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# Design Construction and Maintenance of Highway Safety Features and Appurtenances

## Users Handbook

National Highway Institute

## 3.10 - CRASH TESTED LIGHT SUPPORTS

Roadway illumination is installed for a number of reasons including enhancing roaduser safety, deterring crime, enhancing business activity, and to establish a community image. Adequate illumination which is designed, installed, and maintained properly enhances safety by [3.10.1]:

- Supplementing vehicle headlights to increase motorist visibility in complex traffic environments.
- Allowing a motorist to discern a potential hazard in time to recognize it, react, brake and stop or maneuver around it.
- Increasing visibility by reducing the amount of eye adaptation required due to varying lighting levels.
- Reducing the effect of the glare from oncoming headlights.
- Illuminating pedestrians on or along the side the roadway.
- Assisting motorists in identifying the placement, and cross traffic use, of intersections and railroad grade crossings.

Roadway illumination is usually provided by locating luminaries along the side of the road, in the median area, or offset from the roadway outside the clear zone. Most roadside luminaire assemblies consist of a cobra head type luminaries mounted on a single support bracket with the pole located either behind a curb or preferably 6 m from the travelway. Current practice at narrow medians is to mount the lighting assembly on a concrete barrier with two cobra heads or segmented reflector type luminaries per pole. These median mounted lighting assemblies often include an individual lowering device to allow the luminaries to be lowered one at a time for servicing. This eliminates the need for a bucket truck and the required traffic control is significantly reduced. Offset luminaries are designed to be located well off the roadway and aimed at an approximate 45 degree angle on poles up to 23 m tall. An individual lowering device is used when an area is inaccessible to a bucket truck. High mast lighting currently employs the traditional high mast type luminaire or the offset type luminaire. What distinguishes the high mast, in addition to the mounting heights being from 23 m to 60 m or more, is the kind of lowering device used. A high mast lowering device incorporates a 2 m to 3 m diameter mounting ring to which all the luminaries are attached. The ring with up to twelve luminaries is lowered for servicing. The offset luminaire has individual lowering devices which allow each luminaire to be lowered independently. Breakaway devices should be used on all poles for which one is available, except for those installed on median barriers and high mast poles. Poles which are not outside the clear zone but for which no breakaway device is available (usually due to height and weight restrictions) must be shielded with appropriate barriers or crash cushions.

### 3.10.1 LUMINAIRE SUPPORTS

The luminaire support includes all structural hardware required to hold the support in place. This generally includes the following parts:

- Pole (frequently called a mast).
- A mast arm (frequently called a support arm) which extends the luminaire over the roadway.
- Foundation.
- Base (or a breakaway device).
- Lowering device.

Not all of the above items are included in every lighting system. For example, some decorative lighting systems, such as figure 3.10.1, are of the post top style and do not have a mast arm. Other systems are of the davit design, figure 3.10.2, where the arm and pole are of one unit. Some luminaries are wall mounted, thereby eliminating the entire support. Other systems have the pole directly buried, thereby eliminating the base and foundation, while still others are mounted directly to existing utility poles. The following is a description of the common hardware parts of luminaries.

Figure 3.10.1 - Post top decorative lighting unit

Figure 3.10.2 - Davit arm pole

### 3.10.2 MAST ARMS

The purpose of the mast arm is to extend the luminaire over the edge of the roadway while permitting the pole to be placed at a distance from the roadway edge. Mast arms can be as short as 1 m and as long as 9 m. They can be installed with one arm per pole for roadside installations, figure 3.10.3, or with two masts (balanced design), figure 3.10.4, for median installations.

### 3.10.3 POLES

Poles are available in a number of materials for which the advantages and disadvantages are listed below.

**Steel**

Steel poles are available in galvanized, painted, powder coated, and weathering types plus a combination of powder coating over galvanizing. Galvanized is the most popular of the steel types due to the comparatively low cost and extended life. Painted poles are used primarily when a color is desired but requires continual maintenance. The powder coating over galvanizing serves the same purpose and is maintenance free. Weathering steel poles can cause aesthetic problems due to rusty runoff.

Figure 3.10.3 - Roadside lighting installation

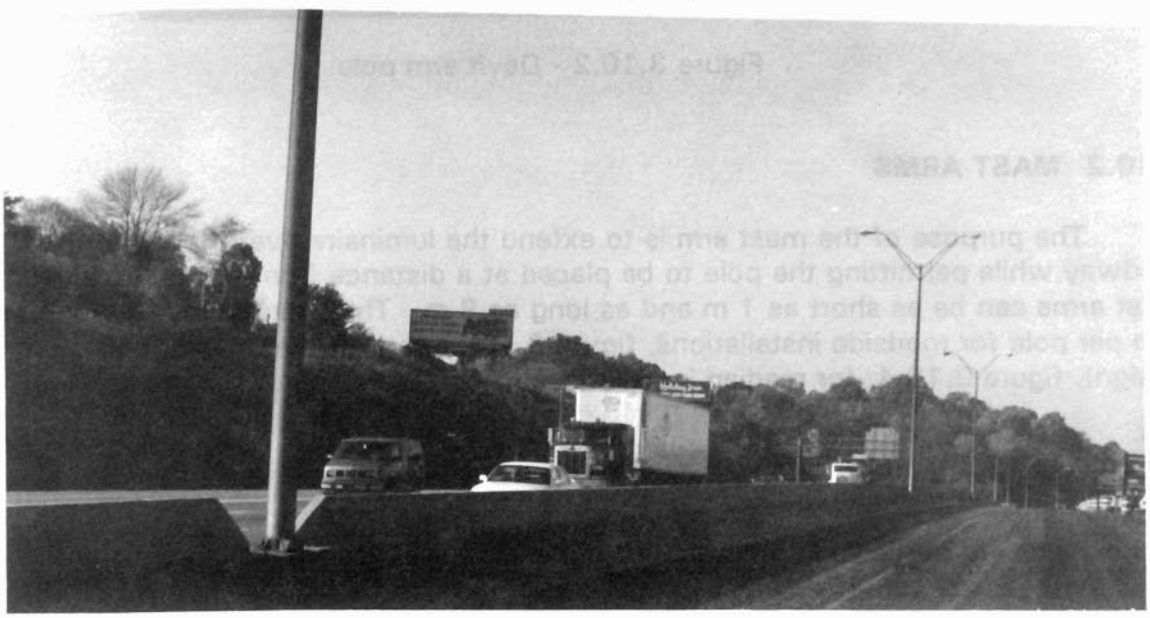

Figure 3.10.4 - Median lighting installation

**Aluminum**

Aluminum poles are popular due to their resistance to corrosion and the resultant low maintenance cost. They have an added advantage of being lighter in weight than most other types. Aluminum poles operate well as breakaway designs when impacted at the design height. Since they are less rigid than steel posts, however, aluminum poles can result in an increased probability of improper breakaway operation when impacted higher than the design height. Aluminum poles are also considerably more expensive than most other types.

