

**Occupational safety and health —
demolition of buildings— code of
practice**

DKS 2867: 2018

TECHNICAL COMMITTEE REPRESENTATION

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Kenyatta National Hospital (KNH)

Radiation Protection Board

Kenya Medical Research Institute (KEMRI)

Kenyatta University — Department of Environmental Health

National Environmental Management Authority (NEMA)

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Occupational safety and health — demolition of buildings — code of practice

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Foreword

This Kenya Standard has been prepared by the Sub-Technical Committee on Occupational Health and Safety under the guidance of the Standards Projects Committee, and it is in accordance with the procedures of the Kenya Bureau of Standards.

During the preparation of this standard, reference was made to the following documents:

ISO 45001:2018- Occupational health and safety management systems — Requirements with guidance for use

ISO 14123-1:2015 Safety of machinery — Reduction of risks to health resulting from hazardous substances emitted by machinery — Part 1: Principles and Specifications for machinery manufacturers

Acknowledgement is hereby made for the assistance received from these sources.

PUBLIC REVIEW DRAFT

Occupational safety and health— demolition of buildings— code of practice

1 Scope and field of application

1.1 Scope

This standard lays down safety and health requirements for carrying out safely the demolition/dismantling of all types of buildings, for example, residential building (load-bearing structure, multistoreyed framed structures), public buildings and factories.

1.2 Application

This standard shall apply to personnel engaged in manual or mechanical demolition/dismantling of all types of buildings.

2 Normative references

The following referenced documents are indispensable for the application of this Kenya Standard. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 45001:2018- Occupational health and safety management systems — Requirements with guidance for use

ISO 14123-1:2015 Safety of machinery — Reduction of risks to health resulting from hazardous substances emitted by machinery — Part 1: Principles and Specifications for machinery manufacturers

3 Terms and definitions

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

3.1 personnel

include workers, companies and contractors involved in the demolition work of buildings

3.2

workmen

include both men and women workers involved in the demolition of building

3.3

building owner

person or organization having the right to refurbish, demolish or partly demolish a building, by virtue of legal ownership or other legal authority

3.4

client

initiator of the works for demolition or partial demolition for structural refurbishment. The client is usually the structure owner, but could also be, for example, a main contractor.

3.5

competent person

person with sufficient knowledge of the specific tasks to be undertaken and the risks which the work will entail, and with sufficient training, experience and ability to enable them to carry out their duties in relation to the project, to recognize their limitations, and to take appropriate action to prevent harm to those carrying out or affected by the work.

3.6

relevant Authority

organization designated as for demolition of buildings, disposal of the debris materials, and include government regulatory authority

3.7

decommissioning

process whereby an area is brought from its fully operational status to one where all live or charged systems are rendered dead or inert and reduced to the lowest possible hazard level.

3.8 deliberate collapse

controlled removal or weakening of key structural members causing collapse in a planned way of the whole or part of the building or structure being demolished or partially demolished.

3.9 materials recycling

action of reprocessing materials which have previously been processed for inclusion in a product

3.10 permit to work procedure

procedure which sets out the agreed work to be undertaken on identified equipment, or in an identified area, and the precautions to be taken and to be managed as part of a safe system of work

3.11 recovery

operation the principal result of which waste is serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy

3.12

structural refurbishment

alteration to an existing retained building or structure that involves removal or modification of structural elements or members, which might or might not cause instability

3.13

waste

substance or object which the holder discards or intends to discard or is required to discard under the provisions of the national law

3.14

permit to work

a written notice, which sets out the work to be done, the hazards involved and the precautions to be taken before the work commences in order to secure the safety and health of the employee.

4 Approaches to demolition

4.1 Assessment of approaches

On the basis of the results of the options assessment, one, or a combination of the following approaches should be selected.

- a) complete demolition with potential reuse of site (possibly by others).
- b) complete demolition and rebuild.
- c) partial demolition and building some new replacement facilities.
- d) structural refurbishment while not in use.
- e) structural refurbishment while in use.

4.2 Intervention principles

The extent and effect of any particular planned process or physical intervention should be assessed by a competent person. A decision should be taken about which activities would be most appropriate.

When considering the activities and the possible methods to be adopted, the various hazards and thus potential risks should be assessed, for example, where materials are to be removed and where structural instability might be possible, whether planned or unplanned. The amount of materials to be removed is not necessarily the key criterion as the effect of their removal should be considered together with the proposed methods of removal, including the structural instability that could be caused. The need for auxiliary (or temporary) or permanent works to provide interim (or replacement permanent) support should be assessed and, if necessary, planned. The design should ensure that the structure is taken down in a planned and controlled manner, thus avoiding any unplanned structural instability or collapse.

4.3 Selection of the approach

When selecting an approach to demolition activities, a number of factors should be taken into account, including the following:

- a) the information given in relevant guidance documents;
- b) health, safety and environmental requirements;
- c) the needs of the client, the users and the workforce;

- d) the type, age, condition, use and business activity (if appropriate) of the facility and local conditions and constraints (e.g. access, existing services, party walls);
- e) the need to avoid disruption to business continuity, the community and nearby structures;
- f) legislative requirements;
- g) party wall constraints;
- h) cost and commercial benefits.

4.4 Choosing the methodology

To ensure a successful outcome, the following methodologies should be adopted as may be appropriate.

- a) hand working (manually).
- b) mechanical working (machine use).
- c) a combination of manual and mechanical working.

Decision to choose the appropriate methodology should take account of such factors as sustainability, waste strategies, client issues, risk management issues, e.g. increased risk of accident or injury, the potential for statutory nuisance, prohibition and prosecution, and insurance issues.

