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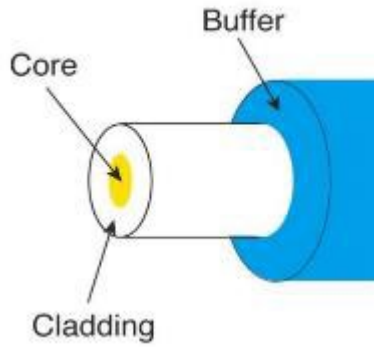
Outside Plant Construction

Review Of Fiber Optic Technology

Fiber Optic Components

Optical fiber can be made from glass or plastic but most communications fiber is all glass. The basic construction of fiber looks like this:



Core: The optical core is the light-carrying element at the center of the fiber and is made up of an ultra-pure optical glass in an elevated temperature process.

Cladding: The cladding surrounding the core is made of pure silica and has a slightly lower index of refraction (i.e., less dense) than the core. This lower refractive index causes the light in the core to reflect when encountering the cladding and remains trapped within the core.

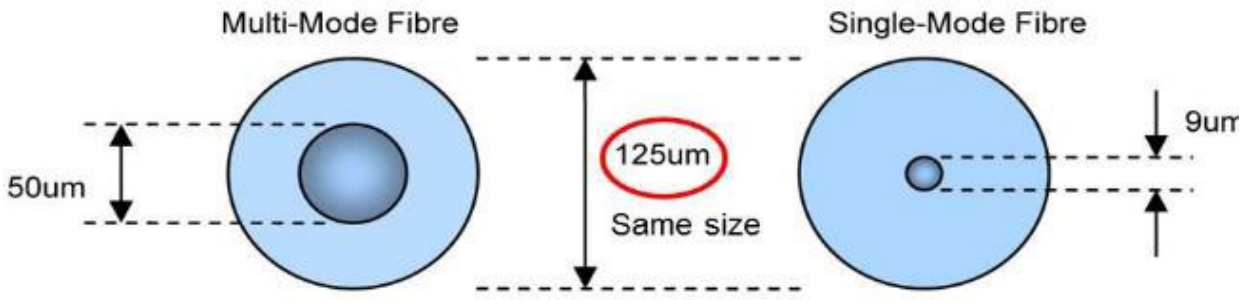
Fiber Manufacture: The core and cladding of the fiber are made first in the form of a large glass rod called a preform that is then heated on the end and pulled into the fiber.

Buffer coating: After pulling the fiber, it is coated with a protective plastic coating to prevent physical damage and protect the fiber from moisture. The buffer is removed during stripping for splicing or termination.

Fiber Geometric Parameters

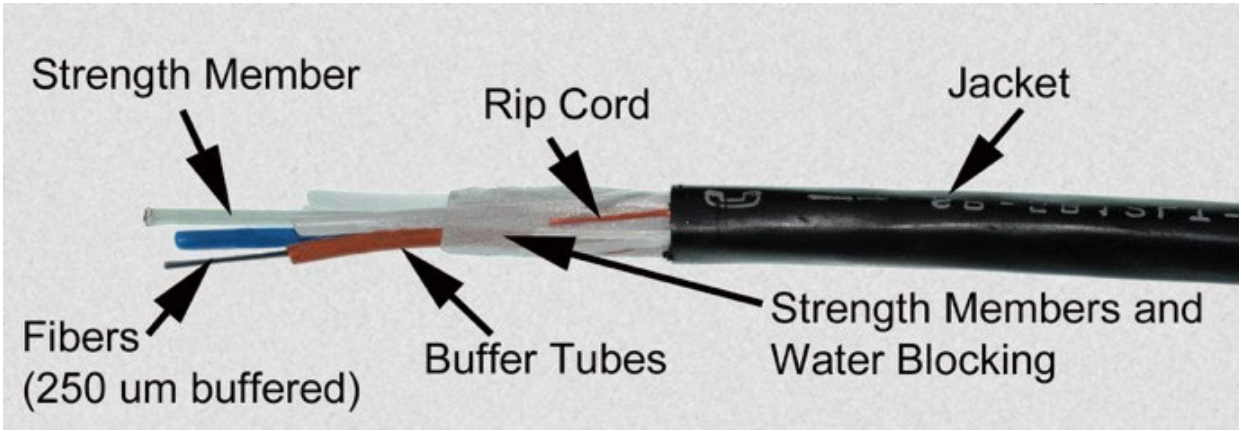
Fiber can either be single-mode (SM) or multimode (MM), but all OSP cable plants are single mode.

Fiber sizes are expressed by using two numbers separated by a slash e.g., 9/125. The first number refers to the core size in microns and the second number refers to the core and cladding size combined in microns. It is impossible to differentiate between SM and MM fiber with the naked eye. There is no difference in the outward appearances; both are 125 microns in size - only the core size differs.

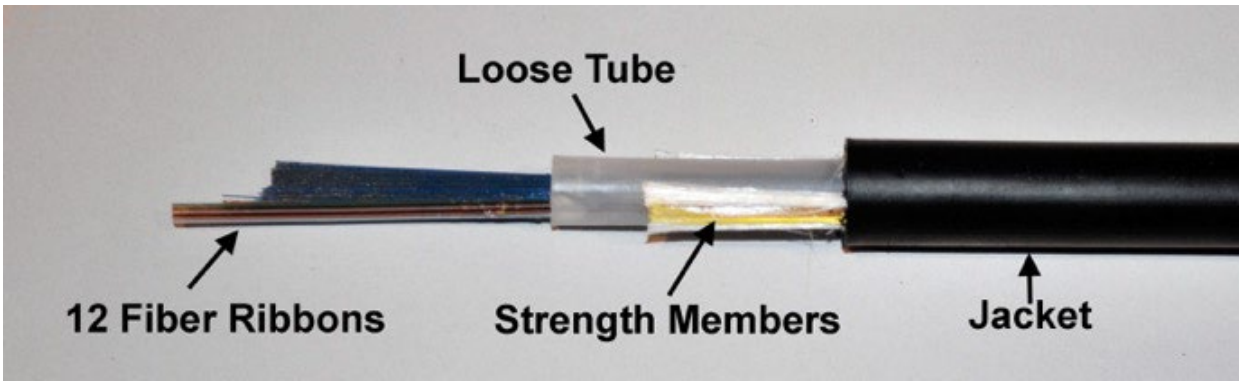


Fiber Optic Cables

A cable protects the fibers from the environment where it is installed. OSP cables may be installed underground in conduit or direct buried, installed aerially on poles or towers or run underwater. The type of cable construction chosen must be compatible with the installation environment and the installation process.

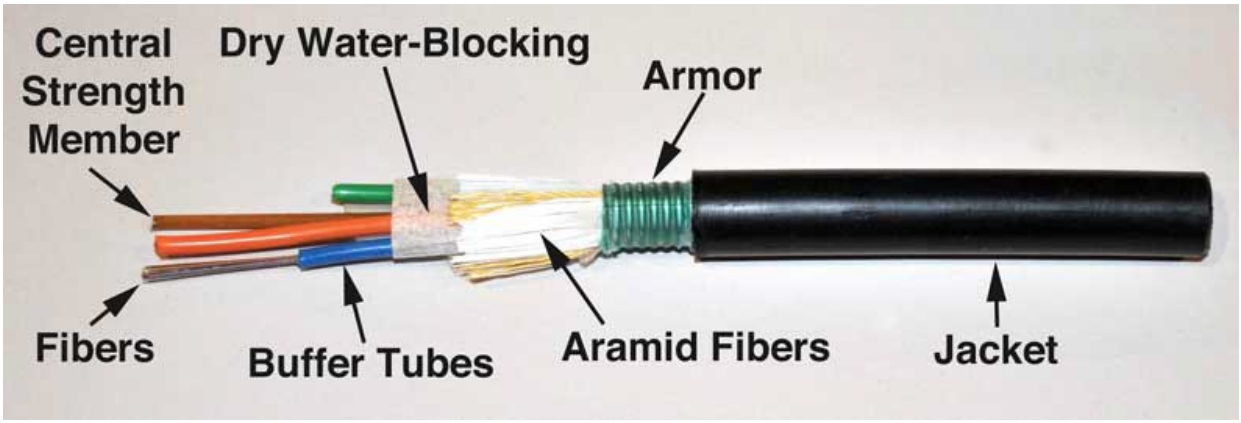


Loose tube OSP cable



Ribbon OSP cable with a central tube

OSP cables are loose tube or ribbon designs. The center of the cable is usually a fiberglass strength member to limit the bending and kinking of the cable. The fibers are protected in tubes with water blocking compounds for protection against moisture. Surrounding the fibers are aramid fiber strength members which provide for the high pulling tension of these cables. Armor is used on directly buried underground cables only, as protection from crushing loads or rodent penetration.



OSP armored loose tube cable

Aerial cables can be loose tube designs lashed to a messenger cable or another fiber optic cable for support, all dielectric self-supporting (ADSS) or figure-8 cable with a messenger attached to the cable. These cables will be covered more in the section on aerial installation.

The jackets of OSP cables are usually Polyethylene (PE). Since raw PE can degrade rapidly through exposure to sunlight, carbon black is combined with the PE to absorb the UV light and protect the plastic from degradation.

Cable jackets should be marked with manufacturer's name, month and year of manufacture,

sequential meter markings, fiber type and the number of fibers. Cables without these markings will not pass inspections in some areas and should not be installed.

Cable Strength members

Aramid fibers (trade name Kevlar - an extraordinarily strong, exceptionally light, synthetic compound developed by DuPont) – are used when a cable is pulled into a duct, with the tension being applied to the Kevlar. The Kevlar is used as a drawstring to pull the cable into the duct so as not to put stress on the fibers.

Pulling eye for fiber optic cable attached by strength members

The term is sometimes also used for the fiberglass or steel rod in some cables used to stiffen it. Impact resistance, flexing and bending are other mechanical factors affecting the choice of strength members.

Moisture/Water-blocking

In a loose tube cable design, a filling compound, either dry water swell-able yarns or powder or gel are commonly incorporated in the cable. This minimizes the chance of water or moisture penetrating the length of the tube if the tube is damaged. Moisture can cause fiber degradation and when water freezes it expands by approximately 9% causing damage to the cable.

Micro Cable Technology

Since SM fiber was first introduced in the early 1980s, not too much has changed in its basic geometric parameters. The SM core size has remained somewhere between 8 and 10 µm depending on the fiber type while the core / cladding diameter has remained at 125 µm. The outside plant (OSP) coating has typically been 250 µm. Standardizing these dimensions has improved interoperability and consistency across optical networks.

A typical standard 144 fiber loose cable would be 15-20 mm diameter (0.6-0.8 inches) and a ribbon cable 12-15 mm diameter (0.5-0.6 inches). Smaller cables are often desirable since more can be placed

in standard ducts or smaller ducts which are easier to bury can be utilized.

A major fiber development has made smaller cables possible – bend insensitive (BI) fibers. BI fibers reduce fiber sensitivity to bending losses so more fibers can be packed into a single fiber tube. Plus, the buffer coating of BI fibers can be reduced to 200 microns to pack more fibers into the cable.

Micro cables with 288 and 144 fibers compared to a pencil

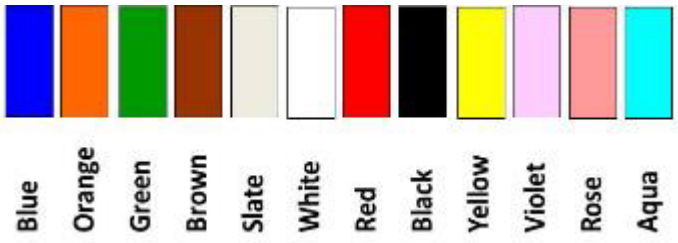
Micro cables offers a great deal more density. Only a few years ago, a cable diameter of ± 12 mm was required for a 48-fiber cable design. Today, a micro cable only 8 mm diameter has a capacity of 144 fibers. This is achieved by using 200 µm coated fibers and doubling the number of fibers in smaller buffer tubes. The 200 µm coated fiber's cross-sectional area is ~46% smaller than that of the conventional 250 µm coated fiber.

Micro cables are designed for installation in micro ducts, small fiber ducts made of high-density polyethylene (HDPE) material. They are typically installed as bundles in larger ducts or directly buried by micro trenching or sawing a shallow trench in roadways or sidewalks. It is accepted that deploying multiple micro ducts is an economically sensible option, helping to reduce the costs of subsequent installation by allowing more micro cables to be installed in the future.

Micro cables are designed for installation in micro ducts by blowing or jetting. Blown cables float on a high-pressure jet of air while being pushed into the micro duct. The high-density polyethylene (HDPE) outer sheaths minimize friction with the inner surface of micro ducts. More significantly, these cables also have optimal stiffness properties to help prevent buckling and easily negotiate modest changes in direction of the micro duct along the jetting route.

The central tube micro duct design provides the highest fiber density, yielding a small cable OD. The individual fibers are bundled into groups of twelve within the cable's central tube, and the bundles are easily identifiable with colored binders in accordance with EIA/TIA-598B, "Optical Fiber Cable Color Coding".

Color codes for ducts may differ from supplier-to-supplier or as supplied to customer order.



EIA/TIA-598B, "Optical Fiber Cable Color Coding"

Splicing and Termination

OSP cables are often spliced to provide exceptionally long link lengths. Cables can be purchased in lengths of 4-12 km but there are limits to how long a length of cable can be pulled in ducts, even with lubrication. And in many cases the cables need splicing for dropping cables at locations or splitting cables for diverse fiber connections.

