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Australian Standard™

The demolition of structures



S t a n d a r d s A u s t r a l i a

This Australian Standard was prepared by Committee BD-059, Demolition of Structures. It was approved on behalf of the Council of Standards Australia on 13 July 2001 and published on 13 September 2001.

The following interests are represented on Committee BD-059:

Construction, Forestry, Mining and Energy Union
Consumers Federation of Australia
Demolition Contractors Association of Australia
Demolition Contractors Association of New South Wales
Demolition Contractors Association of Victoria
Department of Urban Affairs and Planning (NSW)
Master Builders Australia
TAFE New South Wales
Association of Consulting Engineers Australia
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Australian Standard™

The demolition of structures

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PREFACE

This Standard was prepared by the Standards Australia Committee BD-059, Demolition of Structures, to supersede AS 2601—1991.

The objective of this Standard is to provide guidance to planners, engineers, contractors and interested parties on the planning and procedures for the demolition of a structure.

In revising the Standard, the Committee has taken into account experience gained in the application of the second edition, the relative prevalence of the types of structures now being demolished and the increasing trend towards the mechanization of demolition procedures. An increase of public awareness and worker expectations regarding safety issues, as well as increased concern regarding protection of the environment have also been taken into account as well as ecologically sustainable developments. Also addressed has been the changing face of the construction industry in terms of legislative requirements and the trend towards privatization of certifiers and the decrease in the input from regulatory authorities.

The following brief outline indicates the principal changes from the previous edition.

- 1 Reorganization of contents** The Standard has been reorganized so as to be more performance based. The prescriptive items regarding the method for demolishing certain structures has been relocated to an informative appendix, as the committee realizes that there may be more appropriate means of achieving the safe falling of a structure, which requires the contractor to understand and apply risk management when considering a new job. The prescriptive requirements in relation to protection and the health and safety of employees and the public has been retained.
- 2 Planning and execution** The Standard places an emphasis on the planning and execution of a demolition project. The requirements for planning and execution have been expanded upon, which has resulted in the addition of a new Section (see Section 2).
- 3 Regulating Authorities** The Standard has taken account the varying requirements of regulating authorities in the States and Territories, and has addressed this by the removal of regulatory requirements from the main body of the Standard. An appendix has been added for guidance. The Appendix places emphasis on the demolition contractor to ensure work is carried out in accordance with the requirements of the State or Territory, as applicable. The guidance is current at the time of publication. However, it is the demolition contractor's duty to ensure that the relevant requirements of authority and qualifications are current.

The term 'informative' has been used in this Standard to define the application of the appendix to which it applies. An 'informative' appendix is for information and guidance only.

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STANDARDS AUSTRALIA

Australian Standard

The demolition of structures

SECTION 1 SCOPE AND GENERAL

1.1 SCOPE

This Standard sets out requirements and provides guidance to planners, owners, engineers, contractors and interested parties on the planning and procedures for the demolition of a structure.

The Standard also provides advice and guidance on a range of controlled demolition methods so that the risk —

- (a) to the health and safety of the public and site personnel and occupiers of an adjoining property;
- (b) of damage to the immediate environment; and
- (c) of damage to adjoining premises

will be minimized.

This Standard applies to the demolition of buildings and structures. Compliance with the conditions herein does not necessarily mean compliance with all of the parties' obligations.

NOTE: Some States/Territories require demolition contractors to be licensed.

1.2 REFERENCED AND RELATED DOCUMENTS

1.2.1 Referenced documents

The following documents are referred to in this Standard:

AS

1170	Minimum design loads on structures
1170.2	Part 2: Wind loads
1270	Acoustics — Hearing protectors
1319	Safety signs for the occupational environment
1336	Recommended practice for occupational eye protection
1337	Eye protectors for industrial applications
1418	Cranes (including hoists and winches)
1418.1	Part 1: General requirements
1418.5	Part 5: Mobile and vehicle-loading cranes
1470	Health and safety and work — Principles and practices
1674	Safety in welding and allied processes
1674.1	Part 1: Fire precautions
1725	Galvanized rail-less chainwire security fences and gates
1940	The storage and handling of flammable and combustible liquids
2124	General conditions of contract
2187	Explosives — Storage, transport and use
2187.2	Part 2: Use of explosives

AS

- 2294 Earthmoving machinery—Protective structures
- 2294.1 Part 1: General
- 2294.2 Part 2: Laboratory tests and performance requirements for roll-over protective structures
- 2294.3 Part 3: Laboratory tests and performance requirements for falling-object protective structures
- 2294.4 Part 4: Specifications for deflection-limiting volume
- 2321 Short-link chain for lifting purposes (non-calibrated)
- 2430 Classification of hazardous areas
- 2430.1 Part 1: Explosive gas atmospheres
- 2430.3.2 Part 3.2: Specific occupancies—Vehicle workshops, vehicle parking, fuel dispensing stations and aircraft hangars
- 2436 Guide to noise control on construction, maintenance and demolition sites
- 2545 Subcontract conditions
- 2550 Cranes — Safe use
- 2550.1 Part 1: General requirements
- 2550.4 Part 4: Tower cranes
- 2550.5 Part 5: Mobile and vehicle-loading cranes
- 2550.6 Part 6: Guided storing and retrieving appliances
- 2550.7 Part 7: Builders' hoists and associated equipment
- 2550.10 Part 10: Elevating work platforms
- 2550.13 Part 13: Building maintenance units
- 2550.16 Part 16: Mast climbing work platforms
- 2865 Safe working in a confined space
- 3569 Steel wire ropes
- 4000 General condition of contract
- 4801 Occupational health and safety management systems—Specification with guidance for use
- 4901 Subcontract conditions
- 4576 Guidelines for scaffolding
- AS/NZS
- 1576 Scaffolding (all parts)
- 1715 Selection, use and maintenance of respiratory protective devices
- 1716 Respiratory protective devices
- 1801 Occupational protective helmets
- 1891 Industrial fall-arrest systems and devices
- 1891.1 Part 1: Safety belts and harnesses
- 1891.2 (Int) Part 2: Horizontal lifeline and rail systems
- 1891.3 Part 3: Fall-arrest devices
- 2430 Classification of hazardous areas
- 2430.3.1 Part 3.1: General
- 2430.3.2 Part 3.2: Vehicle workshops, vehicle parking, fuel dispensing stations and aircraft hangers
- 2430.3.3 Part 3.3: Flammable liquids
- 2430.3.4 Part 3.4: Flammable gases
- 2430.3.5 Part 3.5: Refineries and major processing plants
- 2430.3.8 Part 3.8: Surface coatings and adhesives

AS/NZS

2161	Occupational protective gloves
2161.2	Part 2: General requirements
2161.3	Part 3: Protection against mechanical risks
2161.4	Part 4: Protection against thermal risks (heat and fire)
2161.5	Part 5: Protection against cold
2161.7.1	Part 7.1: Protection against cuts and stabs by hand knives — Chainmail gloves and arm guards
2210	Occupational protective footwear
2210.1	Part 1: Guide to selection, care and use
2210.2	Part 2: Requirements and test methods
2550	Cranes — Safe use
2550.9	Part 9: Vehicle hoists
3012	Electrical installations — Construction and demolition sites
NOHSC	
2002	WorkSafe Australia — Code of practice for the safe removal of asbestos

1.2.2 Related documents

The following documents provide additional information:

BS

6187 Code of practice for demolition

CAVILL B.A., Demolition of prestressed concrete structures. VSL Prestressing (Aust) Pty Ltd, Sydney, 1988.

NHMRC Approved Occupational Health Guides

NOHSC

7019 National Guideline for Occupational Health and Safety for the Operation of Load Shifting Equipment and Other Types of Specified Equipment

Welding Institute of Australia — Technical Note No. 7

1.3 DEFINITIONS

For the purpose of this Standard, the following definitions apply.

1.3.1 Approval/approved

The granting of formal permission in relation to an application or proposal, with or without conditions, given by an approval authority under statutory power detailed in legislation, or by a competent person, where such an approval authority does not exist.

1.3.2 Clear space

The unobstructed area surrounding the building within the boundaries of the site.

1.3.3 Competent person

A person who has acquired through training, qualification, experience, or a combination of these, the knowledge and skills enabling that person to perform the task required by a recognized Standard.

1.3.4 Debris

Material resulting from demolition or stripping, which is larger than rubble.

1.3.5 Demolition

The complete or partial dismantling of a building or structure, by pre-planned and controlled methods or procedures.

1.3.6 Demolition site

The area within an area, which has been designated and defined by a boundary, within which the practice of demolition will occur.

1.3.7 Demolition drop zone

Zone for the disposal of demolition rubble and debris, which is clear of obstruction and isolated from site personnel and the public, to allow objects to fall freely.

1.3.8 Demolition exclusion zone

The zone or area, below, at and above ground level, from which all unauthorized people are excluded during demolition activities, to protect them from injury or harm.

1.3.9 Guarded

Protected or enclosed by guardrails, safety barriers, or the like.

1.3.10 Hazardous Substances Management Plan

A plan provided by the property owner, the owner's agent, or the person on whose behalf the demolition work is done, which identifies all hazardous substances that may affect the health of site personnel or members of the public.

1.3.11 Hazard

A source or a situation with a potential for harm, in terms of human injury or ill health, damage to property, damage to the environment or a combination of these.

1.3.12 Height of a structure

The height from the finished ground level to the highest part of the structure to be demolished.

1.3.13 Hoarding

A high temporary fence or structure enclosing a demolition site, or a building site during construction or alterations, to restrict access, prevent theft, and provide side but not overhead protection to passers-by.

1.3.14 Incident

Any unplanned event resulting in, or having a potential for, injury, ill health, damage, or other loss.

1.3.15 Immediate environment

The properties, including public thoroughfares and spaces, having common boundaries with the demolition site, and where the property is a public thoroughfare, including the properties directly opposite the demolition site.

1.3.16 Induced collapse demolition

Methods of demolition in which the structural stability of the whole or part of the structure is deliberately altered so that collapse ensues suddenly (includes felling by wire ropes).

1.3.17 Load-shifting equipment

1.3.17.1 Cableway/flying fox

An arrangement where a wire rope is suspended between two tower structures, on which is supported a carriage or fox from which a load may be suspended.

1.3.17.2 *Front-end loader/backhoe*

Self-propelled wheeled machine with a main structural support designed to carry both a front-mounted bucket loading mechanism and a rear-mounted backhoe.

NOTE: When used in the backhoe mode, the machine normally digs below ground level with bucket motion towards the machine; the bucket lifts, swings, and discharges material while the undercarriage is stationary. When used in the loader mode, the machine loads or excavates through forward motion of the machine, and lifts, transports or discharges material.

1.3.17.3 *Front-end loader*

Self-propelled wheeled machine with an integral front-mounted bucket-supporting structure and linkage, which loads or excavates through forward motion of the machine, and lifts, transports and discharges material.

1.3.17.4 *Front-end loader of the skid/steer type*

Self-propelled crawler or wheeled machine in which steering is accomplished by skidding or reversing the track or wheels on one side of the machine. Also with an integral front-mounted bucket-supporting structure and linkage, which loads or excavates through forward motion of the machine, and lifts, transports and discharges material.

1.3.17.5 *Excavator*

Self-propelled crawler or wheeled machine with an upper structure capable of a minimum of 360° rotation, which excavates, elevates, swings and discharges material by the action of a bucket fitted to the boom and arm or telescoping boom, without moving the chassis or undercarriage during any part of the working cycle of the machine.

1.3.17.6 *Dragline*

A lattice boom crane configuration supporting a bucket or scoop, which is thrown outwards and retrieved through materials by a drag cable arrangement.

1.3.17.7 *Forklift truck*

A powered industrial truck equipped with a mast and an elevating load carriage to which is attached a pair of forkarms or other load-holding attachment.

1.3.17.8 *Dozer*

Items of plant composed of wheeled or crawler tractors with a dozer blade mounted at the front-end of the machine.

1.3.18 Manual demolition

Demolition techniques involving the use of hand-held tools such as picks, sledgehammers, jackhammers, and the like.

1.3.19 Mechanical demolition

Demolition techniques involving the direct use of mechanical plant such as cranes, load-shifting equipment, and the like.

1.3.20 Rubble

Broken pieces of the building fabric with no single piece larger than 0.5 m in any dimension, or heavier than 50 kg.

1.3.21 Sequential demolition

Methods of demolition in which elements and members are dismantled sequentially in the reverse order to that in which they were constructed or erected (includes manual and mechanical methods).

1.3.22 Shoring

A system of temporary supports to maintain stability and prevent movement.

1.3.23 Specified cranes

1.3.23.1 Bridge or gantry cranes (remote operation only)

- (a) *Bridge* A crane comprising a bridge beam mounted at each end to an end carriage, capable of travelling along elevated runways and having one or more hoisting mechanisms arranged to traverse across the bridge.
- (b) *Gantry* A crane comprising a bridge beam, supported at each end by legs mounted on end carriages, capable of travelling along runways, at surface or deck level, and which has a crab with one or more hoisting units arranged to travel across the bridge.

1.3.23.2 Vehicle loading cranes

Cranes mounted on a vehicle for the principal purpose of loading and unloading such a vehicle—capacity less than 10 metric tonnes.

