

A STUDY ON PAST FAILURES OF TRENCH EXCAVATIONS

GEO REPORT No. 137

J.S.M. Kwong

**GEOTECHNICAL ENGINEERING OFFICE
CIVIL ENGINEERING DEPARTMENT
THE GOVERNMENT OF THE HONG KONG
SPECIAL ADMINISTRATIVE REGION**

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PREFACE

In keeping with our policy of releasing information which may be of general interest to the geotechnical profession and the public, we make available selected internal reports in a series of publications termed the GEO Report series. The GEO Reports can be downloaded from the website of the Civil Engineering Department (<http://www.info.gov.hk/ced/>) on the Internet. Printed copies are also available for some GEO Reports. For printed copies, a charge is made to cover the cost of printing.

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R.K.S. Chan
Head, Geotechnical Engineering Office
October 2003

FOREWORD

A study was carried out by Ove Arup & Partners (OAP) in 1998 on deep excavations. The study found that no fatalities occurred in the past 20 years in deep excavation failures in association with private developments. However, during the study, fatal incidents related to trench excavations were noted. As a result, one of the recommended follow-up actions included in OAP's study was to undertake a further study on trench excavations. A study on trench excavation was therefore carried out by GEO and the findings of the study are given in this report.

This study has reviewed some of the reported trench-related failure cases with special attention given to those failures affecting slopes and retaining walls. Based on the casualties caused by these "known" trench failures, it is found that the risk associated with trench excavations is found not as low as many may perceive. This study has also attempted to find out the possible main causes of these failures to identify any deficiencies in the existing technical standards and statutory requirements and finally to make recommendations to improve the safety standards in the HKSAR.

This study was carried out by Dr J.S.M. Kwong (Atg. SGE/CNT) under my supervision. Our last year summer student, Mr M C Cheung, assisted in the search of information on the failure cases. Mr I P U (TO(G)) assisted with the preparation of the report. All their contributions are gratefully acknowledged.



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ABSTRACT

The limited file search under this study has discovered that between 1986 and 2000, there had been fifteen “known” trench excavation induced failures involving a total of ten deaths and four injuries. In addition, in a single incident in 1966, six passers-by were killed and sixteen others were injured as a result of the collapse of a retaining wall caused by trench excavation.

This report includes a review of the sixteen cases of trench collapses and trench-induced failures of adjacent slopes and retaining walls. The study has revealed that the common causes of trench collapses and trench-induced slope failures are inadequate shoring and/or improper drainage provision to prevent water ingress into trenches. Such problems could be due to inadequate contract specifications for trench excavations and/or non-compliance of the works with the specified requirements. A review of the existing standards under this study has also identified the lack of a comprehensive guideline on trench excavations in the HKSAR, including temporary shoring support and precautionary measures to prevent any possible adverse effects on the stability of any adjacent slopes due to trench excavations. Site supervision by utility undertakers and auditing check by the authorities may also not be enough to ensure compliance with contract specifications and statutory requirements.

In view of these problems and deficiencies, recommendations are made in this report to enhance the safety of trench excavations, including (a) enhancement of standards, (b) education and promulgation of good practice and (c) increase in site supervision and auditing check.

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1. INTRODUCTION

1.1 Background of the Study

In 1998, GEO appointed Ove Arup and Partners Hong Kong Ltd. to carry out a study entitled “QRA of collapses and excessive displacements of deep excavations” (GEO, 1999). The report was published in 1999 containing the findings of the QRA study, and also recommendations for further studies. One of the recommended items was to extend the QRA study to cover other types of excavations, such as trench excavations. In fact, a number of serious trench related landslides in recent years also prompted the need for such a study.

The main purpose of this trench excavation study is to identify the major deficiencies in the practice of trench excavations in the HKSAR leading to the past serious failures and to recommend appropriate measures to improve the local practice in order to enhance the safety of trench excavations.

The limited search of existing files and information under this study has discovered that between 1986 and 2000, there have been fifteen “known” failure cases associated with trench excavations. The failures resulted in a total of fourteen casualties: ten workers were killed and another three were injured, plus a member of the public received minor injury when a slope adjacent to an open trench collapsed. In addition, in a single incident in 1966 involving the collapse of a retaining wall undermined by trenching work, six passers-by were killed and sixteen injured.

1.2 Methodology of the Study

The study includes a search of readily available information on past trench failures, e.g. from newspaper, file records, fatal incident reports of Labour Department and incident records supplied by utility undertakers.

Since trench excavations are generally regarded as minor works, incidents without fatalities normally do not attract publicity, and hence unreported. As such, information available was found insufficient to allow a rigorous QRA study and instead a study on past failures of trench excavations was therefore carried out. A review has then been carried out on the information extracted about the sixteen cases giving special attention to those recent failures affecting slopes and retaining walls (collectively termed slopes in this report), and causing public safety concerns. Detailed studies have been carried out by the GEO Landslide Investigation Consultants on the landslides reported in Case Nos. 13 and 16, and inadequate drainage provision for the trench excavations is considered to be the main cause of both failures. The report also briefly reviews the current technical standards and statutory requirements for trench excavations, and finally makes recommendations for follow-up actions with the aim of improving the safety of trench excavations in the HKSAR.

2. PAST FAILURES OF TRENCH EXCAVATIONS

2.1 Statistics on Trench Excavation Accidents from Labour Department

Statistics providing information and analysis on work-related accidents in Hong Kong published by the Labour Department can be obtained through Labour Department's web site <http://www.info.gov.hk/labour>. Information available between 1989 and 1998 indicates that the accident rate per 1,000 workers in the construction industry is about 4 times more than the catering industry and 11 times more than the manufacturing industry. In the construction industry the average number of fatalities is about 56 per year with the maximum of 80 in 1993.

The industrial accidents in the construction industry are further analysed in terms of "causes" and the analysis is tabulated in Table 1. One of the causes of accidents is "fall of ground" which is defined by the Labour Department as including (a) subsiding of soil, (b) collapse of trench, (c) mining cave-ins and (d) mud slides. The total number of industrial accidents due to fall of ground is given in Table 2. It should be noted that all eight fatalities due to fall of ground occurred between 1990 and 1999 were associated with trench excavations.

2.2 Other Sources of Information on Trench Failures

In addition to the information provided by Labour Department, information including incident reports, photos and newspaper clippings were also obtained from DSD, WSD, the Hong Kong Electric Co., Towngas and Cable & Wireless HKT, and several newspaper agents. A summary of the sixteen cases relating to accidents in trench excavations is given in Table 3. It should be noted that these cases are by no means an exhaustive list of all incidents, but only those cases made known to GEO.

2.3 Comparison of Fatalities of Trench Excavations with Landslides

Lo (2000) collated data on the number of fatalities resulting from landslides. These data, for years between 1986 and 2000, are plotted in Figure 1 together with those resulting from trench excavations. Although the number of fatalities due to trench excavations is lower than that due to landslides, it certainly is not as low as many may perceive. The safety issue relating to trench excavations warrants more attention than currently received.

3. DIFFERENT TYPES OF FAILURES CAUSED BY TRENCH EXCAVATIONS

A review of the sixteen cases is given in this chapter in which the types of failure and their probable causes of failure are briefly discussed. A case report for each incident with a brief description, photographs and sketch is provided in Appendix A.

It is the perception of many that deep excavations are potentially more dangerous than trench excavations. As such, the design of the shoring system for deep excavations is often under a more stringent checking procedure. Tighter control with close supervision is enforced during construction in almost all deep excavations associated with private

developments. Perhaps, it is because of the tight control, there is no recorded fatality associated with private deep excavation works between 1980 and 1999 (GEO, 1999).

Trench excavations are normally carried out to allow installation or repair of public utilities. Many regard the works being minor in nature and thus tend to ignore the necessary safety measures. However, it should be noted that the excavated depth of one failed trench reported in this study was as shallow as 1 m. In fact, the excavated depths were less than 2 m in seven out of the sixteen failure cases, and six cases with depths ranging from 2 m - 3 m when failed. These statistics demonstrate the potential danger even in shallow excavations, and precautionary measures should not be neglected.

The trench-induced geotechnical failures are categorized into three types (illustrated in Figure 2), namely, collapse of trench, collapse of slope below trench and collapse of slope above trench.

3.1 Collapse of Trenches

The primary causes of trench collapses are commonly due to inadequate or no shoring, improper working procedure or heavy vehicles parked near the trench side. For the purposes of this study, “inadequate shoring” implies no shoring, insufficient shoring supports or shoring not installed in a timely manner. Such problems may have been caused by unsatisfactory contract specification of the shoring requirements, or by non-compliance with specified shoring details, or both. However, the exact causes could not be ascertained based on the limited information that could be extracted from the available records.

According to the information collected, ten out of the sixteen failure cases involved trench collapsing and caving-in, in which nine workers were killed and three injured. This type of failures has a direct implication on the safety of the workers.

3.2 Collapse of Slopes Adjacent to Trenches

The safety of the general public affected by failure of slopes has always been GEO's primary concern. It is noted that there were seven trench related cases involving failure of slopes adjacent to trench excavations, with five cases directly affecting the public's safety. This category of failure can be further divided as follows:

(a) Collapse of slopes below trenches

Infiltration of rainwater into slopes is one of the main causes of landslides in Hong Kong. Open trenches, being more susceptible to infiltration, could lead to failure of adjacent slopes below the trench if drainage is not adequately provided.

Cases 13, 14 and 16 were landslide cases likely to have been induced by trench excavations at the slope crest. One member of the public was injured in Case No. 16 and the

economic consequences (such as, closure of major roads) of the three cases were significant.

(b) Collapse of slopes above trenches

When a trench is excavated near the toe of a slope, special attention should be given in order not to undermine the stability of the slope due to the loss of toe support.

In Cases 1, 5 and 8, trenching works at the toe of the slopes without proper supports led to the collapse of these slopes. Although failure did not occur in Case 11, significant signs of distress involving continuous cracks were developed on the slope above the trench. The failures of Cases 1, 5 and 8 resulted in the deaths of two workers and six passers-by, plus the injuries of sixteen others.

3.3 Summary of the Main Causes of Failures

It is clear from the information on past failure cases that the stability of the trench and adjacent slopes can be adversely affected if trench excavations are not properly carried out. A summary of the main causes leading to different types of failures is given in Table 4. The main factors contributing to the failure of trenches and slopes are: inadequate shoring, inadequate drainage provision leading to ingress of runoff from the surface and infiltration, and loss of toe support. Compaction of backfill upon completion of excavations is also important as trenches loosely backfilled with soil will permit almost as much infiltration from the surface as an open trench. These common causes of failures could be due to inadequate contract specifications of the works or non-compliance with specifications or both. As mentioned before, the exact deficiencies cannot be ascertained from the limited information available.

4. EXISTING TECHNICAL STANDARDS AND STATUTORY REQUIREMENTS FOR TRENCH EXCAVATIONS

A review of the existing technical standards and statutory requirements for trench excavations in the HKSAR has been carried out and the discussion about these standards and requirements are given below.

4.1 Technical Standards

4.1.1 Works Bureau Safety Handbook (Works Bureau, 2000)

There are no specific provisions for trench excavations in the Safety Handbook, but Section 2.4 of the Handbook stipulates the requirements associated with safety and health of workplace in respect of excavations. The main aspects covered by this Section are:

- Excavations to be inspected daily and thoroughly examined by a competent person on weekly basis.

- Shoring to be installed in accordance with planned method/method statement.
- Workers working in the trench to be protected against falls of earth and material, etc.
- Arrangement to be in place to deal with flooding.

This Section of the Handbook appears to give a general guideline mainly on the shoring support for the trench excavations and it lacks guideline on prevention of water ingress into trenches which may adversely affect the stability of adjacent slopes.

4.1.2 Geotechnical Manual for Slopes (GCO, 1984)

The Geotechnical Manual for Slopes provides guidelines relating to trench excavations on or adjacent to existing slopes. The guidelines given in Section 9.4.7 of the Manual recommend the necessary precautionary measures to prevent any possible adverse effects of trench excavations on any adjacent slopes. The main points covered in the Manual are:

- Trench should be protected against ingress of surface runoff by sand bags, concrete kerbs or compacted earthfill bunds. An illustration showing the requirements is given in Figure 3.
- Pumps should be provided at all low points on the trench. (Refer to Figure 3).
- A watchman should supervise the maintenance and functioning of pumps at all times.
- Trenches should be backfilled in layers not greater than 150 mm deep and compacted to 95% of British Standard maximum dry density.