Example:

A building contains a large amount of “soft strip” material. If the building is detached and there is adequate space around the structure, the decision may be taken to manually strip out all of the material to assist in a clean reduction of the remaining structure. However, if the same building is located in a heavily populated or dense area, such as a city or town centre, the best option might be to reduce the structure with all materials in situ and transport this elsewhere for segregation and processing.

4.5 Demolition activities in structural refurbishment

General

Because demolition activities as part of structural refurbishment can alter the load-bearing parts of the structure, the following issues should be assessed.

- a) the load-bearing requirements and the necessary temporary support system.
- b) the potential for unplanned collapse of structure (e.g. often due to lack of understanding of traditional building construction).
- c) fire safety (e.g. fire loading, means of escape, protection).
- d) all services, including electricity and gas (e.g. isolation and disconnection of services, especially where properties either remain in occupation or are the subject of phased handover, leading to work being carried out with live services).
- e) health issues [e.g. noise and vibration, the presence of asbestos, lead, silica, polychlorinated biphenyls (PCBs) or zoonoses carriers, the need to provide welfare facilities].
- f) client issues (e.g. raising awareness, wide variation of client experience, provision of relevant information).

Competent advisors should be involved early in the process. When gathering information, the design team should identify and understand the concerns and needs of:

- i. the client;
- ii. the occupier of the building (who might not be the client, but could be living in the building while the work is done);
- iii. the contractor; and
- iv. any third parties (e.g. members of the public, adjoining owners, emergency services, environmental matters).

The team should also identify the need during the project for emergency procedures in the event, for example, of fire, power loss and security incidents.

4.5.1 Extent and effects of demolition activities in structural refurbishment

The degree to which demolition in structural refurbishment might be invasive and affect the structure should be assessed both before and during the work. This assessment should be undertaken for each element of work and then encompassed into the demolition plan.

4.5.2 Types of work involving partial structural demolition and structural supports

The type of instability created in a structure should be assessed before and after such work as the following is carried out:

- a) removal of floors;
- b) removal of walls;
- c) chimney breast/stack removal;
- d) alterations to traditional building structures;
- e) forming new openings;
- f) excavation/removal of foundations, etc., for basement construction under existing buildings and garden areas;
- g) loft conversions;
- h) facade retention;
- i) cutting back floors to upgrade insulation/create mezzanine/two storey height areas in the building interior;
- j) extensions;
- k) construction of additional floors at roof level of existing buildings;
- l) conversion of office buildings into residential/hotel accommodation;
- m) structural refurbishment, such as:
 - i. modernization, e.g. upgrading a facility where the same use is to be retained;
 - ii. change of use, including subdivision; and
 - iii. significant rebuild, e.g. undertaking major structural works but reusing the existing foundations and retaining the facade.

NOTE: Activities not generally described as structural refurbishment include maintenance jobs, such a painting, gutter cleaning and window cleaning.

5. Planning and managing projects

5.1 Key planning considerations

General

The issues in 5.1.1 to 5.1.8 should be addressed, as appropriate, when planning demolition projects. Sufficient lead-in time should be allocated for completion of these activities.

5.1.1 Effective site knowledge

An assessment and survey of the site should be planned to identify the following, as far as possible:

- a) the extent of decommissioning.
- b) details of the isolation or removal of services and details of temporary supplies.
- c) knowledge and history of the structure, including form, materials of construction, structural interactions and location.
- d) isolation and protection measures for adjacent structures.
- e) hazardous materials.
- f) previous uses of the site.

5.1.2 Complying with legal requirements

5.1.2.1 legislation

Arrangements should be put in place to ensure compliance with legislation in a number of different related fields, including the following:

- a) waste management regulation, 2006
- b) reuse and recycling.
- c) control and minimization of nuisances to the neighboring site (s) including dust, noise, vibration, smoke and traffic movement and management.
- d) air overpressure.
- e) environmental protection, including prevention of pollution.
- f) occupational safety and health Act, 2007
- g) planning (including listed buildings and party wall constraints).
- h) building regulations (Demolitions and construction safety rules)
- i) highways and roads
- j) factories (Building operations and works of engineering construction) rules of 1984

5.1.2.2 permissions, consents and licenses

General

Early consideration should be given as to whether any permissions, consents or permits/licenses are required for the works and whether any special measures need to be put in place, particularly for works on dangerous structures or special sites (e.g. nuclear sites) and for works which could:

- a) affect a public or private road or highway, e.g. works which necessitate:
 - i. the partial or total closure of the road or highway;
 - ii. the erection of temporary structures (e.g. scaffolds, fans, screens, hoardings and supports) on or over the road or highway;
 - iii. the use of plant or equipment on or over the road or highway; and
 - iv. the storage of site vehicles on the road or highway;
- b) affect features outside the curtilage of the site (e.g. footway lights, vaults and other voids under a highway);
- c) affect access routes, for example, to an adjoining property or utilities.
- d) involve scaffolding or a crane jib passing over an adjoining property; or
- e) involve the burning of waste in the open on site.

5.1.2.2.1 heritage sites

The relevant County Planning Authority should be consulted in good time for advice as to:

- a) whether consent is required for:
 - i. demolition or partial demolition of a building or other structure that is a designated heritage asset or is otherwise considered to have heritage significance meriting consideration in planning decisions; and
 - ii. work involving disturbance of the ground (such as removal of soil, foundations or buried services) in an area that is considered to be of archaeological significance;
- b) what information will be required in any application; and
- c) whether the County Planning Authority intends to:
 - i. place restrictions on the work, such as prohibiting alteration or demolition of certain parts of the structure, or require the use of non-contemporary materials or techniques, all of which could have cost and time implications; or
 - ii. require consultation with specialist bodies, which could again have a significant influence on project timing.

