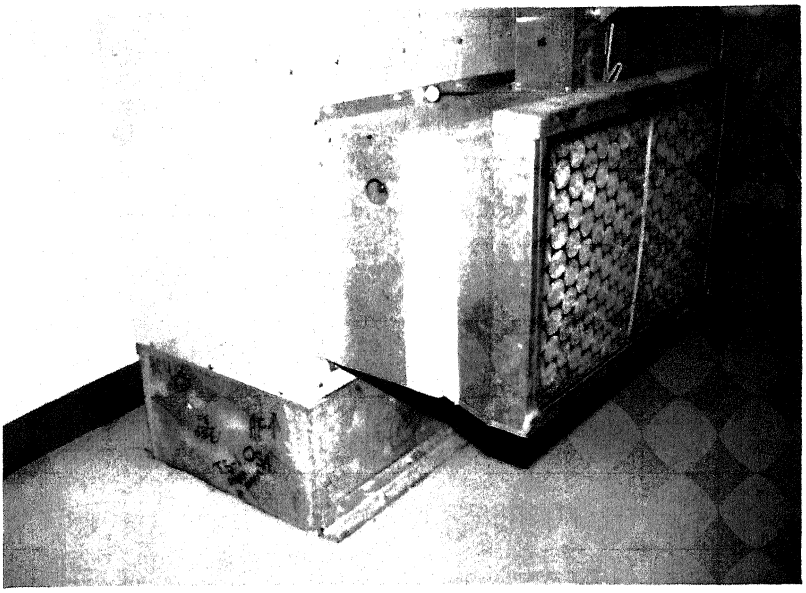

Fig. 3.60 The upper part of this heat exchanger, which holds the piping, is only secured by sheet metal screws. If these fail, the pipes provide the only restraint.

Recommended Practices for HVAC Facilities

Most HVAC damage can be avoided through proper anchoring of equipment. Vibration isolated equipment should have seismically qualified isolators or snubbers should be installed to limit motion. Utility lines to vibration isolated equipment must be provided with adequate slack. Air diffusers should be positively anchored to the duct with fasteners rather than with snap on connections. Some of these units are very heavy and present a hazard to personnel if a diffuser falls. The penthouse structure should be designed to withstand the large seismic motion at the top of the building. The installation of equipment and piping systems that are mounted to the floor, walls and ceiling of the penthouse must take into account the relative deflections that these structures experience.

Description of Spare and Back-up Supply Storage

COs in major cities usually have spare parts facilities in the same building. Parts and tools are stored in cabinets, open bins, and open shelves, Fig. 3.61.

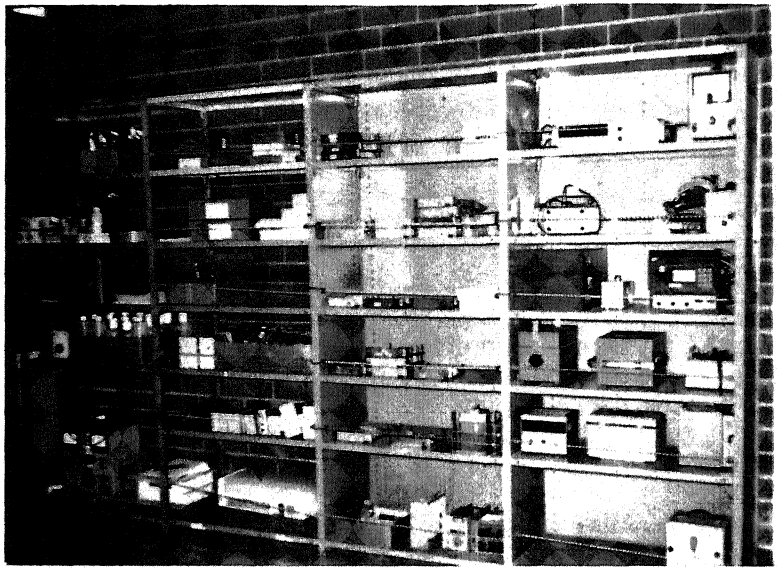

Fig. 3.61 Spare parts and tools stored on open shelves can be damaged in an earthquake. Restraints shown in the figure help keep items on shelves.

Earthquake Performance of Spare and Back-up Supply Storage

Spare parts are often damaged and the inventory is disordered because the parts are not properly stored.

Recommended Practices for Spare and Back-up Supply Storage

As spares parts are not active portion of the communication system, they are usually not given a seismic review. In general, storage of these spare parts is not adequate to protect the parts from earthquake damage. They may be stored on open shelves, stacked in boxes on the floor, or stored in cabinets with unsecured doors or with inadequate anchorage. Damage to spares can affect recovery in the case of damage to the equipment. Spares must be considered as a part of the equipment and be protected. Storage cabinets should be anchored. Open shelves should have lips to prevent items from sliding off of the shelf. Good housekeeping practices should be encouraged so that cabinet doors are kept closed and latched.

