ILO CONSTRUCTION OS&H

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

THEME SUMMARY 13:
WORKING AT OR BELOW GROUND LEVEL

(Photo: Fiona Murie, BWI)

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1 PREFACE

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

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

1.1. Objective

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

> *(a) preventing accidents and diseases and harmful effects on the health of workers arising from employment in construction;*
>
> *(b) ensuring appropriate design and implementation of construction projects;*
>
> *(c) providing means of analysing from the point of view of safety, health and working conditions, construction processes, activities, technologies and operations, and of taking appropriate measures of planning, control and enforcement.*

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

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

This Theme Summary also includes extracts from the ILO's "Safety, health and welfare on construction sites: A training manual" ("The Manual"). Further details of The Manual and the Code are given in Section 7 below "Relevant elements of the Knowledge Base".

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

2 COMMON HAZARDS WITH WORKING AT OR BELOW GROUND LEVEL

Working at or below ground level should create no hazards for anyone on a construction project. Many of the hazards that do arise have the following causes:

- Inadequate site investigation
- Poor technical design leading to collapse under load or working conditions
- Poor mechanical design of plant and equipment (breaks in use, not powerful enough, components fracture or malfunction)
- Failure to control groundwater
- Poor workplace design
- Poor general supervision
- Signalling systems (manual, mechanical, electronic) malfunction
- Misuse of plant and equipment (not used as designed)
- Collisions with moving plant and equipment
- Poor maintenance (breaks or emits noxious gases)

These cause the following hazards:

- Earthworks collapse or cave in
- Exposure to 'unexpected' risks in excavations
- Vehicles fall into excavations
- Loads fall from vehicles
- Crushing due to impact of moving or toppling plant and equipment
- Impact from release of pressure (e.g. concrete exploding from concrete pump hose failure)
- Falling from plant and equipment
- Falls caused by swinging loads, plant and equipment
- Limbs or bodies caught in machinery
- Poor ergonomics
- Physiological and psychological damage through repetitive work
- Physiological and psychological damage caused by poor environment (wet conditions, noise, heat, poor ventilation, chemicals; noxious gases)

These are, of course, just some of the main hazards, there are many more which are specific to particular projects.

3 COMMON EXCAVATIONS

Introduction

Most construction work involves some form of excavation for foundations, sewers and underground services. Excavation or trenching work can be highly dangerous and even some of the most experienced workers have been caught by the sudden and unexpected collapse of the unsupported sides of a trench.

Persons buried under a cubic metre of soil will be unable to breathe due to pressure on the chest, and quite apart from any physical injury they will quickly suffocate and die, for even this comparatively small amount of soil weighs over 1 tonne.

Excavation work involves the removal of soil or a mixture of soil and rock. Water is nearly always present, even if only as moisture in the soil, and heavy rain is a frequent cause of soil slip. The possibility of flooding presents an additional hazard which should always be considered. Cracks are caused by pressure release as soil is removed, or from drying out in hot weather.

Soil varies in its nature (e.g. fine sand which flows easily, and stiff clay which is more cohesive). However, no soil can be relied upon to support its own weight and precautions always need to be taken to prevent the collapse of the sides of an excavation of more than 1.2m in depth.

Some of the specific hazards caused by excavations are:

- Persons becoming trapped and buried in an excavation owing to the collapse of the sides
- Persons being struck and injured by material and other items falling into the excavation
- Persons falling into the excavation
- Unsafe means of access and insufficient means of escape in case of flooding
- Vehicles driven into or too close to the edge of an excavation, particularly while reversing, causing the sides to collapse
- Asphyxiation or poisoning caused by fumes heavier than air entering the excavation, e.g. exhaust fumes from diesel and petrol engines

General requirements

9.1.1. Adequate precautions should be taken in any excavation, shaft, earthworks, underground works or tunnel:

(a) by suitable shoring or otherwise, to guard against danger to workers from a fall or dislodgement of earth, rock or other material;

(b) to guard against dangers arising from the fall of persons, materials or objects or the inrush of water into the excavation, shaft, earthworks, underground works or tunnel;

(c) to secure adequate ventilation at every workplace so as to maintain an atmosphere fit for respiration and to limit any fumes, gases, vapours, dust or other impurities to levels which are not dangerous or injurious to health and are within limits laid down by national laws or regulations;

(d) to enable the workers to reach safety in the event of fire, or an inrush of water or material;

(e) to avoid risk to workers arising from possible underground dangers such as the circulation of fluids or the presence of pockets of gas, by undertaking appropriate investigations to locate them.