**Stainless Steel**

Stainless steel poles are corrosion resistant and relatively light weight. Their high rigidity results in dependable breakaway operation upon impact. They are, however, considerably more expensive than the other pole types.

**Fiberglass**

Fiberglass reinforced plastic (FRP) poles are approved for breakaway use both in the anchor base and in the direct burial series. Shaft lengths are currently limited to 14.3 m which means gives 12 m height for the direct burial series and the full 14.3 m height for the anchor base series. Advantages of FRP poles include no rust, no corrosion, no rot, light weight, no additional breakaway device required, no maintenance, no electrical shock and for the direct burial series no concrete foundation is needed. FRP poles come in many decorative styles and several standard colors.

**Wood**

Wood is perhaps the least expensive of pole types particularly in areas where trees are plentiful. They can be treated to resist deterioration from the environment and damage due to insects. The huge mass of wood poles, however, makes it difficult to design them as breakaway. Section 3.7 discusses breakaway utility pole designs but wooden poles should not be installed on high speed facilities. The use of existing utility poles for luminaire placement has the advantage of reducing the number of poles on the roadside.

**Concrete**

Concrete poles are popular in regions where cement and concrete aggregates are plentiful. One advantage to concrete poles is that they can be economical. Concrete poles cannot, however, be designed effectively to safely break away upon impact. They are extremely heavy even when made by prestressing concrete. Impacts with concrete poles result in large damage to vehicles and severe injury to occupants. Prestressed concrete poles, therefore, should not be used within the traversable area, unless shielded, on facilities with design speeds over 50 km/h. Concrete posts can be a functional and economical type of support on local urban streets if proper consideration is given to placement.

### 3.10.4 FOUNDATIONS

The foundation for a luminaire pole must provide sufficient resistance to overturning moments caused by the static load of the mast arm plus a wind and/or an ice load. It must be capable of maintaining the correct alignment of the luminaire and be able to withstand the impact should the pole be struck. For breakaway poles the foundation must be rigid enough to allow the breakaway device to operate while not becoming a hazard itself.

Luminaire foundations are perhaps one of the most dangerous man-made hazards on the right-of-way. This is due to their placement or location, structural design, and unsafe wiring systems. There are many documented deaths of motorist who survived the impact with a luminaire pole only to be subsequently killed from the resulting explosion and fire. The explosion and fire are usually caused by the fuel tank being ruptured, the vehicle being caught on the improperly constructed foundation, and the electrical system sparking repeatedly until the fuel explodes. In other incidences, medical personnel have been delayed from attending to victims due to risk of electrical shock from exposed conductors near or under a vehicle. All of these consequences can be minimized if not eliminated by the use of luminaries that allow more freedom for the designer in selecting their location, by using the smallest diameter foundation available, and most importantly, eliminating exposure of the wiring system to physical damage.

Historically, pole foundations have been poured-in-place concrete with steel reinforcing rods and anchor bolts. The requirement that upon breakaway nothing shall project more than 100 mm above a chord line drawn between two points 1.5 m apart has caused redesign of concrete foundations. It has been recognized for several years that a problem exists when a foundation is placed on a slope. As early as 1985 a memorandum was issued stating that designers should not allow the slope between the travelway and the foundation to be greater that 1:6. This is even more effective when the diameter of the foundation is as small as possible thus limiting the concrete protruding above the grade line. Obviously eliminating the transformer base would allow the foundation to be sized to accommodate the pole bolt circle; which in most roadway size poles is several inches less than the bolt circle for a transformer base. In order to do this the electrical circuit elements that were formerly housed in the T-base, i.e., splices in the conductors, fuse holders, and surge arresters, must be relocated underground. This requires that the electrical components be capable of being fully submerged and remain waterproof. Figure 3.10.5 provides an example of a small diameter concrete and adjacent underground electrical junction box design.

Augerbases are an effective method of reducing diameter of the foundation. Many states use a galvanized steel "augerbase" foundation instead of concrete. Most concrete foundations require three inches of concrete outside the anchor bolts to provide the necessary strength. Even if the T-base is eliminated, a concrete foundation is 150 mm larger in diameter than the pole base it serves. The flat steel top of the augerbase foundation can be the same size as the pole base, which minimizes foundation size. Another advantage of the augerbase foundation, with the circuit elements underground, is the resistance to damage when an accident breaks the pole. When a concrete foundation, with its anchor bolts poured-in-place, has one bolt damaged the entire foundation should be replaced. The augerbase foundation uses bolts only a few inches long which are replaceable if damaged. Augerbase foundations are easily installed by the electrical crew using the same auger trucks used to drill the hole for the concrete shaft.

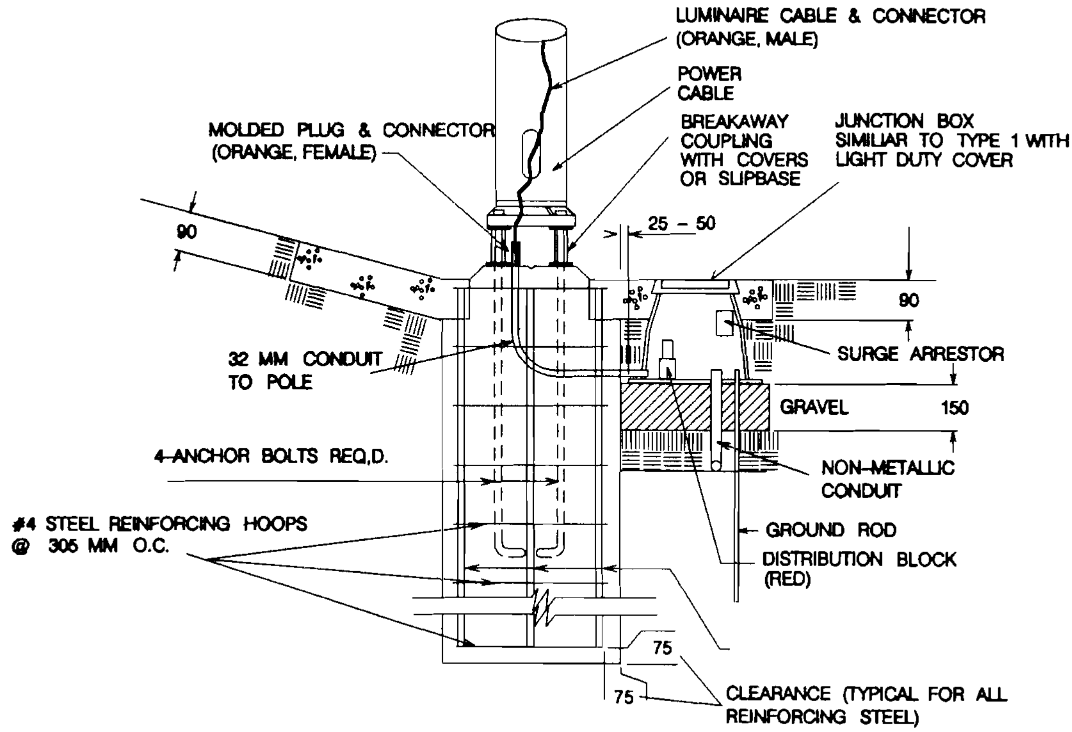


Figure 3.10.5 - Small base concrete luminaire foundation system with underground modular cable distribution system