Advanced technology has reduced the size of switching equipment; a small switch of a few thousand lines can be fitted in a tractor trailer with full plug-in capability. This is a good back-up system in case of a major disaster, to provide replacement telecommunication services.

OTHER BUILDING SYSTEMS

Water and Fire Suppression Systems

Some multi-story CO buildings have office and equipment areas. Office areas may have water sprinkler system for fire suppression, while equipment areas will usually have fire extinguishers or Halon systems that are compatible with electrical equipment. If sprinkler systems in office areas are activated or if water pipes break or leak, water may find its way to equipment areas on lower floors. It is recommended that plastic sheeting be kept available so that it can be placed over equipment to shield it from water leaking through the ceiling.

Some PBX owners use a dry sprinkler system over the MDF and in areas with a large volume of cables.

Water supply failure can affect the cooling system which in turn can affect the electronic and digital equipment performance. Broken pipes or damaged sprinkler heads can cause water damage to electrical equipment. Most HVAC equipment do not have any seismic protection inasmuch as they are not considered critical equipment. These systems usually have water lines connected to them, so that pipes can break or leak and cause flooding in critical areas.

Electric Power Distribution

Central office lighting, test equipment and printers require commercial AC power. Power distribution panels are located on each floor and outlets are distributed throughout the floor. Conduits are sometimes used to route cables, but armored cables are also used. The distribution panels are normally anchored to the wall and conduits or armored cables are anchored to the walls with clamps. A wide range of anchor types is used in the power distribution system. Normally, little consideration is given to seismic protection for the power distribution system, however, its performance has been good.

Utility owned distribution transformers are usually located near the CO. This units are typically unanchored, even in California. These units have shifted in earthquakes and can cause a local power failure. It is recommended that the utility be requested to anchor the distribution transformer that provides power to the CO.

Elevators

For multi-story buildings, service elevators are necessary for moving heavy equipment between floors. The seismic performance of elevators in California has been mixed. The revised elevator code in California, implemented after the San Fernando earthquake, required some retrofits. The national elevator code that was modified for improved earthquake performance a few years later did not require any retrofits. If elevators may be needed after an earthquake, the anchorage of elevator equipment should be verified. Older central offices may

have been provided with an external hoisting system so that heavy or large equipment could be brought into the building through windows.

4. OUTSIDE PLANT

OVERVIEW OF OUTSIDE PLANT

Outside Plant can be defined as equipment and facilities connecting a CO to other COs, and connecting a CO to subscribers. Depending on the distance and the terrain involved, the methods and the equipment used are different. Generally cable is used, and where cable runs exceed 60 km, a repeater is necessary to strengthen the signal, so that the quality of the signal can be maintained. In some congested urban areas and where the terrain between COs is difficult, microwave can be used as the transmission medium. COs frequently have a microwave tower, either on top of the building or next to it. Figure 4.1 shows the primary elements of the outside plant. While satellite links are used for special applications, they will not be discussed in this document.

Cables to subscribers, when they leave a CO, are typically buried. When the cable gets away from the central city its route may change from the ground to poles to become an aerial cable. As the cable approaches the subscriber, distribution wire may be split off at an aerial cross connect and eventually lead to the subscriber with a cable drop. In many newer communities, the distribution cable will be buried. The buried cable will eventually go to a pedestal cross connect and then to the subscriber. The line ends on the subscriber premises, at a phone set, answering machine or fax machine. Table 4.1 lists outside plant facilities, which are classified as transmission media or support facilities.

OUTSIDE PLANT CABLES AND SUPPORT HARDWARE

Description of Outside Plant Cables and their Supports

The ability of the outside plant components to withstand the environment is a major consideration in design and placement. Outside plant must withstand many severe environmental conditions, including rain, flood, snow, wind, sun, and heat. Other vulnerabilities include attacks from animals, such as squirrels and gophers and from vandals. From an earthquake perspective, outside plant may be subjected to

severe vibrations, fault offsets, unstable soils, and liquefiable soils. Other vulnerabilities stem from the fact that cables use special means of conveyance, such as railroad and highway rights of way, electric transmission tower rights of way, railroad and highway bridges and tunnels. These are discussed in a separate section below.

