodged.

A cantilever scaffold should always have foot ties in both directions. This foot lift may be used to fix the location of the uprights on the beams.

The scaffolding should be tied and braced as described in this code, ensuring that the first level of ties is at the first floor level above the cantilevered beams.

27 Truss-out scaffolds

27.1 General

A truss-out scaffold is an independent tied scaffold constructed in accordance with the recommendations of this code and not erected from the ground but supported by a scaffold structure projecting from the face of a building or structure (see Figure 16, Figure 17 and Figure 18).

The location of the fulcrum point for the purpose of the calculation should be taken as the centre of the packing. On site, the packing should be located as required by the designer after liaison with the building owner or his representative.

Where it is undesirable to bolt the tailing end down, it may be propped from the structure above in the manner shown in Figure 15. In this case an uplift force is exerted on the structure firstly by the balancing load and secondly by the driving of the wedges or by the extension of adjustable jacks. The building owner or his representative should agree the suitability of his structure to meet these forces.

When propping is used to secure the tailing end of the cantilever beam, every prop or tube so used should be effectively maintained in position by an assembly of tube and fittings and be itself of adequate strength to carry the loads imposed on it.

The supporting scaffold structure is referred to as the truss-out.

The access scaffold should be designed first. The truss-out should than be designed to match the bay dimensions.

Two types of truss-out are in common use.

a) A truss-out in which the vertical weight is carried by a ledge or sill at a lower level in the wall or outside the building, and the scaffold is tied in at the top of the truss-out (see Figure 17).

b) A truss-out in which the vertical weight is taken on the edge of a slab at a point inside the building and maintained in position by a rigid structure between adjacent floors (see Figure 18).

In case a) the designer and the building owner or his representative should agree on the suitability of the ledge and sill to receive the weight of the scaffold.

Case b) exerts an upward force on the underside of the upper slab above the internal scaffold structure as well as the downward load on the slab edge. The designer and the building owner or his representative should agree on the suitability of the building to resist these forces.

27.2 Loads

The strictest control should be exercised by the user on the loads applied to truss-out scaffolds. There should be full liaison between the designer and the user on this matter and the drawings and calculations should state the load limitations clearly.

27.3 Design of the truss-out

The truss-out should be designed to cater for the vertical self weight of the scaffold and its imposed load and the loads resulting from wind forces. The forces in the rakers should be evaluated, the rakers designed accordingly and stiffened where appropriate and fitted with the necessary check couplers.

The internal restraining scaffold should be designed to cater for the resulting horizontal forces and be adequately locked into the building to prevent inward and outward movement.

In Figure 17, the needle transom should rest on the sill and be fitted with internal and external bridle tubes, as shown.

In Figure 18, the truss-out should be capable of resisting any disortion due to the the vertical reactions and the lateral inward and outward forces.

The points of application of the vertical load to the building should be padded. The shape and spread of the pads should be agreed between the designer and the building owner or his representative and inserted on site as detailed. The vertical forces on the building should be taken at the location of the vertical tubes on the pads.

27.4 Access scaffold

The access scaffold should be tied and braced as described in this code, ensuring that the first level of ties is at the first floor level above the truss-out.

27.5 Single deck truss-outs

Where a single deck truss-out utilizing window openings is required, the form of construction detailed in Figure 16 is suitable. If the clear span between truss-outs exceeds 2.75 m an intermediate triangular frame should be used, as shown.

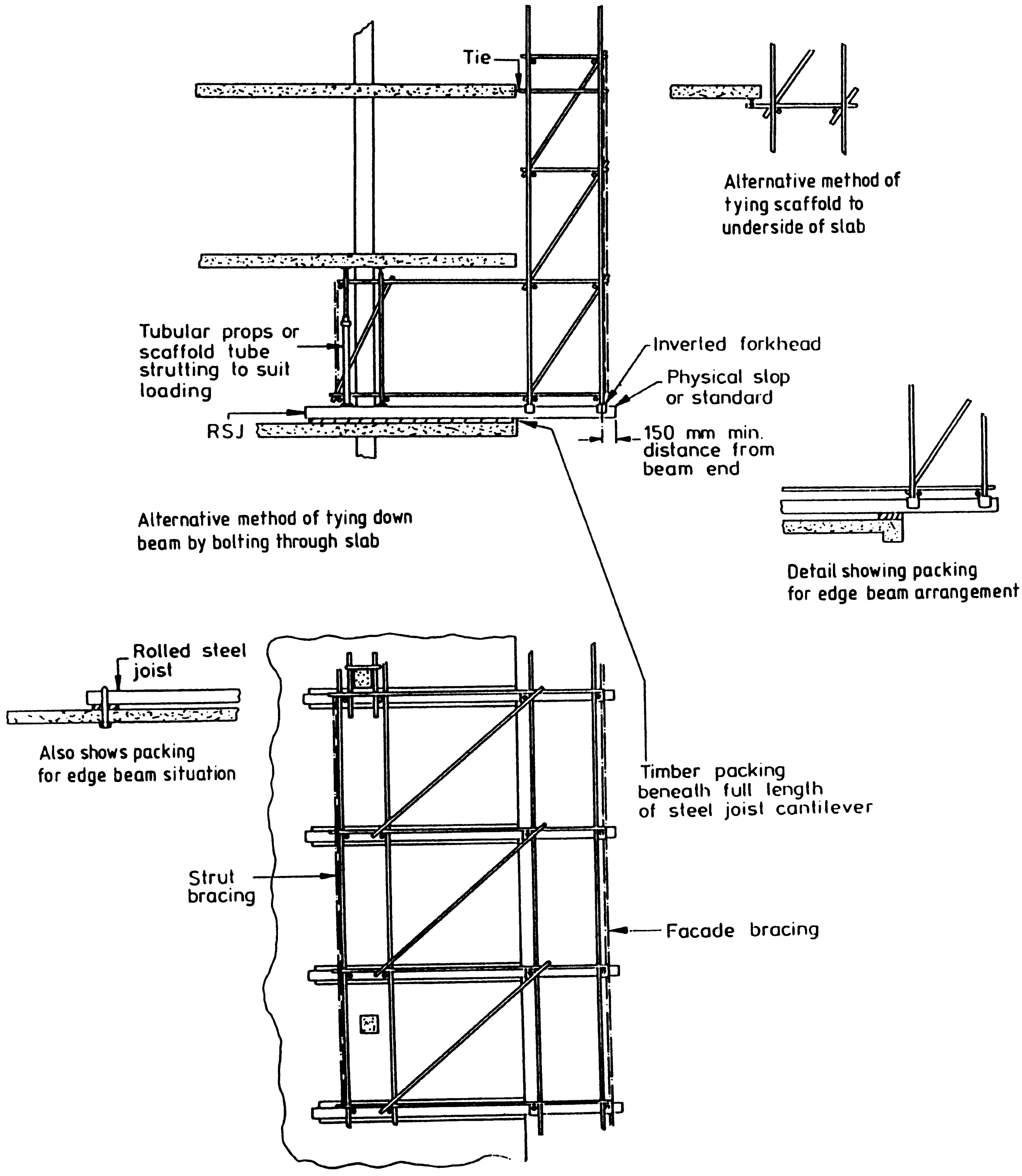


Figure 15 — Typical cantilever scaffold

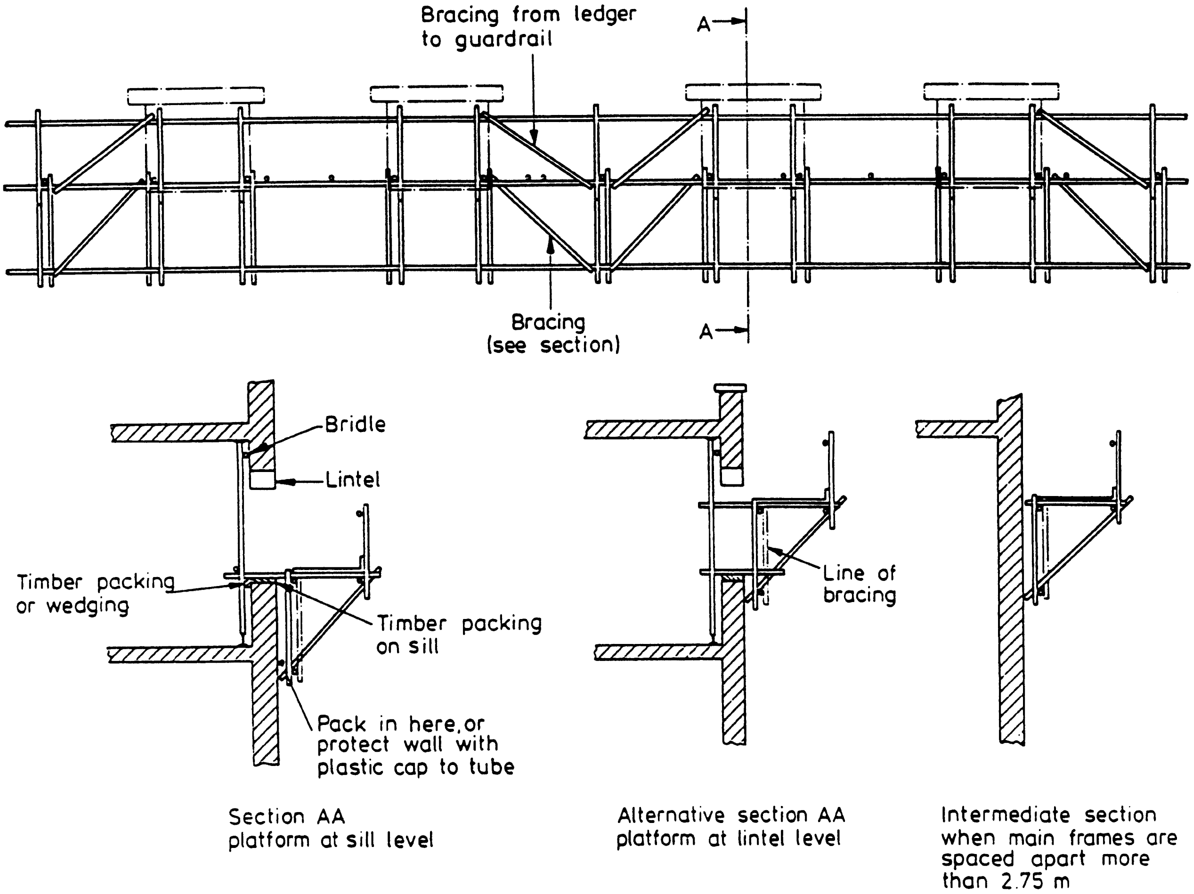
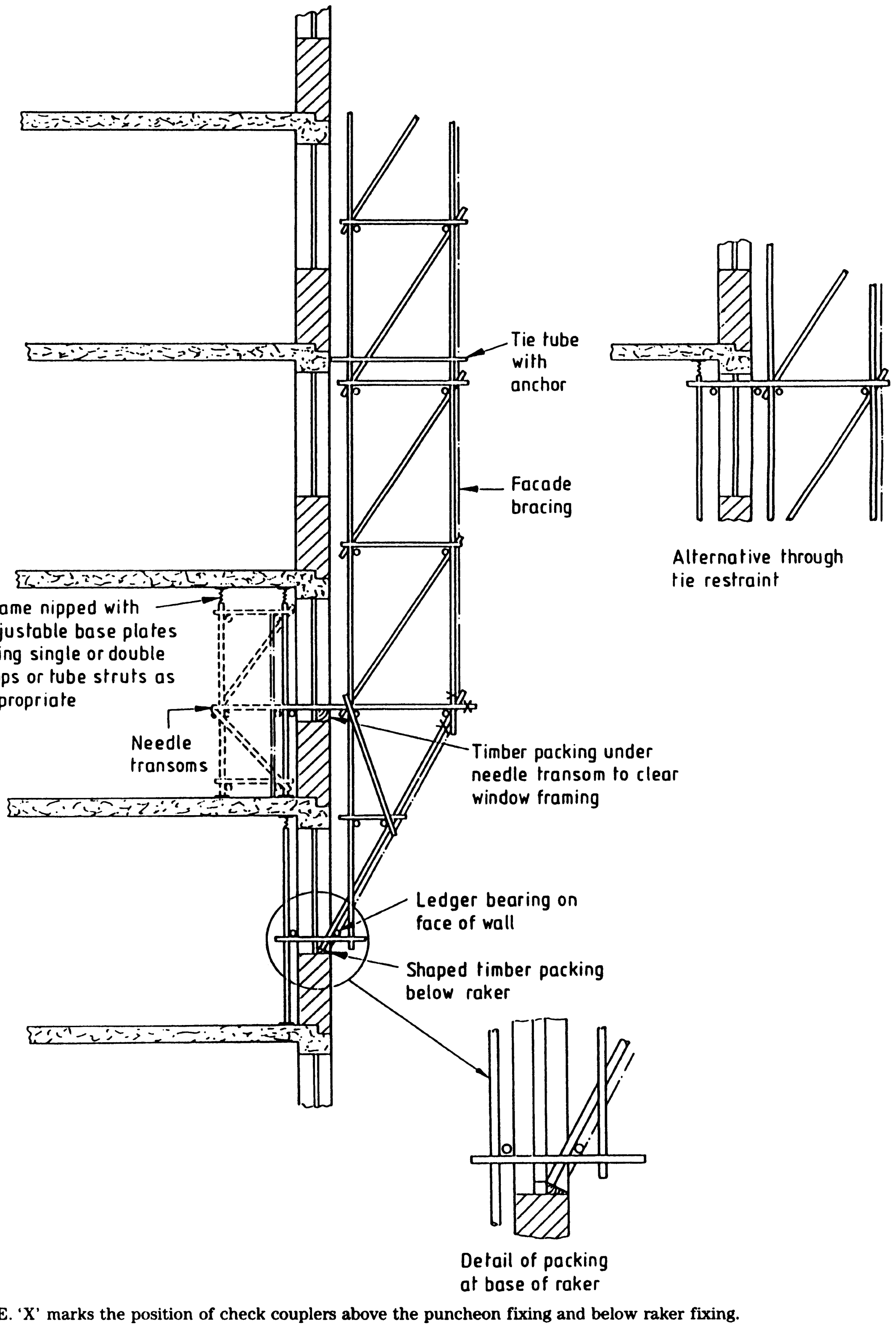
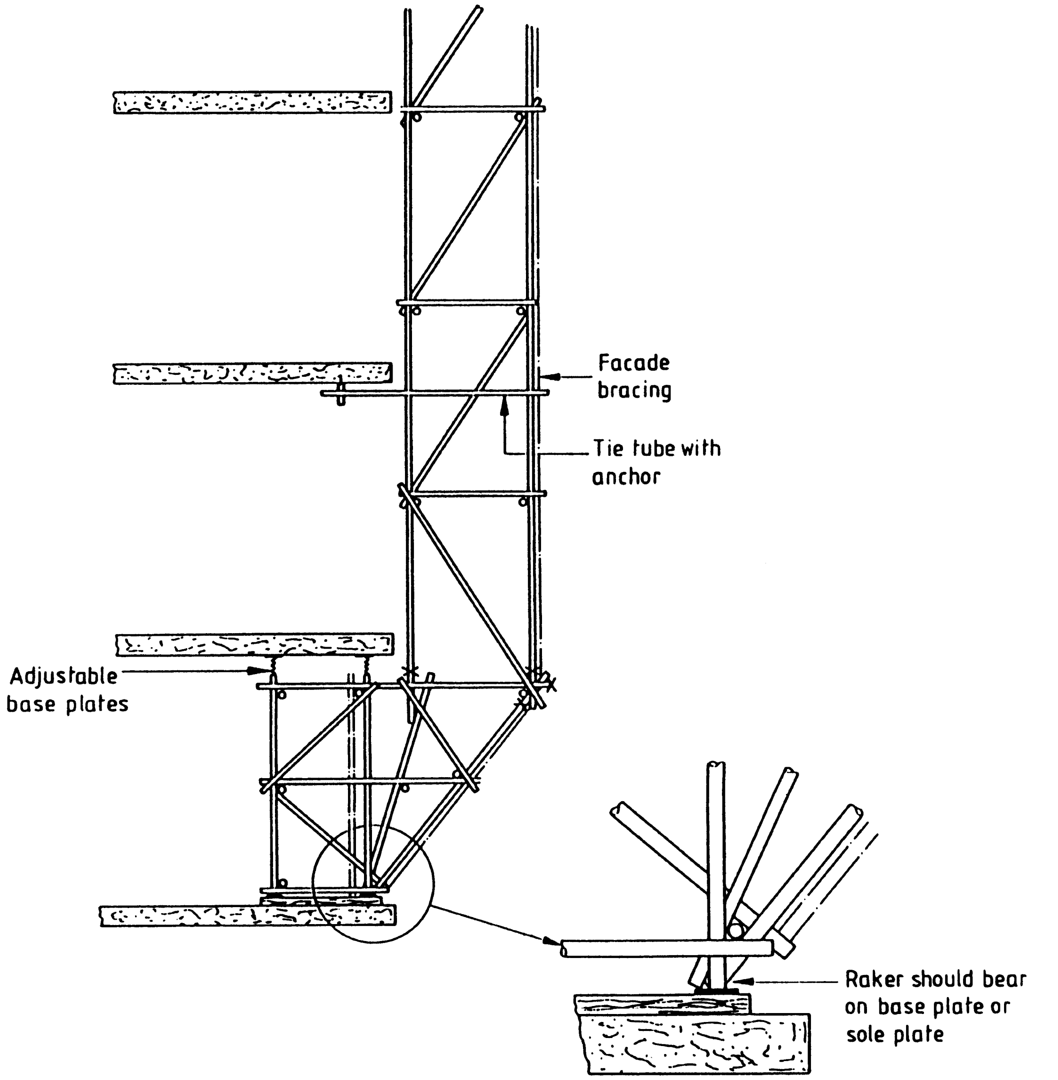


Figure 16 — Single lift truss-out scaffold



NOTE. 'X' marks the position of check couplers above the puncheon fixing and below raker fixing.

Figure 17 — Typical truss-out independent tied scaffold (on existing building)



NOTE. 'X' marks the position of check couplers above puncheon fixing, below raker fixing and at outer end of transom.

Figure 18 — Typical truss-out independent tied scaffold (on building under construction)

28 Free standing towers, power line crossings, guys and struts

28.1 General

Scaffolding materials are commonly used in erecting temporary free standing structures which are self supporting and do not depend totally on other structures for their rigidity or stability. Four classes of these structures are generally distinguished.

a) *Light duty access towers*, stationary and mobile for use inside buildings (imposed load not greater than 1.50 kN/m^2.

b) *Light duty access towers*, stationary and mobile for use in the open (imposed load not greater than 1.50 kN/m^2.

c) *Heavy duty towers*, such as camera towers and welding platforms (imposed loads in excess of 1.50 kN/m^2.

d) *Protection structures*, such as for line crossings.

28.2 Calculations

Free standing towers situated externally and likely to be subject to wind forces, should be the subject of calculations for wind forces and overturning. The strut and tie loads and the forces on any guys and anchors should be evaluated.

28.3 Foundations

All free standing structures should be built on firm foundations and should be vertical. If on sloping ground, they should be prevented from slipping.

Towers inside buildings should be on level floors or adequately compacted sub-bases.

28.4 Bracing

The towers should be adequately stiffened on all sides and in plan at every alternate lift, starting at the base lift of mobile towers.

28.5 Access

Access to the top of towers should be by ladder, either built into the framework or attached to the end of the tower and preferably inside the base area.

28.6 Decking

The working deck should be of adequate thickness. If boarded with scaffold boards, the supports to the boards should comply with the recommendations of Table 4 and the boards, if short, should be prevented from sliding by battens nailed beneath the deck.

The deck should be provided with toeboards and guardrails complying with the recommendations of clause **15**.

Generally, the deck should have at least one edge in the same vertical plane as one side of the tower base so that this edge can be placed up against the work to be done. An operative is thus not required to lean out over the guardrail.

28.7 Operation

The user should apply no horizontal force at any of the working decks, e.g. by hauling heavy ropes or cables, and should not lift significant loads up the outside of the tower or attach a gin wheel on a cantilever tube unless the tower is specifically designed for this purpose.

If large weights, e.g. television cameras, are to be hoisted to the top deck by block and tackle, adequate davits or brackets should be provided and the stability of the tower calculated for the suspension reaction at the top block which might be twice the lifted weight. If the towers are rectangular, the lifting tackle and ladders should be on the shorter side.

Mobile towers should only be used on even ground, never on a slope which is sufficient to allow them to run away.

Castors should normally be kept locked except when the tower is being relocated. When used on surfaces which have a cross fall and/or a longitudinal fall, the user should be particularly careful to see that the brakes are on at all times other than whilst moving the tower. If there is any doubt as to the adequacy of the brakes, the wheels should be chocked.

Mobile towers should never be moved with an operative on the working platform. The force to achieve resiting should be applied at the base.

28.8 Height and base dimensions

The height is measured from the floor to the level of the working deck or top lift, ignoring the height of the guardrail. The least base width is the dimension, centre to centre, of the shortest side of the tower if it is rectangular or two thirds of the apex to side dimension if it is triangular. The height of free standing towers is limited in **28.11** to **28.14** by restricting the height to least base ratio. Specific guidance is given, but no towers should be built with a least base dimension less than 1.2 m.

NOTE The height to least base ratios given in this clause relate to scaffolds constructed from steel scaffolding materials. Aluminium structures are generally lighter than steel and may require the application of different ratios.

28.9 Stability

28.9.1 *General*

All types of free standing structures depend for their stability either on their self weight or on additional guys, anchors, outriggers or kentledge.

The factor of safety for scaffold structures, i.e. the ratio of the overturning moment to the righting moment, should be not less than 1.5. The overturning moment is due to eccentric weight and imposed and environmental loads. The righting moment is due to the self weight, if suitably centered, added kentledge and the anchor, gut or strut forces, if any.

28.9.2 *Kentledge*

Where kentledge is used, it should be fixed round the perimeter of the foot lift and, when necessary, a tube and fittings grid should be installed to receive and locate it. If castors are used, their capacity to take the extra load should be checked.

28.9.3 *Anchors*

28.9.3.1 *General*

Anchor capacities are dependent on ground conditions and reference should be made to the designer for the type, number and location of anchors.

Four types of anchorage are in common use as described in **28.9.3.2** to **28.9.3.5**. Figure 19 shows these types.

28.9.3.2 *Cross tubes attached to the foot lift* (see Figure 19a))

Temporary stability of large structures during construction and permanent stability of small structures may be achieved by using cross tube anchors attached directly to the bottom of the structure. The forces involved should be calculated and the necessary number of anchors inserted. The necessary number of safety couplers should be added to the base frame of the structure and the tensions in the uprights catered for by sleeve couplers and lapping, where necessary.