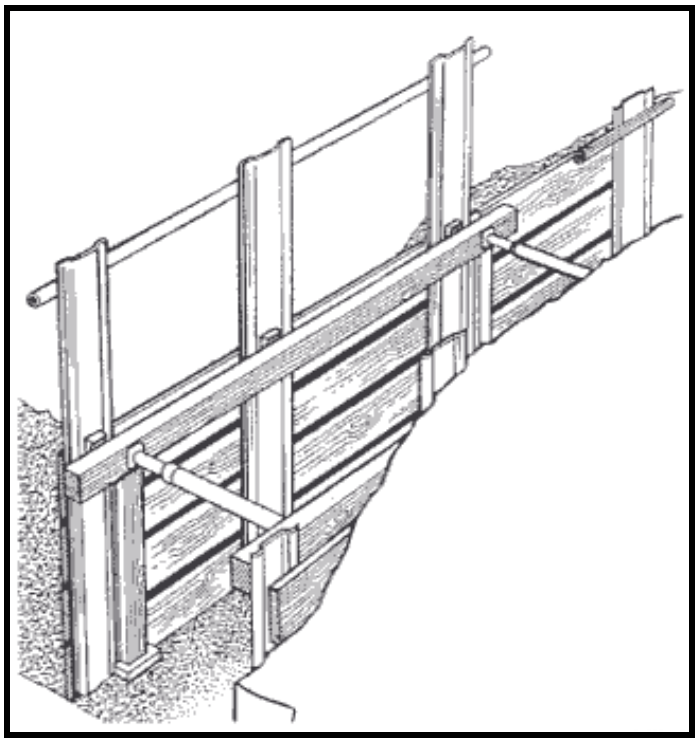
The sides of the excavation or trench should be sloped or battered back to a safe angle of repose, usually 45°, or be supported by timbering or other suitable means to prevent a collapse. The type of support necessary will depend upon the type of excavation, the nature of the ground and the groundwater conditions.

(Photo: Fiona Murie, BWI)

The photo above shows one side of a large excavation battered back, perhaps at rather too steep an angle but the ground may be firm enough to justify the slope. There is also a set of access steps with handrails, but these may not be large enough for all these workers to escape in a sudden emergency, such as flooding.

Close boarding or sheeting is required if the ground is unstable or lacks cohesion. Work should not proceed ahead of the trench support.

The diagram below shows a trench in soft ground being supported by metal ‘trench sheets’ vertically, which support horizontal timbers. The vertical spacing of the timbers depends upon the assessed strength of the ground.



The struts between the sides of the trench are metal 'trench struts', which are adjustable so that they can be firmly braced against the supports. Timber struts, tightened by the use of wedges at the ends, are just as effective.

9.1.2. Shoring or other support for any part of an excavation, shaft, earthworks, underground works or tunnel should not be erected, altered or dismantled except under the supervision of a competent person.

Shoring should be erected, altered or dismantled only by a competent worker operating under supervision. Wherever practicable, it should be installed before excavating to the final depth of the trench – it is necessary to begin when the trench is less than 1.2m deep. The excavation and installation of shoring should then proceed by stages until the full depth is reached.

Workers and others often fall into excavations. Erect suitable barriers high enough (i.e. about 1m) to prevent falls. As shown in the diagram above, projecting vertical trench supports can often be used for this purpose.

As a simple search of 'trench support systems" on the Internet will show, there are many types of trenching and excavation support system available, for example: http://www.aplant.com/catalogue.

9.1.3. Every part of an excavation, shaft, earthworks, underground works and tunnel where persons are employed should be inspected by a competent person at times and in cases prescribed by national laws or regulations, and the results recorded.

9.1.4. Work should not commence therein until the inspection by the competent person as prescribed by national laws or regulations has been carried out and the part of the

excavation, shaft, earthworks, underground works or tunnel has been found safe for work.