Electrical crews are not called upon to tie reinforcing steel, set and properly align anchor bolts, or finish the concrete; all tasks that require skill to perform properly. It has been reported that a two man crew can install 8-10 augerbase foundations per day resulting in significant labor savings. A diagram of the augerbase foundation with underground electrical junction box is provided as figure 3.10.6.

## 3.10.5 BASES

Breakaway luminaire poles are designed to yield at their base attachment to the foundation. There are numerous types of bases currently in service. Some of these are designed for breakaway operation and others are not designed to yield. The non-yielding types have applications where vehicle speeds are low and the danger of the pole falling is greater than the hazard of hitting the rigidly mounted pole. A description of the most common base types is presented below. Not all of these bases are crashworthy. A list of the crashworthy devices and their manufacturers are presented in Appendix F.

### Direct Burial Base

This type of base allows the pole to be directly embedded in the soil, figure 3.10.7. It is the most economical since it eliminates the need for a foundation. It is the common type base for wood and is used frequently with concrete and fiberglass reinforced plastic (FRP) poles. The FRP poles are the only direct bury poles currently approved for breakaway use. The other types are normally limited to low speed facilities or should be located out of the recoverable area.

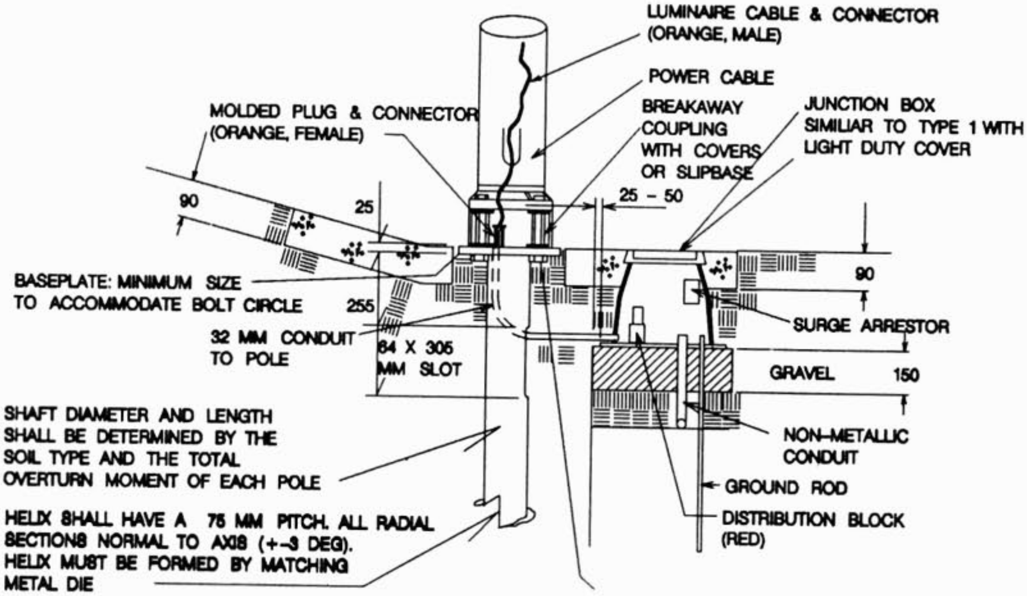


Figure 3.10.6 - Augerbase luminaire foundation system with underground modular cable distribution system

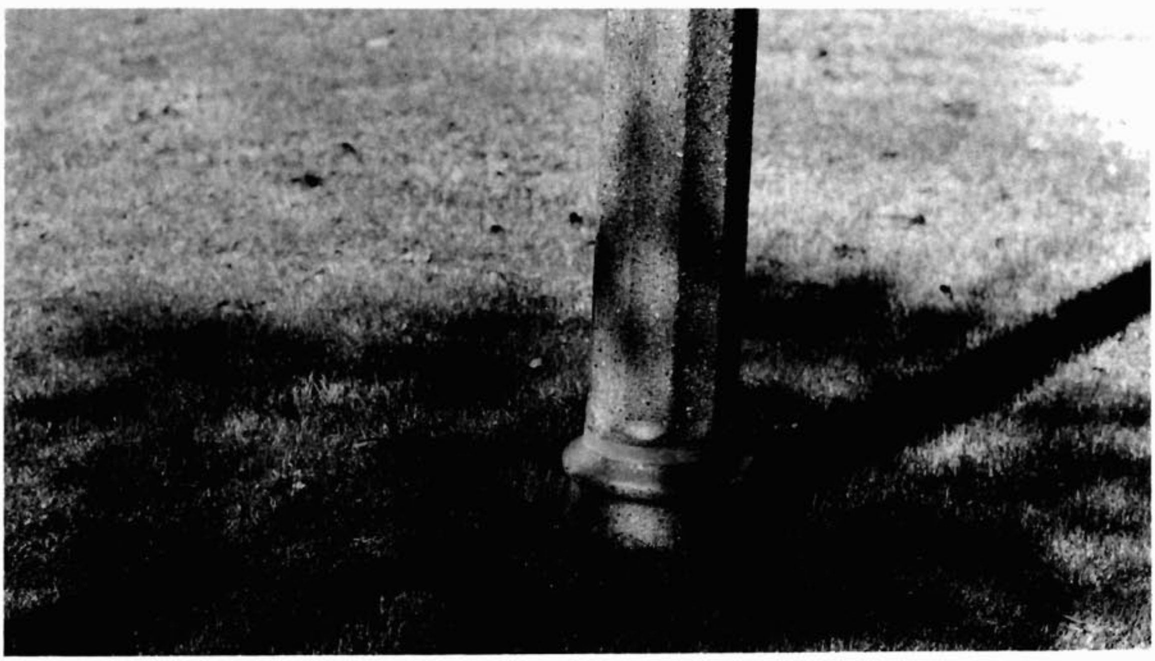

Figure 3.10.7 - Direct burial concrete lighting support base

## Flange Base

Most steel and aluminum poles are fitted with a plate or flange at the base of the pole. With steel poles this usually involves welding a steel plate to the bottom of the pole. With aluminum poles a cast aluminum shoe base is usually fitted to the bottom of the pole. The use of a flange base implies that the flange is to be fastened directly to the anchor bolts embedded in the foundation or to some type of breakaway device. When a flange is in direct contact with the concrete some method needs to be employed that will allow water to flow out and not be trapped in the base of the pole which can cause premature failure of the pole due to rust on the inside. Flange base designs that do not use breakaway features are not crashworthy and should be restricted to where the hazard of the pole falling is greater than the hazard of impacting the rigidly mounted pole. A flange base is illustrated in figure 3.10.8.