28.9.3.3 *Driven tube anchors attached to guys* (see Figure 19b))

Driven tube anchors can be used with as many tubes as required. Tubes should be about 1.75 m long and penetrate 1.25 m into the ground. They should be fixed together with tubes and fittings connected with right angle fittings in preference to lashings. The tubes should be set at right angles to the guy.

The guy should be attached (see Figure 19b)) at the bottom of the front tube and prevented from slipping up by a scaffold fitting.

Driven tube anchors should not be used on a down slope towards the structure. They can be used in clay, sandy or gravelly ground. Special sliding driving hammers are available. Users should refer to designer's and manufacturer's literature for number, type and location.

28.9.3.4 *Screwed in flight anchors* (see Figure 19c))

Two sizes of screwed in flight anchors are available, approximately 200 mm and 300 mm diameter. They are set approximately in line with the guy and are screwed in using a short length of scaffold tube through the ring.

They will not penetrate so deeply on an uphill slope towards the guy and allowance for this should be made.

28.9.3.5 *Plate and pin anchors* (see Figure 19d))

Plate and pin anchors are used where the ground is too stoney or has shattered rock, limestone or chalk near the surface.

Various types of plate are permissible, the example shown is a length from a 100 mm × 100 mm structural angle.

The pins are driven in at right angles to the guy. Anchors should be set so that the guys are flatter than 40° to the horizontal.

For square towers, a separate anchor should be provided for each corner. For anchoring long towers, it is advantageous to fix a ground ledger through all the anchors so that each can supplement the others if required.

28.9.4 ***Guys***

Guys for temporary scaffolding structures should be of 10 mm or 12 mm diameter wire rope, which should be attached to the scaffolding structure and to the ground tube or anchor by a single round turn and three bulldog grips. The recommended safety factor for guy ropes is 3 : 1.

If the guys are fairly steep, e.g. 50° to the horizontal, they can usually be adequately tightened by hand or with the aid of a scaffold tube lever. When this cannot be achieved, a winch or turnbuckle should be used. No tensioning device should be pulled up too tightly, since the force required to pull a wire guy tight results in very considerable tension being placed on the ground anchorage and the structure before it has been loaded with the wind forces.

The tension in guys, especially, if they are maintaining safety nets in position, may rise to a large value and this force will pass into the scaffold structure and down certain of the uprights to the ground as an added load which should be taken into account in designing the structure.

Where guys are necessary they should be attached to node points in the structure.

If guys are being placed on one side of a structure to resist a force not yet applied on the other side, the structure should be made stable against the guy force until the balancing force comes in play.

28.9.5 ***Stabilizers***

A scaffold tube may be used in tension as a stabilizer provided that the necessary number of safety fittings are used to attach it at each end. The length of such a scaffold tube should be calculated. Intermediate bracing of the stabilizer may be required.

It is recommended that all external free standing structures subject to wind pressures are strutted with tubes at least temporarily and if the structures are of low height the tubes may be left in place as stabilizers.

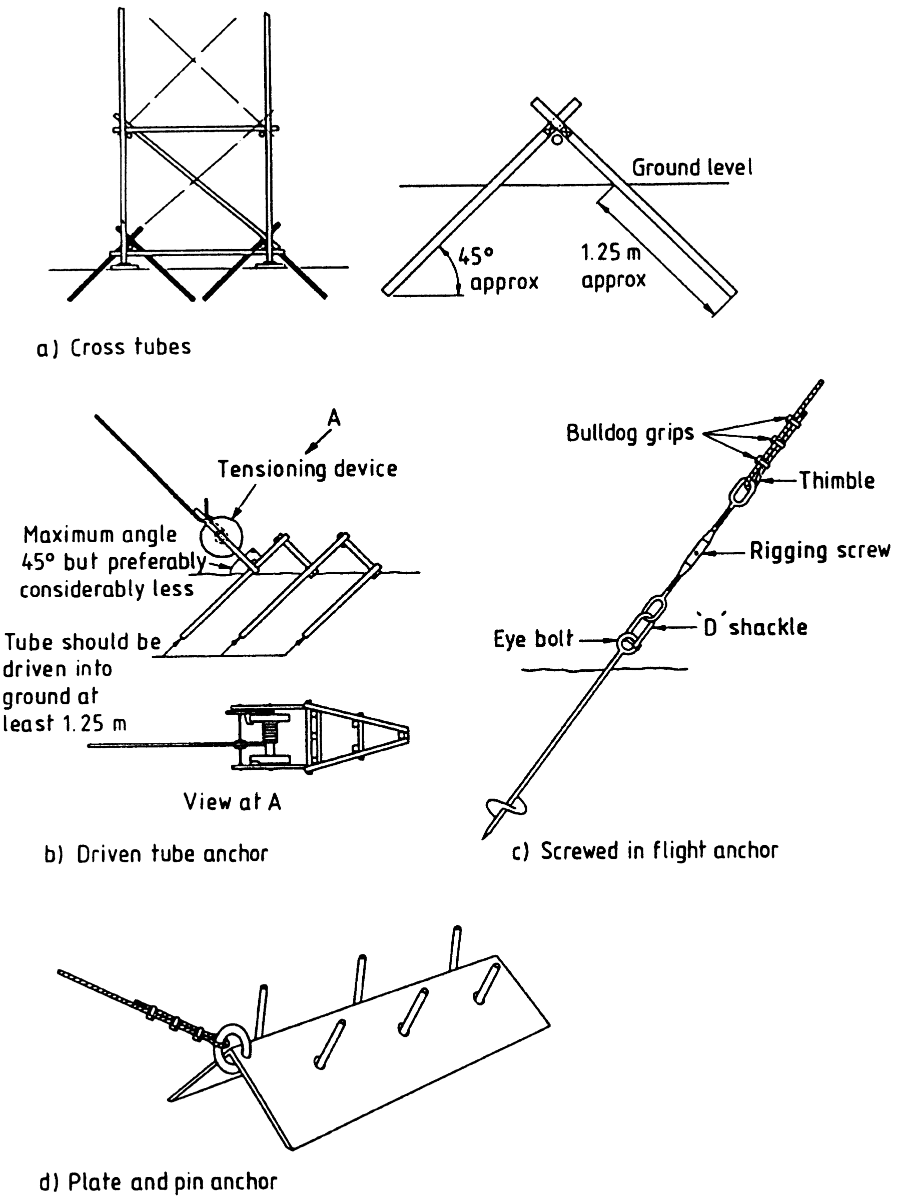


Figure 19 — Anchors

28.10 Temporary tying of all types of tower

When access towers are required to be a height exceeding the height to the least base dimension ratio recommended in **28.11** to **28.14** and a larger base cannot be built or extension buttresses cannot be fixed at the base, the tower should be constructed up to the maximum height allowed by the height to the least base dimension ratio and then tied, roped or guyed in four directions (three may suffice if they can be suitably chosen), if necessary, to the main structure which is being serviced. The tower may then be increased in height and should be additionally tied at levels of approximately every 6 m.

28.11 Stationary access towers within buildings

28.11.1 *Height limit*

The height limit of these towers is achieved by restricting the ratio of the height to the least base dimension. Within buildings there are no environmental loads, but nevertheless some tendency to overturn a tower may occur from raising weights outside its base area, wrongful application of force at the top and normal operations on the top deck.

To cater for this overturning moment, the height to the least base dimension ratio should not be greater than 4.0, when these dimensions are measured as described in **28.8** and steel scaffolding materials are used.

28.12 Mobile access towers within buildings

28.12.1 *General*

Mobile access towers within buildings are constructed in a similar manner to the stationary tower described in **28.11** and are fitted with castors at the bottom of the uprights (see Figure 20 where two alternatives are shown).

28.12.2 *Height limit*

The height to the least base dimension ratio should be limited to 3.5, when these dimensions are measured as recommended in **28.8** and steel scaffolding materials are used.

28.12.3 *Castors*

Castors should be of the swivel type and fixed to the uprights of the tower so that they cannot fall off if the leg is out of contact with the ground. The wheels should be fitted with brakes, which should be on during use. Only castors with the appropriate safe working load should be used.

28.13 Stationary access towers adjacent to buildings

28.13.1 *Height limit*

The height to the least base dimension ratio for stationary towers outside buildings without special means of anchoring should not be greater than 3.5, when these dimensions are measured as recommended in **28.8** and steel scaffolding materials are used.

Stationary towers outside are usually exposed and are therefore subject to wind forces. Frequently towers with a height to the least base dimension ratio less than 3.5 are unstable in locations exposed to high winds. For these circumstances, the wind forces should be calculated and the tower restrained by kentledge or guys to give a factor of safety against overturning of 1.5 in any direction.

28.13.2 *Guys and struts*

When guys, struts and anchors are used, these should be attached to the tower and anchored as recommended in **28.9**.

28.13.3 *Sheeting*

Frequently external towers of considerable size and height are required and may have sheeting attached to them. Advertising towers, camera and commentators' box towers are examples. These should particularly be subject to calculations and site supervision, since the horizontal forces from the wind may be the equivalent of several tonnes and act near the top of the tower.

28.13.4 *Foundations for external towers*

When the ground is soft, sole plates should be used and the tower should be maintained in the centre of the sole plate by the use of substantial nails or other means.

When the ground is sloping, the sole plates should be dug in flat.

28.14 Mobile access towers adjacent to buildings

28.14.1 *General*

Mobile access towers adjacent to buildings are constructed in a similar manner to the stationary tower described in **28.13** and are fitted with castors, which should comply with the recommendations of **28.12.3**, at the bottom of the uprights.

28.14.2 *Height limit*

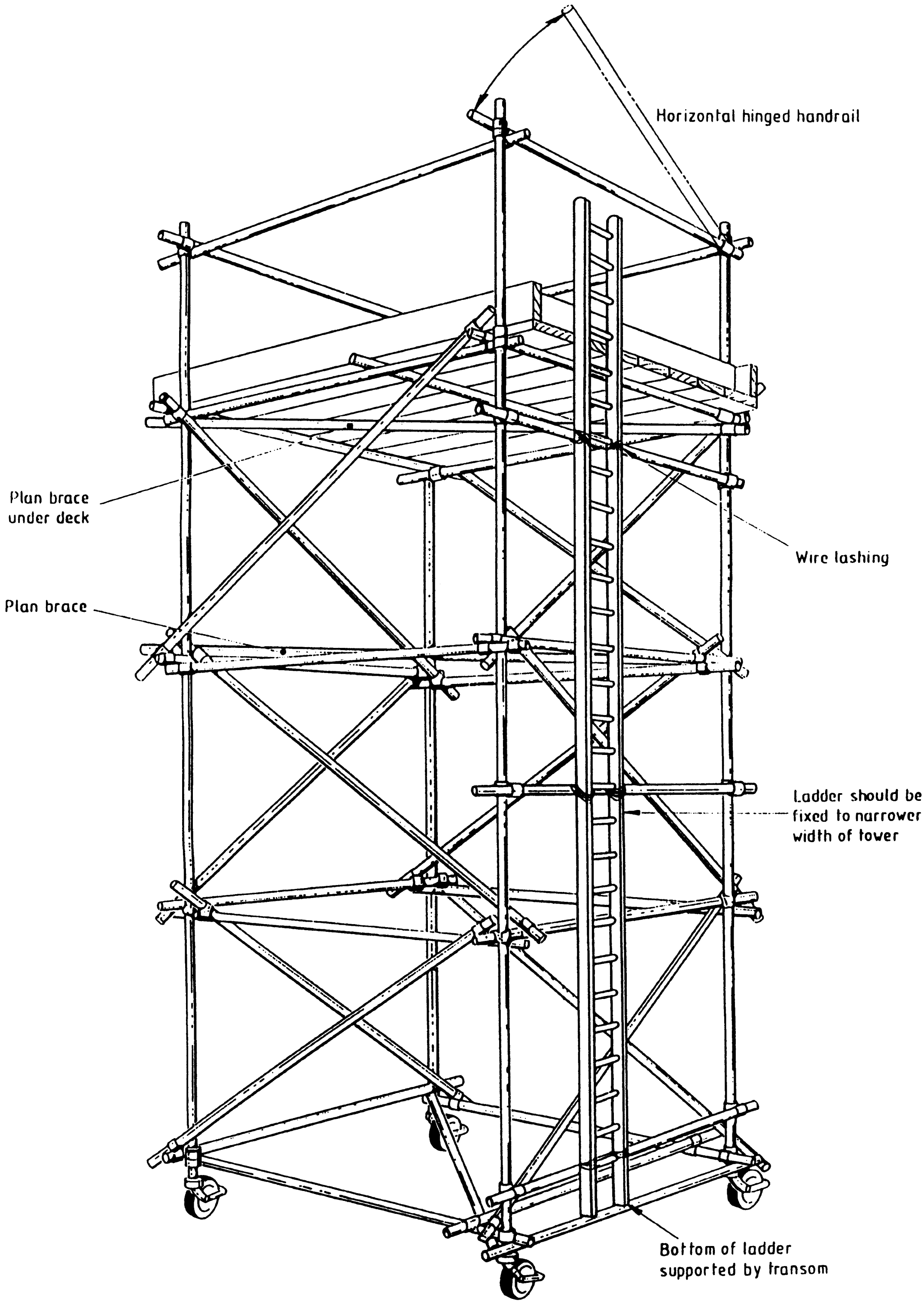
The height to the least base dimension ratio should not be greater than 3. When in use in exposed situations, the tower should be tied to the building it is serving.

Towers outside are usually exposed and are therefore subject to wind forces. Frequently towers with a height to the least base dimension ratio less than 3.5 are unstable in locations exposed to high winds. For these circumstances, the wind forces should be calculated and the tower restrained by kentledge or guys, to give a factor of safety against overturning of 1.5 in any direction.

If kentledge is used it should be fixed in accordance with **28.9**. The capacity of the castors to take the extra load should be checked.

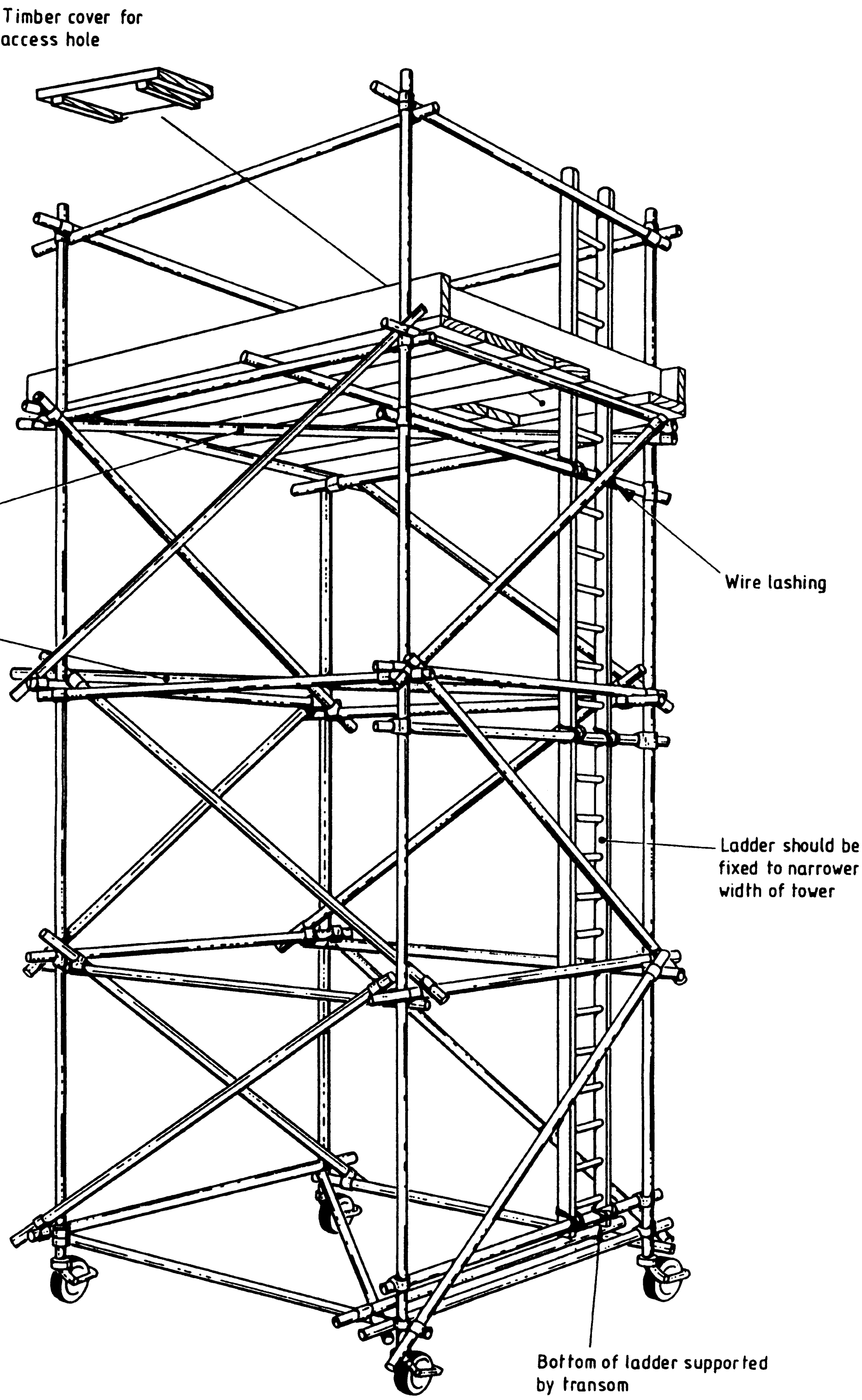
28.15 Power line crossings and other protection scaffolds

Power line crossings and other protection scaffolds typically consist of a pair of long, narrow towers suitable for the duty to be performed with a net or tube mattress spanning between them. They are frequently maintained in position by guys at either side. Figure 21 and Figure 22 show examples.



(a) Mobile tower with external ladder

Figure 20 — Mobile access tower



(b) Mobile tower with internal ladder

Figure 20 — Mobile access tower *(concluded)*

This type of structure is quite stable when completed but during construction, which may take several days, the tower may be unstable against wind forces before the guys are fixed if it is not adequately stabilized temporarily.

Where specified horizontal forces are to be resisted in addition to wind forces, the structure should be plan braced so that those forces may be distributed along the length of the structure and subsequently distributed between the guys and anchors.

When the cross wires maintaining the protection sheeting or nets are on the skew, the guys should be on the same skew.

29 Access birdcages

29.1 Description

A birdcage scaffold consists of a multiplicity of standards arranged at regular intervals in parallel lines, usually evenly spaced apart. These standards are laced together with a grid of ledgers and transoms at every lift height and the top lift is boarded to form the access platform for work on ceilings and soffits, e.g. to fix lighting, ventilation or sprinklers over an inside area.

The side bays of the birdcage may also be required to form a normal access scaffold to the walls supporting the soffit.

There are two types of birdcage:

a) birdcages with more than one lift in the height;

b) single lift birdcages.

The distinction between these two types is due to the different requirements of the bottom and top lifts from the intermediate lifts and the fact that these two special lifts are adjacent in a single lift birdcage.

29.2 Loading

Excepting the working lifts in the outside bays, a birdcage should have only one working lift, i.e. the top lift, and the loading on this should not exceed 0.75 kN/m^2 (see Table 1).

29.3 Dimensions

The standards should be at not more than 2.5 m centres in each direction.

The lift heights should in general be 2 m except where locally concentrated loads are being specially catered for (see also **29.5**).

The width of the edge bays may be reduced to three, four or five boards to meet the requirements for the particular type of access required round the edges.

29.4 Foundations

If the foundations are on unfloated concrete, the standards may be erected directly on to the concrete. If they are on finished concrete or any type of flooring, base plates should be used. Where the base plates would otherwise bear directly onto soft flooring protection pads of timber or timber and hardboard should be used. If the base plates are on a carpet, sole plates, timber or softwood boards should be used. If the base plates are on unfinished sub-grade in a part finished building, timber scaffold board sole plates should be used.

29.5 Ledgers

The ledgers for the first lift may be fixed up to a maximum height of 2.5 m, but subsequent lifts should be at 2 m intervals. Ledgers should be fixed to the uprights with right angle couplers.

When a step in the ledgers is necessary in the lower one or two lifts, to accommodate a sloping or stepped floor, the stepped ledgers should be attached to the same upright so that there is no bay without ledgers.

Joints in ledgers should comply with the recommendations of **13.2**.

A foot lift is not necessary, except in intermittent places where foot ties are required to receive the lower end of braces.

29.6 Transoms

Transoms in the foot ties and in the intermediate lifts should be fixed to the uprights with right angle couplers. In the top lift, they should be fixed to the ledgers to provide level supports for the decking.

Transoms to the working lifts in the side bays may be fixed to the ledgers to provide level supports for the decking.

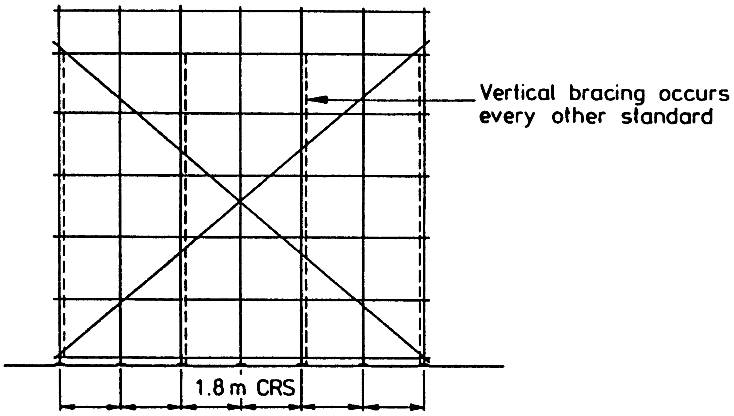
The spacing of transoms should conform to the recommendations of clause **14** and joints should comply with the same recommendations for the joints in ledgers given in **13.2**.

29.7 Stability

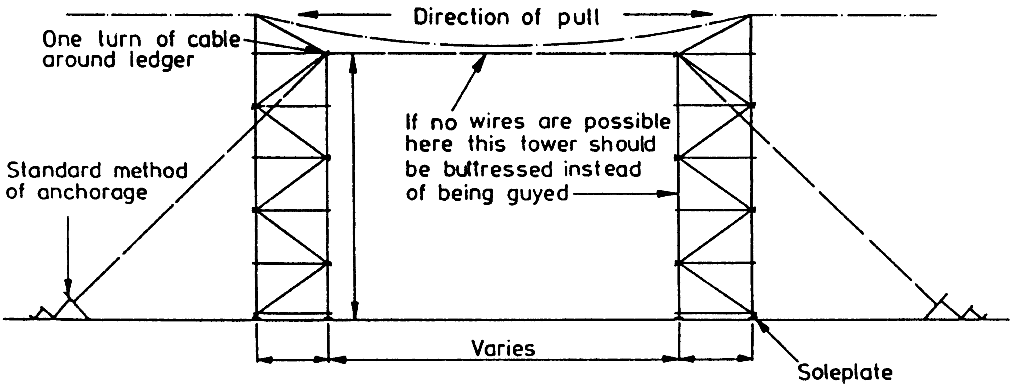
29.7.1 *General*

All birdcage scaffolds require to be braced and/or tied to ensure they are stable. The verticals have to be adequately braced to be strong enough to carry the vertical loading. Birdcages should be stiff enough to resist lateral sway and horizontal loads and be safe from overturning. External birdcages should be braced to resist wind forces and anchored when necessary. Single lift birdcages present a particular design problem (see **29.8**).