9.2.1. Before digging begins on site:

(a) all excavation work should be planned and the method of excavation and the type of support work required decided;

(b) the stability of the ground should be verified by a competent person;

(c) a competent person should check that the excavation will not affect adjoining buildings, structures or roadways;

(d) the employer should verify the position of all the public utilities such as underground sewers, gas pipes, water pipes and electrical conductors that may cause danger during work;

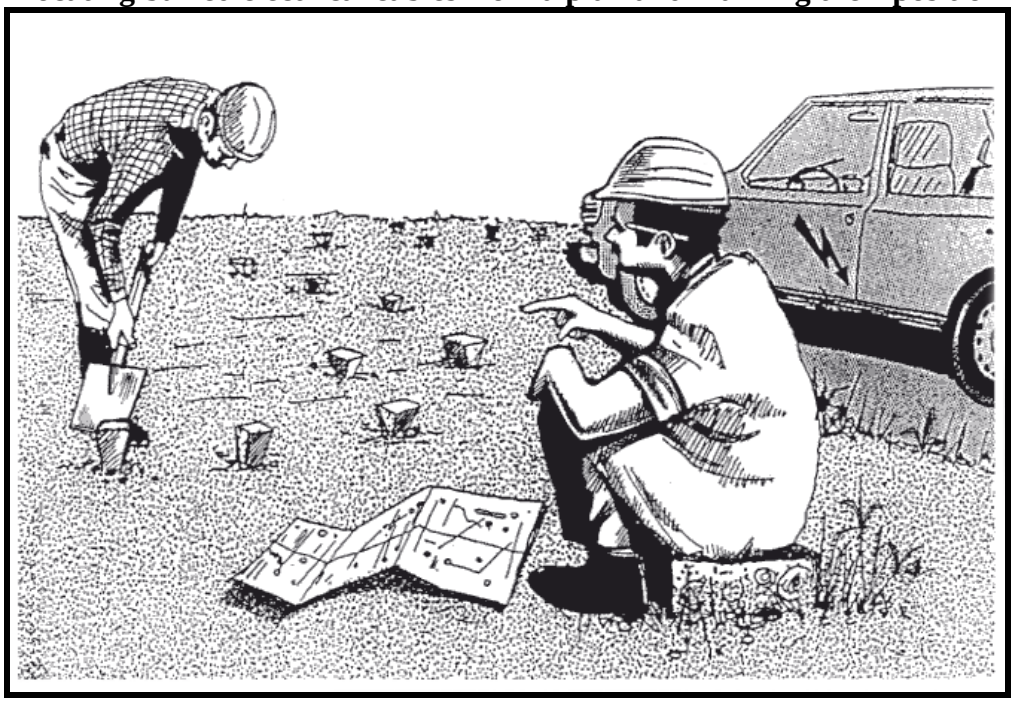
It is safe to assume that there may be underground services below the surface. In built-up areas, it is almost certain that electrical cables, water services and sewers are present. In some locations there may also be gas pipes. Some of these services look alike.

Striking electric cables may cause death or severe injuries by electric shock or severe burns. Broken gas pipes will leak and may cause a fire or explosion. Water and sewer pipes if broken may create sudden risks by flooding an excavation or by causing its sides to collapse.

Every year workers digging on construction sites suffer severe burns when they accidentally hit live buried electrical cables. Buried cables should always be assumed to be live. Before excavating, the project management must inquire of the electricity authority, the local authority or the site owner if they have any plans of the layout of cables in the area. Even if plans exist, it is possible that some cables may not be marked on the plan or may not be exactly where the plan shows, for cables rarely follow an exact straight line.

Traffic signs, street lights and substations which are usually supplied by buried cables, so these give clues to the location of the services. A cable locator must be used if available, but if cables are close together the locator may not be able to tell them apart, and some types of cable cannot be traced by locators.

Locating buried electrical cables from a plan and marking their position



The position of cables should be marked with chalk, crayon or paint or, if the ground is too soft for this, with wooden pegs (and never use sharp spikes). Once the approximate position of a buried cable is known, hand tools must be used to expose it, preferably spades and shovels rather than forks or pick-axes.

Power tools should not be used within half a metre of a cable.

Do not use mechanical excavators within half a metre of a gas pipe. If there is a smell of gas, there must be no sources of ignition nearby such as a lit cigarette or running vehicle engine. The area must be cleared of all persons and the authorities informed and asked to make the pipe safe. Plant or equipment should never be used over or near a gas pipe, as the pipe may fracture.

All exposed pipes and cables should be supported when an excavation is open. They should not be used to support equipment or as steps to get in and out of the excavation. When backfilling a trench with a gas pipe, the fill must be adequately compacted beneath the pipe to prevent settlement which could lead to pipe fracture.

