ISU 3/2015

Tapak Selamat

BAHAGIAN KESELAMATAN TAPAK BINA

Excavation Safety

Work in and around any excavation is always hazardous. Every year, too many construction workers are killed and injured when part of inadequately supported excavations, in which they are working, collapse. In 2015, out of 33 fatalities in construction sites that we studied, 5 casualties were caused by excavation and groundwork. The risk is self-evident when you consider that one cubic metre of soil can weigh as much as one tonne, and it is quite common that for a volume of soil to collapse into unsupported excavation.

This edition of Tapak Selamat presents various hazards related with excavation work, and proposes measures to control these hazards. The key aim of this article is to help officer, who involves in construction site's regulatory enforcement, to identify the main hazards in excavation work and to take the necessary preventive measures (such as through directive letter, notice of improvement and etc.) to prevent them. It is also highly advisable for the officer to take note that some of the requirements in this article are mandatory.

1

INTRODUCTION

definition, site investigation, client.

2

HAZARDS AND CONTROLS

collapse, dislodge, fall, vehicle, plant, stability.

3

INSPECTION

rainstorm and hazard-increasing events, report.

Introduction

1 Excavation means the removal of earth, rock or other material in connection with construction, such as trenching, cofferdam and caisson, or demolition work using tools, machinery or explosives (FMA, 2014). Excavation also includes any earthwork, trench, well, shaft, tunnel or underground working, and cofferdam and caisson are regarded as part of excavation work (Joyce, 2015).

2 Trenchless technology can replace the need for excavation, apart from launch and reception pits. Thay also reduce risks to members of the public from open excavations and subsequent traffic disruption. Many of these techniques are briefly mentioned in the reference (HSE, 1999).

3 One of the most important factors to be deliberated when planning an excavation is the type of the soil which is to be excavated. All excavations, except the most shallow, require some support using trench sheeting (Hughes, et al., 2008).

4 It is essential that an excavation supervisor should assess the likelihood of any changes in ground conditions and revise the working method accordingly (Hughes, et al., 2008). Guidance on the general risk management process is available in the *Guidelines for Hazard Identification, Risk Assessment and Risk Control (HIRARC).*

5 Assessment by excavation supervisor must be preceded by a site investigation, undertaken (by the main contractor) during the planning process and points to consider are (Hughes, et al., 2008) (SafeWork, 2012):

(a) underground essential services – including gas, water, sewerage, telecommunications, electricity, chemicals and fuel or refrigerant in pipes or lines.
(b) previous use of site;
(c) location of existing buildings;
(d) location of new structures;
(e) results of soil investigations;
(f) ground contamination;
(g) water courses (including underground), level of water table and type of soil;
(h) storage and disposal of excavated material;
(i) the methods of transport, haul routes and disposal, amount of working space and storage required;
(j) the most suitable method of temporary support of the excavation walls;
(k) the number of people involved;
(l) local weather conditions;
(m) the length of time that the excavation will be open; and
(n) adequate emergency arrangements.

6 The clients can make a significant contribution for improving the safety and health management of excavation by allocating sufficient funds for site investigation. They should be prepared to allocate further resources for site investigation during the course of construction if the predicted soil or rock conditions, as exposed by the excavation, differ from the conditions predicted from the original site investigation (Joyce, 2015).

7 The position of all underground installations, such as sewers, mains (water or gas) and cables (electrical power or telecommunications) must be verified before the work begins (DOSH, 2000).

8 If excavation work is needed to repair mains (water or gas), piped services or cables (electrical power or telecommunications) which are feeding occupied buildings, it is crucial that there is effective communication between the excavation contractors and the building occupants throughout all stages of the project. The pipe or cable must be isolated before work begins. If the work obstructs the main or emergency exits from the buildings then alternative egress arrangements must be made (Hughes, et al., 2008).

9 After the site survey has been completed, meetings must be organised with the occupants of surrounding buildings and other properties so that any special arrangements can be communicated. Continual liaison with neighbours is an important element in the risk control strategy (Hughes, et al., 2008).

Hazards and Controls

10 All practicable steps (including site investigation and inspection mentioned in paragraphs 5 and 85-86, respectively) must be taken to prevent danger to any person, including, where necessary, the provision of supports or battering, to ensure that (CDM, 2015) –

(a) no excavation or part of an excavation collapses;
(b) no material forming the walls or roof of, or adjacent to, any excavation is dislodged or falls;
(c) no person is buried or trapped in an excavation by material which is dislodged or falls;
(d) no person is exposed to danger of influx of ground or surface water and entrapment in silt or mud;
(e) no person is exposed to risk of being strucked by vehicle or plant; and
(f) stability of structures adjoining or over areas to be excavated is protected.

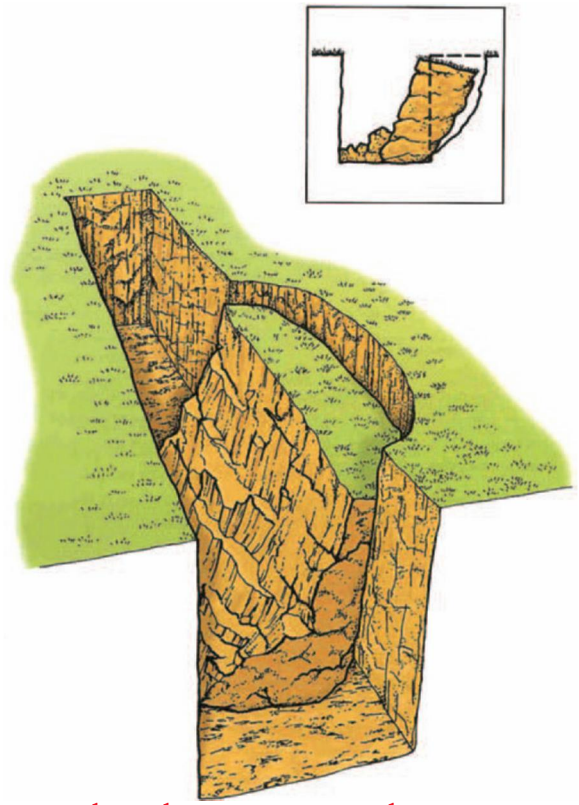

Figure 1. All practicable steps must be taken to prevent danger to any person in and adjacent to the excavation, to ensure that no excavation or part of it collapses (Hughes, et al., 2008).

Figure 2. Stability of structures adjoining or over areas to be excavated must be protected (Hughes, et al., 2008). Where there is any question of stability of structures adjoining or over areas to be excavated, such structures shall be supported where necessary by underpinning, sheet piling, shoring, bracing or other means made or erected according to the design of a Professional Engineer to prevent injury to any person (FMA, 2014).

11 No employee shall be permitted to enter any excavated area unless supports, such as sheet piling, shoring or other safeguards that may be necessary for his protection are provided (FMA, 2014). The design of supports or battering to an excavation requires knowledge of the relevant soil or rock parameters, obtained from appropriate field and laboratory testing as part of the site investigation (Joyce, 2015).

12 For a trench to be excavated without shoring, the side must be cut back to a safe slope (battered back or benched) such that the material in the sides is able to stand under all anticipated conditions of work and weather (DOSH, 2000). Typical slope angles are shown in the Table 1 (HSE, 1999).

13 In a shallow trench where material is uniform and known to be stable and the trench will be backfill within a short time, vertical faces may be safe for depths of up to 1.5 metres (DOSH, 2000).

14 Stepping or benching the excavation sides is an alternative to battering. In this method one or more steps are cut into the excavation side(s). The depth and width of the step need to be determined using the typical slope angles given in Table 1, although the vertical distance should not exceed 1.2 metres (HSE, 1999), and should not be less than 1.2 metres wide (DOSH, 2000).