The need for plan bracing should be considered for free standing birdcages.

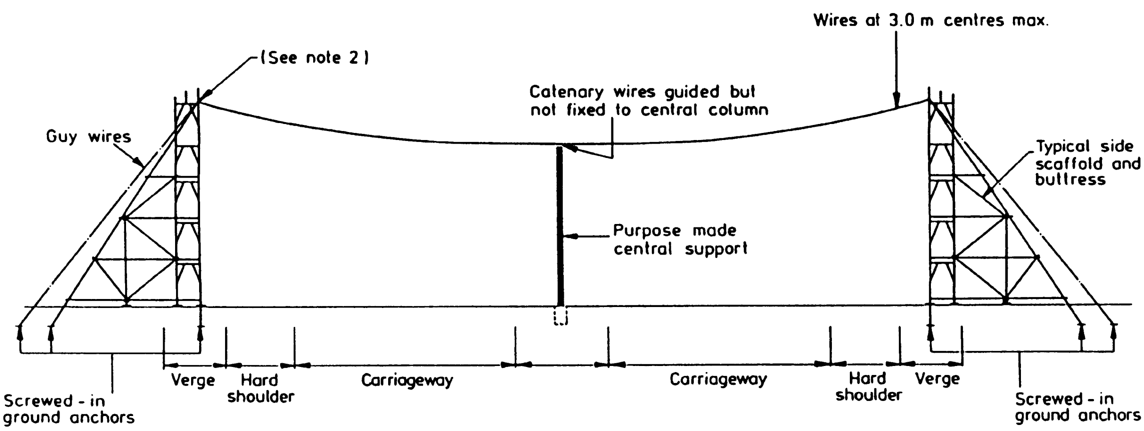


(a) End elevation



(b) Side elevation

Figure 21 — Small power line crossing



NOTE 1. Catenary wires should not be connected rigidly to centre columns.
NOTE 2. Catenary wires should be securely fixed to the inside top ledger with a short wire and 3 bulldog grips.

Figure 22 — Power line crossing over motorway

29.7.2 ***Bracing***

All scaffolds require stiffening, as couplers have only a limited moment capacity and are comparatively flexible. This is normally catered for with diagonal bracing. In situations where the birdcage is subjected to wind, bracing should be provided at the rate of one brace for every six verticals in each line. This may take the form of a diagonal tube from top to bottom, or short tubes from one lift to the next, either zigzag or all of one slope.

The lower end of all diagonal bracing should be attached to the foot of a standard by a swivel coupler or to a foot tie with a right angle coupler. Bracing in either direction should preferably be attached to the ledgers or transoms by right angle couplers or, if this is not possible, to the standards by means of swivel couplers.

29.7.3 ***Tying and butting***

Where an adjacent structure is available, it is often more satisfactory for the birdcage to be stabilized from it. If possible, all four sides should be secured. Where two opposite walls are available, it is sufficient to arrange tubes to butt against them from each side but if only one is available, it is necessary to provide a push/pull fixing. No vertical should be more than 6 tubes away from an edge or other restraint point and at least one such point should be provided for each 40 m^2 of vertical face.

The most satisfactory detail is to extend the transoms or ledgers. Where they are to butt at both ends, timber packers and reveal screws may be used. If a push/pull fixing is needed, see the details in section 3.

29.7.4 ***Mixed support***

Where scaffolds have more than 11 standards in a line, it is not possible to rely on edge support only because some verticals will be too far from a support in at least one direction. Thus some bracing will be essential, but can be used in conjunction with tying and butting. Intermediate parts of the structure served, such as columns, may also be useful in providing stability.

29.7.5 ***Overturning***

When the height of the scaffold is less than the lesser base dimension, overturning is unlikely to be a problem. Otherwise it may be necessary to take support from a part of the permanent structure or use kentledge. At all stages of construction the structure should have a factor of safety against overturning of at least 1.2.

Where careful attention is given to make sure any joints in tension have been lapped or are otherwise capable of transmitting the load, the bottom of the standards may be attached to the ground or to kentledge. Alternatively, horizontal push/pull tying may be used near the top of the birdcage. In some cases it may be possible to butt against walls on opposite sides.

Stabilizing to give the necessary strength to standards, as described in this subclause, will normally provide sufficient rigidity, so that a narrow birdcage would fail from lateral loading by overturning as a unit and not by internal collapse.

29.8 Single lift birdcages

Special attention should be paid to the bracing of single lift birdcages of any height less than 2.5 m. The absence of the braced upper lifts requires that the lateral stability of the deck is derived from one lift of bracing only, which should therefore be correctly positioned and fixed.

The standards should be supplied with foot ties in at least alternate bays in both directions to form boxes. Diagonal vertical plane bracing of alternate boxes in two directions should be fixed. As there are no upper lifts to assist with horizontal integrity, it is particularly important in single lift birdcages that the joints in the horizontal tubes of the top lift are made with sleeve couplers and are staggered in alternate bays.

The working lift should be tied and butted to the main structure of the building at approximately every 8 m round the perimeter.

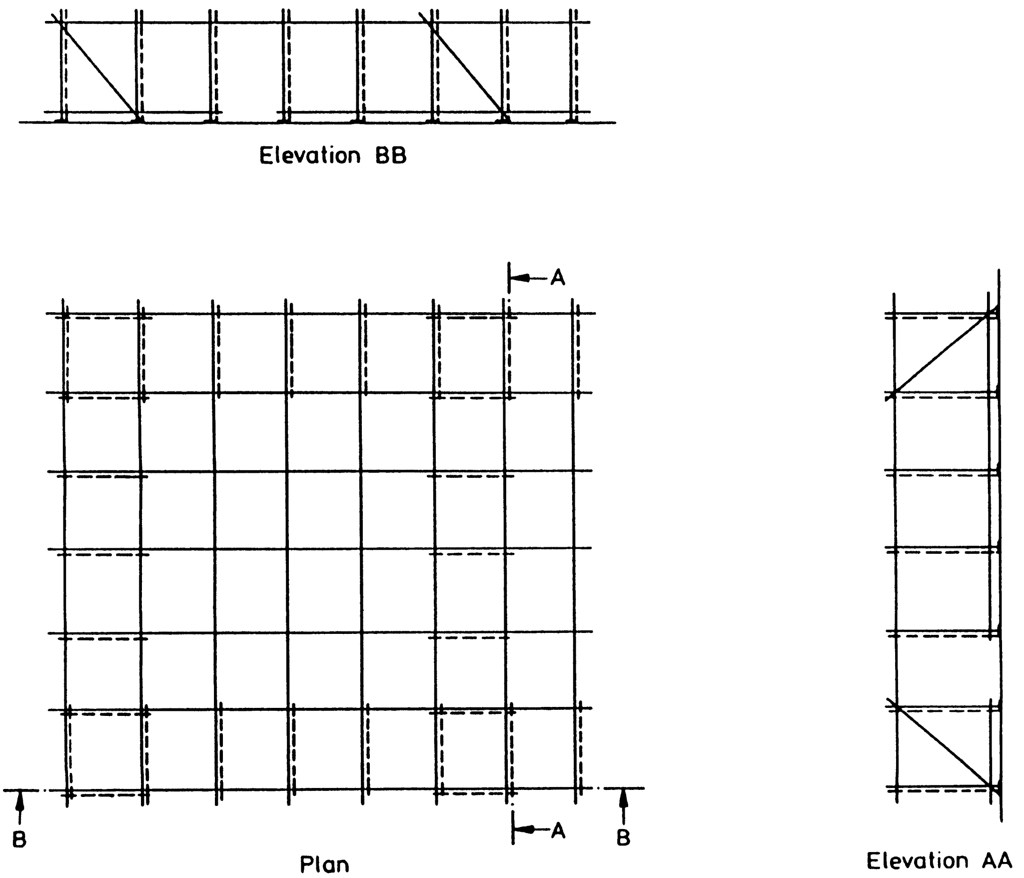
Figure 23 shows an example of a single lift birdcage.

29.9 Top working platform

The top working platform should be constructed in accordance with **29.3** and **29.6** and supported by transoms spaced according to Table 3.

It is inevitable that gaps between the boards occur where the standards protrude through the decking. These gaps should be kept to a minimum and, if possible, to less than 75 mm. Where there is a likelihood of persons below being struck by falling materials, these gaps should be covered with hardboard or similar sheeting.

The outside of the working platform should be kept as close to the walls as is practicable and the edge gaps should preferably not exceed 150 mm. When the edge gap is wider than 150 mm, toeboards and guardrails should be provided.



NOTE 1. A foot tie may be omitted from a line of bays between each pair of braces to facilitate access.
NOTE 2. Where the scaffold is stabilized by box tying around existing columns, the bracing may be omitted locally.

Figure 23 — Single lift access birdcage scaffold (maximum superimposed load 0.75 kN/m^2)

29.10 Storage of materials

No material should be stored on a birdcage unless the storage area has been specially designed (see clause **23**).

30 Hoist towers, ladder towers and stair towers

30.1 Hoist towers

30.1.1 ***General***

Hoist towers are tall narrow structures subject to torsional distortion. In general they should be attached to the main access scaffold and may have common standards with it (see Figure 24 and Figure 25).

The attachment of hoist guides to the ledgers or transoms should be by the method recommended by the hoist manufacturers.

No wind resisting sheeting should be attached to the towers unless account is taken of the wind force.

30.1.2 ***Foundations***

The foundations for hoist towers should be level and firm. Substantial sole plates should be dug into the ground so as to be secure against vibration.

30.1.3 ***Standards***

The standards should be pitched on base plates nailed to the sole plates and should be vertical within an accuracy of 10 mm in any 6 m of height (the variation should not be cumulative).

30.1.4 ***Ledgers and transoms***

Ledgers and transoms should be fixed to the standards with right angle couplers and the lift heights should generally conform with the lift heights of the main scaffold but be not greater than 2 m.

30.1.5 ***Bracing***

Bracing should be fixed with right angle couplers to the horizontal members. All faces of the tower should be braced except the bays through which access is needed.

Plan bracing should be used at the top of the tower and to all members supporting a cat head or a lifting mechanism. In addition, the tower should be plan braced to the main scaffold at levels not more than 6 m apart. The plan bracing should be fixed at tie levels and on alternate sides (see Figure 25).

30.1.6 ***Tying***

Hoist towers and the adjacent scaffold should be tied to the building at every floor level. The height of the tower above the last tie point should not exceed 6 m.

Where there is no access scaffold associated with the hoist tower, the tower should be tied directly to the building.

Any free standing hoist tower or one which is higher than 50 m should be specially designed, braced, tied and anchored as recommended by the hoist manufacturers. It should be adequately stabilized.

30.1.7 ***Access***

At all levels at which access to a hoist tower or hoist way is provided or at which persons are liable to be struck by any moving part of the hoist, the hoist tower or hoist way should be protected by a substantial enclosure.

Where access to the hoist tower is required, gates should be provide and fitted. The enclosure and gates should be at least 2 m high.

Particular attention is drawn to the requirements of Part V of the Construction (Lifting Operations) Regulations 1966 for hoists carrying goods only and to Part VI of the same regulations for situations where persons are carried.

Where persons are carried, an efficient interlocking or safety device should be fitted to every gate to ensure that the gate can only be opened when the cage is at that landing level and also that it should be closed before the cage can move from that landing level.

30.2 Ladder towers and stair towers

30.2.1 ***General***

Ladder and stair towers are generally constructed with one side common with the outside of the access scaffold (Figure 26 shows an example).

Stair towers are more rigid because of the built-in bracing resulting from the sloping stringers for the steps, which may be taken to act as the bracing of the tower at one side. Bracing should be fixed to the remaining sides except in the bays through which access is required.

The superimposed loading adopted in calculations should be not less than 2.00 kN/m^2 for all platforms and stairs in ladder towers and stair towers.

30.2.2 ***Decking***

Both ladder towers and stair towers should be fully decked at the landings and supplied with toeboards and guardrails. Where toeboards cannot be fixed adjacent to steps, double guardrails should be used.

The gaps in the decking to allow access from lift to lift up the ladder or steps should be as small as practicable.

Short boards necessary to complete the decking round the access hole should be tied down and supported at the correct centres (see clause **15**).

30.2.3 ***Ladders***

Ladders in ladder access towers should be fixed in accordance with clause **16** (see Figure 11).

31 Slung scaffolds

31.1 General

A slung scaffold is suspended at a fixed height either below load-bearing projecting brackets or beams or from the structural members of a roof or other overhead structure. The suspension may be by tubular members or by lifting gear and wire ropes which are not provided with the means of raising or lowering when in use. If it is required that there be means of raising or lowering a suspended scaffold, reference should be made to BS 5974.

NOTE Lifting gear means a chain sling, wire rope sling, rings, links, hooks, girder clamps, shackles, swivels, eye bolts or rope eyes.

31.2 Loading

Slung scaffolds are used for a wide variety of applications and should be specially designed.

The imposed load adopted in the calculations should not be less than 0.75 kN/m^2 and there may be multiple platforms at this load rating. Certain areas, particularly walkways, may require to be designed for special loads.

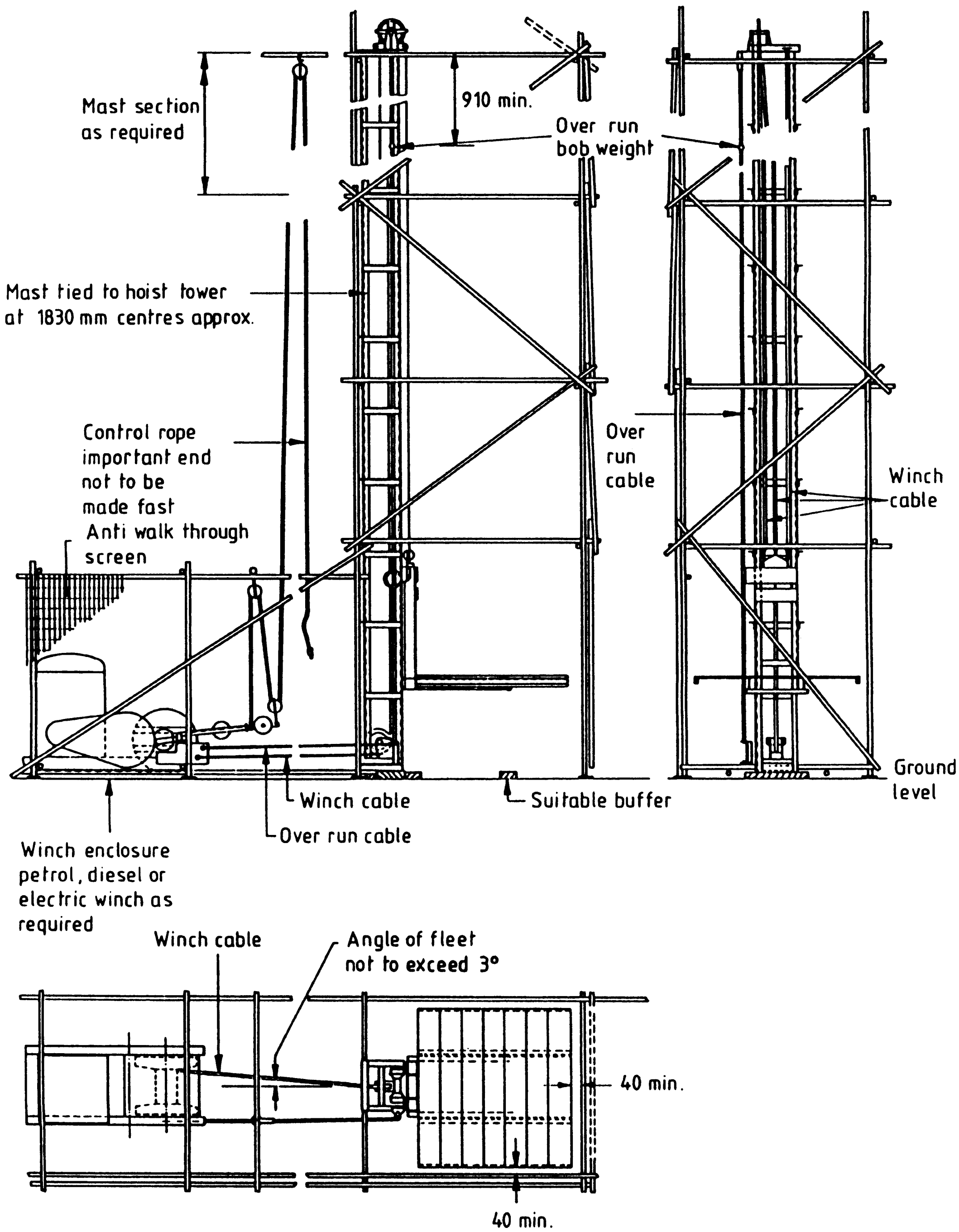
31.3 Dimensions

The dimensions will generally be governed by the spacing of the members from which the decks hang. Special attention should be given to the supporting capacity of the transom and ledgers and the dimensions of the bays fixed accordingly.

31.4 Design

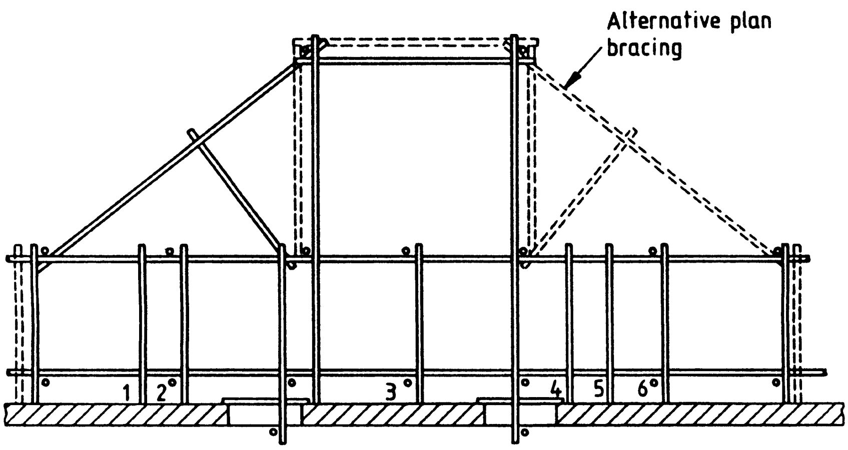
A grid of tubes and fittings made with single tubes coupled together at the points of suspension may be found to be overstressed when the spacing of the hangers is greater than 2.5 m × 2.5 m square.

When this occurs, supplementary transoms and, if necessary, ledgers should be inserted to relieve the overstress. Figure 27 shows typical constructional details.



All dimensions are in millimetres.

Figure 24 — Isolated hoist tower



NOTE. Plan bracing should be at every tie level or at floor levels not exceeding 6 m intervals.

Figure 25 — Plan view of plan bracing and through ties for hoist towers attached to a scaffold

The hanging tackle of tubes and couplers or ropes should be capable of carrying the load applied over the appropriate area of the decking including the self weight of the tube and fittings and the decking.

31.5 Method of scaffold suspension

If the hangers are scaffold tubes, they should be assembled using right angle couplers and the necessary number of supplementary couplers fixed at each end (see **39.8.2**). A check coupler should be used at each end of the hanger. The effect of the inclination of suspension tubes should be taken into account. Sleeve couplers or joint pins should not be used for vertical axial joints unless the joint is lapped.

If the slinging is on wire ropes, these should have a factor of safety of 6 and be fixed to the suspension point and the scaffold by two round turns and two bulldog grips or by using an eye and a shackle capable of safely carrying the loads.

All lifting gear and means of suspension should be thoroughly inspected before and after it is installed and subsequently as required by the statutory regulations (see clause **5**).

Suspension wires may be inclined to reduce the span of the grid of tube. The effect of inclination of the suspension wire needs to be taken into account.

31.6 Suspension points

Any suspension point, member or attachment should be specially designed and formed in such a way that it cannot become dislodged or displaced by oscillations of the slung scaffold.

The designer should satisfy himself that the suspension points are strong enough to support the load and have a factor of safety of two.

31.7 Couplers

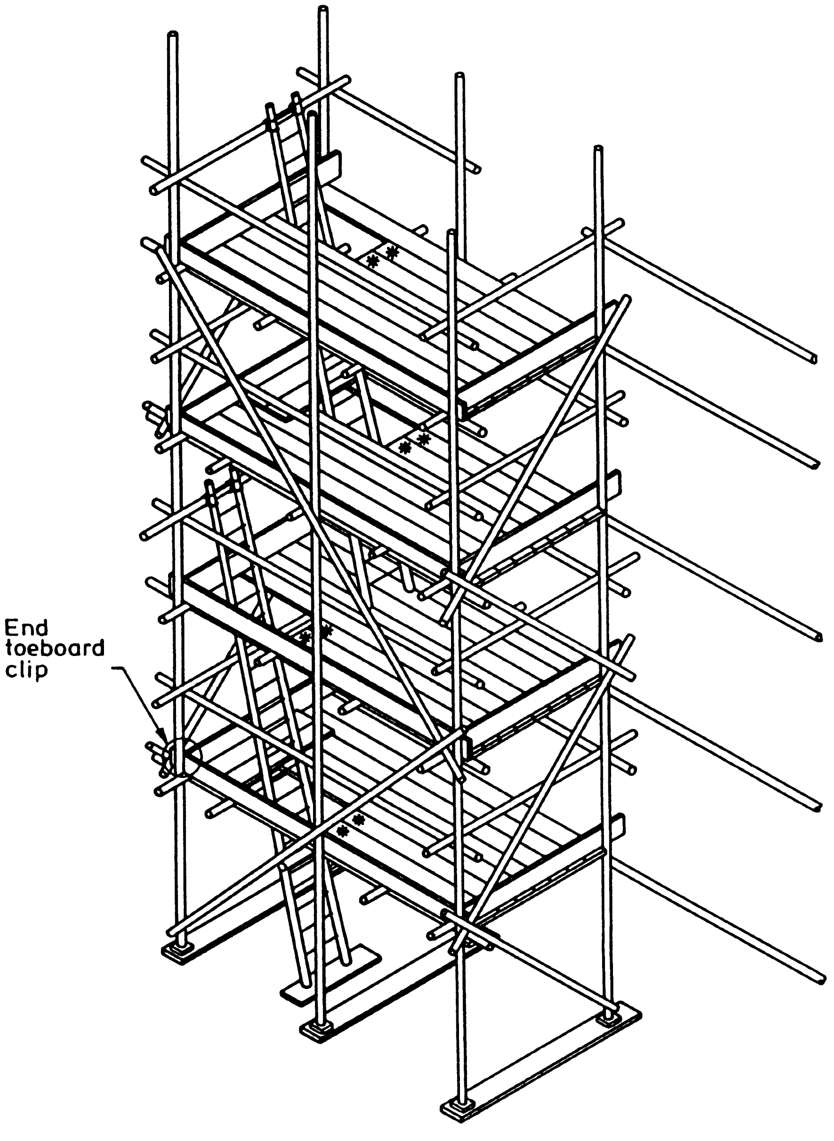
Tubes supporting the boards should be fixed to the ledgers with right angle couplers.