The Slope Manual only provides a broad and general guidelines and this can be enhanced to further improve its practicality and usefulness.

4.1.3 Technical Standards of Utility Undertakers

Many utility undertakers have their own specifications for the trench excavation works. However, there are little or even no specific requirements for drainage provisions to prevent water ingress into the trench excavations which may impair the stability of adjacent slopes. Examples of specifications obtained from DSD and Towngas are given in Appendix B.

4.2 Statutory Requirements for Trench Excavations

4.2.1 Construction Site (Safety) Regulations (Cap. 59I)

Regulation 39 of Construction Sites (Safety) Regulations (CS(S)Rs) entitled “Safety of excavations, etc” under the Factories and Industrial Undertakings Ordinance (Cap. 59) stipulates the responsibilities of the contractor to ensure site safety and the safety of workers. Some key points extracted from the Regulation are given below:

- Regulation 39(1): The contractor shall cause a structure made of timber or other suitable material to be erected in connection with the excavating or earthworking operations....so as to prevent workmen employed on the site from being endangered by a fall or displacement of earth, rock, or other material....adjacent to or forming the side of the excavation or earthwork.
- Regulation 39(2): The contractor shall cause every part of the excavation or earthwork.....to be examined by a competent person at least once in every period of 7 days.
- Regulation 39(3): This regulation (Regulation 39) shall not apply to an excavation or earthwork where, having regard to the nature and slope of the sides of the excavation or earthwork and other circumstances, no fall or dislodgement of earth, rock, or other material is liable to occur so as to strike any such workman or person from a height of more than 1.2 metres.

A “competent person” referred to in Regulation 39(2) is defined in Regulation 2 as “a person who is (a) appointed for that purpose by the contractor required by these regulations to ensure that the duty is carried out by a competent person; and (b) by reason of substantial training and practical experience, competent to perform the duty.”

It should be noted that the CS(S)Rs are mainly intended to protect the safety of workers involved in excavation, and hence there are no specific provisions regarding public safety, such as prevention of ingress of water into trenches which may impair the stability of adjacent slopes.

Those sections of CS(S)Rs relevant to trench excavations are given at Appendix C.

4.2.2 Land (Miscellaneous Provisions) Ordinance (Cap. 28)

Section 8 of the Land (Miscellaneous Provisions) Ordinance (L(MP)O) entitled “Control of excavations in unleased land” under the Laws of Hong Kong stipulates that a person must obtain an “excavation permit” before making an excavation in unleased land. Unleased land includes all public roads and pedestrian pavements.

Any person who makes or maintains any excavation without an excavation permit

issued under Section 8 shall be guilty of an offence and shall be liable on conviction to a fine of \$5,000 and to imprisonment for 6 months, (Subsection 4 of Section 8 of Cap. 28). However, this Ordinance does not have any provision for holding any person liable for non-compliance with the permit or the accompanying conditions.

The Designated Authorities for the issue of excavation permits are stipulated in the Schedule of the L(MP)O. Director of Highways is the Designated Authority in the case of roads or streets maintained by Highways Department. For excavations carried out in unleased land elsewhere, Director of Lands is the Designated Authority.

Those sections of L(MP)O relevant to trench excavations are given at Appendix D.

(a) From Highways Department

Applications (Form HYD 14 (Rev. 1998)) should be made to the respective Highways Regional Office together with supporting documents, such as, layout plan showing the extent of the excavation works, and approved building plans or drainage plans, or a letter of agreement from the Drainage Services Department or the Water Supplies Department.

For works involving excavation on carriageway, the proposed excavation works must be undertaken by contractors approved by the Government. Contractors on the List of Approved Contractors for Public Works under the Roads and Drainage or Waterworks categories are considered approved contractors.

The contractor is required to comply with the Conditions of Permit to ensure safety of road users, road workers and the works. However, under the current practice, there are normally no specific measures set down by the Highways Department in the Conditions of Permit for the prevention of water ingress into trenches.

(b) From Lands Department

Before granting the excavation permit, the respective District Lands Office (DLO) would normally refer the application for excavation permit to the relevant Departments for comments. For example, if the excavation is to be carried out adjacent to an existing slope, DLO would seek GEO's comments on geotechnical issues. In normal cases, GEO would ask the DLO to include conditions requiring the applicants to carry out the trenching works and associated precautionary measures in accordance with guidelines given in Section 9.4.7 of the Geotechnical Manual for Slopes (see Section 4.1.2 above).

For cases where the trenching work is extensive in length, it is not unusual that GEO would recommend the excavation work be carried out in phases.

The contractor is required to observe the conditions accompanying the permit and all the provisions of the Land (Miscellaneous Provisions) Ordinance (Cap. 28) and all the subsidiary legislation made thereunder.

4.3 Findings of the Review of the Existing Standards and Statutory Requirements

A review of the existing standards has revealed the lack of a comprehensive guideline on the good practice of trench excavations in the HKSAR, including temporary shoring support and precautionary measures to prevent any possible adverse effects on the stability of any adjacent slopes due to trench excavations. This review also indicates that there are statutory requirements for provision of supports to trench excavations under the Construction Site (Safety) Regulations and the authorities are also empowered under the Land (Miscellaneous Provisions) Ordinance to impose special requirements (e.g. by means of excavation permits) for safeguarding the workers and the general public. However, the permit conditions imposed by the relevant authorities may not be adequate, particularly regarding the drainage provisions for prevention of water ingress. Furthermore, the auditing site check by the relevant authorities may not be enough to ensure compliance of the excavation works with these requirements as obvious non-compliance have been found in some of those failures reviewed in this study.

5. CONCLUSIONS AND RECOMMENDATIONS

This study has revealed that the common causes of trench collapses and trench-induced slope failures are inadequate shoring and/or improper drainage provision to prevent water ingress into trenches. Such problems could be due to inadequate contract specifications for trench excavations and/or non-compliance of the works with the specified requirements. A review of the existing standards under this study has also identified the lack of a comprehensive guideline on trench excavations in the HKSAR, including temporary shoring support and precautionary measures to prevent any possible adverse effects on the stability of any adjacent slopes due to trench excavations. Site supervision by the utility undertakers and auditing check by the authorities may also not be enough to ensure compliance with contract specifications and statutory requirements.

In view of these problems and deficiencies, GEO should take the initiative in the following recommendations for improvement of the safety of trench excavations in the HKSAR:

(a) Enhancement of Standards

Prepare a comprehensive guideline on good practice of trench excavations by collaborative efforts of all concerned parties, including Works Bureau, Labour Department, utility

undertakers (Government departments and private companies) and GEO.

(b) Education and Promulgation of Good Practice

Widely promulgate the results of this study to increase awareness of the potential risk of trench excavations and promote the use of the proposed code of practice in (a) above when available.

(c) Increase of Site Supervision and Auditing Check

Increase site supervision by utility undertakers and auditing site check by the Authorities to ensure compliance with the contract specifications and statutory requirements.

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Table 1 - Industrial Accidents in Construction Industry Analysed by Cause⁽¹⁾

| Cause of Accident | Year | | | | | |
|---|-------------------------|------------|------------|------------|------------|------------|
| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
| Machinery | 669 (20) ⁽²⁾ | 695 (4) | 719 (9) | 818 (2) | 1008 (3) | 832 |
| Transport | 50 (2) | 57 (3) | 72 (3) | 88 (1) | 153 (2) | 118 (3) |
| Explosion or fire | 110 (2) | 100 (2) | 97 (1) | 85 | 57 | 48 |
| Hot or corrosive substance | 214 | 235 | 149 | 206 | 214 | 187 |
| Gassing, poisoning & other toxic substances | 11 (2) | 8 | 13 | 10 | 11 (1) | No record |
| Electricity | 38 (7) | 33 (3) | 32 (5) | 38 (4) | 54 (4) | 63 (5) |
| Fall of person | 2473 (29) | 2598 (28) | 2412 (29) | 2983 (33) | 3458 (20) | 4651 (31) |
| Stepping on, striking against or struck by object | 7796 (5) | 6898 (1) | 6905 (1) | 8000 (1) | 8547 | 8319 (2) |
| Falling objects | 894 (10) | 1125 (10) | 910 (14) | 967 (8) | 1035 (9) | 988 (13) |
| Fall of ground | 9 (3) | 9 (1) | 1 | 11 (1) | 11 | 1 |
| Handling without machinery | 3290 | 3703 | 3204 | 2532 | 2986 | 3013 |
| Hand tools | 679 | 539 | 561 | 613 | 778 | 866 |
| Miscellaneous | 340 | 423 | 192 | 118 (1) | 247 (2) | 502 (2) |
| Total | 16573 (80) | 16422 (51) | 15268 (63) | 16469 (51) | 18559 (41) | 19588 (56) |

Notes: (1) Data obtained from Labour Department.
(2) The figures in the Table indicate the number of accidents, while the figures inside the brackets indicate the number of fatalities.

Table 2 - Number of Industrial Accidents due to Fall of Ground

| Year | Number of Accidents | Number of Fatal Accidents |
|---|---------------------|---------------------------|
| 1990 | 21 | 1 |
| 1991 | 14 | 1 |
| 1992 | 15 | - |
| 1993 | 9 | 3 |
| 1994 | 9 | 1 |
| 1995 | 1 | - |
| 1996 | 11 | 1 |
| 1997 | 11 | - |
| 1998 | 1 | - |
| 1999 | 5 | 1 |
| Note: Data obtained from Labour Department. | | |

Table 3 - Summary of Failure Cases Relating to Trench Excavations (Sheet 1 of 2)

| Case No. | Location of the Failed Trench | Date & Time of Failure | Nature of Work | Geometry of Trench when Failed (width x depth) | Weather at Time of Failure | Probable Causes of Failure | Consequences of Failure |
|----------|---|------------------------|---|--|------------------------------------|---|--|
| 1 | Adjacent to La Salle Primary School, Boundary Street, Kowloon | 8.6.1966 (12:30 p.m.) | Pipe laying | 2.5 ft x 2.5 ft - 7 ft | Heavy rain | Toe support of the wall removed | 1) Six passers-by died and sixteen were injured 2) Collapse of retaining wall |
| 2 | Kellett Bay near Shek Pai Wan Road | 30.6.1986 | Erecting shoring | 1 m x 2.5 m | Fine | Improper working procedure | One worker died |
| 3 | Nga Tsin Long Road, Kowloon | 22.2.1987 (11:00 a.m.) | Pipe laying | 1.3 m deep | Fine | Improper works method | One worker died |
| 4 | Between CH24+80 and CH25+00 along the Fanling bound carriageway of Sha Tau Kok Road, N.T. | 11.1.1990 (4:15 p.m.) | Levelling blinding concrete | 1.8 m x 2.35 m | Fine | (1) Heavy vehicle parked at trench side (2) Absence of suitable shoring | One worker died |
| 5 | Between the pavement of Lung Cheung Road and ventilation building of MTRC Diamond Hill Station. | 16.1.1991 (4:00 p.m.) | Breaking concrete slab at bottom of trench with pneumatic breaker | 2.5 m x 1.4m - 1.7m | Fine | Toe support of skin wall removed | (1) One worker died (2) Collapse of wall |
| 6 | Lam Kam Road roundabout towards Shek Kong direction | June 1992 (6:30 p.m.) | Steel gas pipe installation work | Not known | Heavy rain | (1) Rise in groundwater table due to heavy rain (2) Poor groundwater control | Traffic affected |
| 7 | Castle Peak Road near Pok Oi Hospital, Yuen Long | 26.2.1993 (3:15 p.m.) | Manual digging of trench | 2.5 m x 4 m | Fine | (1) No shoring (2) Poor groundwater control | One worker died and one worker was injured |
| 8 | Tai Tung Shan Service Reservoir, Tung Chung Road | 6.5.1993 (3:50 p.m.) | Pipe laying | 1.5 m x 1.5 m | Fine (Heavy rain the previous day) | Inadequate shoring | (1) One worker died (2) Failure of an upslope |
| 9 | Ping Ha Road, opposite Lo Uk Tsuen, Yuen Long | 4.7.1993 (3:35 p.m.) | Water drain laying | 1.2 m x 3 m | Fine | (1) Poor shoring (2) Heavy vehicles passed trench side | One worker died and one worker was injured |

Table 3 - Summary of Failure Cases Relating to Trench Excavations (Sheet 2 of 2)