15 Where trench exceeds 3 metres in depth, it should be benched or stepped (DOSH, 2000).

16 Care needs to be taken in the use of the figures in Table 1 as soils in their natural state are often a combination of those listed. A small percentage increase in the water content of some soils can also significantly reduce their natural strength. Battered excavations require regular monitoring. Regular scaling of rock excavations may be necessary (HSE, 1999).

17 Ground support can also be accomplished by timber boards supported by timber walings and struts or by sheet piling or steel trench sheeting supported by timber or steel walings and struts (see Figure 3 and Figure 4) (HSE, 1999).

18 Sheeting is the general term given to steel sheets or timber boards used to support the walls of an excavation. Close sheeting refers to vertical or horizontal sheeting that are arranged close together for added strength, and when the sheets are only placed at intervals, normally in clay, this is known as open sheeting (see Figure 3 and Figure 4 for close sheeting and Figure 5 for open sheeting) (Hughes, et al., 2008).

19 Wales means horizontal planks placed in front of the sheet pilings which form part of the supporting structure for the sides of trenches after excavation (FMA, 2014).

20 Planks used as sheet piling shall be at least 50 millimeters thick. The maximum spacing between wales shall be such as to keep the planks within their safe bending stress (FMA, 2014).

21 Shores and braces shall be of adequate dimensions for stiffness and shall be placed as to be effective for their intended purposes. Each end of each wales piece shall be separately braced (FMA, 2014).

22 Earth-supported shores or braces shall bear against a footing of sufficient area (or toe-in to an adequate depth) and stability to prevent their shifting (FMA, 2014).

Table 1. Typical safe slope angles (in degrees to the horizontal) for battering back sides of an excavation (HSE, 1999).

Material	Dry ground	Wet ground
Gravel	30 – 40	10 – 30
Sand	30 – 35	10 – 30
Silt	20 – 40	5 – 20
Clay	20 – 45	10 – 35
Peat	10 – 45	5 – 35

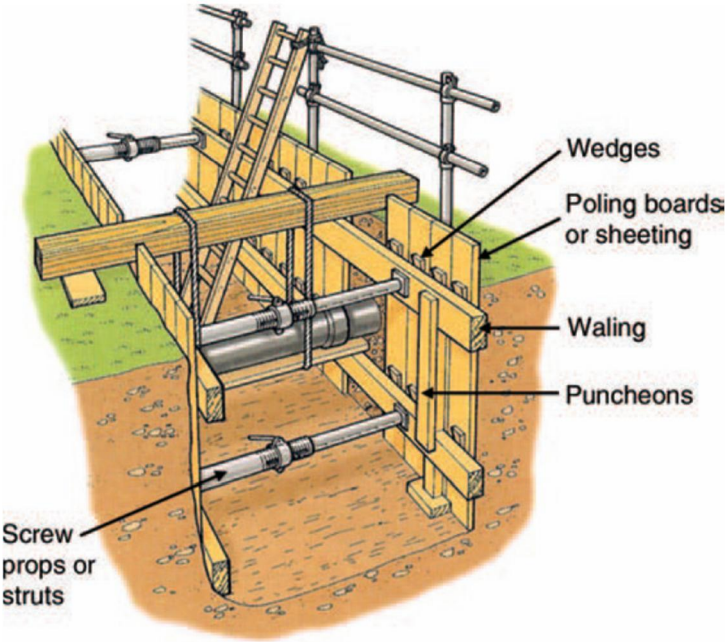

Figure 3. Timbered excavation with ladder access and supported services (guard removed on one side for clarity) (Hughes, et al., 2008). Underground services which are exposed by the excavation are supported.

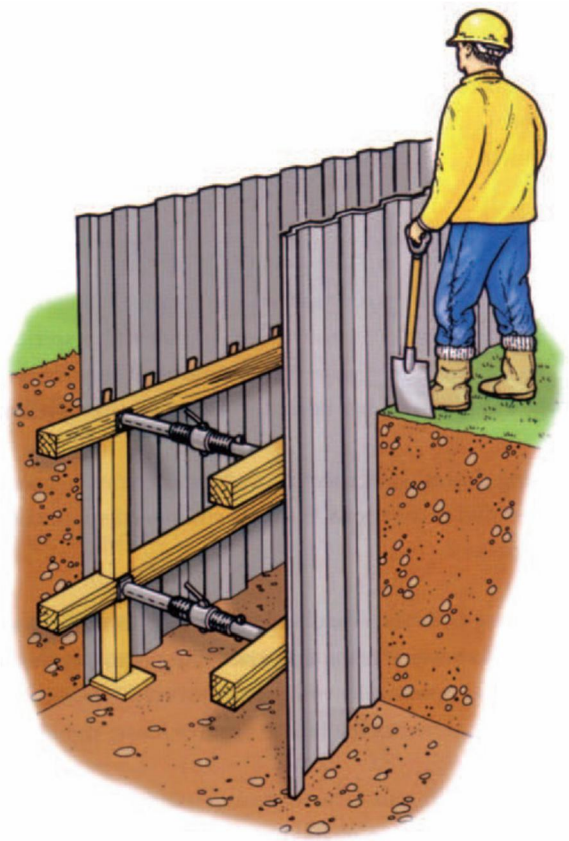

Figure 4. Trench sheets with timber walings, screw props, puncheons and sole plates (Hughes, et al., 2008). Timber packing should be used to prevent struts bearing directly on steel.

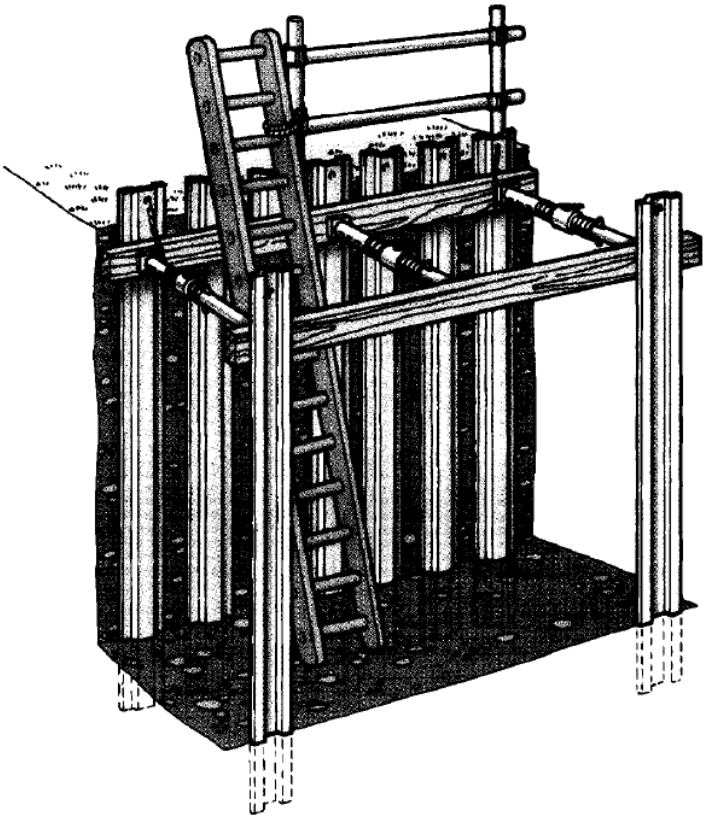

Figure 5. In open sheeting, the sheets are only placed at intervals (HSE, 1999).

23 Temporary supports, such as sheet piling, installed to permit the construction of a retaining wall shall not be removed until the wall has developed its full strength (FMA, 2014). One of the hazards related to this work is illustrated in Figure 6.