31.8 Decking

The decking should be in accordance with clause **15** or **29.9** as appropriate.

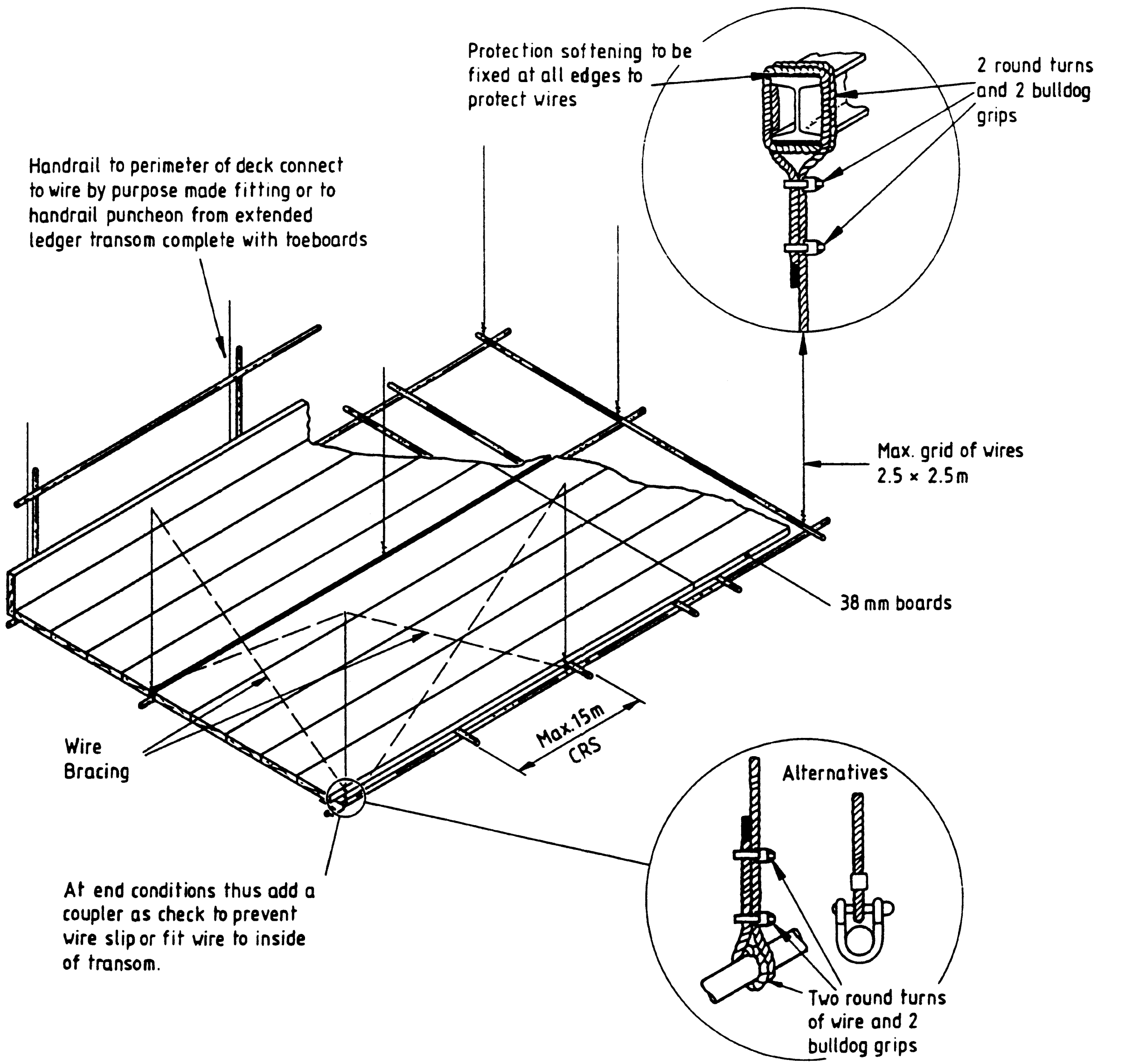
31.9 Bracing

Slung scaffolds should be prevented from swaying either by tying to the main structure or bracing. (See Figure 27 for typical examples.)



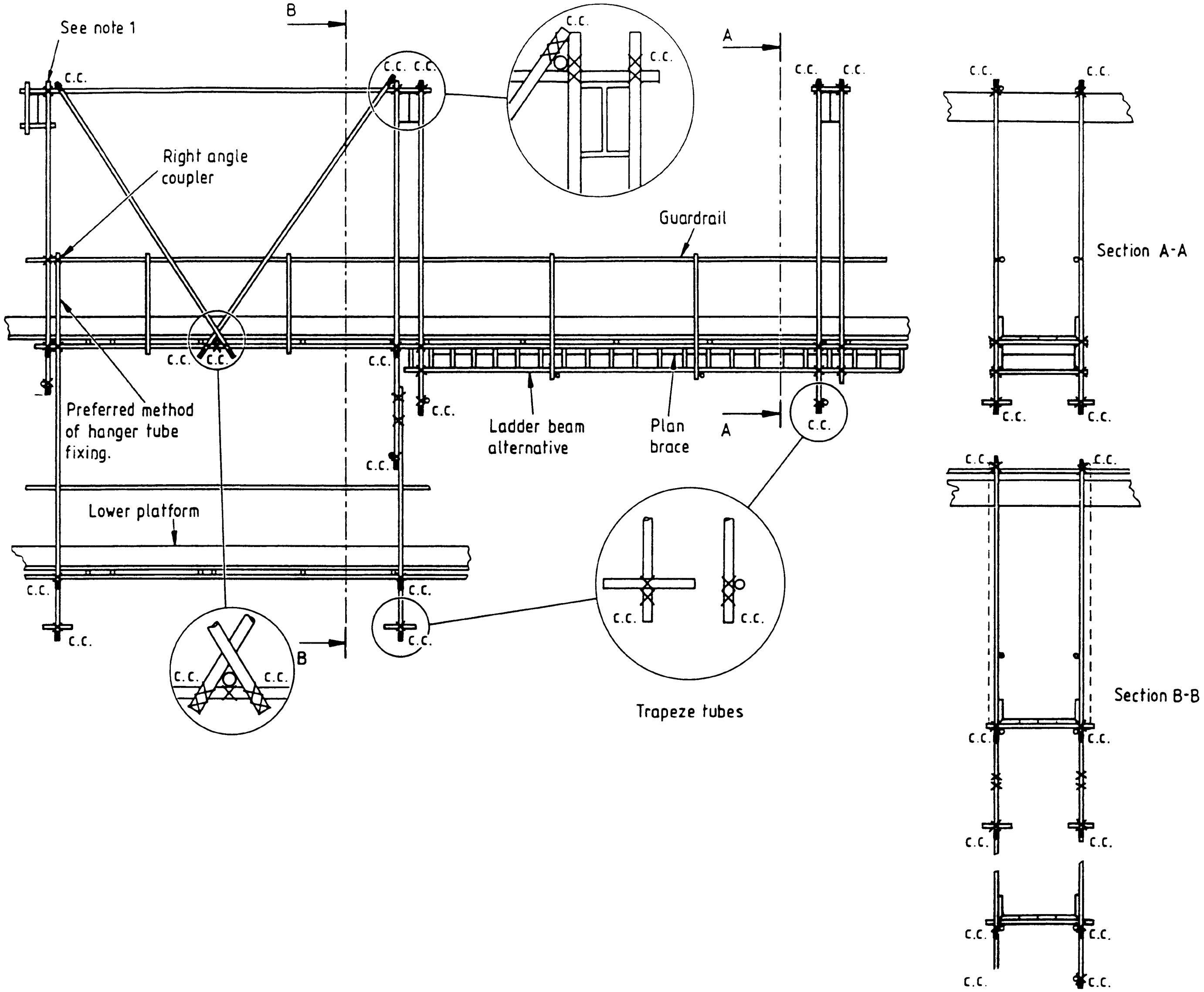
NOTE. Boards marked with an asterisk should be fixed down to a piece of 600 mm board.

Figure 26 — Ladder access tower



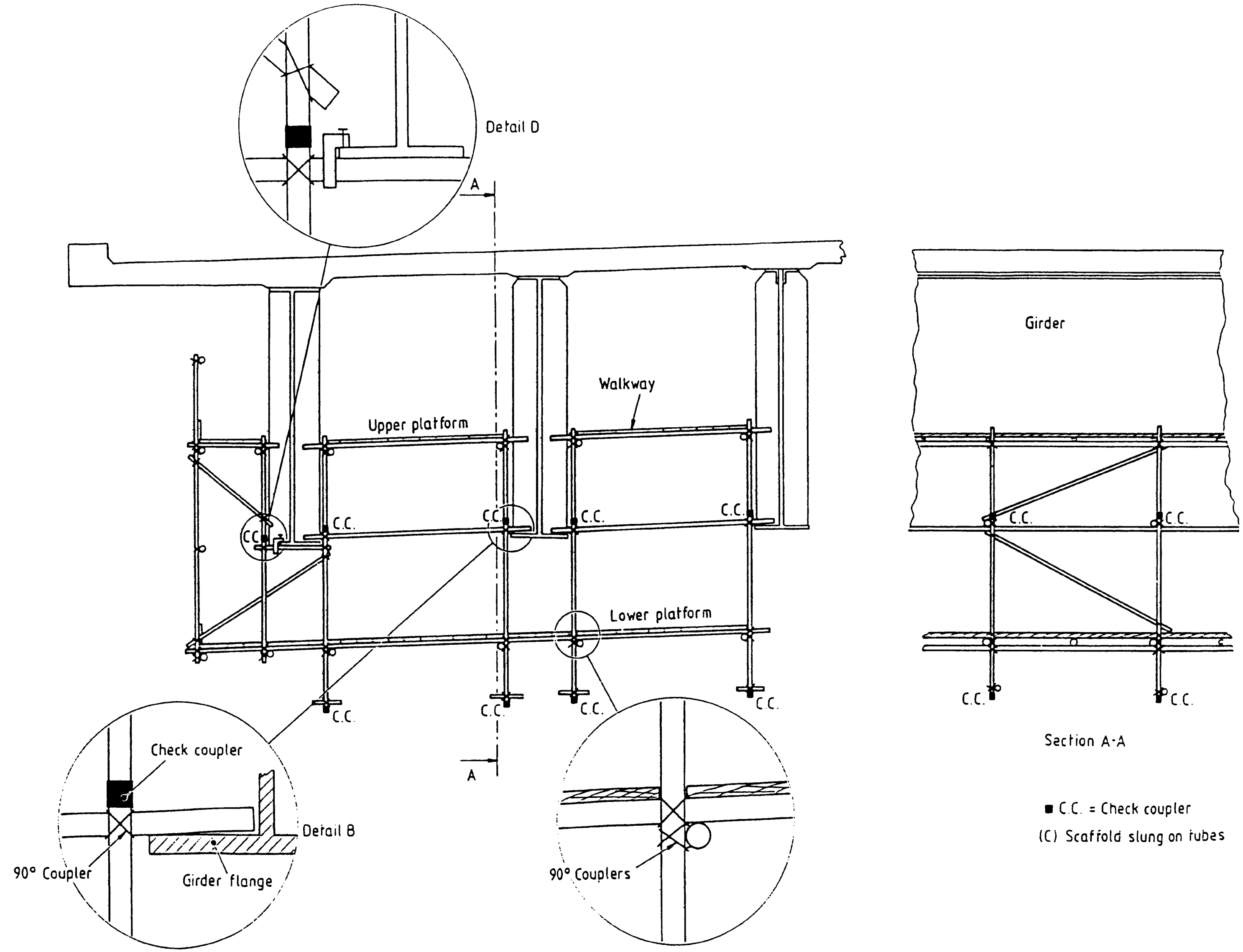
(a) Light duty scaffold slung on wires

Figure 27 — Slung working and protection scaffolds



(b) Scaffolding slung from joints

Figure 27 — Slung working and protection scaffolds *(continued)*



(c) Scaffolding slung from girders

Figure 27 — Slung working and protection scaffolds *(concluded)*

32 Pedestrian bridges and walkways

32.1 General

Pedestrian bridges and walkways are frequently of box type construction with overhead and underdeck bracing. All pedestrian bridges and walkways should be the subject of design and calculation.

32.2 Dimensions of beams

When beams are used as side members, they should be pre-cambered to about 1 % of their span in order to prevent the unsightly sagging of the structure. It is recommended that the depth of the beams be approximately 10 % of the span in order to keep the chord loads as small as possible.

32.3 Loading

The minimum loading adopted for calculations should be 4.00 kN/m^2. Wind loads on the side face of the beams should be calculated in accordance with **39.10**. For further information concerning loading for protective barriers such as handrails, reference should be made to BS 6180.

32.4 Multiple tube chords

The joints in multiple tube chords should be staggered. Frequently the forces are too large to be resisted by normal scaffold couplers or splicing and other methods such as pinned spigots or sleeves should be used.

32.5 Verticals and diagonals

The verticals and diagonals may require doubling or trebling at the ends to take care of the reactions and end shears. Both the verticals and diagonals should be interposed between the multiple tubes of the beam cords.

The most suitable design of truss for construction using scaffolding materials is an N type truss with the diagonals in tension.

32.6 Transoms

Transoms should be placed at every node point. These transoms may be extended outwards at both sides and used to mount transverse diagonal stiffeners to the top chord if the depth of the beams does not allow a complete box to be built. Additional intermediate and board end transoms may be fixed as required.

32.7 Decking

The decking may be of longitudinal boards which may be overlaid with plywood if the public uses the bridge. The decking should be fixed down in an adequate manner against wind uplift.

The decking should be provided with toeboards at each side, guardrails including an intermediate guardrail and, if necessary, expanded metal or other mesh screens along the sides.

32.8 Foundations

The foundations should be designed so as to avoid differential settlement and should be arranged under the end reaction members so that all of the tubes in these end members may carry their correct share of the load. Concrete foundations will generally be required. If necessary, the bearing ends of the beams of larger bridges may be concreted in after the base concrete foundations have been loaded.

32.9 Couplers and fittings

Where the loads in the verticals and diagonals will be so large as to require an impractical number of couplers, consideration should be given to other methods of transferring the load, e.g. shot fired shear pins and welding.

The method adopted to supplement the slip value of the coupler should be made the subject of tests to ascertain that a minimum factor of safety of 2 has been obtained.

33 Temporary ramps and elevated roadways

33.1 General

Temporary access ramps and elevated roadways may be constructed in scaffolding materials. The decking should be supported on a suitable load-bearing framework (see Figure 28). All vehicle ramps and elevated roadways should be the subject of design and calculations.

Timber fenders should be provided at the edge and down the middle of the decking, as necessary, to restrain the traffic to fixed lanes so that the location of the applied loads is known.

Guardrails should also be provided.

33.2 Dimensions

The dimensions suitable for the traffic or construction vehicles should be ascertained and should usually be 1.2 m wider than the widest vehicle. Adequate turning circles may need to be provided at the top or the bottom of the ramps.

33.3 Loading

Loads for pedestrian ramps should be 4 kN/m^2 except for those leading to spectator stands which should be 5 kN/m^2.

If the ramp or roadway is used by the public, vehicles or pedestrians, the loading should generally be in accordance with BS 5400-2 and be approved by the appropriate local authority.

If the ramp or roadway is for the exclusive use of construction traffic, which may be very heavy if it includes earth moving vehicles, the loading should be that for the particular vehicles.

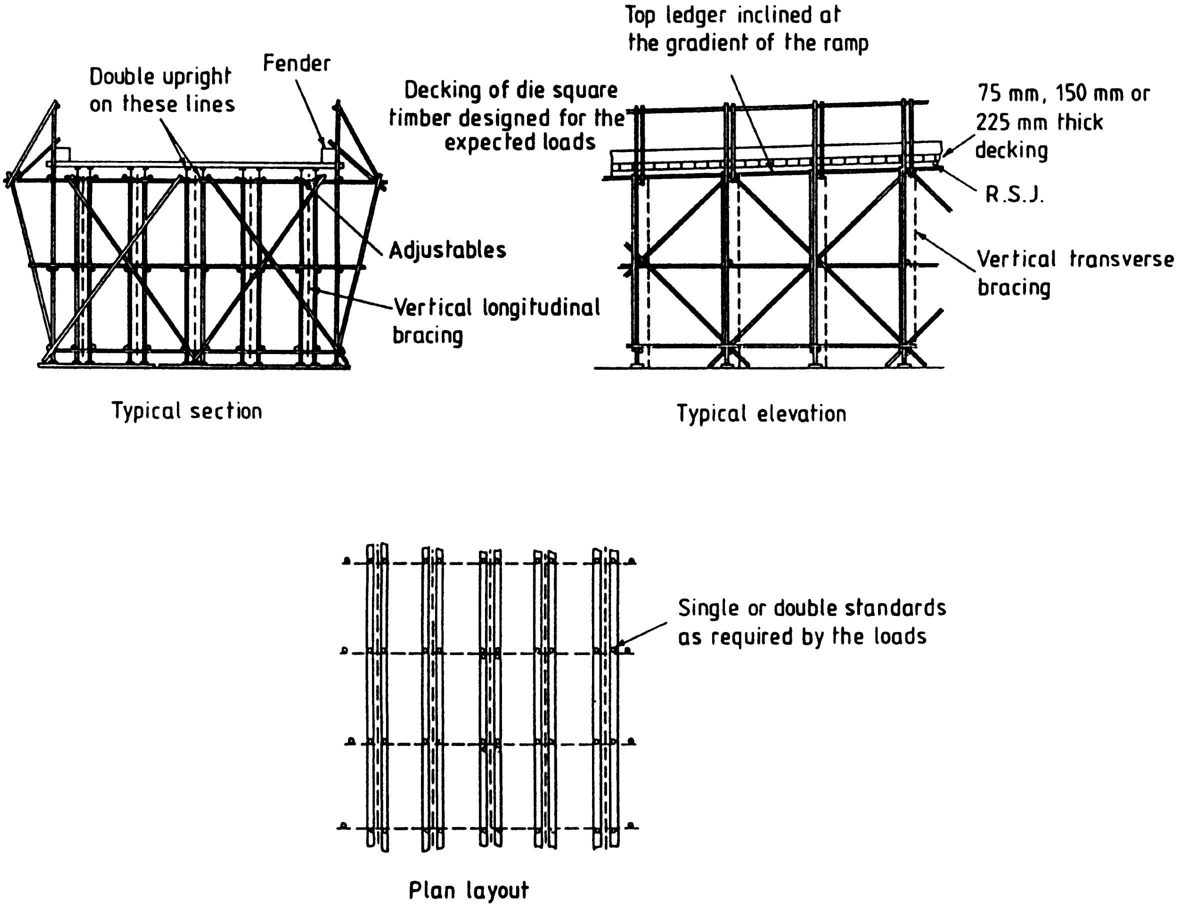


Figure 28 — Typical vehicle ramp

An allowance should be made for impact loads of 25 % above the vehicle weight and payloads. Horizontal surge of 33 % of the total weight of the largest vehicle and payload should be allowed for.

The loads on the fender should generally be taken by the fixings of the longitudinal timbers to the decking and these should be capable of resisting a load of 1.50 kN/m for small vehicles and up to 4.50 kN/m for large construction traffic.

The inclined reaction from loads moving on the slope of ramps and inclines should be taken into account. The bottom of steep ramps should be concreted into a solid foundation to deal with the down slope reaction.

Notices giving maximum permitted vehicle weights and the number of vehicles allowed at any one time should be fixed at each end of elevated roadways and vehicle ramps.

33.4 Decking and slopes

Decking members should be transverse and may be supported on longitudinal timber or steel primary beams. The ends of the decking members should be so placed that wheel loads are not applied at the ends and thus not distributed. On slopes, the decking should be anchored to the structure approximately every 7.5 m so as to avoid an accumulating force down the slope.

Timber members should be in good condition and of a quality suitable for withstanding the stresses calculated from the applied loads.

Pedestrian walkways should be separated from vehicle lanes. Toeboards, guardrails and mesh screens should be provided on pedestrian lanes.

The slope of a pedestrian ramp should preferably not exceed 1 vertical to 12 horizontal and in no case should it exceed 1 vertical to 8 horizontal. Ramps on construction sites should not exceed 1 vertical to 6 horizontal, but there may be cases where this is unavoidable and in such cases, when the slope exceeds 1 vertical to 4 horizontal, foothold lathes should be provided at intervals of 300 mm to 450 mm.

33.5 Foundations

Special sole plates may be required and for vehicle ramps they should generally be at least 75 mm thick. The ground-bearing capacity should be assessed and remedial treatment carried out if necessary.

33.6 Longitudinal beams

Generally longitudinal beams should be of steel but timber may be used. The design stresses should be in accordance with BS 449 or BS 5268 respectively.

The beams should rest on forkheads and be wedged to apply their loads coaxially on to the standards.

33.7 Standards

Standards should be vertical irrespective of the slope of the ramp. Multiple standards should be constructed by grouping scaffold tubes into columns, laced and braced as necessary. Every tube should be pitched on its own base plate and, if necessary, on a sole plate. The columns should also be laced together.

The standards should be of appropriate length and surmounted by the forkhead in such a manner that they are able to receive axial loads. Adjustable forkheads or extending legs may be used.

In the case of a ramp or sloping or cross falling deck, the beams should be wedged and packed to give full bearing to the timber and axial load to the standard. Wedges and packing should be nailed into place so that they will not be dislodged by vibration.

33.8 Ledgers and transoms

Ledgers and transoms should be fixed to the standard with right angle couplers at such lift heights as are required to give the necessary load carrying capacity in the standards.

33.9 Foot ties and head ties

The foot ties should be parallel to the ground, which may be sloping, and head ties should be parallel to the decking. The ledger or the transom may be fixed to each other instead of to the standards.

Where steps are necessary at the foot or the head, no standard should be without ties in the two main directions.

