

CENTRAL OFFICE EQUIPMENT

**Earthquake Bracing
Engineering and Installation
Application**



AG Communication Systems

A Joint Venture of AT&T and GTE

This AG Communication Systems Corporation Practice has been prepared for its Customers, and end users' Employees who operate and maintain the equipment manufactured and so/d by AG Communication Systems Corporation. The information in this Practice is subject to change and may not be suitable in all situations. AG Communication Systems Corporation acknowledges that a customer's special requirements or practices may take precedence over those supplied in this Practice if a conflict develops during installation or ongoing operation. AG Communication Systems Corporation hereby disclaims any responsibility or liability for any direct, indirect, consequential, or special damages that may result from the use of this Practice.

This Practice and the information therein is proprietary and confidential property of AG Communication Systems Corporation and provided with the understanding that it shall not be copied or reproduced in whole or in part or disclosed to others without the prior written permission of AG Communication Systems Corporation.

Copyright ©AG Communication Systems Corporation 1990

	PAGE
CONTENTS	
1. GENERAL	4
2. DESCRIPTION - EARTHQUAKE	4
Earthquake Characteristics	4
Seismic Risk	4
3. TELEPHONE EQUIPMENT BRACING	4
Seismic Coefficient Method	4
Canadian Standard	7
Basic Bracing System	8
4. BRACING APPLICATION	9
Primary Superstructure	9
Secondary Superstructure	10
Earthquake Bracing Superstructure	10
Equipment Bracing Considerations	11
Wall Bracing	12
Battery Frame Bracing	12
Miscellaneous Bracing Considerations	12
5. TYPICAL BRACING LAYOUTS	13
Single-Channel Layouts	13
Double-Channel Layouts	13
Cable Grid Assembly Layouts	16
6. GTE CALIFORNIA STANDARDS	28
7. TELEPHONE EQUIPMENT BRACING	28
Seismic Coefficient Method	28
California Standard	28
8. BRACING APPLICATION	29
Primary Superstructure	29
Equipment Bracing Considerations	29

1. GENERAL

1.01 This practice presents an engineering overview of considerations and applications of earthquake bracing necessary to protect telephone equipment from damage due to seismic shock.

1.02 This practice is reissued to designate the practice as an AG Communication Systems (AGCS) Practice, and to incorporate other changes and additions. Remove the previous issue of this practice from the binder or microfiche file and replace it with this issue.

1.03 This practice also contains general information on earthquakes, the derivation of the seismic coefficient method of structural bracing, the basic system development of earthquake bracing, bracing applications, and typical earthquake bracing layouts.

2. DESCRIPTION - EARTHQUAKE

Earthquake Characteristics

2.01 In simple terms, an earthquake is a form of change or growth in the earth's surface producing strong ground vibrations due to a large release of energy in a short period of time. Earthquake bracing requirements are dependent upon the intensity and magnitude of these vibrations.

2.02 Two types of seismic waves, longitudinal and transverse, are produced during an earthquake. The initial tremor is caused by the longitudinal waves which arrive first; the main tremor results from the transverse waves arriving later.

2.03 The shear waves transmitted through relatively elastic ground are the most important of the seismic waves from an engineering point of view, because particles within an elastic body move in a direction perpendicular to the direction of the shear wave itself. It is this shear wave

property that must be accounted for in earthquake bracing.

Seismic Risk

2.04 Through historical data derived from the occurrence and intensity of earthquakes and the use of the Modified Mercalli (MM) seismicity scale, a series of five seismic risk zones (Figure 1) has been developed. They are as follows:

- (a) Zone 0 - No damage.
- (b) Zone 1 - Minor damage, distant earthquakes may cause damage to structures with fundamental periods greater than 10 seconds. It corresponds to MM levels V and VI (see Table 1 for MM scale).
- (c) Zone 2 - Moderate damage, corresponds to MM level VII.
- (d) Zone 3 - Major damage, corresponds to MM level VIII or higher.
- (e) Zone 4 - Areas located adjacent to faults. (Faults are located in area 3, but are not shown on the map.)

2.05 This zone information is used in several standards to determine the seismic coefficient dependent on the vibration period of the structure.

3. TELEPHONE EQUIPMENT BRACING

Seismic Coefficient Method

3.01 Seismic effect must be considered in designing bracing to protect telephone equipment in the event of an earthquake. The seismic load has a horizontal and a vertical component. Since a structure must withstand its own weight, there is usually an adequate degree of resistance to force in the vertical direction.

3.02 The horizontal component of the seismic force is adopted as the load acting

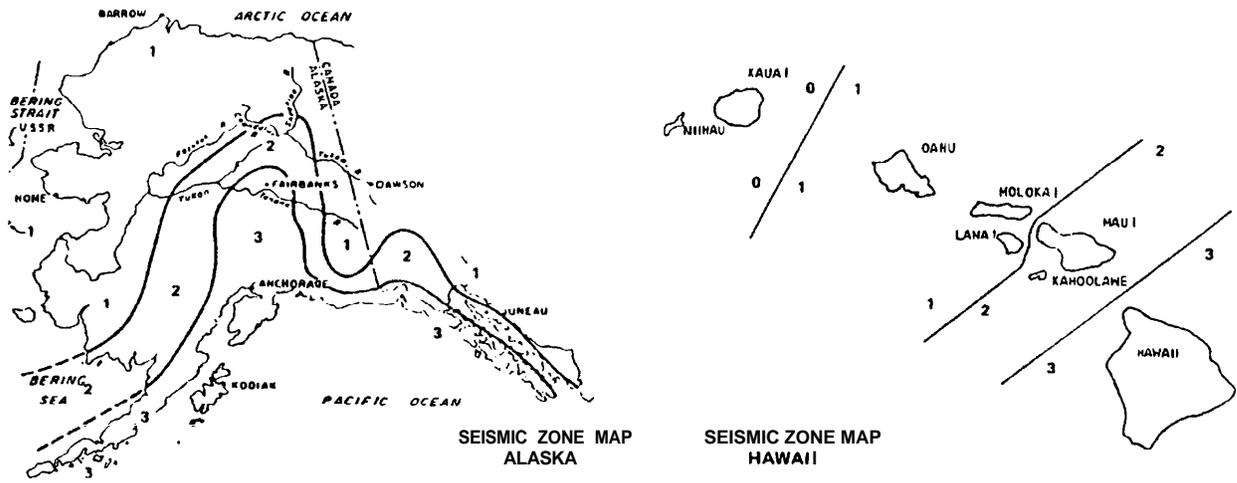


Figure 1a. Alaska and Hawaii.