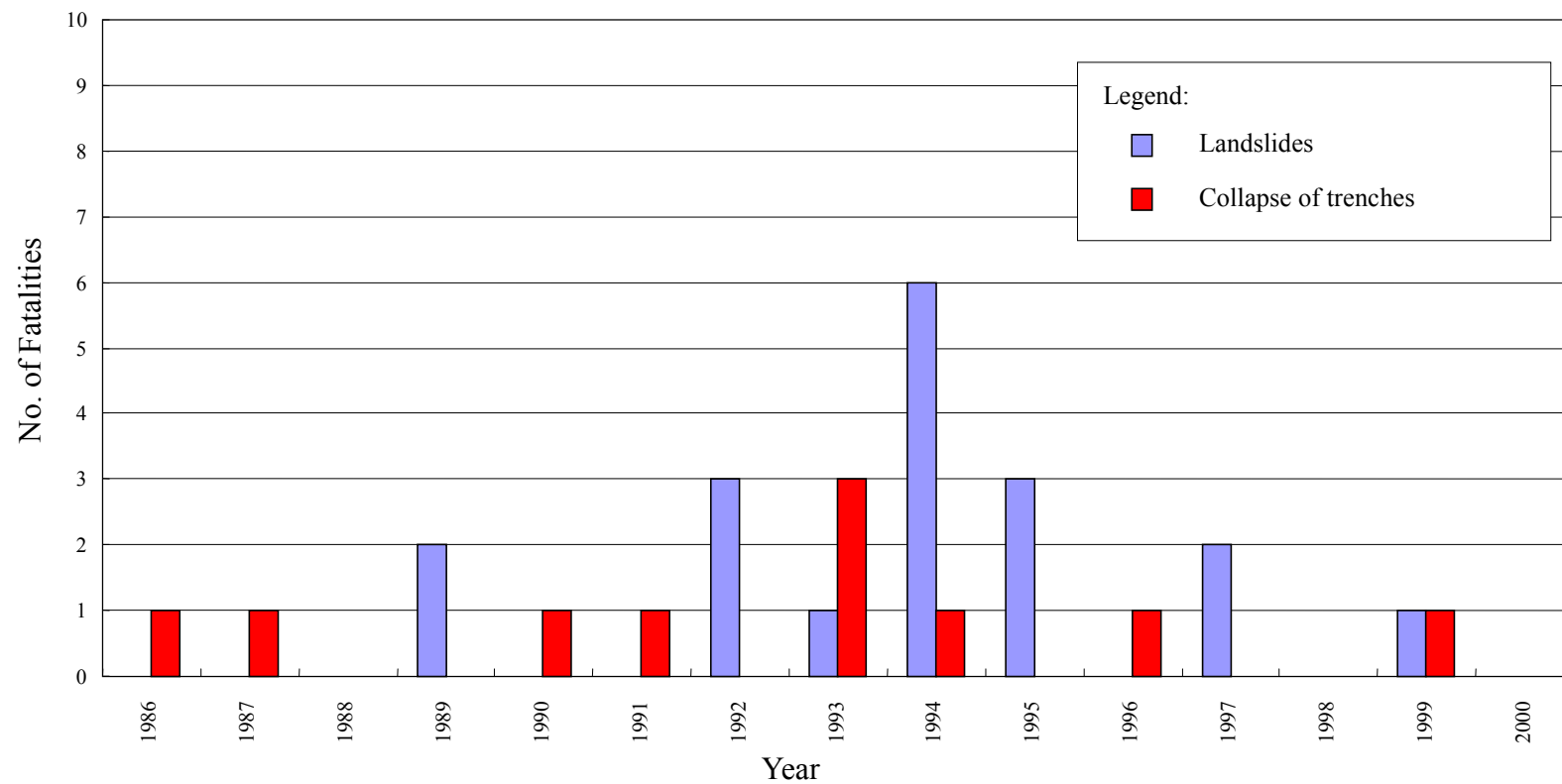
| Case No. | Location of the Failed Trench | Date & Time of Failure | Nature of Work | Geometry of Trench when Failed (width x depth) | Weather at Time of Failure | Probable Causes of Failure | Consequences of Failure |
|----------|---|------------------------|-----------------------------|--|----------------------------|---|--|
| 10 | Junction of Ferry Street & Man Wui Street, Kowloon | 24.12.1994 (3:45 p.m.) | Pipe laying | 2.5 m x 1.7 m | Rain | No shoring | One worker died |
| 11 | Feature No. 7SW-D/F53, opposite Tsang Tai Uk, Sha Tin | 9.1.1996 | Locating cable | 1 m - 2 m deep | Not known | (1) Removal of toe support (2) Poor recompaction work | Continuous cracks developed on upslope |
| 12 | Wang Lee Street near Fuk Hi Street, Yuen Long Industrial Estate | 15.4.1996 (2:20 p.m.) | Pipe laying | 1.8 m x 2.2 m | Intermittent Rain | (1) Improper shoring (2) Presence of water inside trench | One worker died |
| 13 | Pokfulam Road, opposite the Chinese Christian Cemetery | 24.8.1999 (5:05 a.m.) | Construction of box culvert | 2 m x 1 m - 2 m | Moderate rain | (1) Inadequate drainage provisions (2) No protective apron along the outside edge of box culvert | (1) Failure of a downslope (2) Closure of Pokfulam Road |
| 14 | Kennedy Road near 6 Hau Fung Lane | 24.8.1999 | Pipe laying | Not known | Heavy rain | (1) Inadequate drainage provisions (2) Tree pulled out of slope | (1) Failure of a downslope (2) Vacant site and Kennedy Road affected |
| 15 | Sam Mun Tsai Road, (near entrance to Yu On Street), Tai Po | 5.11.1999 (11:15 a.m.) | Erecting shoring | 1.7 m x 2.8 m | Fine | Shoring not installed in a timely manner | One worker died and One worker was injured |
| 16 | An undisclosed location | 2000 | Cable laying | 3 m x 3 m | Heavy rain | Surface water entered and accumulated inside the trench | (1) Failure of a downslope (2) Closure of roads (3) One minor injury |

Table 4 - Types of Failures Caused by Trench Excavations

| Types of Failures Caused by Trench Excavations | Main Causes of Failure | Case No. ⁽¹⁾ | No. of Cases | No. of Deaths / Injuries |
|--|--|---|--------------|--------------------------|
| 1) Collapse of trenches | Inadequate shoring ⁽²⁾ | 2,3,4,6,7,8,9 10,12,15 | 10 | 9/3 |
| 2) Collapse of slopes adjacent to trenches | | | | |
| - Collapse of slopes below trenches | Infiltration into slopes from trenches | 13 ⁽³⁾ ,14,16 ⁽³⁾ | 3 | 0/1 |
| - Collapse of slopes above trenches | Loss of toe support Inadequate compaction | 1,5 ⁽⁴⁾ ,8,11 | 4 | 8/16 |
| <p>Notes:</p> <p>(1) For details of each case, refer to Appendix A.</p> <p>(2) For the purpose of this study, “inadequate shoring” include cases where no shoring was provided, insufficient shoring supports were constructed and shoring was not installed in a timely manner.</p> <p>(3) For cases 13 and 16, detailed studies have been carried out by the GEO Landslide Investigation Consultants on the landslides, and inadequate drainage provision for the trench excavations is considered to be the main cause of both failures.</p> <p>(4) Case 5 may not strictly be geotechnically related. Nevertheless, a worker died of a trench-related accident due to possibly improper working procedure.</p> | | | | |

LIST OF FIGURES

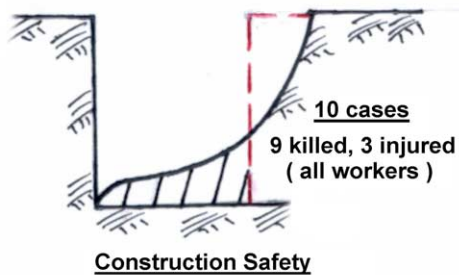
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| 1 | Statistics on Fatalities Relating to Geotechnical Failures | 24 |
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Note: A trench-induced collapse of retaining wall (Case No. 1) in 1966 resulted in six deaths.

Figure 1 - Statistic on Fatalities Relating to Geotechnical Failures

1. Collapse of Trenches



2. Collapse of Slopes Adjacent to Trenches

a. Trench at slope crest

*Due to infiltration into slopes
from trenches



b. Trench at slope toe

* Due to loss of toe support

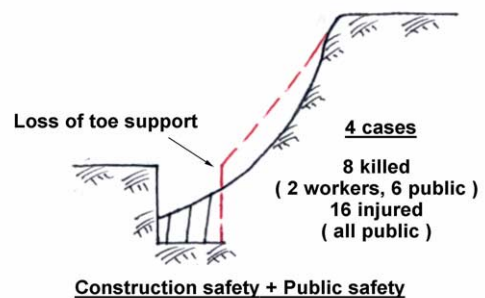


Figure 2 - Types of Failures Caused by Trench Excavations

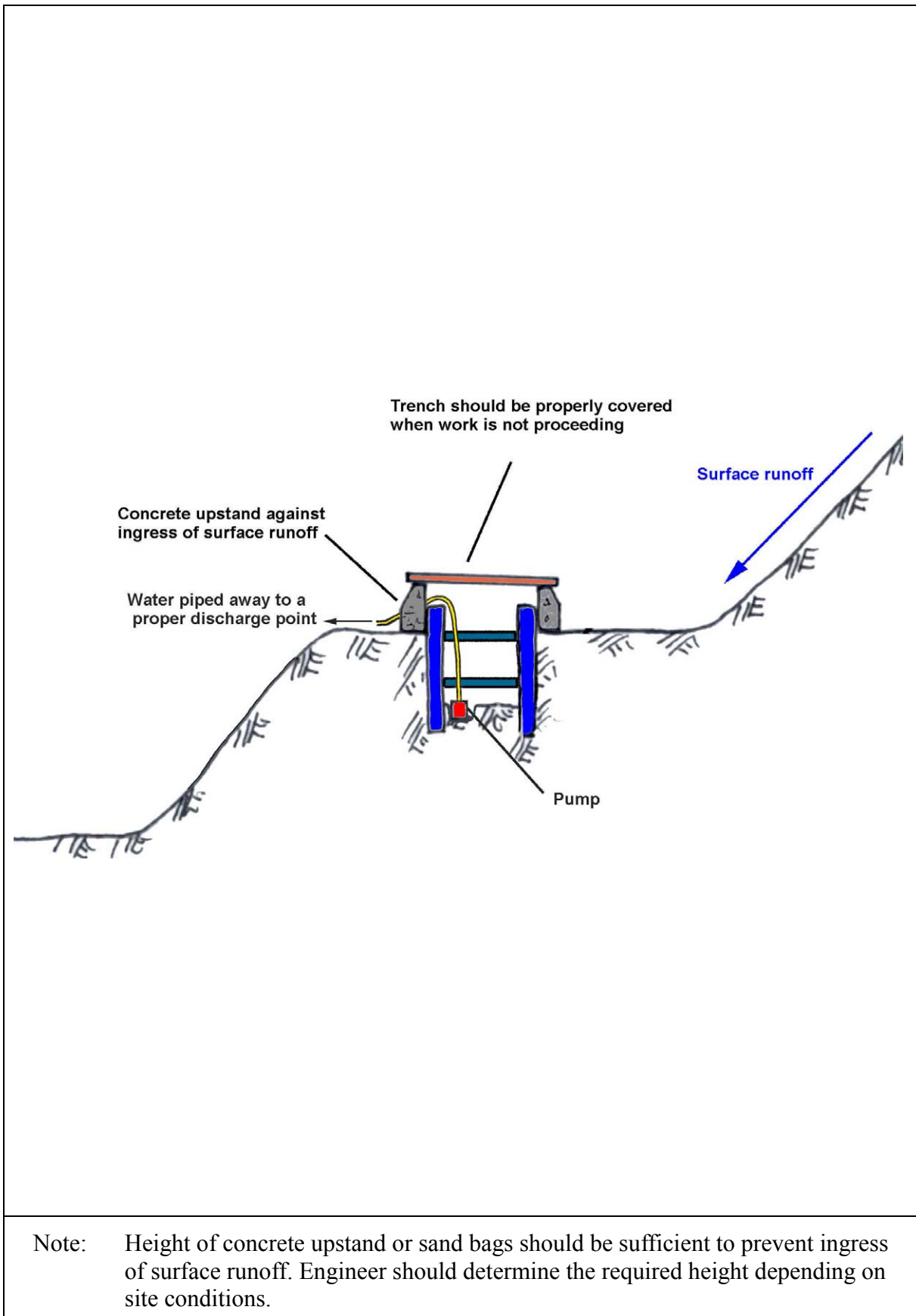


Figure 3 - Recommended Drainage Measures against Ingress of Surface Runoff

APPENDIX A
CASE REPORTS

Case No.: 1

Location: Adjacent to La Salle Primary School, Boundary Street, Kowloon

Date (Time): 8.6.1966 (12:30 p.m.)