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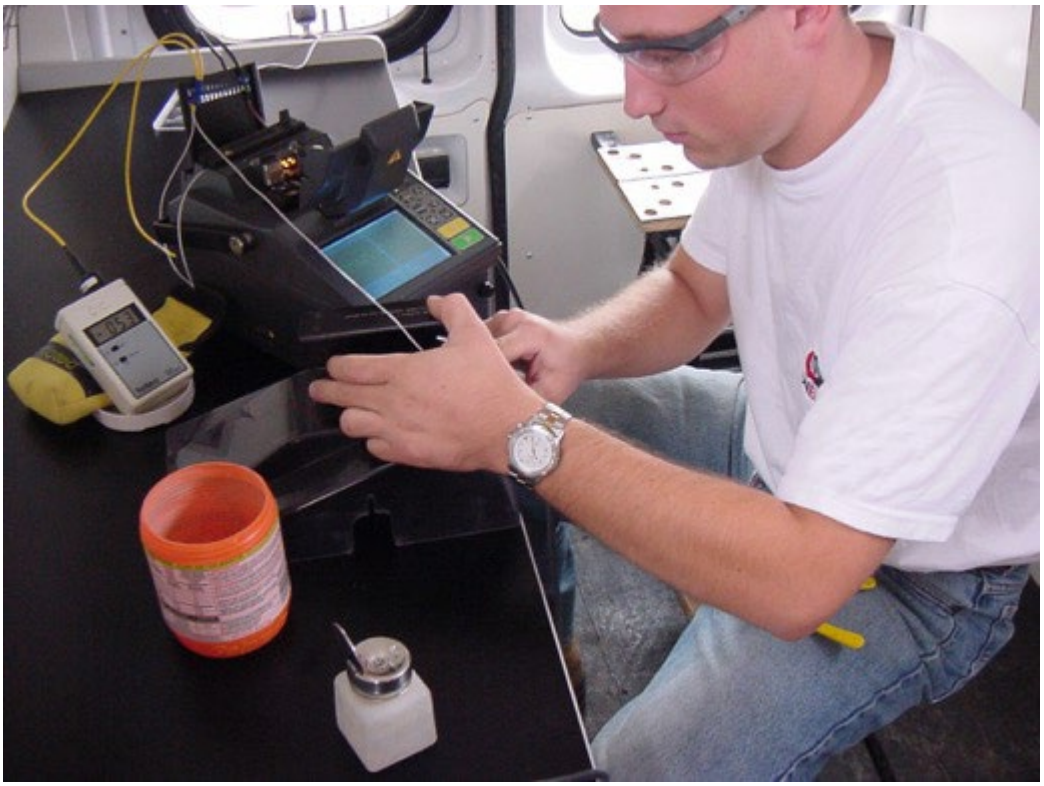
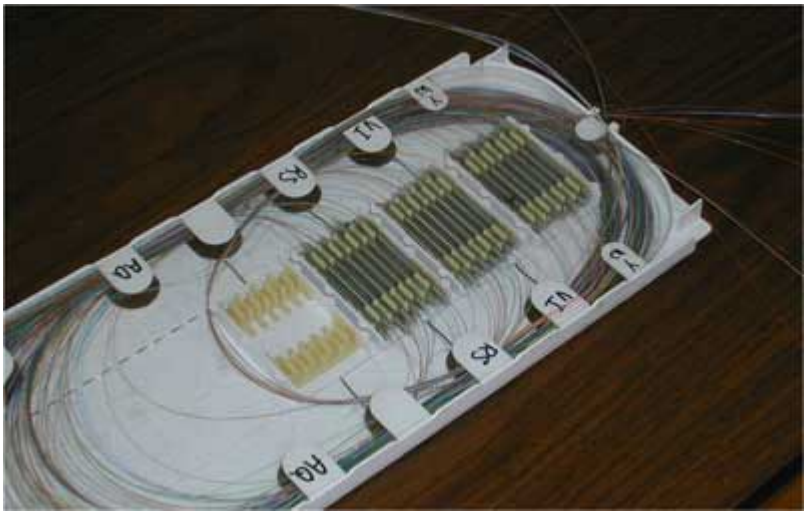


Most splicing is done by fusion splicing, welding fibers together in an electric arc in an automatic fiber splicing machine. Splicing is usually done in a protected environment like an air-conditioned splicing trailer or van to prevent problems with dirt or other contamination.



Splices will be organized in trays which are stacked in splice closures. Closures are sealed to protect the fibers from the environment. Many diverse types of closures are available so designs suitable to the location should be chosen.

Termination of OSP single mode cable is done by fusion splicing a terminated pigtail or a splice-on connector (SOC) on the fiber. Requirements for low loss and reflectance prevent direct termination methods like adhesive/polish connectors from being used in OSP installations.

Hardware to protect the cable plant and splice points includes pedestals, handholes and maintenance holes. Huts and offices are provided for termination of the cable plant at electronics sites.

Project Preparation and Guidelines For Outside Plant Installations

Outside plant (OSP) installations of fiber optic cables can be much more diverse than other installations since every project is unique. OSP installs may include installing aerial cable, direct-buried cable, underground cable in conduit or installing conduit or innerduct and then pulling cable or placing cable underwater. A single link may include several types of installation, for example aerial in one section, pulling in conduit on a bridge crossing and burying the rest of the cable.

Cables may end when pulled into buildings or terminated at the top of poles where surveillance cameras or wireless access points are located. Splices where cables are concatenated can be placed in pedestals, buried underground, or hung in aerial splice closures.

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The diversity of OSP installation makes it extremely important for the contractor to know the route of the cable to be installed intimately. Like the estimator who should walk the route before beginning the estimating process, the contractor needs to see for themselves the actual situations they are going to encounter. That inspection allows them to determine what problems may be encountered, what special equipment may be needed and even double check that all the permits needed are in order. This chapter covers many topics of relevance to OSP construction that should be considered as part of the overall project planning.

1. THE CONTRACTOR MUST OBTAIN THE LOCATES PRIOR TO DISTURBING THE GROUND.
2. CONTRACTOR MUST HAVE A COPY OF THE APPROVED PERMIT FROM THE APPROPRIATE AGENCY ON THE JOBSITE AT ALL TIMES.
3. NO MORE THAN ONE TRENCH OPENED AT ONE TIME THEN BACKFILLED AND COMPACTED IN 10" LIFTS AT THE END OF EACH DAY. (NO TRENCH LEFT OPENED OVERNIGHT)
4. ALL CABLE SHALL BE BURIED AT 24" UNLESS OTHERWISE NOTED.
5. ALL DIRECTIONAL BORES TO HAVE A MINIMUM OF 30" COVER UNLESS OTHERWISE NOTED.
6. ALL DIRECTIONAL CORES CROSSING ROADS SHALL CROSS AS CLOSE TO 90 DEGREES AS POSSIBLE. CROSSINGS SHALL NEVER CROSS AT AN ANGLE

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LESS THAN 45 DEGREES.
7. BONDING SHALL BE PROVIDED BETWEEN ALL ABOVE GROUND METALLIC POWER AND COMMUNICATION PEDESTALS THAT ARE SEPERATED BY 6 FEET
OR LESS. (REF: 1993 NESC SECTION 35, ARTICLE 350.F.)
8. THE CONDITION OF ROAD UPON COMPLETION OF JOB SHALL BE AS GOOD OR BETTER THAN PRIOR TO STARTING.
9. CONTRACTOR SHALL TAKE NECESSARY PRECAUTIONS TO PROTECT ROOT SYSTEMS OF SHRUBS, PLANTS, AND TREES ALONG THE AREA OF
EXCAVATION.
10. CONTRACTOR SHALL COMPLY WITH LATEST EDITION OF OSHA REGULATIONS AND THE STATE LAWS CONCERNING EXCAVATION.
11. SERVICE DROP PATHS ARE GRAPHICAL IN NATURE ONLY AND NOT INTENDED TO BE USED FOR CONSTRUCTION.
12. CABLE PATHS ARE AN APPROXIMATE LOCATION AND SHALL BE PLACED IN THE UTILITY RIGHT OF WAY.

811
Know what's **below.**
Call before you dig.

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Job Safety Analysis Worksheet

Company name:		Date:		JSA No.	
Site name:		Permit to work requirement:	Yes ☐	No ☐	
Contractor:		Approved by:			
Activity:					

Activity List the tasks required to perform the activity in the sequence they are carried out.	Hazards Against each task list the hazards that could cause injury when the task is performed.	Risk control measures List the control measures required to eliminate or minimise the risk of injury arising from the identified hazard.	Who is responsible? Write the name of the person responsible (supervisor or above) to implement the control measure identified.

Remember: Each JSA must be site specific.
Include all workers in the development of this JSA.

WorkSafe VICTORIA

WorkSafe Victoria is a division of the Victorian WorkCover Authority

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A JSA (job safety analysis) is a form and procedure which companies create and use to outline the basic steps in a job or task to surface and think about the potential hazards and incidents involved in doing that job.

The purpose of a JSA is to do a job in the safest way possible. Without creating and completing a JSA, people often go about jobs and tasks in the fastest way possible, and often complete them on autopilot.

A JSA forces a worker or workers to 'take 5' and take stock of the situation, identifying the potential hazards and incidents and taking steps to avoid these issues arising.

The other incredibly helpful part of a job safety analysis is to prioritize safety inputs. JSA's enable people to identify the risk associated with a job hazard on two dimensions:

- Frequency of occurrence or 'likelihood'
- Consequences or the severity of an accident should it occur.

This enables workers to mitigate the largest and most damaging hazards.

Environmental Considerations

It is the Contractor and/or Client's responsibility to prepare a site-specific Environmental Management Plan (EMP). And, as ever, each site is unique and therefore the environmental issues to be considered will vary from site to site.

Environmental Control Officer (ECO)
Every project should start with the appointment of an Environmental Control Officer (ECO) that shall:

- Prior to commencing work, unravel the requirements of the EMP to team members, to ensure understanding and conformity.
- Visit the site weekly.
- Review and approve all areas that have been rehabilitated by the Contractor.
- Keep a record of findings.
- Attend all project meetings.

- Produce a monthly report for the client, with commentary on compliance and/or non-compliance.
- Keep an Incident Log of non-compliance.
- Maintain a record of complaints from the public and communicate this to the client.
- Where necessary, issue a non-compliance report to the Contractor.
- Where serious environmental infringements have occurred, introduce a Temporary Work Stoppage
- Liaise with the appointed Occupational Health and Safety Officer of the client.

The Contractor's Environmental Management Plan (EMP) must include, but is not limited to:

- Statement of Commitment
- List of activity-specific environmental issues related to your site and their impact.
- Incorporating the above, write a series of simple work instructions to ensure compliance.
- Determine the actions required to manage each work instruction.
- A list of tangible contingency and mitigating actions to be implemented if required.
- Provide training for staff and create awareness.
- An organizational chart setting out respective roles and responsibilities.
- Monitoring and Reporting

Contractor Responsibilities must include, but is not limited to:

- Be familiar with and comply with the procedures contained in the EMP.
- Ensure that all personnel are trained, qualified, and experienced enough to undertake their work in an environmentally responsible manner.
- Create an awareness of the Environmental work requirements and the need for them amongst the workforces.
- Procedural briefings to be given before personnel carry out key activities for the first time.

- Ensure that personnel who have formal responsibilities under this plan are trained in the requirements of this EMP.
- Undertake daily site inspections to monitor environmental performance and compliance.
- Immediately notify the ECO in the event of infringements.
- Notify the ECO and in advance of any activity he has reason to believe that may potentially have an adverse environmental impact.
- It is desirable for Environmental matters to be included as a standard agenda item at all project meetings.

Activity-specific Guideline Examples:

In what follows, are a few activity-based examples an EMP must contain, but is not limited to:

Water

- Storm water must be contained in the storm water system to avert flooding.
- Measures must be implemented to distribute storm water as evenly as possible to fend off soil erosion.
- Material from any stockpile must not be allowed to spill or be washed into a gutter or drain.
- The execution of any work shall not block and subsequently unsettle the existing overland water flow or the existing system of drains.
- No person may, without prior written permission, release water onto a public road.
- No person may, without prior written permission, raise the water level of a river, stream or dam which can spill over onto a public road.
- Any water in a trench shall be pumped out before backfilling.
- Water shall be pumped into the storm water system and never into a sewer maintenance hole.
- No work shall be done within 32m of any natural water source without ECO permission.

Dust / Air Pollution

- Where necessary, issue workers with washable dust masks for protection against dust inhalation.
- Dust shall be controlled onsite, especially when windy.
- Minimize or even cease activity during periods of high wind.
- Dampen surfaces to prevent dust from becoming airborne.
- Cover materials are being transported with plastic sheeting or a tarpaulin to prevent them from flying off the vehicle. Dampening of the transported material may also be necessary.
- Cover onsite stockpiles with plastic sheeting or tarpaulins during high wind.
- Regular maintenance of generators, compressors, etc., is essential for controlling exhaust emissions.

Noise Pollution

- Contractors must abide by the National Noise laws.
- Develop a noise mitigation plan before starting construction.
- The level of noise and the duration thereof must be agreed upon and monitored.

- Examples of noise: Jack hammers, concrete saws, bulldozers, trucks, generators, compressors, pneumatic tools, power tools, etc.
- When talking to someone 1m away and you must shout to make yourself heard, then noise levels are too high.
- Hand-held sound meters are lightweight, easy to operate and inexpensive.
- Hearing protection shall always be worn when noise levels are suspected of equaling or exceeding 85 dBA.

Noise PPE

- Use disposable earplugs only once.
- Keep reusable earplugs clean.
- Earmuffs must be a good fit.

Construction Hours

Where possible, restrict construction work to weekdays and limit work hours from 08:00 to 17:00. Should an extension of the work hours be required, the adjacent property owners shall be informed in writing 2 days in advance of any proposed overtime activities.

Whenever practical, when noise levels are identified as exceeding 85 dBA, Noise MUST be reduced by using mufflers, barriers, etc. or the following actions must be implemented once the source of the noise has been ascertained:

- Replacement or adjustment of the worn or loose parts

- Balancing unbalanced equipment
- Lubrication of the moving parts
- Use of properly shaped and sharpened cutting tools.

Trees

- Trees shall not be cut or trimmed unless consent is obtained in writing from the owner and/or the relevant authority.
- Cutting shall be confined to what is necessary.
- Tree roots exposed in the way of the trenching shall not be cut unless unavoidable.

Archaeology and Cultural Heritage

- Even with no designated sites of archaeological sensitivity being identified along a route, the Contractor will be required to have measures in place to deal with potential finds protected by the appropriate laws and authorities.
- Construction near a finding must be stopped, and under no circumstance may any artefacts be disturbed or removed from the site.
- An archaeologist can be called to the site for inspection.