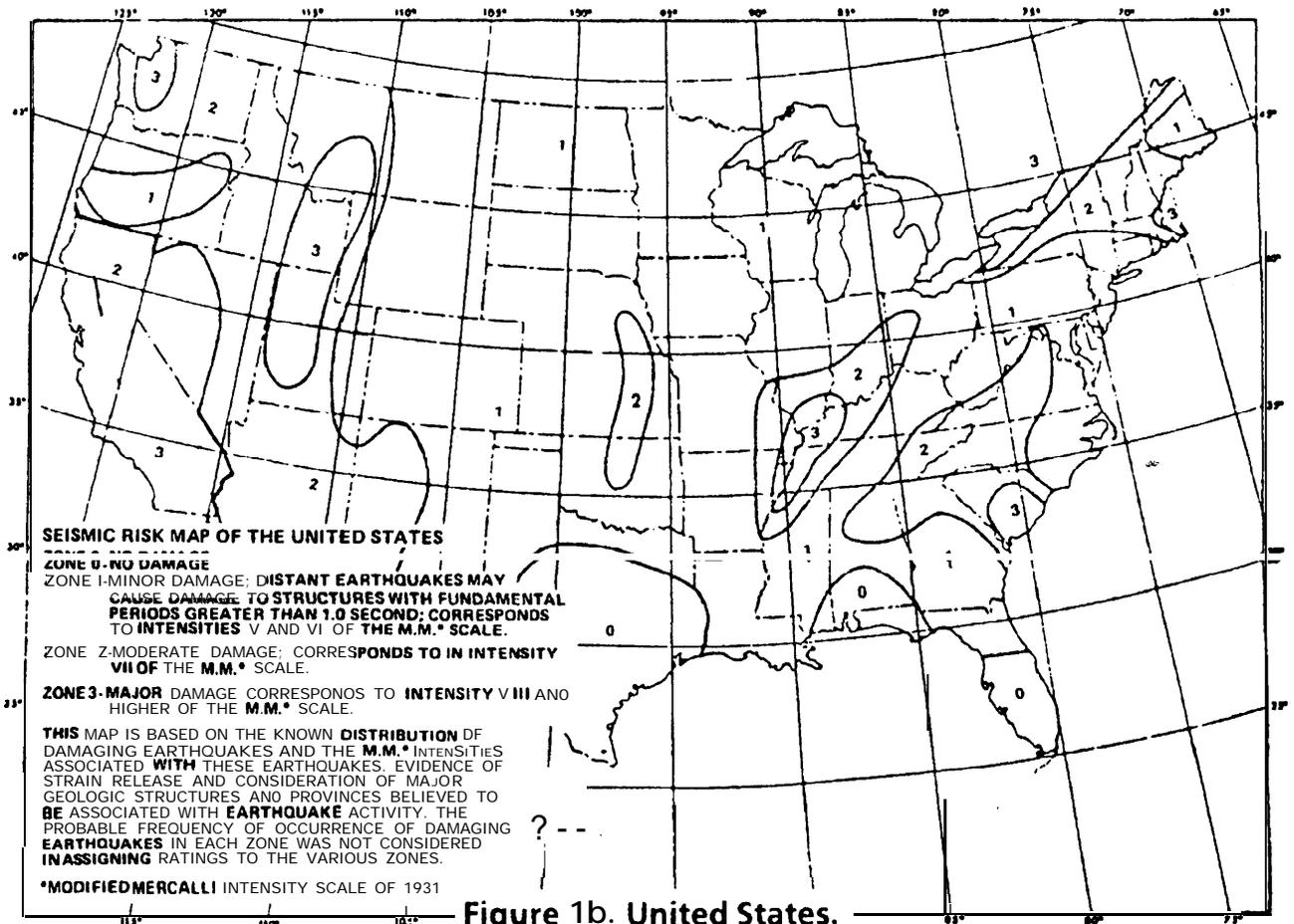


Figure 1b. United States.

Figure 1. Seismic Risk Zones.

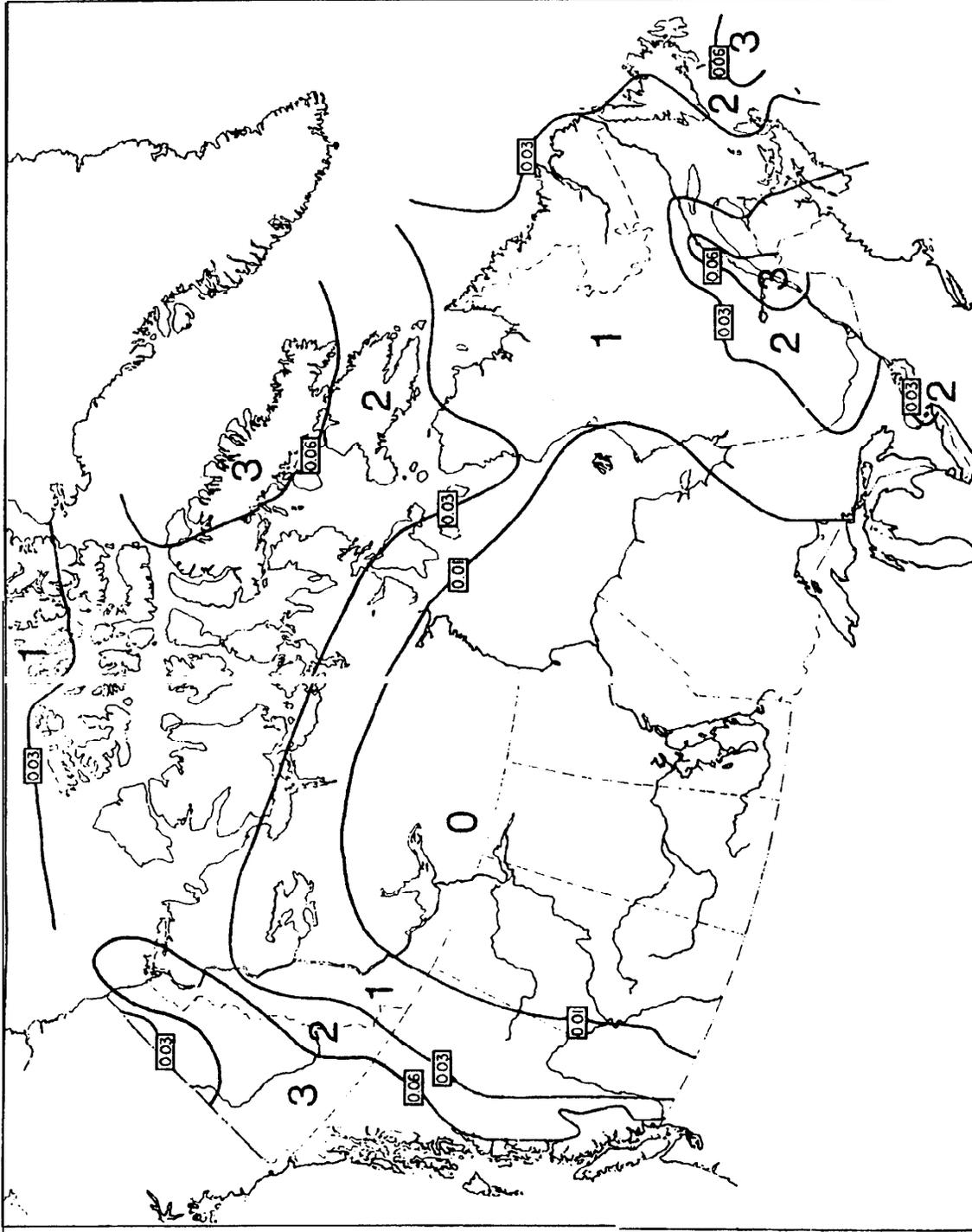


Figure 1c. Canada.

Figure 1. Seismic Risk Zones (Continued).

on a structure during an earthquake. The telephone industry's method for dealing with this seismic load is the seismic coefficient method. This method reduces the dynamic forces acting on a structure during an earthquake into static horizontal loads and designs or uses existing super-structure or earthquake bracing to withstand these loads.

3.03 The seismic coefficient method is based on the following assumptions:

- (a) The seismic force acts as a static external load on the mass of each element of the structure.
- (b) The seismic force acts in a horizontal direction. Its magnitude is

Table 1. Braces Required for Equipment Rooms.

ROOM WIDTH (FEET)	SET OF BRACES PER SECOND RUN
Frame room	1
Switch rooms (up to 50)	2
Switch rooms (50 to 75)	3
Switch rooms (75 to 100)	4
Switch rooms (100 to 125)	5
Switch rooms (125 to 150)	6

NOTES:

1. Braces need not be provided in zones having little or no seismic activity, e.g., zones 0 and 1.
2. Where braces are provided, they should be positioned symmetrically with respect to equipment bays as far as possible.
3. See Figure 3 for a typical layout.

proportional to the mass, the proportionality constant divided by the gravitational acceleration.

- (c) The seismic coefficient is derived through historical experience on the basis of structure type; its value may be updated regularly to reflect recent accumulated experiences.

Canadian Standard

3.04 The seismic coefficient method is applied variously throughout the industry to determine the seismic force that must be resisted. Generally speaking, however, these are variations on the California Standard (see paragraph 7.04). For instance, the 1975 Canadian National Building Code (NBC) uses the following formula:

$$V = ASKIEW$$

where

V = The total lateral force or shear force at the base.

A = The historically derived and assigned horizontal design ground acceleration, dependent on the earthquake zone (Figure 1).

S = The seismic response factor for base shear standard, dependent on the vibration period of the structure. Use standard 5.0 for telephone equipment.