Weather at time of failure: Heavy rainfall

Size of trench: 2.5 ft (wide) x 2.5 ft – 7 ft (deep)

Description:

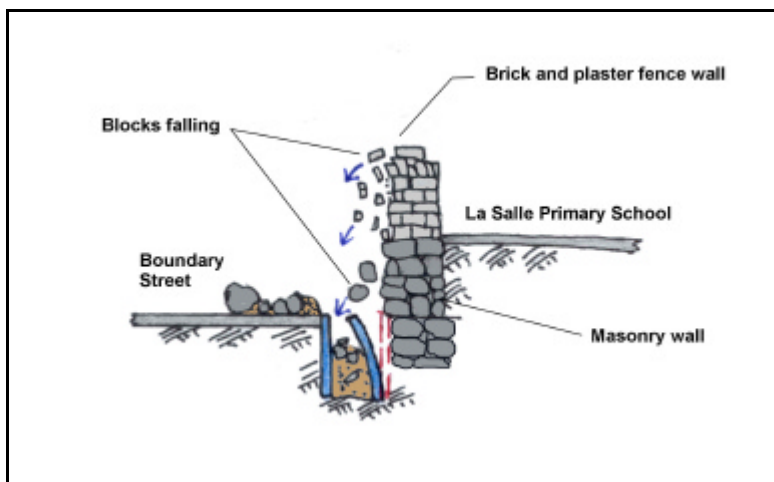
A trench had been dug for pipe laying in the pavement in front of a section of a masonry wall. The 7 ft high masonry wall forming the boundary of La Salle Primary School collapsed outwards onto Boundary Street, killing 6 passers-by and injuring another 16.

Probable causes of failure:

- Poor drainage in the wall allowed infiltration of surface water.
- Removal of support at wall toe.

Consequences of failure:

6 fatalities, 16 injuries (all members of the public)



Case No.: 2

Location: Kellet Bay near Shek Pai Wan Road

Date: 30.6.1986

Weather at time of failure: Fine

Size of trench: 1 m wide x 2.5 m deep

Description:

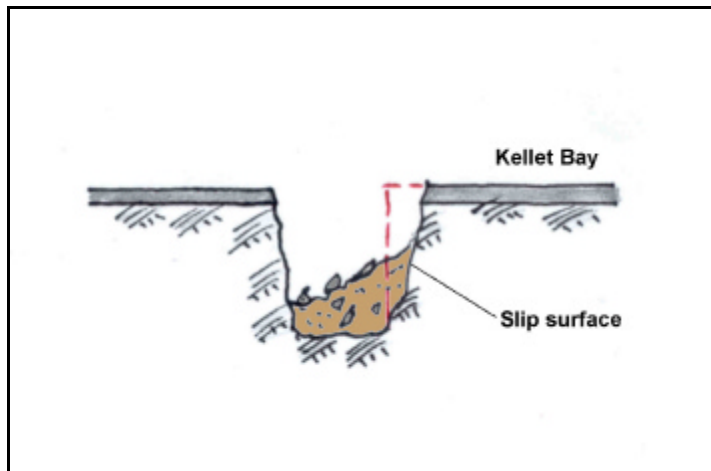
A worker was erecting shoring inside an opened trench for electric cables when it collapsed.

Probable causes of failure:

Improper working procedure

Consequences of failure:

One worker was killed



Case No.: 3

Location: Nga Tsin Long Road, Kowloon

Date: 22.2.1987 (11:00 a.m.)

Weather at time of failure: Fine

Size of trench: 1.3 m deep

Description:

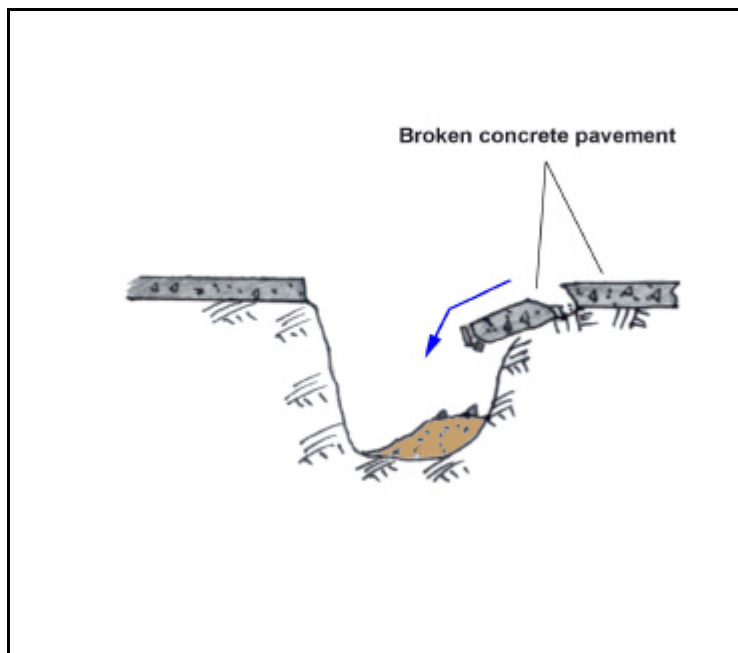
A trench was being excavated for pipe laying. A broken concrete pavement slab fell inside the trench and hit a worker.

Probable causes of failure:

Improper works method

Consequences of failure:

One worker was killed



Case No.: 4

Location: Between CH24+80 and CH25+00 along the Fanling bound carriageway of Sha Tau Kok Road, N.T.

Date: 11.1.1990 (4:15 p.m.)

Weather at time of failure: Fine

Size of trench: 1.8 m wide x 2.35 m deep

Description:

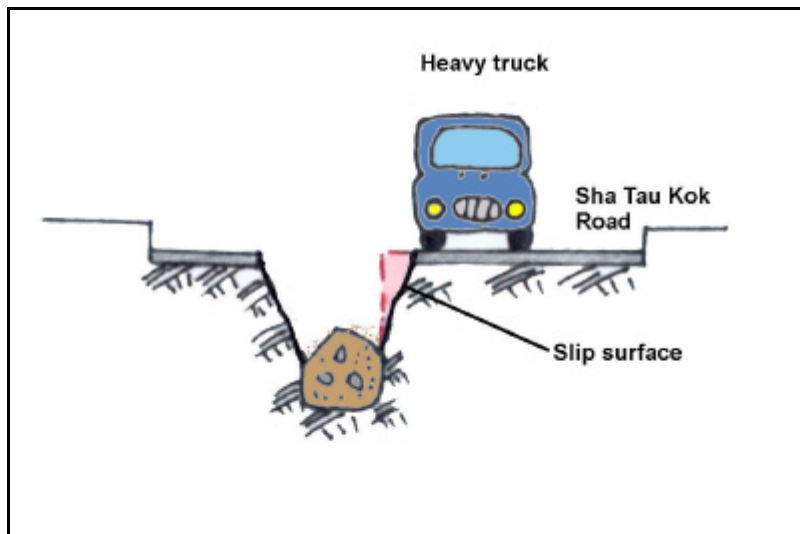
A section of the vertical side of an unsupported trench collapsed. A worker inside the trench was buried by the collapsed soil.

Probable causes of failure:

- A heavy vehicle was parked at the cave-in side of the trench
- Absence of shoring

Consequences of failure:

One worker was killed



Case No.: 5

Location: Between the pavement of Lung Cheung Road and ventilation building of MTRC Diamond Hill Station.

Date: 16.1.1991 (4:00 p.m.)

Weather at time of failure: Fine

Size of trench: 2.5 m wide x 1.4 - 1.7 m deep

Description:

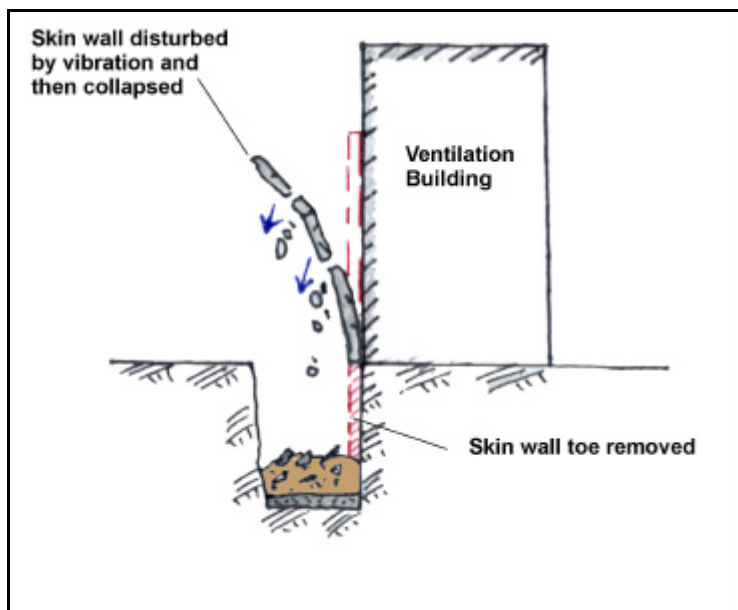
A worker was breaking a concrete slab at the bottom of a trench using a pneumatic breaker when a sand brick skin wall forming one side of the trench collapsed.

Probable causes of failure:

Since the sand brick wall was merely attached to the ventilation building, when the lower part of the wall and the concrete slab were removed, the wall became freely hanged. The stability of the wall was further affected by vibration induced by concrete breaking.

Consequences of failure:

One worker was killed



Case No.: 6

Location: About 30 m from Lam Kam Road roundabout towards Shek Kong direction

Date (Time): June 1992 (6:30 p.m.)

Weather at time of failure: Heavy rainfall

Size of trench: No record

Description:

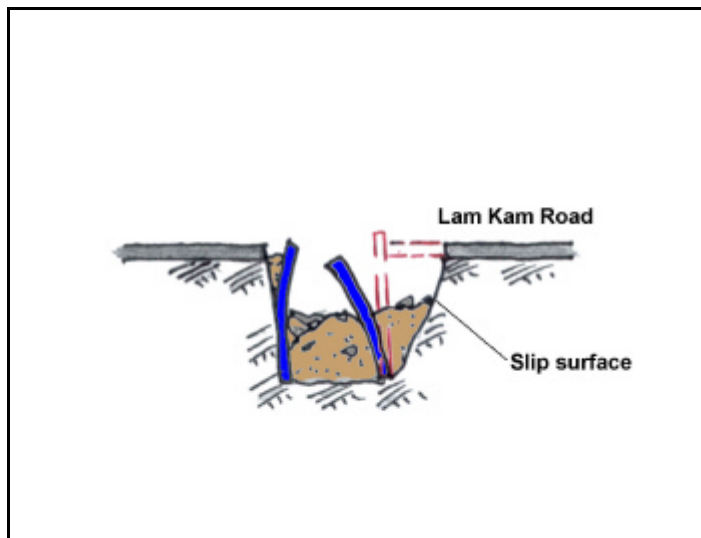
Pipe installation work was being carried out. A trench with shoring collapsed during heavy rainfall.

Probable causes of failure:

- Rise in groundwater level due to heavy rainfall
- Poor groundwater control
- Inadequate shoring

Consequences of failure:

Collapse of Lam Kam Road (lane towards Shek Kong direction) interrupted traffic



Case No.: 7

Location: Castle Peak Road near Pok Oi Hospital, Yuen Long Southern Bypass in North West New Territories Development

Date (Time): 26.2.1993 (3:15 p.m.)