Where necessary, consents should be applied for and obtained before demolition activities commence. The timetable for applications and consents should also be established with the County Planning Authority, and taken into account in the programme for work on site.

5.1.3 Programme management

A detailed programme and timetable of events, as appropriate, should be prepared, detailing the following.

- a) the scheme, sequence and method of proposed demolition.
- b) the plant required and its usage.
- c) traffic management, the plan for controlling traffic to, from and within the site.

- d) the management of arisings, including likely types and amounts, removal and temporary storage on site, and options for reuse, recycling, recovery, disposal, etc., where appropriate.
- e) contingency arrangements, e.g. for partial collapses or misfires when explosives are used.
- f) the agreed start and completion dates.
- g) any limitations, e.g. tidal, nightworks, seasonal.

5.1.4 Protection of the public

Arrangements for protecting members of the public should include the following:

- a) site security, including the provision of, for example, suitable fencing and/or barriers.
- b) the control of spectators and/or site visitors.
- c) exclusion zones outside the site boundaries during critical aspects of the work, when appropriate.
- d) containment of demolition materials.

5.1.4.1 Precautions to be observed before demolition work

- a) Before beginning the actual work of demolition, a careful study shall be made of the structure which is to be pulled down and also of all its surroundings. This shall, in particular, include study of the manner in which the various parts of the building to be demolished are supported and how far the stage by stage demolition will affect the safety of the adjoining structure. A definite plan of procedure for the demolition work, depending on the manner in which the loads of the various structural parts are supported, shall be prepared and approved by the engineer-in-charge and this shall be followed as closely as possible, in actual execution of the demolition work.
- b) Before the commencement of each stage of demolition, the foreman shall brief the workmen in detail regarding the safety aspects to be kept in view.
- c) Before any demolition work is started, every sidewalk or road adjacent to the work likely to be affected shall be closed and /or be adequately protected.
- d) Children and members of the public shall be kept out of the building and the adjoining yard.
- e) If the structure to be demolished is more than two storeyed or 7.5 m high, measured from the sidewalk or street which cannot be closed or safely diverted, and the horizontal distance from the inside of the sidewalk to the structure is 4.5 m or less, a substantial sidewalk shed shall be constructed over the entire length of the sidewalk adjacent to the structure of sufficient width with a view to accommodating the pedestrian traffic without causing congestion. The sidewalk shed shall be lighted sufficiently to ensure safety at all times.
- f) A toe board of at least 1 m high above the roof of the shed shall be provided on the outside edge and ends of the sidewalk shed. Such boards may be vertical or inclined outward at not more than 45 degrees.
- g) Except where the roof of a sidewalk shed solidly abuts the structure, the face of the sidewalk shed towards the building shall be completely closed by providing sheathing /planking to prevent falling material from penetrating into the shed.
- h) The roof of sidewalk sheds shall be capable of sustaining a load of 73 N/mm². Only in exceptional cases, say due to lack of other space, the storing of material on a sidewalk shed may be permitted in which case the shed shall be designed for a load of 146 N/mm².

- i) Roof of sidewalk shed shall be designed taking into account the impact of the falling debris. By frequent removal of loads it shall be ensured that the maximum load, at any time, on the roof of work shed is not more than 6000 N/m². The height of sidewalk shed shall be such as to give a minimum clearance of 2.4 m
- j) Sidewalk shed opening for loading purposes, shall be kept closed at all-time except during actual loading operations.
- k) The deck flooring of the sidewalk shed shall consist of plank of not less than 20 mm in thickness closely laid and deck made watertight.
- l) All members of the shed shall be adequately braced and connected to resist displacement of members or distortion of framework.
- m) Where workers' entrances to the building being demolished are not completely protected by sidewalk sheds, all such entrances shall be protected by canopies extending from the face of the building to a point not less than 2.5 m from it. In such case such overhead protection shall be at least 0.6 m wider than the building entrance or opening and every canopy shall be as strong as the sidewalk shed.

It should be ensured that the demolition operations do not, at any stage, endanger the safety of the adjoining buildings. Moreover, the nuisance effect of the demolishing work on the use of the adjacent buildings should be kept to the minimum.

No structure or part of the structure or any floor or temporary support or scaffold, side wall or any device for equipment shall be loaded in excess of the safe carrying capacity, in its then existing condition.

5.1.5 Environmental management

The need for the following should be assessed during the planning process:

- a) control of noise at the site boundaries;
- b) control of dust emissions;
- c) waste management, including reduction, reuse and recycling;
- d) minimization of materials haulage;
- e) bunding arrangements for storage and dispensing of fuel oils;
- f) wheel washing plant and road-cleaning arrangements, where required;
- g) skip or truck sheeting arrangements;
- h) arrangements for dealing with hazardous materials, e.g. flammable materials, gases, hazardous liquids and asbestos;
- i) anticipated values of air overpressure and ground vibration;
- j) areas of conservation, including flora and fauna;
- k) minimizing landfill;
- l) carbon consumption/agenda.