Environmentally Sensitive Areas (ESA)

An ESA is a type of designation for an agricultural area which needs special protection because of its landscape, wildlife, or historical value.
Such designated areas shall be dubbed “no go” areas and access to, or work in such areas, shall be carefully controlled by the ECO.

Concrete / Cement

- Concrete shall not be mixed directly on the ground.
- All visible remains of excess concrete shall be removed and disposed of at an approved disposal site.
- Cement shall be stored in a dry place, protected from rain, and raised off the floor.

Bird Nests

Bird nests on overhead routes cannot be moved, unless consent is obtained in writing from the relevant authority.
It is desirable to erect the aerial cable above or below a nest such as this.

Hazardous Substances and Materials

- Examples of hazardous substances / materials: gasoline, diesel, petroleum, oil, cement, lubricants, drilling fluid, pesticides, herbicides, etc.
- All potential hazardous or polluting materials shall be stored as far away from drainage inlets as possible.
- Storage areas must be designated, demarcated, and fenced and the necessary firefighting equipment shall be maintained on site.

Fiber Optic Cable Disposal

Skip bins can be filled over a one week or longer period before collection and waste disposal. This service

is efficient, cost effective and guarantees the customer peace of mind knowing that their waste will be disposed of in a legal and ethical manner. Services are available to remove waste or recycle cables.

General Health and Safety Guidelines

It is important to adopt an approach that minimizes or better still, eliminates accidents.

Responsibility of Management

It is the responsibility of management to ensure that all team members and supervisors are trained and familiar with applicable safe working practices, and that they take immediate and decisive action when safe and approved work methods are not followed.

Responsibility of Supervisors

It is the responsibility of the supervisors to ensure that each member of his team wears the required PPE and to ensure that the work area is protected using the necessary signs, cones, flashing lights, traffic control personnel, etc. Personal protective equipment (PPE) refers to protective clothing, hard hats, safety glasses, or other garments or equipment designed to protect the wearer's body from injury. On top of this, practice safe and approved work methods, as generally outlined in this Manual.

Each Party must at all times comply with health and the safety legislation, regulations and guidelines (e.g. OSHA in the US), which must include, but is not limited to:

A competent person shall, before the commencement of any construction work, perform a risk assessment which shall be written into the health and safety plan to mitigate risks and shall include:

- Activity-specific hazard and risk identification.
- Assess and evaluate each identified hazard and risk and rank them i.e., high, medium, or low.
- The best way to protect people is to eliminate the hazard or risk and second best, minimize it.

All areas used by the public shall be maintained free from debris or equipment that may constitute slipping, tripping, or any other hazard.

Adhere to all the health and safety management plan procedures.

Develop and obtain approval for a Traffic Management Plan (TMP).

Report and record all Work Site accidents, incidents, and property damage.

Establishing safe air space requirements prior to the use of lifting and construction equipment.

All personnel shall be required to wear the following personal protective equipment (PPE):

- Protective overall (always).
- Steel-toed safety boots should always be worn.
- Hard hat (when performing work that requires the use thereof).
- Safety glasses (when performing work that requires the use thereof).
- Work gloves help prevent cuts and bruises from sharp or rough edges on pipe/ducts and other objects.
- Always wear high-visibility vests.

The contractor shall ensure that all necessary guards, protective structures, and warning signs are used to protect both workers and third parties. All necessary barriers and fences shall be erected to guide pedestrians and traffic around the work area.

A first aid box will be provided and allocated to a trained, certified first aider. Every injury occurring on site must be treated and recorded. Should an injury require professional medical treatment, the supervisor in charge must complete an accident report. Ensure that the first aid kit is available and accessible, correctly stocked and a register exists to account for used/missing items.

Training and Certification

All employees, management personnel and visitors shall undergo induction training carried out by the Site Manager or a designated deputy before going onto site for the first time. Induction records shall be kept on site for the project's duration. Certifications such as the FOA CFOT or CFOS should be considered as requirements for working on fiber construction projects.

Typical Table of Contents for a Site Safety File

1. Notification of Construction Work
2. Letter of Good Standing
3. Organogram
4. Health & Safety Policy
5. Health & Safety Plan
6. Environmental Policy
7. Environmental Plan
8. Waste Management Plan
9. Fall Protection Plan
10. Emergency Plan
11. Emergency Contact Numbers
12. List of Sub Contractors
13. 37.2 & 5.3.b Legal Agreement
14. Appointments
15. Certificates of Competency
16. Risk Assessments
17. Induction Records
18. Toolbox Talks
19. Inspection Registers
20. Visitors Register
21. Complaints Register
22. Site Diary
23. Weekly Statistics
24. Safety Minutes
25. Audit Template
26. Vehicle List
27. Incident Records
28. Client's SHE Specification
29. Public Liability Insurance

Traffic Management Plan (examples)

No work should commence on a public roadway without first obtaining a wayleave from the road authority concerned. It is the responsibility of the supervisor/s to ensure that each member of his crew wears the required PPE and to ensure that the work area is protected using the various signs, cones, flashing lights, traffic control personnel, etc.

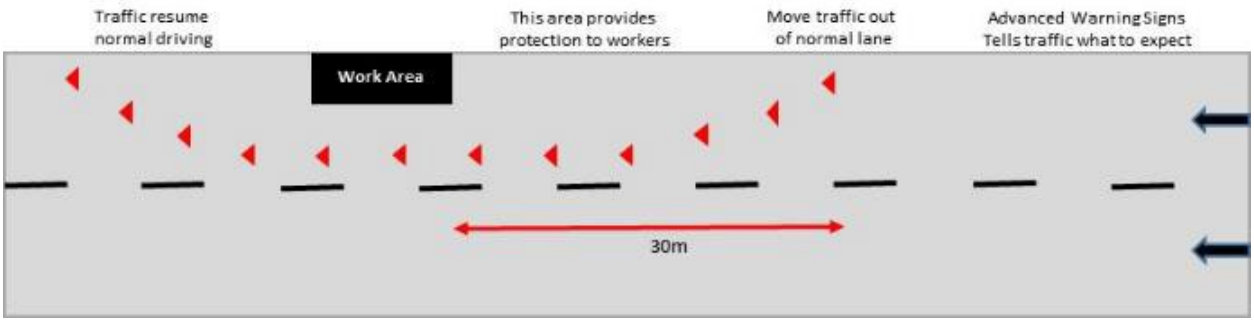
- Traffic movement shall be inhibited as little as possible. Should this be unavoidable, alternative access to routes must be made available.
- Work carried out on busy roads should be restricted to outside the following periods: from 06:30 to 09:00 and 15:30 to 18:00, to ensure the free flow of traffic during peak hours.
- Roads shall be kept free of debris or equipment. Excavated material unsuitable for re-use shall be removed from the site as soon as possible.
- Where cyclists and/or pedestrians are likely to be present, their need for safe and convenient passage must be considered and sufficient, safe crossings shall be planned for.
- Create 'no go' zones around hazardous areas and implement safe work distances.
- Choose signs with messages clearly indicating the actions drivers or pedestrians are required to take.
- Where necessary, traffic control persons shall be used to provide positive guidance to motorists.
- Remember that the visibility of hazards/workers can be diminished in darkness and/or poor weather conditions.

Selecting Signs

Choose signs that are appropriate; signs that accurately describe the work situation.
Start with general sign messages at the beginning of the work zone. Then use signs with more specific messages, stating what action should be taken, closer to the actual work area.

The overall effect of signs should be to make drivers aware of what they are approaching and what action(s) will be required of them.
Drive through checks should be made every so often, both at night and day, to ensure that signs are

properly located to allow adequate driver response time.
Use only signs that appear in the local Road Traffic Signs Manual.
Signs must be kept clean and well maintained if they are to be effective.



Flagging PPE and Communication

- A high-visibility reflective vest
- A white hard hat
- Steel-toed safety boots
- Full length pants or coveralls - no shorts
- During rainy weather, highly visible rainwear

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When two flaggers are used, they can communicate verbally or visually if they are close enough to each other.

It is desirable to appoint one of the flaggers as the coordinator.

Where the end of a one-lane section is not visible from the other end, the flaggers must communicate via two-way radio.

The safety of workers and the travelling public, while passing through the construction area, depends on the efficient actions of flag persons.

A Warning Flag Signal may also be used to warn a road user to proceed slowly and be alert of a hazard in or adjacent to the roadway ahead.

A good, active flag person can be as effective as any other means of drawing attention to a hazard in the roadway.

Wayleaves (Easements)

A Wayleave is permission to use someone else's property to deploy infrastructure. This is also known as a right-of-way or an easement.

Wayleave's will indicate the positions of all other services. So, on "paper," we should not "hit" anything. This can prove to be as misguidedly optimistic: "Never assume anything!" Fortunately, most of us are skeptical about the accuracy of the information presented in Wayleave (a project can have many of them). There is little doubt that a pre-built survey set up to verify the exact location of services indicated (or not) in Wayleave's will do no harm.

A Wayleave agreement must be obtained prior to installing any telecommunications equipment.

Companies doing work in a Road Reserve shall at all times keep a copy of the Wayleave on site.

Companies must familiarize themselves with the Standards and special conditions as set out in this permit.

Companies are held responsible and accountable for the quality of work they deliver, as well as any objectionable actions by their workforce.

Pre-Build Procedures

A fiber installation project is a major undertaking. Responsibility for the oversight of everything from

detailed implementation plans to community relations, ensuring sufficient materials are ordered in a timely manner to safety and environmental concerns, means an intense amount of pre-work and ongoing coordination for the life of a project.

As an unfaltering believer in a pre-build survey: The verification of details contained in pre-build drawings will ensure that potential problem areas are uncovered before the contemplated work kicks-off and potentially save one a lot of trouble later.

Using the information available on the pre-build drawings, walk the pegged-out route by foot, to determine the following:

- Verify the soil classification/s by digging a pilot hole every 3 foot (hard, intermediate, soft)
- If the soil or soil properties are not what were expected as noted in the contract, the client must immediately be consulted.
- Check and verify above and below ground utility locations.
- Note changes in gradient and/or direction.
- Identify all obvious landmarks where the route changes direction (take photos)
- Take photos of all obstacles along the route
- Verify HH / MH positions.
- Note road / rail crossings.
- Record crossings with other services
- Record the presence of structures near the trench.
- Double-check the recorded details on the return journey.
- The route is typically marked using lime.

Pre-Build Survey Equipment and Tools

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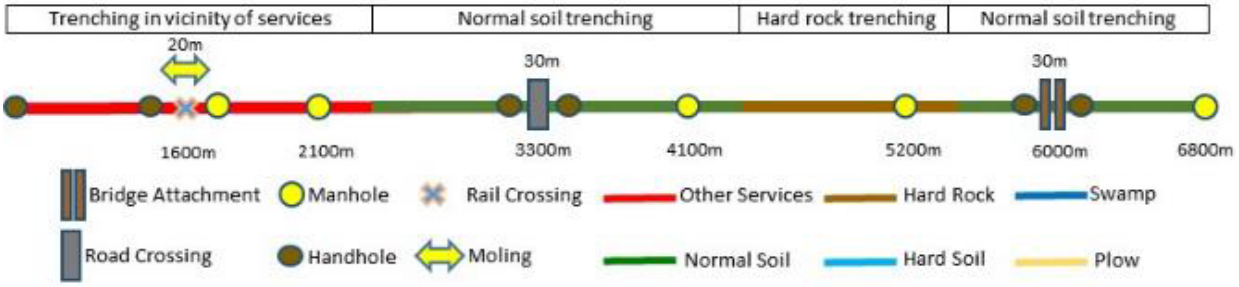
- Smartphone camera or digital camera and spare batteries
- GPS with tracking function and spare batteries (may be available in digital camera or smartphone)
- DCP or CPT tester. Dynamic Cone Penetration (DCP) testing is used to measure the strength of in-situ soil and the thickness and location of subsurface soil layers. Cone penetration or cone penetrometer test (CPT) is another method used to determine the engineering properties of soils.
- Tape measure
- Measuring wheel
- Clip board, notebook, and stationery
- Route drawing/s from the client
- Reflector jacket
- Personal Identification and authorization for the project



Armed with the survey formation, a Project Management Plan can be developed, to ensure delivery on time, within budget and with high quality.

Contractor's Site Camp Establishment / Holding Area

On large projects, a contractor may need to provide a construction site camp / safe holding area, which includes office accommodation. The site location must be at a convenient point and as close as possible to the work site. The contractor must provide a safe holding area to store all material obtained from the client. The contractor will bear all interrelated costs associated with securing the property and the camp establishment.

The camp must be sufficient in size to accommodate all the material and equipment required for the project. The site camp should be fittingly fended and have lockable gates. It should have a suitable office in compliance with local authority requirements. The site must provide sanitary facilities in compliance with local authority requirements. Phone and Internet services should be provided. On completion of the project, the contractor shall reinstate the camp establishment to its original state or better.

Notifications

Businesses / property owners shall be informed one week (7-days) in advance of any construction activities commencing in the vicinity of their properties. These notices will announce upcoming work tasks and potential impacts, such as traffic, parking, and access changes, noise, utility interruptions, vibration, etc. If a private driveway or footway constructed with non-standard materials is to be excavated, the owner of the property concerned must be informed in advance and in writing of the intended work.

Private Property

Where possible, excavations on private property shall not be left open outside normal working hours (08:00 to 17:00). The Contractor shall be responsible for the protection of all trees, shrubs, fences, and other landscape items adjacent to or within the work area. Occupants of the properties must be kept informed at all times of how their access will be affected.

When trenching through entrances to properties, access must be maintained by using steel plates or other temporary bridges of ample strength and, it must be well secured against movement.

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Where a Contractor must undertake tree and bush cutting and/or shrub clearing he must prior to undertaking such work, obtain approval in writing from the relevant authority and/or property owner. The Contractor shall dispose of all cuttings and cleared material.

All drainage systems must be cleared daily.

Surfaces shall always be reinstated to the original state or better. The Contractor shall be solely responsible and accountable to remedy any damages and/or claims, arising due to his activities.

Post Installation Repair and Reinstatements

Reinstatement work must be done by The Roads & Storm Water Department unless a pavement indicates otherwise. Should the wayleave holder make the permanent reinstatement, a 12-month guarantee period commences from the date of completion. Should the wayleave holder undergo a temporary reinstatement, a 2-week maintenance period commences from the date of completion.