Figure 3.10.8 - Flange steel base

## Cast Aluminum Transformer Base (T-base)

T-bases may be steel or cast aluminum and were originally devised to house the transformer. The T-base, figure 3.10.9, proved unacceptable for storage of the ballast due to moisture and insect damage to the electrical components. However, the cast base proved to have safety advantages since it yielded and broke apart upon impact. The ballast is rarely stored in the base anymore but the T-base is still frequently installed to serve as an electrical junction box and because of their breakaway characteristics.

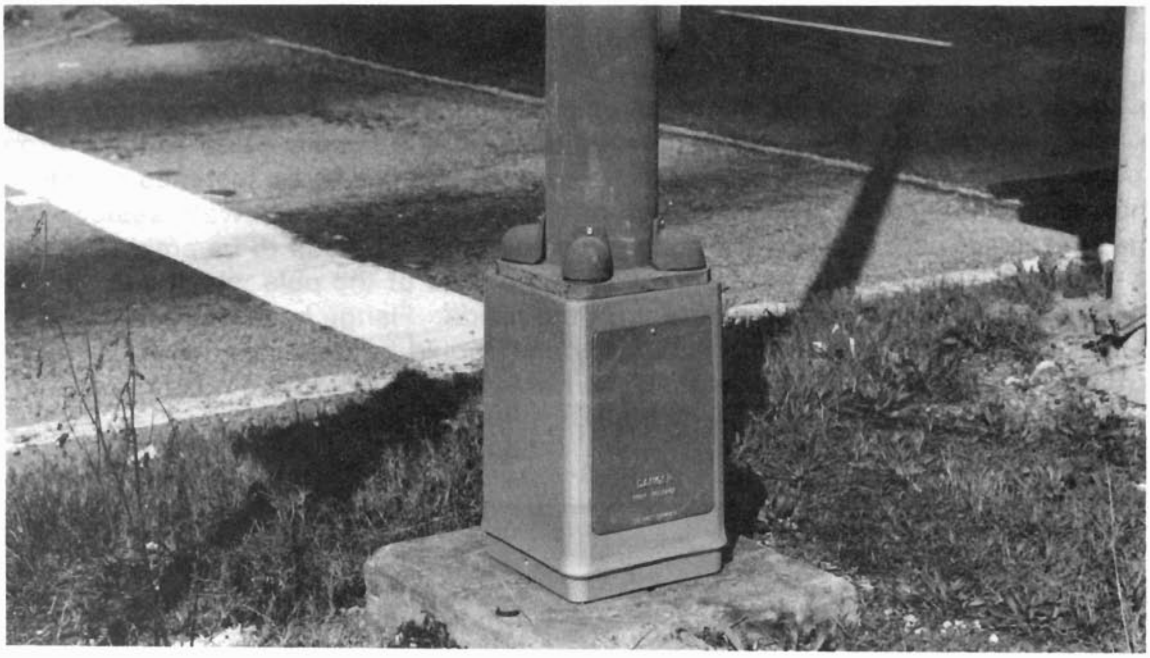

Figure 3.10.9 - Cast aluminum transformer base

**Frangible Couplings**

A number of manufacturers have developed cast and extruded aluminum frangible couplings. The typical coupling, presented as figure 3.10.10, is a short connector which is attached to the foundation on the bottom and the flange of the pole on the top. Upon impact the coupling fractures separating the pole from the foundation. The proper performance of frangible couplings requires the proper matching of coupling and pole. Stiffer poles work best with frangible couplings since the stiffness of the pole results in the impact forces remaining in the direction of impact (shear). Flexible poles such as some aluminum poles, bend upon impact resulting in some of the impact force translating to vertical forces. This places the couplings in compression and tension, forces which the couplings are specifically designed to resist. The use of frangible couplings often results in the need to place skirts around the couplings to keep dirt and water from entering the conduit and to keep rodents from eating the wire insulation.

**Slip Base**

Luminaire support slip bases are designed to resist the wind and vibration loads while safely releasing upon impact from any direction. A typical base, figure 3.10.11, consists of two triangular plates; one welded to the support pole, and the other welded to the foundation attachment. The plates are slotted to allow release upon impact. If installed correctly the foundation part of the slip base will be reusable with minor repairs after impact of the support pole. The following criteria are necessary to ensure that the slip base operates correctly.

Figure 3.10.10 - Frangible coupling luminaire support

Figure 3.10.11 - Roadway lighting support slip base

- Any bolts used to anchor the foundation piece to the foundation must be lower than the plane of the slip base.

- The upper surface of the foundation piece must be no more than 100 mm above the surface of the surrounding terrain.

- An 18 to 22 gauge keeper plate must be placed between the surfaces of the slip base to prevent the device from slipping apart due to wind loads.

- Washers, of sufficient strength to prevent deformations into the vee slots, must be used between the plates and on the top and bottom.

- The bolts must be torqued to the proper level. A table of appropriate torque values is provided in table 3.5.2 of section 3.5.

A four bolt slip base, figure 3.10.12, is also available. Developed by Valmont Industries, it provides added structural resistance to environmental loads and is used extensively by some Western States [3.10.2].