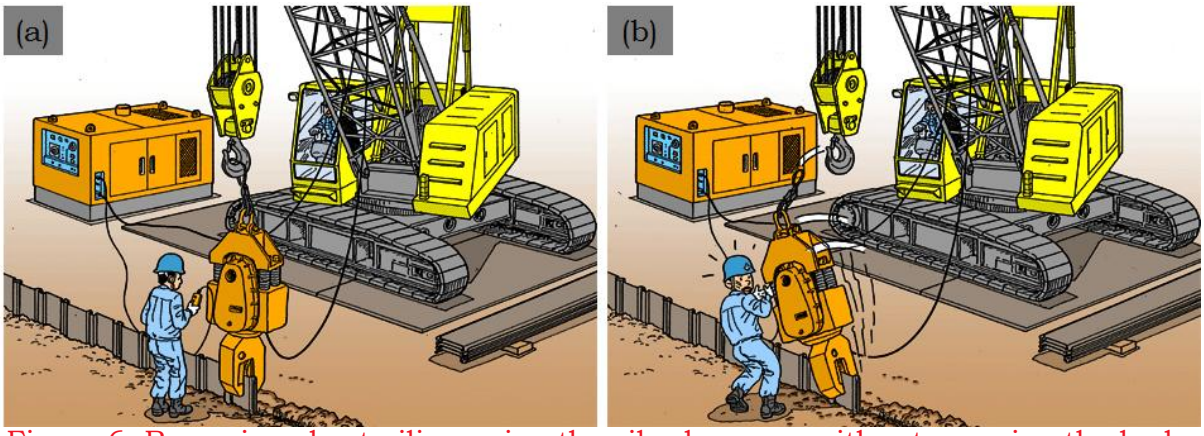

Figure 6. Removing sheet piling using the vibrohammer without securing the hydraulic chuck may cause the vibrohammer to come off its hook and fell onto the worker (JICOSH, 2015).

24 Where banks are undercut, adequate shoring shall be provided to support the overhanging materials (FMA, 2014).

25 The use of proprietary ground support systems such as hydraulic waling frames, manhole shores, trench boxes, drag boxes and slide-rail system must always be in accordance with manufacturer's instructions. Details descriptions of these methods can be sought from HSE (1999).

26 Where there is any question of stability of structures adjoining or over areas to be excavated, such structures shall be supported where necessary by underpinning, sheet piling, shoring, bracing or other means made or erected according to the design of a Professional Engineer to prevent injury to any person (FMA, 2014). See Figure 7.

27 Building foundations that are at a distance of less than two times the excavation depth from the face of the excavation are more likely to be affected by ground movement; underpinning of such structures may be necessary to prevent structural damage (HSE, 1999).

28 Further settlement will occur if excavations are not backfilled adequately. Backfill needs to be placed and compacted in layers and all spaces, including those created when temporary supports are removed, need to be filled. Temporary supports should not be withdrawn until sufficient backfill has been placed to prevent the excavation from collapsing (HSE, 1999).

29 Suitable and sufficient steps must be taken to prevent any person, work equipment (see Figure 8), or any accumulation of material from falling into any excavation (CDM, 2015).

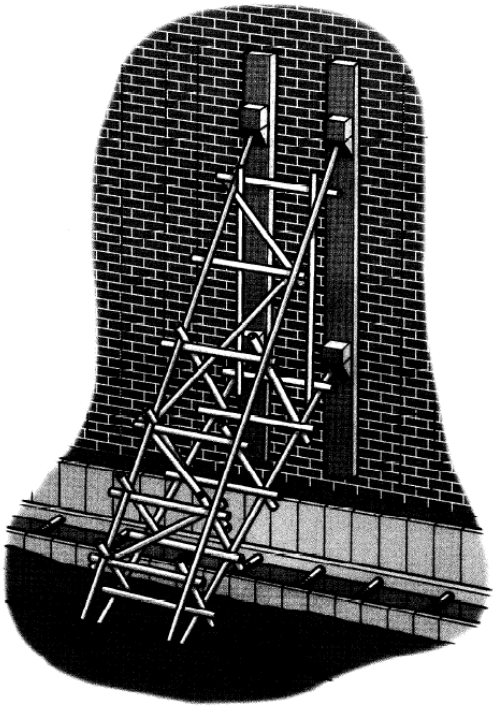

Figure 7. Shoring of building with excavation at base. Care should be taken to ensure that the foundations of nearby buildings or structures are not disturbed or undermined (HSE, 1999).

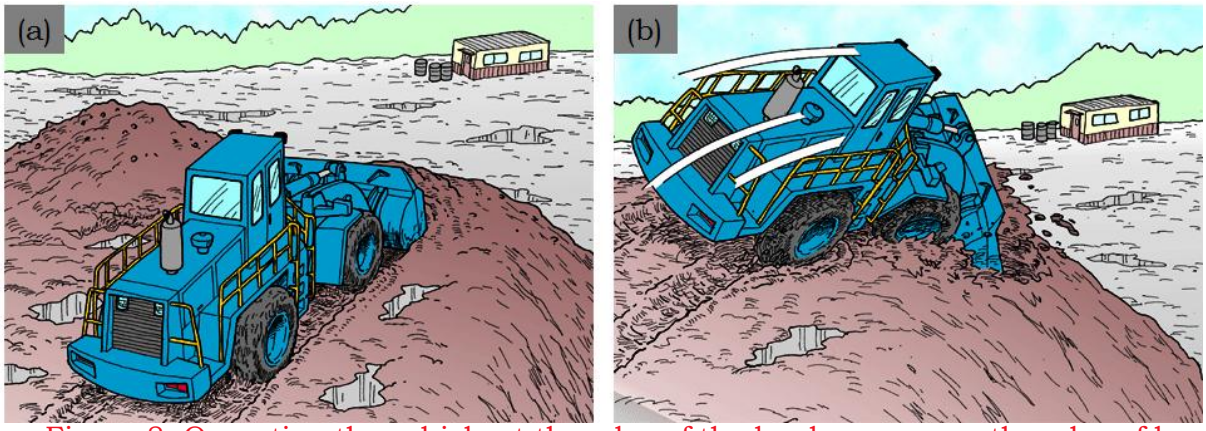

Figure 8. Operating the vehicle at the edge of the bank can cause the edge of bank to collapse (JICOSH, 2015).

30 No employee shall be permitted to work where he may be struck or endangered by an excavating machine or by material dislodged by it or falling from it (FMA, 2014). Example related to this hazard is shown in Figure 9.

31 The steps to be taken are to prevent three occurrences. First, any person falling into an excavation, second, work equipment falling into an excavation and, finally any spoil from the excavation falling back into the excavation. These steps will include physical barriers of appropriate strength and dimensions, and will also include restrictions on traffic and site movement adjacent to the excavations, and site planning so that stock-piling of materials or excavated spoil are sufficiently distant from the edge of the excavation (Joyce, 2015). Storage and disposal of materials or debris must also complied with other provisions of *Factories and Machinery (Building Operations and Works of Engineering) (Safety) Regulations*.

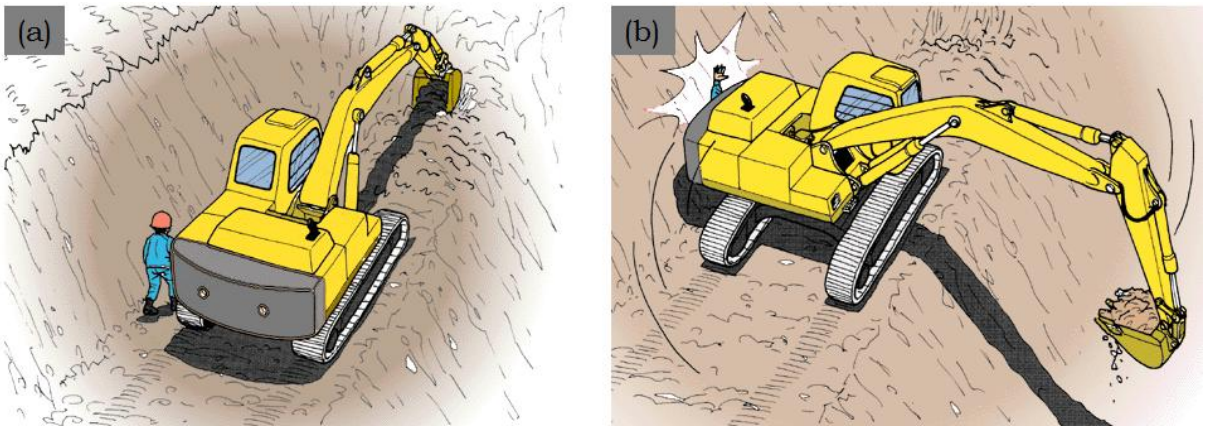

Figure 9. No employee shall be permitted to work where he may be struck by an excavating machine. Put up a barricade to prevent entry and assign a supervisor to the construction site (JICOSH, 2015).