Grassed areas shall be reinstated using the original turf, replacement turf or an equivalent seed. Any constructed footway must be reinstated with the same surfacing materials that existed originally (e.g.,

concrete blocks, slabs, etc.). Material may be reused if undamaged, or else replaced with similar material.

Remedial work will be required if any of the following defects exists depressions (resulting in standing water), humps (crowning), edge depression or cracking. The performance of any trench permanently reinstated by the authorized person will be monitored for twelve (12) months, during which period the authorized person will be held responsible for any remedial work that may be required.

Any excavation left unattended for a period of more than 5 days can be made safe by the road authority and charged to the contractor.

Road Reinstatement

The permanent reinstatement of the surfacing typically consists of 5 inches of hot-mix asphalt. The lower 3 inches must be compacted and rolled asphaltic black base (2 inches of nominal stone size, continuously graded) and the top 2 inches (2 inches of nominal stone size, continuously graded). Cold mix may be used only for temporary reinstatement. The reinstated surfacing must be at least 5 inches wider than the trench on both sides to accommodate any edge breaks.

On completion of the work concerned the authorized person must fill in a completion notice and return it to the road authority within twenty-four (24) hours. The road authority will then arrange a site meeting to do an inspection and to issue a certificate of completion if all requirements have been met.

A twelve (12) month guarantee period for permanent reinstatement by the wayleave holder, or the fourteen (14) day maintenance period for temporary reinstatement by the authorized person, commences on the day after the issue of the certificate of completion.

Rubbish, and other objectionable material of any kind, must be legally disposed of, absolving the client from any liability connected therewith.

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Underground Cable Plant Construction and Equipment

Underground cables are pulled in conduit that is buried underground, usually (3-4 feet) deep to reduce the likelihood of accidentally being dug up. In extreme cold climates, cables may need to be buried at greater depths where their temperatures are colder, and frost penetrates to greater depths. The process usually begins with digging a trench to bury the conduit, which is PVC plastic pipe, sometimes with pre-installed innerduct (also called duct liner) with a pulling tape to facilitate the actual cable pulling process. Directional boring can also be used to avoid digging up the surface, for example in crossing streets or sidewalks.

If the conduit and cables are all dielectric, as they usually are, a conductive marker tape should be buried above the conduit to assist in future cable location and as a warning to anyone digging in the vicinity of the cable. Conductive tape to be detectable should be no more than (12 inches) below the surface.

Dig Once

Due to the disruptive nature of burying conduit, especially under roadways, many governments which grant permits for burying cable require the contractor to install extra conduits along the route to prevent having to dig again for any future cable installations. Since many cities have extensive conduits already buried for other services or may have required extra conduit to be buried during prior installations, conduit may be available for pulling new fiber optic cables.

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Call Before You Dig 811

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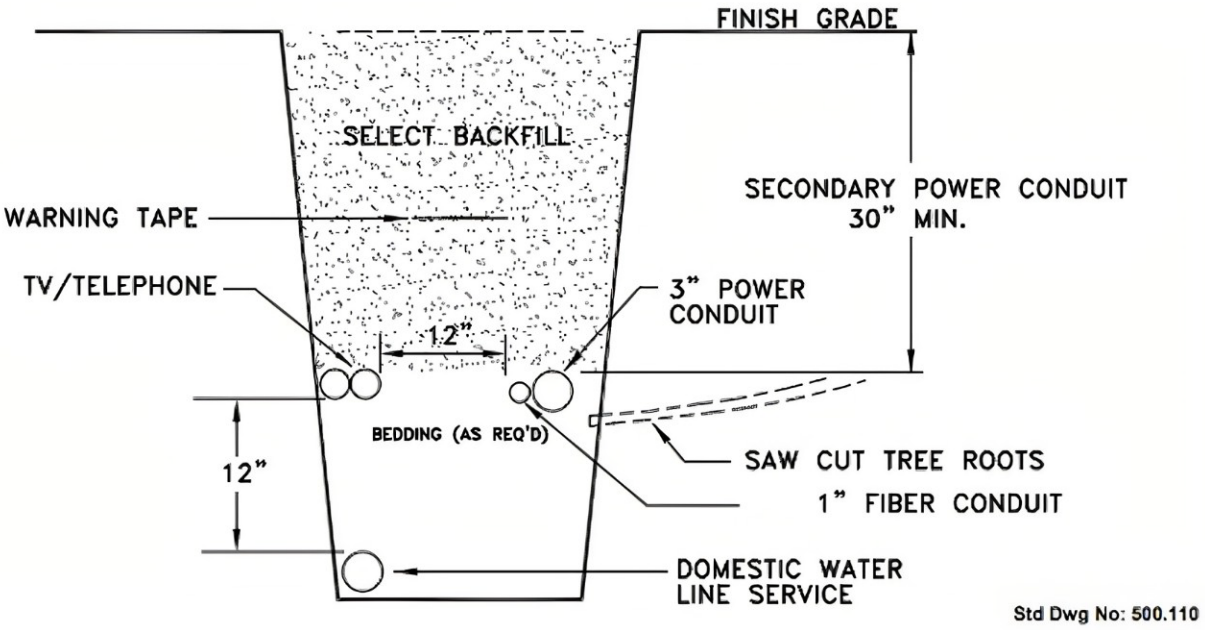
The old story about the fiber optic communications system failure being caused by "backhoe fade" is not a joke – it happens every day. But it reminds us that digging safely is vitally important. The risk is not just interrupting communications, but the life-threatening risk of digging up high voltage cables or gas lines. There are several services that maintain databases of the location of underground services that must be contacted before any digging occurs, but mapping these should be done during the design phase and double-checked before digging to ensure having the latest data.

At the same time as the cable is installed, markers like these indicating its location and ownership can also be installed.

Trenching

It’s immensely important for trenches to be excavated to such a depth that the crown of the duct has at least (32 inches) of backfill cover, in all soil conditions, except for where hard rock conditions are encountered. Where it is not possible to obtain the specified minimum trench depth.



The trench depth in hard rock conditions can be relaxed (i.e., apply for a concession) to a minimum depth of (12 inches) backfill cover over the uppermost duct. But it then requires protection in the form of a concrete slab (either pre-cast or cast in situ) placed on top of the padding material before backfilling. This concrete slab shall have a strength of 20 Mpa reinforced with high tensile wires and measure; (3 inches) thick by (12 inches) wide, and (36 inches) in length.

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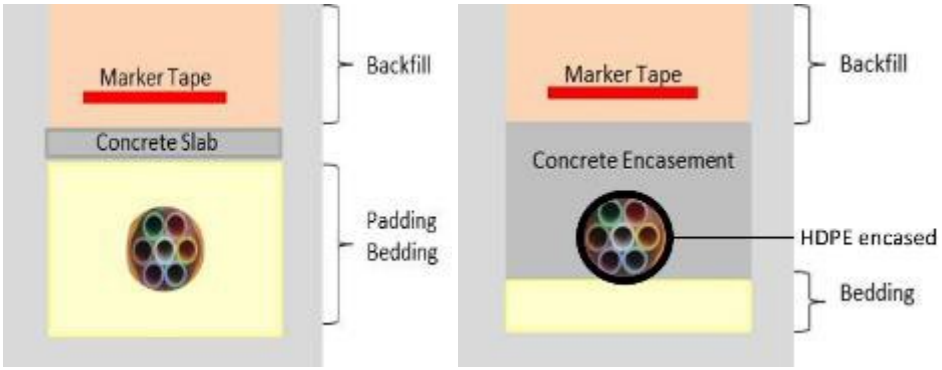


Concrete encasing is not endorsed enthusiastically by everyone; some argue that it turns a previously flexible duct into a long unreinforced concrete beam of little strength, prone to fracture with ground movement. And this in turn could potentially damage an encased duct. A view not shared by everyone.

Before pouring concrete, a slump test must be performed (take photos of this procedure). How do we measure the ideal slump? A slump of 4 inches or less is typically deemed acceptable (must not shear-off or collapse) - or as per client spec. Concrete that is poured too wet will be weak, regardless of how it is cured

Trench Width

One other obvious consideration is the width of the trench, which of course, is dependent on the duct diameter.

Trenches that are too narrow will not allow for proper duct installation, whereas trenches that are overly wide are unnecessarily costly. On top of this, a too wide a trench will allow for too much duct snaking from the reel memory. Below are typical examples of proper trench sizing:

Location of Wiring Method or Circuit	Type of Wiring Method or Circuit									
	Column 1 Direct Burial Cables or Conductors		Column 2 Rigid Metal Conduit or Intermediate Metal Conduit		Column 3 Nonmetallic Raceways Listed for Direct Burial Without Concrete Encasement or Other Approved Raceways		Column 4 Residential Branch Circuits Rated 120 Volts or Less with GFCI Protection and Maximum Overcurrent Protection of 20 Amperes		Column 5 Circuits for Control of Irrigation and Landscape Lighting Limited to Not More Than 30 Volts and Installed with Type UF or in Other Identified Cable or Raceway	
	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.
All locations not specified below	600	24	150	6	450	18	300	12	150	6
In trench below 50-mm (2-in.) thick concrete or equivalent	450	18	150	6	300	12	150	6	150	6
Under a building	0 (in raceway only)	0	0	0	0	0	0 (in raceway only)	0	0 (in raceway only)	0
Under minimum of 102-mm (4-in.) thick concrete exterior slab with no vehicular traffic and the slab extending not less than 152 mm (6 in.) beyond the underground installation	450	18	100	4	100	4	150 (direct burial) 100 (in raceway)	6 4	150	6
Under streets, highways, roads, alleys, driveways, and parking lots	600	24	600	24	600	24	600	24	600	24
One- and two-family dwelling driveways and outdoor parking areas, and used only for dwelling-related purposes	450	18	450	18	450	18	300	12	450	18
In or under airport runways, including adjacent areas where trespassing prohibited	450	18	450	18	450	18	450	18	450	18

Notes:
1. Cover is defined as the shortest distance in millimeters (inches) measured between a point on the top surface of any direct-buried conductor, cable, conduit, or other raceway and the top surface of finished grade, concrete, or similar cover.
2. Raceways approved for burial only where concrete encased shall require concrete envelope not less than 50 mm (2 in.) thick.
3. Lesser depths shall be permitted where cables and conductors rise for terminations or splices or where access is otherwise required.
4. Where one of the wiring method types listed in Columns 1–3 is used for one of the circuit types in Columns 4 and 5, the shallowest depth of burial shall be permitted.
5. Where solid rock prevents compliance with the cover depths specified in this table, the wiring shall be installed in metal or nonmetallic raceway permitted for direct burial. The raceways shall be covered by a minimum of 50 mm (2 in.) of concrete extending down to rock.

Areas where work is to be performed shall be cleared of all trees, shrubs, rubbish, and other objectionable material of any kind, which, if left in place, would interfere with the proper performance or completion of the contemplated work.

Pilot Holes

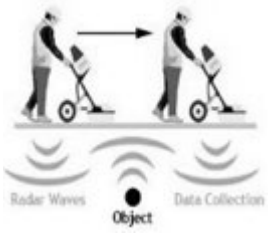
When the trench has been set out, pilot holes need to be dug at (80-100 feet) intervals, particularly at points where the new trench crosses existing services. The pilot holes should be at least 5 inches deeper and wider than the proposed trench.

Pilot holes are one of the most effective methods utilized not only for the location of services, but also to determine the position of a trench, relative to other services.

Location of Services

The Contractor will be liable for any damage to existing services. It is the responsibility of the Contractor to locate all existing services. No excavation work should begin without having a copy of the approved wayleave/s on site. A utility representative can be asked to point out the position of a service and sometimes even oversee the work.

Cable Locators can find the exact path and even estimate the depth of the utility service. Investing in a ground penetration radar (GPR) is the best investment for fail-safe trenching. They are used to identify underground services and formations although readings can be affected by the presence of high voltage power cables.



Ground Penetrating Radar Diagram

Any trenching done in the vicinity of existing services should be done very carefully to prevent accidental damage to a service. Hand excavating is necessary to uncover known services prior to commencing with

mechanical excavation.

Any damage to existing services must be reported immediately to the project manager.

Trenches Deeper than 4 feet.

Where the depth of a trench exceeds 4 feet and workers need to enter the trench, adequate measures must be taken by the contractor to provide support for this trench. No person must work alone in an excavation or trench that is greater than 4 foot deep.

3 basic methods used for protecting workers against trench cave-ins are:

- sloping
- trench boxes
- shoring

A ladder provides a safe means of access to the trench.

Barricades and signs are to be used at safe distances from edges to protect unattended excavations.

Machinery must never be placed in or near excavations and trenches where exhaust fumes may contaminate below ground atmospheres that workers are required to occupy.

Care shall be exercised in the moving or removal of shoring to prevent the caving or collapse of the trench faces being supported.

Suggested Trenching Practices (not mentioned elsewhere)

- All excavation work must be performed under the supervision of a responsible person who must be competent to exercise such supervision.
- Proper excavation and preparation of the trench will inhibit unanticipated longitudinal and cross-sectional strains and stresses on the duct.
- Trench walls shall be vertical for at least the height of the bedding and then as vertical as possible.
- Exercise care when trimming trench floors to ensure that they are level.
- If any street furniture (street names, traffic signs, bus shelters, etc.) must be moved, arrangements must be made with the relevant authority for the removal, storage, and re-erection.
- Mark-out the proposed trench with lime.

Barricading Construction

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- Provide adequate warning, guidance and protection for motorists, pedestrians, cyclists, and workers from all foreseeable hazards.
- In high traffic areas, erect fencing or place barriers measuring at least 3 to 6 feet in height as close as possible to the excavation. All barricading shall be well supported.
- An additional precaution is to provide clearly visible boundary indicators at night or when visibility is poor.
- Always wear high-visibility vests, safety boots and hard hats when working at or near a public street or highway or when working at night.
- When excavations are in progress next to the road, ensure proper and sufficient warning road signs placed at distances well before and after the work in progress. To warn approaching traffic, a flag person must be placed at least 150 feet before a “men at work” sign. Approved road cones must be placed at regular intervals along the whole route where trenching is in progress.
- Backfill as soon as possible.

