MCMC MTSFB TC G025-1:2020

TECHNICAL CODE

BASIC CIVIL WORKS -
PART 1: GENERAL REQUIREMENTS

Developed by

Malaysian Technical Standards Forum Bhd

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MCMC MTSFB TC G025-1:2020

Development of technical codes

The Communications and Multimedia Act 1998 ('the Act') provides for Technical Standards Forum designated under section 184 of the Act or the Malaysian Communications and Multimedia Commission ('the Commission') to prepare a technical code. The technical code prepared pursuant to section 185 of the Act shall consist of, at least, the requirement for network interoperability and the promotion of safety of network facilities.

Section 96 of the Act also provides for the Commission to determine a technical code in accordance with section 55 of the Act if the technical code is not developed under an applicable provision of the Act and it is unlikely to be developed by the Technical Standards Forum within a reasonable time.

In exercise of the power conferred by section 184 of the Act, the Commission has designated the Malaysian Technical Standards Forum Bhd (MTSFB) as a Technical Standards Forum which is obligated, among others, to prepare the technical code under section 185 of the Act.

A technical code prepared in accordance with section 185 shall not be effective until it is registered by the Commission pursuant to section 95 of the Act.

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Committee representation

This technical code was developed by the Fixed Network Facilities Sub Working Group under the Network and Broadcast Infrastructure and Facilities Working Group of the Malaysian Technical Standards Forum Bhd (MTSFB) which consists of representatives from the following organisations:

Core MTX Sdn Bhd

Digi Telecommunications Sdn Bhd

edotco Group Sdn Bhd

Malaysian Digital Economy Corporation

Maxis Bhd

Redsun Engineering Sdn Bhd

Telekom Malaysia Berhad

TIME dotcom Bhd

U Mobile Sdn Bhd

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Foreword

This technical code for Basic Civil Works – Part 1: General Requirements ('this Technical Code') was developed pursuant to section 95 and section 185 of the Act 588 by the Malaysian Technical Standards Forum Bhd (MTSFB) via its Fixed Network Facilities Sub Working Group under the Network and Broadcast Infrastructure and Facilities Working Group.

The *Basic Civil Works* documents consist of the following parts:

Part 1: General Requirements

Part 2: Open Trench

Part 3: Micro Trench

Part 4: Horizontal Directional Drilling

These series of Technical Codes shall replace SKMM/G/01/09, *Guideline on the Provision of Basic Civil Works for Communications Infrastructure in New Development Areas*.

This Technical Code (Part 1: General Requirements) consists of all common requirements related to basic civil works for the purpose of installation and maintenance of communications network facilities. This Technical Code shall be read together with the rest of the other series of *Basic Civil Works* depending on specific method of civil works.

This Technical Code shall continue to be valid and effective from the date of its registration until it is replaced or revoked.

BASIC CIVIL WORKS - PART 1: GENERAL REQUIREMENTS

1. Scope

This Technical Code specifies the general requirements for basic civil works for the purpose of installation and maintenance of communications network facilities using open trench, micro trench and horizontal directional drilling methods which covers:

a) planning of civil works;

b) safety and precautions;

c) processes and procedures;

d) traffic management plan;

e) material specifications;

f) testing and acceptance;

g) milling and reinstatement; and

h) procedure for project completion.

2. Normative references

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

BS EN 197-1, *Composition, specifications and conformity criteria for common cements*

BS EN 10255, *Non-alloy steel tubes suitable for welding and threading. Technical delivery conditions*

BS 657, *Dimensions of common clay building bricks*

BS 4360, *Specification for weldable structural steels*

ATJ 2C/85, *Manual on Traffic Control Devices Temporary Signs and Work Zones Control*

JKR/SPJ/2008, *Standard Specification for Road Works, Section 4: Flexible Pavement*

Prosedur Permohonan Syarikat Utiliti Kepada JKR

3. Abbreviations

For this Technical Code, the following abbreviations applies:

ACWC	Asphaltic Concrete Wearing Course
BM	Building Management
CAD	Computer-Aided Design

CBYD	Call Before You Dig
CIDB	Construction Industry Development Board
COA	Certification of Acceptance
ETP	External Trenching Permit
FOC	Fibre Optic Cable
GI	Galvanised Iron
GPR	Ground Penetrating Radar
HDD	Horizontal Directional Drilling
HDPE	High-density Polyethylene
ITP	Internal Trenching Permit
NFP	Network Facilities Provider
OSHE	Occupational Safety, Health and Environment
PVC	Polyvinyl Chloride
TMP	Traffic Management Plan
UDM	Utility Detection Mapping

4. Terms and definitions

For the purposes of these series of Technical Codes, the following terms and definitions apply.

4.1 Building

Includes any house, hut, shed or roofed enclosure, whether used for the purpose of a human habitation or otherwise, and also any wall, fence, platform, staging, gate, post, pillar, paling, frame, hoarding, slip, dock, wharf, pier, jetty, landing-stage or bridge, or any structure support or foundation connected to the foregoing.

4.2 Building management

The entity responsible to maintain the infrastructure provided within Private Property Line (PPL) in good condition. It may include individual premises owner or Joint Management Body (JMB).

4.3 Call Before You Dig (CBYD)

CBYD is a customise online portal managed by Malaysian Access Forum Berhad. CBYD acts as a notification centre which will notify and alert the CBYB members before any digging works are carried out. The objectives of CBYD are to:

a) reduce the number of incidents and disruptions to the services provided by telecommunication companies and public utility owners;

b) ensure underground and aerial assets are safeguarded against unplanned fibre or cable cuts;

c) expedite restoration time to resume services in the event of fibre or cable cut; and

d) promote safe deployment practices to all.

4.4 Conduit

A raceway or circular cross-section of the type permitted under the appropriate electrical code.

4.5 Duct

A single or multi-way duct made of PVC or other materials. An enclosed raceway for wires or cables usually used in soil or concrete, an enclosure in which air is moved.

4.6 Jointing chamber

Any manhole, joint box, or other underground vault or chamber at which ducts are terminated.

4.7 Landowner

The owners of the land are:

a) The registered proprietor of the land;

b) The lessee of a lease including a sub-lessee of the land whether registered or not;

c) The agent or trustee of any of the owners described in paragraphs (a) and (b) of this definition if in the opinion of a local authority any of those persons cannot be traced or, if any of those persons has died, his legal personal representative; or

d) The person for the time being receiving the rent of the premises in connection with which the word is used whether on his own account or as agent or trustee for any other person or as receiver or who would receive the same if such premises were let to a tenant.

4.8 Local authority

Any City Council, Municipal Council or District Council, as the case may be, and in relation to the Federal Territory means the Commissioner of the City of Kuala Lumpur appointed under section 4 of the Federal Capital Act 1960 [Act 190].

4.9 Manhole

A large hole in a road or path, covered by a metal or concrete plate that can be removed and is used to access the underground ducting during cable installation work. It is also used to place the cable jointing closure or some of network elements.

4.10 Network facilities

Any element or combination of elements of physical infrastructure used principally for, or in connection with, the provision of network services, but does not include customer equipment.

4.11 Network Facility Provider (NFP)

A person who owns or provides any network facilities.

4.12 Network service

A service for carrying communications by means of guided and/or unguided electromagnetic radiation such as fixed network communications services.

4.13 Pilot hole

An excavation to determine the position of plants or any obstructions and shall be carried out by manual labour using hand tools. The usual form of a pilot hole for a duct trench is across the line of the trench, and for jointing chamber, etc., at any position necessary to indicate a clear excavation space for the proposed structure.

4.14 Project manager

The project manager is the person or employee of the company which owns and be responsible of the civil works project. Project manager is responsible to plan, procure, implement and manage the construction of civil works

4.15 Property developer

A company, an individual, a partnership, a co-operative society, a body of person who or which engages in or carries on or undertake or causes to be undertaken property development.

4.16 Rock

The definitions of rock are divided into the following types:

4.16.1 Boulder rock

This means a solid stone in boulder formation similar in character to hard rock having a measurement exceeding 246 cm^3.

4.16.2 Hard rock

This means a solid mass of virgin rock which may have seams but is virtually unaffected by a blow from a pickaxe and requires pneumatic tools for economical excavation.

4.16.3 Soft rock

This means a bed of virgin rock (i.e. un-worked rock) which may consist of a mass of soft stone or a mass of hard stone containing fissures or seams, it being possible, in either case, to excavate by using an ordinary pickaxe, but if so excavated would result in a very uneconomical rate of progress, necessitation the use of compressor and pneumatic tools for economical excavation.

4.17 Way leave

A right of way granted by a landowner or relevant authorities, for the purposes such as erection of ducting system and installation of cable or equipment.

5. Planning of civil works

Planning of civil works shall be carried out before starting any civil works. The project manager shall determine the suitable of construction method during the civil works planning stage. Planning of civil works includes selection of the route, tools, materials and approval from relevant government agencies, local authorities and land owners.

5.1 Civil works construction method

In general there are three civil works construction methods which are open trench, micro trench and Horizontal Directional Drilling (HDD). Civil works construction method is generally determined by the

land owner, which can be and not limited to private parties, local authority or related agency that are responsible to the construction of land or road.
Open trench is a conventional method which may provide the lowest deployment cost. However, open trench method requires massive excavation work, expensive milling cost and may not be suitable in areas with limited road side or carriageway with high traffic. Open trench method is suitable to be deployed in low traffic road or greenfield area. Detailed requirements are specified in *MCMC MTSFB TC G025-2:2020 (Open Trench)*.

Micro trench work is considered as an alternative civil works method in providing new underground duct for telecommunication. This method may not be suitable for certain types of areas based on the ground conditions, surrounding utilities and shall always consider the aspect of safety and environmental. Detailed requirements are specified in *MCMC MTSFB TC G025-3:2020 (Micro Trench)*.