5.1.5.1 Duties of contractors

Contractors should:

- a) consider waste minimization and recycling in accordance with the waste management hierarchy during the planning stages, and implement systems to prevent downstream breaches in environmental legislation, such as the duty of care, and illegal deposit of waste.
- b) give priority to minimization before construction, for example, through designs, layout and other decisions, with preference given to on-site reuse and recycling, followed by off-site reuse and recycling, recovery and disposal.
- c) identify the amount of space available on site for processing materials, e.g. where on-site processing is impractical, it might be more productive to send the waste to a materials recycling facility (MRF, also known as a “transfer station”).
- d) obtain advice during planning from relevant enforcement Authorities as to what will be allowed for the burning of materials, both by open fire or incineration, as these activities are subject to local and national restrictions

5.1.6 Occupational safety of the workforce

General

Measures for the following should be put in place:

- a) obtaining details of personnel access and working platforms, including the procedure for their maintenance and subsequent removal as the structure is reduced.
- b) establishing appropriate working spaces and exclusion zones.
- c) protecting the workforce, including reference to any permit to work procedures.
- d) providing effective communications, including warning signs and signals.

5.1.6.1 Specific safety precautions

- a) On every demolition job, safety signs shall be conspicuously posted all around the structure. All doors and openings giving access to the structure shall be kept barricaded or manned except during the actual passage of workmen or equipment. However, provision shall be made for at least two independent exits for
- b) Escape of workmen during any emergency.
- c) during nights, red lights shall be placed on or about all the barricades.
- d) Where in any work of demolition it is imperative, because of danger existing, to ensure that no unauthorized person shall enter the site of demolition outside working hours; a security guard should be employed. In addition to securing the site he shall also be responsible for maintaining all notices, lights and barricades.
- e) All the necessary safety appliances shall be issued to the workers and their use explained. It shall be ensured that the workers are using all the necessary safety appliances while at work.
- f) The removal of a member may weaken the side wall of an adjoining structure and to prevent possible damage, these walls shall be supported until such time as permanent protection is provided. In case any danger is anticipated to the adjoining structure, the same shall be vacated to avoid any danger to human life.
- g) The power on all electrical service lines shall be shut off and all such lines cut or disconnected

at or outside the property line, before the demolition work is started. Prior to disconnecting of such lines, the necessary approval shall be obtained from the electrical authorities concerned. The only exception will be any power lines required for demolition work itself.

- h) All gas, water steam and other service lines shall be shut off and capped or otherwise controlled at or outside the building line, before demolition work is started.
- i) All the mains and meters of the building shall be removed or protected from damage.
- j) If a structure to be demolished has been partially wrecked by fire, explosion or other catastrophe, the walls and damaged roofs shall be shored or braced suitably.
- k) Walkways and passageways shall be provided for the use of the workmen who shall be instructed to use them and all such walkways and passageways shall be kept adequately lighted, free from debris and other materials.
- l) All nails in any kind of lumber shall be withdrawn, hammered or bent over as soon as such lumber is removed, from the structure being demolished, and placed in piles for future cleaning or burning.

5.1.7 Occupational health of the workforce

Processes for the following should be put in place in accordance with the relevant legislations:

- a) Hazard recognition, risk assessments and control measures for:
 - i. substances potentially hazardous to health, e.g. from heavy metals or other toxic substances, including when working with materials which can be reused or recycled; and
 - ii. exposures to harmful substances such as asbestos and radioactivity.
- b) assessments and control measures for noise and dust on sites.
- c) identification of deleterious atmospheres, such as oxygen deficiency in confined spaces.
- d) hazard recognition and risk assessments for the need for, and the provision of, appropriate personal protective equipment (PPE).
- e) appropriate welfare arrangements, including for when the work involves exposure to contaminated materials or dirty work.
- f) health monitoring of all staff.

5.1.8 Predicted weather conditions

Arrangements should be made where appropriate for liaison with, for example, the Meteorological Department to obtain forecasts of sudden and severe weather changes, such as strong winds, lightning, snow and heavy rain, and indications of how these can affect the planned works and programme.

5.2 Planning and managing for site work

5.2.1 recommended systems of work

- a) demolition works should be planned in such a way that it is undertaken using systems of work that take into consideration safety, health, the environment and efficiency.

- b) before demolition work is started, glazed sash, glazed doors and windows, etc., shall be removed. All fragile and loose fixtures shall be removed. The lath and all loose plaster shall be stripped off throughout the entire building. This is advantageous because it reduces glass breakage and also eliminates a large amount of dust producing material before more substantial parts of the buildings are removed.
- c) all well openings which extend down to floor level shall be barricaded to a height of not less than one metre above the floor level. This provision shall not apply to the ground level floor.
- d) all those involved from concept through tender to contract execution should ensure effective planning and communication, and the provision of sufficient time to allow the execution of a successful and efficient project.
- e) the timescales required for the acquisition of any licenses or permits should be allowed for in the programming of works.
- f) after the contract has been awarded, and before work commences, the contractor should determine the proposed safe sequence of operations on the basis of an assessment of the comparative risks, related specifically to the site and conditions. This sequence should be used to assess and expand the construction phase plan (CPP) for the tender and proposed programme of works. The expanded plan for the tender should form the basis of the CCP (demolition plan) for the demolition.
- g) the methods of work should allow for demolition activities and site clearance as stipulated by the contract, taking account of any constraints imposed by the client. Adequate time should be allowed for setting up the site prior to work commencing and for executing the works.
- h) the demolition work shall be proceeded within such a way that it causes the least damage and nuisance to the adjoining building and the members of the public, and also satisfies all safety requirements to avoid any accidents. All existing fixtures required during demolition operations shall be well protected with substantial covering to the entire satisfaction of the rules and regulations of the undertakings or they shall be temporarily relocated.
- i) all floor openings and shafts not used for material chutes shall be floored over and be enclosed with guard rails and toe boards.

5.2.2 Risk management

General

Tenderers/contractors should look for the hazards in the project, including how and where the work could be done and the equipment and materials used.