Trenching Near Curbs, Guttering, Paving and Driveway Crossings

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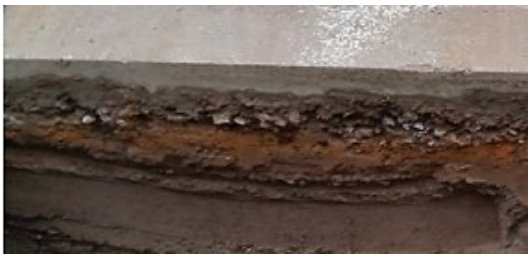
- Where excavations pass beneath curbs, guttering or driveways, etc., proper support shall be provided for these structures until tunnelling and backfilling is completed.
- Where tunneling is not an option, the existing concrete paving shall be neatly cut with an angle grinder to deliver smooth, uniform edges.
- Where ducts are to be laid beneath existing paving blocks, the pavers shall be carefully removed to be reused. Paving blocks must be re-laid on a bedding of sand and reinstated to their original state or better.

Road Crossings



- The contractor shall inform the relevant road authority 48 hours prior to the work or as required by local ordinances. It is the responsibility of the Contractor to ensure that every law regarding traffic, safety, traffic signs and barricading is complied with.
- Directional drilling is the preferred method for crossing roads as it causes minimum disruption.

- The angle of the crossing should be as near a right angle to the road centerline as possible.
- The edge of the trench must be cut using asphalt/concrete cutters to deliver smooth, uniform edges.
- The minimum depth that any service may be placed under a road is 32 inches.
- The duct/s shall extend at least 20 inches above the road's edge.
- All excavated material and equipment must be placed and demarcated in such a way to not inconvenience vehicles and pedestrians.
- No person may off-load on a public road any materials that are likely to cause damage to a road surface.

Stream and River Crossings

Before any serious thought is given to the installation of a high-density polyethylene (HDPE) duct at a river crossing, the network designer will consult with a geotechnical expert to conduct a comprehensive study.

This investigation will reveal the most efficient way to accomplish the crossing in question. Horizontal directional drilling (HDD) (discussed later) has become a popular river crossing option, and as explained later, rightfully so.

The duct must be sealed at both ends to prevent water or dirt ingress.

Bridge Crossings

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This work is typically undertaken by experts in this field. First and foremost, the use of existing ducts or service culverts within bridges must be fully explored. Not all bridge structures will have the exact same installation configuration and procedures may vary to accommodate your specific requirements. Ducts attached to the underside of bridges must not affect its load bearing capacity, reduce the clearance, or cause other issues.

The contractor shall inform the bridge owner 48-hours prior to the commencement of the work.

The most common method to be used will involve the use of a hydraulically operated crane fitted with a safety basket be positioned adjacent to the bridge balustrade. From this position, workers wearing safety harnesses can be hoisted over the balustrade and lowered into a working position as required.

Bracket mounting positions can now be marked out on the side or underside of the bridge as directed by the design drawings and instructions. Next, drill the holes, fit the concrete anchors and mounting brackets, and firmly secure them.

The steel or ultra-high-density polyvinyl chloride (UPVC) base carrier duct can now be positioned and firmly secured. The micro ducts can then be pulled through the newly mounted base carrier. Use a continuous length of duct (no joints permitted).

Where required and as stipulated in the design instructions, both the approach and departure ends may have to be encased in concrete where they traverse the bridge abutments and enter the ground. It is desirable of course, for the end-product to be both safe and visually appeasing.

Trenching Near Power Cables

Where no physical barrier exists, no duct or cable shall be laid within (24 inches) measured horizontally, nor cross within (12 inches) measured vertically from any high voltage power cable. Where this separation is compromised, the duct or cable must be separated by concrete slabs.

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The standard protection slab is (36 x 12 x 3 inches) thick. This slab will be reinforced with (1/8 inch) high tensile wires.

Rock Blasting

Blasting for excavation shall not be performed without written permission obtained in advance, from the agency having jurisdiction. Procedures and methods of blasting shall conform to all local laws and ordinances. It is the responsibility of the Contractor to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to blasting.

Duct Deviation

Handholes and manholes typically facilitate changes in direction. However, ducts may deviate from a straight line provided that individual lengths may be offset by no more than (1.4 inches), the offset is in the same direction, this to avoid creating S-bends and the maximum overall deviation between MHs / HHs does not exceed 15˚.

Spacers should be used when placing multiple ducts in a trench. They prevent ducts from twisting over and around each other. By keeping the ducts in straight alignment, cable jetting and/or pulling tensions will be reduced.

Steep Gradient Trenching

Where excavations need to be done on inclines, a layer of sandbags should be placed at regular intervals (15 feet), to prevent the possible wash away of backfill material. Always consider the risks of land stability or earth movement, when trenching on embankments (specialist technical investigation may be required).

Tree Roots

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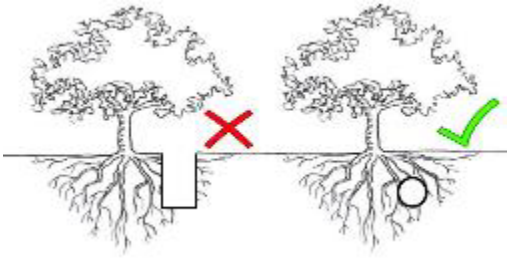

Prior to undertaking tree/bush/shrub clearing/cutting as may be necessary for trenching, approval in writing from the relevant authority and/or property owner needs to be obtained. Tree roots exposed while trenching must not be cut unless unavoidable. Never cut roots over 1 inch in diameter unless advice has been sought from the local authority. Ducts are to be sleeved in a HDPE pipe, if not 5 inches away from existing tree roots.

Surface Material

Surface material (paving slabs, soil, grass, etc.) removed for construction must be kept apart by placing them on opposite sides of a trench, where they are least likely to interfere with traffic, pedestrians, and drainage systems. Mow-able lawn shall be cut in square blocks and put aside and be kept moist until reinstated. Where trenches pass through gardens, the contractor shall seek direction from the owner.

Duct Un-Coiling and Installation Process

Duct un-coiling can be accomplished by pulling the conduit straight into a trench from a stationary rotating de-coiler or by laying the conduit into the trench from a forward moving de-coiler positioned on a trailer. Ducts shall not be un-coiled without the use of a Vertical or Horizontal De-Coiler. De-coilers will prevent twisting, bending, or kinking from occurring during the installation process.

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Once the duct coils are secured inside the de-coiler, only then can the containment straps on the duct coil be cut. Next, rotate the de-coiler slowly to unwind the duct out in one plane.

Generally, the ducts are placed in the trench, one length at a time and joined on the floor of the trench using couplers. As the ducts are laid and jointed, install end caps on ducts at all MH/HHs to prevent water and dust from entering. Care shall be taken to ensure that no dirt collects between the duct and coupler to deliver an airtight seal.

Ducts shall be laid in a straight line between MH/HHs. It is never ideal to have directional changes, but if unavoidable - keep the bending radius as big as possible and offset is in the same direction. At MHs or HHs where the duct goes straight-through, allow for sufficient slack for the duct to be secured against MH or HH walls.

Duct Installation - Moving Trailer Method

This method is most efficiently used where the path to be followed does not contain any obstructions that require the duct to be placed under. Move the trailer slowly along the trench route while unwinding and placing the duct in the trench. Take care not to over spin the reel.

Duct Installation - Pulling Method

The duct can also be pulled and placed by hand or by a mechanical pulling machine with the help of a pulling device that is fitted in-between duct and mechanical pulling machine. the two types of pulling attachment devices most used are a pulling grip or basket grip.

Filling the Trench

A typical trench will be filled with the materials shown in the diagram below.

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Bedding and Padding

Bedding is the material constituting the even floor of an excavated trench onto which ducts are laid. The bedding should be raked if necessary to ensure it is level. Padding the layer of material covering the ducts. The material used for bedding and padding must be of a granular, non-cohesive nature, graded between 0.6 mm and 13 mm, or as per client spec. It is desirable to pass both bedding and padding through a sieve before putting it back in the trench.

Care shall be taken to place padding material simultaneously on both sides of the duct to prevent lateral movement. The compaction of padding shall be executed manually using a hand tamper. Duct buckling is much more probable when the padding material does not provide adequate side support.

Backfill and Warning Tape

After the padding is tamped, backfilling of the trench can be done. Material excavated from trenches

may be used as backfill, if it contains stones no greater than 150mm (6 inches) in diameter, trash, or organic matter that could potentially damage ducts.

Backfill material is to be installed in layers not exceeding 300 mm (12 inches), with each layer compacted before the next is added. After compacting the first layer of backfill, the warning or marking tape is placed. Take photos of this procedure as proof of existence. Hopefully, the warning tape will be encountered before damaging any ducts or cable.

Backfilling (Concrete)

Before filling the trench with concrete, check the consistency of the concrete (slump test). Tamper the concrete using special care not to damage the ducts. Check for cavities in the concrete. Allow for the concrete to cure (harden).

As mentioned earlier, some contractors believe a concrete backfill turns a once flexible duct into a long unreinforced concrete beam of negligible strength, very likely to fracture with ground movement. This in turn could potentially damage the duct. This view is not shared by everyone.

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Trench Compacting

Once a poorly compacted layer is in place, it is difficult if not impossible to achieve good compaction in the layers above. This is a key point; a consequence of poor backfill compaction is the high percentage of air voids. Manual compaction is performed until the ducts are covered by both a 6 inch layer of padding and 1 foot of backfill, at which point a vibratory plate compactor can be used.

The compaction of the final backfill layer shall be by means of a compaction machine and shall be compacted to a density higher than or at least equal to that of the virgin soil parallel to the trench. After completion of the backfill, a DCP test must be done. This test must be documented.

Optimum Moisture Content (OMC)

Moisture conditioning of the backfill material shall be carried out by the contractor. If not specified by the client, the following 2 Field Tests for Optimum Moisture Content (OMC) can be used:
A handful of backfill tightly squeezed in the hand, shall be wet enough so that it binds together with no more than slight crumbling when the hand is opened.

Dynamic Cone Penetrometer (DCP) Testing

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- All excavations are subject to compaction tests - which must be documented.
- 8 tests per mile is recommended.
- Uses a free-falling 18-pound hammer which strikes a cone, causing the cone to penetrate the soil and then measuring the penetration per blow, called the penetration rate (PR), in mm/blow.
- Always keep the DCP vertical and watch where you place your fingers.
- The trench density must be better or at least equal to that of the virgin soil parallel to the trench.
- A 1/2-inch PR is typically deemed acceptable.

Micro-trenching

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The time-honored method of burying ducts involves digging trenches with a backhoe or a pick and shovel brigade. Alternative methods of deploying underground fiber cables include using storm water drains and sewers, while another is micro-trenching, which involves using a machine to cut a narrow slot in the road surface. The benefits of micro-trenching are less disruption to roads and sidewalks, faster deployment, and more cost-effective trenching.

Micro trenching is also highly effective with micro ducts and blown micro cables. A single groove can hold a 6-duct micro duct that can allow installation of 144 or 288 fiber cables. If only one cable is needed at the time of construction, adding cables in the future can be done without additional construction.

Depending on the type of road and the depth of existing services, the micro-trench can be anything from (0.8 to 2.5 inches) wide and, (12 to 20 inches) deep, usually near the edge of the roadway. The machine has a blade in front (much like a giant angle grinder) which cuts into the road surface.

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Horizontal Directional Drilling (HDD)

HDD is a drilling process where a drill head is steered underground. This method is adopted by all companies but generally sub-contracted to specialists. HDD is the preferred method to crossroads, highways, railway lines, rivers and all other services that may prove to be too dangerous or costly to cross using conventional methods like trenching and/or ploughing. Rigs capable of drilling up to 300 meters (1000 feet) in one drill are available and various sizes of ducts can be installed with this equipment.

The depth of any hole drilled for the installation of a new service, must be at least 800 mm (32 inches) below surface of the road, or as per client spec. At river crossings the distance between the bottom of the water and the drilling hole should be 10-times the diameter of the pipe and not less than 3 m (10 feet). If the accuracy of the drilling is not specified in the wayleave, the area in which the drilling may wander should not exceed a (1.6 inches) diameter around the predetermined axis.

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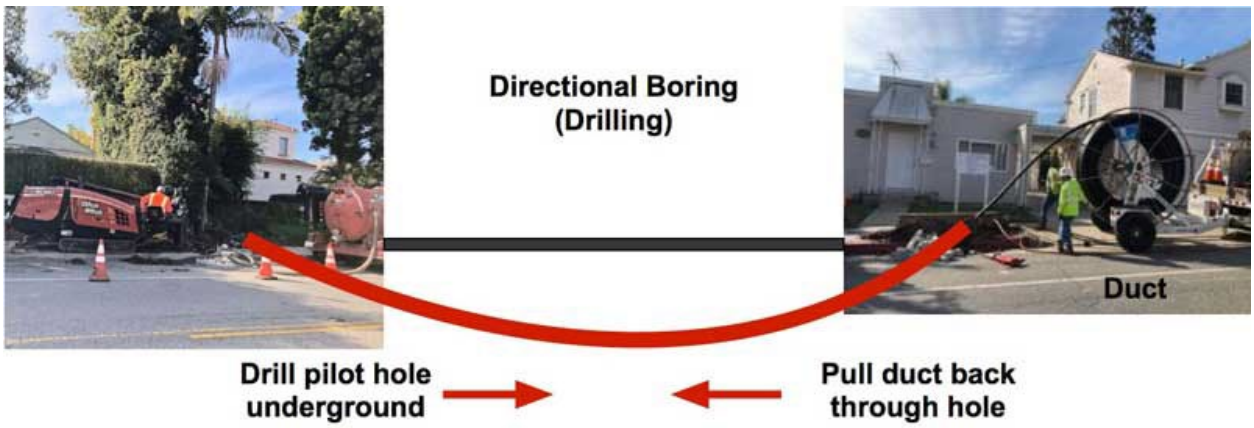

The HDD process involves 3 installation stages: pilot drilling, reaming the pilot hole and pulling the duct into the reamed hole. The course of the drill is monitored and can be controlled as rods progress following an upward sloping path, before emerging at an intended point. The drill head is then removed and replaced with a back reamer, ± 20% larger than the duct or cable to be pulled into the hole. The duct is attached to a swivel connection on the back reamer. The drill-rods and reamer are rotated and pulled through the hole, enlarging it and pulling-in the duct at the same time. The whole operation is carried out with pressurized drilling mud, which both carries away the spoil and supports the hole.