32 Banks shall be stripped of loose rocks or other materials which may slide, roll or fall upon persons below (FMA, 2014).

33 Open sides of excavations where a person may fall more than 3 metres shall be guarded by adequate barricades and suitable warning signs shall be put up at conspicuous positions (FMA, 2014).

34 Adequate barricades comprising guard and intermediate rails and toeboards (HSE, 1999).

35 Where there is a fall risk of less than 3 metres but an additional hazard caused, for example, by standing water ot reinforcing bars projecting upwards, the same standard of fall protection should be provided (HSE, 1999).

36 No person shall be permitted to position or operate machinery in a manner likely to endanger himself or others in the vicinity of the excavation site (FMA, 2014). Examples of steps to be taken are depicted in Figure 10 and Figure 11.

37 Workers should never remain in a trench or other excavation when they are in the vicinity of materials being deposited into the trench by plant (HSE, 1999).

38 Suitable and sufficient steps must be taken to prevent hazards associated with passing traffic and vehicle collision with the excavation, its workers or passing pedestrians (CDM, 2015). Examples of steps to be taken are illustrated in Figure 12 and Figure 13.

39 Whenever any work is being performed over, on or in close proximity to a highway or any other place where public vehicular traffic may cause danger to men at work, the working area shall be so barricaded and suitable warning signs and warning lights shall be set up to direct traffic away from it, and when necessary, the traffic shall be specially controlled by designated persons (FMA, 2014).

40 All work carried out on a road or highways shall have an approval of the road controlling authority before any work starts. Temporary warning sign shall be erected and traffic control exercised in accordance with the requirements from other relevant authorities (DOSH, 2000).

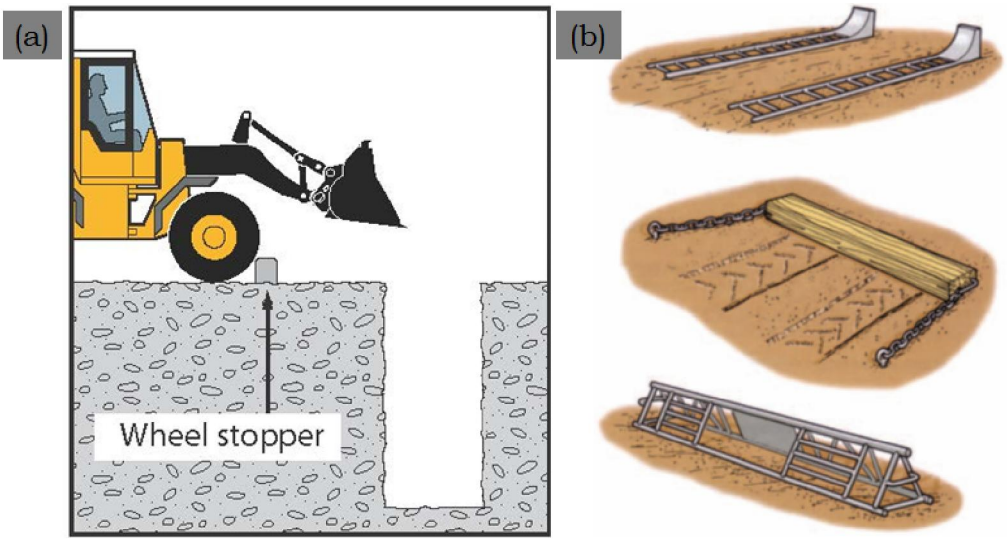

Figure 10. Adequate and well-anchored stop blocks should be provided on the surface to prevent vehicles being driven into the trench, cofferdam or caisson (a). Examples of stop blocks for dumpers (b) (Hughes, et al., 2008).

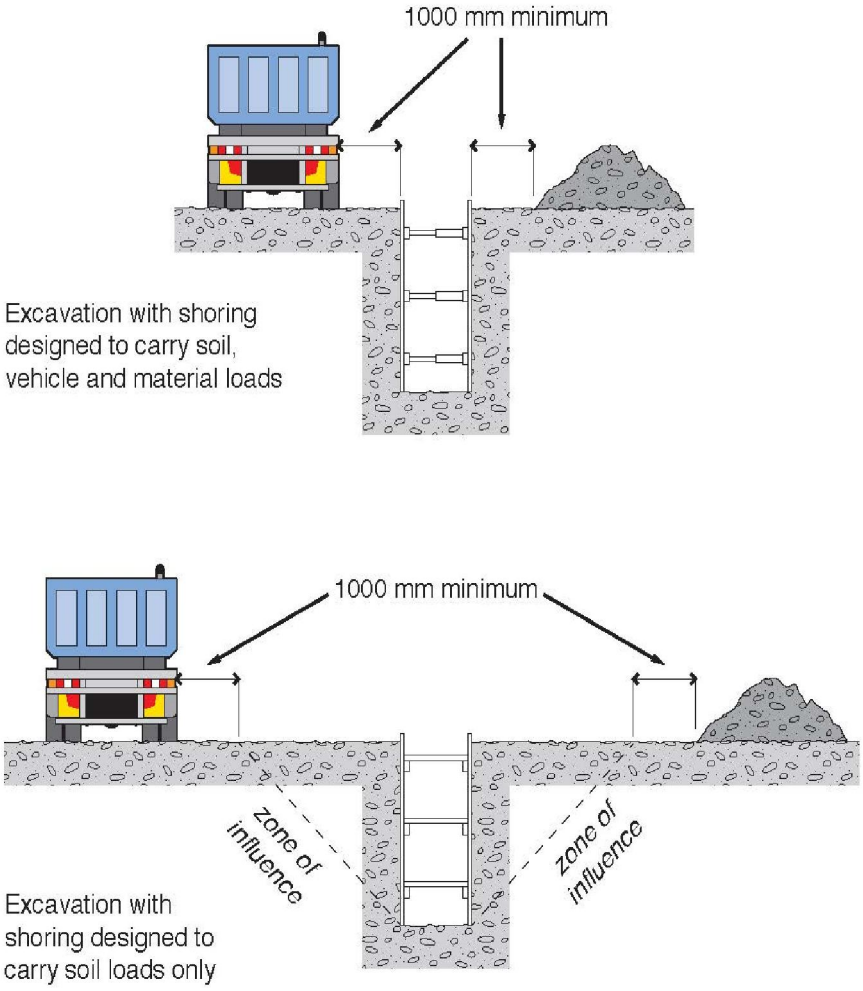

Figure 11. Mechanical plant, vehicles, storage of materials (including excavated material) or any other heavy loads should not be located in the 'zone of influence' of an excavation (SafeWork, 2012).