When planning methods and sequences of work, a suitable and sufficient risk assessment should be carried out and recorded. This should include selecting methods, materials and equipment to remove or minimize risk from work.

5.2.2.1 Risk assessment

The following principles of risk assessment should be followed when determining methods and sequences of work:

- a) identify the hazards associated with the proposed work;
- b) consider who might be harmed and how, including workers, site visitors, members of the public and anyone affected by the work;

- c) evaluate the risks and identify the precautions required by, for example, comparison with good practice and categorization of risk level (likelihood and severity);
- d) record the findings and implement the control measures for the residual risks;
- e) review the risk assessment and update if necessary.

The risk assessment should take into account any constraints that the client has identified, but the contractor should be given the freedom to determine the proposed methods of demolition.

The risk assessment should identify the risks associated with the work and enable the contractor to select appropriate demolition solutions that remove or reduce the risks before the work commences.

The contractor should then select the most suitable methods of demolition which include measures to properly control any remaining risks.

5.2.2.2 Risk control

The steps required for effective risk control are simple. First, a determination should be made as to whether the hazard can be eliminated altogether. If not, consideration should be given to the control measures required to reduce harm, e.g. equipment, systems of work and sequencing. If the risk is unacceptable, alternative control measures should be applied till the risk is acceptably low.

The following principles should be applied to the control of risk:

- a) if possible, avoid the risk completely by using safer alternative methods or materials.
- b) address risks at source, rather than using superficial control measures that result in a high or unnecessary residual risk remaining in place.
- c) wherever possible, adapt the work to the individual, particularly in the choice of work equipment and methods of work, as this makes the work less monotonous, improves concentration and reduces the temptation to improvise equipment and methods.
- d) take advantage of technological progress, which often offers opportunities for safer and more efficient working methods.
- e) incorporate the protective and preventive measures into a coherent plan to reduce progressively those risks which cannot altogether be avoided, taking into account working conditions, organizational factors, the working environment and social factors.

5.3 Competencies and training

5.3.1 Competencies

All demolition and structural alteration activities should be carefully planned and carried out by competent practitioners and organizations. People making appointments should take reasonable steps to ensure that those appointed are competent for what they are expected to do. Likewise, those accepting such appointments should only do so if they are competent to undertake the particular activity. Clients and procurers of demolition works have a key role and should ensure that all contractors, designers and other

team members that they propose to appoint have either the competence to carry out the work themselves or have engaged the services of an individual or organization with these competencies.

5.3.2 Training

Management should ensure that the necessary levels of competence exist and are developed by appropriate training as required. This should include industry-recognized training schemes intended to ensure that managers, supervisors and operatives in the demolition industry are competent at the level of experience that they claim and that they have received suitable training in, for example, health and safety and waste management.

5.4 Personal protective equipment (PPE) on site

The method of work chosen should ensure that the exposure to risk is minimized to such an extent that PPE is required to provide protection only against those risks that cannot be avoided by any other planned approach to the work. The following shall therefore be observed:

- a) as a result of the known risks to health and safety that are present during demolition work, all personnel should be required to wear, in addition to safety helmets, suitable basic protective equipment such as footwear, gloves and high-visibility clothing as appropriate. Additional PPE, e.g. eye protection, fall arrest systems (including full body harnesses), hearing protection, respiratory protection equipment (RPE) and ori-nasal masks, should be issued only when alternative methods of work which do not require additional protective equipment have been assessed and found to be unsuitable when hot cutting).
- b) appropriate training should be provided in the use of PPE, when needed.
- c) such equipment should be suitably maintained and stored to ensure continued levels of required performance.

Examples of hazards which should be catered for through the provision of planned control measures include the following.

- i. chemicals which have been stored or used.
 - ii. arisings from lead paint, asbestos, dust, fumes or substances
- d) contractors should establish emergency procedures to be followed in the event of premature collapse, fire or explosion. Suitable and sufficient emergency procedures should be prepared in an emergency plan for identified scenarios, in association, as appropriate, with the emergency services, public and private bodies such as local authorities, transport operators, housing managers, waterways operators, and health, safety and environment regulators. The emergency plan should set out appropriate actions (including limits of actions) and identify with whom the responsibilities are placed. The emergency plan should be incorporated into the demolition plan.
 - e) all persons on site should be instructed in the emergency procedures. All those who could come on to site should also be made aware of the procedures. A means of contacting the emergency services should always be available while work is in progress, even on small jobs.
 - f) the arrangements should be tested by carrying out exercises at suitable intervals to familiarize site personnel with the procedures, to test their effectiveness and, where necessary, to ensure effective liaison with the emergency services and others as appropriate.

- g) where there is a risk of fire, suitable fire precautions should be put in place including adequate escape routes, as appropriate, identification and illumination of those routes, exits that are readily usable, means of raising the alarm, and firefighting equipment and emergency plans.

5.5 Permit to work procedures

5.5.1 Permit to work

An employer shall issue a permit to work to any employee, likely to be exposed to hazardous work processes or hazardous working environment in order to secure the safety and health of the employee. Such work and work environment that may require permit to work include:

- a) work on or near live electrical plant;
- b) entry to or work in confined spaces;
- c) moving machinery that requires isolation before approach; or
- d) hot work.

The permit to work procedure should be used:

- i. to ensure that personnel working in the restricted area are aware of the hazards involved, and the identity, nature and extent of the work to be done and precautions to be taken.
- ii. to ensure that a formal check is undertaken to confirm elements of a safe system of work are in place before people are allowed to enter or work in the restricted area;
- iii. where there is a need to exclude or coordinate other people or their activities which could affect work or conditions in the restricted area; and
- iv. if the work requires the authorization of more than one person, or there is a time limit on entry.