K = The building frame factor.

I = The importance factor of 1.3 because all utilities must be protected 30 percent greater than nonpublic building.

E = The foundation factor (normally 1.0 unless soil is of poor quality).

w = The weight factor. (The fixed equipment load of frames, wiring, supports, braces, hardware, and all permanently installed material).

NOTE: For electronic equipment, it is expected that this total fixed live load will approximate 100 pounds per square inch (psi). Transient floor loads such as people and portable equipment are not to be included.

Basic Bracing System

3.05 Ideally, telephone equipment racks should be designed and manufactured to resist seismic forces as freestanding frames, but, since most equipment is not used in areas of high earthquake probability, this capacity is not incorporated into standard frames. It is more economical to use standard frames braced at the top to resist overturning forces than to use freestanding frames. The bracing system designed to withstand these forces is based upon the theory of a simple truss so that each part shares the potential thrust or weight of the equipment.

3.06 The basic bracing system (Figure 2) consists of a series of horizontal members running at right angles to the equipment lineup, fastened to the top of the racks and parallel to the secondary superstructure.

3.07 These members may be light channels, two-bar, or the perimeter framing of cable grid. At intervals along the horizontals are pairs of diagonals arranged in a V and fastened at the top to the primary superstructure and at the bottom to the secondary superstructure. Each diagonal of the V is considered to be acting in tension and compression, and may consist of threaded rod (for short bracing only), TELSPAR® tubing, or UNISTRUT® channel. A truss assembly, similar in construction to the

other bracing system members, is located parallel to the equipment lineup and parallel to the primary superstructure on the two outside sides of the bracing system.

3.08 The basic configuration of the bracing system is rectangular or boxlike. Each irregular area to be braced is divided into rectilinear portions (Figure 3), and bracing of that area is done accordingly. In new reinforced concrete construction, UNISTRUT P-3300 channels, or equivalent, are cast into the slab soffit parallel to the equipment lineup. Adapting the bracing system concept to existing buildings requires a certain amount of ingenuity. For example, where the overhead or overhead consists of metal decking, the UNISTRUT channel can be used by welding it to a suitable reinforcing plate (Figure 4). The UNISTRUT channel is preferred over single concrete inserts because it allows for greater flexibility in the location of braces.

3.09 To complete an earthquake-resistant installation, the auxiliary equipment must also be suitably braced. Because of their weight, battery racks require special attention. Usually, the battery framework is rugged enough, provided it is fastened down with adequately sized anchors; however, it requires overhead bracing for adequate protection.

3.10 Power boards, transfer switches, etc, should not be mounted on walls susceptible to collapse. Connection from batteries to busbars should not be rigid. Keeper plates (Figure 5) must be installed around standby generators and air-conditioning equipment that are mounted on vibration isolators with no capacity to absorb lateral loads. The best braced telephone equipment will not operate without a power source.

TELSPAR® and UNISTRUT® are Registered trademarks of the Unistrut Corporation.

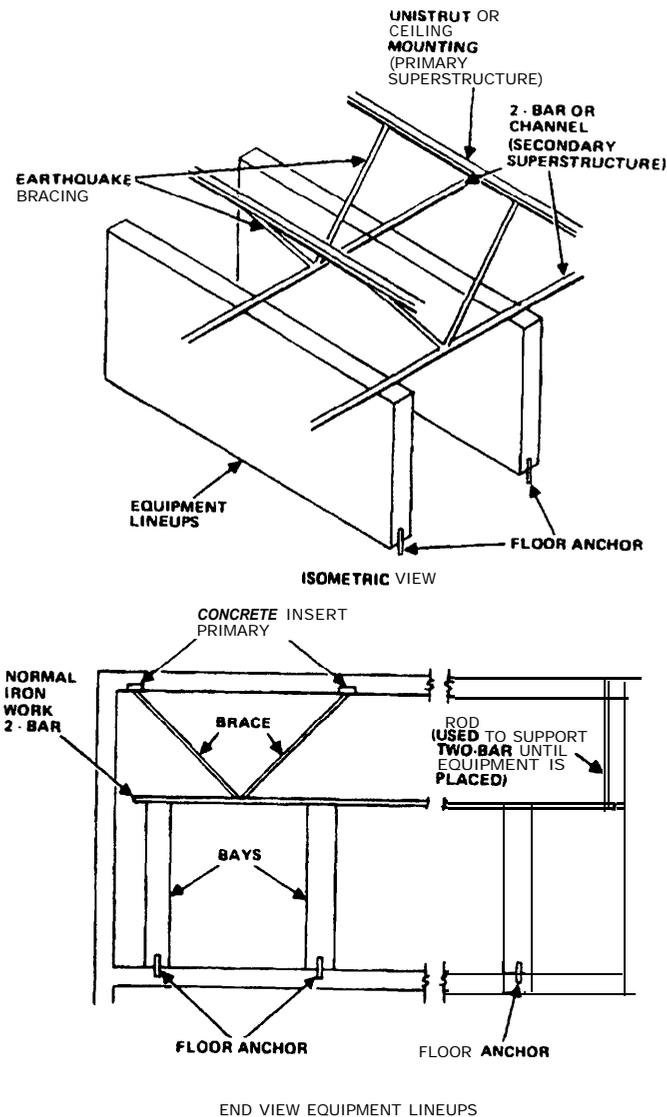


Figure 2. Simplified Diagram Illustrating Bracing Concepts.

4. BRACING APPLICATION

4.01 Each installation must be custom designed to fit the room provided and the type of equipment installed. This part will give general information as to the primary, secondary, and bracing superstructure necessary to protect the various equipment from seismic destruction.

Primary Superstructure

4.02 The most efficient method of bracing is to the ceiling. For any given building,

the use of the primary superstructure is the most economical. For a new building, continuous P-3300 series channel with lugs, or its equivalent, is cast directly into the underside of the ceiling parallel to the equipment lineup. This same P-3300 series channel without lugs can be welded with the inclusion of a reinforcing plate and a new or existing ceiling or roof deck. This primary superstructure must be specified in the PS drawing. Its direction parallel to the equipment lineups must be ensured. P-3300 UNISTRUT channel is preferred as it allows for channel interchange.

Secondary Superstructure

4.03 If cable grid and cables are installed with no equipment lineups under the secondary superstructure, install floor-mounted stanchions to relieve the weight from the roof slab. Additional 1/2-inch by 13-inch threaded rod may be installed to provide sufficient support for the secondary superstructure when no equipment lineups (or stanchions) are in place if the ceiling has not been designed for the loads. Secondary superstructure is constructed of two 2-inch by 9/16-inch channels placed on their longitudinal axes, or a 2-inch channel placed on its smaller axis on top of telephone equipment perpendicular to the equipment bays. The channel is ordered by the engineer by an X quantity of 2-inch channel in specified lengths.

4.04 All layouts for double-channel secondary superstructure must indicate the splice locations and the dimensions of the holes. Special attention must be given to the location of the brace so that secondary splicing does not interfere with brace connections to secondaries. Standard length of 2-inch channel is 20 feet. Splicing of the secondary channel must be a shear connection and not butted up with splicing dips. Double-channel must have separators to prevent deformation due to compression force in the horizontal plane.

