E SELF-SUPPORTING TOWERS

ERECTION

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1. GENERAL

1.01 This section outlines the general considerations involved in erecting E Self-Supporting Towers, and includes recommended procedures and precautions.

1.02 Erection drawings are furnished with the tower, and provide information necessary for the field assembly of the tower, including the location and orientation of every piece and subassembly. All steel (except nuts, bolts, and washers) is identified by stencils, stamps, or metal tags which correspond to the markings shown on the erection drawings. The identifying mark of leg members is located on the outer face near the lower end. These drawings also show the number and type of bolts, nuts, and washers required to join the members. A more than adequate supply of each specified type of bolt, nut, and washer is furnished with the tower, but care must be exercised to assure that the proper type and size of each is used for each joint.

2. PRE-ERECTION CONSIDERATIONS

2.01 Tower erection should not be started until all required permits have been obtained, as outlined in Section AG25.350. Note that the Federal Aviation Agency (FAA) requires notification 48 hours prior to starting construction and should also be notified as soon as construction is completed.

2.02 The permit issued by the Federal Communications Commission (FCC) to construct and operate a radio system usually indicates whether or not lighting and painting to improve visibility are required. Where only receivers are to be installed and it has been determined that FCC permission is not required, the FAA will determine the necessity for markings to improve visibility. If lighting is required, arrangements must be made to assure the availability of electric power at the site, and the lighting facilities must be ordered and on hand at the tower site. Note that the standard lighting kit provides only the material which goes on the tower. Conduit and wire from the base of the tower to the lighting control panel in the building should be ordered locally. Methods of lighting and painting towers are described in Sections AG25.230 and AG25.300.

2.03 The rules of the FCC and FAA require that temporary warning lights be placed on any tower which is required to have permanent air obstruction warning lights. The number of sets (or levels) of temporary lights required will be the same as the number of levels of permanent lighting. Where two or three levels of permanent lights are required, only one temporary set of lights is required (at the top) until the level of the first permanent lights is exceeded. Temporary lights should then be installed at approximately the level of permanent lights, and in addition, a set of temporary lights is always required at the uppermost point of the structure. Even on towers requiring only one level of permanent lighting, a set of temporary lights is required at the top of the structure, and this applies even though only one section of the tower may have been erected by sunset.

2.04 Temporary lights are to burn steadily from sunset to sunrise. Top lights are to consist of two 100- or 111-watt lamps (No. 100 A21/TS or No. 111 A21/TS) enclosed in aviation red obstruction light globes. Two similar lights are required at each level where permanent lights would be installed. (Permanent lights may be used in lieu of temporary lights.) All side lights are to be positioned so that at least one of the two lights at each level will be visible from any angle of approach. Many

tower erectors are equipped with temporary warning lights for use during erection but it is advisable to notify the erector if temporary lighting will be required, and whether it will be one-, two-, or three-level.

2.05 Section AG25.350 provides information on foundations and anchors for E Self-Supporting Towers. Steel erection should not be started until the results of concrete compression tests are known to be satisfactory. (See Section AG25.130 for a discussion of concrete.)

2.06 The tower grounding system should be completed and the ground connections at each pier should be readily accessible. Installation of the grounding system is described in Section AG25.350.

2.07 All equipment to be installed on the tower should be available when required, and its mounting location on the tower should be specified to the contractor so that hoisting equipment may be positioned to avoid conflict.

2.08 If aerial electric power facilities are in a location that may present a hazard to, or interfere with, hoisting equipment, tag lines, etc, arrangements should be made or have the power company relocate, de-energize, or insulate their facilities.

2.09 Foundations should be carefully checked to ensure that they are located correctly, are of the right size, and include all specified reinforcing steel and anchor bolts. Details of layout are covered in Section AG25.350.

2.10 It may be desirable to install a talking circuit on the tower to facilitate adjustment of antennas or reflectors during system lineup. Information on this subject is contained in Section AG25.230. A physical circuit can be avoided by use of a walkie-talkie radio, if this equipment is available. This equipment may also be of value during tower erection.

2.11 If safety climbing equipment is to be installed, the materials should be on hand. This is not furnished with the tower and must be ordered separately.

2.12 If the base shoes are leveled, and the tower is fabricated properly and erected in accordance with good practice, the tower will not vary from vertical to any appreciable degree. In any case, the tower should not deviate from vertical by more than its total height in feet divided by 720. Methods for observing vertical alignment are outlined in Section AG25.300.