HDD is a trenchless method of installing underground duct at variable angles using a guidable drill head. The drill path may be straight or gradually curved, and the direction of the drilling head can be adjusted at any stage during the initial pilot bore to steer around obstacles or under highways, rivers or railways. The method is suitable for variety of soil conditions and duct diameters. HDD is suitable to be used in city or heavy traffic area. Detailed requirements are specified in *MCMC MTSFB TC G025-4:2020 (Horizontal Directional Drilling (HDD))*.

5.2 Works specification

There are several aspects of works specification including determining the number of duct-ways, duct size and distance of the construction. Detailed study shall be done to ensure the number of duct-way for cable laying meets the purpose with optimised costing.

The shortest route and location shall be selected where the duct can be constructed in one continuous length.

The project manager shall consider future requirements of the duct-way by determining the suitable number of ways during initial planning. This is to ensure that the civil works project is cost effective and able to cater for future expansion.

5.3 Duct routing

Route planning begins by determining the starting and the end point of the civil works. Selected route shall minimise damages to trees, landscape, carriageway or structure. Route planning should consider future expansion and development.

Protection against impact resulting from road repairing process is not possible due to the shallow depths used in micro trench technique. It is therefore essential to carefully plan the routes on which this technique is to be used in order to provide long-term stability of the routes.

6. Safety and precautions

6.1 Safety equipment

Safety equipment for the construction works shall strictly adhere to the guidelines and standards issued by the relevant authorities. All workers shall be equipped with personal protective equipment such as safety helmet, safety boot and safety vest. All safety equipment shall be in good condition.

6.2 Safety elements

The construction environment, safety requirements and safety conditions shall be as follows:

a) effective fire-fighting apparatus and material in good working condition shall be prepared at the job location;

b) power supply sockets for different voltages in the machine room should have clear identification;

c) hazardous goods such as inflammables, explosives and pigtails are forbidden in machine room;

d) reserved holes in the building plate should configure with safe cover;

e) add safety device to the project to ensure the safety of construction; and

f) put an end to safety misadventure in communication construction.

6.3 Working at the roadside

Barrier and warning signage shall be placed at appropriate location in order to provide ample response time for road users or traffics as shown in Figure 1. A flagman should be assigned to control traffic (if necessary) as shown in Figure 2.

Figure 1. Barrier and warning signage at the roadside

Figure 2. Flagman to control traffic

A base support or platform shall be placed under the feet of excavation machine as protection to prevent road from being marked with scars and blemishes when the machine is in operation. The boring liquid shall be dealt with carefully and shall not stain the road.

6.4 Handling of ducts

The handling of ducts shall be in such a manner that the ducts are not damaged by dragging it over sharp or jagged objects. The ducts shall be sealed at both ends with a cap or a plug to prevent water, drilling fluids and other foreign materials from entering the ducts as they are being pulled back.

7. Civil works process and procedure

7.1 Way leave and permit

The project manager shall be responsible to obtain the necessary way leave from the land owner or relevant authorities during the planning stage of work.

The project manager shall be responsible to obtain the necessary consents, approvals, permits from the relevant authorities in respect of the works:

a) the relevant standards and guidelines by the authorities such as *Prosedur Permohonan Syarikat Utiliti Kepada JKR* shall be complied;

b) the relevant permits shall be obtained (External Trenching Permit (ETP) from the relevant authorities and Internal Trenching Permit (ITP) from landowner or Building Management (BM)); and

c) joint inspection with the authorities may be required to be conducted upon the completion in order to obtain "*Sijil Siap Kerja*" or "*Pengesahan Siap Kerja*".

7.2 Documentation

Generally, the following are the list of documentation required by the authorities for way leave and work permit application. However, it may vary depending on the respective authorities:

a) application letter/form;

b) detailed technical proposal or drawing;

c) contractor's information;

d) Utility Detection Mapping (UDM);

e) joint site survey report (if required);

f) copy of insurance;

g) work schedule;

h) Traffic Management Plan (TMP);

i) method of statement;

j) security deposit; and

k) sites photos (before and after).

7.3 Rules and regulations

During planning and installation works, the following items shall be followed:

a) project manager shall appoint OSHE and Construction Industry Development Board (CIDB) certified civil works contractor to carry out the installation work;

b) project manager and the civil works contractor shall adhere to the agreed acceptance procedure;

c) the civil works contractor shall prepare all the documentation required for the acceptance procedure;

d) the civil works contractor shall prepare all the necessary tools and test gears and all the relevant representative of the authorities are required to be present during the acceptance procedure;

e) the acceptance procedures should be performed and completed on the same day to minimise traffic obstruction;

f) the civil works contractor shall ensure all relevant permits are obtained and in compliance with all the relevant rules and regulations; and

g) the necessary document shall be issued by project manager shall issue Certification of Acceptance (COA) upon completion of acceptance procedure.

7.4 Call Before You Dig (CBYD) registration

To minimise damages to underground utility facilities, CBYD initiative has been developed as a platform to disseminate information on any digging or trenching work.

Project manager is highly recommended to register any digging or trenching work through CBYD portal (www.cbyd.com.my).

7.5 Utility Detection Mapping (UDM)

UDM is an underground utilities mapping practice that involves managing certain risks associated with utility mapping at appropriate quality levels, utility coordination, utility condition assessment, communication of utility data to concerned parties, and utility map design.

The scanning of the proposed route is required before excavation works involving open trench and HDD are carried out to avoid unnecessary damages to other underground utilities. Excavation works shall only commence upon confirmation on the underground accessibility, otherwise the route shall be relocated.

UDM will provide the information as below:

a) detailed investigation of any available records, plans, and maps;

b) field staking of the exact location of the proposed features in possible conflict with existing utilities;

c) location of existing buried utilities or any other structures;

d) restoration of the pilot hole and marking of the location;

e) formal report and inventory, detailing all ground proofs, subsurface features, and utilities found;

f) Computer-Aided Design (CAD) drawings;

g) the following items shall be indicated in the utility mapping report;

i) X, Y and Z view direction along the trenching route.

ii) proposed trenching route including the depth;

iii) location of existing manhole and proposed manhole;

iv) proposed location of pilot holes;

v) all utilities in the ground and distance and depth between each utility; and

vi) cross section of the trenching route (Y-Z view) at three points of scanning as required.

The UDM can be done using tools such as cable locator and Ground Penetrating Radar (GPR). Figure 3 shows an example of the GPR tool. The GPR is capable to detect any utilities underground (metal or non-metal) at maximum depth of 8 m. However, all depth measurements by GPR are from the top of the utilities. Thus, appropriate calculation shall be done to determine the HDD depth.

Figure 3. Sample of GPR equipment

Figure 4 shows an example of underground cable locator. The cable locator can only detect metal-based material via direct connection or signal induction where the detection depth normally can only be detected up to 6 m. To detect Fibre Optic Cable (FOC) route, a sonde (transmitter) shall be used and pulled into a vacant duct. By using the sonde, the depth of detection can be increased up to 15 m.

Figure 4. Sample of underground cable locator

At initial planning stage, the project manager shall determine the area of scanning size and interval distance of scanning (as illustrated in Figure 5) by considering the following requirements.

a) The width of scanning is 10 m along the route from a manhole to another manhole.

b) Due to high risk area, the scanning interval for distance within 20 m from the manhole shall be between 1 m to 3 m.

c) The area beyond 20 m from manhole is categorised as low risk area. Thus, the scanning interval shall be between 7 m to 10 m. However, the scanning interval shall be scaled down to 5 m if site supervisor has evaluated the area as high risk.

Items a), b) and c) above are illustrated in Figure 5. Marking or pegging shall be done along the proposed route at the same interval of scanning.

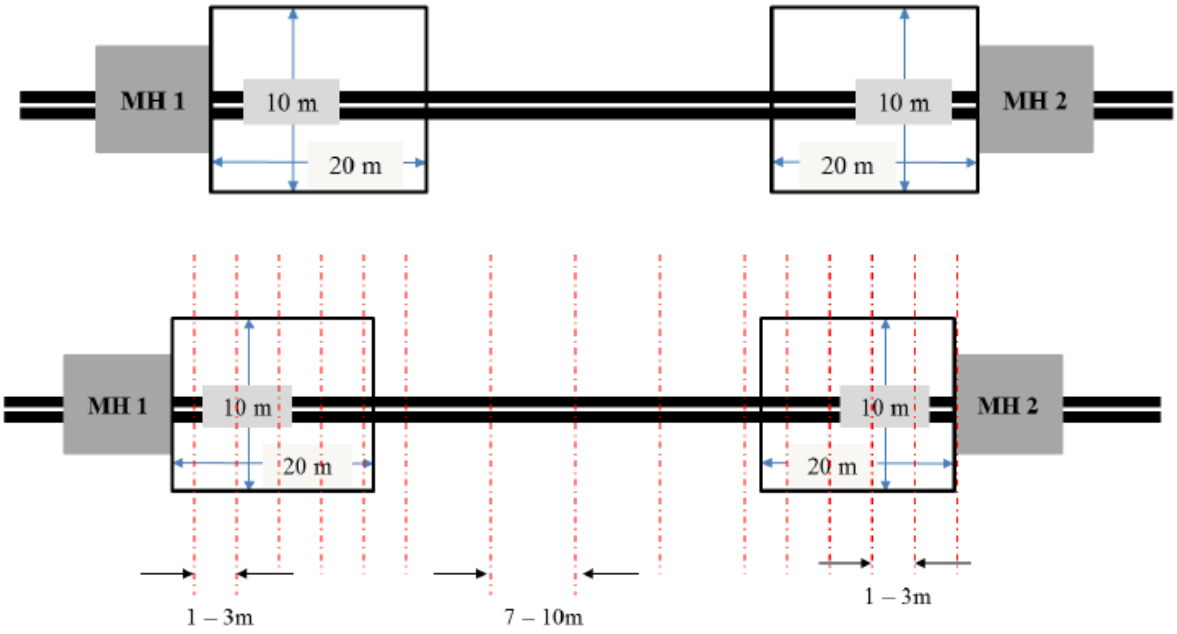

Figure 5. Scanning size and the interval distance

The scanning process for utility detection using GPR equipment is illustrated in Figure 6.