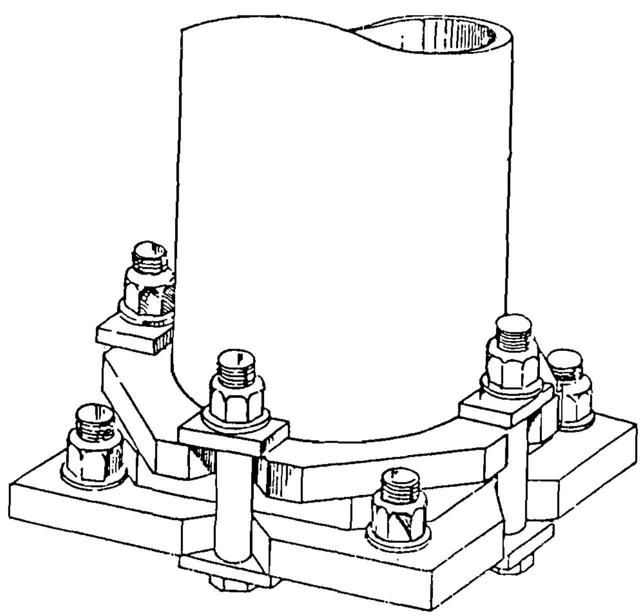

Figure 3.10.12 - Four bolt roadway lighting support slip base by Valmont Industries

**Shear Base**

The design concept for the shear base is to load the rivets or welds which secure the base to a foundation plate. When struck by a vehicle the rivets or welds are sequentially sheared and the support breaks away. Typical designs for shear bases are thin walled stainless steel bases and a family of cast aluminum bases (not T-bases).

**Other**

There are other breakaway methods that relate to specific materials used for the pole. These include a fiberglass reinforced plastic pole with an anchor base that will break above the cast aluminum base and several systems used with aluminum poles that are approved.

### 3.10.6 BREAKAWAY WIRING SYSTEMS

Past research efforts have concentrated on evaluating the structural breakaway characteristics of luminaire poles. In addition to the pole itself having breakaway ability it is recognized that the underground wiring system also be capable of properly separating. There are a number of reasons for requiring proper separation of the wiring system. One of these reasons is that the size, and associated tensile strength, of the wire cable is sufficient to significantly increase the deceleration rate of impacting vehicles and to also change the trajectory of the falling pole. Another reason is that improper separation of the electrical cable can result in bare conductors that are still energized, posing an electrical and possible fire hazard at the accident scene.

Early efforts to reduce electrical hazard used line fuses placed in a breakaway device. These widely used "breakaway fuse holders", that for years have been the standard, have not, however, been certified by testing. Prior experience indicates that they frequently perform improperly during an accident situation. Rather than properly separating; the device frequently pulls off the wire leaving an exposed end that is potentially deadly. Part of the problem with the breakaway fuse holder is the location of the device in the pole or T-base and the 610 mm to 910 mm of distribution cable inside the base. This extra length of wire is placed in the pole to allow workmen the ability to pull the wire out of the pole and make the necessary connections. Upon impact this extra length of wire fails to result in proper separation of the breakaway fuse, and allows the wiring insulation to be damaged by the fractured pole. The resulting bare electrical conductor poses a safety hazard due to the relatively high voltages used in underground roadway illumination systems.

Most luminaire underground wiring systems operate on 480 volts. The reason for using 480 volts is that the voltage drop in the copper conductors that supply a given load is only one-fourth the value of the voltage drop when using 120 volts and one-half that of 240 volts. In addition, luminaries are designed to perform within a certain percent of the rated voltage. Thus for a given percent, i.e., 10%; the allowable drop would be 4 times greater for a 480 volt circuit compared to a 120 volt circuit (48 vs 12 volts) or twice that of a 240 volt circuit. These factors are additive so a 480 volt circuit requires a much smaller copper wire to deliver the necessary amount of energy over a long distance. Using 480 volts is desirable but proper precautions and installation techniques must be used to reduce the inherent hazard on the public right-of-way.

A modular cable system developed by $MG^2$ Inc., and Duraline, eliminates a number of problems presented by the current wiring method. This Cable System is a submersible, modular plug and cable system that allows the circuit components, (i.e., the low amperage, fast acting, current limiting fuses; the surge arrester (where desired) and the conductor splices) to be placed in an underground junction box adjacent to the pole foundation [3.10.3]. The circuit breakaway connector can be positively positioned at the top edge of the conduit inside the pole base. Since the stiff, typically #4 or #6 copper, conducting cables never enter the pole, the system unplugs at ground level. The impact that knocks down the pole will not put stress on the electrical cables and will not weaken splices in adjacent poles. When this system, figure 3.10.13, is combined with a properly installed foundation, the possibility of fire and explosion or electrical shock is significantly reduced if not eliminated. Most importantly, with the modular cable assembly, upon knockdown there is no exposed electrical hazards, as can exist with the conventional wiring method.

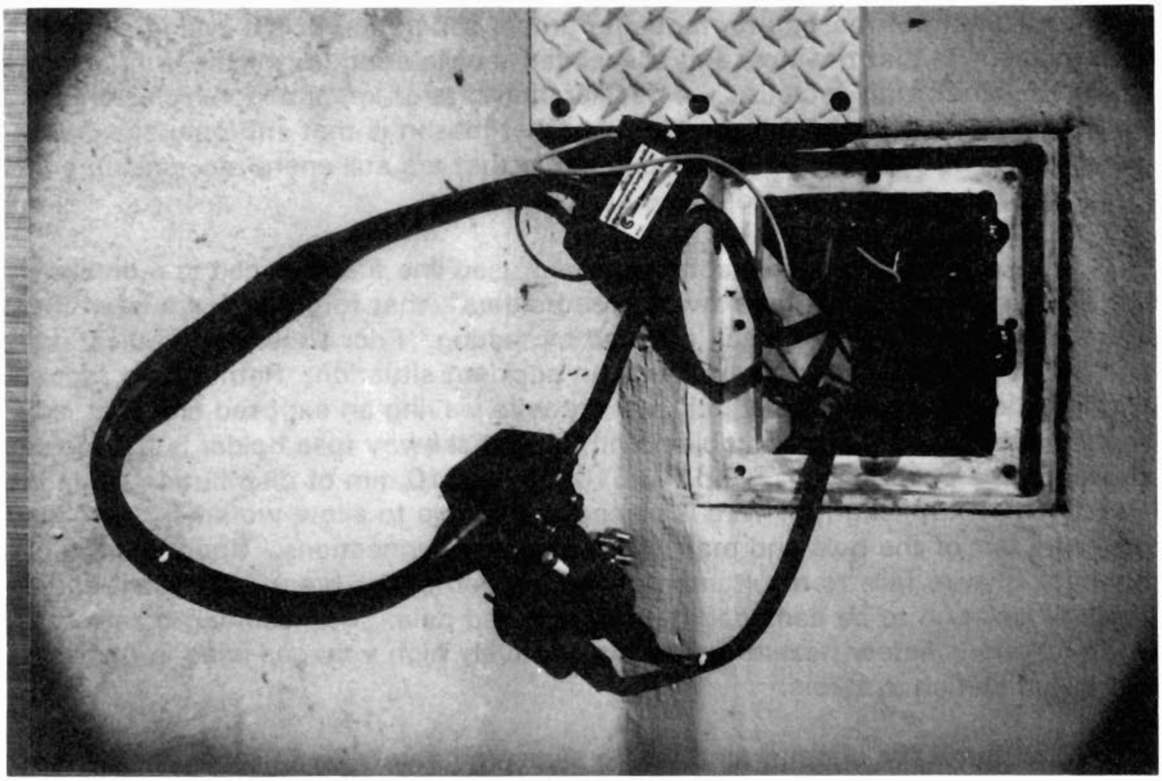

Figure 3.10.13 - Duraline modular pole cable system by MG² Inc.