3. INSTALLATION OF BASE SHOES

3.01 The base shoes must be oriented on their individual piers so that the intersection of the vertical wing plates is nearer the outside corner than any other corner of the pier. The line formed by the junction of the two wing plates should slope slightly toward the center of the tower.

3.02 Both the foundation surface and the base shoe should be cleaned of mud, grime, and other foreign matter. The foundation may be damp, but standing puddles or pools of water on its surface should be eliminated.

3.03 As shown in Fig. 1, each base shoe should be set on four steel wedges located about midway between the anchor bolts. The four base shoes should be set so that they are level and at the same elevation ($\pm 1/8$ inch). If this is not done, the tower will be extremely difficult (if not impossible) to assemble. Wedges should be positioned so that the base shoe is about 1 inch above the surface of the foundation. The shoe should be leveled in two directions with a spirit level, and the nuts on the anchor bolts tightened. Leveling should be checked after the nuts have been tightened, and, if necessary, the wedges should be adjusted to relevel the shoe. After the nuts are tightened, the wedges should provide a clearance of 3/4 to 1-1/4 inches for grout between the base shoe and the top of the pier.

3.04 The base shoes of the E Self-Supporting Tower are grouted only after 25 feet or more of the tower has been erected and the first level of internal bracing installed. (See 4.13.) The grout should consist of one part portland cement (Type I or III) to two parts sand (by volume). Clean sand from a reliable supplier should be used. The sand and cement should be thoroughly mixed in a dry condition. Water should be added sparingly so that the mixture retains a granular appearance and does not become wet enough to resemble plastic mortar. Water must be clear and fit for drinking. The final mixture must form a lump when squeezed

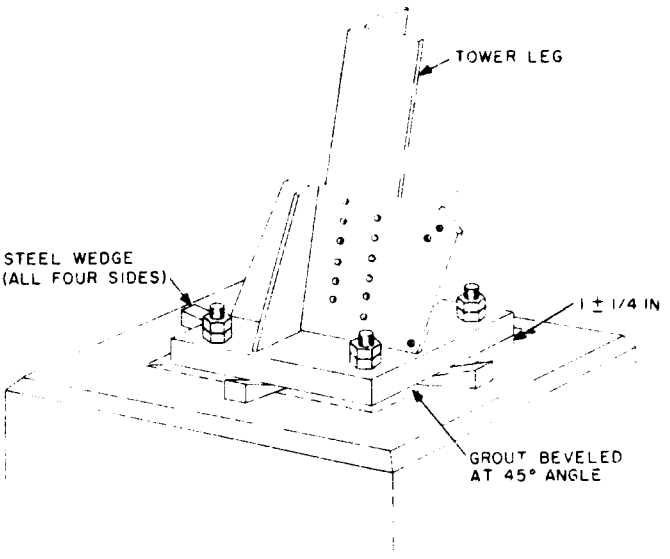


Fig. 1—Baseplate

in the hand and upon being disturbed, must crumble freely. Water is deliberately kept to a minimum to obtain high compressive strength.

3.05 Grout should be forced under the shoe from all four sides, and should completely fill all voids. Next, the nuts of the anchor bolts should be loosened and the wedges carefully withdrawn. The nuts should be ***carefully*** retightened and the voids left by the wedges filled. (It is not necessary to wait for the grout to set before doing this.) The grout should be beveled as illustrated in Fig. 1.

4. ERECTION CONSIDERATIONS

4.01 Erection of steel towers is usually performed by contractors rather than by Telephone Company personnel. It should be noted that the contractor is responsible for the job, the construction methods he chooses to use, and is presumably the best judge of the condition of his equipment and the loads which it can handle. The Telephone Company representative should, however, assure normal safeguards (see Section AG25.300) and require the contractor to correct any obviously dangerous items such as frayed winch lines and ropes.