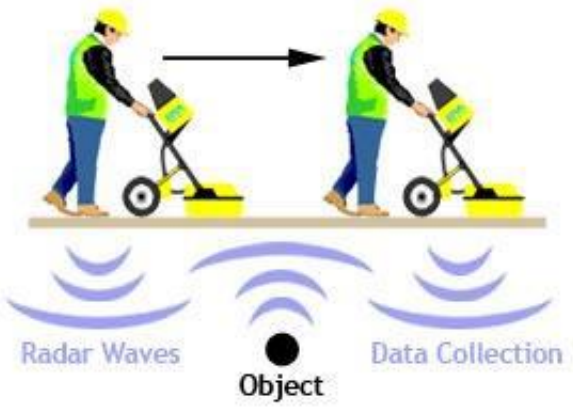

Figure 6. Scanning process for UDM using GPR

At the end of the UDM scanning process, the civil works contractor shall submit the UDM report to project manager for validation and get consent prior to the commencement of work.

The example of X-Z view of UDM is shown in Figure 7 below.

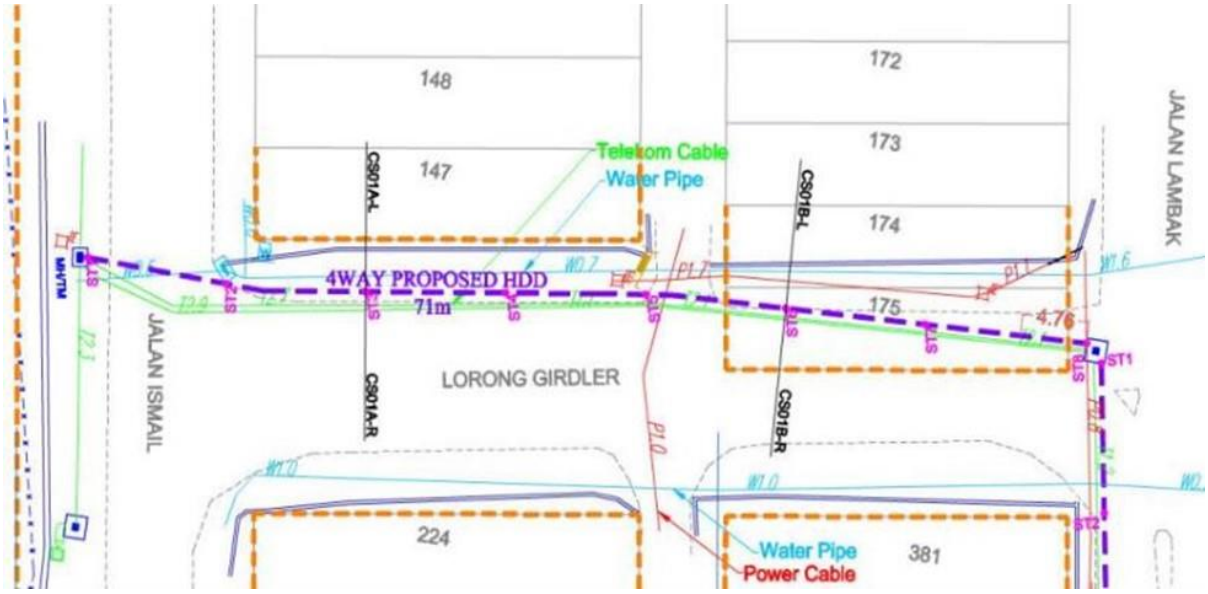

Figure 7. X-Z view of UDM

The example of X-Y view of UDM is shown in Figure 8 below.

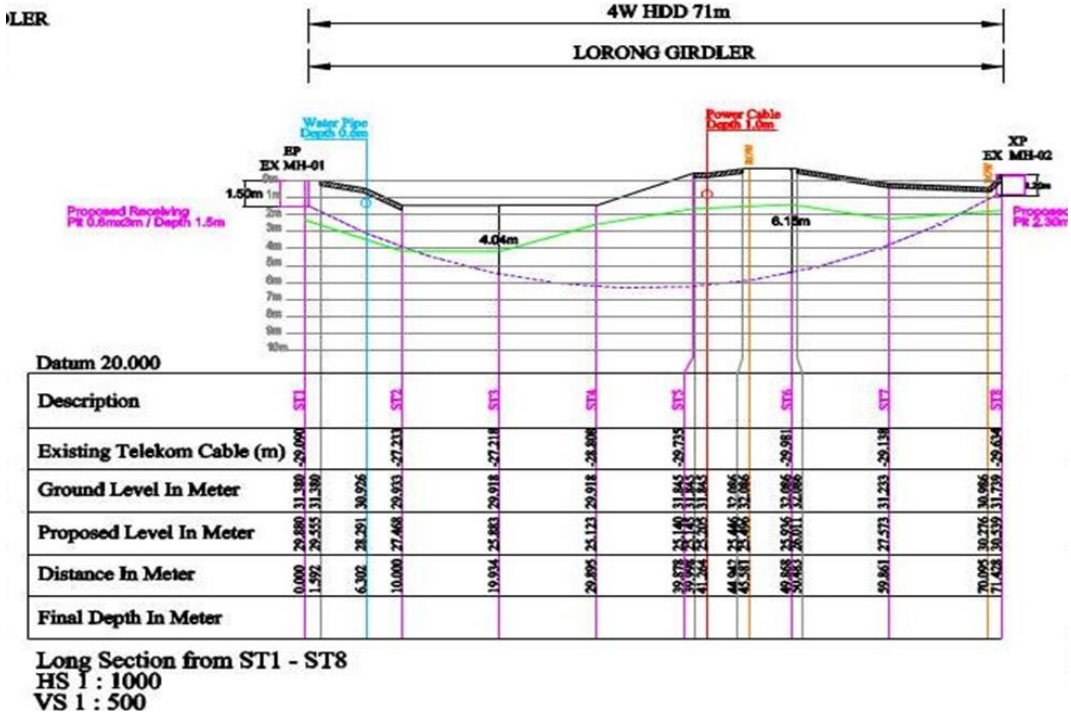

Figure 8. X-Y view of UDM

The example of Y-Z view of UDM is shown in Figure 9 below.

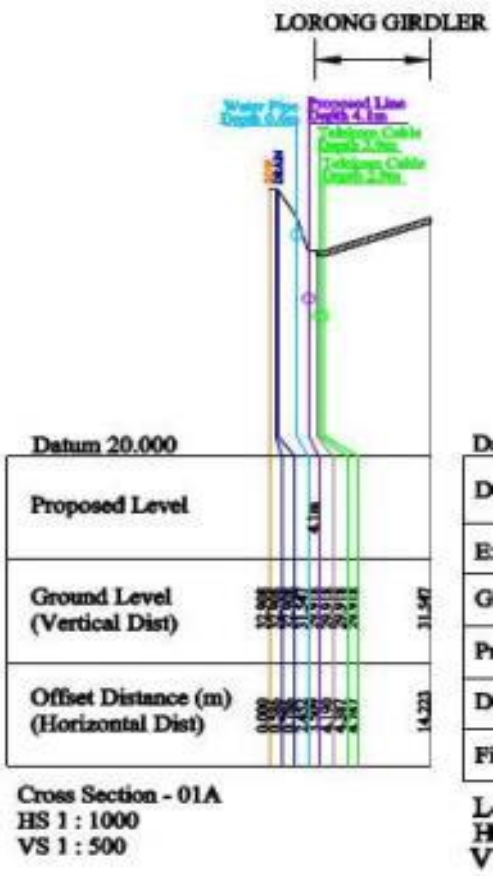

Figure 9. Y-Z view of UDM

7.6 Clearance

Project manager shall ensure duct clearance from other utilities and services as below.

7.6.1 Clearance from electricity supplies

As much clearance as is practicable shall be given to the bases of standard electric lamp, electricity supply pillars, traffic signal posts and etc. Where it is impossible to provide a clearance of more than 150 mm, a layer of concrete Quality B not less than 50 mm thick, shall be placed between the 2 sets of plant.

Where the 2 sets of plants cross each other, the standard minimum vertical clearance is 50 mm. However, a clearance down to 25 mm may be allowed in difficult cases. Wherever the clearance is 50 mm or less, the space between the 2 sets of plants shall be filled with a layer of concrete Quality B. The length of the layer of concrete shall be not less than the width of the communications plant.

For high-voltage electricity supply cables, the minimum clearance distance between the 2 sets of plant shall be as provided in Table 1.

Table 1. Minimum clearance distance for high-voltage cable between the 2 sets of plant

Set of plant (exceeding 650 V)	Minimum clearance (mm)	Description
High-voltage single-core cables	460	No exception to this requirement will be permitted
High-voltage multi-core cables	300	In difficult cases a reduced clearance will be permitted

7.6.2 Clearance from gas pipe

All ducts shall be kept at minimum 1 m clearance from any gas pipe. In case the clearance cannot be obtained due to any limitation, a minimum 50 mm Quality B concrete wall shall be built to separate gas pipe and communication infrastructure.

7.6.3 Clearance from other services

All ducts, whether asbestos-cement, Polyvinyl Chloride (PVC), iron or steel laid direct in the ground shall be kept well clear of water mains and service pipe, sewers and subways, and manholes and joint boxes belonging to other undertakers. In order to permit the use of 'tapping' machines on water mains at least 150 mm clearance shall be given wherever possible.

This clearance shall also be given, if practicable, to the other classes of plant mentioned above. In no case shall the clearance be less than 25 mm. Where, the 2 sets of plant cross each other, the minimum vertical clearance shall be 50 mm, provided the approval has been obtained from the authority concerned.