1.3.23.3 Non-slewing, non-articulating mobile cranes

Non-slewing or non-articulating mobile cranes not exceeding three tonnes capacity and including vehicle tow truck operations.

1.3.24 Stripping

The removal from a building of internal fittings, fixtures, services and non-loadbearing elements.

1.3.25 Work plan

Specifically prepared document that details the methods and procedures for the safe demolition of the structure.

1.4 NEW OR ALTERNATIVE METHODS

This Standard shall not be interpreted as preventing the use of alternative methods. Such methods may be used provided that safety standards are not less than those provided in this Standard.

1.5 HEALTH AND SAFETY

1.5.1 Public

1.5.1.1 General

People walking or driving past any demolition work shall be protected from falling objects, projections, dust, noise, mechanical plant, including trucks entering and leaving the site, and welding and cutting sparks, at all times while work is in progress. Undue noise during extended working hours shall be avoided

Throughout the demolition operations, safety shall be maintained in public places adjoining the site. Safety of the public shall be maintained by providing street closures, hoardings, scaffolding and other types of overhead protection, either singly or in combination, in accordance with the requirements of this Standard.

1.5.1.2 Lighting

Lighting of public places adjoining the site shall be provided so that obstructions resulting from the demolition operations are clearly visible at all times.

1.5.1.3 Falling materials

In both the planning and execution of the demolition work, action shall be taken to prevent demolished materials from falling freely outside the boundaries of the demolition site or exclusion zone.

Where the site adjoins a public thoroughfare, the common boundary between the two shall be fenced in accordance with Clause 1.5.1.4 and Clause 1.5.1.5, and shall be provided with such other protective structures as may be required by Clauses 1.5.1.1, 1.5.1.7 and 1.5.1.8. These actions shall be considered as providing protection to the public from injury from falling rubble and debris.

Where the demolished materials are to be lowered directly onto, or into a public place, a specific ground area shall be allocated for these activities. Barriers shall be erected and maintained around the area to prevent the public from entering. An observer may be also used to monitor the operation.

1.5.1.4 Security fencing

Security fencing shall be provided around the perimeter of the demolition site, including any additional precautionary measures taken to prevent unauthorized entry to the site at all times during the demolition period. Security fencing shall be the equivalent of chain wire as specified in AS 1725.

1.5.1.5 Hoardings

Where the demolition site adjoins a public thoroughfare, the common boundary between them shall be fenced for its full length with a hoarding, unless the least horizontal distance between the common boundary and the nearest parts of the structure is greater than twice the height of the structure (see Figure 1.1).

The hoarding shall be constructed of solid materials to a height of not less than 1.8 m adjacent to the thoroughfare.

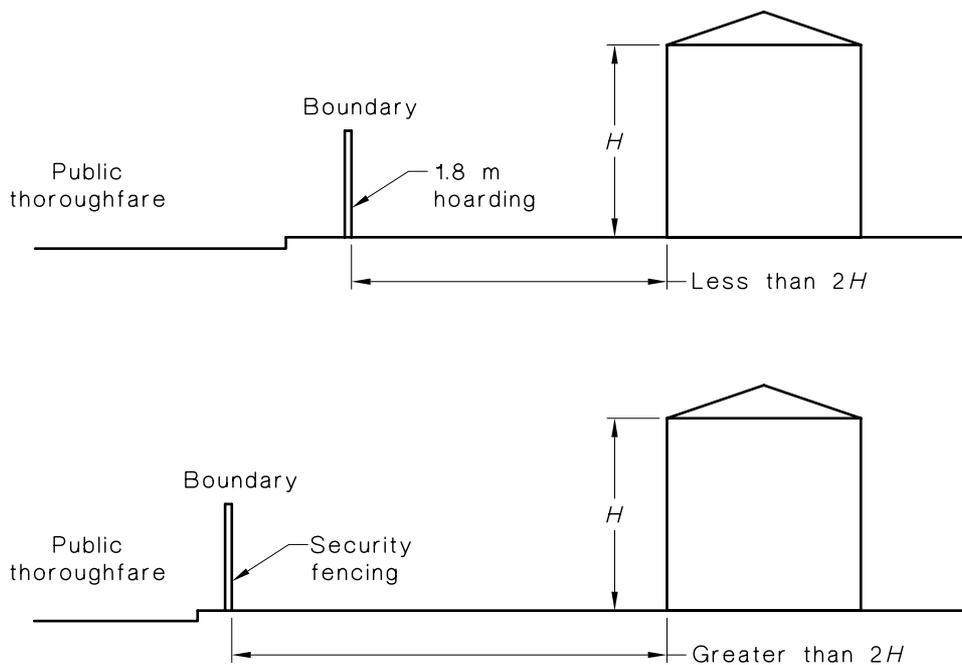


FIGURE 1.1 HOARDING/SECURITY FENCE

1.5.1.6 Warning notices

Notices lettered in accordance with AS 1319 and displaying the words 'WARNING DEMOLITION IN PROGRESS', or a similar message, shall be fixed to the fencing at appropriate places to warn the public.

1.5.1.7 Scaffolding

Where required by Clause 1.5.1.1, the scaffolding shall be heavy-duty scaffolding complying with AS 1576 (all parts), or its functional equivalent. The scaffolding shall —

- (a) enclose the work area;
- (b) be impenetrable and able to withstand the impact of rubble; and
- (c) be maintained and inspected on a regular basis.

NOTE: The scaffolding is intended to be a protection only against falling or rebounding rubble and/or to provide a safe working platform for personnel. It is not intended that it be used as a storage area for demolished material. AS 4576 may be used as guidance.

1.5.1.8 Overhead protection

Where a demolition site adjoins a public thoroughfare with a footpath alongside the common boundary then, in addition to the hoarding required by Clause 1.5.1.5, the footpath shall be covered by an overhead protective structure and the facing facade protected by heavy-duty scaffolding, unless either —

- (a) the vertical height above footpath level of the structure being demolished is less than 4.0 m; or
- (b) the least horizontal distance between footpath and the nearest part of the structure is greater than half the height of the structure.

The overhead structure shall consist of a horizontal platform of solid construction and vertical supports, and the platform shall —

- (i) extend from the common boundary to the edge of the carriageway for the full length of the boundary;
- (ii) have a clear height above the footpath of not less than 2.1 m;
- (iii) terminate at the edge of the carriageway with a continuous solid upstand projecting not less than 0.5 m above the platform surface; and
- (iv) together with its supports, be designed for a uniformly distributed live load of not less than 7 kPa.

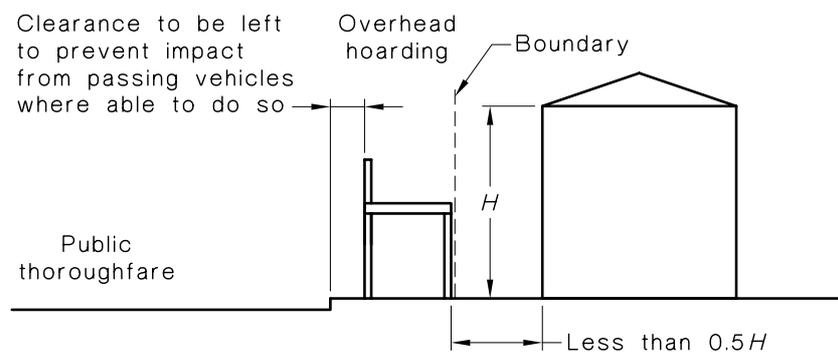


FIGURE 1.2 OVERHEAD PROTECTION

1.5.2 Site personnel

1.5.2.1 Safety of work areas

Every access and egress and work area, and all openings and exposed edges, shall be illuminated and protected.

1.5.2.2 Personal protective clothing and devices (PPE)

While on the site, every worker and every visitor shall wear a safety helmet complying with AS/NZS 1801. Also, every worker shall wear protective clothing and where appropriate, the following protective equipment:

- (a) Eye protectors complying with AS 1336 and AS 1337.
- (b) Respirators complying with AS/NZS 1715 and AS/NZS 1716.
- (c) Hearing protection complying with AS 1270.
- (d) Industrial safety gloves or mittens complying with AS/NZS 2161.
- (e) Safety footwear complying with AS/NZS 2210.1 and AS/NZS 2210.2.
- (f) Safety footwear complying with AS/NZS 2210.1 and AS/NZS 2210.2.
- (g) Industrial safety belts or harnesses complying with AS/NZS 1891 (all parts).
- (h) Highly visible clothing.

1.5.2.3 Working in confined spaces

Requirements and procedures should be in place to prevent occupational illness, injuries and fatalities to persons entering and working in confined space. Confined spaces should be made safe for those entering confined spaces, and the likely hazards associated with such work areas and the relevant safe work processes necessary to deal with these hazards should be highlighted.

The responsibilities before entry into a confined space and during the entire operation should be emphasized. Such responsibilities cover conditions of work not only for an organization's own employees but also for any other contractors or persons on the premises. Steps shall be taken to eliminate or control hazards. All persons involved in the entry of a confined space shall be trained and instructed on the nature of the hazard and the precautions to be followed (see AS 2865).

1.5.2.4 Cutting and welding

Where high temperature cutting or welding is to be carried out, the precautionary measures given in AS 1674.1 shall be observed, including the following:

- (a) Any fire hazard (including the presence of flammable or combustible liquids, gases, vapours, dusts, fibres or substances) within 15 m from the hot work shall be identified and controlled.
- (b) Relevant hazards that may exist outside the area referred to in Item (a) above shall be taken into consideration.
- (c) The possibility of changing circumstances during the progress of the hot work, and whether they may render the area unsafe for the work to continue, shall be taken into consideration.
- (d) The hot work area shall be ventilated properly.
- (e) The equipment, including emergency firefighting equipment, shall be located in a suitable place.
- (f) The hot work area shall be isolated.

- (g) A safe entry into and exit from the hot work area shall be provided.
- (h) Testing shall be carried out for the presence of any flammable gas or flammable vapour in the atmosphere within the area referred to in Item (a) above and in any pipe, drum, tank, vessel and piece of equipment adjacent to or involved in the hot work.
- (i) The concentration of any flammable gas and flammable vapour, as determined by the testing required by Item (h) above, shall be less than 5% of its lower explosion limit (LEL).
- (j) The responsible officer shall make a thorough inspection of the site.
- (k) When the responsible officer is satisfied that the hot work can safely proceed, that person shall issue a hot work permit
- (l) Where specified by the hot work permit, a firewatcher shall be stationed in the area near the hot work, for the purpose of safeguarding personnel and equipment.
- (m) The hot work shall not start until compliance with all of the above requirements has been carried out.

Where it is necessary to cut or weld material that is covered with lead-base paints or other paints, coatings, or plating capable of producing noxious or other harmful fumes, the operators of torches and related equipment shall be provided with and required to use respiratory equipment. Other site personnel within the vicinity of such operations shall be similarly protected.

NOTE: Welding Institute of Australia Technical Note No. 7, provides advice.

1.5.2.5 *Fire protection*

A fire hydrant service or a fire hose reel service that is in a building shall be available at all times during the demolition of the building, so that all remaining storeys not under demolition are served, unless an alternative system is provided. Access to the fire protection service, including any booster fitting, shall be maintained at all times and where the existing fire protection service is not available during demolition, a fire main, or dry riser shall be provided for multistorey buildings.

Portable fire extinguishers shall be maintained in an operable condition at all times in working areas and areas not protected by other fire services.

1.5.2.6 *First aid*

Facilities and equipment for administering first aid shall be provided.

1.5.2.7 *Amenities*

Amenities for site personnel shall be provided

1.5.2.8 *Electrical safety*

Temporary electrical installations that supply electricity to appliances and equipment used for the execution of the demolition works shall comply with AS/NZS 3012 and any additional requirements of the electrical supply authority.

1.6 HAZARDOUS SUBSTANCES

1.6.1 Audit

A competent person shall determine the presence of hazardous substances or conditions in the structure, and all parts of the site, which may be hazardous to the health of the site personnel or the public if disturbed by the stripping or demolition. The nature and location of each hazard shall be recorded and both the record and proposed method on controlling the hazards shall be recorded in a Hazardous Substances Management Plan and included in

the contract documentation. The Hazardous Substances Management Plan shall include, but not be limited to, location and quantity of each substance, the method in which that substance is to be controlled or removed, the methods of monitoring exposure limits, and the handling, storage and disposal procedures to an approved landfill or approved storage area.

The purpose of the audit is to identify the location, extent, accessibility, type and condition of hazardous substances such as asbestos, PCBs, lead paint, underground storage tanks, chemical and other hazardous containing materials in relation to the proposed demolition or stripping work, and to assess the risk to employees and other persons. The audit shall be supported by a laboratory analysis of the suspected hazardous substances.

Noxious dust can be produced by the cutting or breaking up of materials containing asbestos or other fibres.

Toxic fumes can be produced by the burning of certain inorganic substances such as some types of paint or of synthetic substances such as some types of plastics.

Particular concentrations of vapours remaining from volatile liquid storages, and of dust from some granular materials, ignite explosively when exposed even to a small heat source such as a spark or a glowing cinder.