4.02 The particular procedure used in erecting towers will vary among contractors. Usually, after the base shoes have been leveled and the anchor nuts tightened, the four lower leg sections are installed. The associated horizontal and diagonal bracing is installed on two opposite faces of the tower (Fig. 2, Faces A and C). The bracing in the other two faces (B and D) is not installed at this time, to avoid interference with the gin pole. The legs are held in place by a number of interrupted rib (drive) bolts. All rib bolts are to be equipped with flat washers and Anco nuts (Fig. 3). Washers are employed to ensure that the nut can be turned up tightly without running into the ribbed part of the bolt, since some of the ribbed portion may extend out of the member. The ribs gouge into the sides of the hole into which they are driven, thus ensuring a snug fit and preventing rotation when the nuts are tightened. The underside of the bolt head should be in contact with the surface of the member involved. Care must be taken to avoid overdriving bolts. There should be no gap between the nut and the washer or between the washer and the adjacent surface of the member. All leg splices are to be made with interrupted rib bolts. Do not permit the use of machine or ordinary tower bolts or the re-use of rib bolts for this purpose. Some contractors may install bolts with the heads on the inside of the angle, so the nut will be exposed and more easily tightened.

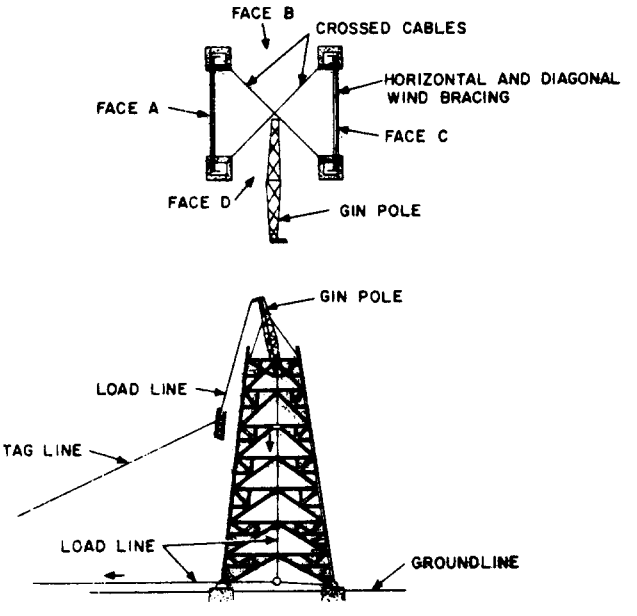


Fig. 2—Typical Construction Method

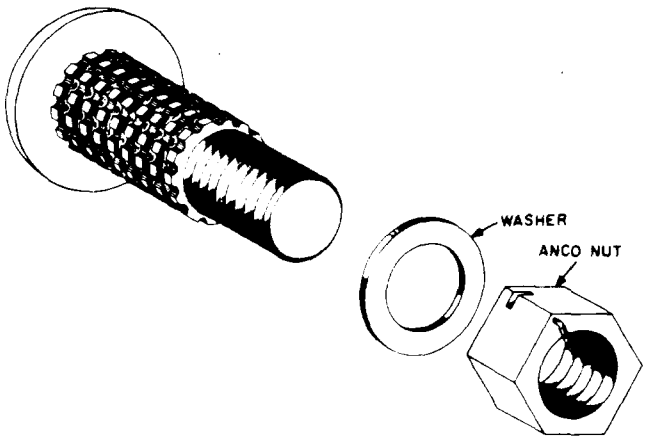


Fig. 3—Interrupted Rib Bolt Assembly

4.03 A typical method of erecting self-supporting towers is illustrated in Fig. 2. Two cables are crossed on the ground, and their ends fastened to the foundation piers. The gin pole is laid through the center of the tower with its lower end resting on, and shackled to, the cables at their intersection (Fig. 2). The use of wood gin poles for erecting these towers is not recommended.

4.04 The gin pole is set upright in the center of the tower, and temporarily guyed while the diagonal and horizontal bracing is installed on the remaining two faces of the tower. Four sets of blocks and tackles are employed to support the gin pole. One end of each set is fastened to the pole somewhat above its center point, and the other end fastened to a tower leg at the highest point at which all the bracing has been installed.

4.05 Components are usually laid out and assembled on two opposite sides of the tower. Two legs and their connecting bracing are assembled, and all bolts tightened. Splice plates are installed at the top of each leg, but the nuts and PALNUTS are not tightened at this time.

4.06 The associated bracing to complete the third and fourth faces of the tower is attached to each assembled panel, but the nuts are not tightened. Unbraced legs or assembled panels should not be left freestanding. If time will not allow all associated bracing to be installed, sections should not be hoisted into position on the structure.

4.07 The gin pole is tipped to one face by adjusting the block and tackle on each leg. The assembled panel is hoisted into position and splice plate nuts tightened. The gin pole is tipped to the opposite face, and the corresponding panel hoisted. The associated bracing for the remaining two faces is swung across, and bolted in position.