7.7 Obstructions

When any water or electric supply main, drain or other plant which has seemingly been abandoned, constitutes an obstruction to the works, all efforts shall be made to ascertain who are the owners with a view to consulting them before the obstruction is disturbed in any way.

In no circumstances shall the electric supply mains be interfered without the sanction of the owners concerned.

There are few obstructions (but not limited to) that project manager may face during the civil works process and procedure. The examples of obstructions are listed below.

7.7.1 Ducts under railway

In laying ducts under railway tracks, invariable Galvanised Iron (GI) ducts shall be used. The minimum distance between the surface of the road and the top of the body or barrel of the uppermost duct shall be a 1,070 mm. A gradual fall shall be given from the centre of each side of the track to prevent water accumulating in the duct.

7.7.2 Duct in tunnel

When ducts are to be laid in a tunnel, all spaces around and in between the ducts shall be completely filled in with concrete Quality B, unless otherwise required.

8. Traffic Management Plan (TMP)

It is important to adhere to all approved TMP, road safety rules and other safety requirements imposed by relevant authorities at all times during work implementation as specified in ATJ 2C/85, *Manual on Traffic Control Devices Temporary Signs and Work Zones Control*.

8.1 Type of road

Project manager needs to determine type of road where the work is to be executed which include:

a) federal road;

b) state road;

c) residential area road;

d) village road; and

e) highway.

A different type of road may be subject to different procedures to obtain the work permit or way leave.

8.2 Apply work permit from authorities

Project manager is required to obtain work permit from the authorities or road owners, and observe all conditions for the approved work permit.

8.3 Site arrangement as per layouts of traffic control

Project manager is required to ensure the site arrangement is done according to the following:

a) traffic control zone;

b) layout for work on the road; and

c) sign and traffic control devices.

Determine the specific traffic control zone before site arrangement of the sign and traffic control devices can be positioned correctly on the road. Traffic control zone is a distance between the first advance warning sign and the point beyond the work area where traffic is no longer affected. Traffic control zones can be divided into 3 specific parts as follows:

a) advance warning area

The first temporary signboard. The length should be:

i) 2 km to 1 km for expressways;

ii) 500 m for most rural roadways or open highways conditions; and

iii) at least 100 m for urban roadways.

b) transition area

It contains the tapers which are used to close lanes. Length of taper separation is consistent with the speed limit and lane width of existing roads. Table 2 shows the taper lengths, the recommended number and spacing of channelising devices; and

c) Buffer space

It is an open or unoccupied space between the transition and work areas. It also provides protection for traffic and workers.

Table 2. Taper specification

Speed limit (km/h)	Taper length			Number of channelizing	Spacing (m)
	Lane width (m)				
	3	3.5	3.75		
30	17	20	22	5	6
40	30	35	40	6	7
50	50	55	60	7	9
55	60	70	75	8	10
65	80	95	100	9	12
70	130	155	165	13	13
80	150	175	190	13	15
90	170	195	210	13	16

Work area is that portion of the roadway which contains the work activity and is closed to traffic and set aside for exclusive use by workers, equipment, and construction materials. Termination area provides a short distance for traffic to clear the work area and to return to the normal traffic lanes.

Traffic control devices shall be placed as follows:

a) temporary signs shall be placed in positions where they will express their messages most effectively and placement shall therefore be accommodated to road design and alignment;

b) temporary signs shall be mounted on portable supports that are suitable for temporary conditions;

c) retro-reflective sheeting of minimum engineering grade shall be used on all temporary sign; and

d) temporary traffic control devices shall conform to the related authority requirement.

9. Manhole

Manhole(s) on the road side shall be provided so that the Network Facilities Provider (NFP) can connect their underground manholes and ducts. For new development area, manhole together with the underground ducting shall be provided by property developer.

Property developer is strongly advised to consult with NFP on the appropriate selection of the location and size of manhole to be allocated. For public or common area, the manhole normally builds by NFP, local authority or land owner. The typical manhole design and its specifications is shown in Figure 10.

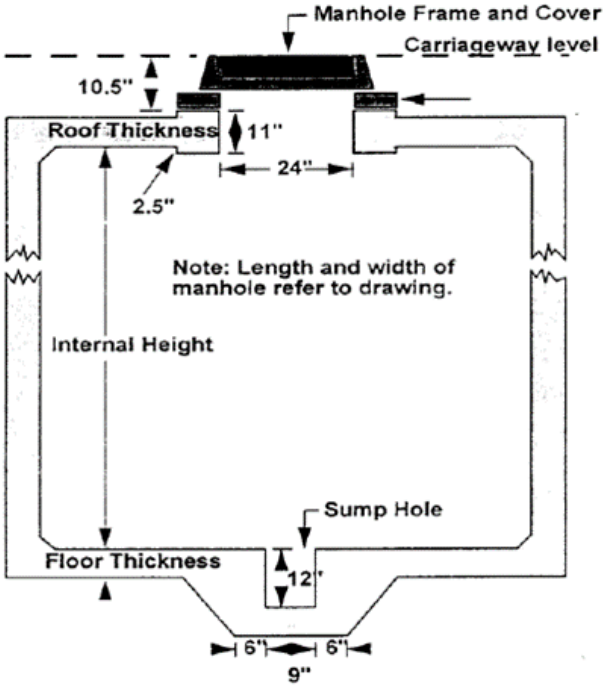

Figure 10. Typical manhole design and specifications

9.1 Size of manholes

The standard types and sizes of manholes, but not limited to, with the code reference are shown in Table 3. The types and sizes of manhole may be used for reference only. The actual deployment can be different based on the application.

Table 3. Manhole size

Manhole type code	Internal dimension (L x W x H) (mm)	Number of 100 mm duct ways	PVC socket 100 mm	Loading weight (t)
R1B	1 980 x 1 370 x 1 830	6	12	22.5
R2A	3 280 x 1 500 x 1 830	12	24	22.5
R2A(M)	3 740 x 1 640 x 2 000	16	32	22.5
JC9C	1 960 x 1 260 x 1 020	4	16	22.5
JC9	1 810 x 890 x 1 150	4	8	22.5
JRC7	1 160 x 855 x 850	2	4	22.5
JB30	850 x 850 x 650	2	4	22.5
Handhole	300 x 300 x 300	2	4	5.0
NOTE: Other sizes deployment may defer and subjected to approval from qualified Professional Engineer.				

9.2 Manhole planning

Planning shall be done carefully to ensure the layout plan or manhole route meets the objectives and to avoid any changes during installation work. The planning shall include the following items:

a) Determine the location of the manhole to be installed

The preferable location shall be in grass verge to avoid any activities such as maintenance and operation conducted in dangerous area.

b) Determine the type of manhole to be used.

The selection of manhole shall be based on the following criteria:

i) the requirement of duct capacity which is depends on the number of potential subscribers and future demand growth; and

ii) the manhole location to be installed.

Manhole size is bound by the capacity of duct and cable that require to be installed in particular area. A correct size shall be chosen to ensure is can sustained for long term. Manhole location shall follow as per local authority approval. For easy access to the manhole, it is recommended to install manhole at road verge and installation of manhole at intersection or heavy traffic road shall be avoided. The recommended manhole span is between 50 m to 250 m depending on the location and suitability.

9.3 Type of manhole

Manhole can be installed either by deploying pre-fabricated manhole from factory or constructing the manhole manually at site (in-situ). The pre-fabricated type of manhole is recommended due to firm quality, size and strength because all of the pre-fabricated manhole are properly tested and certified. Currently, there are two types of pre-fabricated manhole as listed below:

a) concrete; and

b) non-concrete type.

9.3.1 Pre-fabricated concrete manhole

Precast manhole is the manhole type that is constructed in factory and delivered to the site during installation work. Precast manhole is the most common type being used due to consistence and controlled quality.

9.3.2 Pre-fabricated non-concrete manhole

Non-concrete manhole is a light weight manhole made from non-concrete material such as High-Density Polyethylene (HDPE), fibreglass, PVC etc. Non-concrete manhole shall only be used at pedestrian area as an alternative due to less loading specification compared to concrete type manhole.

9.3.3 In-situ manhole

In-situ manhole is the manhole that is constructed at site and mainly is due to limitation of accessibility to the location such as remote area, hilly, island etc. In-situ manhole shall be constructed with Quality A concrete.

9.4 In-situ manhole construction

9.4.1 Waterproof construction

All jointing chambers shall be of waterproof construction, whether built of brick or reinforced concrete.

9.4.2 Clearance around conduits

Conduits shall enter manholes at such a depth to ensure a clearance of at least 460 mm between the top of the barrel of the uppermost conduits and the underside of the roof of the manhole. Except where a duct seal is provided, a clearance of 203 mm is required and/or clearance of 152 mm depending on type of manhole, shall be given between the outside of the barrel of the conduits and the adjacent wall. While, a minimum clearance of 460 mm between the underside of the barrel of the lowest conduit and the floor shall be given.

9.4.3 Space for duct growth

Where the duct capacity of any proposed manhole is not fully utilised, the space shall be fitted with dummy ducts for future duct growth by laying in initially at standard depth. The dummy ducts shall be sealed with cement mortar inside the chamber wall.

9.4.4 Duct terminations

To ensure that cables can easily be housed in manholes with a minimum of bending, the conduits should be splayed over the last length to enter the manhole equally on either side.

9.4.5 Excavation work

The ground shall first be excavated to the required dimensions and the sides of the excavation being supported by poling boards or by other means if there is any likelihood of the earth falling-in. The foundations shall then be levelled and rammed. Soft places shall be dug out, filled-in with hardcore, and consolidated.

The excavation procedures are as follows:

a) Excavate the pit hole for manhole to the required depth. Continue digging until the whole pit is complete. Figure 11 illustrates the excavation for the JB30 where Table 4 shows the example of the depth calculation.

b) Measure and recheck the depth of the pit hole.

c) Level and clear the base of the excavated pit hole. Make sure no rocks are found which may cause obstructions during instruction works.