NOTE: AS/NZS 2430.1, AS/NZS 2430.3, AS/NZS 2430.3.1, AS/NZS 2430.3.2, AS/NZS 2430.3.3, AS/NZS 2430.3.4, AS/NZS 2430.3.5, AS/NZS 2430.3.7 and AS/NZS 2430.3.8 provide guidance on such matters

1.6.2 Removal

Where hazardous substances have been recorded in accordance with Clause 1.6.1, or subsequently uncovered, all site personnel shall be immediately informed of their presence and appropriate control measures implemented. Additional measures for public safety shall be implemented. No demolition shall proceed in the immediate vicinity until the risks have been assessed by a competent person. Work may only proceed if it is deemed safe to do so or if the hazardous substances have been removed in accordance with the Hazardous Substances Management Plan.

Hazardous substances, including asbestos, shall be removed only by competent persons.

1.7 PROTECTION

1.7.1 Protection of adjoining buildings

1.7.1.1 Access and egress

Safe access to and egress from adjoining buildings shall be maintained at all times for the duration of the demolition work.

1.7.1.2 Damage and structural integrity

No demolition activity shall cause damage to, or adversely affect, the structural integrity of adjoining buildings.

Consideration shall be given to the use of shoring, and underpinning, and to changes in the soil conditions as a result of demolition, and appropriate action taken

1.7.1.3 Vibration and concussion

The effects of vibration and concussion on adjoining buildings and their occupants shall be minimized, as far as practicable, by selecting demolition methods and equipment appropriate to the circumstances.

1.7.1.4 *Weatherproofing*

Where any surface of an adjoining building is exposed by demolition, the need for weatherproofing the exposed surface shall be investigated and temporary or permanent protection provided as appropriate.

1.7.1.5 *Protective screen/scaffolding*

Where a building or structure adjoins a common boundary and projects above an adjoining building, driveway or access way, in accordance with Clause 1.5.1.8(a) and (b), then a protective structure, screen or scaffolding shall be erected.

NOTE: Permission to erect the screen or scaffolding on the adjoining neighbours' property/airspace may be required to be obtained by the person on whose behalf the demolition is being performed.

1.7.2 Protection of immediate environment

1.7.2.1 *Burning*

The deliberate burning of buildings shall not be used as a method of demolition.

Burning-off shall not be permitted on demolition sites unless approval is obtained. If permission to burn off has been obtained, care shall be exercised in burning any material arising from demolition. Consideration shall be given to prevailing winds and formation of offensive smoke, toxic gases, or both, any fire restrictions, and adequate firefighting facilities shall be available at all times. All fires shall be extinguished at least 1 h before site personnel or an appointed fire-watchman leaves the site.

1.7.2.2 *Dust control*

The techniques adopted for stripping out and for demolition shall minimize the release of dust into the environment

Where there is a danger of an accumulation of dust into the environment, it shall be controlled. This may involve vacuuming, or hosing down.

Dust generated during stripping, or during the breaking down of the building fabric to removable sized pieces, shall be kept damp until it is removed from the site or can be otherwise contained. The use of excess water for this purpose shall be avoided.

NOTE: It should be borne in mind that, in certain environments and under certain stimuli, deposits of combustible dusts on beams, machinery and other surfaces may be subject to flash fires, and suspensions of combustible dusts in air can explode violently.

1.7.2.3 *Noise control*

Noise shall be minimized, as far as practicable, by the selection of appropriate methods and equipment, and by the use of silencing devices. Attention is drawn to the recommendations contained in AS 2436.

1.7.2.4 *Protection of public roads*

Precautions shall be taken to minimize the spreading of mud, rubble and debris by vehicles leaving the site.

1.7.2.5 *Protection of services*

Before a contractor is engaged, a competent person shall determine, as far as practicable, the location and extent of all services (e.g. gas, hydraulic, communications and electrical) and watercourses. No demolition refuse or waste shall be allowed to enter public sewers, drains or watercourses and all live services adjoining the site shall be protected.

1.7.3 Protection of external site

1.7.3.1 Retained buildings or portions

No demolition activity shall cause damage to, or adversely affect, the structural integrity of a building or those portions of a building that are to be retained on the site.

1.7.3.2 Protection of flora

Trees, plants or other flora on the site shall not be removed, lopped, or otherwise trimmed without prior approval.

Flora to be retained on the site shall be protected from damage to their foliage by suitable enclosures.

Heavy vehicles shall be kept well clear of trees and shrubs to avoid damage to their root systems.

1.7.3.3 Vermin

The site shall be kept free of vermin.

1.8 PLANT AND EQUIPMENT

1.8.1 General

All plant and equipment used on the demolition site shall be —

- (a) operated by a competent person;
- (b) used and maintained as recommended by the equipment's supplier and/or manufacturer; and
- (c) in the case of load shifting equipment, and the like, used in the demolition process, provided with overhead protective structures complying with AS 2294.1, AS 2294.2, AS 2294.3 and AS 2294.4 for Falling Objects Protection Systems (FOPS).

1.8.2 Cranes

Cranes shall be selected, used and operated in accordance with the manufacturer's specifications

Cranes used for hoisting and lowering demolished materials shall comply with AS 1418 (all parts) and shall be fitted with a load-indicator and a hoist-limiting (anti-two-block) device.

1.8.3 Gas and flammable liquids containers

Containers for oxygen, acetylene and liquefied petroleum gas shall be handled with care, and be stored and used away from sources of heat and falling objects. Flammable liquids shall be stored and handled in accordance with AS 1940.

SECTION 2 PLANNING AND EXECUTION

2.1 GENERAL REQUIREMENTS

Before the commencement of any stripping or demolition work, an initial investigation of the structure and the site shall be carried out in accordance with Clause 1.6. and Clause 1.7.2.5.

On the basis of this investigation, in conjunction with investigation of the structure and site, a work plan shall be prepared and documented in accordance with Clause 2.3 and submitted for approval. No stripping or demolition activity shall be commenced until the work plan has been approved.

Where conditions revealed during execution of the works necessitate changes in the approved work plan, notification shall be given and approval received before the proposed changes are put into effect except that in an emergency situation, the necessary changes shall be effected immediately and notification of the changes given within the next 24 h.

NOTES:

- 1 A check list for contractors, covering items in this and subsequent Sections, is given in Appendix A.
- 2 Additional information on legal and contractual considerations is given in Appendix B.

2.2 INVESTIGATION

2.2.1 General

The investigation of the structure shall be carried out by a competent person, in accordance with Clause 2.2.2, and of the site, in accordance with Clause 2.2.3. Opinions of other competent persons such as a structural engineer shall be sought as required.

At the earliest possible time, the demolition contractor shall be provided with copies of the as constructed drawings and other building information.

The results of the investigations shall be recorded and the records kept for inspection as required. Where appropriate, relevant records shall be included with the work plan to substantiate the choice or safety of a particular sequence, method, or technique of demolition.

2.2.2 Investigation of the structure

An investigation of the structure shall include but not be limited to identification and confirmation of the following:

- (a) The materials of construction and, in particular, the location, nature and extent of any hazardous substances, to be carried out by a competent person.
- (b) The type of structural system and the sequence of construction.
- (c) The elements and members essential for maintaining stability, against vertical and horizontal loads, of the structure as a whole and of individual portions or members.
- (d) The type, extent and status of services (e.g. electrical, gas, mechanical, plumbing and drainage) contained within the structure and in particular those that are to be maintained during demolition.
- (e) The condition of the structure and its fittings and fixtures with regard to their state of disrepair or deterioration.
- (f) Any other details of the structure regarding its strength, construction or contents which will influence the selection of demolition procedures given in the work plan.

- (g) Confined spaces that are contained in the structure or created by the demolition process, including cellars, basements, garages, strong rooms, plant rooms, lift shafts, cool rooms, chemical storage rooms, service ducts, ceiling and floor spaces.

NOTES:

- 1 Apart from Item (e), much of this information should be obtainable from the plans and specifications approved by the building authority at the time of construction. However, even if these are available, verification by visual inspection combined with physical investigations, such as the cutting of chases or taking of sample cores, will still be required.
- 2 Where plans and specifications are held by a building authority, it will usually be necessary to obtain authorization from the current owner of the structure to gain access to them.
- 3 Building floors or parts thereof sealed for stripping or for hazardous substances removal may be defined as confined spaces.

2.2.3 Investigation of the site

An investigation of the site shall include, but not be limited to, identification of the following:

- (a) The type, location, extent and status of any underground service conduits, cables, or pipework particularly those which are to be retained in service during or after demolition.
- (b) The location and extent of any underground structures such as basements, cellars, or storage tanks (USTs), all of which may be defined as confined spaces.
- (c) The nature and extent of any retaining structures that support adjoining ground or buildings.
- (d) The location and extent of any concentrations (dumps) of noxious, toxic, or other hazardous substances.
- (e) The location and extent of any above-ground services, e.g. overhead powerlines.
- (f) The general condition of land and structures on adjoining sites, adjoining sites, footpaths and public spaces, particularly where these are close to or on the boundaries of the demolition site.

2.3 WORK PLAN

A work plan shall be prepared by a competent person and shall include, but not be limited to, documentation of the following information:

- (a) The location of the site on which the structure to be demolished stands.
- (b) The overall height of the structure above ground level and the least distance from the structure to each site boundary (all to the nearest 0.5 m).
- (c) A brief description of the type of building (occupancy class), its structural support system services and the principal materials of its construction.
- (d) A description of the methods of demolition proposed to be used and type of major equipment proposed for implementing those methods and the means of moving such equipment from floor to floor.
- (e) A description of the methods proposed for handling and disposing of demolished materials and, in particular, of hazardous substances.
- (f) A description of the proposed sequence of carrying out the demolition works and an estimate of the time, in days, that it is likely to take to complete all or each of the stages of the work.
- (g) Details of protective measures, including overhead protection and scaffolding required by Clauses 1.5. and 1.7.

- (h) The dimensions of the demolition exclusion zone shall be determined after considering existing conditions and work methods. Depending on the demolition method the zone may need to be larger than the demolition site during key stages of the demolition operation.
- (i) Any other plans, illustrations, or written documents as may be necessary to clearly define or substantiate the proposals made under Items (d) to (g).
- (j) Provision of a traffic management plan for the structure and site.
- (k) Provision of an environmental management plan for the site and structure
- (l) Occupational health and safety system (see AS 4801)

The competent person shall ensure that the proposals contained in the work plan comply with the requirements of this Standard. If it is proposed that mobile equipment be driven by operators on a suspended floor, Item (d) above shall include the size and weight of each such piece of equipment and the proposed method of raising and lowering the equipment and of moving it from floor to floor. Furthermore, the statement in Item (i) above shall specify the support to be given to the suspended floor concerned and such other limitations on the operation of the equipment and loading on the floor as may be necessary to maintain the safety of the operators and other site personnel.

2.4 EXPLOSIVES

When explosives are under consideration as a demolition method, whether it be for part or whole of a structure in conjunction with, or not in conjunction with, other demolition methods, the following requirements, in addition to the requirements of Clauses 2.1, 2.2 and 2.3, shall be met:

- (a) Before a contractor is engaged, a competent person(s) experienced in the fields of demolition, explosives and structural engineering shall assess the suitability or otherwise of the structure or component for demolition using explosives. This assessment shall include consideration of the surrounding environment, exclusion zone and opinions from the approval authority, local planning and building authority, emergency service providers, utility providers, air service and maritime authorities, and police.
- (b) The investigation of the structure and surrounding site shall also include consideration of the effects of pre-weakening of structural components, fly, air blast, ground vibrations, dust, climatic conditions, site security, the area available, and required size of the exclusion zone. Tests shall be conducted as required.
- (c) Where approval is given for demolition involving explosives, the competent person responsible for preparation of the work plan and use of explosives at the demolition site shall have prior experience with the type of structure or component to be demolished, and the initiation system and the types of charges to be used.
- (d) In preparing the work plan, other competent persons shall be consulted as required, including but not limited to people competent in structural engineering and geotechnical investigations. The work plan shall also include the submission points listed in AS 2187.2.

2.5 EXECUTION

The work shall be executed by competent persons, with due regard at all times for safe working practices and in accordance with the work plan, a copy of which shall be kept on site. Any modifications to the work plan, which may be necessary as the work progresses, shall be made by a competent person, in accordance with Clause 2.1.

NOTE: Some recommendations regarding the competence of site personnel are given in Appendix C.

SECTION 3 METHODS OF DEMOLITION

3.1 GENERAL PRECAUTIONS

3.1.1 Supervision

At all times demolition work shall be supervised by a competent person.

3.1.2 Stability of the structure

The structure to be demolished and all its components shall be maintained in a stable and safe condition at all stages of the demolition work. Temporary bracing, guys, shoring, or any combination of these, shall be added for stability where necessary.

Masonry walls are inherently unstable and controls need to be implemented to effect the removal of the wall without affecting the stability of the remaining wall returns.

Slabs and beams, which are either pre-tensioned, or post-tensioned with fully grouted tendons, may be demolished as for reinforced members.

Tilt-up panels, post-tensioned slabs and beams in which the tendons are ungrouted, or only partially grouted, shall not be demolished without prior written direction from an engineer conversant with this type of construction.

Considerable care needs to be exercised to avoid cutting a prestressed tendon that is ungrouted or only partially grouted.

NOTE: See Appendix D for guidance on the demolition of prestressed members.