4.08 After all associated horizontal and diagonal bracing has been installed, and all nuts tightened, the gin pole is raised to the next higher position. It is usually set to allow about 2 feet of headroom when sections are hoisted.

4.09 The lower end of the gin pole is usually supported by four steel cables which are attached to diagonally opposite legs at a point where all bracing has been installed. It is common practice that as soon as the lower end of the gin pole clears a point at which interior bracing is required, the bracing is installed. The set of cables crossed on the ground is usually left in place, with the load line snatch block shackled to their intersection.

4.10 There are other satisfactory construction methods, such as boom cranes, which are used quite frequently. Some contractors erect supplementary portable towers on the site for use in hoisting tower sections and equipment items.

4.11 All bolted connections in the tower, except leg splices, are made with 5/8-inch high strength tower bolts. The number of bolts in each connection is indicated on the erection drawings. A typical bolt assembly is shown in Fig. 4. Bolt heads should be drawn snugly against the surface of the member which they pass through. ***Bolts of strength lower than the specified strength should not be substituted under any conditions.*** The plain washer shown ensures that the service nut can be fully tightened without running into the unthreaded part of the bolt. The unthreaded part of the bolt should, however, extend through the shear plane at the interface between the fastened members (Fig. 5). The service nut should be installed with the chamfered side against the washer, not against the PALNUT. The PALNUT is provided as insurance against loosening of the service nut due to vibration. Tower bolts are usually installed with the head on the inner side of vertical members and on the lower side of horizontal members.

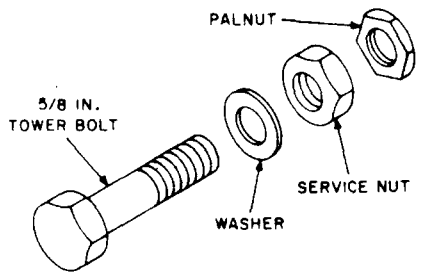


Fig. 4—Typical Bolt Assembly

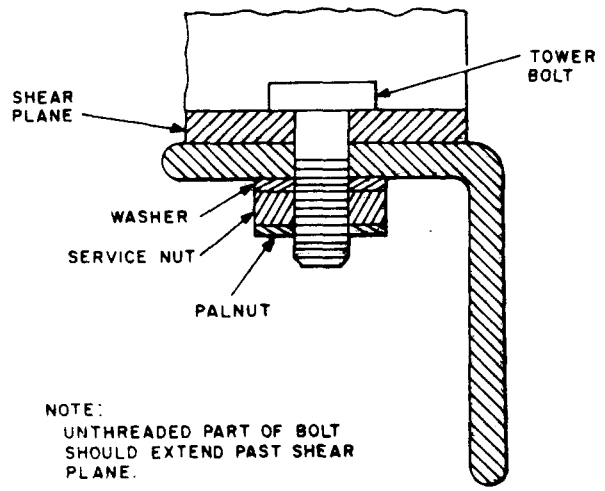
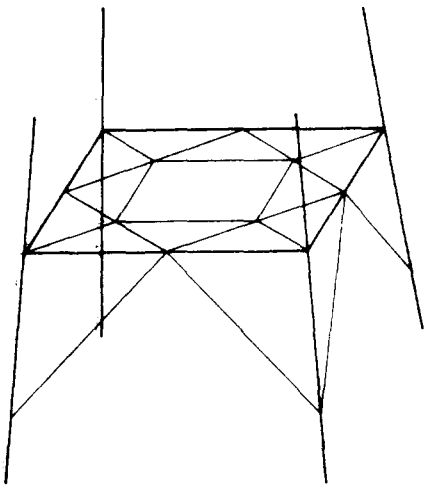


Fig. 5—Tower Bolt in Place

4.12 Installation of the first level of internal bracing provides a check on both the accuracy of fabrication and alignment of the foundation piers and anchor bolts. Fig. 6 and 7 illustrate types of internal bracing which are used in the E Self-Supporting Tower. Internal bracing in the horizontal plane is all that is required to determine whether the tower can be trued up. In general, it seems desirable to install the first level of internal bracing as soon as possible, however, procedures could vary according to the erectors.

4.13 For either type of bracing shown, some difficulty will usually be experienced in completing the square formed by joining the midpoints of the sides. The tower cross section tends to form a parallelogram until the internal bracing is installed to square it up. Some forcing is to be expected, but deformation of members (buckling or bending) should not be permitted. Usually the square can be completed without too much difficulty by adjusting the position of the steel wedges under the base shoes.