33.10 Bracing

Both longitudinal and transverse bracing should be present, usually on every line of standards. The bracing should be capable of catering for the loads referred to in **33.3**.

Where an adjustable forkhead or an adjustable leg has been used, forkhead bracing in both directions should be fixed where necessary.

Plan bracing should be fixed if required.

33.11 Tying and butting

When possible, the structure should be tied into adjacent structures and locked into the earthworks or concrete at each end. At the lower end it is preferable to butt the decking into a concrete starter ramp.

33.12 Through access ways

Through access ways under the deck and clear spans within the structure should be avoided if possible.

34 Masts, lighting towers and transmission towers

34.1 General

Masts, lighting towers and transmission towers are constructed in the same way as fixed external towers, but usually differ in the height to base ratio for which values up to 30 are sometimes required by local circumstances.

Some of the special requirements which should be taken into consideration in design are given in **34.2** to **34.10**.

34.2 Loading

The vertical loading and self weight may be less significant than the loads resulting from wind and other horizontal forces.

Large overturning moments are usually encountered which result in large loads in the legs, both in tension and in compression. The lift heights should be determined to accommodate the thrust in the legs. The strength of the joints on the tension side of the structure may be the limiting factor to the height and exposure to wind.

Wind loads should be calculated in accordance with **39.10**.

34.3 Foundations

The foundations should be designed to resist the forces and moments transmitted to them from the tower. Where guys are provided, allowance should be made for flexing of the tower before the guys take up their load.

Driven tubes or similar anchors embedded in the ground may not be adequate on their own. To improve the restraint provided by the anchors they may be embedded in a concrete foundation block. Alternatively, it may be necessary to embed the whole of the lowest level of lacing tubes in order to provide adequate stability.

34.4 Guys

Guys and appropriate anchorages are often needed and should be in accordance with **28.9**. The vertical forces in the standards resulting from the guy tensions should be taken into account.

34.5 Standards

The joints in standards should be by sleeve couplers, lapped or secured by shear pins, where necessary.

34.6 Ledgers and transoms

Ledgers and transoms of unboarded lifts should be fixed to the uprights with right angle couplers.

Transoms on boarded lifts may be fixed to the ledgers.

34.7 Bracing

Zig zag bracing and in some cases cross bracing to all faces should be fixed to the extended ledgers and transoms by right angle couplers.

The forces in the bracing, particularly in the lower lifts, may be in excess of the safe working load of the right angle couplers, in which case supplementary couplers or shear pins should be used at each end of the braces.

34.8 Sheeting

Sheeting should not be used unless the forces on it have been taken into account in the calculations. The vertical surface area of all attachments should be kept to a minimum.

It is preferable that, after fixing the equipment which the tower supports, the boarded decks and ladders and any vertical sheeting are removed for the life of the tower.

34.9 Icing

In exposed locations, the effect of the accumulation of ice on towers and long guys should be taken into account. Steps should be taken to prevent water accumulating inside the tubes.

34.10 Access

Access may be provided by ladders built into the mast with landings in accordance with clause **15**.

35 Lifting gantries

35.1 General

Figure 29 shows a typical lifting gantry constructed from scaffold materials. The load is lifted between the two scaffold towers which are held and kept apart by the cross head carrying the lifting beam. Cantilever lifting gantries should be avoided if possible. All lifting gantries should be the subject of design and calculation.

A lifting gantry is usually a free standing structure and the design should ensure that it is stable in use. It may be used for a fixed lifting point or as a continuous runway. The safe working load should be displayed.

35.2 Loading

The towers and the cross head should be capable of carrying the lifted load and the moments and surges resulting from it. Consideration should be given to the horizontal and vertical impact loads.

35.3 Cross head

The cross head may consist of a prefabricated beam or a built up beam of scaffold materials. In either case the height of the towers should be such that rakers to the cross head can be installed.

Multiple tube cross heads, consisting of two or more transoms side by side, may be used. Alternatively, two tubes mounted in parallel one above the other may be suitable.

The lifting gear mounted on the cross head should comply with the statutory regulations relating to it (see clause **5**).

35.4 Towers

The standards should be vertical, pitched on base plates and prevented from being vibrated off them.

The ledgers and transoms should be fixed to the standards with right angle couplers at lift heights which are determined by the load-carrying capacity of the standards.

The design of the standards should take into account the fact that a large percentage of the load in each tower will be carried by the inside leg.

35.5 Traffic fenders

Traffic fenders should be installed between the towers when lorries are to use the gantry.

35.6 Bracing

The towers should be fully braced. Bracing is usually required on every pair of standards.

When the forces in the raker and the ledger bracing in the tower demand it, the necessary check couplers should be installed.

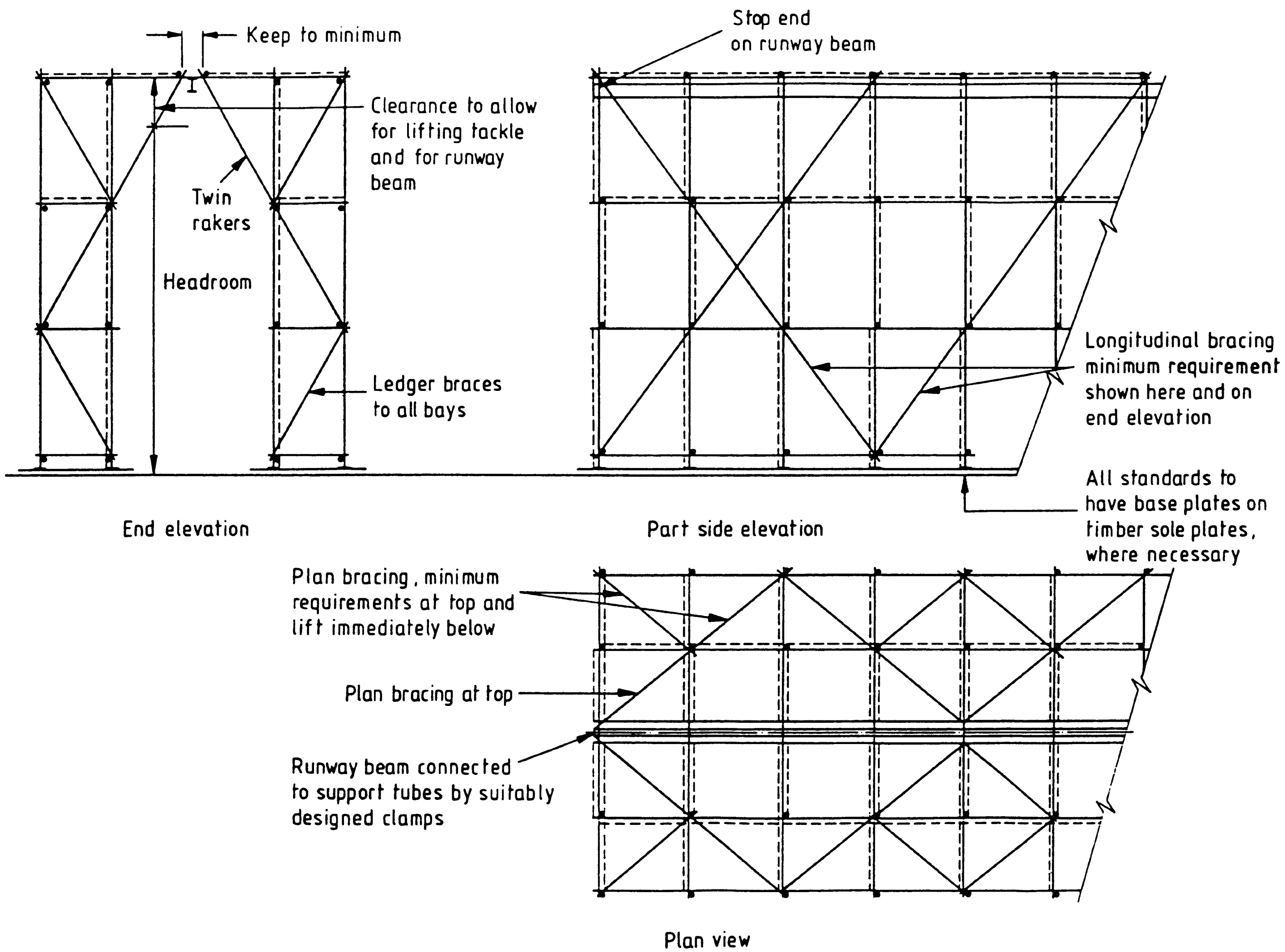


Figure 29 — Typical lifting gantry

When there is a likelihood of transverse surge, the tower ledger bracing may be extended outwards to form a buttress with extended transom foot ties.

36 Temporary buildings and temporary roofs

36.1 General

A temporary building is a sheeted structure designed to provide cover for an area. It may stand on the ground or on top of a building or be an extension of a scaffold round a building. It may have fully sheeted walls and roof or only a roof or a roof with skirts.

The application of this standard is limited to temporary buildings and temporary roofs which do not exceed the following dimensions:

a) 10 m in total height;

b) 6 m between the top and the highest point of tying to the permanent structure;

c) 20 m roof span between the support structures disregarding knee braces.

Beyond any of these limits specialist advice should be sought, in particular because of the risks associated with wind induced deflection and vibration.

Standard scaffolding materials and prefabricated frames may be used for the walls and scaffold tube trusses or prefabricated trusses or beams for the roof. Sheeting rails and purlins are added to support the sheeting.

Roofing clips or sheeting clips should not be used for fixing corrugated sheeting unless other means are used to prevent outward movement.

36.2 Loading

36.2.1 *Self weight*

The self weight is the mass of the structural framework and its covering.

NOTE Some details on the mass of corrugated sheeting are given in **39.3.2**.

36.2.2 *Wind load*

The wind forces on the walls and roof should be as given in CP 3: Chapter V-2. Particular attention should be given to increased local pressures (for example near the perimeter of the roof) which may occur.

36.2.3 *Snow load*

In appropriate conditions because of short duration for which temporary buildings/roofs are erected snow loads may be ignored. For long durations and special conditions the loading should be assessed in accordance with BS 6399-3.

36.2.4 *Imposed load*

The imposed load due to operatives working during erection and dismantling should be taken as 0.375 kN/m^2.

36.2.5 *Loading combinations*

The designer should consider which of the applied loads will occur within the lifetime of the structure and the probability of any of combination these loads occurring at the same time.

36.3 Type and design of structure

The layout of the structure should be such that there is a well defined system for transferring the loads to the ground. When the form of the design has been chosen, the various structural elements and joints should be designed and constructed so that the elements themselves and the rigidity of the joints between them are adequate for their purposes and are used in accordance with the manufacturer's recommendations.

The assembly as a whole should be stable against side sway due to wind forces with a factor of safety of 1.5 and against overturning with a factor of safety of 1.2. Wind loads should be calculated in accordance with **39.10**.

The cross fall of roofs should be not less than 5°. The lateral thrusts derived from arched or ridged roofs should be taken into consideration in the design and construction. In the case of steeper ridged roofs, this thrust should be taken by ties designed and inserted for this purpose.

The load resulting from transverse wind forces may be taken account of by the incorporation of suitably stiff framing and a means for transferring the local wind loading to it.

The overturning of the structure as a whole may be prevented by ground anchors or kentledge round the perimeter or by guys and anchors (see **28.9**).

If forces in knee bracing and in braces to tube and fittings trusses are too large to be resisted by one coupler, the necessary supplementary couplers should be added or the fittings pinned with shear pins. When couplers interfere with the sheeting, a secondary rafter and raised purlins should be added above the truss to carry the sheeting.

Longitudinal bracing should be inserted in the long walls and transverse bracing in the end walls or end gable. Plan bracing should be inserted in the roof.

When the temporary building is an extension to an access scaffolding, the bracing and tying of this access scaffold should be supplemented as necessary. The effect of the horizontal forces on the walls of the building should be considered.

When a temporary building or roof is constructed on the top of an existing building the necessary anchor points should be suitable to resist the loads imposed upon them.

36.4 Sheeting

The usual types of sheeting employed for temporary buildings are as follows:

a) corrugated steel or corrugated aluminium;

b) asbestos cement;

c) rigid plastics;

d) plywood;

e) tarpaulins;

f) flexible plastics;

g) flexible plastics covered panels.

The gauge thickness of corrugated steel sheeting should be chosen after consideration of the durability required. A thickness of 26 gauge is recommended only for short term requirements, when the sheeting is not to be re-used. For normal use the recommended sheeting is 22 gauge or 24 gauge thicknesses (see Table 8).

A load of 0.9 kN on any square with a 125 mm side allows for loads incidental to erection and dismantling on rigid roof coverings.

The attention of the designer is drawn to the undesirable sagging which occurs in flexible plastics sheeting and tarpaulins used for roof covering. Special fixings may be required.

For structures with a very limited life, e.g. at sports arenas and exhibitions, fixing cords of known breaking strength may be used with flexible sheeting to cater for excessive gust wind speeds.

For welding screens and other places where there is a fire hazard, corrugated steel sheeting should be used.

Asbestos cement sheeting is easily broken and may not be suitable for more than one use. Where it is used, warning notices should be displayed. Where persons are working on such a roof, crawling boards should be used. Some other materials are also fragile. Special attention should be paid to the fixing of perimeter sheeting.

The roof drainage arrangements should be agreed between the designer and the user. Gutters should have a fall of not less than 1 vertical to 100 horizontal. The rain water pipes should be in agreed locations and tied securely to the structure.

37 Spectator terraces and seating stands

37.1 General

Spectator terraces and seating stands form temporary accommodation for spectators and can be classified into standing terraces and seating stands. Either type may be covered or open. They are essentially stepped platforms of boards or special components resting on a tubular framework. The going and the rise are dimensions which should be determined.

For seating stands, the seats may be separate or in bench form and the space allocation per seat should be determined.

There are many prefabricated units available which will facilitate modular construction. These units may be used on a base framework of tube and fittings or on prefabricated scaffold frames.

NOTE Attention is drawn to the Institution of Structural Engineers publication "Safety considerations for the design and erection of demountable grandstands"[6] (May 1989).

37.2 Loading

The loadings adopted in calculations for the platform should be in accordance with Table 5. For further information concerning loadings for protective barriers such as hand rails, reference should be made to BS 6180.

Wind loading should also be considered, with reference to the recommendations of CP 3: Chapter V-2.

Table 5 — Loadings for show stands and places of assembly

Structure	Loading
	kN/m²
Show stands (sitting accommodation)	4.00
Show stands (standing accommodation)	5.00
Access corridors, stairs and ramps	5.00

37.3 Guys and anchors

When the stand is covered and subject to large wind forces, guys and anchors may be required. These should be adequate to withstand the calculated forces, especially the force of the wind entering the stand from the front and being impeded by both the roof and the rear wall skirt.

[6] Available from the Institution of Structural Engineers, 11 Upper Belgrave Street, London SW1X 8BH.

On sloping ground, the framework should be secured against slipping down the slope. Driven tube anchors in crossed pairs coupled to the foot ties at suitable intervals will usually suffice. These foot tie anchors should be adequate to cater for the forces from the wind coming from the rear of the stand and being impeded by the stepped deck. Any anchors and guys used should be constructed in accordance with **28.9**.

37.4 Foundations

Sole plates should be used for foundations and on sloping ground these should be dug in flat. On uneven ground, individual short sole plates may be used.

37.5 Standards

Standards should be pitched on base plates and be of such a length that they do not protrude through the decking at the top.

37.6 Ledgers and transoms

Ledgers and transoms should be fixed to the standards with right angle couplers, except for the foot lift and the top lift on which the transoms may be fixed to the ledgers.

A foot lift should always be fixed and this may be inclined on sloping ground.

37.7 Bracing

Spectator stands are subject to large horizontal surges in addition to wind forces. Bracing should be provided in both directions to accommodate 10 % of the vertical imposed load in addition to the wind load. The bracing should be fixed to the ledgers and transoms with right angle couplers, at one level whenever possible, and should be fixed to the foot lift.

37.8 Decking

The decking may be of special units or of scaffold boards, in which case they should be supported in accordance with clause **15**.

Steps in corridors between seats or terraced stands should preferably have a rise between 100 mm and 250 mm and should all be of constant height.

Landings, horizontal areas and access bridges should be fitted with guardrails and toeboards. At the ends of the stands, guardrails with intermediate rails or other protection should be provided to give a maximum vertical gap of not more than 500 mm.

The decking and seats should be of smooth clean timber or other suitable material which will not cause a hazard. The grouping and spacing of seats should comply with the requirements of the appropriate authority.

37.9 Couplers and fittings

Couplers and fittings should be clean and free from burrs and paint which might injure persons or damage clothing.

38 Temporary storage on site

38.1 General

Racking for the storage of goods or of building or scaffolding materials is usually designed and constructed in the form of a birdcage of scaffold tube with bay lengths and lift heights suitable to the size and nature of the goods to be stored.

38.2 Loading

The weight and quantity of the goods to be stored should be agreed with the user.

The weight stored in any bay should preferably be less than the amount which would overload single fittings so that multiplicity of supplementary couplers is avoided.

To allow for impact, an additional factor of 25 % should be allowed on the maximum individual load to be deposited.

The design should take account of the wind force on the racking, including any sheeting cover, and its contents.

38.3 Foundations

Because of the heavy loads frequently occurring in racking, the foundations should be specially designed. Suitable sole plates should always be used except on a concrete base.

38.4 Standards

The standards should pitched on base plates and not deviate from the vertical by more than 5 mm in 3 m.

38.5 Ledgers and transoms

The tubes which are parallel to the front of the rack receive the weight of the goods stored and therefore should be above the tubes running from front to back so that the fittings on these latter tubes will act as supplementary couplers.

Both the ledgers and transoms should be fixed directly to the standards with right angle couplers. Supplementary fittings may be required.

38.6 Bracing

Bracing should be fixed in two directions in a quantity which will be adequate to resist impact and be commensurate with the method of loading. It should be able to withstand at least 5 % of the load capacity of the rack. Where it is impossible to place it across the face of the rack, it should be concentrated in particular bays, e.g. every tenth.

38.7 Plan bracing

Plan bracing is particularly important in racking because of the impacts during loading and unloading. It is recommended that plan braces be inserted at vertical intervals of approximately 3 m.

38.8 Fenders

Where mechanical loading is to be used, the provision of fenders and bollards at the appropriate places should be agreed with the user.

38.9 Attachment of racking to other structures

Racking should generally be in small units separated by access corridors. Each unit should be tied to a permanent structure, if this can be arranged and agreed with the user.

38.10 Slab and post racks

Racks for storing slabs on edge, e.g. pre-cast concrete facing slabs for buildings, or columns or posts vertically, should preferably be designed so that the material stored remains vertical and cannot be placed inclined against the rack. The ends of the rack should be fenced off so that goods cannot be stored leaning on the end.

38.11 Racking roofs

Racking installations are frequently used for supporting temporary roofs to cover the storage area. The combination of wind forces, the roof self weight and the weight of the stored material usually results in high loads in both the vertical and horizontal directions. Proper account should be taken of these loads.

Section 6. Structural calculations for scaffolds

39 Technical data and notes on calculation

39.1 General

The following technical data are applicable to the material and construction of all those access scaffolds in which the main structural tubing is steel tube complying with the requirements of BS 1139. Some data are also provided in appendix D for aluminium tube complying with BS 1139. Some guidance on design calculations is given.

Where appropriate values are not given in this code, the masses given in BS 648 and the imposed loads given in BS 6399-1 and BS 6399-3 should be used. Data for some commonly used materials are given below.

39.2 Loading

Typical loadings caused by typical site activities are given in Table 1. When these are not appropriate a direct assessment should be made.

39.3 Mass of materials

39.3.1 ***Scaffolding materials***

The mass of various scaffolding materials is given in Table 6.

Table 7 gives the mass of larger quantities of various scaffolding materials.

39.3.2 ***Mass of corrugated steel sheeting for roofs and temporary buildings***

Table 8 gives the mass of sheeting to be allowed for in design of temporary structures. It can be used to determine the nominal mass for any particular length of sheet, or the length for any particular mass of sheet(s). When calculating the mass, as laid, allowance should be made for the amount of overlap of the sheets and the additional mass of the fittings.

39.3.3 ***Mass of men and materials***

The mass of men and various materials is given in Table 9.

39.3.4 ***Some unusual loads which frequently require consideration***

Accumulation of debris from demolition on boarded decks, flue cleaning or boiler scaling has a density of 1 600 kg/m^3.

A covering of ice of about 20 mm on a scaffold tube adds about 5.0 kg/m to the mass of the tube.

Concrete spillage on the top of the ledgers adds about 1.5 kg/m to the mass of the tube.

Table 6 — Mass of scaffolding materials

Scaffolding materials	Mass
Steel scaffold tube, 48.3 mm diameter	4.37 kg/m
Steel couplers and fittings	1.00 kg to 2.25 kg
Boards	
38 mm thick, 225 mm wide	6 kg/m or 25 kg/m^2
50 mm thick, 225 mm wide	8 kg/m or 33 kg/m^2
63 mm thick, 225 mm wide	10 kg/m or 41 kg/m^2

39.3.5 ***Stored materials***

Clauses **23**, **24** and **38** deal with special loading for the storage of materials. The mass of all the materials to be placed on a scaffold should be assessed to check if the load ratings recommended in clauses **23**, **24** and **38** are satisfied.

It is generally preferable to construct special loading bays for material storage.

39.4 Mass of lifts, one bay long, in an independent tied scaffold

39.4.1 ***General***

The mass of those lifts with bay lengths in accordance with Table 1 are given in **39.4.2** and **39.4.3**. The mass of other bay sizes carrying other masses should be calculated from the data given in **39.3**. The weight of the mass quoted is supported on two standards.

39.4.2 ***Unboarded lifts***

Table 10 gives the mass of one lift of an unboarded scaffold, taking into account two standards of lift height, two ledgers and two or more 1.5 m transoms, a portion of the ledger bracing, a portion of the longitudinal bracing and a portion of the ties and the fittings.