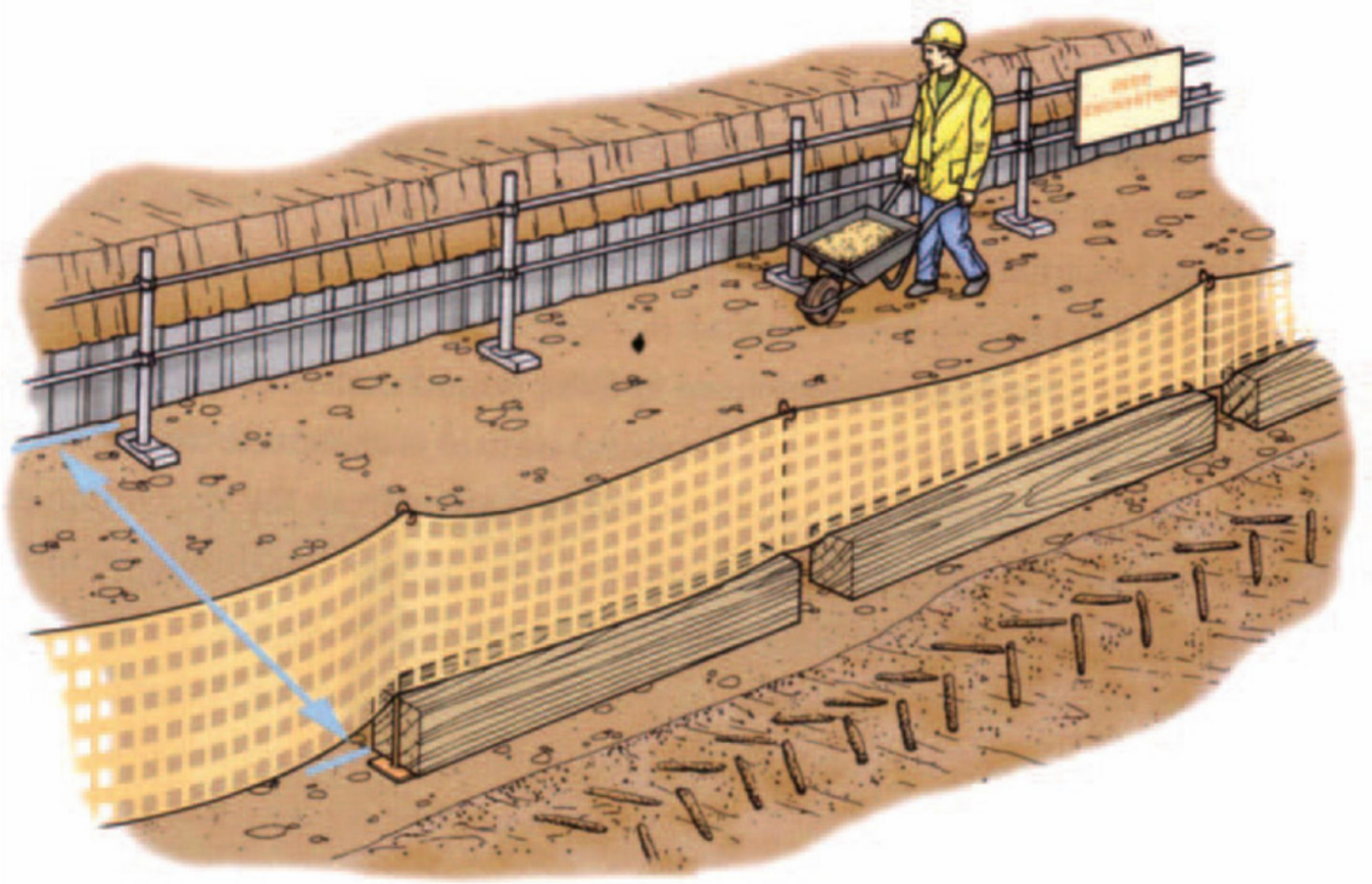

Figure 12. Vehicle protection at top of an excavation to prevent hazards associated with vehicle collision with its workers (Hughes, et al., 2008).

41 All vehicles used at construction worksites must be roadworthy and registered with the appropriate authority (FMA, 2014).

42 No person shall drive a vehicle of any class or description in a construction worksite unless he is the holder of a driving licence authorising him to drive a vehicle of that class or description (FMA, 2014).

43 Operators of powered mobile plant can often have severely restricted visibility of ground workers or nearby pedestrians, particularly those close to the plant. Figure 14 shows some of the blind spots for operators of typical excavation equipment (SafeWork, 2012).

44 Where natural lighting is not adequate to ensure safe working conditions, adequate and suitable lighting, including portable lighting where appropriate, should be provided at every workplace and any other places on the construction site where a worker may have to pass (DOSH, 2000).

45 Artificial lighting should, as far as practicable not produce glare or disturbing shadows (DOSH, 2000). Futher guidance on lighting can be sought from the *Factories and Machinery (Safety, Health and Welfare) Regulations*.

Figure 13. Working on or in close proximity to a highway or any other place where public vehicular traffic may cause danger to men at work, the working area shall be so barricaded and suitable warning signs and warning lights shall be set up to direct traffic away (Hughes, et al., 2008).

46 Where necessary to prevent danger, lamp should be protected by suitable guards against accidental breakage (DOSH, 2000).

47 All public walkways, sidewalks, and the thoroughfares bordering on or running through any excavation site shall be provided with substantial guard-rails or board fences. In addition, temporary footwalks beyond the the kerb shall be substantially constructed and provided with protection on both sides (FMA, 2014).

48 A flagman or watchman shall be designated to warn the public of the approach of trucks and to direct the trucks in and out the property. Danger or warning signs shall be posted at all truck entrances and exits (FMA, 2014).