Points to remember when searching for buried services

Hand dig with care, as cables may be just below the surface

Use a spade or shovel and not a fork or pick-axe,
and do not spear the tools into the ground

If you find a cable embedded in concrete,
do not break it out but seek advice

If a cable is damaged, even slightly, keep well clear

Do not work bare-chested
Normal work clothing can provide some protection from flash burns

(e) if necessary to prevent danger, the gas, water, electrical and other public utilities should be shut off or disconnected;

(f) if underground pipes, cable conductors, etc., cannot be removed or disconnected, they should be fenced, hung up and adequately marked or otherwise protected;

(g) the position of bridges, temporary roads and spoil heaps should be determined;

(h) if necessary to prevent danger, land should be cleared of trees, boulders and other obstructions;

(i) the employer should see that the land to be excavated is not contaminated by harmful chemicals or gases, or by any hazardous waste material such as asbestos.

9.2.2. All excavation work should be supervised by a competent person and operatives doing the work should be given clear instructions.

9.2.3. Sides of excavations should be thoroughly inspected:

(a) daily, prior to each shift and after interruption in work of more than one day;

(b) after every blasting operation;

(c) after an unexpected fall of ground;

(d) after substantial damage to supports;

(e) after heavy rain, frost or snow;

(f) when boulder formations are encountered.

9.2.4. No load, plant or equipment should be placed or moved near the edge of any excavation where it is likely to cause its collapse and thereby endanger any person unless precautions such as the provision of shoring or piling are taken to prevent the sides from collapsing.

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

"Trench construction, safety: Caterpillar 3128 crawler mounted backhoe straddles trench for underground pipe. Worker in trench is fine grading/cleaning trench with shovel. Workers standing in 8ft deep trench have no support against sidewall collapse. Safety and laws require the trench walls to be supported or sloped back at depths greater than 5ft."

9.2.5. Adequately anchored stop blocks and barriers should be provided to prevent vehicles being driven into the excavation. Heavy vehicles should not be allowed near the excavation unless the support work has been specially designed to permit it.

9.2.6. If an excavation is likely to affect the security of a structure on which persons are working, precautions should be taken to protect the structure from collapse.

9.2.7. Sides of excavations where workers are exposed to danger from moving ground should be made safe by sloping, shoring, portable shields or other effective means.

9.2.8. All support work should be regularly checked to ensure that the props, wedges, etc., are tight and no undue deflection or distortion is taking place.

9.2.9. All timber subject to the varying weather conditions should be regularly checked for dryness, shrinkage and rot.

Points to remember when working in excavations

Never work ahead of the side supports in a trench
even when you are erecting shoring

Appearances can be deceptive. The shallowness of an excavation or the solid appearance of the ground are not necessarily an indication of safety

Deep trenches look dangerous,
but most fatal accidents occur in trenches less than 2.5m deep

Always wear a safety helmet when you work in an excavation

Underground construction

9.3.1.1. Underground construction work should be carried on in accordance with plans approved by the competent authority when required by national laws and regulations. The plan should define excavation methods, rescue and evacuation methods in case of fire, flood and fall or dislodgement of earth or rock.

9.3.1.2. All underground construction work should be supervised by a competent person and operatives doing the work should be given clear instructions.

9.3.1.3. All occupied workplaces underground should be inspected at least once in every shift.

9.3.1.4. Places occupied by solitary workers should be inspected at least twice in every shift.

9.3.1.5. At least once in every week, thorough inspection should be made of all machinery, equipment, structures, supports, roadways, means of egress, magasines, medical facilities, sanitation and working places.

9.3.1.6. All workers should be withdrawn from underground workings if:

(a) the ventilation fails; or

(b) other imminent danger threatens.

9.3.1.7. A suitable communication system should be maintained from the vicinity of the face of underground workings to the surface with stations at intermediate workplaces.

9.3.1.8. In tunnels and other underground workings where an explosive mixture such as methane and air may form, operations should be carried on in accordance with national laws and regulations applicable to gassy mines or coal mines.

9.3.1.9. Air should be tested to ascertain if it is hazardous and no one allowed entry until it is fit for breathing.

9.3.1.10. Escape routes should be properly indicated with signs visible in dim light.

4 SHAFTS AND HEADINGS

See also Theme Summary 10: "General plant & equipment".

9.3.2.1. Every shaft not sunk through solid rock should be cased, lined or otherwise made safe.

9.3.2.2. Shuttering for masonry lining of shafts should only be removed gradually as the masonry progresses.

9.3.2.3. Workers employed on sinking shafts should be provided with staging, scaffolds or cradles from which they can work safely.

9.3.2.4. A thorough inspection of the shaft should be made:

(a) before a shift descends;

(b) after blasting.