The aim of a permit to work procedure should be to provide a managed, safe, restricted working area. The permit to work procedure, including the issue of a permit, should be regarded as an integrated part of a “safe system of work”, but does not by itself make the job safe. The permit to work procedure should support that safe system and provide a record of activities, authorizations and timings for the protection of those undertaking the activities, and sometimes others.

There should be sufficient procedural control of temporary works, including the appointment of a temporary works coordinator with responsibility for ensuring that structural stability is maintained throughout temporary structural states during operations. An assessment should be made as to whether a permit to work system is appropriate.

5.5.2 Emergency arrangements

Emergency arrangements should be put in place before entering a confined space. The following should be provided, as appropriate:

- a) rescue and resuscitation equipment.
- b) measures for raising the alarm and rescue.
- c) measures for safeguarding the rescuers.
- d) fire safety measures.

- e) control of plant.
- f) first aid.
- g) public emergency services.
- h) effective communications.

5.5.3 Welfare and first aid

5.5.3.1 Welfare provision

Welfare facilities should be provided and maintained at readily accessible places for the duration of the works. These facilities should be suitable and sufficient and include toilet and washing facilities, portable drinking water and showers, if required by the nature of the work for health reasons.

Accommodation should be provided in the immediate vicinity, or should be conveniently accessible for the place of work and for shelter, drying wet clothing and storing clothing not worn during working hours

5.5.3.2 First aid

Those undertaking demolition activities should ensure that adequate first aid provision is made available. Those on site should be informed of the first aid provisions that have been made for them. The level of first aid to be provided should be determined initially by risk assessments carried out prior to the work commencing.

6. Removal of materials

General

There shall be an approved waste disposal contract in place in order to effectively dispose of the demolished materials as appropriate. An approved site by the regulatory Authority should be used for the disposal. Once the demolished materials have been ascertained to be hazardous-free by the relevant Authority, disposal can be through sale, recycling, reuse or reclamation of disused sites. The need for temporary, auxiliary and permanent items should be assessed, taking account of the need to manage the waste streams from the site. The following methods may be used:

a) through chutes

- i. Wooden or metal chutes may be provided for removal of materials. The chutes shall preferably be provided at the centre of the building for efficient disposal of debris. Chutes, if provided at an angle of more than 45° from the horizontal, shall be entirely enclosed on all the four sides, except for opening at or about the floor level for receiving the materials.
- ii. Opening for the chutes shall not exceed 1.20 m in height measured along the wall of the chute and in all storeys below the top floor such opening shall be kept closed when not in use. To prevent the descending material attaining a dangerous speed, chute shall not extend in an unbroken line for more than two storeys. A gate or stop shall be provided with suitable means for closing at the bottom of each chute to stop the flow of materials.
- iii. Chutes at an angle of less than 45° to the horizontal may be left open on the upper side provided that at the point where such a chute discharges into a chute steeper than 45° to the horizontal, the top of the steeper chute shall be boarded over to prevent the escape of materials.

- iv. Any opening into which workmen dump debris at the top of chute shall be guarded by a substantial guard rail extending at least one metre above the level of the floor or other surface on which men stand to dump the materials into the chute.
- v. A toe board or bumper, not less than 50 mm thick and 150 mm high shall be provided at each chute opening, if the material is dumped from the wheel barrows. Any space between the chute and the edge of the opening in the floor through which it passes shall be solidly planked over.

b) through holes in the floor

- i. Debris may also be dropped through holes in the floor without the use of chutes. In such a case the total area of the hole cut in any intermediate floor, one which lies between floor that is being demolished and the storage floor shall not exceed 25 percent of such floor area. It shall be ensured that the storage floor is of adequate strength to withstand the impact of the falling material.
- ii. Openings in all the floors below the floor from which materials are being removed, shall be protected by standard railings and toe boards or preferably planked over if the holes are not being used for dumping materials.
- iii. All intermediate floor openings for passage of materials shall be completely enclosed with barricades or guard rails not less than one-metre-high and at a distance of not less than one metre from the edge of general opening. No barricades or guard rails shall be removed until the storey immediately above has been demolished down to the floor line and all debris cleared from the floor.
- iv. When the cutting of a hole in an intermediate floor between the storage floor and the floor which is being demolished makes the intermediate floor or any portion of it unsafe, then such intermediate floor shall be properly shored. It shall also be ensured that the supporting walls are not kept without adequate lateral restraints.

6.1 Removal of debris

- a) As demolition work proceeds, the released serviceable materials of different types shall be separated from the unserviceable lot at suitable time intervals and properly stocked to prevent obstruction where demolition work is being done.
- b) The unserviceable materials obtained during demolition shall be collected in well-formed heaps at properly selected places, keeping in view safe conditions for workmen in the area. The height of each unserviceable materials heap shall be limited to ensure its not toppling over or otherwise endangering the safety of workmen or passersby.
- c) These materials shall be removed from the demolition site to a location as required by the relevant Authority. Depending on the space available at the demolition site, this operation of conveying them to its final disposal site may have to be carried out a number of times during the demolition work. In any case, the demolition work shall not be considered as completed and the area declared fit for further occupation till all the unserviceable materials have been carried to its final disposal site and the demolition area tidied up.
- d) Materials which are likely to cause dust nuisance or undue environmental pollution in any other way, shall be removed from the site at the earliest and till then, they shall be suitably covered. Such materials shall be covered during transportation also.