The covering must not be less than three times the final diameter of the drilling hole and at a minimum of 1.5m (6 feet). Soil removal during the drilling process is the responsibility of the contractor.
As always, the location and depth of underground services must be pre-determined before drilling can commence - as sudden deviations are not possible to bypass obstacles.

Direct-Buried Installations

On paper, direct-bury is simple and very cost-effective - you dig a trench, install the cable, and re-instate. However, once in the ground, it is perhaps more susceptible to damage from unrelated digging activities than cable in a duct, and much more importantly, it is difficult to access and repair.

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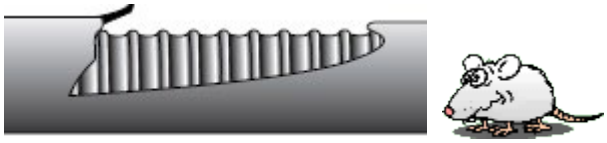
In general, plowing-in the direct burial cable is the most desirable and economical method of cable placement in open or rural areas where there likely to be fewer obstacles to impede the progress of the plowing equipment. In urban or sub-urban areas where there can be many obstacles such as underground utilities, sidewalks, road crossings etc., trenching has advantages.

On all direct-buried installations, armored cable must be deployed -which provides for both crush protection and prevention of rodent penetration.



If only an armored cable is to be placed, a trench no wider than (15 inches) will do. The trench should be (4 feet) deep or as stipulated in the wayleave. Grade off abrupt changes in terrain ahead of the plough. Excavate at least 5 m at the starting point, to allow for the plough to immediately lay the cable at the correct depth.

Always start the plough tractor's movement slowly and increase speed gradually only after the cable slack is taken up from the cable delivery system.

Ploughing operations must be observed continuously for obstructions, proper feeding of the cable, specified depth, following of the marked route, and the safety of the crew. Stoppages in the plough-in process should only be for the loading of cable or marker tape and when the terrain demands for this.

Warning Tape must be placed approximately 1 foot below the ground surface, directly above the cable.

It is critically important for manholes and hand holes to be built only after the plowing-in of the cable. Pre-fabricated man holes and hand holes are often utilized.

Each section, after plowing-in, the cable must be checked with an OTDR (Optical Time Domain Reflectometer) for possible damage.

After the plough in process is completed, the trench must be levelled by back blading with the plough-in machine or using a TLB to level the disturbed areas.

Armored Cable Grounding (Earthing), Bonding and Surge Protection

The National Electrical Code (NEC) recommends that non-current carrying armor shields and metallic strength members be bonded and grounded.

Proper grounding and bonding is required for the safe and effective dissipation of unwanted electrical current, and it promotes personal and site safety. Typically, optical fiber cables do not carry electrical power, but the metallic components of a conductive cable are capable of transmitting current. When the armored cable is correctly bonded and grounded, it minimizes the risk of unwanted electrical current that could potentially harm personnel, property, or equipment. Required…By electrical codes and equipment manufactures | To protect personnel and equipment

The armoring of optical fiber cables shall be lugged and bonded to an earth bar using a soft multi-stranded 6 mm² green / yellow insulated bonding cables. Bonding cables shall be kept as short as practically possible and must contain no sharp bends.

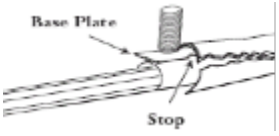
Note: The difference between the terms bonding and grounding:

- Bonding is the multiple connections to metallic parts (at every joint), required to form a continuous electrical path.
- Grounding is the act of connecting that path to an earth.

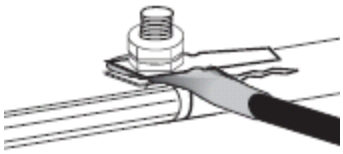
The Procedure

Use a cable knife to score the outer sheath of the armored cable approximately 25 mm (1 inch) long. Take care not to damage the inner sheath.

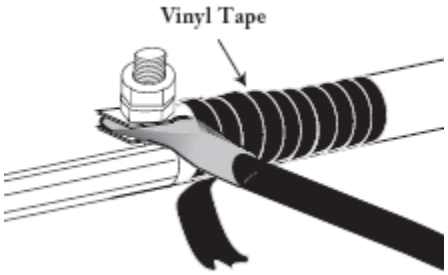
Slide the base plate under the armor.



Place the top plate over the base plate and tighten down the lock nut.



Cover the grounding clamp and split portion of the sheath with vinyl tape and connect to the ground system or bond thru.



Underground Cable Markers

In 'non-built-up areas' underground routes must be marked with identifiable markers.
GPS coordinates of all MHs /HHs must be taken and documented to form part of the as-built documents. These markers shall have a length of not less than 6 ft and a diameter of not less than 5 inches. Markers shall be planted 24 inches deep, opposite a MH or HH and be well compacted. Passive markers can also be buried at key points during construction or used to mark existing facilities.

Manholes and Handholes

Manholes (MH) and handholes (HH) shall be positioned as far away as possible from road junctions. MHs and HHs must be built according to prescribed dimensions and specifications.

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Before any concrete is placed the Contractor shall examine the shuttering for firmness and correctness of position and remove all dirt and other foreign matter.

Hand mixing of concrete is permitted in exceptional cases but only with written permission of the client. Concrete mix shall be such that a strength of 20MPa (2.5:2.5:1) is obtained 28 days after pouring.

Duct entry points into HHs / MHs must be drilled, without cracking or damaging the surrounding structure. Ducts shall enter and exit HHs / MHs in line with the direction of the route, for them to be coupled thru without any obvious effort, as a continuous duct.

HH / MH external labeling should be done on the coping and NOT the lid, as lids can get damaged and be replaced. GPS coordinates for the location must be recorded. On completion of a HH / MH, the Contractor shall re-instate the area around the HH / MH to its original state or better.
HH / MH covers shall be finished flush with the surface area.

Where bricks are used to construct HHs the following must apply:

- Written permission obtained from the client.
- Use only baked quality clay bricks sourced from an approved manufacturer.
- The wall thickness must be double brick or better.
- Re-enforce every third layer of bricks.
- The outer wall must be waterproof.
- Use an approved footway-type or roadway-type frame and cover.

HH Installation

- All duct entries and exits at the HHs must be a watertight seal.
- All ducts in HHs shall be coupled through.
- Incoming ducts must have a watertight seal.
- Ducts must be sealed with a watertight coupling cast or inserted into the wall of the HH.
- HH covers must be watertight or must have at least a double seal.
- HH covers should be 150 mm (6 inches) above natural ground level with the fill shaped back to natural ground level in a 2 m (6.5 feet) radius around the HH cover.
- On paved sidewalks or verges, next to roads or streets, a cast in-situ concrete or asphalt backfilling shall be sloped to not impede pedestrian traffic. In these instances, the HH installation shall be such that it is not more than 2 inches higher than the surrounding paved sidewalk.
- The inside surface of the HH shall be sealed using an approved bituminous product.

HH / MH Inspection

- Splice closures are secured.
- Cable slack neatly stored and secured with no compromise to the bending radius.
- Leave tidy and clean.
- Ducts sealed in-between the wall.
- End Caps fitted to empty ducts.
- Used ducts sealed in-between cable and duct.
- Cables and ducts are clearly labelled.
- HH/MH clearly marked on the coping.
- Locating disk in position.

Safe HH / MH Working Procedures

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- Obtain a HH / MH entry ref for the work to be undertaken.
- At least 2 people must be present before entering a MH.
- Ensure that the vehicles are parked in such a manner that they do not create an obstruction or hazard to traffic and/or pedestrians.
- Use barricades and cones that are clearly visible around the HH / MH.
- Pour water around the lid of the HH / MH, to prevent creating a spark when opening it.
- Lift HH / MH covers using your legs and place the cover at least 2 m (6.5 feet) away from the opening.
- Before entering the confined space, test at 3-levels (bottom, middle, and top) for:
- Oxygen content
- Flammable or explosive gases
- Hydrogen sulfide
- Each level must be tested for a minimum of 60 seconds.
- Use only an approved calibrated gas detector.
- Ensure that the gas detector is in operation the entire time spent in the MH.
- An aluminum ladder in good operating condition must be used to enter the MH.
- Raise or lower tools and/or equipment into a MH using a rope or bucket.
- Never place equipment or tools near the edge of a HH / MH.
- Constant ventilation is required when performing work within an MH.
- Water in a MH (not containing object-able content) shall be pumped-out into the storm water system. If not possible, or onto area, a suitable distance away, with positive drainage.
- Never fusion splice in a HH or MH.

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Installation Underground in Other Services

There are methods using robots to install fiber optic cable in storm sewers or other underground pipes. They have been used in central cities where construction is difficult but not widely.

Trenchless Technology

Trenchless technology has opened doors to many new and interesting developments. Projects that were once thought too grand in scale to be reality are now being successfully completed utilizing state-of-the-art Horizontal Directional Boring Machines. The greatest ambitions of pipeline professionals are now in the realm of reality and the industry has celebrated some truly remarkable milestones.

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Vacuum Excavating

We are a leader in air-vacuum excavation systems, having pioneered the use of high-pressure air delivered through our premium nozzles to expose underground utilities. Our underground utility locating equipment is designed to dig potholes and trenches in any kind of soil.

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Missile Boring

When worksite will not allow for directional boring equipment, pneumatic missile boring can be utilized. Our method of pneumatic missile boring is perfect for compact work sites and eliminates the need for a large, cumbersome, and costly directional boring or drilling rig in most cases.

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Trenching & Plowing

BbI utilizes the latest in QUAD Plows and Trenchers. We can use many methods to complete the trenching that is required and use the proper method to minimize disruption to the surrounding area.

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Aerial Cable Installation

Deploying fiber above ground on poles or towers removes the need for underground digging and is particularly useful when the ground is uneven, rocky or both. Aerial installation is much less costly than underground construction also.

Fiber in a duct solution has a major aesthetic advantage; once installed, they are invisible, leaving no mark on the landscape. Unlike aerial installations, they are less affected by most adverse weather like high winds or freezing rain. But underground installations can be vulnerable to flooding damage.

However, there are several reasons for choosing an aerial solution, such as:

- Aerial fibers are typically much faster and cheaper to deploy than buried networks.
- The planned route may be undulating, rocky or both, making digging less appealing.
- All-Dielectric Self Supporting (ADSS) cables can be erected near power transmission lines. This allows for pole sharing, which reduces installation costs and speeds up deployment.

Before beginning aerial installations, the design of the cable plant must be properly done and checked. Routes must be surveyed, ground conditions tested, all components procured and received. Permits from local authorities must be obtained and coordination with local agencies such as traffic and police must be meticulously planned.

If poles exist already, it is required to have proper permits for adding communications cables and the poles must be “made ready” by the owner of the poles are authorized parties. This may take considerable time which must be factored in the planning of the project. Sometimes lightweight fiber

cable may be lashed to previously installed cables such as older copper phone cables or CATV hardline coax, but proper permissions must be obtained.

Prior to installation, the location of splice points and storage of slack cables must be determined and noted in the design. Splice locations should be chosen with the need for parking a splice truck, van, or trainer nearby.

Cable Jackets

Polyethylene (PE) is the material of choice for use as an aerial OSP cable jacket. The performance of raw PE can degrade rapidly through exposure to sunlight but the addition of carbon black to the cable jacket absorbs the UV light to protect the plastic jacket of the cable. Jacket colors other than black are rarely used for aerial installations and then only for enhancing identification.

Safety

Aerial cable installation can be hazardous as personnel may working at considerable height above the ground on ladders, bucket trucks or even climbing poles and near electrical transmission wires. All workers should have proper training and personal protective equipment before being allowed to work on aerial installations.

Pole Handling Personal Protection Equipment (PPE)

- Safety boots with steel caps.
- Protective clothing with long sleeves.
- Shoulder pads.
- Gloves.
- Hardhat.

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Climbing Ladders

- Keep hands free of tools or materials when climbing or descending a pole or ladder.
- Workers climbing up or down ladders must always face the ladder and maintain a 3-point contact. This effectively means that 2-hands and 1-foot or 2-feet and 1-hand must be always on the ladder.
- Ladder must be positioned correctly (1-4 ratio).
- The ladder must be properly secured (lashed and held).
- The ladder must be in good condition.
- The ladder must suit the application.
- A worker must be correctly positioned on the ladder.
- A safety harness must be worn and secured to the pole once the working position is reached.
- Never climb intermediate poles if the span they support is being placed under tension.

Transportation of Poles

Poles must never exceed the 20 inches vehicle overhang and must have a red flag secured on the overhanging end. Poles that are loaded onto a pole carrier must be secured to ensure that the cargo does not move while it is in transit.

Pole Off-Loading Procedure

Ensure that the removal of any one pole will not cause shifting or rolling of any of the remaining poles.

Step 1: Unfasten the poles.
Step 2: Slide one pole at a time towards the rear end of the vehicle.
Step 3: When the pole reaches its equilibrium point, the people on the vehicle must raise their end slowly.
Step 4: The people on the ground gently pull the pole until 1m of it is left on the back of the vehicle bed.
Step 5: The persons on the ground receive the pole and gently place it on the ground.

A pole must never be dropped on the ground, as this could damage the pole and/or cause injury to team members.

Pole Handling Ratios

Smaller poles may be handled manually with sufficient personnel available but larger poles require proper mechanical aids.

23-foot pole =4 people
26-foot pole =6 people
30foot pole = 8 people or a mechanical aid
32-foot pole = mechanical aid.
36-foot + pole = mechanical aid

Survey

- Survey rods must be planted in line at selected pole positions so that, when erected, the poles will be in a straight line.
- A spirit level must be used to verify that there is no lean to the rods.