NOTE:
THIS TYPE PLAN BRACING USED ON TOWERS OF 150 FEET OR LESS; ALSO FOR UPPER 125 FEET OF TALLER TOWERS. (SOME FACE BRACING OMITTED FOR CLARITY)

Fig. 6—Tower Bracing

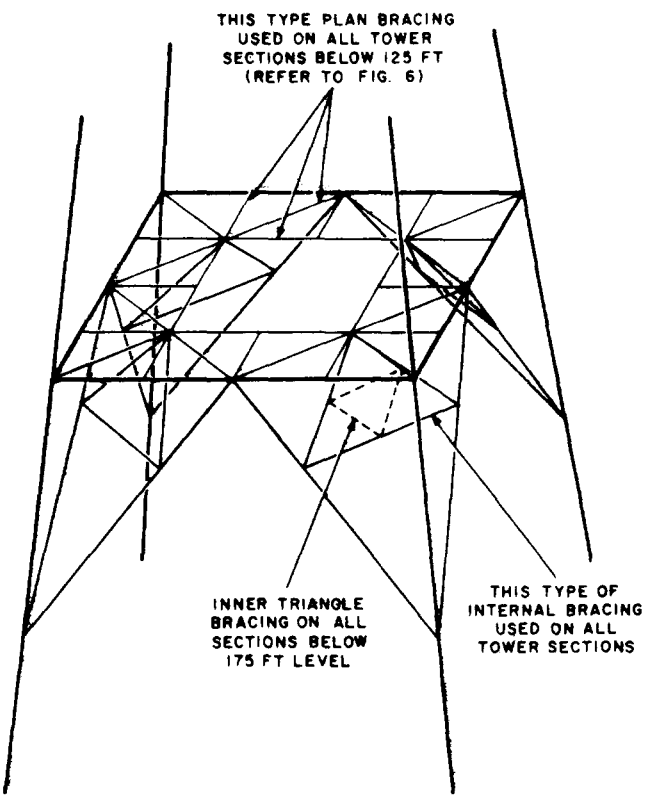


Fig. 7—Tower Bracing

4.14 Errors in fabrication are rare, but they do occur. Sometimes such errors can be detected by comparing measurements of similar pieces, eg, one leg versus an adjacent leg. These measurements should be checked against the fabrication drawings, which are included in the specification covering the manufacture of the tower. Each piece of steel (except nuts, bolts, etc,) may be identified by its mark number.

4.15 Incorrect spacing of the foundation piers or differences in height of piers can make it virtually impossible to erect the tower. These dimensions should be checked carefully before any tower components are modified or replaced.

4.16 Fig. 8 shows a butt leg splice where there is no change in size of the leg angles. Note that the ends of leg members are not required to bear against each other. Some difficulty is occasionally experienced in making up these joints due to irregularities in galvanizing, or because of slight misalignment of holes. Another possible source of difficulty is insufficient chamfer of the outside corner at the splice angle. The reason for the chamfer is to provide clearance for the fillet on the inside of the leg angle. (Outside corners have an extremely small radius—perhaps 1/16 inch—see Fig. 9.) Leg angles with an unusually generous fillet will produce the same effect as too little chamfer. The remedy is to grind the splice angle to obtain a greater chamfer. Occasionally, it will be found that holes do not line up closely enough to permit full bolting without drifting of holes. There is no objection to removing excess zinc (galvanizing) which may unduly reduce hole size but, generally, reaming of holes is undesirable. Members which cannot be joined without further field fabrication should not be installed without checking dimensions against shop drawings to determine the nature of the mistake in fabrication. Members which are merely too long may be cut to proper length provided distances between bolt holes are correct and edge distances will be correct after cutting. Grinding may be permitted in lieu of cutting; cutting by a torch should not be allowed.