Table 7 — Mass of quantities of scaffolding materials

Mass	Length of steel tube	Approximate number of steel fittings (average 1.8 kg)	Number of boards (38 mm × 225 mm of length 3.9 m)
tonne	m		
1	228	560	46
2	457	1 120	92
3	685	1 680	138
4	915	2 240	184
5	1 143	2 800	230
7	1 600	3 920	322
10	2 286	5 600	460
15	3 430	8 400	690
20	4 570	11 200	920
25	5 720	14 000	1 150

Table 8 — Mass of corrugated steel sheeting

Standard thickness	Approximate equivalent Standard Gauge	Number of corrugations (nominal cover width is given in parentheses[a])									
		8/3 (610 mm)		10/3 (762 mm)		10½/3 (800 mm)		12/3 (914 mm)		12½/3 (952 mm)	
mm		kg/m	m/tonne	kg/m	m/tonne	kg/m	m/tonne	kg/m	m/tonne	kg/m	m/tonne
0.425		2.50	400	3.05	328	3.18	315	3.59	278	3.80	263
0.50	26	2.94	341	3.59	279	3.74	267	4.23	236	4.47	224
0.60	24	3.52	284	4.31	232	4.49	223	5.07	197	5.36	187
0.70	22	4.11	243	5.02	199	5.23	191	5.92	169	6.25	160
0.80		4.70	213	5.74	174	5.98	167	6.77	148	7.15	140
0.90		5.28	192	6.45	156	6.73	151	7.61	133	8.04	126
1.00	20	5.87	170	7.17	139	7.48	134	8.46	118	8.93	112
1.20	18	7.05	142	8.61	116	8.97	111	10.15	99	10.72	93
1.60		9.40	106	11.48	87	11.96	84	13.53	74	14.29	70
2.00		11.75	85	14.35	70	14.95	67	16.92	59	17.87	56

[a] The nominal width is the width of the sheeting after manufacture and is subject to manufacturing tolerances.

39.4.3 ***Boarded lifts***

The values given in Table 11 do not include the mass of the scaffold, which is given in Table 10. It takes into account the additional mass of the boards, the toeboard, the guardrail and fittings and the working mass on the lift (cf. **39.9.1**).

Table 9 — Mass of men and materials

Item	Mass
Man (average)	80 kg
Man with small tools (average)	90 kg
Spot board and mortar	30 kg
Wheelbarrow full of mortar	150 kg
Tarpaulins and fixings	1 kg/m^2
Ladders and fixings	8 kg/m
100 bricks	275 kg
Timber (softwood)	500 kg/m^3 to 650 kg/m^3
180 litres of water or liquids in containers	200 kg
Packaged flooring tiles, ceramic tiles, roofing tiles, slates	1 600 kg/m^3
Timber scaffold poles butt end top end	 5.8 kg/m 1.9 kg/m

Table 10 — Mass of an unboarded lift one bay long

Lift height	Length of bay (m)						
	1.2	1.5	1.8	2.0	2.1	2.4	2.7
	Mass of unboarded lift						
m	kg	kg	kg	kg	kg	kg	kg
1.2	61	63	66	68	69	71	74
1.37	62	65	67	69	70	73	75
1.5	63	66	69	70	71	74	77
1.8	66	69	71	73	74	77	79
2.0	68	70	73	75	76	78	81
2.1	69	71	74	76	77	79	82
2.4	71	74	77	78	79	82	85
2.7	74	77	79	81	82	85	87

39.5 Section properties of scaffold tubes

The data given in Table 12 apply to tubes in the as new condition.

For data appropriate to steel tubes that are not covered by BS 1139 but which are nevertheless occasionally incorporated in scaffolding structures, reference should be made to BS 4360 and BS 4848-2.

39.6 Strength of scaffold boards and other timber members

39.6.1 ***Scaffold boards***

In some circumstances the strength of scaffold boards may be brought into play to contribute to the structural strength of the tubular framework.

This is admissible, provided that the necessary calculations and design have been carried out. Table 13(a) gives some data for scaffold boards.

When boards are used on edge as transoms, they should be maintained on edge by scaffold fittings and, if necessary, tubes.

The utilizations of the strength of a board on flat does not permit the omission of transoms supporting the boards at a maximum spacing in accordance with Table 3.

Table 11 — Extra mass of a boarded lift (with imposed loads) one bay long

Width of scaffold	Loading	Length of bay (m)						
		1.2	1.5	1.8	2.0	2.1	2.4	2.7
		Extra mass of boarded lift						
	kN/m²	kg	kg	kg	kg	kg	kg	kg
3 boards[a]	0.75	111	134	158	174	182	205	229
4 boards[a]	0.75	139	168	202	220	230	261	291
4 boards[a]	1.50	221	271	327	357	374	426	476
4 boards[a]	2.00	276	339	410	450	470	536	600
5 boards[a]	0.75	166	202	240	265	277	315	352
5 boards[a]	1.50	269	331	393	437	456	521	583
5 boards[a]	2.00	337	416	496	552	576	658	737
5 boards[a]	2.50	405	501	599	667	695	795	891
5 boards[a]	3.00	466	579	681	757	803	917	1 031
6 boards[a]	2.00	398	493	589	657	686	781	877
6 boards[a]	2.50	480	595	711	791	830	946	1 062
6 boards[a]	3.00	562	696	834	927	974	1 110	1 247

[a] Boards of 225 mm width × 38 mm thickness.

39.6.2 ***Other sections of timber***

Table 13(b) gives the moduli of section and the working moments of resistance of timber sections which are frequently used in scaffolding particularly in suspended and slung scaffolds and in spanning trenches with sole plates.

39.7 Vertical loading of scaffolds and height limitations

39.7.1 ***General***

Vertical components have to support both the loads applied to the platforms and the self weight of the scaffold itself. Their strength depends on the length of individual sections of standard between points of lateral support, the fixity, continuity and straightness of the standards and the way the couplers transfer their loads, none of which are known with certainty. Loads can seldom be predicted precisely and a scaffold's available capacity is reduced by the need to carry its own weight.

In addition, the scaffold's structure as a whole will probably not be constructed precisely to the patterns chosen. For these reasons precise design is not possible and guidance on the approach to adopt is given in **39.7.2** and **39.7.7**.

39.7.2 ***Permissible stresses P_c on the gross section for axial compression***

Using the procedure given in BS 449-2, values may be calculated for various slenderness ratios. The effective length between supports, l, is divided by the radius of gyration, r, to give a slenderness ratio l/r. Table 14 (see note) gives corresponding values of P_c, permissible working stress, for various values of l/r. Column three of Table 14 gives stresses for as new tube in accordance with BS 1139 and column five gives stresses for the same tube with a corrosion allowance. This latter value should be used unless it is known that tubes in better condition will be used. Depending on the fixity of individual tubes, the effective length may not be equal to the actual length and the slenderness ratio should be modified accordingly (see appendix C).

NOTE As tube complying with BS 1139-1:1982 is likely to be available for some time yet the strength values are given in Table 14 for tube manufactured to both the 1982 and 1990 editions of the standard.

39.7.2.1 *Derivation and source of permissible stresses*

The permissible stresses for steel tube are based on the following Perry-Robertson formula as it is given in appendix B of BS 449-2:1969.

$$K_2 \times P_c = \frac{Y_s + (\eta + 1)C_o}{2} - \sqrt{\left[\left\{\frac{Y_s + (\eta + 1)C_o}{2}\right\}^2 - Y_s \times C_o\right]}$$

where

- P_c is the permissible average stress (in N/mm^2)
- K_2 is a coefficient to allow for lack of straightness in addition to η, together with lack of square ends and some corrosion (taken as 2 to calculate the values given column 5 of Table 14)
- Y_s is the minimum yield stress (in N/mm^2)
- C_o is the Euler critical stress in (N/mm^2)

$$C_o = \frac{\pi^2 E}{(l/r)^2} = \pi^2 \frac{210\ 000}{(l/r)^2}$$

- η $= 0.3 \left[\frac{l}{100r}\right]^2$
- l is the effective length (in m)
- r is the effective radius of gyration (in m)
- l/r is the slenderness ratio.

39.7.3 ***Maximum allowable compressive loads imposed on standards***

Table 14 gives safe working loads for tubes which are supported at the centres stated. Unless it is known that steel scaffold tubing is in as new condition, the figures in column 6 of Table 14, which includes a corrosion factor of 15 % should be used. Where the effective length is not equal to the actual length, an appropriate stress should be adopted from Table 14 and the load capacity calculated. For tall scaffolds, a futher modification will be required (see **39.7.6**).

39.7.4 ***Doubling the standards***

Where it is necessary to include additional (double) standards to achieve the desired height, care should be taken that the loads are evenly distributed. Each standard should then be assumed to carry an equal proportion of the load.

39.7.5 ***Uneven or off centre loading***

Where the imposed load is not evenly distributed over the platform, for instance where bricks are stacked on the outside of the scaffold, the working platform may be considered to be loaded so that $\frac{2}{3}$ of the extra mass, w, is on the outside ledger and the remainder on the inside ledger. The weight of the boards and the operatives using the inside of the platform should be taken into account.

The scaffold height should then be calculated on the basis of a hypothetical distributed mass of

$2 \times \frac{2}{3} w$, i.e. $1\frac{1}{3}w$.

Where the load distribution differs from that assumed above, a different factor may need to be applied (cf. **39.9.2.2**).

Where fans and cantilevered loading bays are attached to the outside of a scaffold, these should be taken into account and it may be necessary to calculate the load distribution for each standard separately.

39.7.6 ***Maximum heights of scaffolds***

Scaffolds are not always built to proper tolerances, nor are they always properly tied to the structure which they are serving. These errors in construction are cumulative. In addition, there is frequently a considerable abuse of scaffolds both by local overloading and by wrongful removal of ties and braces.

The problems due to abuse and deviations generally increases as the size, especially the height, of a scaffold increases. Frequently the consequences of failure also increase with increased height.

It has been found desirable in practice to limit the height to which the scaffolds can be built by applying a suitable safety coefficient, unless specific calculations have been carried out (but see **8.5**).

This safety coefficient should be applied to the calculated heights to reduce it to a lesser value, which will be the recommended height on the construction site.

Table 12 — Section properties of scaffold tubes

Type of tube	Outer diameter	Nominal wall thickness	Mass per linear m	Cross-sectional area (*A*)	Moment of inertia (*I*)	Modulus of elasticity *E*	Elastic modulus *z*	Radius of gyration *r*	Minimum yield strength	Maximum allowable stress in bending P_{bc}	Maximum allowable stress in axial compression P_c	Maximum allowable shear stress	Maximum allowable stress in axial tension P_t	Stiffness *EI*
	mm	mm	kg/m	cm^2	cm^4	N/mm^2	cm^3	cm	N/mm^2	N/mm^2	N/mm^2	N/mm^2	N/mm^2	N/mm^2
Steel tube complying with the requirements of BS 1139														
Part 1:1982	48.3 ± 0.5	4.0	4.37[b]	5.57	13.8	210 000	5.70	1.57	210	139[a]	See Table 14	93	127	$2\ 898 \times 10^7$
Part 1: Section 1.1: 1990	48.3 ± 0.5	4.0	4.37[b]	5.57	13.8	210 000	5.70	1.57	235	155		104	142	$2\ 899 \times 10^7$

[a] In the cases where tube may require the application of an allowance for corrosion, P_{bc} should be limited to 125 N/mm^2 for tubes having a yield stress of 210 N/mm^2 and 139 N/mm^2 for tubes having a yield stress of 235 N/mm^2.

[b] Tolerances are $^{+12.0}_{-8.0}$ % on single tubes and ±7.5 % on batches (10 tonnes or more).

Table 13(a) — Properties of scaffold boards[a]

Basic cross-sectional size[b]	Minimum section modulus	Working moment of resistance
mm	cm^3	N·m
38 × 225	47.5	468
50 × 225	81.0	798
63 × 225	132.0	1 300

[a] Based on a maximum working stress of 9.85 N/mm^2.
[b] Boards used on flat.

Table 13(b) — Properties of timber[a] other than scaffold boards

Basic cross-sectional size	Minimum section modulus	Working moment of resistance
mm	cm^3	N·m
50 × 100		
on flat	41.6	286
on edge	83.2	572
75 × 150		
on flat	140.6	965
on edge	281.2	1 930
75 × 228		
on flat	213.7	1 467
on edge	649.6	4 460
150 × 300		
on flat	1 125	7 723
on edge	2 250	15 446

[a] Based on a maximum working stress of 6.86 N/mm^2.

This safety coefficient is related to the height of the scaffold, and the recommended value for this factor, C, is determined as follows.

$$C = 1 + \frac{h}{a}$$

where

h is the calculated maximum height of the scaffold based on the attainment of maximum allowable stresses in the standards (in m)

a is a constant length of 200 m.

This factor is an arbitrary divider and, in addition to the factor of safety, is normally applied to the yield stress of the steel to obtain the allowable stresses. Table 16 gives some values of the safety coefficient for various calculated heights and the resulting reduced heights for typical practical construction. It is not possible to apply these safety coefficients directly to the self weights, loads or allowable stresses, since these values are required without modification for the design of beams, bracing, joints etc.

Table 14 — Maximum permissible axial stresses and loads in steel scaffold tubes manufactured in accordance with BS 1139-1.1:1990 with a yield stress of 235 N/mm^2

Effective length *l*	Slenderness ratio *l/r*	"Used" tubes		"As new" tubes	
		Permissible axial compressive stress P_c	Permissible axial load	Permissible axial compressive stress P_c	Permissible axial load
mm		N/mm²	kN	N/mm²	kN
0					
250	15.9	116.6	70.0	137.2	76.4
500	31.8	113.6	63.3	133.7	74.5
750	47.8	107.8	60.1	126.9	70.7
1 000	63.7	98.1	54.7	115.4	64.3
1 250	79.6	84.4	47.0	99.2	55.3
1 500	95.5	69.1	38.5	81.3	45.3
1 750	111.5	55.5	30.9	65.3	36.4
2 000	127.4	44.7	24.9	52.6	29.3
2 250	143.3	36.5	20.3	42.9	23.9
2 500	159.2	30.1	16.8	35.5	19.8
2 750	175.2	25.26	14.1	29.7	16.6
3 000	191.1	21.4	11.9	25.2	14.1
3 250	207.0	18.4	10.3	21.7	12.1
3 500	222.9	16.0	8.9	18.8	10.5
3 750	238.8	14.0	7.8	16.4	9.2
4 000	254.8	12.3	6.9	14.5	8.1
4 250	270.7	11.0	6.1	12.9	7.2
4 500	286.6	9.8	5.5	11.5	6.4
4 750	302.5	8.8	4.9	10.4	5.8
5 000	318.5	8.0	4.4	9.4	5.2
5 250	334.4	7.2	4.0	8.5	4.7
5 500	350.3	6.6	3.7	7.8	4.3
5 750	366.2	6.0	3.4	7.1	4.0
6 000	382.2	5.6	3.1	6.5	3.6

NOTE 1 It is recommended that, for columns carrying dead and imposed loads, l/r < 207.
NOTE 2 For struts and braces intended to carry wind loads and lateral forces, l/r < 271.
NOTE 3 For members designed as ties but which may suffer reversals of loading, l/r < 383.
NOTE 4 Where there is combined bending and axial compression, treat as for combined stresses in BS 449, using the appropriate value of l/r and stress from Table 14.
NOTE 5 For tube complying with BS 1139-1:1982, see appendix E for equivalent data.

Table 15 — *Deleted*

39.7.7 *Calculation of the height of scaffolds*

For the purpose of calculation of scaffold height, a lift is initially considered as being supported by the full load-carrying capacity of only two standards, as in practice the load-carrying capacity of the four standards in the lift of an independent tied scaffold is shared by the lifts on either side of the more central lift thus effectively halving the capacity available to each lift. The method (known as the strut buckling method) used for the calculation for steel scaffolds is as follows.

a) The number, size and loading of the working platforms and the lift height are chosen. Assume the lift height or strut length to be the basic length of the standard or strut, ignoring the beneficial effects of end fixity and continuity, i.e. effective length equals one.

b) The self mass, *s*, of the unloaded scaffold per lift is taken from Table 10, and the number of such lifts is taken as *n*.

c) The extra mass, *w*, of the working lifts is then taken from Table 11 and if there are more than one working lift the values are totalled to give the total extra mass of the working lifts, *W*, and allowance is made if necessary for off centre loading (see clause **39.7.5**).

d) The allowable load on one standard in the lift is taken from Table 14. This is doubled to give the strength of a pair of standards.

e) The allowable load on two standards is then equated to a load exerted by a mass of $W + ns$, enabling the number of lifts, n, to be calculated and from this the calculated heights of the scaffold, h.

f) The safety coefficient corresponding to the calculated height, h, is taken from Table 16 and the calculated height divided by this coefficient to give the recommended height on site, H.

Worked examples of this calculation are given in appendix B.

Following comparison of the *calculated* safe height using single standards and the *required* height for the site, it is likely that modification of the design will be needed, either by reducing the working loads on and self weight of the scaffold or by increasing the vertical load-carrying capacity of the scaffold, perhaps by increasing the number of standards.

Table 16 — Safety coefficients to be applied to the calculated heights of scaffolds designed on the allowable stresses[a]

Calculated maximum height based on the allowable stresses in standards h	Safety coefficient C	Recommended maximum height limit on typical construction H
m		m
0	1.00	—
10	1.05	9.5
20	1.10	18.2
30	1.15	26.1
40	1.20	33.3
50	1.25	40.0
60	1.30	46.0
70	1.35	51.8
80	1.40	57.1
90	1.45	62.1
100	1.50	66.7
120	1.60	75.0
140	1.70	82.4
160	1.80	88.9
180	1.90	94.7
200	2.00	100.0
220	2.11	104.2

[a] Intermediate values should be the subject of specific calculation.

39.8 Allowable loads on couplers

39.8.1 *The load on the couplers*

The largest mass given in Table 11 is 1 247 kg, which, when applied to two ledgers and thence to two couplers, gives a force of approximately 6.25 kN to each coupler which is the coupler's safe working load.

Any load more severe than that given in Table 11 should be checked by calculation and the load on the couplers checked.

39.8.2 *Safe working loads*

Fittings which comply with the requirements of BS 1139-2.1:1991, BS 1139-2.2:1992 or BS 1139-2:1982 will have the capacities given in Table 17. It is necessary that they are in reasonable condition and properly fastened. They may be used on steel or aluminium tubes complying with the requirements of BS 1139 unless the supplier states that they are suitable for use only with certain types of tube. Greater loads may be used on the recommendation of the manufacturer or supplier.

Other couplers may be used, in which case the factor of safety should be not less than 2.0 related to the slip or ultimate strength, as appropriate to the conditions of use. Where tests have been assessed in accordance with **8.2** of BS 1139-2.1:1991 a divisor of 1/1.6 = 0.625 may be used.

When it is intended to increase the safe working capacity of a joint by the use of supplementary couplers to back up the main coupler, the information required regarding the strength of the proposed arrangement should be obtained from the manufacturer or supplier.

Where the main coupler is a swivel coupler, no more than one supplementary coupler should be used unless butt tubes are used to give additional support.

Data on torsional stiffness of right angle couplers complying with BS 1139-2.1:1991 are available from the supplier.

The resistance of couplers rotating round a tube is small and should not normally be used in the design of a scaffold unless the information regarding the characteristic strength of the arrangement is available from the coupler supplier. This strength is normally sufficient for erection purposes.

39.9 Loads on ledgers, struts and braces

39.9.1 *Load on the ledgers*

The transfer of loads to the ledgers should be such that overloading does not occur. This may be achieved in extreme circumstances by special bracing of the transoms, doubling the ledgers, knee bracing or by using special strength or thickness of boards, including double boarding.

When puncheons are used to bring lower ledgers into play to supplement those on the working lift, the design should be such that the equivalent mass of the loadings in these ledgers does not exceed those in Table 18.

Table 17 — Safe working loads for individual couplers and fittings

Part or Section of BS 1139	Class	Type of fitting	Type of load	Safe working load
Part 2:1982 Section 2.1:1991	— A	Right angle coupler	Slip along a tube	6.3 kN
Section 2.1:1991	B	Right angle coupler	Slip along a tube	9.4 kN
Part 2:1982	—	Swivel coupler	Slip along a tube	6.3 kN
Section 2.1:1991	A	Swivel coupler	Slip along a tube	5.3 kN
Section 2.1:1991	A	Parallel coupler	Tension	4.7 kN
Section 2.1:1991	A	Sleeve coupler – frictional	Tension	1.5 kN
Part 2:1982 Section 2.1:1991	— B	Sleeve coupler – frictional	Tension	3.0 kN
Section 2.1:1991	B	Sleeve coupler – frictional	Bending	0.59 kN·m
Part 2:1982	—	Sleeve coupler – frictional	Bending	0.79 kN·m[a]
Part 2:1982 Section 2.2:1991	— —	Putlog coupler	Force to pull the tube axially out of the coupler	0.53 kN
Part 2:1982 Section 2.2:1991	— —	Joint pin (expanding spigot coupler)	Shear strength	21.0 kN
Part 2:1982 Section 2.2:1991	— —	Putlog ends	Shear strength	1.12 kN
Part 2:1982 Section 2.2:1991	— —	Adjustable base plate	Axial compression	30.0 kN

NOTE 1 In 1982, all fittings were specified in BS 1139-2.

NOTE 2 Fittings in accordance with BS 1139-2.1:1991 are marked with EN 74 and where appropriate “A” or “B”.

[a] Based on steel tube in accordance with BS 1139-1:1982 (see foreword and **6.2**).

Table 18 — Equivalent mass of safe ledger loads

Length of ledger	Centre point mass		Uniformly distributed mass	
	New tubes	Used tubes	New tubes	Used tubes
m	kg	kg	kg	kg
1.2	269	242	538	484
1.5	216	194	432	388
1.8	179	161	358	322
2.0	162	145	324	290
2.1	154	138	308	276
2.4	135	121	270	242
2.5	129	116	258	232
2.7	120	108	240	216

39.9.2 ***Safe loads which can be applied to ledgers***

39.9.2.1 *Unboarded platforms*

Using the recommendations of **39.5** and rounding off the value, Table 18 gives the mass equivalent to the recommended loading for simply supported spans for steel tube in accordance with BS 1139. As in the case of Table 14, unless it is known that as new tube will be utilized, only the figures for used tubes should be taken.

39.9.2.2 *Boarded platforms*

When scaffold boards are in place they contribute bending strength to the platform and transfer load from the middle of the bay to the ends. Also the ledgers have some continuity.

As the load from a ledger is transferred by a right angle coupler, its capacity will limit the load which can be put on the ledger.

The loads placed on a platform are frequently placed towards the outside edge and apply between 2/3 and 4/5 of their total load to the outside ledger, but a minimum allowance should be made for a load equivalent to 200 kg of men and materials being applied to the inside ledger.

This allowance should not be taken as covering the concentrated loads likely to be imposed on a ledger by a stack of close-packed materials such as a pack of bricks. Such cases may well require special consideration at the design stage, in accordance with the recommendations of clauses **23** and **24** (cf. **39.7.5**).

Where scaffolds are to have loads placed by means of fork lift trucks or any other places where there may be impact from deposited loads, allowance should be made in the scaffold for the enhanced loading, by means of extra standards, ledgers and boarding.