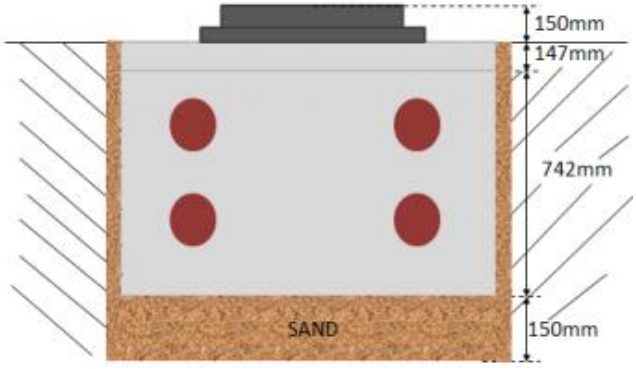

Figure 11. Manhole construction

Table 4. Example of calculation

Description	Excavation depth (mm)
Body height	742
Slab height	147
Manhole cover height	150
Thickness of sand handling	150
Total depth of pit hole	1,189

9.4.6 Templates

Two light wooden templates, slotted (not drilled) to receive the reinforcing bars, shall now be set up. The lower template shall be fitted about 305 mm above the foundation and shall be supported on 4 small pegs at its corners. The upper template shall be fixed to correspond with the lower template, but about 305 mm below the position at which the roof of the manhole is placed.

9.4.7 Erection of floor

Shuttering for the sump hole shall now be set up and concrete laid over the foundation to the thickness of 38 mm. The mixing and placing of the concrete shall be done in accordance with Clause 10 of this Technical Code.

The end of side-wall-to-floor corner reinforcement shall now be placed so that horizontal portions are just covered by the concrete. The vertical portions shall pass through the slots in the template and be set as to obtain 19 mm cover from the outside faces of the walls when these are erected. Additional concrete shall next be laid until the level is 19 mm less than the concrete level for the floor. This shall be done as soon as possible after placing the first layer of concrete, so that the two layers unite thoroughly. Anchor irons shall now be set in the floor in accordance with the relative drawings.

The interior wall-reinforcement shall now be placed with the horizontal portions flush with the surface of the concrete in the floor and the vertical portions passing through the slots of both templates so as to obtain 19 mm cover from the interior face of the walls when these are erected. The remaining 19 mm layer of concrete is then laid to reach the specified floor level.

9.4.8 Erection of walls

When the floor has been left for at least 12 h, the erection of the walls shall be commenced. The portion of the floor on which the walls will be erected shall be cleaned and rendered with a 7 mm thickness of neat cement, well trowel and placed in position, just before wall concreting is commenced. The wall shall, as far as possible be erected continuously to their full height, but if during erection a break of 2 h or more is unavoidable, the existing work shall be cleaned and rendered as previously described before proceeding.

The horizontal bars and side-to-end-wall corner reinforcement shall be placed as walls are built up. It is unnecessary to wire-up this reinforcement, since there is no tendency for these bars to move once placed. The templates shall be removed when the work reaches such a stage that they impede the placing of the concrete.

9.4.9 Erecting of roof

When the walls have been built to the requisite height, shuttering for the roof shall be set up, the boards being arranged to form a recess at the position of the roof beams. A 26 mm thickness of concrete shall then be laid throughout the roof area, including the recess of the beams. The beam reinforcement which

have been previously assembled by threading and the wiring the stirrups to the bars, may now be laid at one movement, the main reinforcing bars being set to obtain 26 mm cover. The remainder of the roof reinforcement shall be laid and, to give the correct cover of 19 mm, the rods shall be just visible above the surface of the concrete.

The alternate bent bars may be conveniently supported by a single-wired fixing at the point where they enter the beam reinforcement. The concrete in the roof-to-wall corner reinforcement embedded. The correct cover of 19 mm to the roof can be checked by a wood spike and, when correct at each end of the horizontal part of the rod, will ensure that the vertical portion has the correct cover throughout its length. The upper face of the beams shall be spade-finished, and the roof given a slight slope to the sides to avoid accumulation of water on the roof.

9.4.10 Striking of shuttering

Finally, after the lapse of time the shuttering shall be struck and the floor given a 19 mm rendering of cement mortar, with a fall to the sump hole on all sides, and the manhole frame fitted in.

9.4.11 Arrangement of reinforcement

The arrangements of reinforcement for each type of manhole shall necessarily be done in accordance to best practice and normal specifications.

9.4.12 Concrete curing times for jointing chambers

The minimum periods after completion of concreting for which shuttering shall remain in position which shall elapse before reinstatement of the paving of surfaces may be commenced, and which shall elapse before traffic is allowed to pass is given in the Table 5.

When the shuttering is removed the concrete should present a reasonable smooth surface. Any projection shall be removed and exposed cavities filled-in with cement mortar.

Table 5. Manholes built in the carriageway or footway

Type of cement used	Minimum period from completion of concreting		
	(a) to remove of shuttering	(b) before commencing reinstatement	(c) before allowing passage of traffic
Portland cement or its equivalent	5 days 5 days	7 days 5 days	7 days 7 days
Rapid-hardening cement	2 days 2 days	3 days 2 days	3 days 3 days
High alumina cement	10 h 10 h	24 h 24 h	24 h 24 h

High alumina cement generates heat, therefore, the striking of the shuttering shall be commenced before the expiration of 12 h and the concrete prevented from becoming dry at any time within 24 h of mixing, by watering it.

9.4.13 Jointing chamber fittings

The following fittings supplied shall be hot-dip galvanised:

a) Grating for sump holes shall be fitted to the sump holes of all manholes.

b) Anchor iron shall be fitted accordingly.

c) Steps manhole shall be installed in the position shown in the relative drawings for the manholes. The steps shall also be used in entrance shafts for all manholes.

d) Steel ladders shall be used in all types of manholes. The ladders shall be fixed to suit the different heights of the manholes.

e) Bolts for the attachment of cable bearers. In all type of manhole, the bolts required for the walls shall be fixed temporarily in the shuttering during the construction of the manhole, to ensure that they will remain in their correct position while the concrete is setting. The positions for holes in the shuttering shall be obtained by using the cable bearer as a template.

f) Cable bearers wall type. The bearers shall be fixed to the walls as described in e).

g) Cable bearers (brackets) shall have the initial provision of 2 per cable bearer, e.g. in a R2A type manhole, where the cable bearers are fitted 3 to a wall making a total of 6 cable bearers, the number of brackets provided shall be 12.

h) Pins for locking cable bearer are designed to facilitate the removal of brackets.

9.4.14 Fitting of manhole cover

Manhole cover shall be made from Quality A concrete. The following procedure shall be followed:

a) Where the manhole is to be set at the minimum depth one course of brickwork shall be laid between the manhole roof and frame.

b) Where due to anticipated alterations in level, the manhole is to be set at an increased depth; one or more additional course of brickwork shall be laid. This particularly important in the case of manholes built in the footway where there is possibility of the frames and covers being installed to carriageway level at a later date. Cement mortar shall be used both for setting the brickwork and foe bedding the manhole frame.

c) 24 h shall elapse after the building of a jointing chamber before the frame and cover are installed. The water used in the concrete shall not exceed 643 l/m^3.

d) The frame shall be positioned accurately in relation to the cover before being filled so that the cover is flush and level with the surrounding carriageway. 2 methods of filling and setting may be employed:

   i) In-situ filling - The frame shall be embedded on a layer of stiff cement mortar; care being taken to ensure that the frame is fully supported along all four sides. The level of the frame shall be adjusted to the level of the surrounding road surface by pieces of mild-steel packing approximately 152 mm x 51 mm and of appropriate thickness. The cover shall then be placed in the frame.

   ii) When the cover is correctly suited, the edges of the frame and the cover shall be at the same level, if any irregularity can be felt, by running the finger along the joint, or if the cover rocks, the frame shall be packed up until the edges are at the same level and the cover is free from rock. The cover and the frame shall then be filled with concrete Quality A or an asphalt and granite mixture.

   iii) Great care shall be taken when filling the frame to ensure that no voids are left; the concrete in each pocket shall be thoroughly tamped with the reinforcing rod. Finishing shall be done with a trowel, the concrete in the cover compartments being left slightly proud but not more

than 3.2 mm at the edge to 6.4 mm crown in the centre of the cover to allow for shrinkage, wear and to protect the metal weds.

e) Where in-situ filling is not possible, the frame shall be placed on a level surface with a piece of building paper beneath it to prevent concrete adhering to the floor. The levelling of the frame and cover, and the concrete filling shall then be done as described in method d) i). The frames and covers shall be left undisturbed for a minimum of 3 days. When the frame is installed, it shall be bedded on stiff 1:3 cement mortar.

9.4.15 Concrete curing times for manhole covers

The minimum period which shall elapse according to below items:

a) before disturbing the frame or cover where in-situ filling is not employed;

b) before removing the cover or covers from the frame after the complete installation including cement mortar bedding; and

c) before allowing the passage of traffic after the complete installation including cement mortar bedding (refer Table 6).

Table 6. Concrete curing time for manhole covers

Type of concrete	Before disturbing when in-situ filling is not used (days)	Before removing cover from frame (days)	Before allowing the passage of traffic (days)
Ordinary cement	5	3	7
Rapid hardening cement	3	2	3
High alumina cement	10 h	10 h	1

9.5 Construction of joint boxes

9.5.1 Excavation

The ground shall first be excavated to the required dimensions, the sides of the excavation being timbered if necessary. The foundations shall then be levelled and rammed.

9.5.2 Floor

Concrete of Quality A for the floor shall next be laid level to the required thickness. Irons anchor reinforcing bars shall be inserted where specified on the relative drawings. The fall of 25 mm shown in the drawings for the floor, can be achieved by rendering with cement mortar with a smooth finish.