Earthquake Bracing Superstructure

4.05 Verify on site the location of all equipment bays before determining earthquake brace locations and positions. In a switchroom with an irregular shape, only the rectangular portions of the room are used for determining the earthquake bracing (Figure 3). The lateral supports considered as bracing are installed with a minimum of two braces for the first bay and one for each additional bay in the lineup. Each set of earthquake braces must brace an equal length of secondary run. The diagonal braces are generally

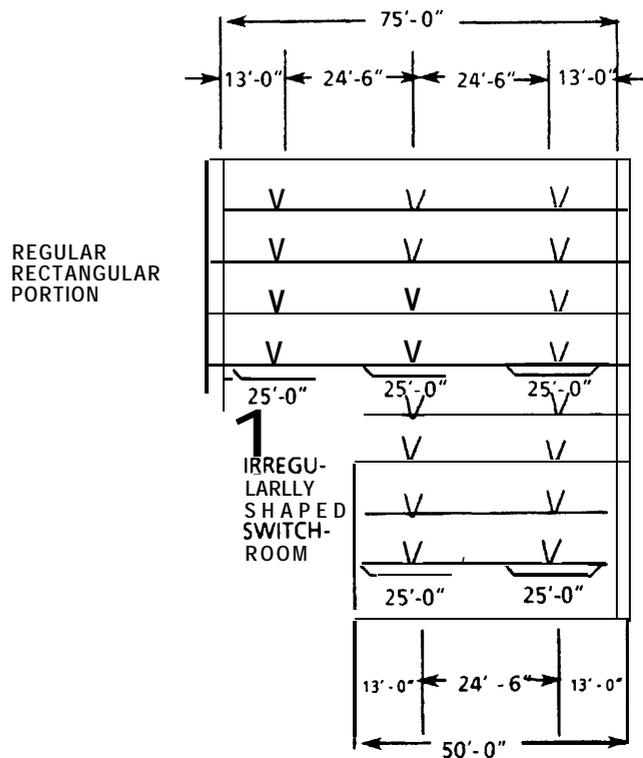


Figure 3. Typical Bracing Location Dimensions for Irregularly Shaped Room.

UNISTRUT P-1000 or TELSPAR tubing, or equivalent.

4.06 An angle of 45 ± 10 degrees must be maintained between the bracing and the secondary superstructure. In general, the length of the brace is calculated by using the primary superstructure height, subtracting the secondary superstructure height, dividing this by the sine of the bracing angle (0.70711 for a 45-degree angle), and subtracting the attachment hardware height. Additional primary superstructure may have to be provided to maintain the 45 ± 10 degrees requirements.

4.07 The earthquake bracing must be installed parallel to the secondary superstructure whether it be double-channel, two-bar, or cable grid, at points indicated.

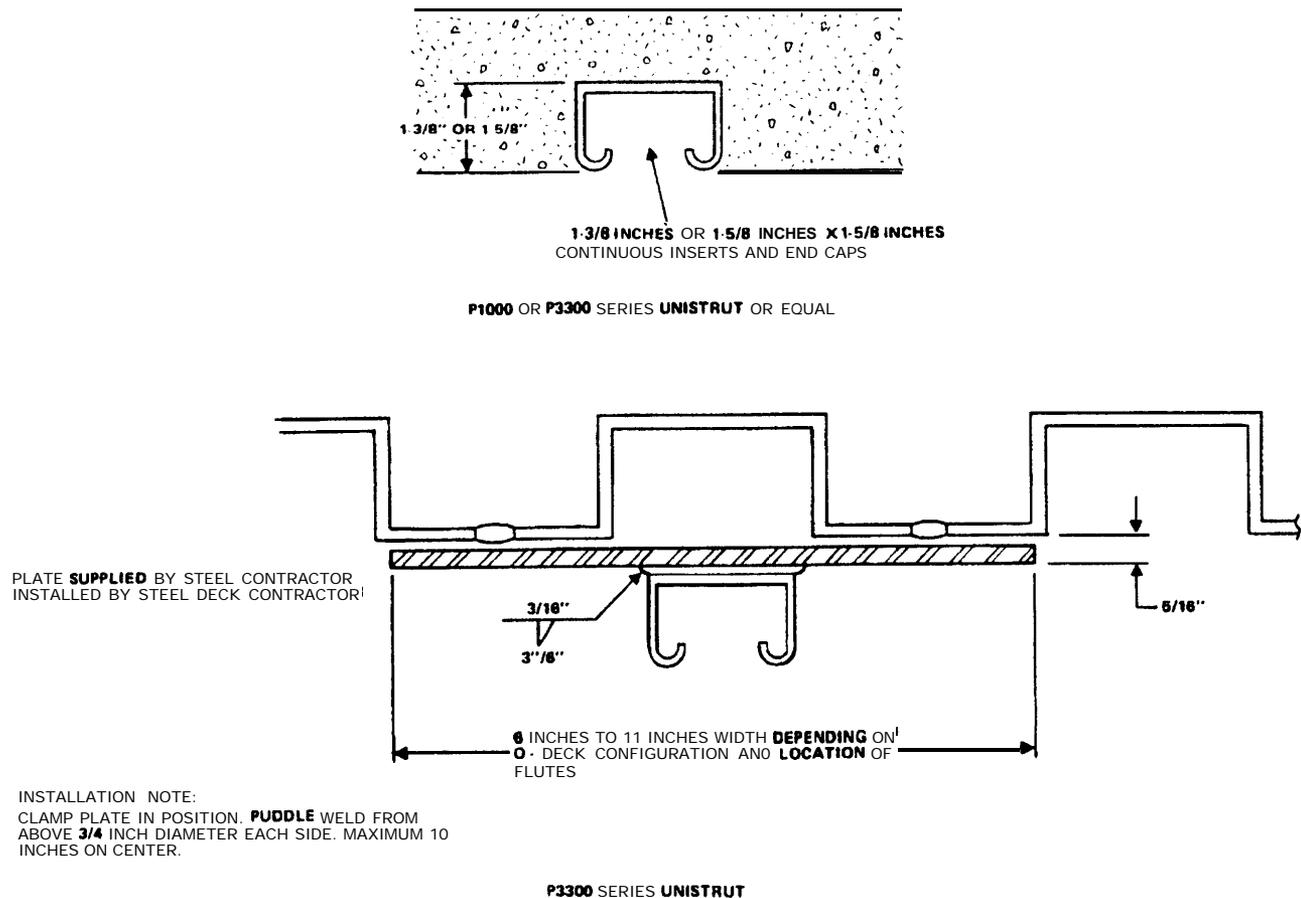


Figure 4. Typical Primary Superstructure.

If the TELSPAR tubing diagonal brace lengths exceed 10 feet, additional rod bracing is required.

Equipment Bracing Considerations

4.08 As stated previously, each installation must be custom designed to fit the room and equipment. Some general considerations relating to the equipment must be made. All types of equipment bays and relay racks that have a height greater than one and one-half times the smaller floor dimension must be anchored to the floor. Use 3/8-inch bolts at all corners of each frame, with 4,825 pounds pullout and 3,943 pounds shear.

NOTE: Securing frames to the floor with double-sided tape, even for temporary periods, is not recommended.

4.09 Any equipment -bay over 7 feet must have some lateral support while any 11-foot 8-inch rack must also have ceiling inserts provided and earthquake bracing (in specified areas). Racks and lineups with heights between are determined on an individual basis as to whether earthquake bracing must be provided or not. Some ECC equipment cabinets, bays, and relay racks must be supported with box-type support so that the equipment can stand alone and independent of the structural support of the building. U-bolts or shear-type bolt fasteners should be used at all intersections of ironwork and at the top of equipment bays, replacing J-bolts used previously.

4.10 High-strength bolts should be specified for all equipment installations. Tapered or split-ring washers are necessary at tapered sections of ironwork to prevent bending of bolts when tightening. Any cap

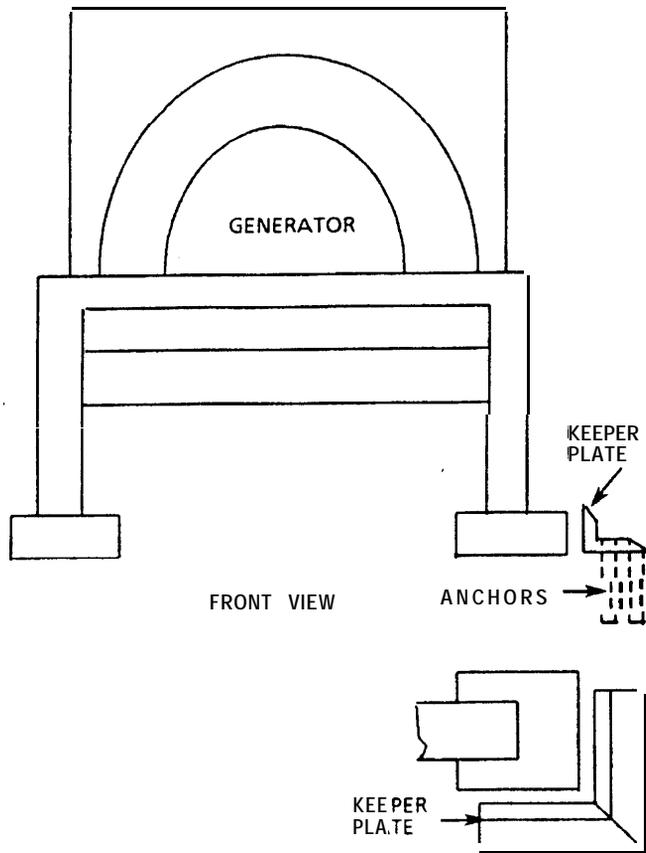


Figure 5. Keeper Plate for Standby Generators.

screws or nuts 1/2-inch by 13 or larger must be tightened to 45 foot-pounds torque.