9.3.3.1. All underground workings should be traversed by a regular air current to keep them in a fit state for working and, in particular:

(a) to avoid excessive rises in temperature;

(b) to dilute harmful dusts, gases, vapours and fumes to safe concentrations;

(c) to prevent the oxygen content of the atmosphere from falling below 17 per cent or a level prescribed in national laws and regulations.

9.3.3.2. In all underground workings it should be possible to reverse the air flow.

9.3.3.3. In tunnels where blasting is done:

(a) an adequate supply of air should be taken to the face by mechanical ventilation;

(b) after every blast the face should be cleared of harmful gases and dust as far as practicable by exhaust ventilation; where necessary, the dust should be controlled with water sprays or fog guns;

(c) if necessary to remove the fumes, auxiliary ventilation should be provided.

9.3.3.4. Where adequate ventilation is not possible, workers should be provided with suitable breathing apparatus. Only in very exceptional circumstances should people be allowed to work without adequate ventilation.

9.3.4.1. No combustible structure should be built or any flammable material stored within 30m of a shaft, tunnel mouth, hoisting-engine house or ventilation-fan house.

9.3.4.2. As far as practicable, combustible materials and flammable liquids should not be stored underground.

9.3.4.3. Lubricating oils, grease and rope dressings underground should:

(a) be kept in closed metal containers;

(b) be stored in a safe place away from shafts, hoists, explosives and timber.

9.3.4.4. Unless there is no risk of fire or explosion, naked lights and smoking should not be allowed underground.

9.3.4.5. Petrol engines should not be used underground except under conditions approved by the competent authority.

9.3.4.6. If welding or flame cutting is done underground:

(a) timber supports and other combustible structures or materials should be protected by a fireproof screen;

(b) suitable fire extinguishers should be kept readily available;

(c) a constant watch should be kept for outbreaks of fire;

(d) welding fumes should be removed by exhaust ventilation.

9.3.5.1. Electrical installations in shafts and tunnels should comply with the relevant national laws or regulations.

9.3.6.1. All places where workers have to work or pass should be adequately lit.

9.3.6.2. In addition to the main lighting, there should be emergency lighting that functions long enough to enable the workers to reach the surface safely.

9.7.1. The haulage system should comply with the national laws and regulations.

9.7.2. In tunnels where there are rail tracks, unless there is adequate clearance between the rolling stock and the sides, recesses should be provided at suitable intervals which should be large enough to accommodate two persons and should be at least 60cm deep.

9.7.3. Mechanical haulage operations should be controlled by suitable signals.

9.7.4. Trains and single cars should have headlights and tail-lights.

9.7.5. Rerailing by hauling with a winch should only be done under the control and supervision of a competent person.

9.7.6. Workers should not be transported on locomotives or in cars other than those specially provided for that purpose.

9.8.1. Adequate measures should be taken to prevent the formation of, or to suppress as close to the source as practicable, all dust in tunnelling operations and in particular siliceous dusts consisting of particles less than 5 microns in size.

5 DEMOLITION AND CONTAMINATED SITES

See also Theme Summary 14: "Working at height".

General provisions

14.1.1. When the demolition of any building or structure might present danger to workers or to the public:

(a) appropriate precautions, methods and procedures should be adopted, including those for the disposal of waste or residues, in accordance with national laws or regulations;

(b) the work should be planned and undertaken only under the supervision of a competent person.

14.1.2. Before demolition operations begin:

(a) structural details and builders' drawings should be obtained wherever possible;

(b) wherever possible, details of the previous use should be obtained to identify any possible contamination and hazards from chemicals, flammables, etc.;

(c) an initial survey should be carried out to identify any structural problems and risks associated with flammable substances and substances hazardous to health. The survey should note the type of ground on which the structure is erected, the condition of the roof trusses, the type of framing used in framed structures and the load-bearing walls;

(d) premises such as hospitals, telephone exchanges and industrial premises containing equipment sensitive to vibration and dust and all premises sensitive to noise should be located;

(e) a method of demolition should be formulated after the survey and recorded in a method statement having taken all the various considerations into account and identifying the problems and their solutions;

(f) a building should be checked and it should be verified that it is vacant.

14.1.3. All electric, gas, water and steam service lines should be shut off and, as necessary, capped or otherwise controlled at or outside the construction site before work commences.

14.1.4. If it is necessary to maintain any electric power, water or other services during demolition operations, they should be adequately protected against damage.

14.1.5. As far as practicable, the danger zone round the building should be adequately fenced off and signposted. To protect the public a fence 2m high should be erected enclosing the demolition operations and the access gates should be secured outside working hours.