### 3.10.7 LOCATION OF POLES

A primary goal of a lighting designer is to eliminate the potential hazard by locating the luminaire pole where it is least likely to be struck. With the older style luminaries, i.e., cobra heads, the light source had to be located in a closely defined position due to limited provisions for adjusting the direction of the beam pattern. There are a number of luminaries available today that are designed to be mounted "offset", 30 m or more from the travelway, figure 3.10.14.

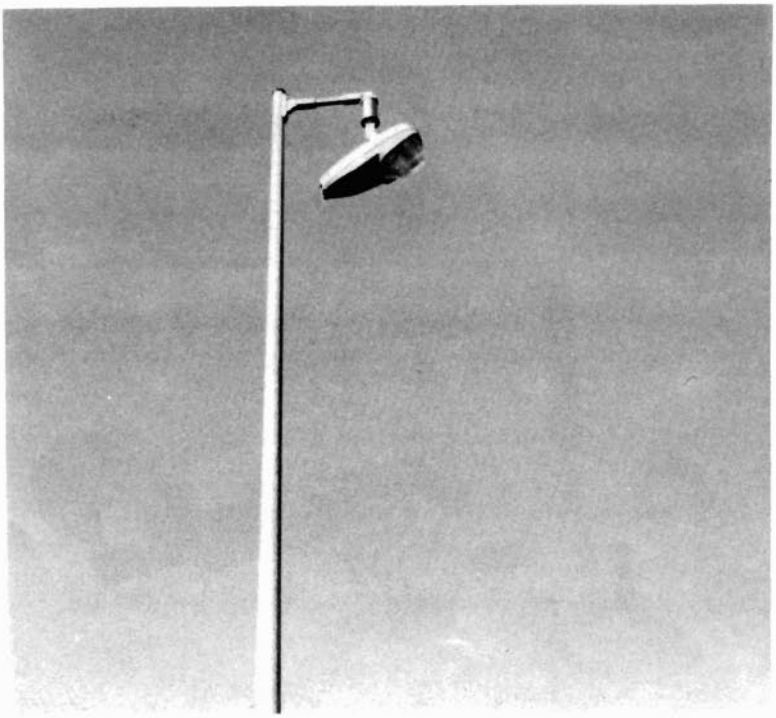

Figure 3.10.14 - Offset luminaire

The first reports on the illumination pattern and accident experience of these offset luminaries were favorable when they were introduced over 25 years ago. One resistance to their wide spread use has been the difficulty in getting a bucket truck to the pole location for service. Design changes made to the luminaire, and the development of a heavy duty reliable device which allows the luminaries to be lowered to ground level, figure 3.10.15, reduces some of the early service problems.

## 3.10.8 GUIDELINES FOR CONSTRUCTION OF LIGHTING INSTALLATIONS

- Inspect materials and equipment when delivered to the jobsite to be sure all items are as described on the Approved Materials Lists. Ask questions about any discrepancies no matter how seemingly insignificant.

- During the progressive steps of the installation, review the installation requirements for each phase. Ask for manufacturer's suggested installation procedures when available.

- Envision what the operating environment will be like for each locale/area of the project. Install electrical equipment so as not to be a hazard to motorists or an inconvenience to maintenance personnel.

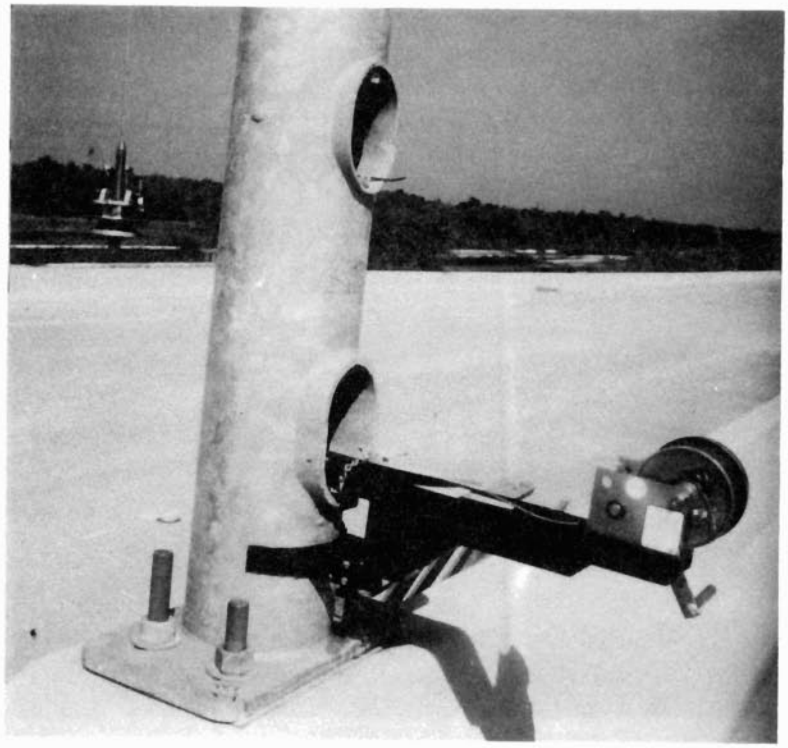

Figure 3.10.15 - Lowering mechanism for offset luminaire

- Route conduits away from areas that might be later used for guard rail posts or incidental signs.
- Install underground junction boxes away from shoulders where vehicles would normally park.
- Underground junction boxes and lighting pole foundations must not exceed 100 mm above the surrounding ground level.
- Conduits crossing existing roadways must be installed using approved methods and equipment to assure no damage is done to the base or paving.
- Locations of roadway crossing need to be marked for future availability.
- Conduits transitioning from underground to exposed on a bridge structure should go through wing walls which have core drilled holes. Do not place conduits over the top of the abutments or wing walls where mowing equipment might damage them.
- Securely strap all exposed conduits, especially where people might climb on the conduit when crossing the abutment or wing wall.

- Use a flexible connection between conduits attached to abutments/wing walls and moveable structures, such as a bridge deck.

- Expansion joints need to be installed in all exposed conduits attached to concrete structures.