NOTE: After tightening, the torque mark line for the nut and bolt should be marked with a dark felt-tipped ink pen.

CAUTION

USE SPLIT RING LOCK WASHERS ONLY ONCE. DO NOT ATTEMPT TO RETORQUE. WHEN THESE LOCK WASHERS ARE LOOSENED, THEY LOSE THEIR SHARP EDGES AND THEIR RESISTANCE TO LOOSENING.

Wall Bracing

4.11 Fastening to walls or columns is not recommended. However, if it is necessary to fasten any equipment to a wall or column for any reason (Figure 6), it should

be brought to the attention of the building engineering department for concurrence.

Battery Frame Bracing

4.12 Battery frames must be earthquake braced. The battery frames should be anchored to resist 1,000 pounds per upright. The batteries are anchored to the frames and joined together with UNISTRUT channel or its equivalent. Adequate bracing must be ensured in each direction.

Miscellaneous Bracing Considerations

4.13 The following general considerations should be reviewed when considering bracing for miscellaneous central office equipment.

- (a) Power boards, transfer switches, etc, should not be mounted on walls susceptible to collapse. Floor-to-ceiling lateral supports should be provided, if necessary.
- (b) Rectifiers must be anchored against overturning and shear.
- (c) Bus bars should be braced against lateral displacement with rods.
- (d) Battery-to-bus bar connections must not be rigid; cabling is preferred for tank-type batteries and flexible braid for rack-type batteries.
- (e) Clearances must be maintained around waveguides at entrances to buildings or passages through rigid walls or panels.
- (f) Mount the emergency generator and the air-conditioning equipment to prevent lateral displacement.
- (g) Oil tanks and other fuel storage facilities should be reviewed.

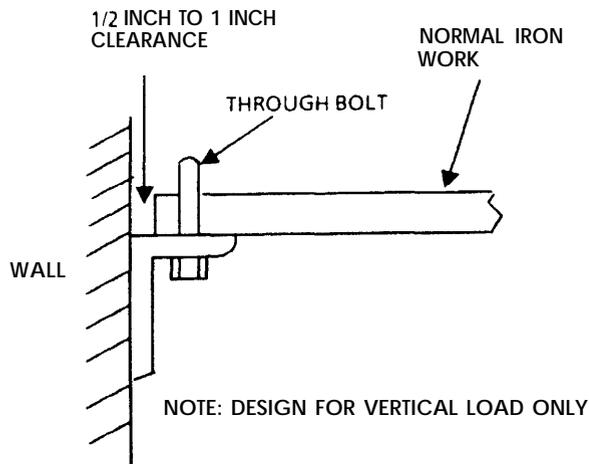


Figure 6. Typical Wall Attachment Detail.

- (h) Review cable runways, if used, in detail for vertical and horizontal loading. Review projected loading at hatches with equipment and power engineers.
- (i) Lash Halon tanks to the wall.

5. TYPICAL BRACING LAYOUTS

Single-Channel Layouts

5.01 Figure 7 shows the overall layout of the earthquake bracing for single-channel secondary superstructure. Dimensions are in inches. Other figures referenced with Figure 7 show more detail for methods of junctioning and fastening the various rods, channels, angle irons, etc, together. Figure 8 shows a typical truss assembly for the single-channel bracing arrangement.

5.02 Figure 9 shows a typical upper-junction method of fastening a UNISTRUT brace to the top plate and of fastening the top plate to the continuous channel insert.

5.03 Figure 10 shows a typical earthquake brace, lower-junction method of fastening UNISTRUT bracing to the bracing plate and to the single channel.

5.04 Figure 11 shows the method of fastening a typical drop rod to the primary superstructure, in this case, keystone

decking. The installation procedure is as follows:

- (a) Install keybolt, washer, and coupling nut.
- (b) Torque the coupling nut to 45 foot-pounds.
- (c) Install the jamb nut to the rod assembly and insert the rod into the coupling nut, then tighten.

NOTE: A 1/2-inch rod must go W-inch into the coupling. A 5/8-inch rod must go 5/8-inch into the coupling.

- (d) Torque the jamb nut to 45 foot-pounds.

5.05 Figures 12 and 13 show the typical lower and upper junction fastening of the truss assembly drop rod with its single-channel bracing arrangement.

Double-Channel Layouts

5.06 Figure 14 shows the overall layout of the earthquake bracing superstructure for a two-channel secondary. Dimensions are in inches. The figures referenced in Figure 14 show in more detail methods of junctioning and fastening the various rods, channels, angle irons, etc, together. The bracing arrangement shown in Figure 8 is similar to the truss assembly used with the two-channel bracing arrangement.

5.07 The upper junction method of fastening for the two-channel bracing arrangement is the same as for single channel bracing and for cable grid bracing. See Figure 9 for this method of fastening.

5.08 Figure 15 shows a typical earthquake-brace, lower-junction method of fastening UNISTRUT bracing to its bracing plate, and the bracing plates fastening to the two-channel bracing arrangement.

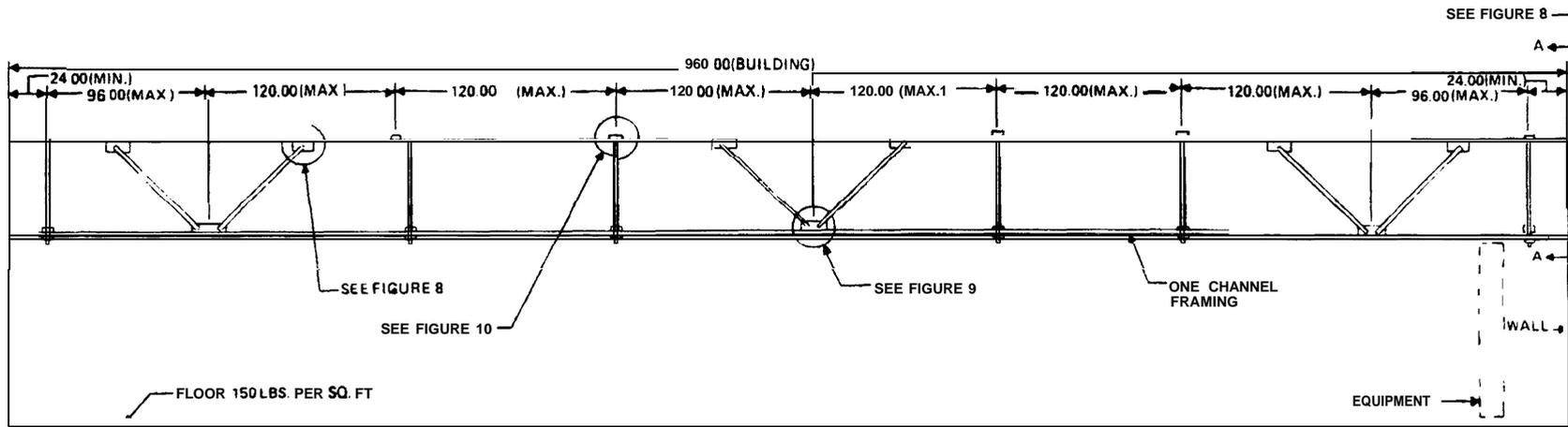


Figure 7. Typical Single-Channel Bracing Layout.