9.5.3 Walls

Brickwork for the walls shall be laid in cement mortar, and flush pointed. The bricks shall be dipped in water before they are laid. Brackets for joint box shall be fitted as the walls are erected.

9.5.4 Roof

Roof shuttering shall be set up and concrete of Quality A for the roof shall be laid to a depth of 25 mm and reinforcement set to give the correct cover. Additional concrete shall then be placed to the specified thickness for the roof.

9.5.5 Striking of shuttering

Shuttering shall be struck as follows:

a) for carriageway joint boxes, after the lapse of time;

b) for footway joint boxes, after 24 h, irrespective of the type of cement used; and

c) 20 mm cement mortar rendering shall be applied to level the floors or they shall be built up to give the 25 mm drainage fall where required.

9.5.6 Protection of cables and associated equipment

Measures shall be taken to protect cables and associated equipment during the cutting of duct entries into existing structures or the demolition and rebuilding of jointing chambers. Such measures may include any or all of the following:

a) A ladder shall be provided for access in and out of manhole excavations. Under no circumstances may cables, joints and associated equipment be used for climbing, standing or sitting on.

b) Sufficient pumping capacity shall be made available and operated to ensure that when cables are removed from their bearers they shall not be immersed in water at any time.

c) All cables shall be protected at duct entries by packing with foam rubber to act as a cushion when any movement occurs.

d) During demolition of the roof of a manhole a deck of timber between the cables and the roof of the manhole shall be erected to protect the fixed network communications outside plant from falling debris in the following manner:

   i) A minimum of three 229 mm x 76 mm timber upright shall be evenly spaced against each long wall of the manhole with the 229 mm side against the wall. The length of the upright shall be such that they terminate approximately midway between the uppermost cables and the roof. Further length of 229 mm x 76 mm timber shall be placed horizontally on top of the uprights and secured, and between the uprights at the bottom, all positions to be wedged and blocked to the satisfaction of the authorised officer. Lengths of poling boards or other similar timber shall then be placed on top of the horizontal supports.

   ii) When the manhole roof and walls have been demolished down to the level of the timber decking and all debris and decking removed, the cables and other associated equipment shall be suspended from beams on the surface of the ground to the satisfaction of the authorised officer.

   iii) Cables and joints and other equipment shall be protected by wrapping (not tying) with several layers of sacking while timber decking is being erected or dismantled.

e) During rebuilding operations, cables shall be supported on wooden benches with cushions of sacking or similar material once the floor has been laid and the concrete allowed to set.

9.6 Plinth for cabinet

9.6.1 Site

The plinth shall be constructed on a suitable site where it shall not:

a) be an obstruction to pedestrians;

b) be damaged by vehicles; and

c) spoil the appearance of the surroundings.

9.6.2 Construction

The foundation of the plinth is dig to the standard dimensions and the 152 mm PVC with 762 mm radius bend is located. 762 mm radius bends are necessary to obtain variat/ons in depths of cover and to accommodate the number of tail cables associated with the cabinet to be installed. The top of the bend may be shortened where necessary.

The concrete shall be Quality A mix. Normally, Portland cement is used, but if it is necessary to accelerate the hardening of concrete, rapid-hardening cement may be used.

9.6.3 Template

A simple 3.2 mm thickness aluminium or any other metal template made locally shall be used to ensure correct setting of the bend and bolts in the concrete foundation. Place a 254 mm diameter gasket with 165 mm diameter centre hole and appropriate bolt holes over the concrete footings.

9.6.4 Bonding at jointing chambers for earthling facilities

Where metal pipes are laid and terminated at jointing chambers the break in continuity shall be made good by embedding 51 mm x 3.2 mm GI strips of required lengths in the walls of the jointing chamber during construction, and welding the ends to the pipes.

9.7 Lead-in duct to manhole

Before lead-in duct to manhole to be done, the duct shall be adjusted to a position in such a way it should be correctly fitted into the manhole. The duct shall be gradually positioned by increasing or decreasing the duct way level within a distance of 1 m to 2 m. As such no sharp bending took a form during the work. The lead-in duct to manhole is illustrated in Figure 12.

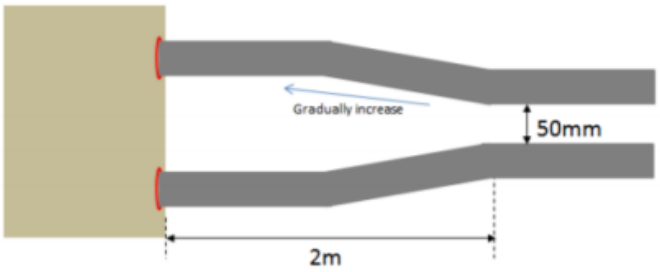

Figure 12. Lead-in duct to manhole

9.8 Fitting the manhole cover

The procedure to fit the manhole cover onto a manhole are as follows:

a) After the completion of manhole installation, the manhole cover shall be lifted by using a crane and put onto the manhole.

b) To ensure that the cover has being put properly and evenly horizontal. Measure the horizontal level of the manhole using appropriate tool.

Failure to put the manhole cover evenly horizontal will jeopardized the overall strength of the manhole structure.

The manhole cover shall be at the same level of the ground surface as shown in Figure 13.

Figure 13. Ground and manhole cover at the same level

9.9 Backfilling around manhole

The spaces outside the walls of manhole and surrounding area dug up shall be completely filled with sand free from stones and rammed (as Figure 14). Precautions shall be taken during ramming that not disturbs any work which already completed.

Figure 14. Manhole backfilling

9.10 Raise-up

Raise-up of the manhole's neck shall be done when the ground level around the chamber was lifted by local authorities or other third parties. The raise-up is done through English bond bricks arrangement as in Figure 15 and the thickness is 9 inches. Inside of the raise-up shall be plastered with Portland cement.

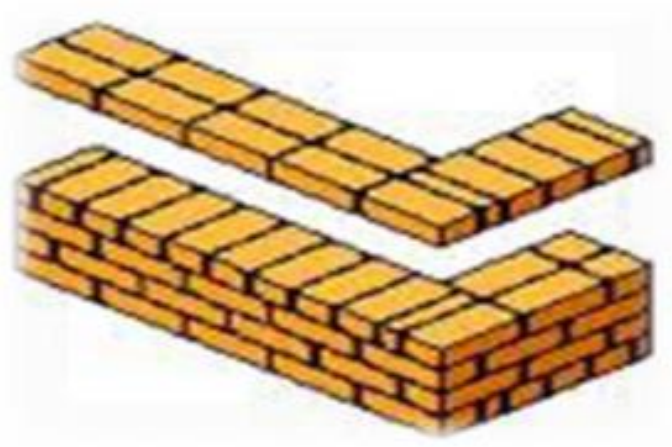

Figure 15. English bond bricks arrangement

10. Duct

10.1 Duct category

Duct is divided into three categories as shown in Figure 16:

a) main duct;
b) subduct; and
c) microduct.

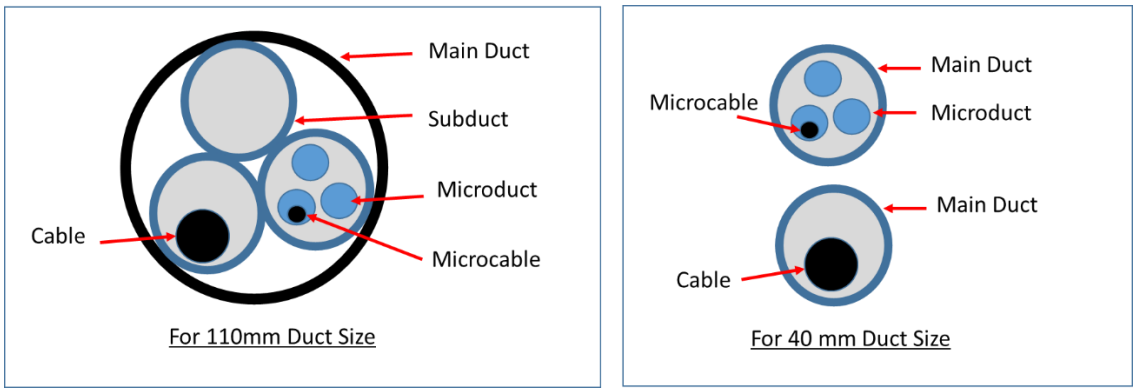

Figure 16. Duct category

10.1.1 Main duct

For open trench method, normally PVC duct or GI Pipe with diameter around 110 mm size is commonly used. However, other type of duct such as GI Pipe or HDPE may also be used for certain cases.
For HDD method, only HDPE type is allowed due to flexibility, high pulling strength and tensile requirement. The duct size should be 110 mm or 40 mm depend on the application. Other type such as PVC duct or GI pipe is not recommended.

10.1.2 Subduct

To maximize the duct space, subduct is used to lay multiple cables inside the main duct. Number of subducts is normally between 3 and 5 depending on subduct size and usage cable size. The sample of subduct arrangement inside the duct is shown in Figure 17.