- As the survey advances, the rear rods used for lining up - will be withdrawn and survey pegs driven into the ground in the exact position previously occupied by the survey rod.
- The location of the poles to be erected along roads shall be in accordance with the way leave drawings and conditions stipulated by the authorities concerned.
- Square wooden pegs shall be used to mark the position of every pole, stay or strut.
- The numbering (or other details) and marking of the wooden pegs shall be done as agreed by the client and contractor.
- The tops of pegs that show the positions of angle poles must be marked with blue lumber crayon crosses.
- A survey peg for a strut position must show the approximate spread of the strut.

Survey Equipment and Tools

- Digital camera spare batteries.
- GPS with tracking function and spare batteries.
- DCP tester.
- Tape measure.
- Measuring wheel.
- Survey pegs and hammer
- Road cones.
- Clip board, survey sheet/notebook and stationery.
- Construction vehicle – with signage and an orange light mounted on the rooftop.
- Road map and/or proposed route detail drawing/s from the client.
- Reflector jacket.
- Personal Identification.

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Survey - Gather Route Information

- The information on this route must accurately indicate distances.
- Take photos of all obstacles on the route (existing services, bridge crossings, rocky areas, buildings, built-up areas, paved/tarred areas, wetlands, overhead obstacles, etc.).
- Identify all obvious landmarks where the route changes direction (take photos).
- Note down any road repair work necessary - record distances and GPS coordinates.
- Provide a series of DCP test readings along the route and document the exact positions.
- Description of the topography along the route (sloping, edge of cliff, adjacent to lake, forest surroundings, rivers, swampy areas, etc.) - record distances and GPS coordinates.
- Description of the ground condition along the route and distances (rocky, sandy, grassy, clay, etc.) - record distances and GPS coordinates.
- Indicate the distance to the nearest town, where the civil works material (sand, cement, stone, water, tools, etc.) can be sourced from.
- Locate warehouse/camp sites where material can safely be stored.
- Indicate the availability of hospitals / clinics / police stations along the route - in case required during operational activities.
- Plan the route to allow for projected road or rail deviations.
- Double-check recorded details on the return journey.

Pre-Install Meeting

A pre-install meeting or meetings must be held to discuss the survey results, the optimum pulling sites, span lengths, installation equipment and hardware requirements, coordination, splice locations, terrain, and other vital installation topics.

Checks to be undertaken prior to commencing with the planned aerial work

- Does the contractor have approved aerial route drawings, signed by the client?
- Do the drawings show the alignment of the aerial route within the wayleave specification?
- Are the wayleaves in place? (Must always be kept on site).
- Have the locations of existing services been marked and shown on drawings?
- Are the aerial route drawings being marked indicated on which side of existing road/pathway to stay?
- Has the accessibility of poles to splicing vehicles been considered?
- Does the cable have a UV resistant cable jacket?

Wooden pole inspection (prior to installation)

- Correct type of pole supplied? (Length and thickness)
- Excessively bent or cracked poles should never be used. Horizontal cracks perpendicular to the grain of the wood may weaken the pole. One large knot or several smaller ones at the same height on the pole may be evidence of a weak point on the pole.
- Inspect the pole for evidence of termites or ants.
- Ensure that all poles are fitted with ‘end plates’ and strapping at both ends.
- The poles should never be off loaded and stacked on the ground for extended periods as this could cause damage to the poles as well as the environment.
- Hammer Test (existing poles): Rap the pole sharply with a hammer weighing about 2 pounds, starting near the ground line – then continue upwards around the pole to a height of approximately 5 feet. The hammer will produce an unmistakable sound and rebound sharply when striking sound wood. Decayed areas will be indicated by a dull sound, or a less pronounced hammer rebound.

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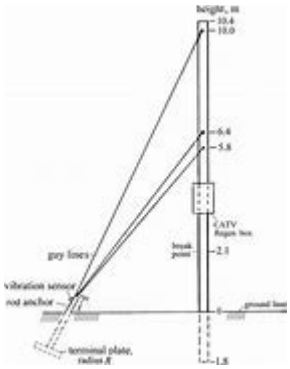
Hole-digging Tools

The tools provided for hole-digging include picks, shovels, earth augers, crowbars, drills, and sledgehammers. The tools to be used for any work are determined by soil conditions. On large projects and wherever ground conditions permit, hydraulically powered Earth Augers can be used. It looks much like a corkscrew and produces extremely clean holes.

Pole Holes

Poles must be buried sufficiently deep for stability. The depth depends on the height of the pole. Check with local authorities to confirm these dimensions.



Length of pole	Plant depth
< 6 m (20 feet)	0.9 m (3 feet)
7 – 8 m (23 – 26 feet)	1.2 m (4 feet)
>9 m (30 feet)	1.5 m (5 feet)

All excavations for pole holes will be such that the survey peg indicates the center of the hole. If the holes are too large, the soil will be unnecessarily disturbed, and the poles will not be supported by solid earth. (A diameter of approximately 400mm (16 inches) is recommended). Where a hole is dug on sloping ground, the depth of the hole shall be measured from the lowest point on the ground surface. In extreme rocky conditions where holes cannot be excavated to the specified depth, an arrangement between contractor and client can be reached for poles to be set in concrete.

Poles set in Concrete

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Where poles are planted in soil that is difficult to compact, such as sand and swampy areas and in extreme rocky conditions, the poles can be cast in concrete. Only new wooden poles can be set in concrete. The hole must be circular in shape. The hole diameter must be kept to a minimum but be sufficiently wide to accommodate at least 4 inches of concrete between the sides of the pole and the undisturbed ground.

The concrete to be used must be made from a mixture of 1 part cement, three parts sand and three parts crushed stone (1:3:3 mix - 15MPa). Concrete must not be compacted around the poles, but thoroughly tamped around the pole with a suitable wooden stick, until the hole is filled. The bottom of the pole must be allowed to “breathe” – therefore, backfill with 4 inches of soil before pouring concrete.

Pole Spacing

It is advisable to maintain a uniform span length and depart from this only when it is rendered necessary by conditions such as: (1) uneven ground (2) sharp bends (3) or to avoid dangerous positions. This may necessitate the planting of additional poles or omitting of poles. Steel measuring wires for standard span lengths should be made locally. When the length of span has been chosen the appropriate wire should be used to determine the distance between successive poles. A steel tape measure should be used for checking the length of the measuring wire daily during the survey.

Local ADSS Span Lengths

All dielectric self-supporting fiber optic cable can be installed without a messenger over relatively long span. ADSS installation will be covered later.

Type of route	(m)
Short span	83
Medium span	250
Long span	500

Pole Planting Process

- Ensure that all holes necessary for pole dressing are drilled prior to erection.
- A pole should be erected by laying it on the ground in such a position that by raising the top section, the base should slide into the hole.
- Backfilling and ramming must take place in (6 inches) intervals.
- Where stones are available, they should be used to stiffen the holding.
- During the backfill and ramming process, always ensure that pole plumbness is maintained.

Suggested Pole Planting Work Practices

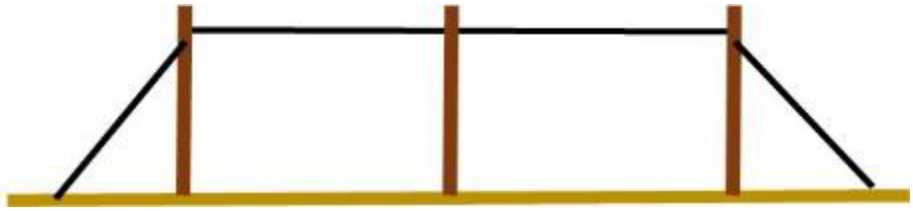
- Avoid dongas, culverts, drains or water channels.
- Avoid obstructing private roads and entrances.
- Restrict road crossings to a bare minimum, and if possible, stick to the same side of the road throughout.
- Avoid trees and where not possible, select a position which will minimize interference from trees – even at the expense of construction costs being increased slightly by this action.
- Along national and other proclaimed roads the poles and stays should be in the position agreed to by the Road Authority and as indicated on the wayleave.
- Keep the route as far away as possible from power lines.

- Where the ground is exceptionally soft, poles may be planted (12 in) deeper than specified, but only if the necessary vertical clearance is maintained.
- Ensure that all holes necessary for pole dressing are drilled prior to erection.
- Maintain at least 3 feet from trig beacons and stations.
- The principle to be followed in all cases is that neither stays nor poles are to be planted where they are likely to cause obstruction or to be dangerous to users of the road, or where they are likely to interfere with ordinary road maintenance such as the clearing and trimming of the edges of the road or the cutting of drains, gutters, etc.
- In railway reserves, the poles should be located as close as possible to the boundary fence.

Types of Stays

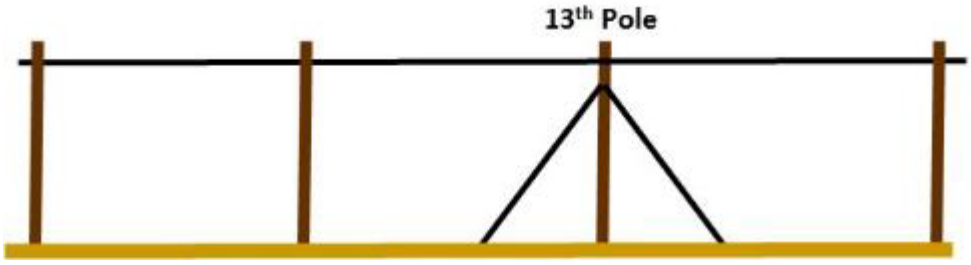
Terminal Stays

Terminal stays are provided where the route starts and ends. This stay must be on the side of the pole opposite the direction of the cable route.



Line Stays

Line stays should be installed at every 13th pole along the route or spaced alternatively as per specification. Line stays must be installed on poles either side of rivers and road crossings where normal span lengths are exceeded.



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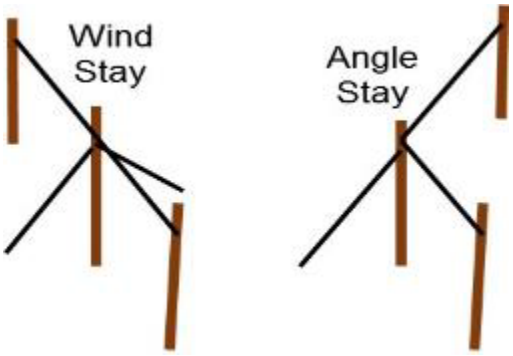
Wind stays & Angle stays

Wind stays are used to stabilize a cable route against wind. Fitted at 90˚against the direction of the cable route and on either side of a pole. Angle stays are used to counter-act a change in direction of the cable route by more than 15˚or as per client specs.



Stay Guards

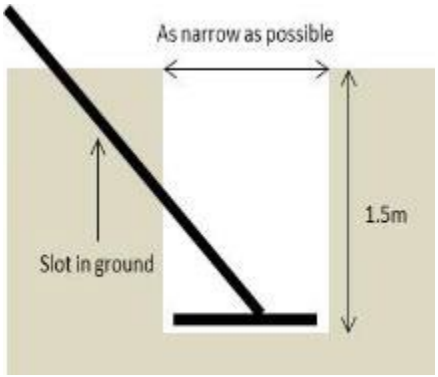
Stay guards must be fitted on all stays exposed to pedestrians, cyclists, or vehicles, to make them more visible.

Struts

Struts can be used as an alternative to where stays create traffic hazards, block roads or where a property owner objects to the fitting of a stay. Struts must be installed on the opposite side of the pole to where the angle stay would have been fitted, to counteract cable strain.

Stay Holes

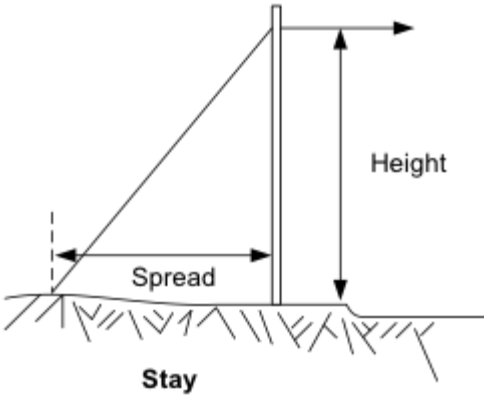
The cross-section of the hole shall be confined to the smallest size necessary to accommodate a stay plate.



The depth of stay holes shall be (5 feet) meters or at such a depth where the unthreaded portion of the stay rod protrudes by no more than (1 in) above ground level. Stay rods without plates may be used where solid rock is encountered. The stay rod is now inserted in a hole drilled into the rock and secured with cement. In difficult to dig ground conditions shallower holes are allowed subject to approval and shall then be backfilled using concrete.

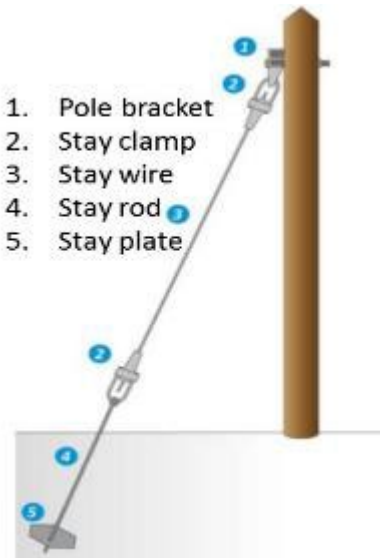
Spread/Height Ratio

The spread is the distance from the foot of the pole to the point to where the stay enters the ground.



- The height is the distance from the ground to the pole attachment.
    - Wind stays shall have a spread/height ratio of 0.6:1
    - Terminal and line stays has a spread/height ratio of 1:1

Termination of Stay Wire to Pole or Crosshead



- Wrap the top pre-formed “make-off” without overlapping around the pole twice at the prescribed height with ends meeting.
- Twist the top of the preformed “make-off” around the stay wire.
- Cut the stay wire to the correct length to ensure that the proper spread/height ratio is maintained.
- Place the bottom of the preformed “make-off” through the crosshead eye.
- Then pull tight and cut the suspension wire in line with the crosshead and twist the bottom preformed “make-off” around the stay wire (ensure that the crosshead is threaded to the outer most of the stay rod).

Messenger Wires (Suspension Strands)

If the cable is to be lashed to a messenger wire, the messenger wire must be sufficiently strong to support the cable under expected environmental conditions, including wind and possible ice in winter. If designing an aerial system requires installing a messenger wire, the design must include calculations for the messenger wire size based on expected cabling loads, span lengths and other possible uses including future cables being added to the span on the same messenger wire.