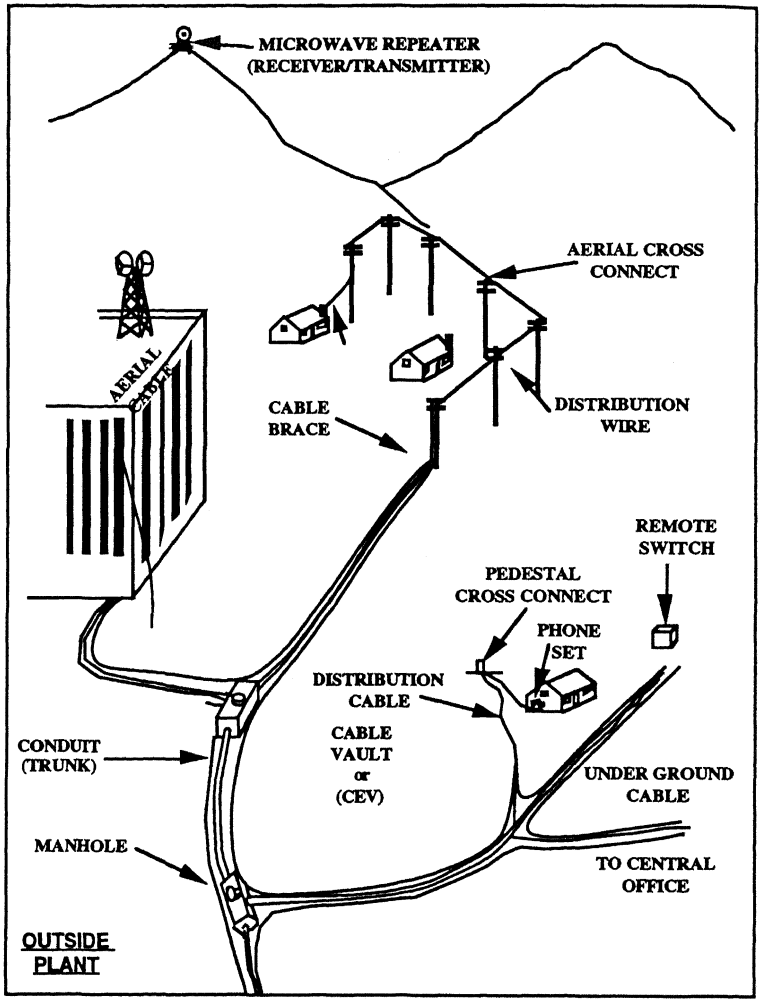

Fig. 4.1 Outside Plant Components

Table 4.1 Outside Plant Components

	Transmission Media		Components
1	Outside Plant Cables and their Supports	3	Repeaters
2	Radio (Micro) Waves	4	Towers
		5	Manholes and Handholes
		6	Cross Connects and Protectors
		7	Special Conveyance
		8	Subscriber Equipment

Telecommunication companies use buried cables or aerial cables. Buried cables are either run inside a conduit or bare, at depths that vary from .3 m to 2.3 m, Fig. 4.2. Slack in cables is usually provided at points such as manholes or at a splice housing. Some cables are placed on the ground without burial, but are still referred to as "buried." Aerial cables are often installed on poles shared with power lines.

The conductors for outside plant cables are copper, or fiber-optic. The copper cables connected to subscribers carry signal and power. The trunks also carry power for repeaters or regenerators. Optical fiber-optic cables carry signals only.

Copper Conductor

A cable usually consists of multiple pairs of insulated twisted wires in one sheath. The sheath provides physical protection against the environment; it is hermetically sealed, or gel-filled to protect the cable against moisture. The cable is usually measured in MMC (Mega-Meter of Conductor), which is equal to the end-to-end length of the cable times the number of wires. For example, 1,000 meters of cable containing 1,000 pairs of wires is 2 MMC.

There are many cable products manufactured by a number of companies world-wide. While fabrication and materials will vary

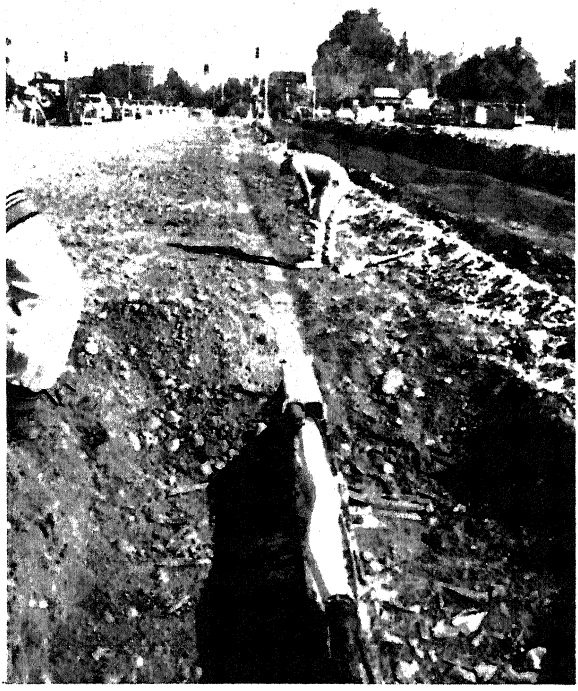

Fig. 4.2 Cable being buried using direct burial method.

between manufacturers, the number of twisted pairs or optical fibers is the main distinction. An exception to this is submarine cables, which is outside of the scope of this document. Outside plant cables serve three functions: trunks, distribution, and drops.

Trunks are used to interconnect COs and to connect a CO to a distribution area. Usually the trunks are routed inside conduits and are terminated at a manhole for a distribution area. Distribution cables are then used to connect from the manhole to a local cross connect pedestal. The majority of distribution cables are routed inside conduits. Drop wires are used to connect from distribution cable to subscriber premises. Trunks and distribution cables are usually buried, while wires can be either buried or aerial. Newly developed residential areas have used buried drop wires.