39.9.3 ***Struts and braces***

Struts and braces may be required to span the diagonal of a lift 2.7 m in height and a bay 2.7 m wide. Such a brace will be 3.82 m long. This length is usually admissible when the strut or brace is to stiffen the structure. However, where a diagonal brace or strut that is an individual length of tube is required to carry a specific load rather than a side sway or wind load, it should have an unsupported or free length not greater than 3 m. If it is part of a continuous bracing system being maintained in position and fixed with right angle couplers at both ends, it may be 4 m in length. The load in a strut should not exceed the value given in Table 14, as modified by note 2, for the appropriate length. The maximum free length of such struts should be 4 m.

39.9.4 ***Rakers used to stabilize free standing structures***

Tubes and couplings that are used as rakers to stabilize free standing towers when used in accordance with **9.5** may be unsupported over a length not exceeding 6 m. The compressive load on the strut should not exceed the value given in Table 14. Tension loads should not exceed 1.25 times the safe working load of the assembly of couplers at the ends of the tie, as indicated in **39.8**.

39.10 Wind forces on scaffolding

39.10.1 ***General***

Wind blowing through scaffolding induces forces into the framework. These forces should be resisted by individual members within the scaffolding system in such a way that the stability of the scaffold is maintained, e.g. by connections to an existing structure or by external guys, struts or anchors.

Various calculations are required to assess the following wind forces on a scaffold:

a) the wind force on the clad structure of tubes, couplers and boards;

b) the wind force on any portion of the structure which is covered with vertical protection tarpaulins, sheets or advertisements or is occupied by temporary offices or any other obstacle which prevents the free passage of wind through the structure;

c) uplift forces on decks, protective fans, etc.

CP 3: Chapter V-2, detailing wind loads for the design of buildings, is applicable, in part, to the design of scaffolding structures which are not fully clad and may be used as a starting point for the calculation of the wind forces.

Where a scaffold structure is fully sheeted and roofed in the form of a temporary building, the recommendations of CP 3: Chapter V-2 should be used to evaluate the wind forces on the structure; where the scaffold is unsheeted or only sheeted in small areas the procedure to be adopted should be as given in **39.10.2**.

39.10.2 ***Evaluation of the wind forces on the unsheeted portion of scaffold structures***

39.10.2.1 The site location is determined and the basic wind speed, V in m/s, is selected from the map of basic wind speeds (see Figure 31).

The design wind speed V_s is then calculated from the following equation.

$$V_s = V \times S_1 \times S_2 \times S_3$$

where the wind speed factors S_1, S_2 and S_3 are modification factors depending on the circumstances of the site and the height of the scaffolding.

Unless special topographical effects are present the value of S_1 should be taken as 1.0. In very exposed sites and some valleys which are so shaped that funnelling of the wind occurs with accelerated wind blowing up the valleys, a value for S_1 of up to 1.36 should be used. In steep sided enclosed valleys sheltered from winds, wind speeds may be less than normal and a value for S_1 of 0.9 may be adopted. This should only be used in those rare cases where there is sufficient evidence to justify S_1 being below unity.

The factor S_2 takes into account the effects of ground roughness and the variation of wind speed with height above the ground. Values of S_2 may be estimated from Figure 32. The height should be taken from the ground to the portion of the scaffold structure being considered.

The factor S_3 is based on the risk of winds of a given severity occurring during a given period. It will be seen from Table 19 that the factor varies with the design life of the scaffold and increases as the scaffold design life increases. No value for S_3 below 0.77 should be used. Reference should be made to CP 3: Chapter V-2 for other values of S_3, if greater than normal safety is required.

Table 19 — Values of wind speed factor S_3 (for probability level 0.63)

Life of scaffold	Wind speed factor (S_3)
years	
Less than 2	0.77
2 to 5	0.83
5 to 10	0.88
over 10	1.00

Having calculated V_s, the dynamic pressure, q, to be used in subsequent calculations should be obtained from Table 20.

39.10.2.2 An assessment should be made of each portion of the scaffold which is supported against wind loads by any tie, guy, anchor, strut or other means. The area of tube broadside on to the wind being considered should be assessed for each portion in turn in order to determine the wind force to be resisted by the support.

The effective area of the tube for any support should be obtained by summing the appropriate lengths of the vertical and horizontal tubes transverse to the wind and the projected lengths of the sloping tubes and multiplying the length obtained by the diameter of the tube, i.e. effective area is $L \times 0.0483\ m^2$, where L is in metres.

Wind forces on toeboards should be calculated using the area of toeboard transverse to the wind multiplied by the dynamic pressure from Table 20 and the appropriate wind force factor from Table 21.

39.10.2.3 For simplicity of calculation, the wind need not be considered as blowing in directions other than along the axes of the building, with the wind forces acting parallel to or perpendicular to the building faces. Corresponding force directions and factors are given in Table 21; the force factors tabulated and the directions shown allow for the effects of winds blowing from other directions provided that all four directions are considered.

The wind forces to be resisted by each support should be calculated by multiplying the dynamic wind pressure obtained from Table 20 by the appropriate area as determined in **39.10.2.2** and by the wind force factors obtained from Table 21 applicable to the zone in which the support occurs.

The support should be designed to resist the lateral force (shear) in either direction combined with the pressure of suction force of the wind. In considering the design of the individual members supports, the allowable stresses recommended in this section may be exceeded by 25 % in cases where the excess stresses or forces are due solely to wind force.

Table 20 — Dynamic wind pressures for various design wind speeds

Dynamic wind pressure q (in N/m²) for a design wind speed, V_s (in m/s) of:										
[a]V_s	0	1.0	2.0	3.0	4.0	5.0	6.0	7.0	8.0	9.0
m/s	N/m²	N/m²	N/m²	N/m²	N/m²	N/m²	N/m²	N/m²	N/m²	N/m²
10	61	74	88	104	120	138	157	177	199	221
20	245	270	297	324	353	383	414	447	481	516
30	552	589	628	668	709	751	794	839	885	932
40	981	1 030	1 080	1 130	1 190	1 240	1 300	1 350	1 410	1 470
50	1 530	1 590	1 660	1 720	1 790	1 850	1 920	1 990	2 060	2 130
60	2 210	2 280	2 360	2 430	2 510	2 590	2 670	2 750	2 830	2 920
70	3 000									

[a] Example: The dynamic wind pressure for a design wind speed of 46 m/s is 1 300 N/m².

Table 21 — Wind force factors

Pressure zone (see Figure 30)	Wind direction[a] →	←	↑	↓
	Wind force factor			
1	2	2	2	2
2	1	1	0.3	0.3
3	1	1	0.2	0.2
4	0.3	0.3	1	1
5	0.2	0.2	1	1

NOTE 1 Wind forces act in the direction of wind flow and can exert pressure, suction or lateral forces on the scaffold supports.
NOTE 2 Force factors apply to partial scaffolds as well as to complete scaffolds and should be determined according to wind directions and the scaffold position relative to the building.
[a] Relative to the building in Figure 30(a).

39.10.2.4 The procedure described in **39.10.2.1** to **39.10.2.3** should not be further modified by introducing shielding factors into the calculations. However, a check calculation may be made to assess the total wind forces acting on any building face and no total force on the scaffold along that face greater than that which would be generated by an unperforated surface perpendicular to the wind and of the breadth and height of the scaffold need be considered. In such cases the calculation procedures described in this section should be used and the number of designed supports provided should be such that their total designed load capacity will not be less than the calculated solid body value. The calculated supports should be provided at the windward end of the scaffold for each wind direction and beyond their limits nominal tying should be provided.

Figure 30(a) and Table 21 give factors applicable where there is a solid wall behind the scaffold. In cases where the total area of holes in the wall is between 20 % and 40 % of the gross wall area and/or any hole exceeds 10 m^2 in area, a factor of 2.0 should be used in the calculation of the wind force arising from a face-on wind at the positions of the holes (see Figure 30(b)).

If the wind can pass through openings in the facades and impinge on the scaffold along the leeward face, the increased wind force on the leeward scaffold should be taken into account in the design of its supports by using factors numerically equal to the face-on facade but opposite in sense, i.e. suction instead of pressure.

Where a facade has a total area of openings greater than 40 % of the gross wall area, reasonably evenly distributed over the facade, the wind may be assumed to act on that part of the scaffold in front of the perforated facade as if the facade had no effect on the wind flow and the factor to be applied should be increased from 0.3 or 0.2 to 1.0 (see Figure 30(c)).

Due to the special effects of wind flow at the corners of the building, forces there are greater. This is allowed for in the use of the factor 2.0 at the corners as shown in Table 21. Special attention should be paid to the supports provided at the corners of the building to ensure that they are adequate to resist the increased local wind forces.

Wind effects on scaffolding adjacent to structures which are not rectangular or square should be assessed on the same basis as that described above but using factors appropriate to the wind flow around the structure under consideration.

39.10.3 ***Evaluation of the wind forces on sheeted portions of the scaffold***

The area of the sheeted or solidified portion of the scaffold at right angles to the wind direction should be taken at its face area and multiplied by the dynamic wind pressure from Table 20 to obtain the wind force to be transmitted to the supports.

Sheeted parts of the scaffolding may occur opposite openings in the structure where the wind could blow through the building and impinge on the back of the sheeted area. This area would then be affected by both the normal leeward suction and by pressure from the wind passing through the building. In assessing the effective pressure on that part of the sheeted portion opposite such openings, an appropriate pressure factor not less than 0.7 should be taken in the direction of the wind flow.

In the case of skew winds flowing past sheeted areas, the force acting in the direction of the wind flow and at the plane of the sheeting should be calculated from the following equation.

$$F = A \times q \times 1.5 \times C'_f$$

where

- F is the force in the plane of the sheeting (in N)
- A is the area of sheeting (in m^2)
- q is the dynamic pressure obtained from Table 20 (in N/m^2)
- C'_f is the frictional drag coefficient, normally 0.04.

39.10.4 ***Wind effect on fans or decks***

Projecting fans or decks will be subject to wind uplift and should be checked for overall and local stability. The uplift may be resisted by the self weight of the unloaded deck or, if that does not provide an adequate factor of safety, by tying it down. If tying is used, all parts of the deck should be securely fixed and the designer should ensure that those parts to which the deck is secured are themselves adequate to resist the induced forces.

The wind direction is diverted up and down the face of a long block, the neutral point being about $\frac{2}{3}$ of the way up.

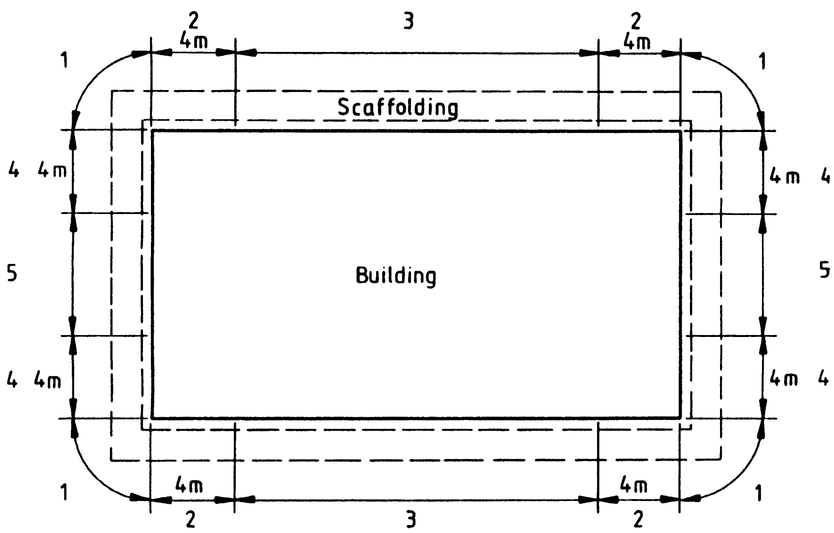
The uplift forces assumed to act on the fan or deck in the top third should be calculated using a net uplift pressure equal to the dynamic wind pressure from Table 20, based on the design wind speed applicable at the height of the fan or deck, multiplied by a factor.

The factor should be 0.7 except where the fan or deck occurs in the top 10 % building height when the factor should be 1.2. Decks situated above the building and within 2 m of the eaves should also be checked for uplift using the factor 1.2. Any deck more than 2 m above eaves level need not be checked by calculation but should be securely held in position against uplift.

There will normally be adequate downward capacity in fans in the lower part of the structure but this should be checked.

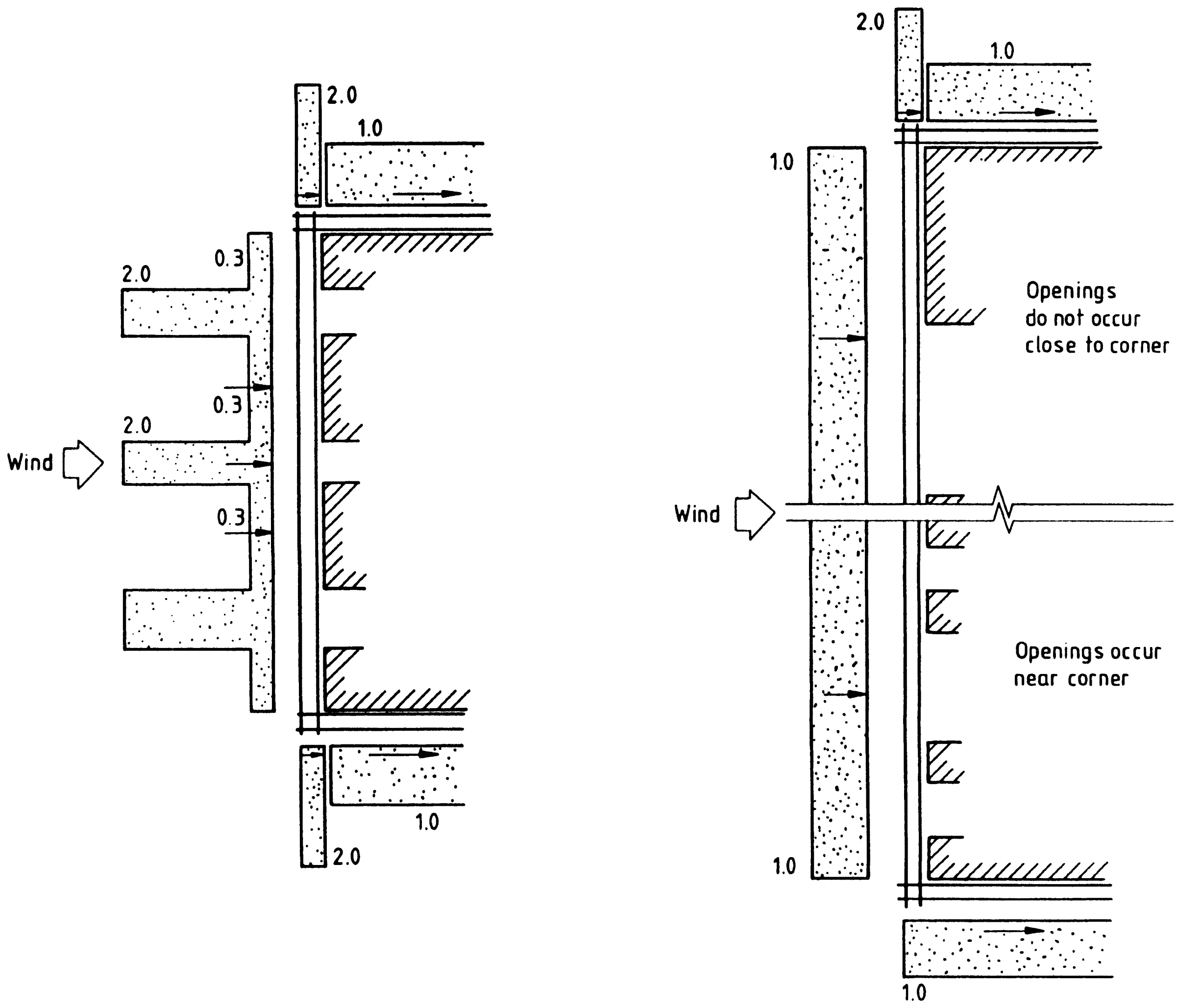
For sloping fans horizontal forces as evaluated in **39.10.2** should be considered.

The area of a net that presents resistance to the wind can be taken as the sum of the projected area of its cords.



(a) Plan of building and scaffold showing pressure zones

Figure 30 — Wind force factors



NOTE. A factor of 2.0 applies also to any opening of over 10 m^2.

(b) Facade holes 20 % to 40 % of wall area

(c) Facade holes exceed 40 % of wall area

Figure 30 — Wind force factors *(concluded)*

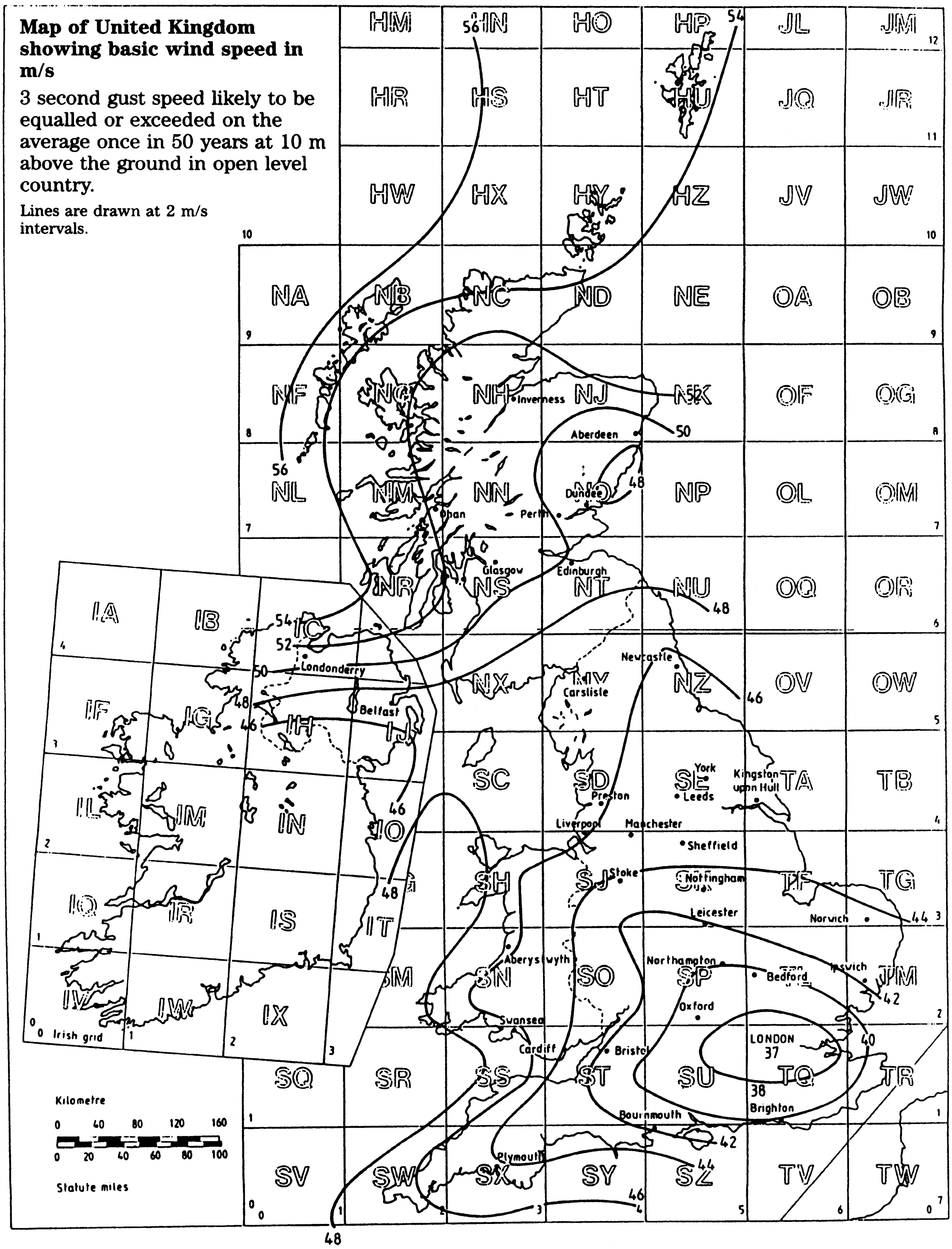
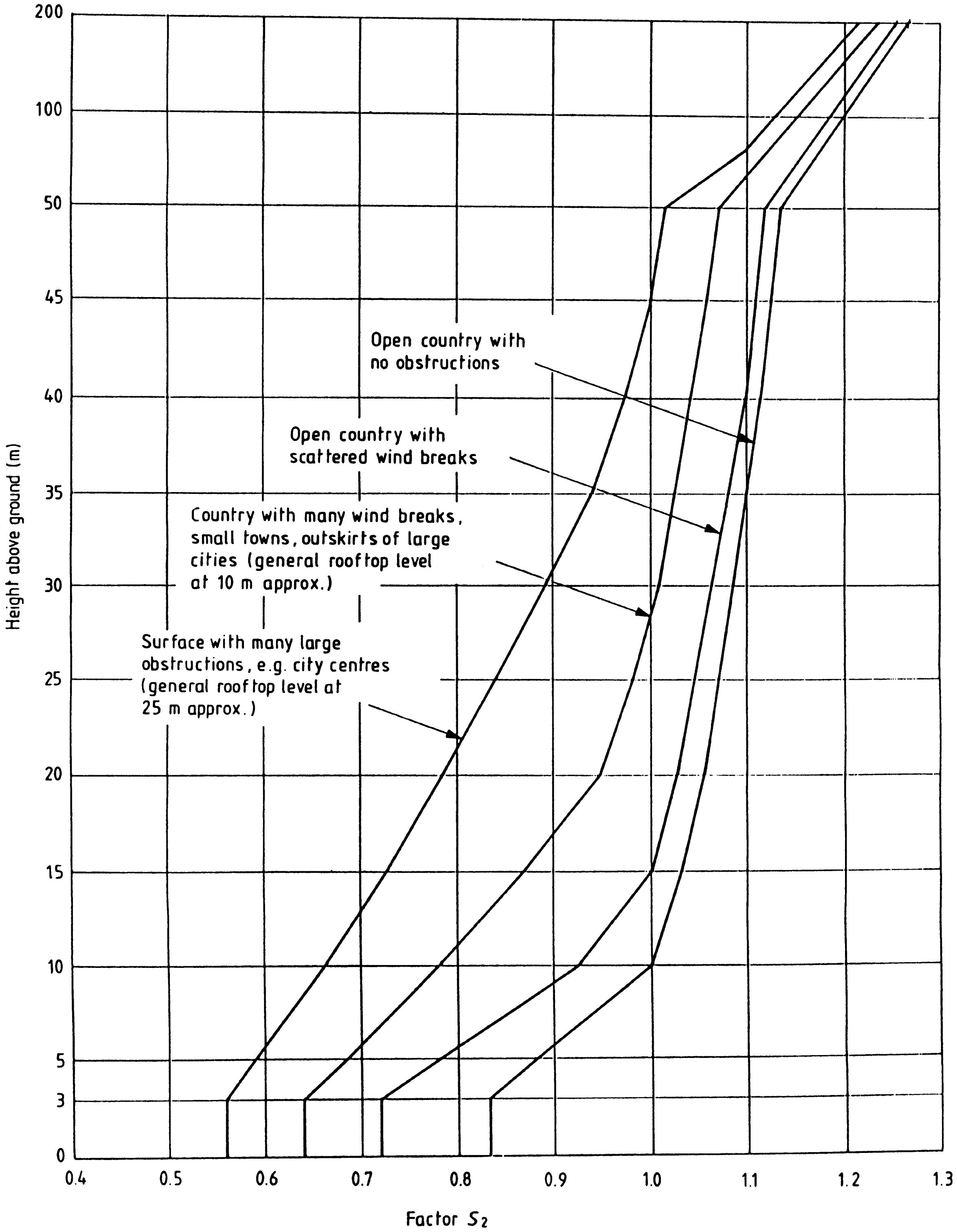


Figure 31 — Basic wind speed, *V*



NOTE. This graph is based upon class A individual member values from CP 3 : Chapter V : Part 2.