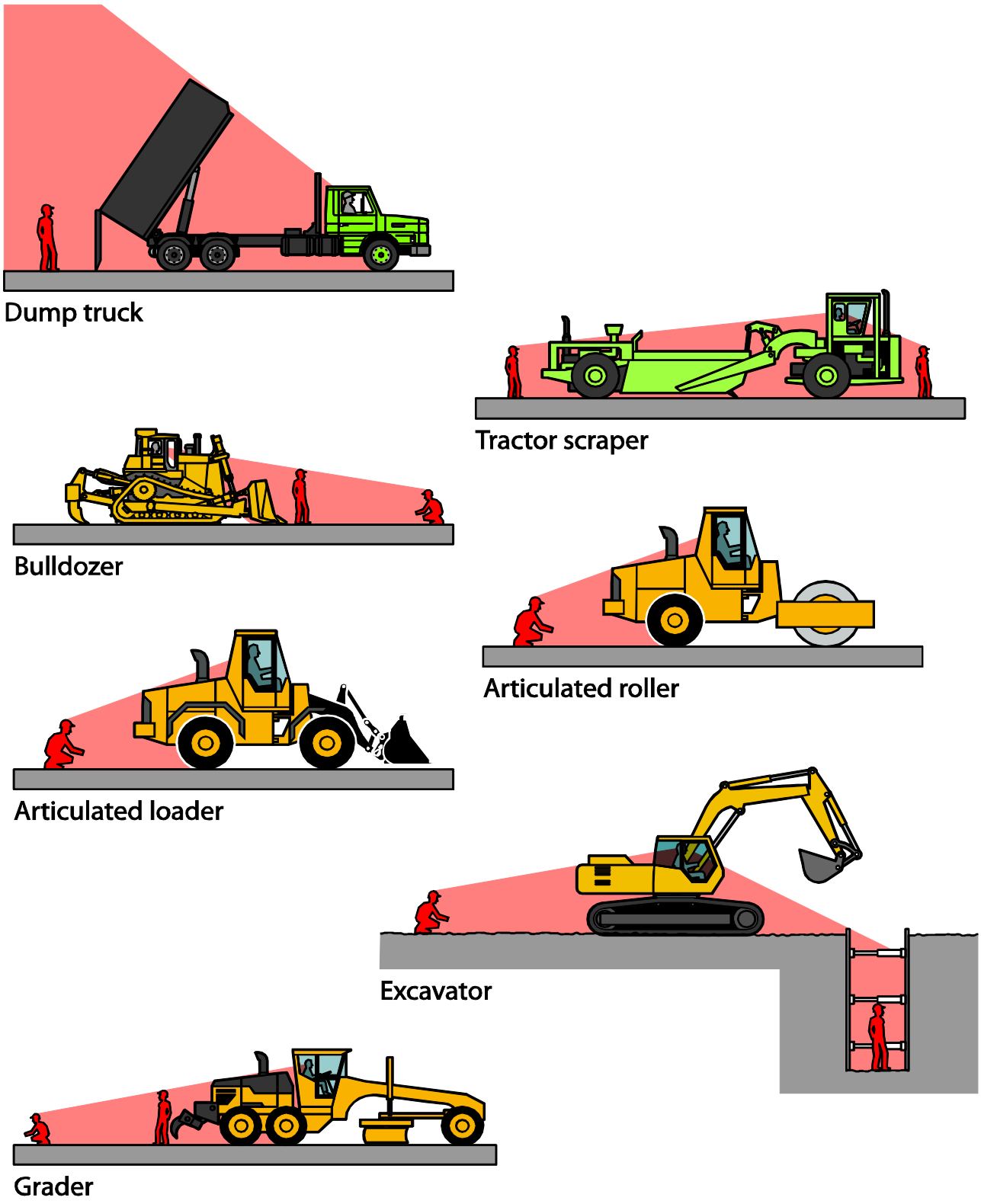

Figure 14. Mobile plant operator blind spots. Powered mobile plant operating near ground personnel or other powered mobile plant should be equipped with warning devices (for example, reversing alarm and a revolving light) (SafeWork, 2012).

49 During darkness, all public sidewalks shall be adequately illuminated and warning lights or flares shall be placed about the property to ensure safety for pedestrian and vehicular traffic (FMA, 2014).

Figure 15. All public walkways, sidewalks, and the thoroughfares bordering on or running through any excavation site shall be provided with substantial guard-rails or board fences. Barriers around excavation by footpath (Hughes & Ferret, 2008).

50 Stairways, ramps or runways shall be provided as the means of access to working levels below ground except where the nature of progress of the work prevents their installation in which case ladders or other safe means shall be provided (FMA, 2014). Ladders and step-ladders must also comply with *Part IX of Factories and Machinery (Building Operations and Works of Engineering) (Safety) Regulations*.

51 In every excavation of more than 1.2 metres deep there shall be provided ladders, stairways or ramps to furnish safe access to and egress from such excavation. Such access shall be installed in sufficient numbers and in such locations as to be readily accessible (FMA, 2014).

52 Where necessary access-ways of at least 600 mm width, with edge protection, should be provided (see Figure 16). The need to cross trenches can be reduced by limiting the length of trench left open (HSE, 1999).

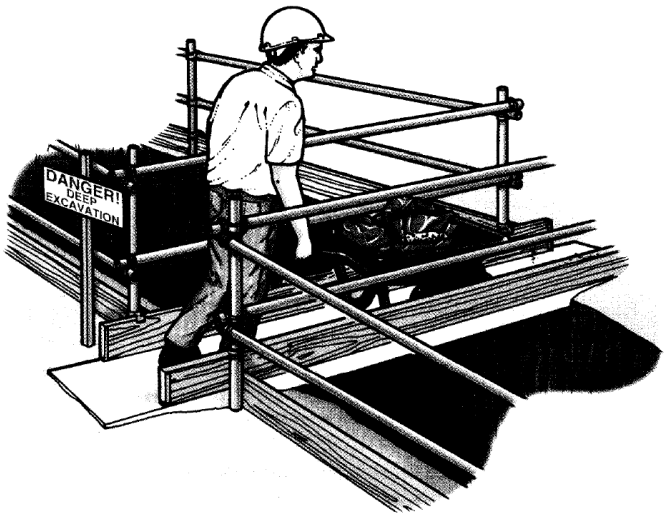

Figure 16. Access-way across trench (HSE, 1999).

53 Suitable and sufficient steps must be taken, where necessary, to prevent any part of an excavation or ground adjacent to it from being overloaded by vehicles, plant, work equipment or material (CDM, 2015).

54 If vehicle, plant, work equipment or material is needed close to the excavation, the Professional Engineer will need confidence in the soil or rock properties to factor in a sufficient factor of safety in the event of inadvertent loads being placed adjacent to the excavation (Joyce, 2015).

55 Excavated materials and other superimposed loads shall be placed at least 610 millimeters from the edge of open excavation and trenches (or a distance of the trench depth as shown in Figure 11), and shall be so piled or retained that no part thereof can fall into the excavation, or cause the banks to slip or cause the upheaval of the excavation bed (FMA, 2014). When determining the safe distance, consideration shall be given on the depth and slope of excavation, nature of soil material and the weight of the superimposed load (DOSH, 2000). See Figure 17.

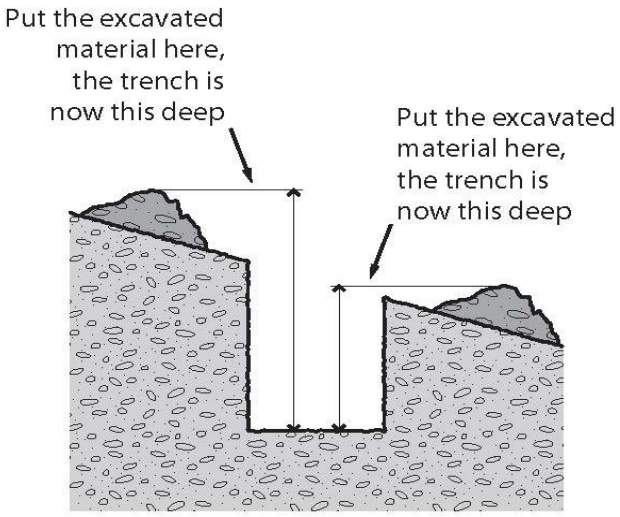

Figure 17. Excavated material impact on effective excavation depth (SafeWork, 2012).

56 Placing material on the lower side of the excavation will reduce the effective height of the excavation and the risk of material falling or being washed into the excavation. Care should be taken to ensure that material placed on the high side of the excavation does not increase the risk of ground collapse, or flooding by ponding or holding back runoff water. Excavated material should be placed so that it channels rainwater and other run-off water away from the excavation (SafeWork, 2012).

57 Where employees are exposed to the hazard of falling into the water in which one may drown, there shall be provided at all times during the exposure, adequate equipment and personnel with appropriate training for keeping persons afloat and for promptly rescuing persons (FMA, 2014).

58 If excavation work takes place below the local groundwater level or water table, then water will flow into the trench. Drowning hazards due to sudden influx of ground or surface water and entrapment in silt or mud must also be assessed and controlled (Hughes, et al., 2008).

59 The supports to the side of the excavation should be designed to control the entry of groundwater and the design of support works should take any additional hydrostatic loading into account (HSE, 1999).

60 De-watering and de-silting facilities should be provided to prevent floods and pollution of the drainage system and surrounding areas (DOSH, 2000), the effect of pumping from sumps on the stability of the excavation should be considered (HSE, 1999). Other de-watering techniques such as well pointing, or deep wells or other methods of controlling the flow of groundwater such as ground freezing and injecting grouts, should be considered.

61 Groundworkers can be exposed to numerous health hazards, notably, leptospirosis (Weil's disease) caused by micro-organism, gastro-enteritis, hepatitis A and tetanus. Exposure will vary and assessments should be made to determine which controls may be necessary (HSE, 1999).

62 Health risks can arise through contact with ground contaminated, for example asbestos, coal-tar residues, lead alkyls or mercurial compounds, during previous use or landfill (HSE, 1999).

63 The pre-tender safety and health plan (by the client) needs to detail the hazards likely to be encountered as identified during site investigation and soil sampling. The principal contractor's construction phase plan should describe how the risks will be dealt with (HSE, 1999).