14.1.6. Demolition operations should only be carried out by competent workers.

14.1.7. The fabric of buildings contaminated with substances hazardous to health should be decontaminated and where necessary appropriate protective clothing and suitable respiratory protective equipment should be provided and worn.

14.1.8. Where plant has contained flammable materials, special precautions should be taken to avoid fire and explosion.

14.1.9. The plant to be demolished should be isolated from all other plant that may contain flammable materials. Any residual flammable material in the plant should be rendered safe by, for example, cleaning, purging or the application of an inert atmosphere as appropriate.

14.1.10. Care should be taken not to demolish any parts which would destroy the stability of other parts.

14.1.11. Demolition activities should not be continued under climatic conditions such as high winds, which could cause the collapse of already weakened structures.

14.1.12. When necessary to prevent danger, parts of structures should be adequately shored, braced or otherwise supported.

14.1.13. Structures should not be left in a condition in which they could be brought down by wind pressure or vibration.

14.1.14. Where necessary to keep down dust, buildings being demolished should be sprayed with water at suitable intervals.

14.1.15. Foundation walls serving as retaining walls to support earth or adjoining structures should not be demolished until the adjoining structure has been underpinned or braced, and the earth removed or supported by sheet piling or sheathing.

14.1.16. Where a deliberate controlled collapse technique is to be used, expert engineering advice should be obtained, and:

(a) it should only be used where the whole structure is to come down because it relies on the removal of key structural members to effect a total collapse;

(b) it should only be used on sites that are fairly level and where there is enough surrounding space for all operatives and equipment to be withdrawn to a safe distance.

14.1.17. Buildings and structures which are not carrying their design loads may be pre-weakened prior to a deliberate collapse, but in such cases:

(a) the pre-weakening should be carefully planned so that, despite the removal of redundant members and the partial cutting of load-bearing members, the structure should have sufficient strength to resist wind loads or impact loads until such time as a deliberate collapse is achieved;

(b) the dead load should be reduced systematically by the removal of surplus material, machinery, cladding, walls and parts of floors before work begins on the structural frame.

14.1.18. Where explosives are used to demolish key members, the blast protection and safe distances should be agreed in advance. The work should only be undertaken by personnel experienced in the controlled application of explosives in accordance with national laws and regulations.

14.1.19. The shot-firers should establish the area at risk to enable the area to be appropriately cleared or evacuated, if necessary. Blast protection should be of a high standard but should not be considered as an alternative to defining the area likely to be affected.

14.1.20. When equipment such as power shovels and bulldozers are used for demolition, due consideration should be given to the nature of the building or structure, its dimensions, as well as to the power of the equipment being used.

Cranes used in demolition

A cast-steel ball or weight suspended from a crane jib is an extensively used method of demolition. Cranes as such are not designed for extremes of shock loading likely to arise when a demolition ball is in use and therefore should be used only to drop the ball vertically on a free fall for such operations as breaking up concrete slabs. They should not be used for swinging the ball. Excavators which are convertible to cranes are designed for drag-line operations which impose a shock load and are more suited to use with a ball.

The excavator manufacturer’s recommendations as to weight and attachment of the ball should be followed. Generally the weight of the demolition ball should not be more than 33 per cent of the machine’s safe working load and not exceed 10 per cent of the hoist rope’s minimum breaking load. All parts should be inspected twice daily, and a high standard of maintenance is necessary. As an operator you need to be familiar with demolition balling and should be protected from debris by a protective structure with safety glass or metal mesh.

14.1.21. If a swinging weight is used for demolition, a safety zone having a width of at least one-and-a-half times the height of the building or structure should be maintained around the points of impact.

14.1.22. Swinging weights should be so controlled that they cannot swing against any structure other than the one being demolished.

Useful advice from The Concrete Network:
http://www.concretenetwork.com/concrete/demolition/ball_and_crane.htm

Ball and Crane for Demolishing Masonry and Concrete Structures

One of the oldest and most commonly used methods for building demolition, the ball and crane uses a wrecking ball weighing up to 13,500 pounds to demolish concrete and masonry structures. During the process, the ball is either dropped onto or swung into the structure that is to be demolished.

The ball and crane, however, is not suitable for all demolition applications. Some limitations:

- *While the concrete can be broken into rather small pieces, additional work in the form of cutting rebar may be necessary.*
- *Only highly skilled and experienced crane operators should be used on ball and crane demolition projects -- smoothness in controlling the swing of the ball is important since missing the target may tip or overload the crane and a mild swing-back may cause the ball to hit the boom.*
- *The size of the building that can be demolished with this method is limited by crane size and working room, including proximity to power lines.*
- *This form of demolition creates a great deal of dust, vibration and noise.*

(185 words so ‘fair use)

14.1.23. If a clamshell bucket is used for demolition, a safety zone extending 8m from the line of travel of the bucket should be maintained.