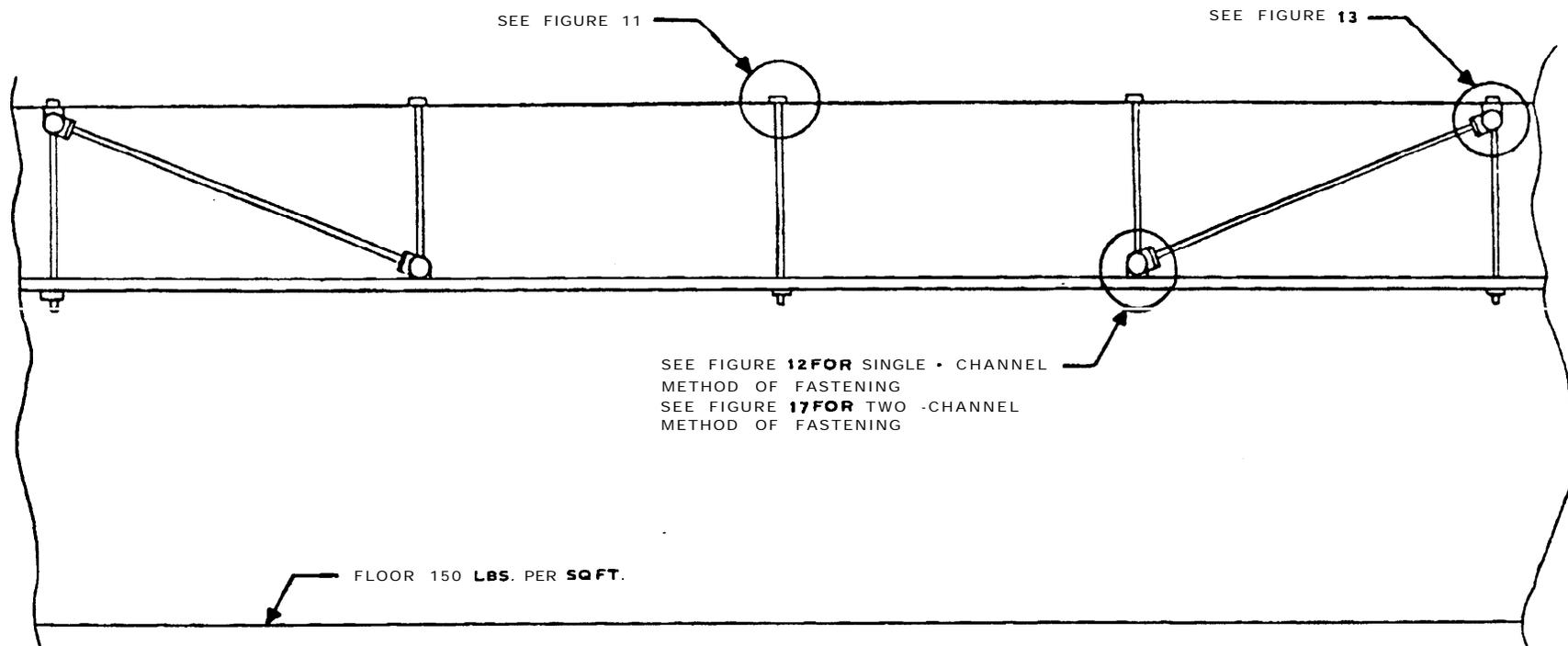


Figure 8. Typical Single-Channel Truss Assembly.

5.09 Drop rods are fastened to the primary superstructure as shown in Figure 11.

5.10 Figure 16 shows the typical method of fastening drop rod to the two-channel secondary.

5.11 Figure 13 shows the typical upper-junction method of fastening the two-channel truss assembly drop rod. Figure 17 shows the typical lower-junction method of fastening.

Cable Grid Assembly Layouts

5.12 Figure 18 is an overall layout of the earthquake bracing superstructure for use with cable grid. Dimensions are in inches. The figures referenced within Figure 18 show the junctioning and methods of fastening the various rods, channels, angle irons, etc, together. Figure 19 shows a typical truss assembly that is used with the cable grid bracing arrangement.

5.13 The upper-junction fastening of the UNISTRUT that is used with the cable grid

bracing arrangement. is the same as that shown in Figure 9.

5.14 Figure 20 shows a typical lower-junction method of fastening UNISTRUT bracing to its mounting plate and of fastening the plate to the cable grid.

5.15 Figure 21 shows the typical method of fastening a drop rod to a UNISTRUT insert that is used with the cable grid bracing.

5.16 Figure 22 shows the method of fastening a drop rod to the cable grid itself.

5.17 Figures 23 and 24 show the typical lower-junction and upper-junction methods of fastening the truss assembly drop rods used with the cable grid bracing arrangement.

5.18 Figure 25 shows the typical methods of fastening cable grid to racks without two channels.

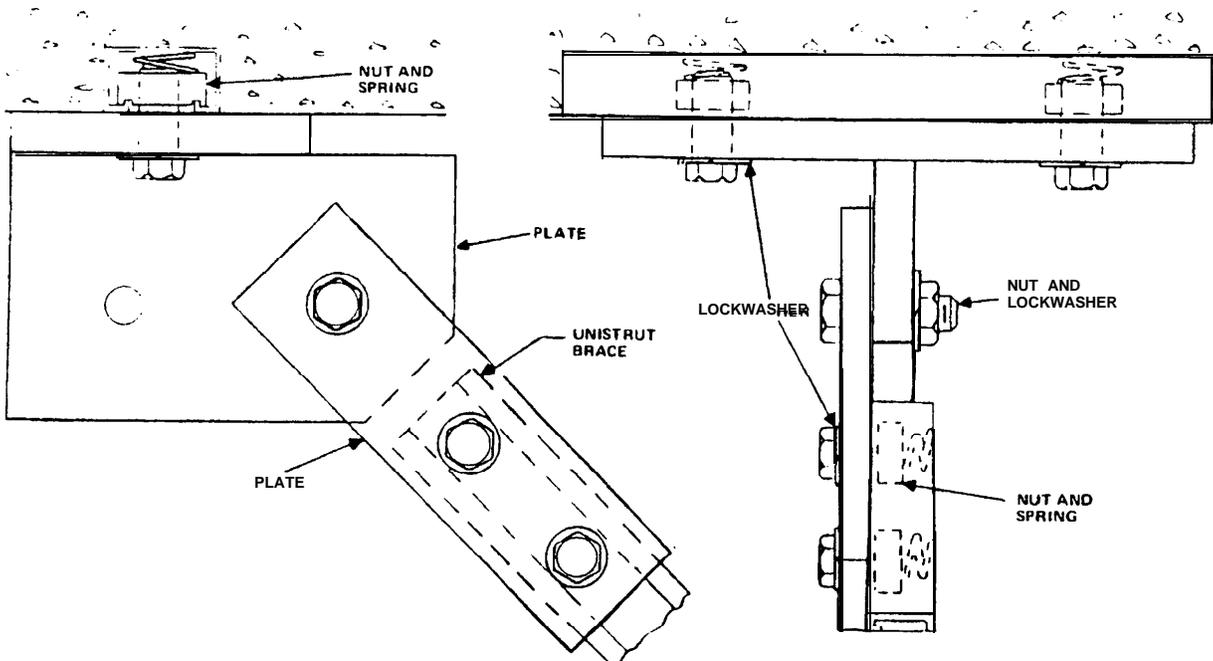


Figure 9. Typical Single-Channel, Upper-Junction Method of Fastening.