- e) Unauthorized use of the debris (or the unserviceable materials) in any work shall not be permitted. The released materials classified as 'serviceable' shall be inspected by a competent person before being used.

6.1.1 Airborne dust control

The following mitigation measures should be used to control dust emission during demolition work:

- a) provide sufficient misting water sprays to reduce airborne dust;
- b) keep stockpiles for the shortest time possible;
- c) avoid dust-generating work on high wind days.

7. Stairs, passageways and ladders

- a) Stairs and stair railings, passageways and ladders shall be left in place as long as possible.
- b) For the use of ladders, provisions laid down in ISO 14122 shall be followed.
- c) All stairs, passageways and ladders to be used by workmen during the process of demolition shall be maintained in a safe condition.
- d) Ladders or their side rail extend not less than 1.0 m above the floor or platform to which such ladder gives access.
- e) All ladders shall be secured against, slipping out at the bottom and against movement in any direction at the top.

8. Demolition of walls

- a) While walls or sections of masonry are being demolished, it shall be ensured that they are not allowed to fall as single mass upon the floors of the building that are being demolished so as to exceed the safe carrying capacity of the floors. Overloading of floors shall be prevented by removing the accumulating debris through chutes or by other means immediately. The floor shall be inspected by the engineer-in-charge before undertaking demolition work and if the same is found to be incapable to carry the load of the debris, necessary additional precautions shall be taken so as to prevent any possible unexpected collapse of the floor.
- b) walls shall be removed part by part. Stages shall be provided for the men to work on, if the walls are very thin and dangerous to work by standing over them.
- c) no section of wall whose height is more than 15 times of thickness, shall be permitted to stand without lateral bracing unless such wall is in good condition and was originally designed to stand without such lateral bracing or support.
- d) structural or load supporting members on any floor shall not be cut or removed until all the storeys above that floor have been demolished and removed.
- e) before demolishing any interior or exterior wall within 3 m of the opening in the floor immediately below, such opening shall be substantially planked over, unless access is denied to workmen to that portion of the area of the floor immediately below the opening, in the floor of the storey being demolished, where any debris pieces passing through this opening may fall.
- f) in framed structures, the steel frame may be left in place during demolition of masonry work. Where this is done, all steel beams, girders, etc., shall be cleared of all loose materials as the demolition of masonry work progress downward provided it is still strong enough to stand as an independent structure.

- g) walkways shall be provided to enable workmen to reach or leave their work on any scaffold or wall. Such walkways shall be not less than 3 planks, nor less than 0.8 m in width. At the completion of each day's work, all walls shall be left stable to avoid any danger of getting overturned.
- h) foundation walls which serve as retaining walls to support earth or adjoining structure, shall not be demolished until such an adjoining structure has been underpinned or braced and the earth removed by sheet piling or sheathing.

9. Demolition of floors

- a) In cutting holes in a floor which spans in one direction, a slit of width not exceeding 300 mm shall be cut at the first stage for the entire length of the slab along which it spans. The opening shall thereafter be increased to the desired width by suitable instalments.
- b) Planks of sufficient strength not less than 50 mm thick and 250 mm wide shall be provided at spacing not greater than 0.4 m for the workmen to work. The length of planks shall not be less than 2 m. These planks shall be so placed as to give workmen firm support to guard against any unexpected floor collapse.
- c) Stringers of ample strength shall be installed to support the planks where necessary and the ends of such stringer shall be supported by floor beams, girders and not by floor slab alone.
- d) When floors are being removed, no workmen shall be allowed to work in the area, directly underneath and such area shall be barricaded to prevent access to it.
- e) The demolition of floor shall be started only after the floor in question and the surrounding floor area for a distance of 6.0 m have been entirely cleared of persons, and the debris and other unnecessary material removed.
- f) Planks used for temporary protection shall be sound and at least 50 mm thick. They shall be laid close together with the ends having at least 100 mm bearing over solid support to prevent tipping under load. If corrugated GI Sheets are used for temporary protection, it shall be secured to the solid support with suitable framework.

10. Demolition of steel structures

- a) When a derrick is used, care shall be taken to see that the floor on which it is supported is amply strong for the loading so imposed. If necessary, heavy planking shall be used to distribute the load to floor beam and girders.
- b) Overloading of equipment shall not be allowed.
- c) Tag lines shall be used on all materials being lowered or hoisted up and a standard signal system shall be used and the workmen instructed on the signals.
- d) No person shall be permitted to ride the load line.
- e) No beams shall be cut until precautions have been taken to prevent it from swinging freely and possibly striking any worker or equipment to any part of the structure being demolished.

- f) All structural steel members shall be lowered from the building and shall not be allowed to drop.

11. Demolition of exterior walls of multistoreyed structures

- a) In demolition of exterior walls of multistoreyed structure, it is advisable to provide catch platform of heavy planking to prevent injuries to the worker working below and to the public, when the external walls are more than 20 m in height.
- b) Such catch platform shall be constructed and maintained not more than 3 storeys below the storey from which exterior wall is being demolished. When demolition has progressed to within 3 storeys of ground level, catch platform will not be considered necessary.
- c) Catch platforms shall not be less than 1.5 m in width, measured in a horizontal direction from the face of the structure and shall consist of outriggers and planks. Planks shall be laid tight together, without openings between them and the walls. Catch platform shall be provided with a continuous solid parapet along its outer edge of at least 1 m height. The parapet shall be constructed of the same specification as the platform.
- d) Catch platform can be constructed of material other than wood also, provided such material is of equal strength.
- e) Catch platform shall be capable of sustaining a live load of not less than 6 100 N/m².
- f) The outriggers shall be of ample strength and shall not be spaced more than 3 m apart.
- g) Materials shall not be dumped on catch platform nor such catch platform shall be used for the storage of materials.