4.17 Freshly cut surfaces, or any surface where galvanizing has been damaged, should be painted immediately. The best protection is probably provided by the zinc-rich type of paint. These paints are 90 percent (or more) powdered zinc and will provide some galvanic protection in the same

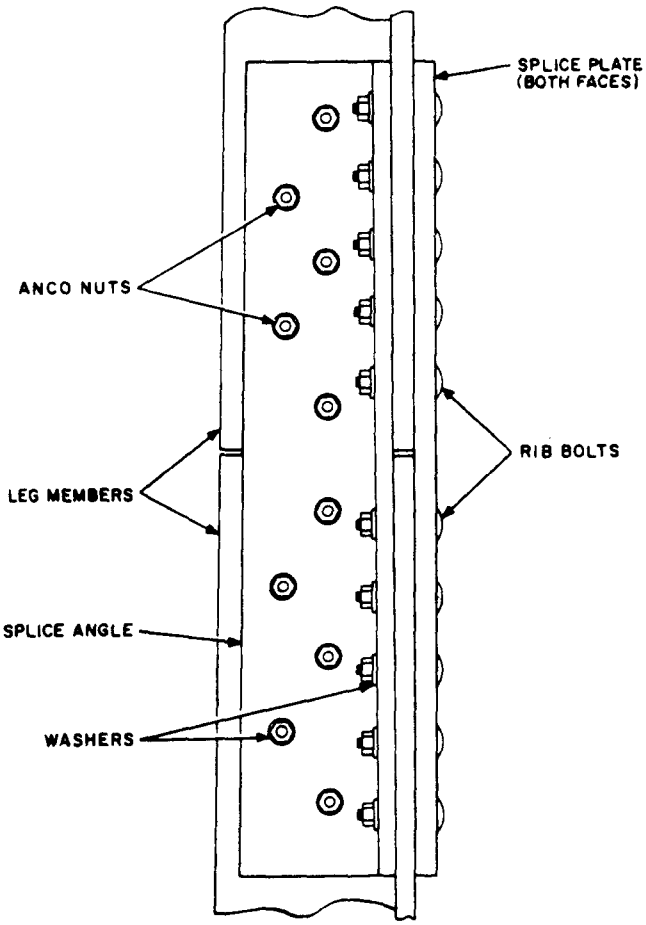


Fig. 8—Butt Leg Splice

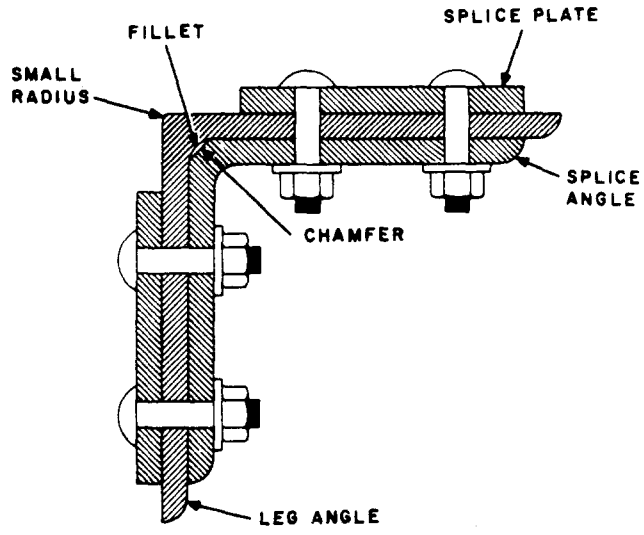


Fig. 9—Cross-Sectional View of Butt Leg Splice

fashion as galvanizing. They also have the property of preventing rust from creeping under the paint film. They should not be applied to steel which is damp or wet, or coated with mud, oil, grease, mill scale, bird droppings, etc. To be effective, paint of this kind should have a coverage rate not exceeding 350 square feet per gallon. If this type of paint is not available, zinc oxide—zinc dust paint—is an acceptable substitute. It must be applied over clean dry metal and should conform to Federal Specification TT P 641 Type I or Type II.

4.18 To obtain savings in fabrication and erection, leg angle sizes are gradually decreased from bottom to top. Changes in leg sizes affect both width and thickness. The latter produces a problem at splices which is solved by the use of filler plates (Fig. 10). Note that the filler plate is fastened to the thinner angle by one bolt which does not pass through the splice plate and angle.

4.19 Not all splices are butt splices. All towers over 100 feet high contain one set of lap splices which occur approximately 100 feet down from the top of the tower. At this point the leg size changes from 6 by 6 by 5/8 inches to 8 by 8 by 1/2 inches. The lap splice puts the smaller angle inside the larger, and the outside of the smaller angle is chamfered for the same reason as the splice angles used at butt splices.