3.1.3 Loading on floors

Suspended floors and their supporting members shall not be loaded by machinery, or by falling or accumulated rubble or debris, to the extent that there is excessive deflection, permanent deformation, or danger of collapse.

3.1.4 Loading against walls

Walls shall not be laterally loaded by accumulated rubble or debris, to the extent that they are in danger of collapse.

3.1.5 Protection of openings

Openings in existing walls and floors, through which there is a risk of persons falling to a lower level, shall be either properly guarded or boarded over and the boarding secured against unauthorized or accidental removal.

3.1.6 Glass

Precautions shall be taken to prevent glass from falling onto persons in or outside the building.

3.1.7 Weather

Precautions shall be taken to ensure that the stability of all parts of the structure, and the safety of persons on and outside the site, will be maintained in the event of sudden and severe weather changes.

Severe weather changes refers to the localized high winds that often accompany rapidly moving cold fronts, as well as tropical cyclones. In these circumstances inadequately braced walls and columns may be blown over and loose debris can become airborne, particularly if it is in sheet form. The wind forces can be calculated in accordance with AS 1170.2 for the design of bracing or restraint systems.

3.1.8 Site access

The site shall be secured at all times against the unauthorized entry of persons or vehicles.

Provision shall be made for ready access to the site by emergency services personnel, in the event of fire or accident.

3.1.9 Access within the structure

At least one access and egress route, connecting all undemolished floors to the nearest street and clearly marked, shall be provided as an emergency exit. The marked route shall be kept free of accumulations of demolished materials at all times and provision shall be made for illuminating the entire route in the event of an emergency.

3.1.10 Live services

Services within a demolition site required to be maintained during the demolition shall be protected and made safe.

3.1.11 Disconnected services

Services within the structure not required to be maintained during the demolition work shall be properly disconnected and sealed before any stripping or demolition commences.

3.1.12 Use of lifts during demolition

Where lifts are kept in use during demolition, the lift cars shall not be overloaded. Maintenance shall be continued throughout any period of lift usage.

3.2 DAMAGED OR RUINOUS BUILDINGS

Appropriate safety precautions shall be taken during the assessment and demolition of buildings that have been identified as being fire damaged, ruinous or otherwise dangerous.

3.3 REMOVAL OF HAZARDOUS SUBSTANCES

3.3.1 General

Removal of hazardous substances shall be carried out only by competent persons, or competent and registered persons if so required prior to the start of any demolition or stripping work (see Clause 1.6.1).

3.3.2 Removal of asbestos

Removal of asbestos or materials containing asbestos fibre shall be in accordance with the NOHSC (WorkSafe Australia), *Code of practice for the safe removal of asbestos*.

3.3.3 Removal of other materials

Precautions to be observed, and procedures to be adopted during the removal of hazardous substances other than asbestos, shall be in accordance with the relevant State or Territory regulations appertaining to those materials

3.4 SEQUENTIAL METHODS

3.4.1 General

3.4.1.1 Sequence of demolition

Generally, structures shall be demolished in the reverse order to that of their construction. The order of demolition for buildings shall be progressive, storey by storey, having proper regard to the type of construction, and retaining the stability of the structure

3.4.1.2 *Removal of demolished materials*

Demolished material shall not be allowed to fall freely outside the structure, unless it is confined within a chute or similar enclosure. Demolished material shall not be allowed to fall freely within a structure, unless it is confined within a shaft, similar enclosure, or demolition zone.

In multistorey buildings, where demolished materials are allowed to fall freely through the internal floor opening demolition drop zone, the following shall apply in addition to the above:

- (a) At the working level, each opening shall be —
 - (i) enclosed around its perimeter, during removal of materials, by substantial vehicle buffers not less than 300 mm high above floor level; and
 - (ii) guarded by suitable barriers at all other times.
- (b) At all levels below the working level, access to the areas through, or onto, which material is falling shall be prevented by appropriate means (e.g. screens, guardrails).
- (c) At the level where falling material is accumulated for removal from the confines of the building —
 - (i) the requirements of Clauses 3.1.3 and 3.1.4 shall be observed; and
 - (ii) removal of accumulated materials shall not commence until action has been taken to prevent materials falling from above.

Demolished material shall be removed progressively from the site and, at any time, shall not be allowed to accumulate to the extent that it presents a hazard to the public or to site personnel.

3.4.1.3 *Cutting and lowering of large members*

If necessary to suit the capacity of the available hoisting equipment, large members shall be cut into smaller sized portions before lowering. Whole or large portions of members shall be lowered in a controlled manner so that there is no likelihood of them falling freely. Wherever possible, a crane or similar lifting device, shall be used to support beams or columns while they are being separated from the remainder of the structure.

NOTE: Where appropriate, sample pieces of members should be cut and test-weighed and the weight per unit length, or weight per unit area, of a member determined. This will provide a guide to the maximum length or area that can be safely handled by the available equipment.

3.4.2 **Manual demolition**

Personnel shall be permitted to work only from a safe work area or from a safe access system. Where concrete members are being demolished manually, the reinforcement shall not be cut while breaking out of the concrete is in progress.

During the progressive removal of individual rafters or trusses from a pitched roof, sufficient purlins and bracing shall be retained to ensure stability of the remaining roof rafters or trusses. Where necessary to maintain stability, temporary bracing shall be added. Particular care shall be taken to provide safety measures against personnel falling through or off the roof.

3.4.3 **Mechanical demolition**

3.4.3.1 *By crane (demolition ball)*

Where mechanical demolition by a steel ball is employed, the clear space in which the equipment is to operate shall have a minimum dimension of 6 m or 50% of the height of the building to be demolished, whichever is the greater.

The crane shall be selected and used in accordance with the relevant parts of AS 2550. The boom head shall be not less than 3 m above the highest part of the building to be demolished.

NOTE: Limits on the capacity of the equipment are provided in the crane manufacturer's specifications.

Only the following techniques shall be used:

- (a) Vertical drop.
- (b) Swinging in line with the boom, but not beyond the vertical point of the boom head.
- (c) Slewing the boom.

An anti-spin device shall be used on the hoist rope in conjunction with the ball attachment equipment. The supporting ropes shall be of such a length or be so restrained that it is not possible for the ball to swing against any structure other than that being demolished. Boom luffing for the purpose of swinging the ball shall not be permitted. The hoist rope, anti-spin device, and the attachment of the demolition ball to the hoist rope shall be inspected in accordance with the relevant parts of AS 2550.

3.4.3.2 *By load-shifting equipment*

Where demolition is carried out by load-shifting equipment operating from ground level, Clause 3.5 shall apply. In addition, care shall be taken to minimize the risk of the equipment tilting by ensuring that it is operated from firm, stable ground.

3.4.3.3 *On suspended floors*

Load-shifting equipment, and the like, shall not be operated on a suspended floor unless —

- (a) the type, size, weight and usage of the particular piece of equipment has been specified in the work plan;
- (b) it has been demonstrated by calculations based on principles of structural engineering that the floor is capable of sustaining the static and operating load of the equipment including attachments plus demolished materials, without excessive deformation or collapse, either —
 - (i) without additional support from below; or
 - (ii) where it is determined for propping to be applied from below, props used for supports shall be structurally sound and in an operational condition, braced, in each storey, in two directions approximately at right angles to one another, spaced and arranged so that the loads they transmit do not exceed their manufacturer's specified rating; or
- (c) it is moved between suspended floor slabs by —
 - (i) appropriate hoist equipment; or
 - (ii) a fabricated ramp designed by a practising structural engineer, detailed and certified in the work plan and supported by the principles of structural engineering.

Effective communication shall be maintained between the equipment operator and the demolition supervisor while the equipment is operating.

Where a particular piece of equipment has been specified in the work plan, another piece of equipment of the same type and usage may be substituted for it, provided that the substituted equipment is neither larger nor heavier than the specified equipment.

NOTE: Load-shifting equipment should, as far as practicable, be located on a beam. Skid steer loaders using a breaker may not be appropriate to be used on suspended floors with their limited reach.

3.5 INDUCED COLLAPSE METHODS

3.5.1 General

Induced collapse methods of demolition shall not be used unless they can be controlled and—

- (a) there is sufficient clear space in the direction of the collapse to ensure that collapsing materials will fall and remain within the confines of the site; and
- (b) the area onto which the collapsing materials are likely to fall is —
 - (i) capable of withstanding the impact of the falling materials; and
 - (ii) kept clear of all persons at the commencement of and during the collapse.

3.5.2 Pulling with ropes or chains

3.5.2.1 General

The rope or chain shall be of sufficient length so that the horizontal distance from the demolition work to the pulling mechanism is not less than 1.5 times the height from the pulling mechanism to the highest part of the structure to be pulled.

When pulling is in progress, no person shall be closer to the sides of the rope or chain than 75% of the horizontal distance between the pulling mechanism and the structure being demolished.

3.5.2.2 Ropes and chains

Ropes shall comply with AS 3569 and have a diameter not less than 12 mm. Chains shall comply with AS 2321 and be constructed from material of not less than 8 mm in diameter. The rope or chain shall be inspected by a competent person before use. Damaged ropes and chains shall not be used.

The rope or chain shall be firmly fixed at both ends and the tension shall be gradually applied.

3.5.2.3 Pulling mechanism

The pulling mechanism shall be capable of applying the required tension forces without sliding on, or lifting from, the surface on which it is located. Where the mass of the mechanism and the frictional forces developed between the mechanism and the surface are insufficient for this purpose, the necessary additional anchorage or counterweights, or both, shall be provided.

3.5.3 Direct pushing or pulling

Where collapse is to be induced by pushing or pulling directly on the structure with load-shifting equipment, the equipment shall be used and maintained in accordance with the manufacturer's recommendations

3.5.4 Collapse induced by explosives

Explosives shall not be used to induce the collapse of the whole, or parts, of a structure unless approved.

NOTE: The use of explosives is controlled by legislation in each State.

3.6 GUIDANCE

NOTE: See Appendix E for guidance on the demolition procedures for a range of structural systems.

APPENDIX A
DEMOLITION CHECK LIST
(Informative)

A1 PRELIMINARY INVESTIGATIONS

A1.1 Legal

- (a) Are there any statutory, regulatory, or other legal impediments to the demolition of the building?
- (b) Is the owner/principal legally empowered to have the building demolished?
- (c) Has the owner/principal identified all hazardous substances located on site including asbestos, PCBs, lead paint, underground storage tanks, chemicals, etc. as per Clause 1.6.1?
- (d) Has the owner/principal obtained permission to occupy adjoining neighbours' property, including airspace, for the purpose of erecting protective scaffold/screens for the demolition works.
- (e) Has the owner/principal provided all existing architectural, services and engineering drawings available for the demolition project?
- (f) Are the tender/contract documents sufficient and complete? (see Appendix B for further information).

A1.2 Structural

- (a) Identify principal structural materials (timber, masonry, steel, concrete) in roof, floors, columns, walls (external and internal).
- (b) Identify secondary materials in ceilings, wall-panelling, partitions, floor finishes.
- (c) Identify the structural system and check its elements for deterioration, viz. —
 - (i) elements resisting vertical loads (floors, beams, columns, walls); and
 - (ii) elements resisting horizontal loads (service cores, shear walls, braced frames, rigid frames).

NOTE: If no structural plans or specifications are available, the assistance of a structural engineer may be necessary for the last item.

A1.3 Services

From the drawings provided —

- (a) identify and locate service supply mains (water, electricity, gas) and extent of reticulations;
NOTE: If no services drawings are available, a services search company may need to be employed to locate all above- and in-ground services.
- (b) identify and locate emergency services (fire-detection and firefighting); and
- (c) establish nature, location and extent of other services (sewerage, drainage, airconditioning, lifts).

A1.4 Site

- (a) Identify and locate underground services and their points of entry to and exit from the site.

- (b) Determine levels of basements, cellars and other underground areas relative to —
 - (i) adjacent ground levels; and
 - (ii) adjoining basement or footing levels.
- (c) Identify retaining structures providing support to adjoining properties.
- (d) Determine the location, nature and condition of all hazardous substances identified in the Hazardous Substances Audit (see Clause 1.6.1).
- (e) Determine most suitable points of ingress to and egress from the site for —
 - (i) site personnel; and
 - (ii) demolition equipment
 and routes for removal of demolished materials.
- (f) Examine and record the condition of buildings on the adjoining sites, particularly where these abut a common boundary.
- (g) Determine the need for, and the extent of, any required security fencing, hoardings, or overhead protection for footpaths.

A2 WORK PLAN

- (a) Develop overall procedure based on investigations.
- (b) Develop a level-by-level procedure for stripping, breaking-up and removal of stripped and demolished materials.
- (c) From the level-by-level procedure, determine nature, number and sizes of mechanical equipment, and number and skills of personnel to be deployed on the working level.
- (d) Obtain advice from a structural engineer on whether structure of working level can safely sustain proposed loads and, if not, modify proposed procedures accordingly.
- (e) Ascertain what restrictions are imposed on working hours, use of public thoroughfares, noise levels, and the like.
- (f) Prepare detailed work plan, including a time chart, in accordance with Clause 2.3.
- (g) Obtain a written statement in accordance with Clause 2.3.
- (h) Obtain approval for the work plan.