- Be sure rocks, pebbles, and other debris are removed from a conduit before installing the conductors. Any small hard object might damage the wire insulation.

- Test the insulation resistance of all conductors after wire splices are made. Record the values for future maintenance procedures.

- Ascertain that the contractor is experienced in the installation and adjustments of all components, i.e., lowering devices, surge arresters, pole breakaway devices and proper aiming of luminaries. Require manufacturer representatives to train contractor personnel if necessary.

- Require a supervised operation test, such as 30 nights burning the luminaries during which the contractor is required to monitor the system and immediately make any necessary repairs.

- Before beginning the 30 day burn test, make a comprehensive inspection of the entire system including the conduit, junction boxes, pole foundations, incoming service points, field measurements of the lighting levels, insulation tests, ground system resistance tests, and operation of all lowering devices.

- Provide the maintaining authority copies of the lighting system installation plans, electrical submittal data, and sources for all electrical devices or spare parts.

- Meet with the maintaining technicians at the site to demonstrate operation of the system and train them in use of any unfamiliar equipment.

- Remind the maintaining authority they are expected to keep the system operating but, if questions arise, they can contact a particular person or office for assistance.

### 3.10.9 INSPECTION OF CAST ALUMINUM AND SLIP BASE LUMINAIRE SUPPORTS

The following inspection tips are applicable to more than just the cast aluminum and slip base luminaire supports. These two types are specifically discussed since they are most popular and complex support type in current use. Field inspection forms for these luminaire bases are contained in Appendix I.

**Cast Aluminum Transformer Bases**

Pole maintenance

- Look for evidence that the pole has been hit. If it has been hit, replace the damaged parts.
- Visually check the pole to make sure that it is straight. Straighten the pole as necessary by loosening and tightening the nuts on the bolts in the footing.
- Look for evidence of rust. If rust covers more area than a 25 cent piece, the pole should be scheduled for weather proofing.

Breakaway base maintenance

- Make sure that all nuts, bolts, and washers are installed. Install any that are missing.
- Check the nuts holding the transformer base on the footing and the bolts at the connection between the pole and the transformer base. All of these connections must be securely tight. If they are not tight, they should be tightened.
- Make sure that the access door is installed. Install it if it is missing.
- Make sure that the door fastening screw on the access door is installed. Replace it if it is missing.
- Check the condition of the grout. If it is cracked or missing, it should be replaced.

Footing maintenance

- Check the footing for damage. Report any damage for correction.
- Look for soil erosion around the footing. If soil has eroded, it should be replaced and compacted.
- Make sure that the area is graded properly so that a vehicle will impact the post correctly. If it is not graded correctly, this work should be scheduled.

**Slip Base Luminaire Support**

Pole maintenance

- Look for evidence that the post has been hit. If it has been hit, replace the damaged parts.

- Visually check the post to determine if it is straight. Install shims in the breakaway base as necessary.

- Look for evidence of rust. If rust covers more area than a 25 cent piece, the pole should be scheduled for weather proofing.

Slip base assembly maintenance

- Make sure that all nuts, bolts, and washers are installed. Replace any that are missing.

- Loosen the bolts on the base and then tighten them to the torque specified by the manufacturer.

- Make sure that the keeper plate is installed. Install the keeper plate if it is missing.

- Check to see that the slip base plates are installed. Install them if they are missing.

- Look for evidence of rust and repair it. Any evidence of rust on the slip base surfaces should be repaired.

Footing maintenance

- Check the footing for damage. Report any damage for correction.

- Look for soil erosion around the footing. If soil has eroded, it should be replaced and compacted.

- Make sure that the area is graded properly so that a vehicle will impact the post correctly. If it is not graded correctly, this work should be scheduled.

### 3.10.10 SUMMARY OF LUMINAIRE SAFETY CRITERIA

The FHWA Office of Engineering has issued acceptance letters to manufacturers of luminaire support systems which have been determined as acceptable in accord with the 1985 AASHTO specifications on sign and luminaire supports [3.1.3]. A summary of the acceptance letters and a brief description of each device is provided as Appendix F. The following criteria are necessary to ensure satisfactory impact performance of approved luminaire supports.

- Only use designs that have been approved as crashworthy by the FHWA.

- The FHWA has established upper limits on the support mass and height of luminaire supports. These limits are applicable even when the breakaway characteristics have proven acceptable by crash testing. The maximum acceptable support mass is 454 kg and the maximum luminaire support height is 18.3 m. These values are increased from the limits of 272 kg and 15.2 m, cited a few years ago. Any further increases in these limits will need to be based on full-scale crash testing and an investigation of vehicle characteristics beyond those recommended in NCHRP Report 350 [3.1.1 and 3.1.11].

- The breakaway devices are designed to operate by being subjected to horizontal forces (device placed in shear). The devices are designed for this to occur when impacted at a typical bumper height of about 510 mm. Locating luminaire supports where they will be impacted at a different height will result in forces being directed parallel to the support and thereby, loading the devices in tension and compression. This results in improper operation of the breakaway device and possibly severe impacts and injuries to vehicle occupants. Superelevation, slope rounding and offset side slopes, curves, curbs, vehicle departure angle, and speed can all influence the striking height of a typical bumper. Negative side slopes should be limited to 1:6 between the roadway and the luminaire to help ensure that errant vehicles strike the support at an acceptable height [3.1.1].

- Use a wiring system that allows all circuit components to be shielded from impact, preferably underground, and that assures that all electrical energy potentially available at the pole foundation surface is limited by the current-limiting fuses. Conductors protected only by a circuit breaker should not be accessible in the pole base.

- The major cost of a luminaire assembly is the pole, foundation and breakaway devices. Select luminaries based on performance and design flexibility that allows more selection of pole locations to produce a lighting system with fewer potential hazards.

- As a general rule the pole will fall in line with the path of an impacting vehicle. The mast arm usually rotates so that it is pointing away from the roadway when resting on the ground. Consideration, however must be given to the fact that falling poles may endanger pedestrians and may pose a danger to other motorists.

- A maximum 100 mm stub height must be maintained to prevent vehicle snagging. Quick disconnect electrical circuitry should also be used to facilitate the breakaway mechanism, thereby reducing the hazard of electrical shock from exposed wiring after impact and to ease repairs.

- Foundations should be properly sized for surrounding soil conditions. Foundations that move through the soil upon impact place the breakaway mechanisms in bending rather than shear resulting in improper actuation.

- Curbs, regardless of their shape or height, will elevate an impacting vehicle. The rise in height begins approximately 460 mm from the curb and can extend as far as 3050 mm. When possible, therefore, luminaire supports should be placed 3050 mm from the curb. If this is not possible then they should be located closer than 610 mm from the curb. Luminaire poles placed between 610 and 3050 mm behind curbs increase the chances of improper breakaway operation.