Weather at time of failure: Fine

Size of trench: 2.5 m wide x 4 m deep

Description:

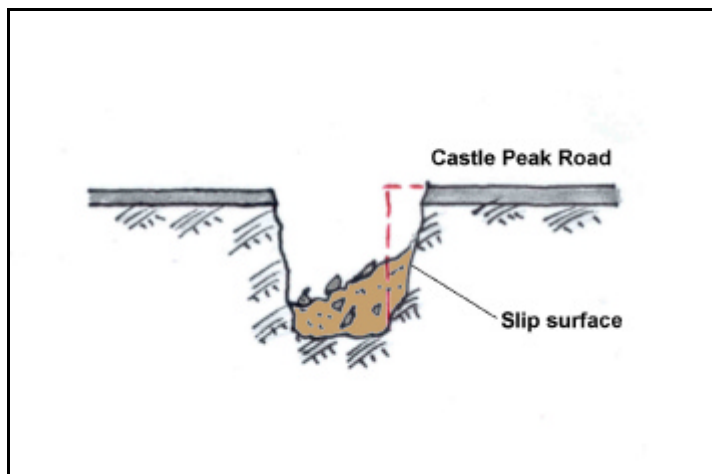
A trench was being dug manually. A worker was hit by collapsed soil when the trench failed.

Probable causes of failure:

- No shoring
- Poor groundwater control

Consequences of failure:

One worker killed, one injured



Case No.: 8

Location: Tung Chung Road, Temporary Water supply to North Lantau Tai Tung Shan Service Reservoir

Date: 6.5.1993 (3:50 p.m.)

Weather at time of failure: Fine (heavy rain the previous day)

Size of trench: 1.5 m wide x 1.5 m deep

Description:

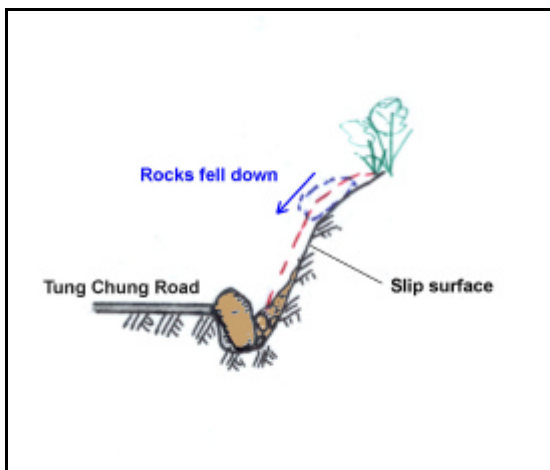
A pipe was being laid when a worker inside the trench was struck by a rock falling from an adjacent upslope.

Probable causes of failure:

- Inadequate shoring support

Consequences of failure:

- One worker was killed
- Failure of a upslope



Case No.: 9

Location: Ping Ha Road, opposite Lo Uk Tsuen, Yuen Long

Date: 4.7.1993 (3:35 p.m.)

Weather at time of failure: Fine

Size of trench: 1.2 m wide x 3 m deep

Description:

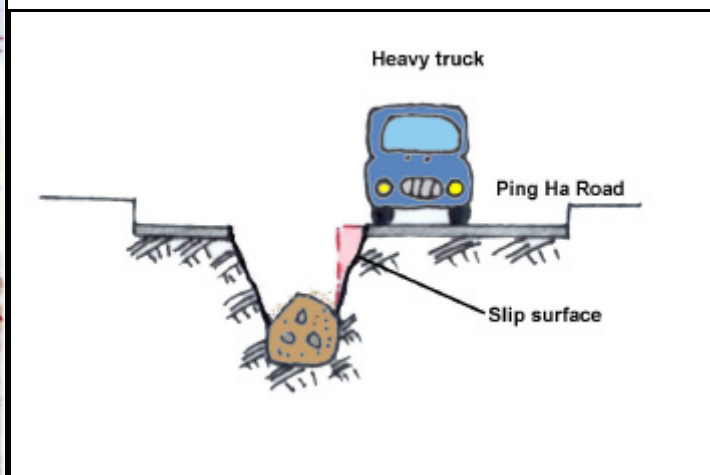
Workers were laying a pipe inside an unsupported trench of 3 m deep. A worker was buried while a cave-in occurred.

Probable causes of failure:

- No shoring
- Heavy vehicle passed trench side

Consequences of failure:

One worker was killed and one was injured



Case No.: 10

Location: Junction of Ferry Street & Man Wui Street, Kowloon

Date: 24.12.1994 (3:45 p.m.)

Weather at time of failure: Raining

Size of trench: 2.5 m wide x 1.7 m deep

Description:

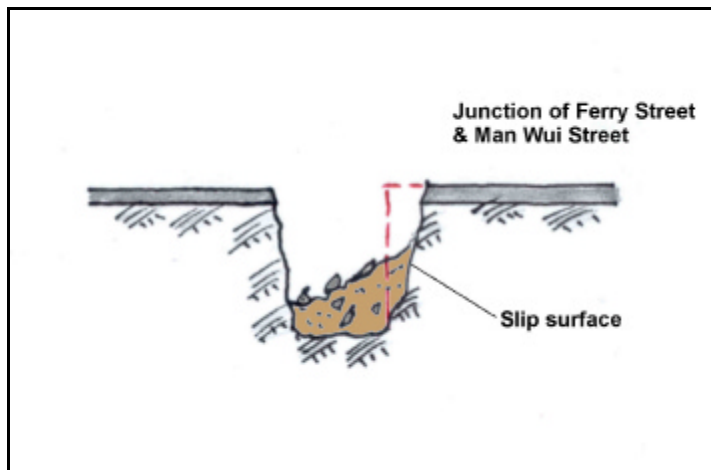
A worker was engaged in pipe laying inside a 1.7 m deep trench when the trench collapsed.

Probable causes of failure:

No shoring

Consequences of failure:

One worker was killed



Case No.: 11

Location: Feature No. 7SW-D/F53, opposite Tsang Tai Uk, Lion Rock Tunnel Road, Sha Tin

Date: 9.1.1996

Weather at time of failure: Not known

Size of trench: 1 m - 2 m deep

Description:

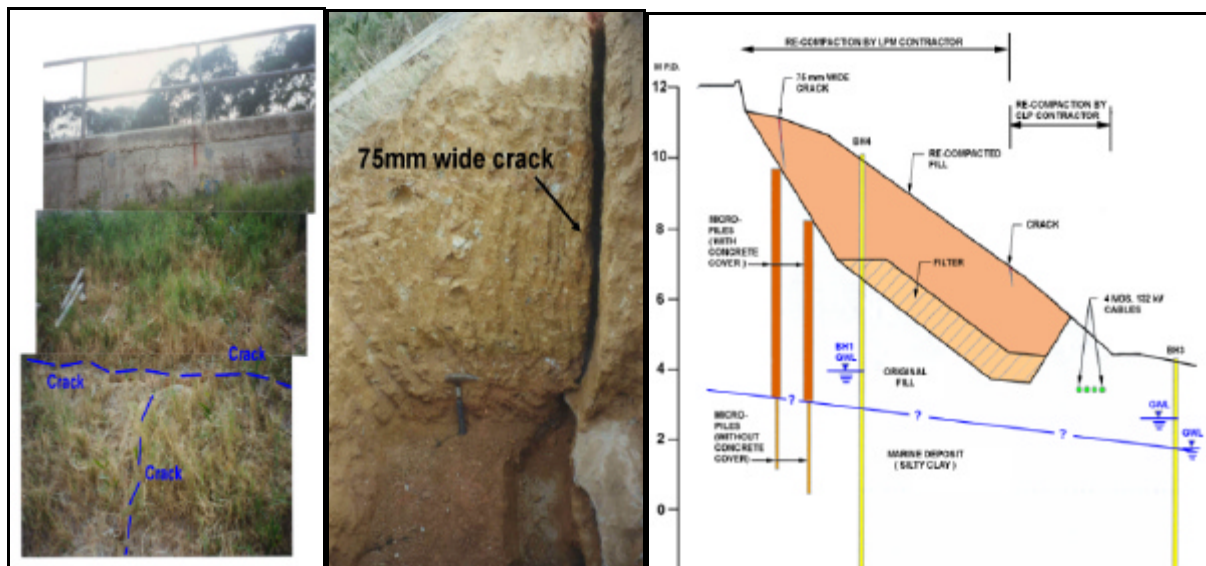
An utility undertaker (UU) dug a trench to locate four 132 kV electric cables found buried along the toe of a fill slope being compacted in December 1994. When compaction of the backfill in the trench was found not up to standard, the UU returned and recompact the backfill from July to September 1995. By that time compaction of the fill slope had long been completed. During a site inspection on 9.1.1996, it was noted that continuous cracks had developed on the fill slope.

Probable causes of failure:

- Removal of toe support during UU's excavation works
- Improper construction sequences
- Inadequate compaction of backfill

Consequences of failure:

The entire fill slope had to be recompact.



Case No.: 12

Location: Wang Lee Street near Fuk Hi Street, Yuen Long Industrial Estate

Date: 15.4.1996 (2:20 p.m.)

Weather at time of failure: Intermittent rainfall

Size of trench: 1.8 m wide x 2.2 m deep

Description:

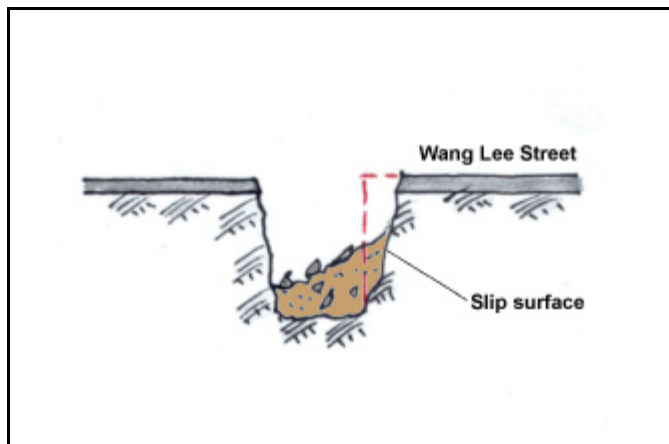
Workers were preparing to lay a pipe inside a trench. The trench caved in and a worker was hit by collapsed soil.

Probable causes of failure:

- Improper shoring
- Presence of water inside trench

Consequences of failure:

One worker was killed



Case No.: 13

Location: Pokfulam Road, opposite the Chinese Christian Cemetery

Date: 24.8.1999 (5:05 a.m.)

Weather at time of failure: Moderate rainfall

Size of trench: 2 m wide x 1 m - 2 m deep

Description:

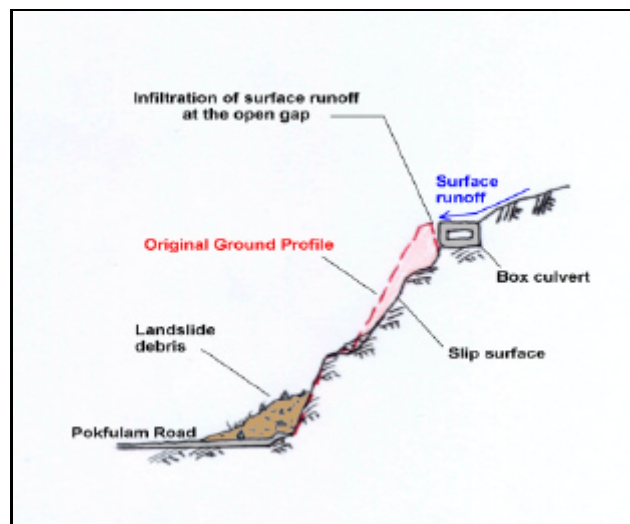
A new box culvert was being constructed at the slope crest. Water entered the open gap between the box culvert and the ground and infiltrated into the slope. A landslide occurred.

Probable causes of failure:

- Infiltration of water
- Inadequate drainage provisions (affected stability of the slope during rainfall)
- No protective apron has been constructed along the outside edge of box culvert

Consequences of failure:

- Failure of a downslope
- Closure of Pokfulam Road



Case No.: 14

Location: Kennedy Road near 6 Hau Fung Lane

Date: 24.8.1999

Weather at time of failure: Heavy rainfall

Size of trench: No record

Description:

A trench was being excavated at the slope crest. Water entered the trench and infiltrated into the slope. A landslide occurred.