64 The use of pneumatic breakers over even short periods carries serious risk of both noise-induced hearing loss and hand-arm vibration syndrome including vibration white finger. Consideration needs to be given at the planning stage to alternative excavation methods and further references can be sought from the *Factories and Machinery (Noise Exposure) Regulations* and *Guidelines on Occupational Vibration*.

65 The use of explosives for excavation work must comply with the *Part XV of Factories and Machinery (Building Operations and Works of Engineering) (Safety) Regulations*.

Trench, Cofferdam, Caisson or Tunnel

66 Pilings, shoring and bracing or other supports used in a trench, cofferdam, caisson or tunnel to protect employees against falling or sliding materials shall be of adequate strength (FMA, 2014).

67 People working in trench, cofferdam, caisson or tunnel should not work in isolation and another person should be present in the immediate vicinity at all time. Where trenching work is at a remote location, effective means of communication such as telephone or two-way radio should be available to call for advice in case of problems or to call for help in emergencies (DOSH, 2000).

68 Where the trench, cofferdam, caisson or tunnel to be excavated exceeds 4 metres in depth, such protection shall be constructed in accordance with the design and drawings of a Professional Engineer (FMA, 2014).

69 Where the trench, cofferdam or caisson requires two length of sheet piling or other supports, one above the other, the lower piling shall be set inside the bottom wales of the upper piling and shall be driven down and braced as the excavation continues (FMA, 2014).

70 A cofferdam, caisson or tunnel must be (CDM, 2015) –

(a) of suitable design and construction;
(b) appropriately equipped so that workers can gain shelter or escape if water or materials enter it; and
(c) properly maintained.

71 Common hazards and risks in deep trench, cofferdam, caisson or tunnel constructions generally relate to the confines of working underground. Further guidance on working in confined spaces is available in the *Industry Code of Practice for Safe Working in a Confined Space*.

72 Dust and gases shall be controlled by ventilation or otherwise so as to prevent concentrations tending to injure health or obstruct vision or from exceeding safe levels (FMA, 2014).

73 It is important for persons in and around trench, cofferdam, caisson or tunnel to wear suitable personal protective equipment. All necessary measures should be taken by the employer to ensure that the personal protective equipment is effectively worn (DOSH, 2000).

74 Safe trench, cofferdam, caisson or tunnel construction depends on adequate pre-construction site investigation of the ground and site (as listed in paragraph 5) and accurate interpretation of the information obtained (SafeWork, 2012). Designers, such as Professional Engineer, should:

(a) obtain or be provided with all available relevant information;
(b) be advised of any gaps in the information for planning and construction;
(c) undertake or be involved in data acquisition for the site investigation program; and
(d) have on-site involvement during the site investigation.

75 The information obtained from the site investigation and the anticipated excavation methods should be considered in preparing a trench, cofferdam, caisson or tunnel design (SafeWork, 2012). The design should include:

(a) details on the trench, cofferdam, caisson or tunnel dimensions and allowable excavation tolerances;
(b) temporary and final support and lining requirements for each location within the trench, cofferdam, caisson or tunnel;
(c) for tunnel, details of expected drive lengths and location of shafts; and
(d) any other requirements for the finished trench, cofferdam, caisson or tunnel.

76 The design should also include information on the excavation methods and ground conditions considered in the design. This will allow the design to be reviewed if another excavation method is chosen or the ground conditions differ from that expected as the excavation proceeds (SafeWork, 2012).

Electrical Hazards

77 Before work is begun, the employer shall ascertain by inquiry or direct observation, or by instruments, where any part of an electric power circuit, exposed or concealed, is so located that the performance of the work may bring any person, tool or machine into physical or electrical contact with it (FMA, 2014).

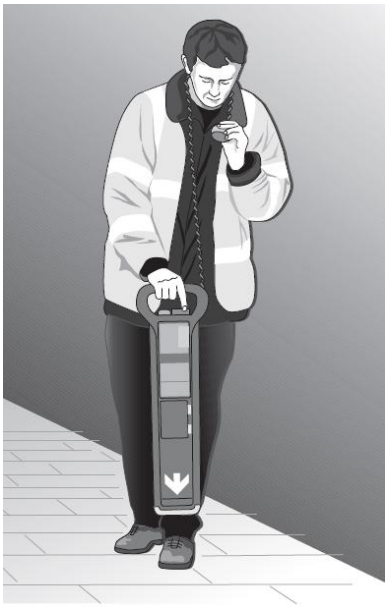

Figure 18. Using a cable locator by properly trained people to identify as far as possible the actual location of underground services (Hughes, et al., 2008).

78 The employer shall post and maintain proper warning signs in the national language where such a circuit exists (FMA, 2014).

79 The employer shall advise his employees of the location of such lines, the hazards involved and the protective measures to be taken and shall, if practicable, de-energise the electrical power circuit (FMA, 2014).

80 No employer shall suffer or permit an employee to work in such proximity to any part of an electric power circuit which exposes him to contact with the same in the course of his work unless the employee is protected against electric shock by de-energising the circuit and earthing it or by guarding it by effective insulation or other means acceptable (FMA, 2014).

81 In work areas where exact location of underground electric power lines is unknown, employees using jack-hammers, bars or other handtools which may come into contact with such lines shall be provided with insulated protective gloves and insulated protective footwear (FMA, 2014).

82 No bare wires or other unprotected conductors shall be located within 4 metres of any surface where employee may work or pass, unless completely guarded by a fence or other barrier (FMA, 2014).

83 Highly visible barriers should be erected at least 6 metres away (horizontally) from overhead lines to prevent inadvertent approach to them. Crossing points beneath the lines need to be clearly defined by means of red and white 'goal post' arrangements and signs (see Figure 19 and Figure 20)

84 Elevated power lines shall have a sufficient vertical clearance where they cross highways, access roads or areas travelled by trucks, cranes, shovels or other similar equipment and shall not be lower than 5.2 metres from the ground surface (FMA, 2014).

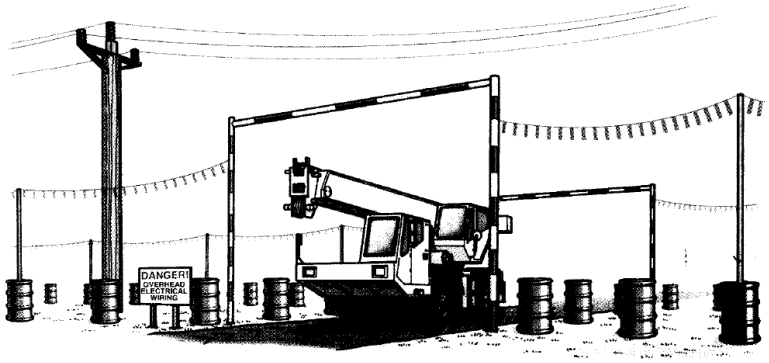

Figure 19. Precautions for overhead lines: 'goal post' crossing points beneath lines to avoid contact by plant (HSE, 1999).