Designs for the messenger wire should include the type of wire chosen, how it is attached to the poles for both dead ends and crossovers, slack and sag, etc. The proper design is the minimum acceptable size of messenger wire with adequate strength, because larger wires weigh more and are more susceptible to wind and icing. Consulting with a knowledgeable applications engineer, often those with the fiber optic cable supplier, can provide the knowledge needed to design and install the proper messenger wires.

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Installing messenger wires on electrical utility poles for fiber installation.

Lashing Fiber Optic Cable to a Messenger Cable

The installation process of a lashed aerial fiber optic cable will generally require one or more bucket trucks to allow workers to reach the location of the lashing, guide cables around poles and through trees or other obstacles and move the lasher across poles.

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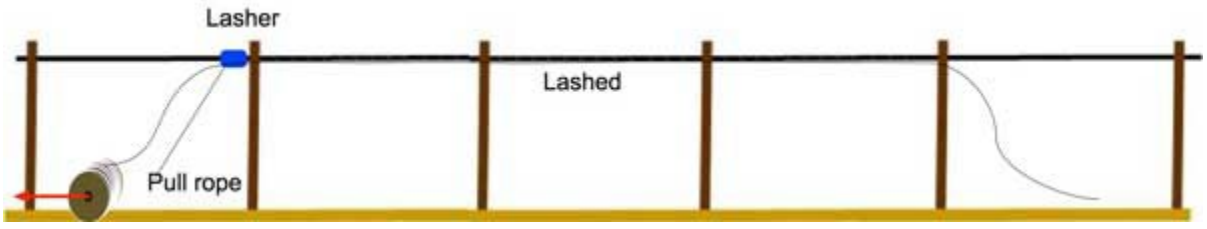
Two trucks lashing cable to a messenger. The lasher is just to the left of the pole.

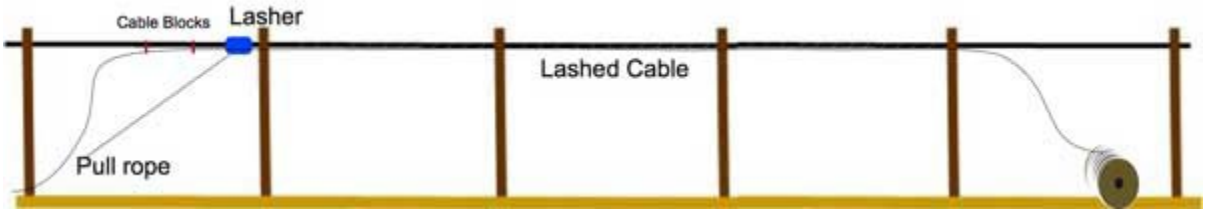
There are two ways to lash cable to a messenger, the moving reel method and the stationary reel method. In the moving reel method, the reel is moved slowly under the route while the lasher is pulled along to lash the cable to the messenger. This method generally only works when the reel vehicle can drive along the entire route.



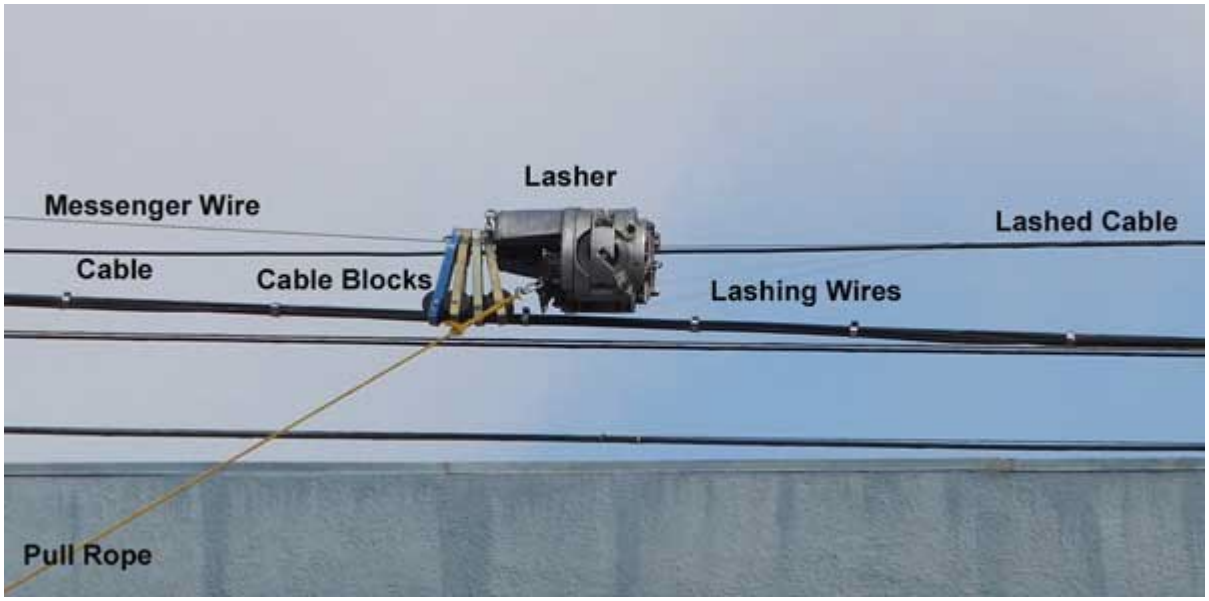
Moving reel method

The stationary reel method leaves the reel in place and the cable is pulled along the route and temporarily attached to the messenger with cable blocks. After the cable is placed, the lasher is pulled along the route to lash the cable. The lasher can push the blocks to the next pole for removal or be

removed as the lasher moved along the route.



Stationary reel method



Lasher being pulled for stationary reel method

Extra Fiber For Handling And Service Loops

At the ends of every section of cable where it is being spliced or terminated, the cable must be long enough to reach the splicing van or trailer plus about (16 feet) to allow for entry into the splicing van or trailer and have sufficient cable length for preparation and splicing.

The cable plant design should include plans for location and placement of service loops to store this excess cable and a splice closure safely and neatly after splicing is complete.

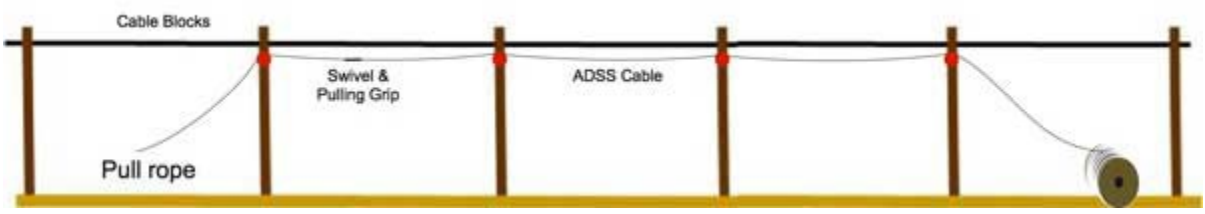
Installation Of All-Dielectric Self-Supporting (ADSS) Cable

ADSS is a special OSP cable that is designed to sustain larger tension loads over long periods of time. ADSS cable does not need any additional support, so it is small, lightweight, and easy to install. Because it is non-conductive, it can be installed on towers or poles nearer electric wires, making it especially popular with electrical utilities. It can also be installed on long spans (up to 3.5 miles in some cases) so it is easier to install in rugged or rural areas where it is difficult to install a messenger wire first.

ADSS cable plants require careful designs to ensure the route is accessible by personnel and/or vehicles for pulling cable and splicing. Notes the locations of poles so proper span lengths can be chosen. The cable plant design should include plans for location and placement of service loops to store this excess cable and a splice closure safely and neatly after splicing is complete.

As with any specialized cable, it is recommended that the designer work with the manufacturer to ensure the span lengths are chosen appropriately for the cable and the proper mounting hardware is chosen. Every manufacturer of ADSS cable has recommendations for hardware and special handling instructions for installation. Hardware for the secured ends of the cable (called dead-ends) and supports at intermediate poles must be chosen to be appropriate for the cable size and tension loads. Special attention must be paid if the cable bends at the pole; special hardware may be needed.

Since ADSS cable does not need a support wire, it needs to be supported by pulleys at each pole during installation. After the cable has been pulled, pulleys will be replaced by supports at intermediate poles and dead ends at locations where it is tensioned for drops or because it is at the maximum span length specified for the cable. Poles must be prepared for the installation of the pulleys and the final cable hardware before cable pulling begins.



Installing ADSS Cable with the stationary reel method

A pulling rope is attached to the cable with a swivel pulling eye and a wire grip. The cable reel should be placed well away from the first pole to prevent bending the cable excessively at the first pulley. The reel should have a brake to maintain significant tension as the cable is being pulled to prevent excess sagging between poles.

The cable is positioned on the first pulley by a worker in a bucket truck or if the cable is low enough, by a worker on a ladder or using a special support pole. The cable is pulled by the pull rope while the worker in the bucket truck places the cable on the pulleys in sequence. Care should be taken to ensure the cable does not touch the ground and get dirty.

A moving reel installation method can be done if there is a clear route for driving a vehicle with the reel of cable. A bucket truck follows to place the cable in the pulleys. Care must be taken to maintain the proper tension while paying off the cable from the reel.

Once the entire cable has been pulled into place, the support hardware for each intermediate pole can be attached and the pulleys removed. At the ends of the section, the dead-end hardware is attached to the cable and the entire span is tensioned from one end.

Since ADSS does not have a steel messenger, wind vibration can be a problem with the lightweight fiber optic cable. Wind vibration can cause degradation of the support hardware. Vibration dampers of several types can be installed to control wind vibration.

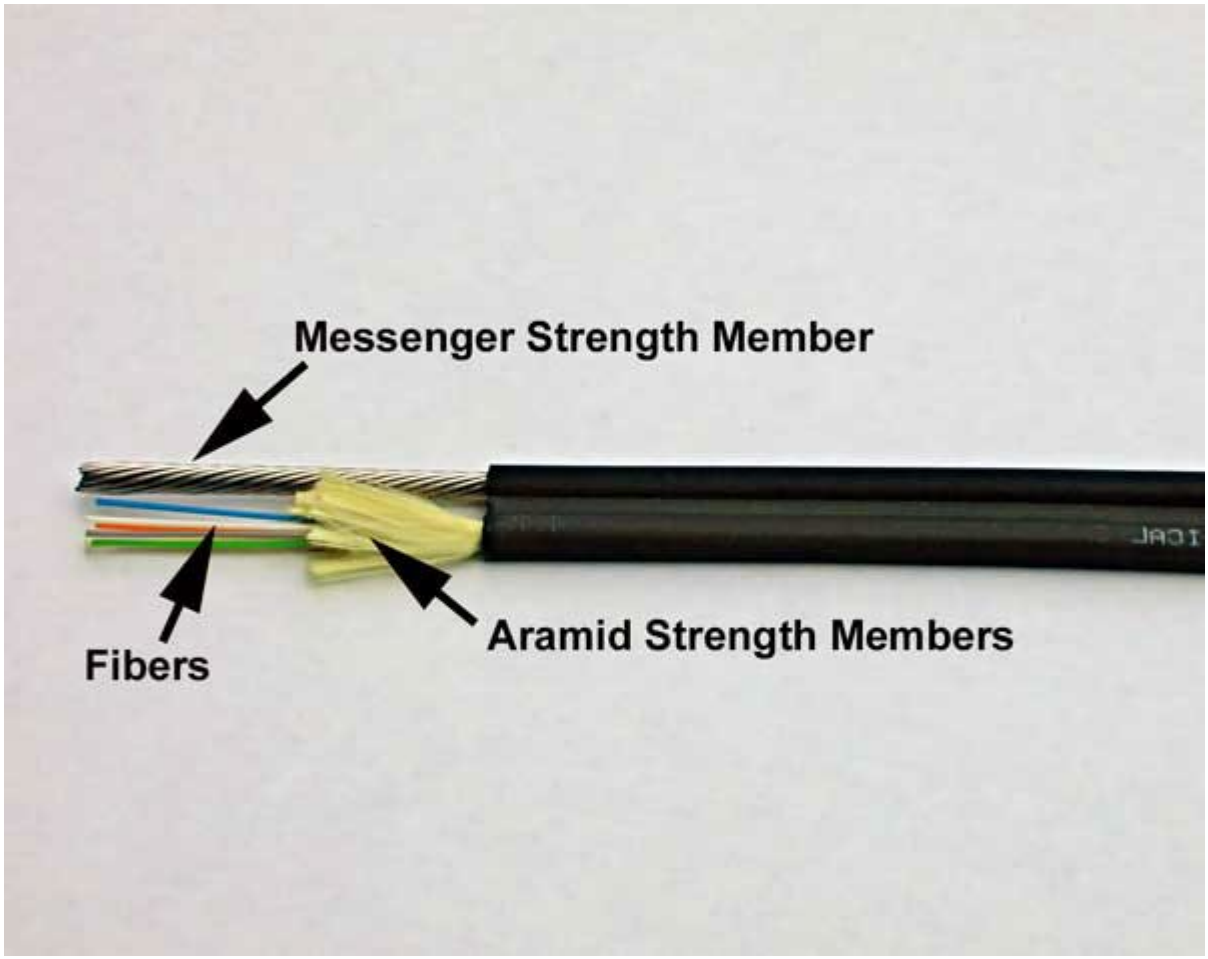
At the ends of a section of cable where it is being spliced, the cable must be long enough to reach the splicing van or trailer plus about (16 feet) to allow for entry into the splicing van or trailer and have sufficient cable length for preparation and splicing.

Dual dead ends are used to secure the two cables meeting at the pole for splicing. All slack cable should be stored on cable storage brackets attached to the cables or the pole. Special fittings are available for slack storage and should be chosen for the location of the storage.

Figure-8 Cable

Figure-8 cable is an OSP cable with a messenger wire molded on the side of the cable. It is less commonly used for aerial installations but may be useful where no messenger is available. It is installed like a messenger wire, but care must be taken to protect the fiber cable from damage.

resound


Messenger Strength Member
Fibers
Aramid Strength Members

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Aerial Equipment

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