Probable causes of failure:

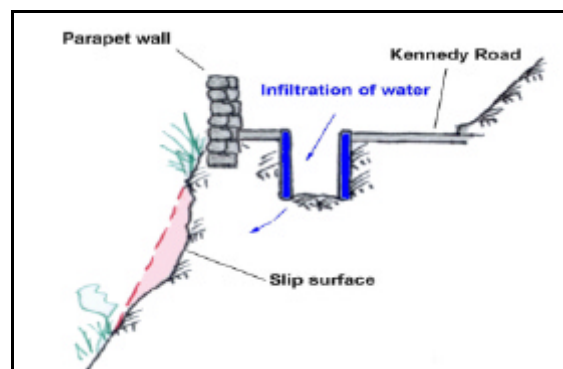
Inadequate drainage provisions

Consequences of failure:

- Vacant site and Kennedy Road affected
- Failure of a downslope



14-8-1999 (Before Landslide)



26-8-1999 (After Landslide)

Case No.: 15

Location: Sam Mun Tsai Road, (near entrance to Yu On Street), Tai Po

Date: 5.11.1999 (11:15 a.m.)

Weather at time of failure: Fine

Size of trench: 1.7 m wide x 2.8 m deep

Description:

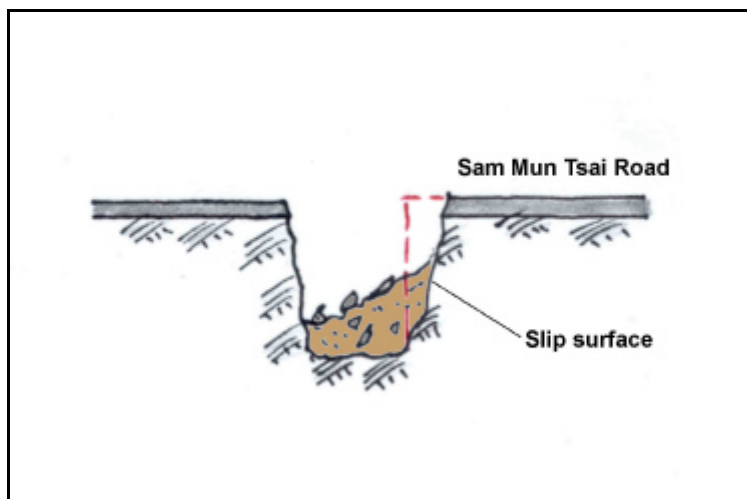
A trench had been dug to facilitate pipelaying. Workers were preparing to install shoring when the trench collapsed.

Probable causes of failure:

Shoring not installed in a timely manner

Consequences of failure:

One worker was killed and one was injured



Case No.: 16

Location: An undisclosed location

Date: 2000

Weather at time of failure: Heavy rainfall

Size of trench: 3 m wide x 3 m deep

Description:

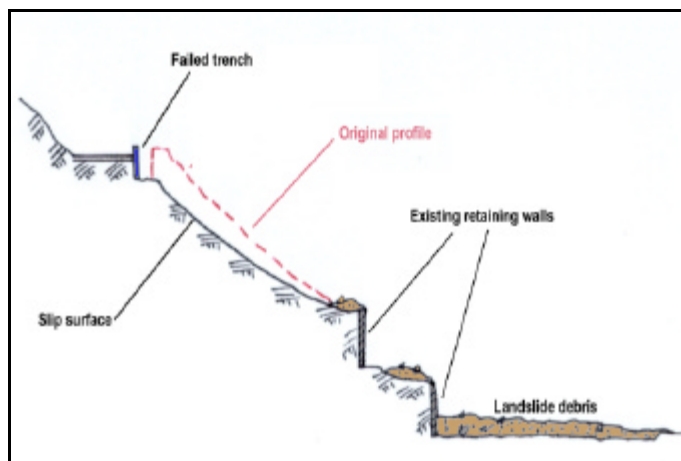
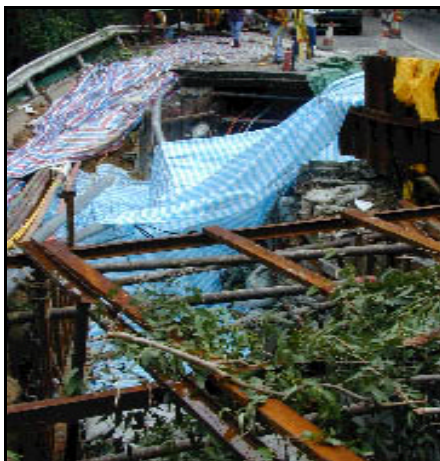
A trench was being excavated at the crest of a fill slope to facilitate the laying of cables. A landslide occurred.

Probable causes of failure:

- Surface water entered and accumulated inside the trench

Consequences of failure:

- One minor injury
- Closure of roads
- Damage to buildings
- Failure of a downslope



APPENDIX B
EXAMPLES OF TRENCHING SPECIFICATION

DRAINAGE SERVICES DEPARTMENT

6. SAFETY IN THE WORKING ENVIRONMENT

6.7 Working in Excavations

1. Erect suitable temporary works to prevent persons from being endangered by a fall or displacement of earth, rock or other material adjacent to or forming the side of an excavation or earthwork.
2. Examine an excavation or earthwork by a competent person at least weekly.
3. Provide a suitable barrier at the edge of an excavation, shaft, pit or opening from which a person is liable to fall more than 2 meters.
4. Securely cover an excavation shaft, pit or opening from which a person is liable to fall more than 2 meters.
5. Do not place material near the edge of an excavation, shaft, pit or opening so as to endanger anyone.
6. Do not place loads or plant or near the edge of an excavation, shaft, pit or opening where it is likely to cause the collapse of the side thereby endangering anyone.
7. Provide adequate means to enable a person to reach a position of safety in case of emergency, where they are working in an excavation, shaft, tunnel, pit or opening in the ground where there is reason to apprehend danger to them from rising water or irruption of water or material.

PARTICULAR SPECIFICATION

5.11 Shoring to Trench for Pipelaying, etc.

The Contractor shall submit to the Engineer for comment within one month from the commencement of the Contract the typical design, which has been satisfactorily checked by an Independent Checking Engineer, of the shoring or temporary support to trench up to a depth of 9 m. Unless prior agreement is given by the Engineer, this typical design shall be used throughout the Contract whenever shoring or similar temporary support is required to protect the excavated surface of the trench for pipelaying or manhole construction etc. The Contractor and Independent Checking Engineer shall ensure that the typical design is applicable to each trench excavation taking into account the particular site conditions including the loading, subsoil properties, stability of adjacent structures and utilities etc., and shall submit to the Engineer a revised design for the shoring or temporary support and further certification when necessary in accordance with SCC clause SCC 28 (6). The submission to and approval by the Engineer of such particulars shall not relieve the Contractor of any of his liabilities and obligations under the Contract.

CONTRACTOR'S TEMPORARY WORKS

- 1.68 (1) Pursuant to SCC Clause 30, the design of the following Temporary Works shall be certified by the independent checking engineer:
- (a) Temporary trench support for trench not more than 3.5 m deep;
 - (b) Temporary trench support for trench deeper than 3.5 m;
 - (c) Temporary decking over excavated trench.
- (2) In addition, method statements certified by the Independent Checking Engineer shall be provided for the erection, use and removal of the following Temporary Works:
- (a) Temporary trench support for trench not more than 3.5 m deep;
 - (b) Temporary trench support for trench deeper than 3.5 m;
 - (c) Temporary decking over excavated trench.
- (3) Any Temporary Works erected in close proximity to traffic shall be protected against impact from vehicles by suitably designed protective measures. The Contractor shall design such protective measures with regard to the conditions prevailing on the Site and the effect of any such impact. Such protective measures are to be designed as part of the Temporary works and included in any requirement for independent checking.
- (4) The Contractor shall submit to the Engineer his proposals for carrying out the Contractor' Temporary Work together with the documents required under sub-clauses (1) and (2) of this clause not later than 2 months before the date planned for the commencement of any construction work or such shorter period as may be agreed with the Engineer. These proposals shall include, without limitation, details of the following:
- (a) - Temporary road decking
 - In-situ supports for underground services

The details to be forwarded shall include inter alia:

- (i) Layout, including vertical profile, of the temporary decking arrangements.
- (ii) Type of temporary road decking to be used and details of the surface finish.
- (iii) Layout, details and supporting calculations of the decking and its support system.

- (iv) Sequence for installation and subsequent removal of the temporary decking and associated support system.
 - (v) Arrangements for drainage of the temporary decking, including supporting calculations.
 - (vi) Arrangements for carrying out regular inspections of the temporary decking.
 - (vii) Provisions for providing access for utility companies to inspect and maintain their services.
 - (viii) Details of temporary barriers, lighting posts and the like to be installed on the decking system.
- (b) Temporary waling and strutting to excavations

The details to be forwarded shall include inter alia:

- (i) Drawings and details of the layout of the temporary waling and strutting.
 - (ii) Supporting calculations.
 - (iii) Arrangements for preloading the strutting system.
 - (iv) Sequence for installation and subsequent removal of the temporary waling and strutting.
 - (v) Estimates of expected movements, ground water table levels, expected movements of adjacent ground and structures at each stage of the waling and excavation phase together with supporting calculations.
 - (vi) Proposals for installing temporary waling to the tolerances required.
 - (vii) Proposals for plant required to install temporary waling.
 - (viii) Not used.
 - (ix) Proposals regarding location and type of any non-standard temporary waling considered necessary.
- (c) All shoring including sheet piling installed as Temporary Works shall be terminated at a uniform level flush with existing ground level or as otherwise instructed by the Engineer.
- (d) Dewatering

The details for dewatering shall include:

- (i) Drawings of the layout of each stage of the excavation, including details of the dewatering of separate stages of the excavation.
 - (ii) Arrangement and details of dewatering systems including pumping, ground water cut-off and ground treatment.
 - (iii) Arrangements and details of measures to monitor the effectiveness of the dewatering system.
 - (iv) Standby back-up arrangements in the event of system failure.
- (e) Not used.
- (f) Proposals for dealing with utilities

The details to be forwarded shall include inter alia:

- (i) Proposals for locating and identifying utilities.
 - (ii) Temporary supports for utilities to be supported in situation.
 - (iii) Arrangements for temporary diversions and subsequent reinstatement of utilities.
 - (iv) Contingency plans identifying appropriate action should the utility services be damaged.
- (g) Method of excavation

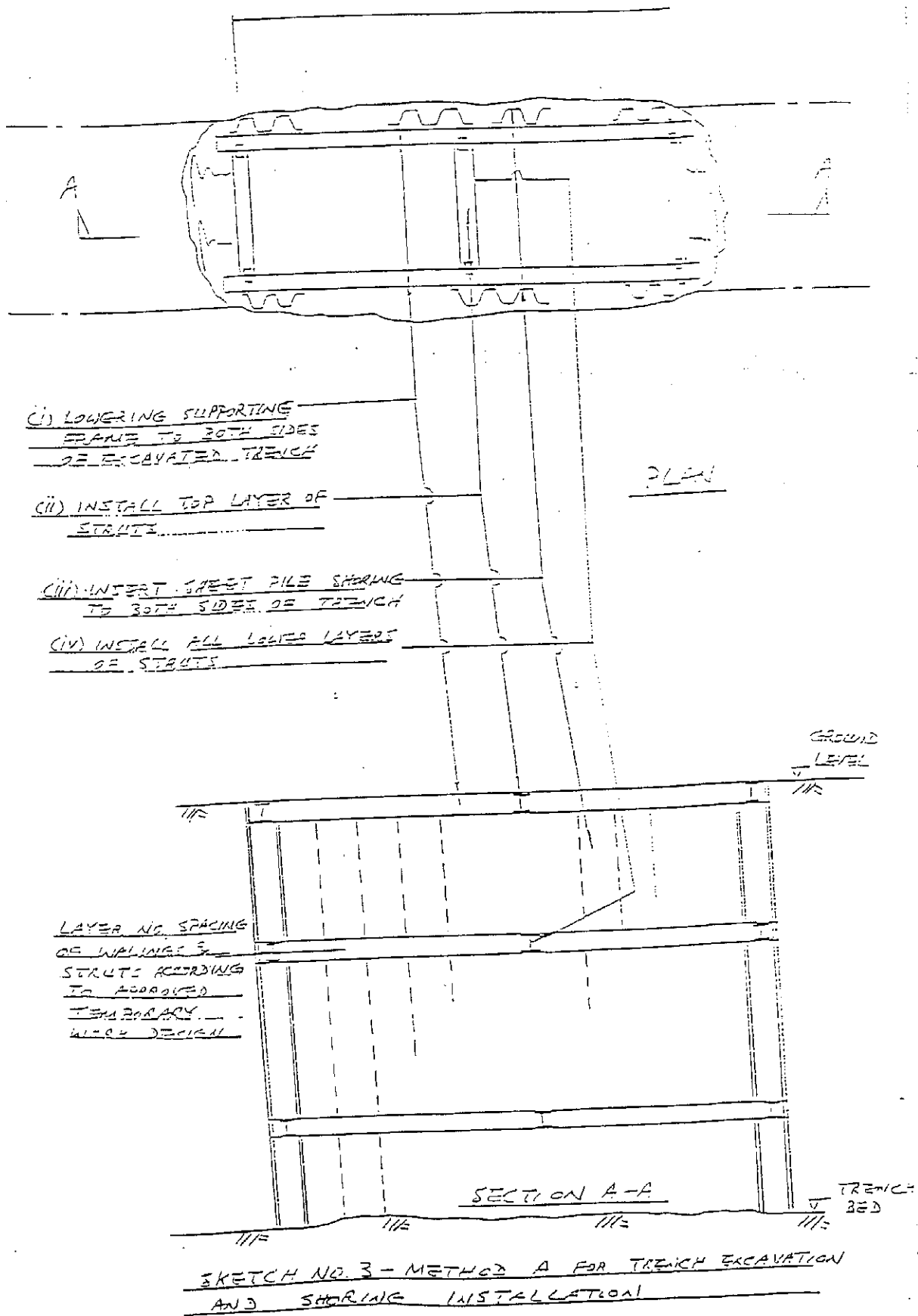
The details to be forwarded shall include inter alia: -