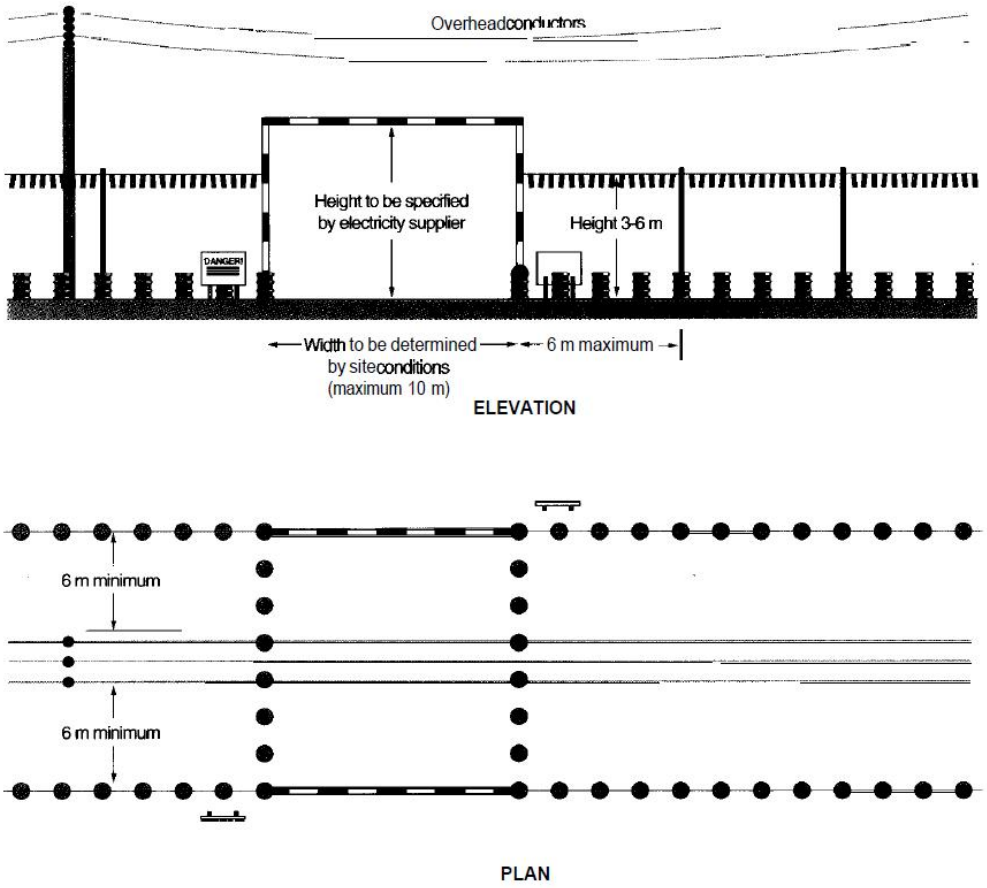

Figure 20. Diagram showing normal dimensions for 'goal post' crossing points and barriers (HSE, 1999).

Inspection

85 Construction work must not be carried out in an excavation where any supports or battering have been provided in accordance with paragraph 10 unless (FMA, 2014) (CDM, 2015) –

(a) the excavation, its vicinity and any work equipment and materials which may affect its safety have been inspected by an excavation supervisor –

(i) at the start of the shift in which the work is to be carried out;

(ii) after any event, such as rainstorm or other hazard-increasing occurrence, likely to have affected the strength or stability of the excavation; and

(iii) after any material unintentionally falls or is dislodged; and

(b) the excavation supervisor who carried out the inspection is satisfied that construction work can be done safely carried out there.

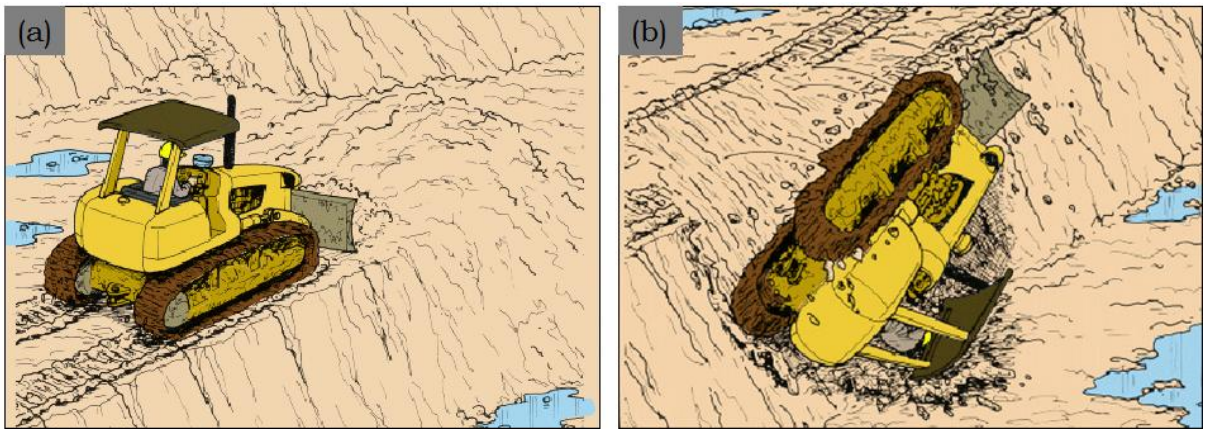

Figure 21. The excavation and its vicinity must be inspected by a designated person after rainstorm (JICOSH, 2015).

86 The requirement for inspection by an excavation supervisor only arises where the excavation is either supported or where the profile of the edge of excavation has been cut to a slope. The condition of the support or the angle and profile of the slope within the excavation has to be inspected (Joyce, 2015).

87 To identify events that are likely to affect the strength or stability of the excavation requires close inspection and monitoring throughout the excavation, to the extent that a competent geotechnical engineer may have assessed a need for an in-situ monitoring system to check for pore pressures and soil movements (Joyce, 2015).

88 Where the excavation supervisor carrying out an inspection informs the person on whose behalf the inspection is carried out of any matter about which they are not satisfied, construction work must not be carried out in the excavation until the matter has been satisfactorily remedied (CDM, 2015).

89 It is especially important that the excavation supervisor is properly trained in geotechnical principles, and has sufficient seniority and experience not to be unduly influenced by the commercial consequences when safety and health matters associated with excavations are at stake (Joyce, 2015).

Reports of Inspections by Excavation Supervisor

90 Where an excavation supervisor carries out an inspection is not satisfied that construction work can be carried out safely at the place inspected, the excavation supervisor must (CDM, 2015) –

(a) inform the person on whose behalf the inspection was carried out, before the end of the shift within which the inspection is completed, of the matters that could give rise to a risk to the safety of any person; and

(b) prepare a report which include –

(i) the name and address of the person on whose behalf the inspection was carried out;

(ii) the location of the place of construction work inspected;

(iii) a description of the place of construction work or part of that place inspected (including any work equipment and materials);

(iv) the date and time of the inspection;

(v) details of any matter identified that could give rise to a risk to the safety of any person;

(vi) details of any action taken as a result of any matter identified in sub-paragraph (v);

(vii) details of any further action considered necessary; and

(viii) the name and position of the person making the report; and

(c) provide the report, or a copy of it, to the person on whose behalf the inspection was carried out, within 24 hours of completing the inspection to which the report relates.

91 Where the excavation supervisor who carries out an inspection works under the control of another (whether as an employee or otherwise) the person in control must ensure the excavation supervisor who carries out the inspection complies with the requirements of paragraph 90 (CDM, 2015).

92 The person on whose behalf the inspection was carried out must (CDM, 2015) –

(a) keep the report or a copy of it available for inspection by an Inspector or Officer of DOSH –

(i) at the site where the inspection was carried out until the construction work is completed; and

(ii) after that for 3 months; and

(b) send to the Inspector/ Officer such extracts from the copies of the report as the Inspector/ Officer may from time to time require.

93 Report will be the evidence that the regulatory requirements have been followed, and, moreover, they will also be the evidence needed to investigate the cause of any failures in excavations, cofferdams or caissons (Joyce, 2015).

94 The preparation of more than one report is not required where more than one inspection is carried out within a 7 day period (CDM, 2015).

95 The last report should be prepared when either the excavation is completed to its final profile without any permanent works or at such time when the permanent works are completed within the excavation. In the case of cofferdams or caisson, the last day of inspection will be on the day that the cofferdam or caisson is dismantled or incorporated into the permanent works (Joyce, 2015).

96 The person undertaking the inspection can be an external consultant. By this means the person for whom the inspection is being carried out can ensure that the appropriate level of competence is obtained. The employer or person under whose control the inspector carries out the work is under a duty to ensure that the external consultant turns up each day and carries out the inspection as required by paragraph 90 (Joyce, 2015).

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