14.1.24. Where necessary during the demolition of buildings or other structures, appropriate catch platforms capable of withstanding safely a live load of 6.0 kN/m2 and at least 1.5m wide should be provided along the outside of exterior walls so as to prevent danger from falling objects.

Demolition of walls

14.2.1. Walls should be demolished storey by storey beginning at the roof and working downwards.

(Photo & caption by (Photo: Robert Carr, http://myconstructionphotos.smugmug.com)
Building construction demolition:
Samsung SE 350 LC2 backhoe grapple tears window out of building wall.

14.2.2. Where necessary, unsupported walls should be prevented from falling by means such as shoring and ties.

Demolition of floors

14.3.1. When necessary to prevent danger, workers demolishing floors should be provided with planking or walkways on which to stand or move.

14.3.2. Openings through which material is dropped should be adequately fenced or barricaded to prevent danger.

14.3.3. All work above each tier of floor beams should be completed before the safety of the tier supports is impaired.

Demolition of structural steelwork

14.4.1. All practicable precautions should be taken to prevent danger from any sudden twist, spring or collapse of steelwork, ironwork or reinforced concrete when it is cut or released.

14.4.2. Steel construction should be demolished tier by tier.

14.4.3. Structural steel parts should be lowered and not dropped from a height.

6 CONFINED SPACES

Introduction

Every year there are fatal and serious accidents caused by persons entering confined spaces without the necessary tests being carried out or the correct safety and rescue equipment being provided. In many cases attempted rescue has ended in tragedy, with the death of the poorly equipped rescuer as well as the person to be rescued. While a closed tank with a restricted access opening may be the obvious example of a confined space, such spaces may also include open manholes, sewers, trenches, bored piles, pipes, ducts, enclosed basements and other places where there is inadequate ventilation.

Dangerous atmospheres can arise when there is a lack of oxygen or when toxic or flammable gases are present. These may be due to exhaust gases from plant and transport, carbon dioxide forming in chalk soil, decomposition of sludge in a sewer, leaks from gas mains, rusting of metalwork, or the presence of petrol and various kinds of waste from factories and trade premises. Work being done in a confined space can make it dangerous. Examples are some painting work, the use of adhesives to fix floor tiles, and cleaning fluids.

Many of these accidents would have been avoided if supervisors and workers had been properly trained and a permit to enter and a permit to work system had been in operation.

The ILO Code

17.4.1. An information system should be set up by the competent authority, using the results of international scientific research, to provide information for clients, architects, contractors, employers' and workers' representatives on the health risks associated with the hazardous substances used in the construction industry.

17.5.1. Where workers are required to enter any area in which a toxic or harmful substance may be present, or in which there may be an oxygen deficiency or a flammable atmosphere, adequate measures should be taken to guard against danger.

17.5.2. The measures regarding dangerous atmospheres to be taken pursuant to paragraph 17.4.1 above should be prescribed by the competent authority and should include prior written authority or permission from a competent person, or any other system by which entry into any area in which a dangerous atmosphere may be present can be effected only after completing specified procedures.

17.5.3. No naked light or flame or hot work such as welding, cutting and soldering should be permitted inside a confined space or area unless it has been made completely free of the flammable atmosphere, tested and found safe by a competent person. Only non-sparking tools and flameproof hand lamps protected with guard and safety torches should be used inside such confined space or area for initial inspection, cleaning or other work required to be done for making the area safe.

17.5.4. No person should enter a confined space or area with a dangerous atmosphere or deficiency of oxygen unless:

(a) the atmosphere has been found to be safe after suitable testing by a competent person (which should be repeated at suitable intervals);

(b) adequate ventilation is provided.

17.5.5. If the conditions in the preceding paragraph cannot conveniently be fulfilled, persons may enter such spaces for prescribed periods using air lines or self-contained breathing apparatus and safety harnesses with lifelines.