- (i) Layout, details and supporting calculations for proposed access shafts.
 - (ii) Sequence of excavation within each zone.
 - (iii) Method of excavation and removal of excavated material.
 - (iv) Proposals for plant required for excavation and removal of excavated material.
 - (v) Arrangement for disposal of excavated material.
- (h) Construction of RC Works

The details to be forwarded shall include inter alia: -

- (i) Layout and sequence of concrete pours.
- (ii) Layout, details and supporting calculations for formwork.

- (iii) Layout, details and supporting calculations for falsework.
 - (iv) Proposed location and details of construction joints.
 - (v) Method of placing concrete.
 - (vi) Proposals for plant for placing concrete.
 - (i) Methods of supporting all trenches in public highways and details of all trench supports for trenches of depth greater than 2.0 m or those trenches of depth greater than 1.5 m and width greater than 2.0 m.
 - (j) Method of maintaining flows in the existing and partly constructed drainage systems.
 - (k) Temporary Traffic Arrangement, including maintaining access for emergency vehicles.
 - (l) Heading under culverts.
- (5) The Engineer may also require further calculations and details. Any submission by the Contractor under PS Clause 1.68 does not relieve the Contractor of any of his duties or responsibilities for the Temporary Works.



SECRET NO. 4 - NOTIFIED B FOR TRACING
EXPLANATION AND SUGGESTIONS INSTRUCTIONS,
TYPE THE SECRET FOR TRACING OF
THE SECRETARY DEPT.

THE HONG KONG AND CHINA GAS CO. LTD

- 16.8 Particular care should be taken to exclude rocks, sharp stones and other sharp objects from the trench bed. When laying across rock or irregular ground, the trench should be excavated to a minimum of 75 mm below the correct depth and backfilled with suitable material.
- 16.9 The excavated material should be properly treated in accordance with the statutory requirements.
- 16.10 Where excavated material is stacked along the side of the trench, care must be taken to avoid the danger of debris falling into the trench and to prevent the weight of excavated material causing a collapse of the trench and thereby endanger any person working in it. Suitable space should be left for surface water drainage and where necessary loose excavated materials should be contained by vertical boards or suitable containers.
- 16.11 Excavated material should be stacked or shifted off site to maintain reasonable access to the public.
- 16.12 In firm soil, where the depth is not more than 1.2 m and there is no possibility of heavy loads exerting pressure on the sides of the trench, it will generally be unnecessary to provide support for the trench sides, but if there is doubt as to the stability of the soil, especially in bad weather, the trench sides should be effectively supported. For trenches with depth exceeding 1.2 m, trench support should normally be required unless, having regard to the nature and slope of the sides of the excavation or earthwork and other circumstances, no fall or dislodgement of earth, rock or other material is liable to occur so as to bury or trap a person or to strike such person from a height of more than 1.2 m. The poling board method (see Figure 16.1) is normally sufficient but if the excavation is likely to be deep then runners should be used.
- 16.13 Where loose ground is encountered either close board timbering or sheet piling should be used (see Figures 16.2 and 16.3).
- 16.14 In deep excavations a safe means of entrance and exit should be constructed and staging provided where necessary.
- 16.15 Each joint hole should be cut of sufficient size to enable the joint to be properly made.
- 16.16 The minimum normal cover of pipes shall be 900 mm in carriageway and 450 mm in footway. In special circumstance where the minimum cover cannot be achieved, the pipes should be protected by adding suitable steel capping plates on top of the pipes. In such case, approval must be sought from the responsible Section Manager or his delegate. The steel capping plates should be protected against corrosion and suitable warning notices should be affixed on top of the capping plates.
- 16.17 Where waterlogged ground is encountered, consideration should be given to the use of dewatering equipment, having regard to the stability of nearby structures. Provision

should be made to carry the surface water away from the trench properly and in no circumstances should water be allowed to spread over the roadway.

- 16.18 In certain cases it may be necessary to temporarily bridge excavations, e.g. to provide access to premises or to resume full carriageway for traffic when working in roads at restricted hours. Suitable road plates can be employed in these cases. Road plates should be in accordance with Highways Department's requirements.
- 16.19 All personnel engaged on works in a carriageway should be issued with and encouraged to wear high visibility clothing. All personnel working in a construction site should wear safety helmet.

17 PIPELAYING

17.1 General

- 17.1.1 Immediately prior to being laid in the trench, each pipe and fitting should be inspected for cuts, deep scratches, pitting or other damage.
- 17.1.2 When doubt exists as to the soundness of the pipe or fitting, it should be marked and kept away from use. Reference should be made to the SSS for further instructions.
- 17.1.3 Before pipes are jointed, bores should be inspected and any loose rust and/or foreign matter cleared.
- 17.1.4 During pipeline construction, particular care should be exercised to prevent the ingress of water or other substance into the system. When the site is unattended, open ends of pipes should be suitably sealed off using expansion stoppers, caps/plugs, fused caps or other approved means.
- 17.1.5 If a connection is to be made to an existing main/service, the first pipe to be laid should be in line with the existing main/service. Also, the gap between the two should be proved by excavation to be clear of obstructions. In the case of MP or IPA main/service, the existing capped/plugged and should be secured to the satisfaction of the SSS before trench excavation takes place.
- 17.1.6 Where a pipe passes through an external wall or solid floor, a sleeve of approved material should be built into the wall. The annulus between the sleeve and the carrier pipe should be sealed with an approved non-setting compound.
- 17.1.7 It is preferable to lay gas pipes with a minimum clearance of 300 mm (600 mm if the gas pipe is of steel material) from other utilities' plant where practical.