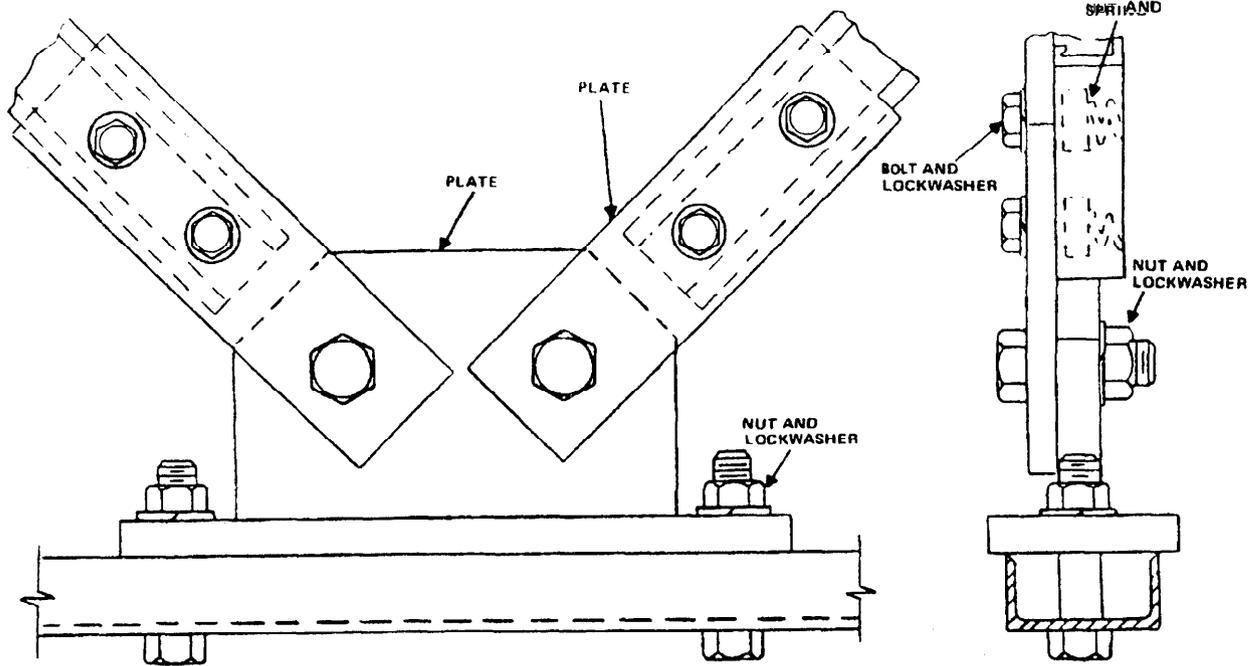


Figure 10. Typical Single-Channel, Lower-Junction Methods of Fastening.

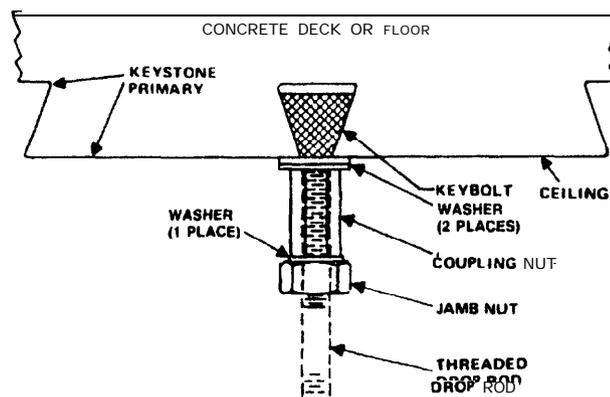


Figure 11. Typical Drop Rod Method of Fastening to Keystone Decking.

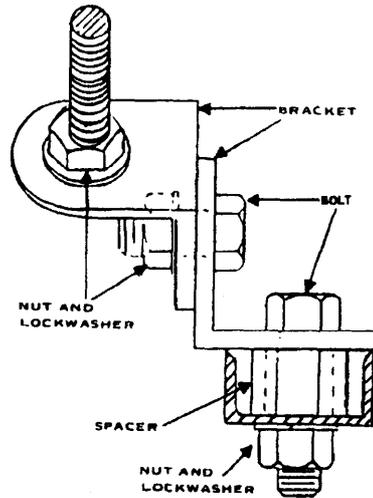


Figure 12. Typical Truss Assembly Single-Channel, Lower-Junction Fastening Methods.

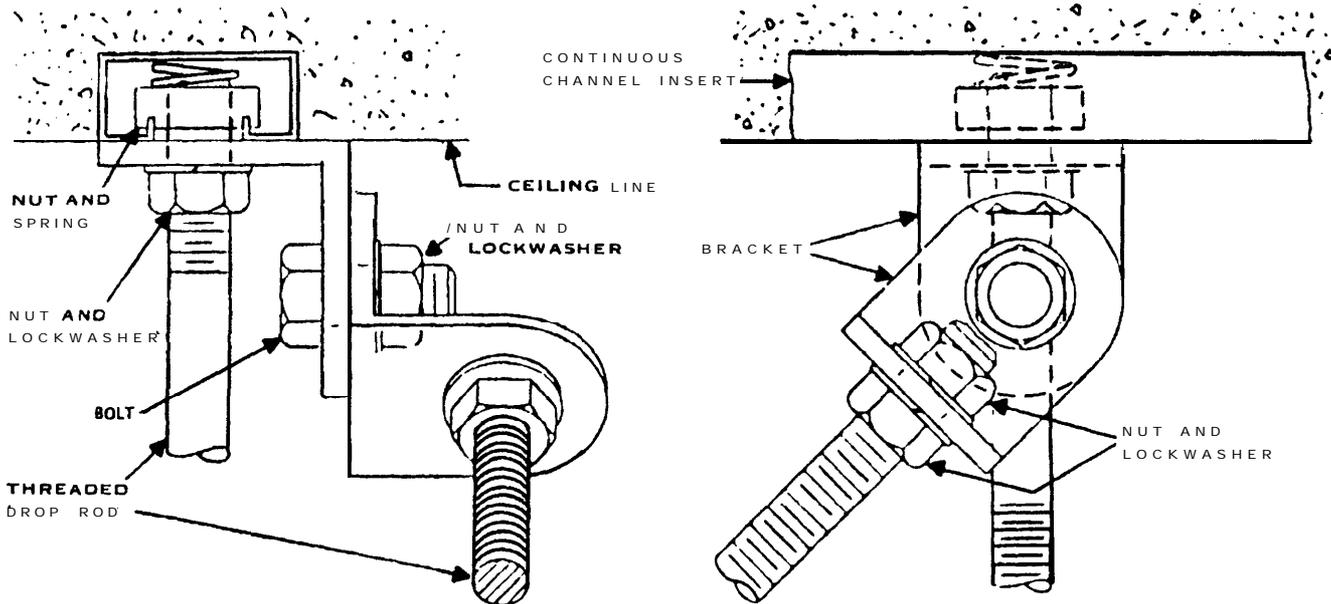


Figure 13. Typical Truss Assembly Single-Channel, Upper-Junction Fastening Method.

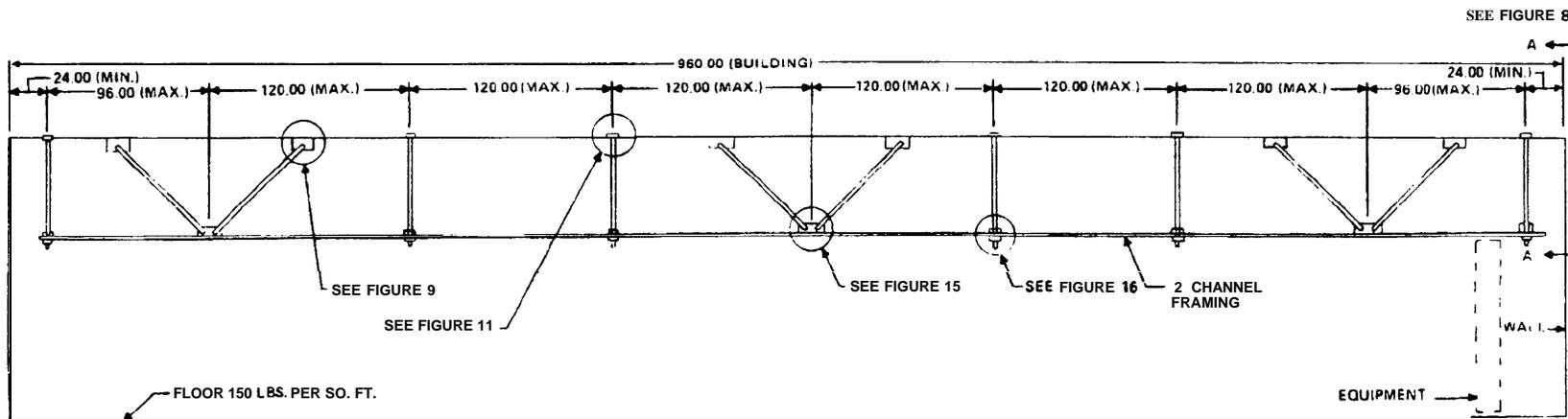


Figure 14. Typical Double-Channel Bracing Layout.