4.20 In general, details of hoisting are best left to the contractor. However, it may be worthwhile to caution the contractor on one possibility, in the event he has not previously erected an E Self-Supporting Tower. That is, a panel should ***not*** be hoisted by means of a single hitch made at the midpoint of the horizontal member because the dead weight may cause buckling. (Two hitches using a spreader bar will avoid this possibility.) ***Members which have been bent or buckled should be replaced.*** All sizes of towers use K bracing on the face and these panels can be damaged by improper methods of hoisting (Fig. 11). K bracing becomes fairly elaborate as the distance between leg members becomes greater.

4.21 Access to the tower is provided by special step "bolts," each of which is designed to support 500 lbs (Fig. 12). This step bolt is attached by a single 5/8-inch bolt to the tower leg up to a level 75 feet from the top and to a step bolt ladder angle for the top 75 feet. Rotation is prevented by the right-angle bend which engages the outer

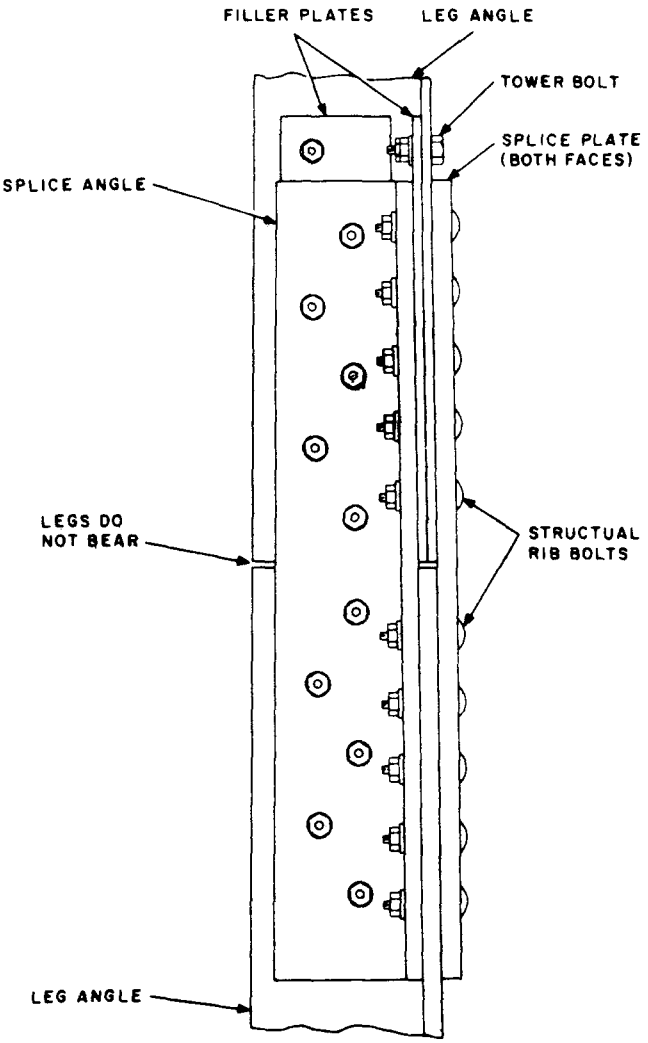


Fig. 10—Filler Plate

corner of the leg angle. The 135-degree bend in the step results in alternate steps being in the same plane when mounted on a 90-degree angle as opposed to the conventional straight step bolts which would be at right angles. Since a splice plate is not of sufficient width to provide restraint for the step, a filler plate must be placed on the outside of the splice plate where a step falls at a leg splice. The filler plate should be attached by not less than two splice bolts. Filler plates and extra length bolts are provided as required (Fig. 12). Step bolts may be eliminated in the lower 8 feet of the tower to provide some deterrent to unauthorized climbing.

4.22 All 100-foot and higher towers are equipped with a safety strand where the climber must transfer from the leg of the tower to the