FIGURE 16.1 : OPEN POLING IN MODERATELY FIRM GROUND

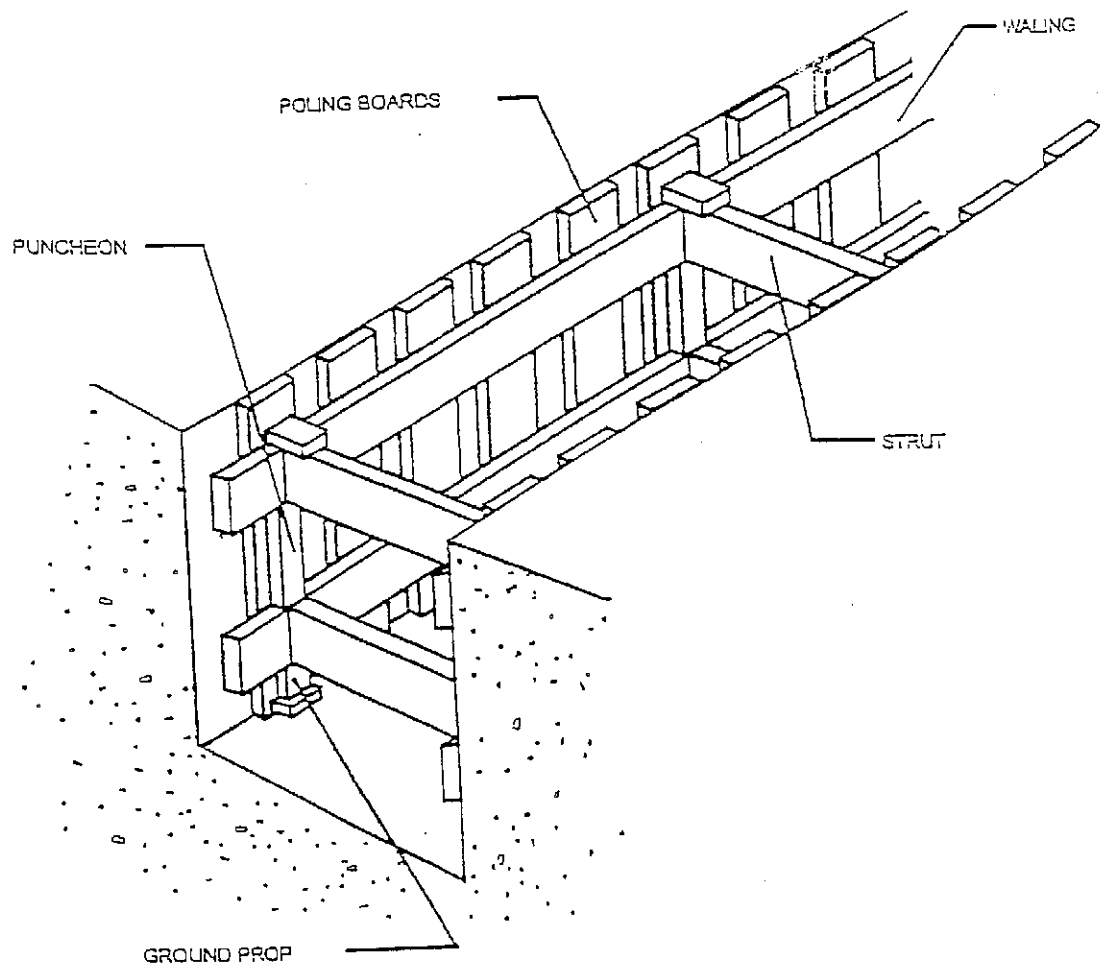


FIGURE 16.2 : CLOSE BOARD TIMBERING

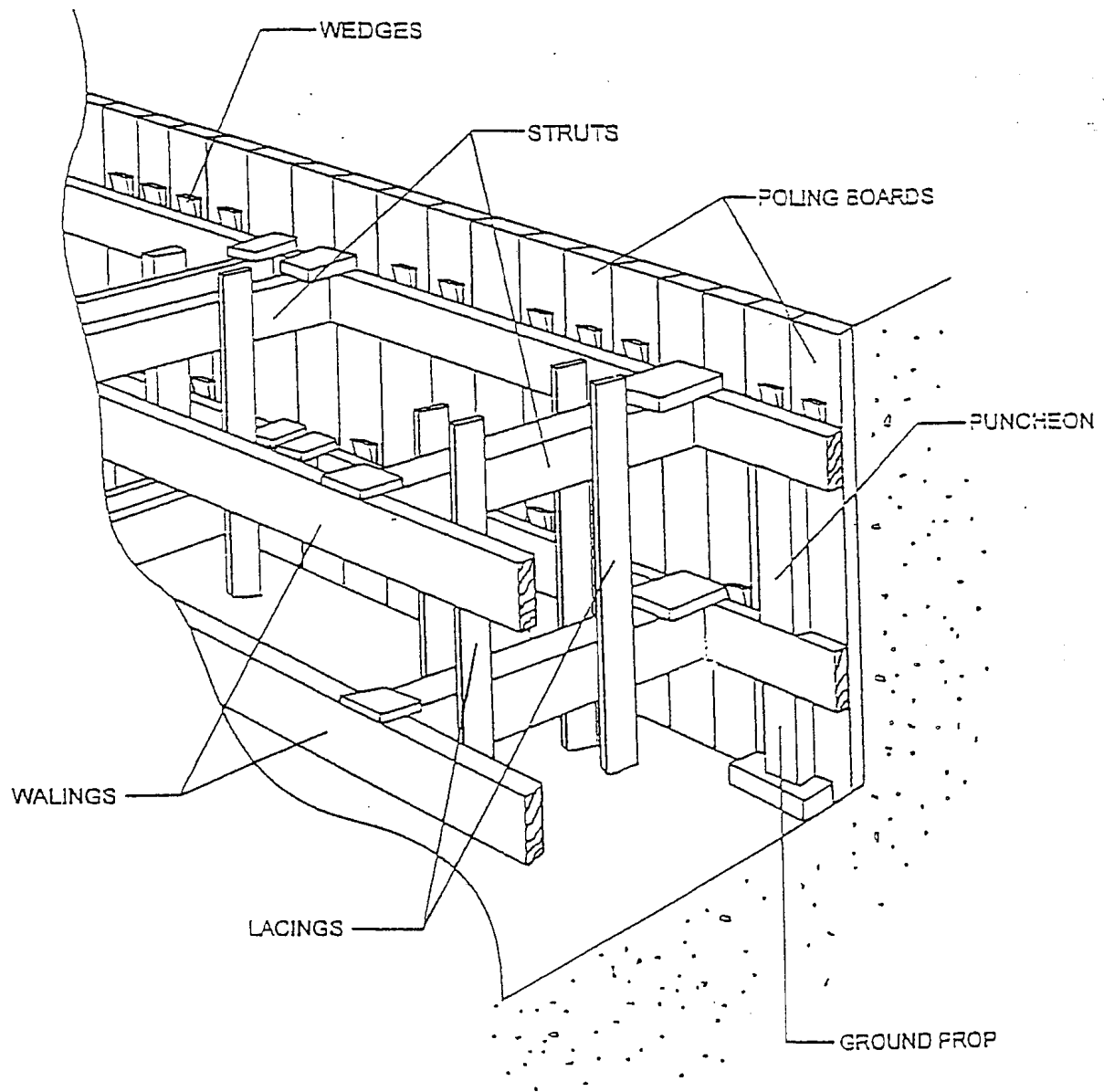
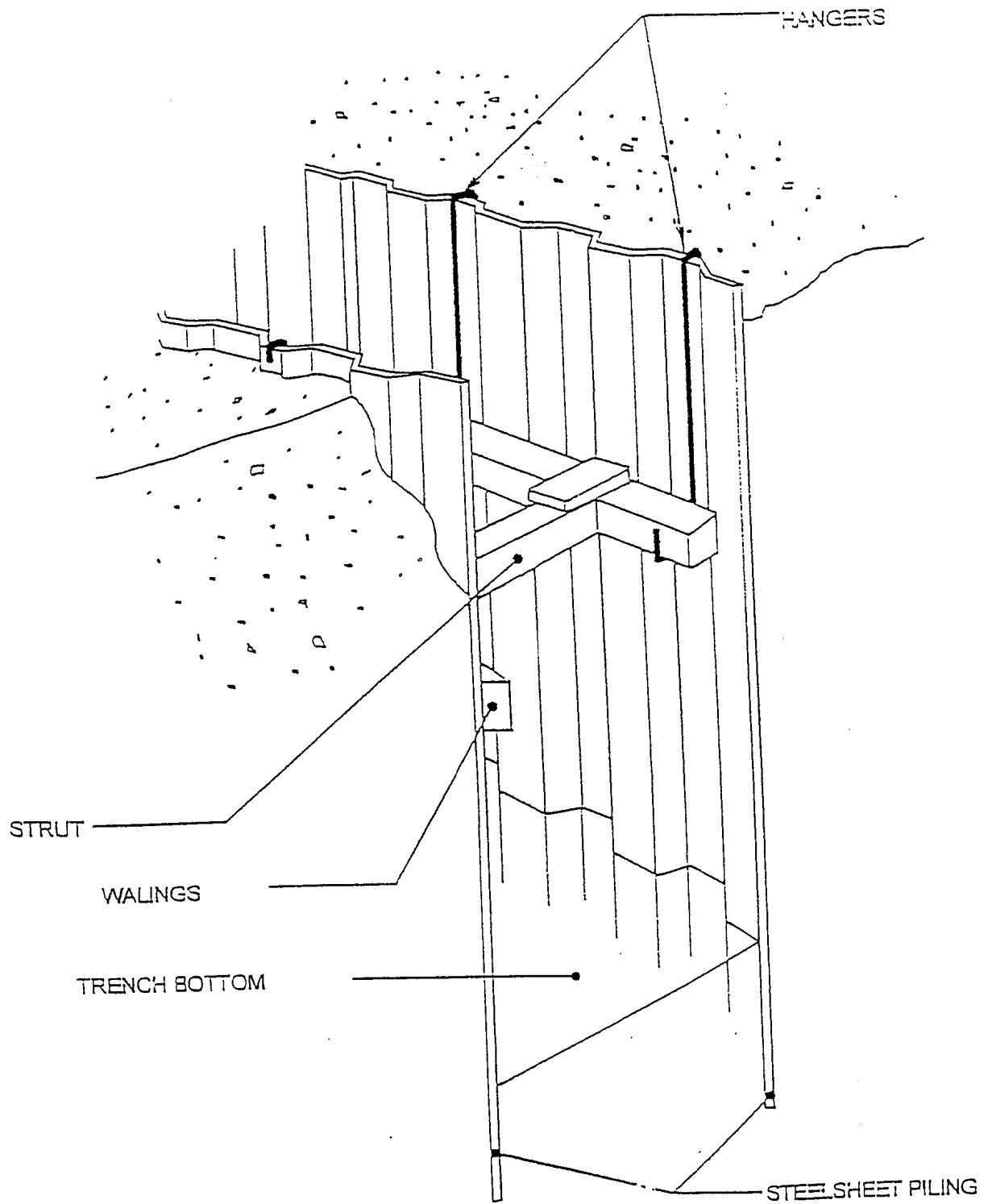


FIGURE 16.3 : SHEET PILING



APPENDIX C

CONSTRUCTION SITE (SAFETY) REGULATIONS (CAP. 59 sub. Leg. I)

**CONSTRUCTION SITES (SAFETY) REGULATIONS
(CAP. 59 sub. leg. I)**

2. Interpretation

“competent person” (合資格的人), in relation to any duty to be performed under these regulations by a competent person, means a person who is

- (a) appointed for that purpose by the contractor required by these regulations to ensure that the duty is carried out by a competent person; and
- (b) by reason of substantial training and practical experience, competent to perform the duty.

39. Safety of excavations, etc.

- (1) The contractor responsible for any construction site at which excavating or earthworking operations are being carried on shall cause a structure made of suitable timber or other suitable material to be erected in connexion with the operations as soon as may be necessary after their commencement so as to prevent workmen employed on the site from being endangered by a fall or displacement of earth, rock, or other material (including waste material and debris) adjacent to or forming the side of the excavation or earthwork.
- (2) The contractor shall –
 - (a) cause every part of the excavation or earthwork where workmen are employed to be examined by a competent person at least once in every period of 7 days after the commencement of the excavation or earthwork until it is completed or abandoned; and
 - (b) ensure that after any such examination no further work in respect of the excavation or earthwork is carried on until there has been obtained from the person in respect of the examination, or in respect of any further examination that may be necessary, a report in the approved form which includes a statement to the effect that the excavation or earthwork, and every structure erected under paragraph (1), is safe and secure.
- (3) A report under paragraph (2) of an examination and the results thereof, signed by the person carrying out the examination, shall be
 - (a) made in the approved form and contain the prescribed particulars; and
 - (b) delivered forthwith to the contractor concerned.

(4) This regulation shall not apply

- (a) to an excavation of earthwork where, having regard to the nature and slope of the sides of the excavation or earthwork and other circumstances, no fall or dislodgement of earth, rock, or other material is liable to occur
 - (i) so as to bury or trap a workman or other person employed in or near the excavation or earthwork; or
 - (ii) so as to strike any such workman or person from a height of more than 1.2 meters; or
- (b) in relation to a workman actually engaged in the erection of any structure or in rendering any excavation or earthwork safe, or to a person engaged in examining any such structure, if other precautions which are reasonably adequate to ensure his safety are taken.

56. Information to be furnished to Commissioner

- (1) Subject to paragraph (2), a contractor who undertakes construction work shall, within 7 days after the commencement of the work, furnish in writing to the Commissioner the following information
 - (a) the contractor's name and address;
 - (b) if the contractor is a firm, the name under which it carries on business and the name and address of every partner in the firm;
 - (c) the name and address of every subcontractor employed on the work;
 - (d) the location of the construction site;
 - (e) the nature of the work;
 - (f) the date upon which the work was commenced;
 - (g) whether any mechanical power is being or will be used in connexion with the work and, if so, the nature of the mechanical power; and
 - (h) the expected duration of the work.
- (2) Paragraph (1) shall not apply if-
 - (a) at the date of commencement of the work
 - (i) the contractor has reasonable grounds for believing that the work will be completed in a period of less than 6 weeks from that date; or

- (ii) any other construction work is being undertaken at the same construction site and the information specified in paragraph (1) has been furnished to the Commissioner in respect of that construction work; or
- (b) not more than 10 workmen are or will be employed on the work at any one time.

68. Offences and penalties relating to contractors

- (1) (a) Any contractor who contravenes any of the provisions of regulation 39 (1) or (2) shall be guilty of an offence.
- (2) (a) A person guilty of an offence under paragraph (1) shall in respect of a contravention of regulation be liable to a fine of \$200,000.

70. Offences by competent examiners, etc.

- 1(A) Any competent person who having carried out any test, inspection or examination required by these regulations fails or refuses to deliver forthwith, or within a reasonable time thereafter, to the contractor concerned a report referred to in regulation 39(3) shall be guilty of an offence and shall be liable on conviction to a fine of \$50,000.
- (2) Any such competent examiner or competent person who delivers to a contractor any certificate, or report which is to his knowledge false as to a material particular shall be guilty of an offence and shall be liable on conviction to a fine of \$200,000 and to imprisonment for 12 months.

APPENDIX D

LAND (MISCELLANEOUS PROVISIONS) ORDINANCE (CAP. 28)

LAND (MISCELLANEOUS PROVISIONS) ORDINANCE (CAP. 28)

8. Control of excavations in unleased land

- (1) Except under and in accordance with a prospecting licence, mining licence or sand removal permit, a person shall not make or maintain any excavation in unleased land, except under and in accordance with an excavation permit issued under this section.
- (2) The Authority may issue an excavation permit authorising the making of excavations in unleased land.
- (3) An excavation permit shall be valid for the period specified therein, but the Authority may extend the period for which the permit is valid.
- (4) Any person who contravenes subsection (1) shall be guilty of an offence and shall be liable on conviction to a fine of \$5000 and to imprisonment for 6 months.
- (5) The Authority may, if any person makes or maintains an excavation in unleased land, without an excavation permit, carry out such works as he considers necessary to reinstate and make good the land on which the excavation is made or maintained and any other land the reinstatement and making good of which is, in his opinion, necessary in consequence of the excavation and may recover the cost of any work carried out by him under this subsection from the person who made or maintained the excavation.

9. Reinstatement of unleased land after excavation

- (1) A person who makes an excavation in unleased land under an excavation permit shall, before the expiry of the permit, reinstate and make good the land as required by any conditions of the permit.
- (2) If any unleased land is not reinstated and made good in accordance with subsection (1) either –
 - (a) before the expiry of the permit; or
 - (b) as required by any conditions of the permit,

as the case may be, the Authority may carry out such work as he considers necessary to reinstate and make good the land, and any other land the reinstatement and making good of which is, in his opinion, necessary in consequence of the excavation, notwithstanding that the works for the carrying out of which the excavation was made have not been completed.

- (3) The Authority may recover from the person to whom the excavation permit was issued –
- (a) the cost of any work carried out by the Authority under subsection (2); and
 - (b) the cost of work carried out by the Authority to reinstate and make good any unleased land if the necessity for such work –
 - (i) arises within 12 months after the completion of work for the reinstatement and making good of the land under this section; and
 - (ii) is attributable to any fault on the part of such person or his servants or agents.

10. Provision of safety facilities in connexion with excavation

If any condition of an excavation permit requiring the provision of facilities for the safety or convenience of the public is contravened, the Authority may provide such facilities and recover the cost thereof from the person to whom the permit was issued.