- If a luminaire support is placed behind a barrier it may not be necessary to provide a breakaway feature. In general if the support is within the design deflection distance of the barrier then either the barrier should be stiffened or a breakaway pole support used.

- Some agencies place luminaire assemblies on top of concrete median barriers. High angle impacts, or impacts by large trucks or buses, can result in a luminaire on top of the barrier being struck. Breakaway design is not recommended for this type of installation due to the risk that a downed pole might pose to opposing traffic.

- If a luminaire support is to be placed on top of a concrete barrier then the barrier must be adapted to fit the pole base. Concrete safety shape types are typically designed with an approximate 150 mm wide top surface. Since luminaire bases are typically 200 to 305 mm in width it is required to either widen the barrier top to 305 mm, or flare the barrier in the area of the luminaire.

- Design alternatives should be investigated with the goal of reducing the number of luminaries used along a section of roadway. Higher mounting heights can significantly reduce the total number of supports needed. Tower or high mast lighting, can be used to effectively illuminate major interchanges. This method reduces the number of poles and locates the supports much further from the roadway.

- It should be noted that some agencies are experiencing problems with the failure of aluminum T-bases due to environmental load. It is believed that the failure, such as figure 3.10.16, is initially caused by minor impacts by mowing units and other maintenance equipment with the T-base. This causes small cracks at the bottom flange of the T-base which are made worse by the environmental loads. The result is eventual separation of the bottom flange from the T-base as in figure 3.10.17.

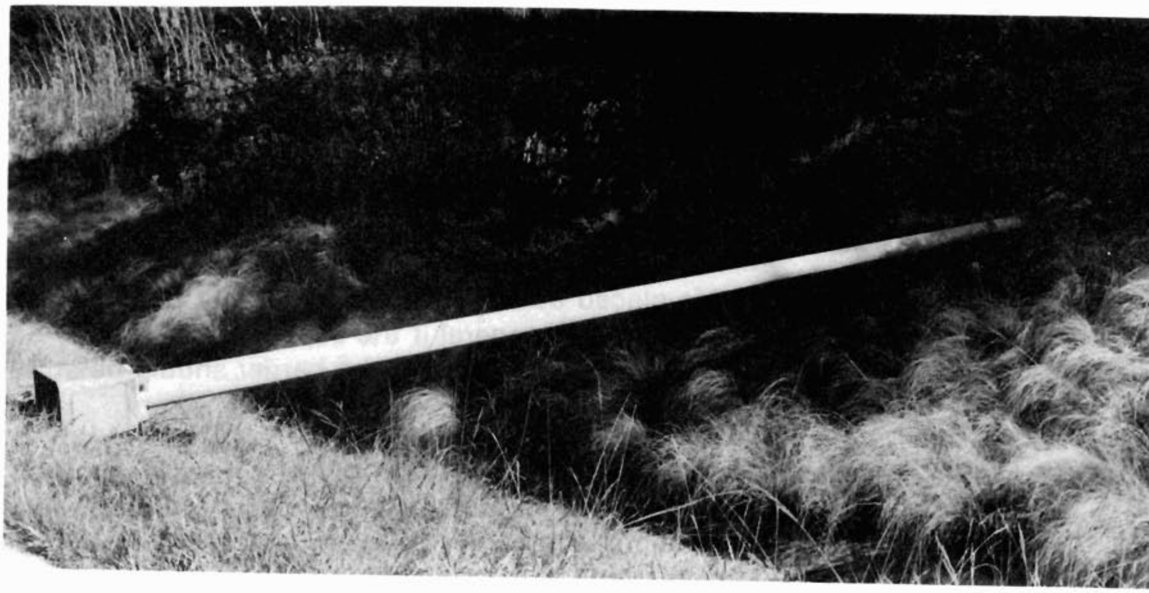

Figure 3.10.16 - Failure of luminaire support without impact

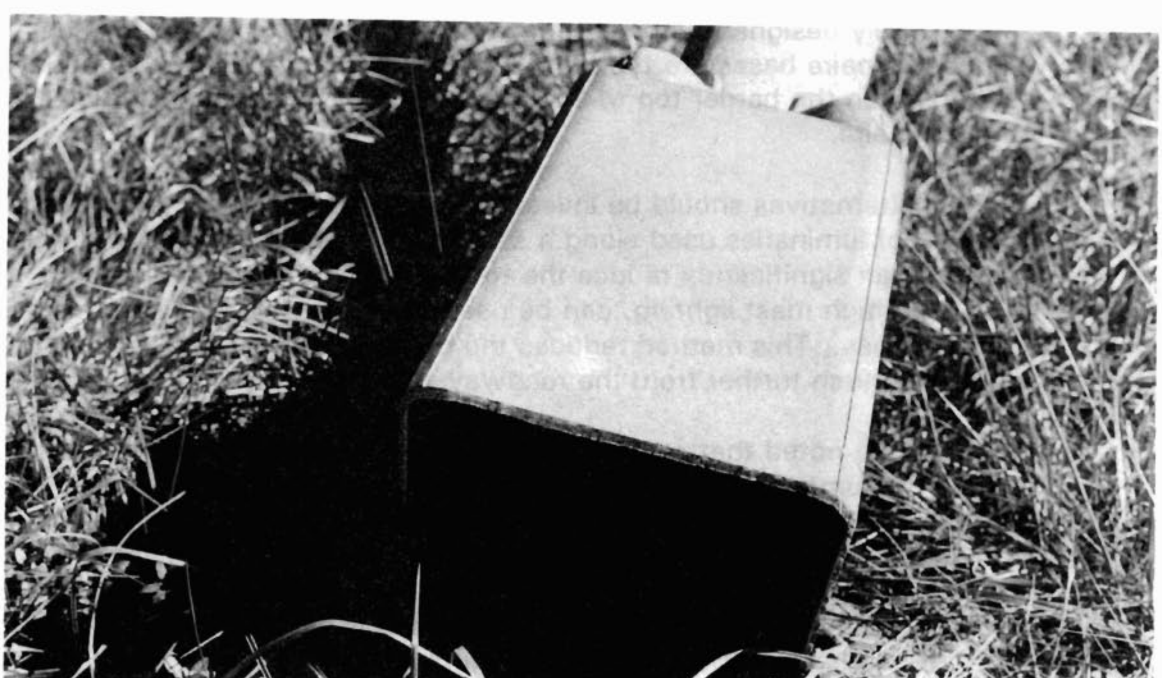

Figure 3.10.17 - Separation of bottom flange from T-base