A3 EXECUTION

A3.1 Preliminaries

- (a) Obtain all necessary permits and approvals and give all required notices.
- (b) Secure site boundaries with fences or hoardings as appropriate.
- (c) Establish permanent and emergency entrances and exits.
- (d) Establish amenities.
- (e) Fully inform all site personnel of the work plan, and safety procedures, and establish procedures for dealing with emergencies (accidents, fires).
- (f) Ensure that all necessary plant, equipment and tools are available and in good working order.

A3.2 Daily checks

A3.2.1 Before commencing

Before commencing work, check the following:

- (a) All openings and elevated free edges are properly guarded.
- (b) Any temporary bracing, shoring, or propping is tight, stable and secure.
- (c) All fire and safety services are operational and all other services to the working level have been properly disconnected.
- (d) All hazardous substances have been removed from the working level.
- (e) Lines of communication to the supervisor are clear and operational.
- (f) All emergency access routes are clear of debris and clearly marked.

A3.2.2 Before leaving

Before leaving the work site, check the following:

- (a) All partly demolished elements are stabilized.
- (b) All demolished materials have been removed or secured against inclement weather.
- (c) All fires or embers have been properly extinguished.
- (d) All emergency access routes are clear of debris and clearly marked.
- (e) All boundaries have been secured against unlawful entry.
- (f) All public thoroughfares are clear of demolished materials and any hazard is properly lit, guarded and clearly marked.

APPENDIX B
CONTRACTUAL CONSIDERATIONS
(Informative)

B1 GENERAL

Contractual arrangements for demolition works may be of two kinds, namely —

- (a) a main contract, in which the demolisher's contract is directly with the owner of the building (the Principal); or
- (b) a subcontract, in which the demolisher's contract is with another contractor who has a main contract arrangement with the Principal.

In both cases the contract is an agreement between the parties for specified work to be carried out by the demolition contractor for a sum of money (irrespective of how the sum is derived) and usually within a specified period of time.

The key element to a demolition contract is the agreement between the parties before commencement of the work. It is important, therefore, that there be a permanent record of the agreement and that the agreement covers unambiguously all aspects of the contractual arrangements. The contract documents are intended to fulfil this role and are taken to be mutually explanatory.

B2 CONTRACT DOCUMENTS**B2.1 General**

Like building contracts, contract documents for demolition works are composed of three major elements, namely —

- (a) the general conditions, which set out formally the obligations of the parties and their relationship to one another;
- (b) the plans, which delineate, in the form of drawings, the physical nature and extent of the work; and
- (c) the specification, which sets out in writing, in performance or prescriptive terms, the detailed description of the nature and extent of the work and specific requirements regarding each aspect of the work to be undertaken.

B2.2 General conditions

AS 2124/AS 4000 and AS 2545/AS 4901 should be used as the general conditions for demolition contracts. Both of these documents are widely accepted, by the construction industry and principals alike, as giving fair and just treatment to both parties to the contract. They clearly define the responsibilities and obligations of each party to one another and to third parties, in most areas where agreement is required. They also provide accepted rules for the making of payments and the settlement of disputes should they arise.

Although these documents are intended for use mainly in relation to contracts for the erection of buildings and structures, they are equally applicable to the demolition of buildings. In particular, AS 2545 is especially applicable where AS 2124 forms the conditions for the main contract. In the following it is assumed that one or both of these documents form part of the contract documents.

For a particular demolition project, some of the provisions of AS 2124 or AS 2545 may not be entirely appropriate. In such cases the relevant clauses may be overridden or suitably modified by special conditions of contract, annexed to the general conditions.

B2.3 Special conditions

Because AS 2124 and AS 2545 are of a general nature, they will rarely be fully sufficient by themselves for a particular project. It is usual, therefore, to supplement their requirements with 'special conditions' appropriate to the project in hand. As indicated above, special conditions should also be added where the general conditions need to be overridden or modified for the particular project and both of these documents make provision for this to be done.

Ownership of demolished materials is a typical example of the need for a special condition. Unless otherwise assigned, demolished materials belong to the Principal; legally, so too are any costs or profits accruing from their disposal. This situation is not covered in the general conditions and agreement on this subject will need to be covered by a special condition, or specified in one of the other contract documents.

The provision of plans by the Principal may be another area requiring special conditions. This is dealt with more fully in the following.

B2.4 Plans

The provision of plans by the Principal is covered in the General Conditions. In the case of a construction contract situation, the Principal or his agent (architect, engineer) would certainly be in the best position to provide the necessary documents. This may also be the case where demolition is part of an overall construction project, i.e. a subcontract situation, and the Principal is also the original owner of the building to be demolished.

In other circumstances, such as the consolidation of adjacent sites for redevelopment sale, the Principal may be the latest in a succession of owners and, therefore, in no better position to obtain the required information any quicker than the contractor. However, by virtue of ownership, a Principal should have more ready access to the documents where these are held by other parties.

It is essential that as much information as possible about the building be made available to the demolition contractor at the earliest possible time, and because circumstances will vary greatly from project to project, it is essential that the provision of plans by one or other of the contracting parties be clearly spelt out in the contract documents. Since the 'provisions' regarding plans of the General Conditions has only limited application, as noted above, this matter should be included in either the Special Conditions or the specification.

B2.5 Specification

Because it is specific to the particular project, the project specification is equally as important as the plans.

If the demolition is part of an overall construction contract, the Principal's specification would normally cover demolition aspects either in the 'Preliminaries' section, or as a separate 'Trade' item.

As the Standard requires a work plan (see Clause 2.3), it could be included as part (or instead) of a specification, depending on the particular circumstances.

It is important that the extent of the works be clearly defined in the specification (or the work plan). This is particularly so where partial demolition, or demolition below adjacent ground level is concerned. The removal of footings, or below-ground retaining walls, can be a hazard to the stability of adjoining ground and buildings, especially if there is likely to be a significant delay before the ground can be permanently supported by subsequent construction.

The specified extent of work is also of vital importance in a subcontract situation where the interface between trades needs to be considered.

B3 CONTRACT ADMINISTRATION

Most aspects of contract administration are covered formally in the General Conditions (AS 2124 and AS 2545). The key to smooth running of the project from this point of view however, is a well documented working plan and a fully instructed, capable workforce. Equally as important, from the strictly administrative viewpoint, is the keeping of proper records during the progress of the work and the giving of timely notices (in writing) when required, or when unforeseen circumstances arise. Verbal instructions, whether given or received, should always be confirmed in writing.

Both this Standard and the General Conditions require supervision of the work by a competent person. In addition, the General Conditions requires that the supervisor be the contractor or his nominated representative. The contractor should, therefore, ensure that the supervisor has the expertise and experience to carry out the work in a safe and timely manner and to manage available labour and equipment resources efficiently and economically.

B4 OTHER MATTERS

A prudent Principal should, as a matter of course, establish the bonafides of the contractors employed, namely that they have the necessary expertise, labour and equipment to carry out the contract for the agreed amount, within the agreed time and in the manner specified in the contract documents. The contractor should, therefore, be prepared and able to provide to the Principal, such information as is required for this purpose.

Likewise, a prudent contractor should establish that the Principal is the rightful owner of the property to be demolished, and has the capacity to pay for the work. As indicated in Paragraph A1 of Appendix A, it would also be prudent for the contractor to ascertain before commencing that there are no statutory, regulatory or other legal impediments to the demolition of the structure concerned, or at least to ensure that he is suitably indemnified against such a situation.

Although these considerations are not strictly matters for contractual agreement, they are an important part of the issues to be settled before entering into a contractual arrangement.

NOTE: AS 4000 and AS 4901 may be used in place of AS 2124 and AS 2545, respectively.

APPENDIX C
CERTIFICATION AND QUALIFICATIONS OF PERSONNEL

(Informative)

Licensing or registration of demolition personnel is currently required in most States and Territories, which is in addition to the recognized competency certificates common to both the demolition and construction industries such as —

- (a) crane operators, doggers, chasers and spotters;
- (b) plant operators;
- (c) load-shifting operators;
- (d) riggers;
- (e) hoist and lift operators;
- (f) scaffolders; or
- (g) first aid personnel.
- (h) The recognition of competency for demolition personnel varies throughout Australia.

Table C1 shows a summary of the registration/licensing details.

TABLE C1
STATES AND TERRITORIES LICENCING REQUIREMENTS

State/ Territory	Act governing	Registration body	Licensing requirements
NSW	Occupational Health and Safety Act 2000	WorkCover	WorkCover
Vic	Building Act 1993, Building Regulators Act 1994	Building Control Commission, Building Practitioners Board	Building Practitioners Board
SA	Building Workers Contractors Act 1995	Workplace Services	Consumer and Business Affairs
WA	Occupational Health and Safety Act 1996	WorkSafe WA	WorkSafe WA
Qld	Occupational Health and Safety Act 1995	Department of Industrial Relations — Workplace Health and Safety Division	Department of Industrial Relations — Workplace Health and Safety Division
TAS	Occupational Health and Safety Act 1995	Department of Infrastructure and Energy Resources — Workplace safety Board of Tasmania	NA
ACT	Building Act 1972	Building Electrical and Plumbing Control (BEPCON)	Builders Licence
NT	Health Work act 1986	Department of Industry and Business—Work Health Authority Section	NA

APPENDIX D

NOTES ON THE DEMOLITION OF PRESTRESSED CONCRETE STRUCTURES

(Informative)

D1 BACKGROUND**D1.1 Historical**

Commercial prestressing systems were first introduced into Australia in the early 1950s when locally manufactured precast and prestressed floor units became available in Victoria. By the mid 1950s, prestressing was also being used in some cast in situ construction, and by the end of the decade both forms of construction were well established. The first Australian Standard on prestressed concrete (CA 35) was published in 1963, by which time the use of prestressing, in at least some building structures, had spread to most major urban centres.

From the demolition point of view, it can be seen from the above that concrete building structures built prior to 1950 would not be prestressed. For a few buildings constructed between 1950 and 1960 it is possible that some precast elements, particularly flooring units, are prestressed. For certain types of buildings constructed after 1960 there is a reasonable probability that the structure is prestressed, at least in some major structural elements..

D1.2 Prestressed concrete

Like normally reinforced concrete, prestressed concrete utilizes the tensile strength of steel to overcome the low tensile strength of concrete. However, unlike normally reinforced concrete, the prestressing steel is stretched from outside the member before the member receives its principal load. The forces in this stretched reinforcement are transferred to the member, by a variety of means, as compressive stresses in the concrete, which reduce or nullify the tensile stresses arising from the external loads.

Prestressing reinforcement, or tendons, also differs from normal bar reinforcement in that it usually consists either of high-tensile wires from 5 mm to 7 mm in diameter arranged singly or in groups, or of high-tensile steel cables approximately 9 mm to 15 mm in overall diameter and again arranged singly or in groups. Tendons can also consist of single high-tensile steel bars from 19 mm to 38 mm in diameter, with threaded ends. Single or grouped wires are most likely to be found in precast elements, whereas cables are generally found in cast in situ elements, although they are also used to join segmental precast units so that they act together as a single structural member.

D1.3 Methods of prestressing

There are two basic methods of prestressing, namely pre-tensioning and post-tensioning to distinguish whether stressing (tensioning) of the tendons occurs before, or after the casting of the concrete respectively.

- (a) *Pre-tensioning* Pre-tensioned members are formed up between pairs of rigid buttresses spaced so that there is a working clearance between the ends of the forms and the adjacent buttress. The tendons pass through close-fitting holes in the ends of the forms and are attached at each end to the buttresses.

Before casting the concrete, the tendons are tensioned (usually by hydraulic jacks) and anchored in their stretched condition to the buttresses, as shown in Figure D1(a). The concrete is then placed in the forms around the tendons, compacted, cured and stripped. When it has attained its specified transfer strength, the anchorage of the tendons at the buttresses is gradually released, transferring the restraining forces from the embedded tendons to the concrete by direct bond. The slack tendon protruding

from the member is then cut off flush with the ends of the member as shown in Figure D1(b) and the member removed from between the buttresses.

Pre-tensioning is best suited to precasting techniques and is found almost exclusively in this type of member.

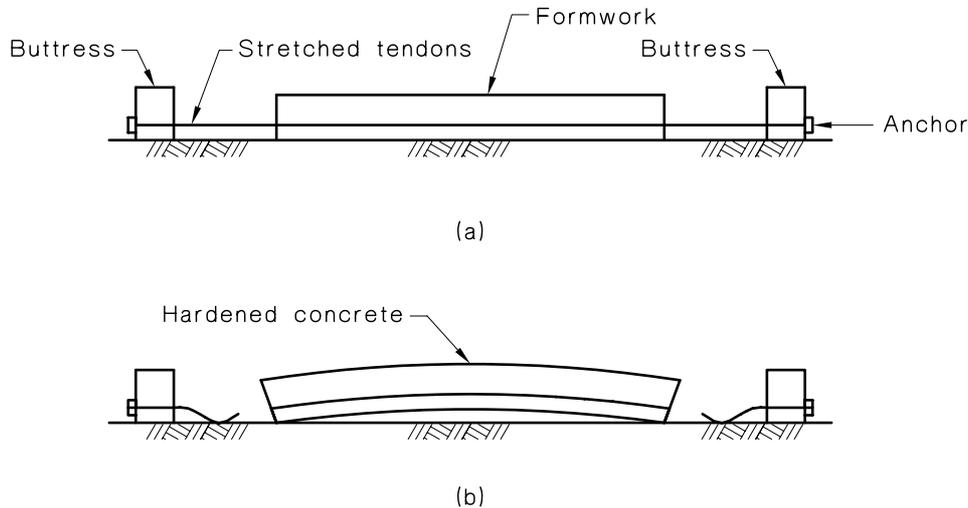


FIGURE D1 PRE-TENSIONING

- (b) *Post-tensioning* Post-tensioned members are formed up as for normally reinforced in situ members. The tendons are placed loose in hollow metal tubes, or ducts, which terminate in steel anchor plates through which the tendons pass. The ducts with the tendons are placed in the forms with the tendons protruding outside, and the anchor plates fixed to the forms and sealed to prevent wet concrete from entering the ducts. The concrete is then placed around the ducts, compacted, cured and vertical faces stripped at the appropriate time, the member being supported by the remaining formwork.