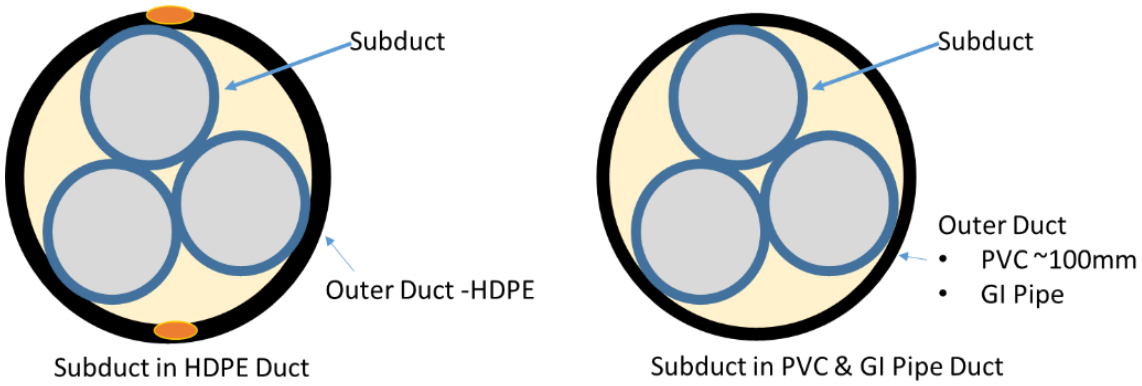

Figure 17. Subduct

With 40 mm subduct size, 3 subducts can be installed in one 110 m duct. For 32 mm subduct size, maximum 5 subducts can be installed in one 110 m duct. Size of subduct shall be planned with maximum of 70 % cable filled ratio. There are 2 types of subduct (refer Figure 18) as follows:

a) smooth wall type normally is use as cable conduit when blowing technique is employed during cable installation; and

b) corrugated type is meant for standard pulling method.

The application may vary according to type of duct.

Figure 18. Subduct type

10.1.3 Microduct

Microduct can be installed in sub-duct or directly in main duct. Number of duct way also depends on the application and capacity of cable. It is use normally for cable blowing method for microcable type installation. Size of microduct will depend on duct and cable size. Microduct can be installed individually or in a bundle.

The types of microduct are shown in Figure 19.

Figure 19 Single and bundle microduct

10.2 Duct specifications

The common specifications for the HDPE duct is shown in Table 7.

Table 7. Duct specifications

Specifications	Description
Material Type	HDPE, PVC, GI
Diameter	32 mm, 40 mm or 110 mm
Duct Colour	Black
Stripe Colour (if any - optional)	Yellow
Stripe Width	a) 32 mm and 40 mm duct: 4 mm - 6 mm b) 110 mm duct: 5 mm - 8 mm
Outer Marking Colour	Yellow
Outer Marking Size	Font size 20 pt

10.2.1 High-density Polyethylene (HDPE) duct

HDPE material is a polyethylene thermoplastic made from petroleum, and its high level of permeability and strong molecular bond makes it suitable for high pressure pipelines. HDPE is normally used for construction via HDD method. However, the same material also can be used for open trench application especially for area that require extra protection such as on the road, drain or bridge crossing section.

The minimum grade of HDPE for communication application shall equivalent or greater than SDR13.5 grade. The diameter size can be 32 mm, 40 mm or 110 mm. The sample of HDPE duct is as shown in Figure 20.

Figure 20. HDPE duct for communications

The HDPE pipe shall be used without any significant dimensional or surface deformities and shall be free from visible crack, holes or defects.

10.2.2 High-density Polyethylene (HDPE) smooth duct

Smooth duct type normally used for blowing application. It provides the less friction between duct surface and cable during cable installation. The smooth duct is made from HDPE and the outer diameter is 40 mm. Other specification shall meet as explained in 9.2.1. Sample of HDPE Smooth duct is shown in Figure 21.

Figure 21. HDPE Smooth duct

10.2.3 PVC type

PVC type duct is recommended for open cut method. Except for the area or condition that require stronger material such as GI pipe etc. PVC duct is suitable when conventional cable pulling is adopted during cable installation. The diameter size of PVC conduit is nominal 107 mm with 6 m length for every piece.

10.2.4 GI pipe type

For area that require extra protection such as road, drain or bridge crossing section, GI pipe shall be used as cable conduit. Diameter size of GI pipe is minimum 50 mm and the grade shall follow according to BS EN 10255. The application and GI grade should follow as below:

a) Road crossing - minimum Grade A for non-heavy traffic and Grade B for heavy traffic road.

b) Pole riser - minimum Grade A.

c) Connection to customer premise - minimum Grade A.

10.2.5 Draw rope

The draw rope shall be installed in every of the new duct or subduct way. Figure 22 shows the real image of draw rope inside the duct. The draw rope will be used to pull the subduct.

Figure 22. Draw rope inside duct

11. Quality of material

11.1 Specification

All materials not otherwise specified to be used for the civil works construction are to be in accordance with the specifications of the Malaysian Standards or its equivalent, in so far as those specifications apply.

11.2 Concrete

The concrete used for encasing conduits shall be at least Quality C. In no circumstances shall the water content be increased appreciably as this will result in a weak concrete; rapid hardening cement shall be used. Table 8 shows the quality, mixture of concrete and the usage.

Table 8. Concrete ratio mixer

Concrete	Parts by measure			Usage
	Cement	Sand	Aggregate	
Quality A	1	2	4	All jointing chambers, filling in covers manhole, plinth, concrete trough.
Quality B	1	3	6	For supporting, protecting or filling in purposes.
Quality C	1	4	3	Encasement of conduits. The maximum size of the aggregate shall be 6 mm.
Cement mortar	1	3	0	Plastering, sealing dummy ducts in jointing chamber, repairing damage or split ducts.

11.3 Concrete for encasing conduits

The concrete used for encasing conduits shall be relatively dry having the consistency of wet sand. In no circumstances shall the water content be increased as this will result in a weak concrete. Rapid-hardening cement shall be used.

11.4 Quality

The jointing chambers and concrete troughs shall be constructed using Quality A concrete. Where a coarse concrete is required for supporting or protecting or for filling-in purposes, Quality B concrete shall be used, unless otherwise specified.

11.5 Mixing

Concrete mixing may be done manually or by machine. Ready mixed shall be the first preference for concreting manholes if available within reasonable distance from work site. When mixed manually the ingredients shall be sand, cement and aggregate repeatedly turned over and mixed in a dry state on mixing boards, after which water from the rose of a watering can shall be added, and the materials shall then again be turned over sufficiently to ensure thorough mixing.

The mixing boards shall be sufficiently large to give ample room for turning over the ingredients entirely from one place to another and shall be so arranged or constructed that liquid cement shall not escape through the joints.

When mixed by machine the ingredients shall be put into the machine dry without prior mixing. The water shall be poured in first. Such machines shall, however, be used only so long as they ensure thorough mixing and are maintained in clean condition.

11.6 Compaction of concrete

The concrete shall be deposited carefully in its intended position as quickly as possible after being mixed, and all concrete footings and foundations shall be tamped and carefully levelled. All concrete shall be compacted by the use of a poker type vibrator until a dense solid mass without voids is obtained. Under no circumstances shall have vibrator be used longer than is necessary to obtain compaction nor left unattended in the concrete, otherwise segregation of the mixture will occur.

11.7 Rejection

Concrete which has become hard, dry, dirty or not placed within 30 min after being mixed shall not be used, and if any earth falls on top of any concrete after laying and before the work is completed it shall be carefully removed.

11.8 Cleanliness

Cleanliness shall be observed in all operations and in relation to all materials.

11.9 Protection

All cement shall be ensured to be protected adequately against moisture while being transported and stored.

11.10 Cement aids

The use of cement aids where an additive is added to ordinary Portland cement to render it rapid-hardening is not recommended and permission for its use shall first be obtained from the authorised officer who shall also determine the amount of additive to be used.

11.11 Water

The standard of cleanliness of water for mixing is that it shall not be contaminated with impurities. The quantity used shall be sufficient, but not more than sufficient, to affect the proper hydration of cement to obtain a plastic mixture. The authorised officer may reject concrete which is, in his opinion, so over watered that it would be deficient in ultimate strength.

11.12 Crusher run

Crusher run stone is crushed rock, limestone or granite with maximum size of 62 mm. Contractor shall obtain project manager's approval before using the crusher run as construction material.

11.13 Sand

All sand shall be clean, sharp, gritty, river sand, free from loam or other impurities and from an approved source. If upon test by washing a sample, the sand is found to contain more than 5 percent by volume of silt, the sand shall not be used. This sand used shall be coarse, the grains graded is size to 5 mm.

Sand for concrete mixture shall be hard, clean, well graded natural sand free from harmful quantities of clay and silt, saline and vegetable impurities, and other deleterious matter.

When river sand is not available, mining sand may be used for concreting provided it is washed with fresh water (clean and free from organic or inorganic matter in solution or in suspension) at least twice. The bed of sand for each washing shall be not more than 60 cm deep in the container.

However, where river and mining sand are not available shore sand may be used for concreting provided it is washed with fresh water (clean and free from organic or inorganic matter in solution or in suspension) at least twice. The bed of sand for each washing shall be not more than 60 cm deep in the container.

Mining and shore sand may be used for backfilling of duct trenches. It shall be hard, clean, well graded natural sand free from harmful quantities of clay and silt and vegetable impurities and other deleterious matter.

All sand except sand for cement mortar shall be within the following grading limits (refer Table 9).

Table 9. General sand grade limit

Sieve test (mm)	Passing (%)
10	100
5	95 - 100
2.36	70 - 95
1.18	45 - 95
0.6	25 - 60
0.3	5 - 30
0.15	0 - 10

Sand for cement mortar shall be within the following grading limits (refer Table 10).

Table 10. Sand grade limit for cement mortar

Sieve test (mm)	Passing (%)	
	Sand for general purpose mortars	Sand for reinforced work mortars
4.75	100	100
2.36	90 - 100	90 - 100
1.18	70 - 100	70 - 100
0.6	40 - 100	40 - 80
0.3	5 - 70	5 - 40
0.15	0 - 15	0 - 10

Sand shall be stored at the site in such a manner that it is not contaminated by coarse aggregate, earth or other foreign matter.

11.14 Aggregate

The aggregate for concrete mixture shall be sound, hard, clean, roughly cubical-shaped particles free from harmful quantities of clay, crusher dust, organic impurities or other deleterious matter. Aggregate containing an excessive proportion of flaky materials shall not be used. Brick clinker or other porous stone shall not be used.

11.14.1 Size of aggregate

For concrete mixture of Quality A, B and C, the grading of aggregate shall be within the following limits (refer Table 11):

Table 11. Aggregate size

Sieve test (mm)	Passing (%)
20	100
10	22 - 55
5	≤ 10

For encasement of conduits, the maximum size of aggregate shall be 6 mm.