12. Mechanical demolition

When demolition is to be performed by mechanical devices, such as high reach arm, weight ball and power shovels, the following additional precautions may be observed:

- a) The area shall be barricaded for a minimum distance of 1½ times the height of the wall;
- b) While the mechanical device is in operation, no workmen shall be allowed to enter the building being demolished;
- c) The device shall be so located to avoid, or be guarded against falling debris; and
- d) The mechanical device when being used shall not cause any damage to adjacent structure, power line, etc.

13. Recommendations for demolition of certain special types and elements of structures

13.1 roof trusses

- a) If a building has a pitched roof, the roof structure should be removed to wall plate level by hand methods. Sufficient purlins and bracing should be retained to ensure stability of the remaining roof trusses while each individual truss is removed progressively
- b) Temporary bracing should be added, where necessary, to maintain stability. The end frame opposite to the end where dismantling is commenced, or a convenient intermediate frame should be independently and securely guyed in both directions before work starts.

- c) On no account should the bottom tie of roof trusses be cut until the principal rafters are prevented from making outward movement.

13.2 heavy floor beams

Heavy baulks of timber and steel beams should be supported before cutting at the extremities and should then be lowered to a safe working place.

13.3 jack arches

Where tie rods are present between main supporting beams, these should not be cut until after the arch or series of arches in the floor have been removed. Particular care should be exercised and full examination of this type of structure undertaken before demolition is commenced. The floor should be demolished in strips parallel to the span of the arch rings (at right angles to the main floor beams)

13.4 brick arches

- a) Expert advice should be obtained and, at all stages of the demolition, the closest supervision should be given by persons fully experienced and conversant with the type of work to ensure that the structure is stable at all times.
- b) As much dead load as possible may be removed provided it does not interfere with the stability of the main arch rings but it should be noted that the load-carrying capacity of many old arches relies on the filling between the spandrels. On no account should the restraining influence of the abutments be removed before the dead load of the spandrel fill and the arch rings are removed.
- c) Special temporary support shall be provided in the case of skew bridges.
- d) A single span arch can be demolished by hand by cutting narrow segments progressively from each springing parallel to the span of the arch, until the width of the arch has been reduced to a minimum which can then be collapsed.
- e) Where it is impossible to allow debris to fall to the ground below, centering designed to carry the load should be erected and the arch demolished progressively. The design of the centering should make appropriate allowance for impact.
- f) Where deliberate collapse is feasible the crown may be broken by the demolition ball while working progressively from edges to the centre.
- g) Where feasible and appropriate, collapse of the structure can be effected in one action by the use of explosives. Charges should be inserted into boreholes drilled in both arch and abutments. This method is the most effective for demolition of tall viaducts.
- h) In multi-span arches before individual spans are removed, lateral restraint should be provided at the springing level. Demolition may then proceed as for a single span; care being taken to demolish the spandrels down to the springing line as the work proceeds. Where explosives are used it is preferable to ensure the collapse of the whole structure in one operation to obviate the chance of leaving unstable portions standing.

13.5 cantilevers (not part of a framed structure)

A cantilever type of construction depends for its stability on the superimposed structure. Canopies, cornices, staircases and balconies should be demolished or supported before the tailing down load is removed.

13.6 *in-situ* reinforced concrete

- a) Before commencing demolition, the nature and condition of the concrete, the condition and position of reinforcement, and the possibility of lack of continuity of reinforcement should be ascertained.
- b) Attention should be paid to the principles of the structural design to determine which parts of the structure depend on each other to maintain overall stability.
- c) Demolition should be commenced by removing partitions and external non-load bearing cladding. It should be noted that in some buildings the frame may rely on the panel walls for stability.
- d) Where hand demolition methods are to be used, the following procedures should be used:
 - i. **Reinforced concrete beams**
For beams, a supporting rope should be attached to the beam. Then the concrete should be removed from both ends by pneumatic drill and the reinforcement exposed. The reinforcement should then be cut in such a way as to allow the beam to be lowered under control to the floor.

- ii. **Reinforced concrete columns**

For columns, the reinforcement should be exposed at the base after restraining wire guy ropes have been placed round the member at the top. The reinforcement should then be cut in such a way as to allow the column to be pulled down to the floor under control.

- iii. **Reinforced concrete walls**

Reinforced concrete walls should be cut into strips and demolished as for columns.

- iv. **Suspended floors and roofs**

Before demolishing suspended floors and roofs, the type of construction should be ascertained. In solid slabs, the direction of the main reinforcement should be determined; the slab should then be cut into strips parallel to the main reinforcement and demolished strip by strip.

Where ribbed construction has been used, the principle of design and method of construction should be determined before demolition is commenced, care should be taken not to cut the ribs inadvertently.

13.7 Precast reinforced concrete

Precast reinforced concrete units used in a structure are normally held in position by the strength of the joints made *in-situ* or on supporting walls, etc. As such, before starting on demolition, the joint structures and/or the supporting mechanisms shall be studied and understood.

In devising and following the demolition sequences due precaution shall be taken to avoid toppling over of prefabricated units or any other part of the structure and wherever necessary temporary supports shall be provided.

13.8 Pre-stressed reinforced concrete

Before commencing of the demolition work involving such structures advice of an engineer expert in such demolition shall be obtained and followed.

13.9 Chimney and spires

Before commencing of the demolition work, involving such structures, advice of an engineer expert in such demolition shall be obtained and followed.