When the concrete has attained its specified transfer strength, hydraulic jacks are attached to the tendons and the tendons stressed and anchored against the anchor plates as shown in Figure D2.

After tensioning of all tendons has been completed, the ducts are filled with liquid cement grout under pressure. When the grout has hardened, the tendons are fully bonded to it and the duct but only indirectly bonded to the concrete around the duct. Supporting formwork can then be removed and the external loads applied.

If the tendons are short, or if there is insufficient clearance from adjoining construction to permit stressing at one of the ends of the tendons, the tendons at that end are fixed to a steel anchor plate, called a dead-end anchor, which is embedded directly in the concrete when it is cast. Stressing is then carried out from one end only, following the same sequence as previously.



(a) Tendon placing



(b) Concreting



(c) Stressing



(d) Grouting

FIGURE D2 POST-TENSIONING

- (c) *Bonded and unbonded tendons* As noted in Item (a) above, in pre-tensioned members the tendons are bonded directly to the concrete in which they are embedded, relying on this bond to transfer the pre-stressing forces into the concrete. In post-tensioned members however, the pre-stressing forces are transferred to the concrete by means of the end plates to which the tendons are mechanically anchored, there being no direct bond between the tendons and the concrete surrounding the ducts. Post-tensioned members, therefore, are essentially unbonded when first stressed and will remain so until the ducts are grouted.

Although grouting of post-tensioned tendons is intended primarily to protect the tendon against corrosion, it also serves to bond the tendons (indirectly) to the surrounding concrete and helps to reduce loss of prestress arising from certain time-dependent factors. Post-tensioned tendons that have been grouted are, therefore, considered to be bonded.

Unlike some overseas Standards, the Australian Standard for prestressed concrete has always required that the ducts for post-tensioned tendons be grouted as soon as practicable after stressing is completed. The only exception to this requirement has always been for pavement slabs or footing beams that are supported directly on the ground, in which case other methods (such as greasing) are required to prevent corrosion of the tendons.

Apart from these exceptions, it is unlikely that post-tensioned structures erected after 1963 will contain unbonded tendons.

D2 DEMOLITION

D2.1 General

Because there are some additional hazards in demolishing prestressed structures, it is important for the demolition contractor to be able to identify prestressed concrete members and distinguish between these and normally reinforced concrete members.

D2.2 Identifying prestressed members

As illustrated in Figure D2, post-tensioned members usually have a surface recess at tendon locations to allow the anchorage to be protected by a mortar covering. The mortar is usually of a different colour to the member concrete and, due to differential shrinkage, a hairline crack is frequently visible around the edge of the recess. Unless the face has been rendered, such anchorages will be easily visible on the ends of post-tensioned beams or along the external edges of post-tensioned slabs. Similar telltale marks will be detected where post-tensioning has been used to join precast members together.

As noted in Paragraph D1.3(a), the tendons in pre-tensioned members have to be cut off or ground flush with the ends of the member. To protect the exposed ends of the tendons against corrosion they are usually covered with a cement render and, hence, may not be easily visible. A light scabbling of the rendered face should reveal their presence.

Where the above indicators are inaccessible or otherwise hidden by other parts of the structure, there are a number of other indicators that can help to identify prestressed members, as follows:

- (a) *Spans* Long span beams or slabs are likely to be prestressed. For beams this would apply to spans of 9 m or more and for slabs, to spans of about 8 m or more. Shorter spans may also be prestressed if heavy permanent loads, such as brickwork or loads from higher storeys, form a large proportion of the total load carried by the member.
- (b) *Slenderness* Suspended prestressed members generally, are more slender than corresponding normally reinforced members. This means that a prestressed member will usually have a shallower overall depth than a normally reinforced member of the same span. Prestressed beams that have been precast will also usually have thinner webs than their reinforced counterparts and their cross-sections are often more complex than the simple rectangular, or uniformly tapering webs of normally reinforced beams.
- (c) *Soffit unevenness* Precast floor units that are prestressed usually have a slight upward camber. Because variability of the prestressing force increases the variability of the deflection characteristics of the units, adjacent prestressed units will generally exhibit a greater unevenness in the plane of their soffits than ordinary precast units.

D2.3 Hazards

The most dangerous hazards associated with the demolition of prestressed structures are related to post-tensioned members with unbonded or inadequately bonded tendons.

First, because members with unbonded tendons rely solely on the integrity of the tendons and their anchorages to transfer the prestress to the concrete, cutting of one or more tendons, or damaging their anchorages, will result in loss of the prestressing force along the entire length of the tendon. Members and floors constructed with unbonded tendons will therefore require propping over their entire length or area to avoid sudden and catastrophic collapse when the tendons are cut. Second, large amounts of energy are stored in the stretched tendons. If this is suddenly released by cutting the tendons, the energy is

transformed into motion of the tendons, which may thereby be expelled some 300 mm to 600 mm from the ends of their anchorages.

Where tendons that are supposed to be fully grouted are, for one reason or another, only partly grouted, similar but somewhat less severe effects are likely if the tendons are cut. Instead of complete collapse, a sudden large deflection may occur and some movement of the anchorage may be the result.

While neither of the abovementioned hazards apply to members with pre-tensioned or post-tensioned and fully grouted tendons, another type of hazard needs to be considered for prestressed beams in general.

The other hazard is related to the sensitivity of prestressed beams to their orientation with respect to the direction of loading. The beams are generally designed to resist loads acting downward in the vertical plane and usually have little resistance to loads acting either vertically upward along their length, or horizontally and perpendicular to their length. Furthermore, the prestressing force is designed to counteract mainly the weight of the beam in its normal orientation. Hence turning a prestressed beam on its side or upside down, particularly when it is suspended, can also cause it to collapse suddenly and catastrophically even though its tendons are bonded.

A somewhat different hazard applies to the special class of post-tensioned prestressed beams known as 'transfer beams'. These are usually located at the first floor levels of multistorey buildings and are designed to transfer the loads from upper storeys to more widely spaced supports below, to create large open spaces at ground floor level. During the construction phase, the tendons in such beams are partially stressed in progressive stages, to balance the loads as they increase over the construction period. Final stressing and grouting occur when the building reaches full height. If no action is taken to reverse the effects of this procedure during demolition, the beam will tend to bow upward an increasing amount as the load from above is reduced. This can lead to local failure of the structure at, or just below, the working level, or to a reverse bending failure and collapse of the transfer beam itself, well below working level, with a consequent progressive collapse of the entire structure.

D2.4 Demolition techniques

D2.4.1 *Pre-tensioned and grouted post-tensioned members*

Pre-tensioned and fully grouted post-tensioned members may be demolished generally as for normally reinforced members, apart from the proviso regarding the orientation of beams while handling them. For this latter reason, beams prestressed in this manner should be fully supported along their soffits, preferably on a lower floor, before being broken up into smaller segments for final removal.

For post-tensioned members generally, no personnel should be allowed in the area in line with a tendon and its anchorages when the tendon is being cut for the first time. If there is some doubt as to whether a tendon is fully grouted or not, the member should be propped from below and sandbags placed around the anchorages as an additional precaution.

For transfer beams, an experienced structural engineer and/or the prestressing equipment supplier should be consulted before attempting any demolition of the structure over the beam, and an appropriate procedure determined. Such procedures should include monitoring of the upward camber of the beam as it is progressively relieved of its load.

D2.4.2 *UngROUTED post-tensioned members*

Demolition of ungrouted post-tensioned members should not be attempted without prior consultation with an experienced structural engineer and/or the supplier of the prestressing equipment. If the member is suspended, the procedure should at the least include full propping of the soffit before any attempt is made to de-tension the tendons.

APPENDIX E
GUIDANCE ON DEMOLITION PROCEDURES
(Informative)

E1 INTRODUCTION

Unlike most industries, demolition is an occupation where the people working within it are unlikely to encounter the same procedures from one job to another. Every demolition project is unique and, as such, requires a unique approach to planning and execution.

This Appendix provides a range of demolition procedures available to the demolisher. It is realised that these are not the only methods available, nor will the procedures listed be suitable for all cases.

E2 COLUMNS AND WALLS

E2.1 General

Columns and walls have to be cut off, or otherwise broken down, close to floor level.

Where demolition of the unsupported height of a column or wall is to be carried out by felling onto a suspended floor, action has to be taken to minimize the effect of impact on the floor.

Freestanding columns or walls are not to be left laterally unsupported.

Masonry walls are inherently unstable and controls need to be implemented to effect the removal of the wall without affecting the stability of the remaining wall section.

E3 ROOF AND FLOOR SYSTEMS

E3.1 General

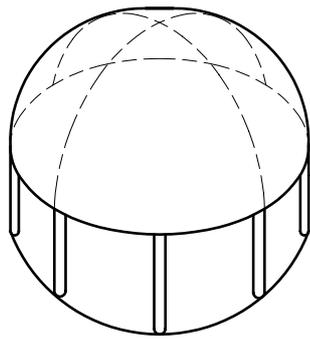
Working on the principle that a demolition job is usually carried out in reverse order to its construction, the removal of roofs is usually the first activity and care should be taken due to the height that this work entails. The remaining structure should be removed systematically, storey by storey, to maintain its structural integrity during demolition.

E3.2 Domed, vaulted or arched roofs

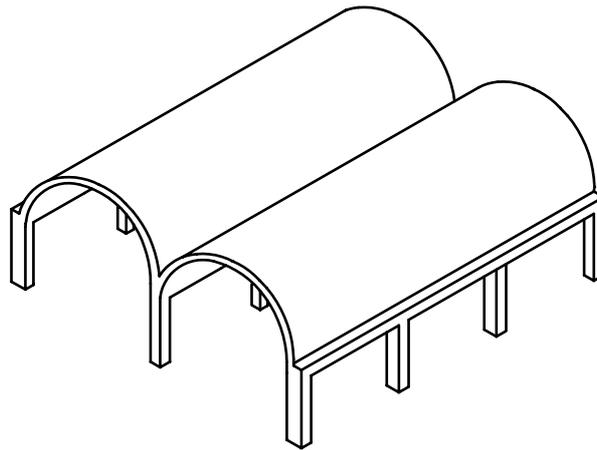
Domed, vaulted or arched roofs (see Figure E1) should not be demolished without consultation with, and direction from, a competent person conversant with this type of structure.

NOTES:

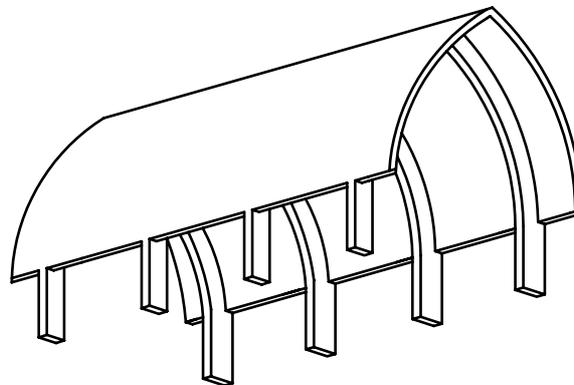
- 1 The competent person should preferably be a structural engineer.
- 2 The stability of these types of roofs is dependent on the resistance to the vertical and horizontal forces developed at their supports. Uncontrolled or even unbalanced release of these forces can result in the sudden collapse of the entire roof.
- 3 The stability of these types of roofs is complex and should be demolished with extra care.



(a) Spherical dome



(b) Barrel vault



(c) Ribbed arch

FIGURE E1 DOMED, VAULTED AND ARCHED ROOFS

E3.3 Flat roofs

Flat roofs should be demolished as for floors.

E3.4 Steel-framed floor systems

E3.4.1 General

Demolition of floor decks supported on columns by a system of steel beams (exposed or encased) should proceed from the perimeter of the floor towards elements that provide resistance to lateral movement of the structure (braced frames, service cores, shear walls and the like).

Beams that provide lateral support to external walls should not be removed until the wall has been suitably stabilized by temporary back-tying, propping, or bracing.

Individual beams should be temporarily supported while their connections to supporting members are being cut, or otherwise disengaged.

E3.4.2 Procedure

For an approximately rectangular panel supported at its corners by columns, the procedure should be as follows:

- (a) Remove the deck from between the supporting steel beams and expose all beam-to-beam and beam-to-column connections.

- (b) Disengage both ends of the secondary beams from their supports on the main beams, by cutting or unbolting the connections as appropriate and either lower the beam to the next level below, or hoist it up then lower it directly to the level from which it is to be removed from the site.
- (c) Disengage both ends of the main beams from their connections to the columns, then proceed as for step (b).