11.15 Bricks

The bricks used shall be best quality hard burned common bricks, either wire cut or plastic pressed, or selected hard hand-made stock bricks or other hard or over-burned hand-made bricks of comparable quality. They shall be of good shape, free from visible particles or lime and from serious cracks, and shall not absorb more than 12 % of their weight when immersed in water for 24 hours (5 bricks from each batch delivered on site shall be tested and all shall be required to pass the test). The dimensions of bricks described as types 2 and 3 in BS 657 or the Malaysian Standard equivalent shall be regarded as standard.

11.16 Cement

All cement used shall be of the best Malaysian or other approved manufacture and shall comply with all the requirements of BS EN 197-1 or the Malaysian Standard equivalent. The cement shall be fresh, fine, smooth, loose and warm tested by hand, and the site supervisor may order that any bag of cement, a portion of the contents of which has hardened, or found unsatisfactory by the hand sampling test be removed from the site forthwith.

11.17 High alumina cement

Before work with high alumina cement is commenced, all tools and plant shall be cleaned of all other types of cement residue and at no stage of the work shall any other type of cement be mixed or allowed to come into contact with high alumina cement, High Alumina Cement shall not be used with PVC duct.

11.18 Cement mortar

The cement mortar shall consist of:

a) 1 measure of cement; and

b) 3 measure of sand.

The materials after being gauged shall be thoroughly mixed in a dry state, and then thoroughly mixed with sufficient water to form a stiff mortar. On no account shall water be added after mortar has once been mixed, and mortar after it has once begun to set shall not be used or mixed with other cement and sand.

An excess of water shall in no case be used for mixing, and if more water than is necessary be used, such mortar after it has once begun to set shall not be mixed with further quantity of sand and cement, but the whole shall be condemned.

11.19 Steel

All steel shall be in accordance with BS 4360 or the equivalent Malaysian Standards for structural steel. All invoices for steel shall be open to inspection by the superintending officer or his representative. If it

is not possible to procure such reinforcing steel in the imperial sizes, then steel in the metric sizes approximating to those in accordance with the Table 12 shall be used.

Table 12. Steel size

Imperial size (inch)	Metric size (mm)
1/4	6
5/16	8
3/8	10
1/2	12
5/8	16
3/4	20
7/8	22
1	25
1 1/8	28
1 1/4	32
1 1/2	40

11.20 Ironwork

Bolts, nuts, rivets and other accessories shall be in accordance with the relevant Malaysian Standards. All bolts, nuts, and screws shall be in accordance with the relevant Malaysian Standards. All invoices for iron shall be open to inspection by the site supervisor or his representative.

11.21 Hardcore

All hardcore shall consist of hard brick, concrete or stone graded down to a minimum of 80 mm.

12. Testing

All duct lines shall be cleaned and tested as specified for the particular duct concerned. On completion of the duct lines between any two jointing chambers or sites, a cylindrical brush connected to the following end of a mandrel shall be passed twice through each 'way' to clean the duct and to remove any foreign matter which may have entered.

12.1 Mandrel test

For general PVC type duct, mandrel test shall be performed after completion of duct installation. When the building of the jointing chamber or any connecting manhole is deferred until after the completion of a section of duct included in the work, the last joint of each duct shall be tested on completion of the jointing chamber or manhole by means of the working mandrel.

Upon the completion of the duct line between any two jointing chamber or sites, the cylindrical brush, as shown in Figures 23, 24 and 25, connected to the following end of a mandrel shall be passed twice through each 'way' to clean the duct and to remove any foreign material which may have entered.

To ensure the alignment of the ducts a working mandrel 457 mm in length and 83 mm in diameter shall be drawn through as the ducts are laid. The test mandrel used for testing shall be 457 mm in length and 83 mm in diameter, the cylindrical brush shall be 108 mm in diameter.

Figure 23. Mandrel and brush

Figure 24. Pulling mandrel from both directions

Figure 25. Mandrel test point at terminated manhole

All tests shall be carried out and if any obstruction or other defect is discovered, it shall be rectified forthwith to satisfaction.

12.2 Alignment test for disturbed ducts

When jointing chambers are provided on an existing duct route or when any disturbance takes place which may affect the alignment of the ducts, a test mandrel of appropriate dimensions shall be drawn through each of the spare 'ways'.

12.3 Blowing test

Duct blowing test shall be performed for HDPE duct smooth wall installation to ensure the duct is suitable to be used for cable blowing later.

The blowing test shall be as follows:

a) Duct integrity needs to be established. The contractor shall check by pressurizing the duct and monitoring air loss. This is to ensure no damaged duct and couplers are properly installed.

b) Prepare a short fibre cable (1 m to 2 m) for installation. Attach the cable to the cable carrier or parachute to the end of the fibre. Feed the cable through the cable blower and into the duct.

c) Apply a silicone-based lubricant into the duct. Additional lubricant may be applied behind the carrier.

d) Connect the cable blower to the system and inject air into the duct behind the cable carrier.

e) The blower will exert a pulling force and the cable will begin to move through the duct. The test is successful when the cable reaches to the end of the duct line.

Figure 26 shows the process of blowing test where pulling force from blower system will pull the parachute through the duct.

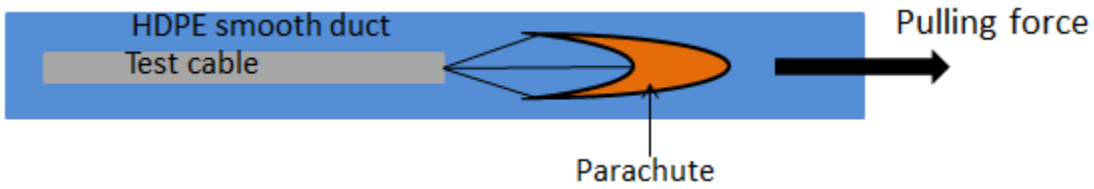

Figure 26. Blowing test

12.4 Plugs or end cap

A hardwood plug or equivalent shall be inserted at the ends of each 'way' in a line of ducts until the lengths has been tested and passed. The plug shall be sufficiently hard to ensure the roundness of the duct during construction.

13. Milling

13.1 Scrape existing road surface

Scraping is a process of removing a part of a paved area surface such as road to receive a new wearing course. Milling process shall be done as instructed by the relevant authorities. The area for milling shall be determined by project manager or as instructed by the relevant authorities.

13.2 Road paving process

Road paving shall be done as per specification JKR/SPJ/2008 or by the relevant authorities.

a) Spray a tack coat of cationic bituminous emulsion (40 %) onto the crusher run layer at the rate of 4.5 m^2/ℓ.

b) Spread evenly the Asphaltic Concrete Wearing Course (ACWC) over the treated stone surface. The thickness of ACWC shall be at least 50mm or as similar to the original thickness before excavation work. Site supervisor shall monitor the milling process to ensure the required thickness is correctly laid and spread.

c) Roll the ACWC surface by using suitable machine until complete consolidation has been obtained. The temperature at the commencement of rolling shall be more than 1,100 °C. The road can only be opened for traffic after 4 hours.

13.3 Coring test

The test is done by drilling a cylindrical sample of paved surfaced as shown in Figure 27. The purpose of the test is to check the thickness of the asphalt premix as shown in Figure 28. The test shall be performed as requested and shall meet the specification as specified by the relevant authority. Generally, the test is carried out within 24 h of laying and compacting the asphalt premix or as instructed by relevant authorities. The diameter of core sample shall be less than 100 mm and the thickness are 150 mm. The rate of sampling shall be one sample per 500 m^2 of premix laid.

Figure 27. Drilling of paved surface for coring test

Figure 28. Measuring of asphalt premix thickness

13.4 Road painting

Road painting shall be done as instructed by the relevant authorities. Prepare and apply 2 coats of approved road line paint (width of 100 mm) on the road to restore the existing road line which was removed during milling process.

14. Reinstatement

Reinstatement shall be applicable as per specification by JKR/SPJ/2008 or any requirements by the relevant authorities.

14.1 Reinstatement of excavated area in grass

The reinstatement of excavated area in grass shall be done by re-planting the grass and plants which were removed during excavation.

14.2 Reinstatement of excavated area in carriageway

Reinstatement shall be accomplished when the excavation is done in carriageway. The procedures are as follows:

a) Spread evenly and compact the 250 mm thickness (or similar to the original thickness before excavation or as instructed by local authority) of crusher run to prepare of receiving the layer of asphalt premix.

b) Pour the asphalt premix with the thickness of 50 mm (or similar to the original thickness before excavation or as instructed by local authority) onto the crusher run layer.

c) Compact the layer of the asphalt premix by using rammer machine such as compactor as shown in Figure 29.

d) Project manager should ensure that there are no changes in the level of surface at the excavated area after the road instatement work is complete. Contractor shall bear any cost for additional work to repair the damage.

e) Repair all damages like curb, finishing (tiles) and etc.

f) Road milling shall commence only after the road reinstatement on the excavated area has stabilized or as instructed by local authority.

Figure 29. Compacting of asphalt premix

15. Completion of works

15.1 Site restoration

After completion of works, all the signage, equipment and tools shall be removed and cleaned. All excavated work areas shall be backfilled and returned to the initial condition as required. All the valuable plants such as trees, landscape, carriageway or structure may require a special recovery process according to the requirements of landowners or the relevant authorities.

15.2 Project handover

The civil works contractor shall retain and keep the following documents for the purpose of acceptance test and handover process with the project manager:

a) as-built drawing;

b) permits from relevant authorities;

c) UDM report;

d) duct-way space record information; and

e) cross sectional diagram of the completed work with the following information:

   i) the depth of the duct-way (vertical alignment) for every 6 m interval; and

   ii) the setback distances.

Acknowledgements

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