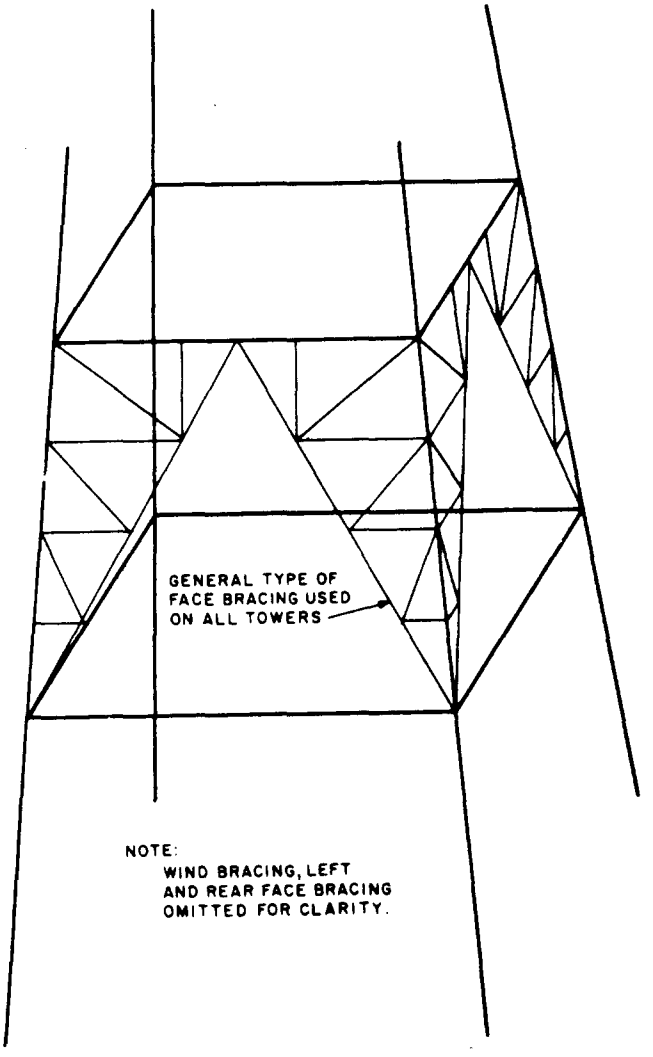


Fig. 11—K Bracing

step bolt ladder angle on the face of the tower. A safety strand may also be provided at the level of side obstruction lights (assuming two-level lighting). The strand may be standard 6M, as used in pole line work. It should have a tension of about 500 to 600 pounds (not critical). Holes are provided for attachment of this strand to the tower legs in all 25-foot panels except the 225-, 250-, 275- and 300-foot panels. The holes are located 4 feet above the horizontal girt in the panel. Section 081-725-200 provides instructions for using the strand. Strand may also be provided at the top of the tower using the leg extensions as posts.

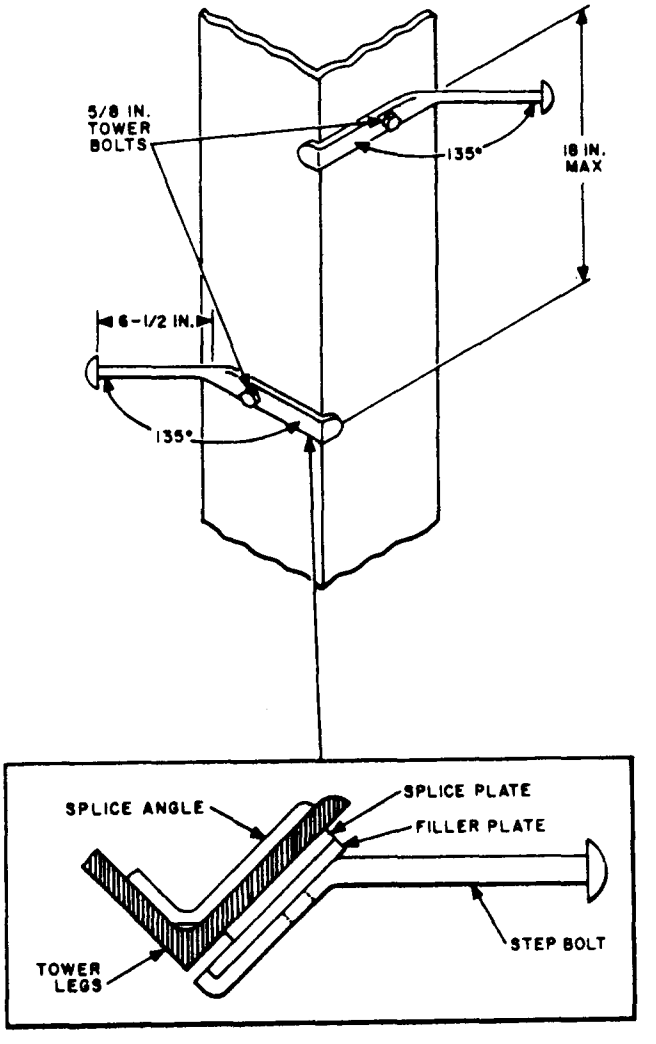


Fig. 12—Typical Step Bolt at Leg Splice