E3.4.3 *Composite steel-and-concrete floors*

Where composite action between a steel beam and a concrete floor slab is relied upon to carry vertical loads, the strength and stability of the steel beam, when separated from the slab, should be checked. If the beam in this condition is found to be inadequate, mid-span support should be provided, in addition to the support recommended by Paragraph E3.4.1, before the slab is removed from either side of the beam.

NOTES:

- 1 Reliance on composite action is usually indicated by the presence of headed steel studs, or angle cleats, welded all along the top flange of the beam and embedded in the thickness of the slab. Preformed sheet-steel decking, which covers the entire slab soffit, is frequently used in conjunction with this type of construction.
- 2 A critical situation may occur when the slab and secondary beams have been removed from one side of a main beam while the slab remaining on the other side is loaded with demolished materials or plant, or both.

E3.5 Concrete-framed floor systems

E3.5.1 *General*

The procedure to be adopted for the demolition of concrete-framed floor systems should take into account the manner in which the floor is designed to transfer loads to its supports. Cantilevered portions of a floor should be demolished before any other portion.

Unless otherwise specified in the approved work plan, procedures should be in accordance with one or more of Paragraphs E2.5.2 to E2.5.5, as appropriate.

NOTE: In general the procedure will depend on whether a one-way or two-way transfer system is to be demolished and on what combination of beams, ribs, columns or walls has been used to support the slab. The most frequently encountered systems are illustrated in Figure E2.

E3.5.2 *Slabs supported only by beams or walls*

Slab panels supported only by beams or walls, or a combination of both, should be demolished in accordance with one of the following:

- (a) Where support is provided on only two opposite sides of the panel, demolish the slabs in strips with their length at right angles to the supporting members. The strips should be not more than 1.0 m wide and may be demolished —
 - (i) from the centre of the strip towards its supports, except for the last strip; or
 - (ii) as for a beam in accordance with Paragraph E2.6.
- (b) Where support is provided on all four sides, the slab can be demolished either —
 - (i) in strips as for Item (a), with the length of the strips parallel to the shorter span of the panel; or
 - (ii) from the centre of the panel towards the supports but only if the ratio of the longer span to the shorter span is not greater than 2.0.

E3.5.3 *Slab panels supported by beams and columns*

Where the floor system is composed of a series of slab panels supported by beams that frame into columns, the slab panels between beams should be demolished in accordance with Paragraph E2.5.2 and the beams in accordance with Paragraph E2.6.

The sequence of demolition of the beams, at any level, should be such that any column carrying vertical load from an undemolished portion of the slab is tied in two directions, at right angles to another to a member that provides resistance to lateral movement of the structure.

E3.5.4 *Slabs without beams, supported by columns (flat slabs)*

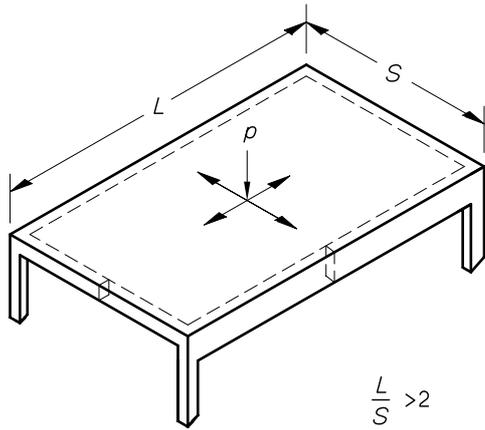
Where the floor at any level is composed of a slab, with or without dropped panels, supported principally by rows of columns that are not interconnected by beams, the procedure for demolition of the floor at that level should be in accordance with the following:

- (a) Proceed from the perimeter of the floor towards those members that provide resistance to lateral movement of the structure (e.g. braced frames, service cores, shear walls and the like).
- (b) In any rectangular panel supported by columns at its corners, proceed from the centre of the panel towards the centre-lines of the rows of columns forming its edges, until the columns are left joined by strips of slab of width not less than one quarter of the span between adjoining columns.
- (c) When all the panels surrounding a column have been reduced in accordance with Item (b), demolish the remaining slab strips intersecting at that column as for beams in accordance with Paragraph E2.6.

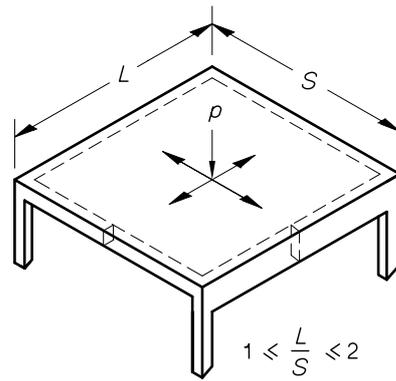
In no case should a column be completely separated from its surrounding slab until the procedures given in Items (b) and (c) have been completed.

NOTES:

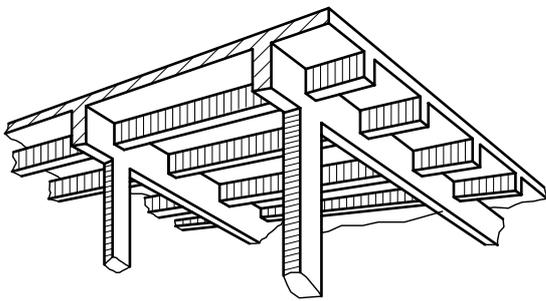
- 1 Although flat slabs are principally supported by columns without beams, support at the perimeter of a floor is often provided by spandrel beams between columns, or by walls.
- 2 In many cases the soffits of flat slabs are stepped down in an area around the columns (drop panels) or the columns are flared (column capitals) just below the soffit of the slab or drop panel. The presence of dropped panels or column capitals, or both, is a good indicator of flat-slab construction.
- 3 In flat-slab construction, both top and bottom reinforcement is usually more heavily concentrated in fairly narrow strips, centred on each row of columns.



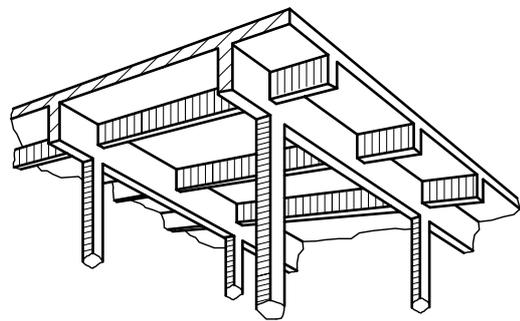
(a) One-way system



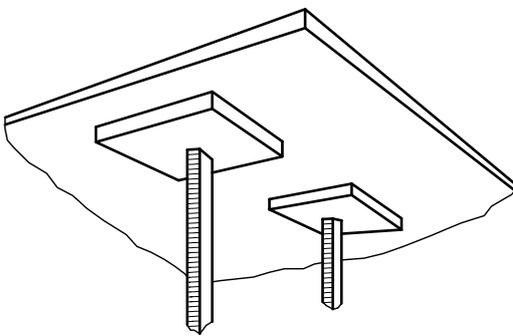
(b) Two-way system



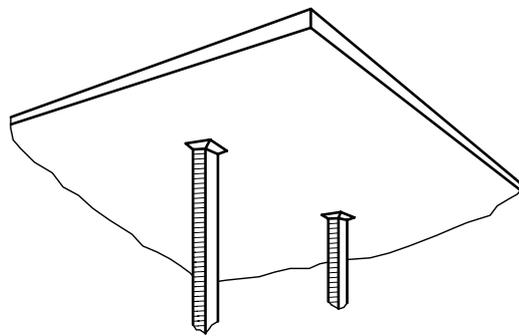
(c) One-way slab and beam
(beam and joist system)



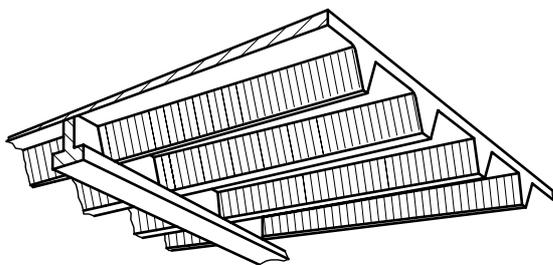
(d) Two-way slab and beam



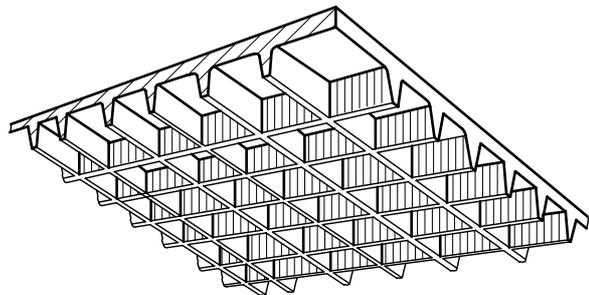
(e) Two-way flat slab



(f) Two-way flat plate



(g) One-way ribbed



(d) Two-way ribbed
(waffle slab)

FIGURE E2 CONCRETE FRAMED FLOOR SYSTEMS

E3.5.5 Ribbed slabs

Where the floor system is composed of a series of equally spaced parallel ribs in one or two directions, the demolition procedure should be in accordance with one of the following:

- (a) Where the ribs run in only one direction (slab and joist) and they are —
 - (i) cast integrally with the slab, the procedure should be in accordance with Paragraph E2.5.2(a), not more than one rib and half the width of slab on either side of it being included in each strip; or
 - (ii) precast units with an insitu topping slab, the procedure should be as for beams in accordance with Paragraph E2.6, each precast unit with the slab directly over it being treated as a separate beam.
- (b) Where the ribs run in two directions at right angles to one another (waffle slab) and support is provided —
 - (i) on all four sides by beams or walls, the procedure should be in accordance with Paragraph E2.5.2(b); or
 - (ii) principally by columns, the procedure should be in accordance with Paragraph E2.5.4.

NOTES:

- 1 Long span, one-way ribbed slabs may have one or two transverse ribs within the span. This does not constitute a two-way system.
- 2 Rib formers, in both one-way and two-way systems, are sometimes made from moulded fibreglass or rigid plastics, which remains as the external finish for the slab soffit. The presence of such formers will need to be determined positively, to distinguish between integrally cast and precast ribs and slabs.

E3.6 Beams in beam-and-slab construction

E3.6.1 Single span beams supported on walls

After detachment from their slabs, single span beams supported on walls should be —

- (a) lifted near each end and, if possible, lowered in one piece to a suitable level for breaking up and removal; or
- (b) if too heavy for lifting and lowering in one piece, temporarily supported within the span and cut into lengths suitable for lifting and lowering with the available hoisting equipment, in a manner similar to that shown in Figure E3.

NOTE: All beam supports have to be in position before the commencement of cutting and lifting.

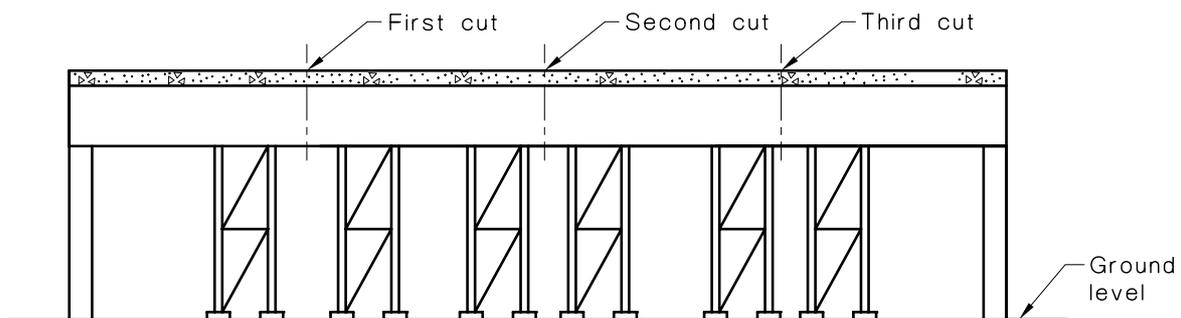


FIGURE E3 DEMOLITION OF A HEAVY SINGLE SPAN BEAM

E3.6.2 *Multiple span beams supported on walls*

After detachment from their slabs, multiple span beams should first be temporarily supported at mid-span then cut through at the centre-line of supports over which they are continuous except that, if a supporting wall is less than 200 mm thick, additional temporary support to the beam should be provided close to each side of that wall before the beam is cut. Each span should then be demolished in accordance with Paragraph E2.6.1.

E3.6.3 *Beams framing into columns*

Where the ends of a beam frame into concrete columns, the following procedure should be used:

- (a) Demolish cantilever portions first.
- (b) Demolish the beam in a manner that does not cause its joints with the columns —
 - (i) to rotate excessively; or
 - (ii) to be laterally displaced excessively with respect to the corresponding joint immediately below.

Columns are not usually designed to take the large amount of bending implied in Item (b), and may collapse suddenly by buckling as a consequence.

E4 LIFTS

E4.1 General

Decommissioning of a lift is a task best left to those with experience in the field. As with all aspects of demolition, there are different methods available, depending on the circumstances found on site.