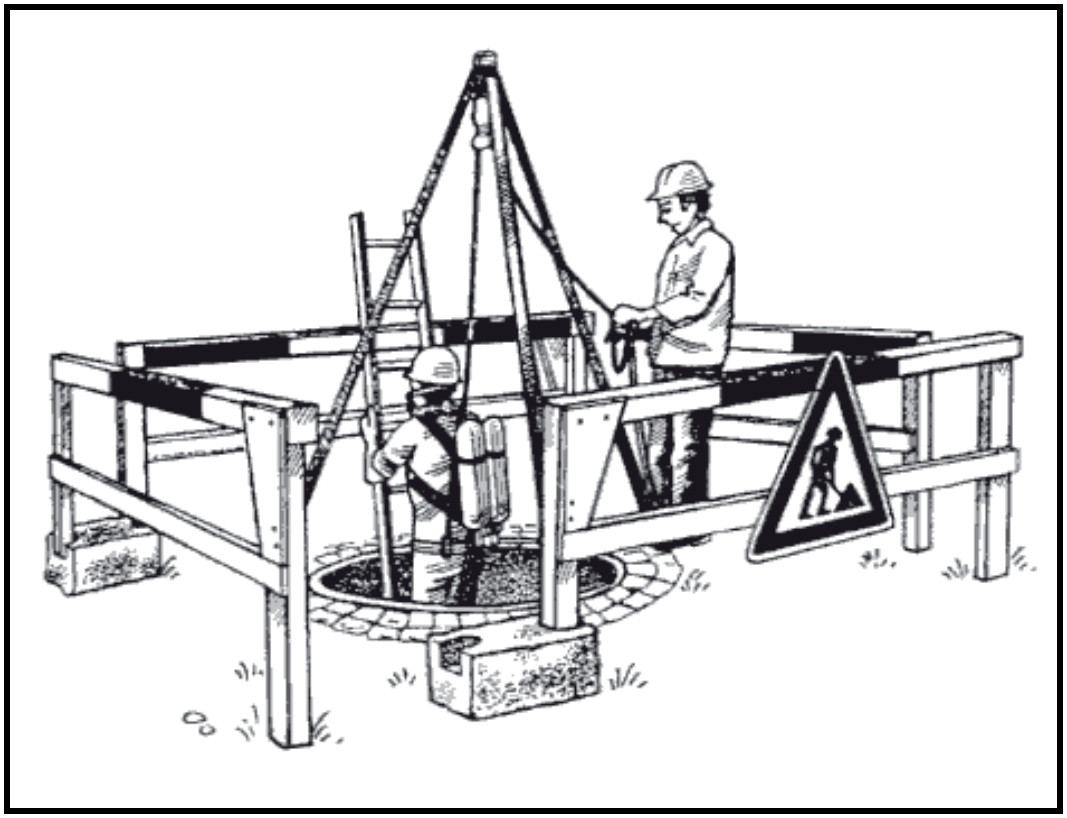
17.5.6. While a worker is in a confined space:

(a) adequate facilities and equipment including breathing apparatus, resuscitation apparatus and oxygen should be readily available for rescue purposes;

(b) a fully trained attendant or attendants should be stationed at or near the opening;

(c) suitable means of communication should be maintained between the worker and the attendant or attendants.

Working in confined spaces



Persons who are actively engaged in work in confined spaces must be fit and properly trained for the job and have the necessary personal protective equipment. They should remember that an oxygen deficiency can render them unconscious, and that toxic fumes can additionally cause dizziness and a feeling of sickness, while gases can be flammable or explosive.

The following precautions are essential before anyone enters a confined space:

- *Nobody should enter without instructions from a supervisor and without a written permit to enter or permit to work. Nobody may enter the confined space until the competent person is satisfied that entry is safe.*

- *Equipment for monitoring the atmosphere at frequent intervals must be provided and must be used by a competent person.*

- *There should be forced ventilation to remove and dilute dangerous gases and provide fresh air.*

- *Monitoring must continue while work proceeds, and everyone must leave immediately if told to do so.*

- *Everyone should have received proper training and instruction in the precautions to be taken, including the use of emergency breathing apparatus.*

- *Rescue harnesses should be worn by everyone inside the confined space, with lifelines attached to a point outside the space.*

- *Not less than two persons should be present when there is work in a confined space. One should be outside the confined space to keep watch and to offer rescue action or assistance. Additional emergency and accident assistance must also be readily available.*

- *A proper procedure for rescue in an emergency should be laid down, with specific duties allocated to specific persons.*

- *When working at a manhole in a road or public area, guard stands must be provided and the appropriate traffic signs displayed.*

- *Everyone has to be trained by a competent person in the use of the safety and rescue equipment.*

7 RELEVANT ELEMENTS OF THE KNOWLEDGE BASE

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

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

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