Figure 32 — Wind speed factor S_2 for varying heights and surface conditions

Appendix A British Standards giving details of materials and components

The following standards give details of materials and components for access and working scaffolds and special scaffold structures in steel which will satisfy the recommendations of this code of practice.

British Standards

BS 4, *Structural steel sections.*

BS 302, *Stranded steel wire ropes.*

BS 449, *Specification for the use of structural steel in building.*

BS 1129, *Specification for portable timber ladders, steps, trestles and lightweight stagings.*

BS 1139, *Metal scaffolding.*

BS 1397, *Specification for industrial safety belts, harnesses and safety lanyards.*

BS 1692, *Specification for gin blocks.*

BS 2037, *Specification for portable aluminium ladders, steps, trestles and lightweight staging.*

BS 2052, *Specification for ropes made from manila, sisal, hemp, cotton and coir.*

BS 2482, *Specification for timber scaffold boards.*

BS 3032, *Specification for higher tensile steel shackles.*

BS 3551, *Specification for alloy steel shackles.*

BS 3913, *Specification for industrial safety nets.*

BS 4344, *Pulley blocks for use with natural and synthetic fibre ropes.*

BS 4360, *Specification for weldable structural steels.*

BS 5240, *Industrial safety helmets.*

BS 5268, *Structural use of timber.*

BS 5974, *Code of practice for temporarily installed suspended scaffolds and access equipment.*

BS 8093, *Code of practice for the use of safety nets, containment nets and sheets on constructional works.*

Appendix B Worked examples of scaffold design (see 39.7.7)

B.1 Symbols and formulae for elastic design of scaffolds

For the purpose of the calculations outlined in this appendix the following symbols apply.

- s is the self mass of the scaffold per lift/bay (in kg)
- w is the extra mass on all the working lifts in a single bay (in kg)
- W is the total extra mass of all the working lifts (in kg)
- P is the allowable load in a standard (in kN)
- n is the number of lifts
- h is the calculated height of the scaffold (in m)
- C is the safety coefficient
- H is the recommended height of the scaffold after the application of the factor C (in m)
- $W + ns$ is the required strength for two standards, which is equivalent to $2P$

$$n = \frac{2P - W}{s}$$

$$h = n \times \text{the lift height}$$

$$H = \frac{h}{C}$$

B.2 Examples of scaffold design

NOTE All examples assume even loading of standards.

B.2.1 *Very light duty scaffold*

Calculate H for three lengths of bay, i.e. 2.1 m, 2.4 m and 2.7 m, of a very light duty scaffold with one working platform, rated at 0.75 kN/m^2, three boards wide and in 2 m lifts.

Bay lengths (m)	2.1	2.4	2.7
s(kg)	76	78	81
W(kg)	182	205	229
P(kN)	24.9	24.9	24.9
n	64.4	62.5	59.8
h(m)	128.8	125.0	119.6
C	1.64	1.62	1.60
H(m)	78.54	77.16	74.75

B.2.2 ***Light duty scaffold***

Calculate *H* for three lengths of bay, i.e. 2.0 m, 2.1 m and 2.4 m, of a light duty scaffold with two working platforms, rated at 1.50 kN/m^2, four boards wide in 2 m lifts.

Bay lengths (m)	2.0	2.1	2.4
s (kg)	75	76	78
w (1st working lift) (kg)	357	374	426
w (2nd working lift) (kg)	357	374	426
W (kg)	714	748	852
P (kN)	24.9	24.9	24.9
n	58.15	56.92	54.17
h (m)	116.30	113.84	108.34
C	1.58	1.57	1.54
H (m)	73.61	72.51	70.35

B.2.3 ***General purpose scaffold***

Calculate *H* for three lengths of bay, i.e. 1.8 m, 2.0 m and 2.1 m, of a general purpose scaffold with two working platforms rated at 2.00 kN/m^2 and one working platform rated at 0.75 kN/m^2, all five boards wide and in 2 m lifts.

Bay lengths (m)	1.8	2.0	2.1
s(kg)	73	75	76
w (1st working lift) (kg)	496	552	576
w (2nd working lift) (kg)	496	552	576
w (3rd working lift) (kg)	240	265	277
W (kg)	1 232	1 369	1 429
P (kN)	24.9	24.9	24.9
n	52.62	49.41	47.96
h (m)	105.23	98.83	95.92
c	1.51	1.49	1.48
H (m)	69.69	66.33	64.81

B.2.4 ***Heavy duty scaffold***

Calculate *H* for three lengths of bay, i.e. 1.5 m, 1.8 m and 2.0 m, of a heavy duty scaffold with two working platforms rated at 2.50 kN/m^2 and two working platforms rated at 0.75 kN/m^2, all five boards wide and in 2 m lifts.

Bay lengths (m)	1.5	1.8	2.0
s (kg)	70	73	75
w (1st working lift) (kg)	501	599	667
w (2nd working lift) (kg)	501	599	667
w (3rd working lift) (kg)	202	240	265
w (4th working lift) (kg)	202	240	265
W (kg)	1 406	1 678	1 864
P (kN)	24.9	24.9	24.9
n	52.41	46.56	42.82
h (m)	104.82	93.12	85.44
C	1.52	1.46	1.43
H (m)	68.96	63.78	59.89

B.2.5 ***Masonry and special duty scaffold***

Calculate *H* for three lengths of bay, i.e. 1.2 m, 1.5 m and 1.8 m, of a masonry and special duty scaffold with two working platforms rated at 3.00 kN/m^2 and two working platforms rated at 0.75 kN/m^2, all six boards wide and in 2 m lifts.

Bay lengths (m)	1.2	1.5	1.8
s (kg)	68	70	73
w (1st working lift) (kg)	562	696	834
w (2nd working lift) (kg)	562	696	834
w (3rd working lift) (kg)	193	236	282
w (4th working lift) (kg)	193	236	282
W (kg)	1 510	1 864	2 232
P (kN)	24.9	24.9	24.9
n	52.45	45.87	38.97
h (m)	104.90	91.74	77.94
C	1.52	1.46	1.39
H (m)	69.01	62.84	56.07

Appendix C Effective lengths of scaffold tube struts

C.1 In general, the degree of joint restraint exhibited at a node point at which cross connections are made by means of scaffold couplers can be assumed as being negligible. This, together with the lack of restraint against rotation provided by such couplers means that, when designing structures using scaffold tube and fittings, effective lengths of less than 1.0L should not normally be used (see L_3 in Figure 33). Effective joint restraint is only likely to exist in riveted or bolted structural connections, or with welded joints combined with reasonable continuity of members. However, if it can be shown that a particular type of coupler provides joint restraint, this may be taken into account when calculating the effective lengths.

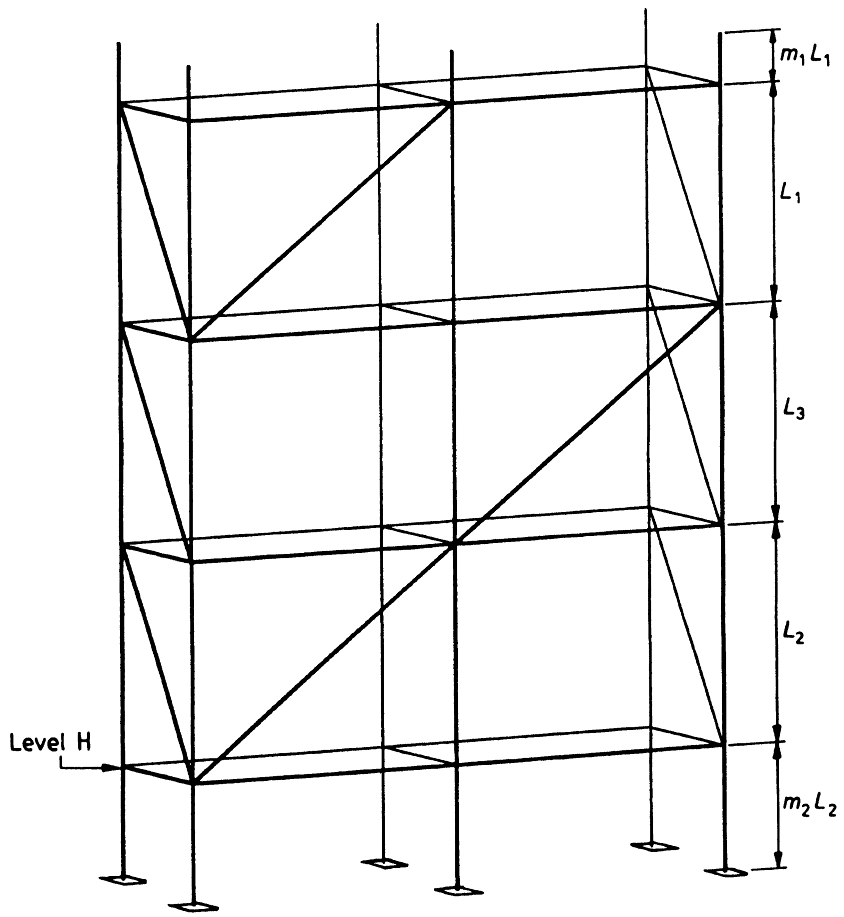
When a structure includes a strut with a free cantilever projection (see m_1L_1 in Figure 33), this cantilever plus the portion immediately adjacent to it (see L_1 in Figure 33) should be considered as having one effective length. The effective length, l, in metres, of such a strut should be determined by the following expression.

$$l = L + 2mL$$

where

L is the length between supports (in m)

mL is the length of the cantilever projection (in m)



NOTE. Configuration of scaffold is diagrammatic only.

Figure 33 — Effective lengths in tube and coupler scaffolds

In a free standing structure, the lower portion (see m_2L_2 in Figure 33) should also be considered as a free cantilever and should be designed in accordance with the above expression.

Where both ends of a projecting member are held in position relative to one another, the member is not a free cantilever and should be treated as a normal strut with a factor of 1.0. For example, such a condition can be achieved for the base projection either by a system of external ties, preventing movement relative to the ground, preferably at level H (see Figure 33), or by the continuation of the diagonal bracing system to the ground. In this case the effective length would be $m_2 L_2 \times 1.0$. It can normally be assumed that friction between a base plate and the ground is sufficient to prevent movement of that end of the projection.

Figure 33 indicates how these effective lengths should normally be applied to a structure in steel scaffold tube. It assumes axial loading on the columns and does not take into account any horizontal loadings. In false work and similar structures, e.g. access birdcages, the unrestrained members may be subjected to horizontal as well as vertical loads and this should be taken into account in the design. Table 22 provides further information on the general philosophy of effective lengths.

C.2 For the purpose of calculating *l*/*r* for struts the effective length, *l*, given in Table 22 should be taken. (Based on BS 449:1969.)

The dimension *L* is the length of strut between intersections of members providing lateral support and *r* is the radius of gyration.

Appendix D Scaffolds using aluminium tube

D.0 Introduction

The recommendations in this code as to the form on construction of scaffolds built from steel tube will generally apply to aluminium tube, except in the few circumstances listed below; in particular the limit to height in **8.5.1** is inappropriate. Because of the difference in structural qualities special design is required for structures formed of aluminium tube. For convenience information concerning aluminium has been collected into this appendix.

D.1 Care of tube

D.1.1 *Straightness of tube*

Bent tube should not be used. Tube should be considered bent if the deviation from a straight line is greater than 15 mm in any 3 m length. Aluminium tube should not be straightened. The straight parts of a bent tube may be cut out and reused but the remainder should be scrapped.

D.1.2 *Heat treatment of tube*

Because aluminium scaffold tube is heat treated in manufacture, heat should not be applied to it by welding, flame cutting etc., unless this is carried out in controlled conditions in the manner recommended in CP 118.

D.2 Chemical and mechanical properties

D.2.1 *Stiffness*

Aluminium is less stiff than steel, therefore when used as a beam it will deflect more than steel. Aluminium scaffold standards will suffer a more rapid reduction in the ability to carry compressive axial loads than steel tube as the effective strut length increases. See **D.5** for design considerations.

D.2.2 *Corrosion and hazard*

Aluminium suffers more rapid corrosion than mild steel in certain circumstances particularly where it is in prolonged contact with copper or copper alloy items in moist conditions.

The difference in the properties of steel and aluminium makes each material more suitable for different conditions and the client should be consulted where cleanliness or freedom from explosion hazard are important.

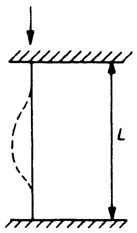
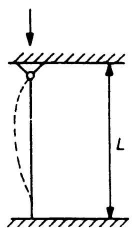
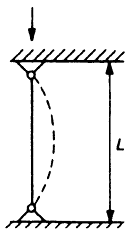
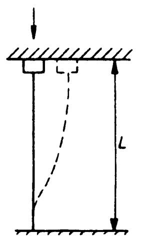
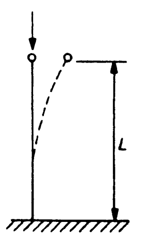
D.3 Stability and stiffness

D.3.1 Access towers built from aluminium tube should have their access ladders fitted internally to reduce the possibility of them being overturned.

D.3.2 Scaffolds should not be constructed with standards of mixed aluminium and steel tube at any one level. However, advantage may be taken of the best characteristics of the two materials by placing aluminium tube on top of steel tube in tall scaffold structures.

D.3.3 When building structures where counterbalancing or deflection may be critical to the design special care should be taken to make allowance for the reduced mass and lower stiffness of aluminium tube compared to steel tube.

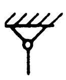
Table 22 — Effective lengths of struts

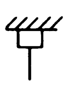
Diagrammatic representation of deformation	Restraint conditions	Effective length (l)
	Effectively held in position and restrained in direction at both ends	$0.7L$[a]
	Effectively held in position at both ends and restrained in direction at one end	$0.85L$[a]
	Effectively held in position at both ends but not restrained in direction	$1.0L$
	Effectively held in position and restrained in direction at one end and partially restrained in direction but not held in position at the other end	$1.5L$
	Effectively held in position and restrained in direction at one end but not held in position or restrained at the other end	$2.0L$

NOTE Key to end condition code in Table 22.

[a] Not normally appropriate for use in tube and coupler structures.

 **Rotation fixed and position fixed.**

 **Rotation free and position fixed.**

 **Rotation fixed and position free.**

 **Rotation free and position free.**

D.4 Maximum allowable compressive loads imposed on standards

Table 23 gives safe working loads for tubes supported at the centres stated. Where the effective length is not equal to the actual length an appropriate stress should be adopted from Table 23.

D.5 Structural design

It will be observed in Table 24 that the maximum allowable stress in bending, P_{bc}, for aluminium tube is greater than the corresponding value for steel tube in Table 12. In Table 14 and Table 23 for columns with effective length less than 1 000 mm the permissible axial loads for aluminium tube are greater than those for steel.

These facts create a hazard if they are taken to indicate that all aluminium tube columns are stronger than steel tube columns. The attention of the designer, erector and user is specially drawn to the rapid reduction of the strength of aluminium tube struts with increased lengths.

Above 1 000 mm effective length the strength of an aluminium tube strut falls away from 48 kN to 12.9 kN at the normal lift height of 2 000 mm whereas a steel tube strut strength falls away only to 29.2 kN which is twice the strength of aluminium strut.

Table 23 — Maximum permissible axial stress and loads in aluminium scaffold tubes

Effective length l	Slenderness ratio l/r	Permissible average stress[a] P_c	Permissible axial load
mm		N/mm²	kN
0			
250	16.0	140	86.1
500	32.0	118	72.6
750	48.1	114	70.1
1 000	64.1	78	48.0
1 250	80.1	52	32.0
1 500	96.2	37	22.8
1 750	112.2	27.2	16.7
2 000	128.2	21	12.9
2 250	144.2	16.7	10.3
2 500	160.3	13.5	8.30
2 750	176.3	11.22	6.90
3 000	192.3	9.39	5.77
3 250	208.3	8.06	4.96
3 500	224.4	6.94	4.27
3 750	240.4	6.06	3.73
4 000	256.4	5.28	2.35
4 250	272.4	4.72	2.90
4 500	288.5	4.22	2.59
4 750	304.5	3.72	2.29
5 000	320.5	3.39	2.08
5 250	336.5	3.06	1.88
5 500	352.6	2.83	1.74
5 750	368.6	2.56	1.57
6 000	384.6	2.39	1.47

[a] Assume K_2 = 1.8 (see **39.7.2.1**).

Table 24 — Section properties of aluminium scaffold tube (HE 30TF) complying with the requirements of BS 1139

Type of tube	Outside diameter	Nominal wall thickness	Mass per unit length	Cross-sectional area *(A)*	Moment of inertia *(I)*	Modulus of elasticity *E*
	mm	mm	kg/m	cm^2	cm^4	N·mm^2
Aluminium tube (HE 30TF) complying with the requirements of BS 1139	48.3 ± 0.5	4.47 ± 0.56	1.67, max. reduction 7.5 %	6.15	14.90	68.900

Table 24 — Section properties of aluminium scaffold tube (HE 30TF) complying with the requirements of BS 1139

Type of tube	Elastic modulus *z*	Radius of gyration *r*	Minimum yield strength	Maximum allowable stress in bending P_{bc}	Maximum allowable stress in axial compression P_c	Maximum allowable shear stress	Maximum allowable stress in axial tension P_t	Stiffness *EI*
	cm^3	cm	N/mm^2	N/mm^2	N/mm^2	N/mm^2	N/mm^2	N/mm^2
Aluminium tube (HE 30TF) complying with the requirements of BS 1139	6.18	1.56	255 (0.2 % tension proof test)	154	See Table 23	83	139	1 026.6 × 10^7

Appendix E Maximum permissible axial stresses and loads in steel scaffold tubes manufactured in accordance with BS 1139-1:1982

Table 25 gives the maximum permissible axial stresses and loads in steel scaffold tubes manufactured in accordance with BS 1139-1:1982.

Table 25 — Maximum permissible axial stresses and loads in steel scaffold tubes manufactured in accordance with BS 1139-1:1982

Effective length l	Slenderness ratio l/r	As new tubes		Used tubes	
		Permissible axial compressive stress P_c	Permissible axial load	Permissible axial compressive stress P_c	Permissible axial load
mm		N/mm²	kN	N/mm²	kN
0		127	70.7	108	60.1
250	15.9	123	68.5	105	58.2
500	31.8	119	66.2	101	56.3
750	47.8	113	63.0	96.2	53.6
1 000	63.7	104	57.7	88.1	49.1
1 250	79.6	90.3	50.3	76.8	42.8
1 500	95.5	75.4	42.0	64.1	35.7
1 750	111.5	61.4	34.2	52.2	29.1
2 000	127.4	50.0	27.9	42.5	23.7
2 250	143.3	40.9	22.8	34.8	19.4
2 500	159.2	34.0	18.9	28.9	16.1
2 750	175.2	28.7	16.0	24.4	13.6
3 000	191.1	24.2	13.5	20.6	11.5
3 250	207.0	20.9	11.6	17.8	9.9
3 500	222.9	18.1	10.1	15.4	8.6
3 750	238.8	15.9	8.8	13.5	7.5
4 000	254.8	14.1	7.9	12.0	6.7
4 250	270.7	12.5	6.9	10.6	5.9
4 500	286.6	11.2	6.2	9.5	5.3
4 750	302.5	10.1	5.6	8.6	4.8
5 000	318.5	9.1	5.1	7.7	4.3
5 250	334.4	8.2	4.6	7.0	3.9
5 500	350.3	7.5	4.2	6.4	3.6
5 750	366.2	6.9	3.9	5.9	3.3
6 000	382.2	6.4	3.5	5.4	3.0

NOTE 1 It is recommended that, for columns carrying dead and imposed loads, l/r < 207.
NOTE 2 For struts and braces intended to carry wind loads and lateral forces, l/r < 271.
NOTE 3 For members designed as ties but which may suffer reversals of loading, l/r < 383.
NOTE 4 Where there is combined bending and axial compression, treat as for combined stresses in BS 449, using the appropriate value of l/r and stress from Table 25.

Index

Publications referred to

BS 449, *Specification for the use of structural steel in building.*

BS 449-2, *Metric units.*

BS 648, *Schedule of weights of building materials.*

BS 1139, *Metal scaffolding.*

BS 1139-1.1:1990, *Specification for steel tube.*

BS 1139-1.2:1990, *Specification for aluminium tube.*

BS 1139-2.1:1991, *Specification for steel couplers, loose spigots and base-plates for use in working scaffolds and falsework made of steel tubes.*

BS 1139-2.2:1991, *Specification for steel and aluminium couplers, fittings and accessories for use in tubular scaffolding.*

BS 2482, *Specification for timber scaffold boards.*

BS 3913, *Specification for industrial safety nets.*

BS 4360, *Specification for weldable structural steels.*

BS 4848, *Hot-rolled structural steel sections.*

BS 4848-2, *Specification for hot-finished hollow sections.*

BS 5268, *Structural use of timber.*

BS 5400, *Steel, concrete and composite bridges.*

BS 5400-2, *Specification for loads.*

BS 5555, *Specification for SI units and recommendations for the use of their multiples and of certain other units.*

BS 5974, *Code of practice for temporarily installed suspended scaffolds and access equipment.*

BS 5975, *Code of practice for falsework.*

BS 6180, *Code of practice for protective barriers in and about buildings.*

BS 6399, *Loading for buildings.*

BS 6399-1, *Code of practice for dead and imposed loads.*

BS 6399-3, *Code of practice for imposed roof loads.*

BS 8093, *Code of practice for the use of safety nets, containment nets and sheets on constructional works.*

CP 3, *Code of basic data for the design of buildings.*

CP 3-Chapter V, *Loading.*

CP 3-2, *Wind loads.*

CP 118, *The structural use of aluminium.*

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