E4.2 Demolition procedures for lifts

When a lift is no longer required, the following procedures should be carried out in an appropriate order:

- (a) Make the lift car independent of its hoisting cable by timber shoring or other suitable means of support.
- (b) Disconnect electrical power to all areas of the lift machinery.
- (c) Where applicable, lower the counterweight to a convenient level and disconnect. Complete unwinding of the cables in a controlled manner.
- (d) Before the removal of the lift machinery room and lift cars, deck over the lift shaft, at least at the two levels immediately below the relevant level, and barricade all lift door openings.

NOTE: On no account should counterweights be allowed to fall freely to the lift pits from upper levels.

E5 BASEMENTS AND OTHER BELOW-GROUND STRUCTURES

E5.1 General

No demolition of basements, cellars and similar below-ground structures, or of those parts of the structure that provide lateral support to them, should be undertaken until either —

- (a) a competent person has assessed site conditions
- (b) it has been established that demolition of the walls or their supporting parts will not cause collapse of the adjoining ground; or
- (c) effective lateral support has been provided to the ground outside the walls.

E5.2 Prevention of flotation

Where a basement has been built in-ground having a high standing water table level, adequate precautions should be taken to prevent flotation when the superstructure is removed.

E6 Storage tanks

Storage tanks should be emptied and gas-freed in accordance with the requirements of AS 1940.

Site specific requirements should include the following:

- (a) Contractor to prepare a detailed work statement describing work methods to be used and demolition exclusion zones to prevent unauthorized persons from entering the zone.
- (b) Restriction and elimination of hot flame, grinding or heat-generating equipment, cutting with cold cutting such as mechanical hydraulic shears is the preferred optional method.
- (c) Ongoing gas testing requirements.
- (d) Whether materials arising from the works is suitable for recycling and in the case of steel whether it is suitable for resale as structural or scrap steel or whether contamination renders it totally unsuitable whereupon disposal is required at a specific landfill site.
- (e) Availability of personal protective equipment, which may include breathing apparatus.
- (f) Fire training with available fire equipment
- (g) First aid equipment.
- (h) Falling from height protective measures.
- (i) Emergency training in the event of major safety incident.
- (j) Action required in the event of significant change in work conditions.
- (k) Effective communication between employees working at heights, or within tanks or other receptacles, to site supervisors and hoisting operators.
- (l) Display of appropriate 'danger' notices.
- (m) Environmental considerations where equipment leakage may have contaminated adjoining ground soil.
- (n) Site security.
- (o) Access and egress.
- (p) Tank warning, for example, a notice adjacent to all tank entries, 'Follow all safe work requirements and notices when working on, or in this tank/receptacle'.
- (q) Protection of any live services and systems.
- (r) Dust suppression methods.
- (s) Work permit application.
- (t) Certification by the client or his representative that the tanks are disconnected from all live services.
- (u) Demolition to proceed in accordance with the approved work plan.

(v) Site induction for all employees

NOTE: The contractor should be provided with a specification fully describing the works in order that all parties undertaking the task have an appreciation of the extent and complexity of the work. This is a basic requirement and with sound knowledge and planning, the contractor should be able to complete the work safely and effectively.

E7 CHIMNEYS

E7.1 General

Chimneys and other tall structures require a particular skill and expertise to demolish in a safe and controlled manner. These structures should only be demolished by contractors who are competent and experienced to do so in a safe and controlled manner.

E7.2 Masonry chimneys

E7.2.1 *Manual demolition*

Manual demolition of masonry chimneys should be carried out from a safe working platform. The platform should be supported by either an internal or external scaffold.

When external scaffolding is used, debris and rubble should be dropped inside the chimney. The debris should be progressively removed to restrict lateral pressure on the walls of the chimney. During removal of rubble and debris, all demolition work overhead should cease.

E7.2.2 *Demolition ball*

The demolition ball should be used in accordance with Clause 3.4.3.1, working progressively from the top of the chimney.

E7.2.3 *Induced collapse*

Induced collapse of masonry chimneys should be used only where a clear space, defined as that segment of a circle centred on the chimney, having an included angle of 40°, being 20° each side of the proposed line of fall, and a radius of at least 1.5 times the total height of the chimney, is available for fall (see Figure E4). The chimney should be felled by a systematic weakening of the base courses on the side of the line of fall. Demolition by explosives should be in accordance with Clause 3.5.4.

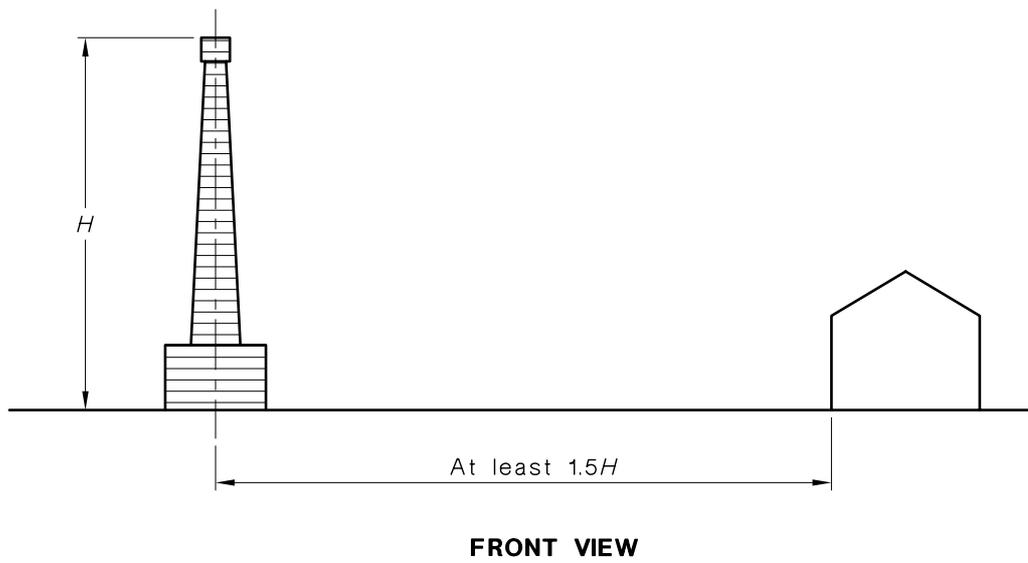
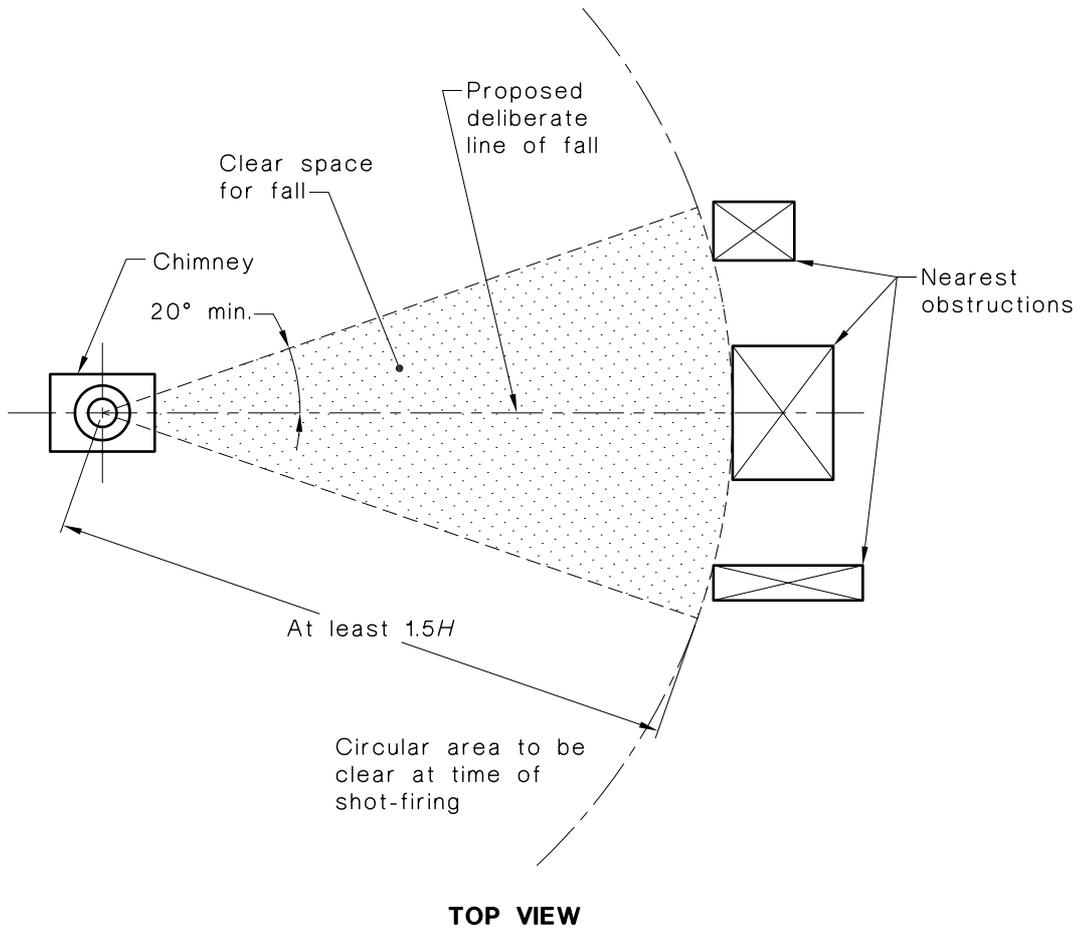


FIGURE E4 FELLING OF MASONRY CHIMNEYS

E7.3 Steel chimneys

E7.3.1 Manual demolition

Manual demolition of steel chimneys should be carried out from a safe working platform supported by an external scaffold.

The chimney should be dismantled from the top. The steel plate should be cut into manageable size portions and lowered to the ground. The internal lining should be demolished progressively with the steelwork and, if appropriate, the rubble and debris allowed to fall to the ground internally. Rubble and debris should be progressively cleared in accordance with Clause 3.4.1.2. During removal of rubble and debris, all demolition work overhead should cease.

Temporary guys should be fixed where necessary. Temporary and permanent guys should be removed systematically as demolition progresses.

E7.3.2 Induced collapse

Induced collapse of steel chimneys should be used only where the clear space defined in Paragraph E7.2.3 is available.

Movement of the chimney should be observed. If the chimney is guyed, two steel wire ropes should be attached at 45° on plan to each side of the line of fall before felling. The rope should be made taut and the guys on the far side of the line of fall should be systematically severed.

E7.4 Concrete chimneys (in situ and precast)

E7.4.1 Manual demolition

Manual demolition of reinforced concrete chimneys should be carried out from a safe working platform supported by an external scaffold.

Starting at the top, the chimney should be either progressively reduced to rubble by manual methods, or dismantled in sections, which are lowered to the ground. The concrete between sections should be removed to expose the reinforcement and each section should be supported while the reinforcement is cut. The lining should be demolished progressively with the shaft.

Rubble and debris may be allowed to fall to the ground internally and should be removed progressively in accordance with Clause 3.4.1.2. During removal of rubble and debris all overhead demolition work should cease.

E7.4.2 Induced collapse

Induced collapse of reinforced concrete chimneys should be in accordance with Paragraph E7.2.3.

E8 REINFORCED PRECAST PANEL WALLS

Where a wall is composed of a series of reinforced precast panels, the nature and condition of the fixings to the rest of the structure and of the jointing between panels should be determined before any demolition of the wall commences.

The following procedure should be used during the course of demolition:

- (a) Remove the panels in the reverse sequence to that used for their erection.
- (b) Where the wall acts as bracing in the direction of its length, provide sufficient temporary bracing in that direction, to the structure as a whole or to adjacent parts, to maintain their stability during and after removal of the panels.

- (c) When lifting or lowering a panel, exercise extreme caution and care when using the original lifting points, fittings or fixings as points of attachment or support, or use of new lifting points or other methods. When removing any individual panel, it should be —
 - (i) fully supported vertically and horizontally while being detached from the rest of the structure; and
 - (ii) lowered to a horizontal position before being broken up.

E9 REINFORCED CONCRETE TILT-UP PANELS

Where a wall is composed of a series of reinforced concrete tilt-up panels, the nature and condition of the fixings to the rest of the structure should be determined before any demolition of the walls commences.

In tilt-up wall construction the concrete wall panels usually form an integral part of the building structure in that they are used to support the building roof and, in the case of multi-level buildings, the perimeter of the upper level floors.

The following should be carried out before commencing demolition:

- (a) The roof structure and the perimeter of upper level floors must be independently supported.
- (b) The tilt-up wall panels must be braced. If original cast-in fittings are used for the attachment of the braces they should be carefully checked for corrosion or damage.
- (c) The method of connection of the base of the wall panels to the ground floor slab or footings is likely to be hidden and must be determined so an appropriate method of demolition can be determined. Similarly with the connection of the upper floors to the wall panels.

The following procedure should be used during the course of demolition:

- (i) Where a wall panel acts as bracing in the direction of its length, provide a temporary bracing in that direction to maintain the stability of the remaining parts of the building.
- (ii) When lifting or lowering a panel, exercise extreme caution and care when using the original lifting points, fittings or fixings as points of attachment or support.
- (iii) When removing any individual panel —
 - (A) fully support it vertically and horizontally while detaching from the rest of the structure; and
 - (B) lower it to an horizontal position before breaking it up.

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