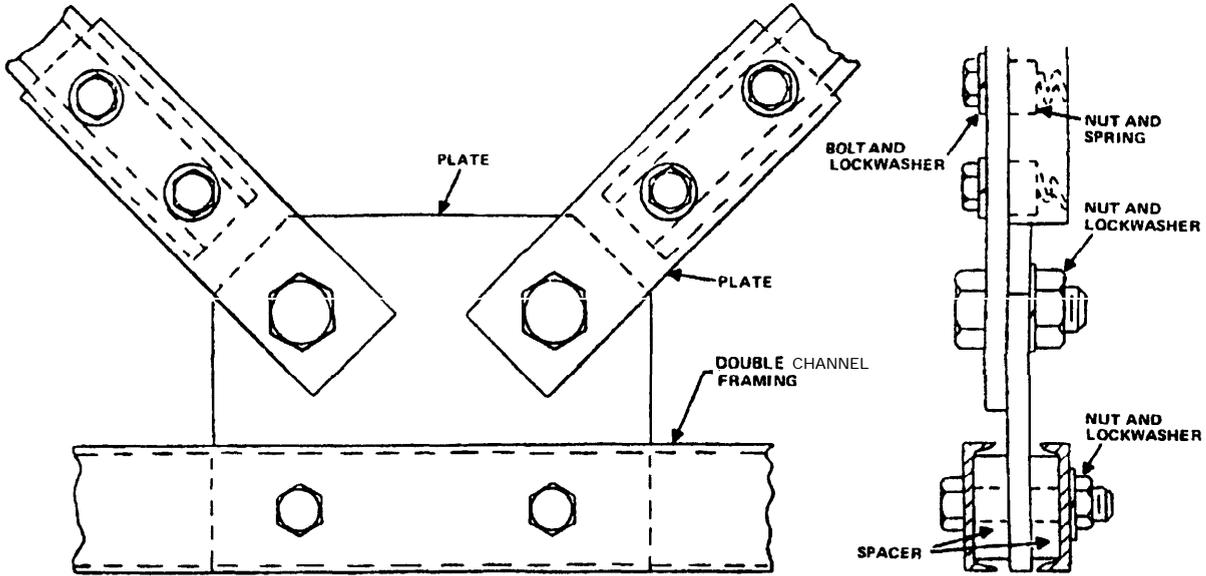


Figure 15. Typical Truss Assembly Double-Channel, Lower-Junction Method of Fastening.

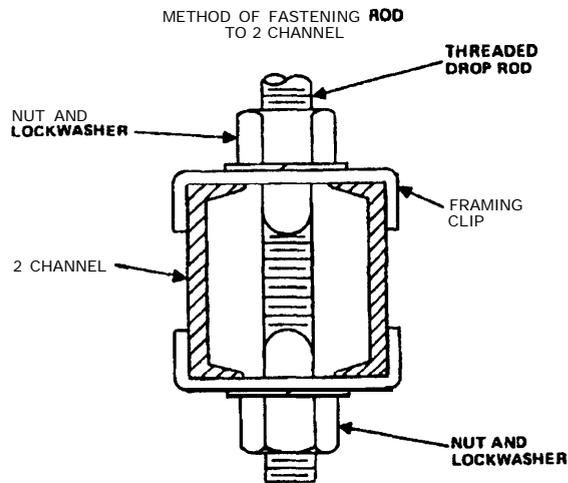


Figure 16. Typical Method of Fastening Drop Rod to Two-Channel Secondary.

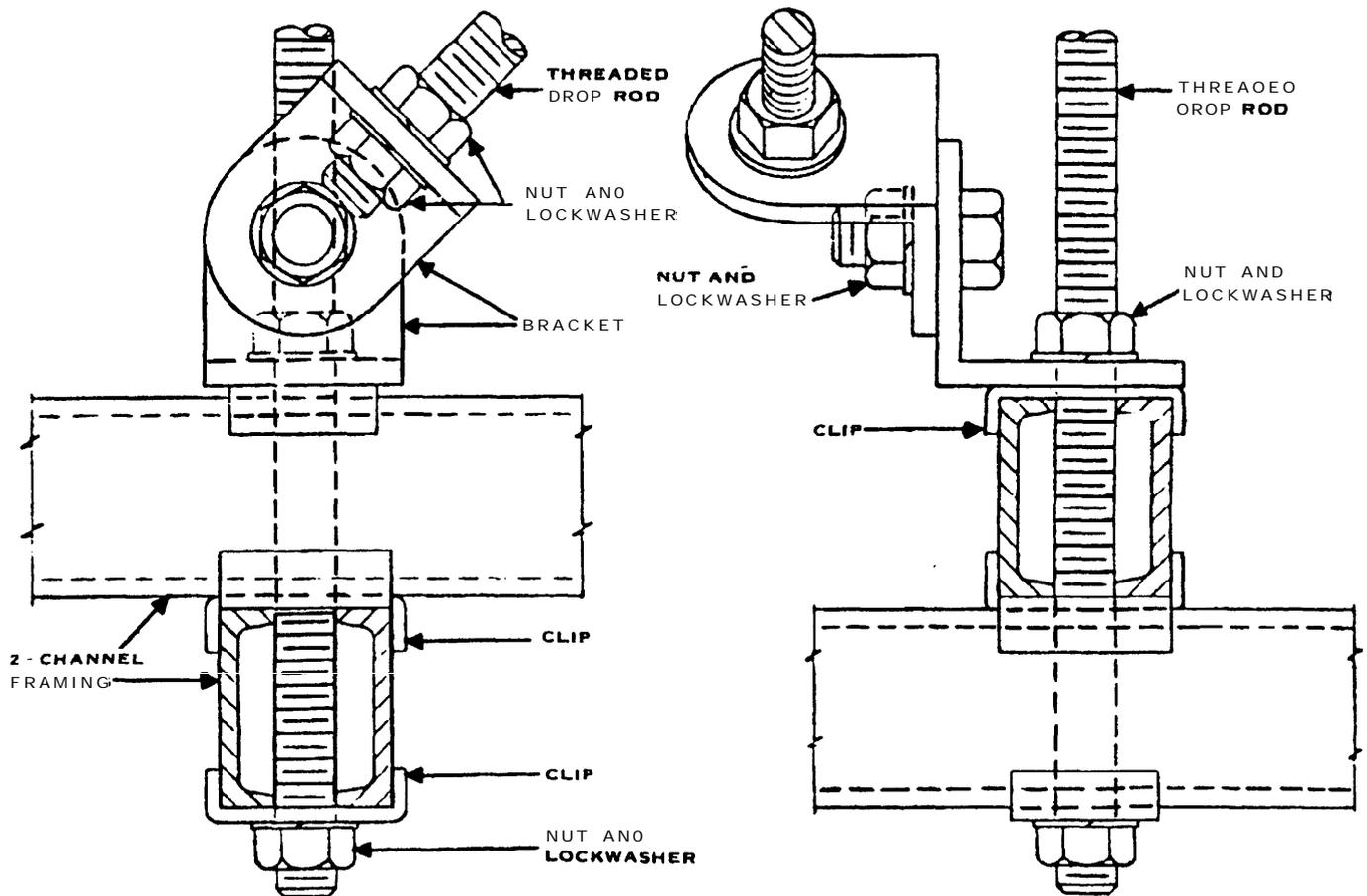
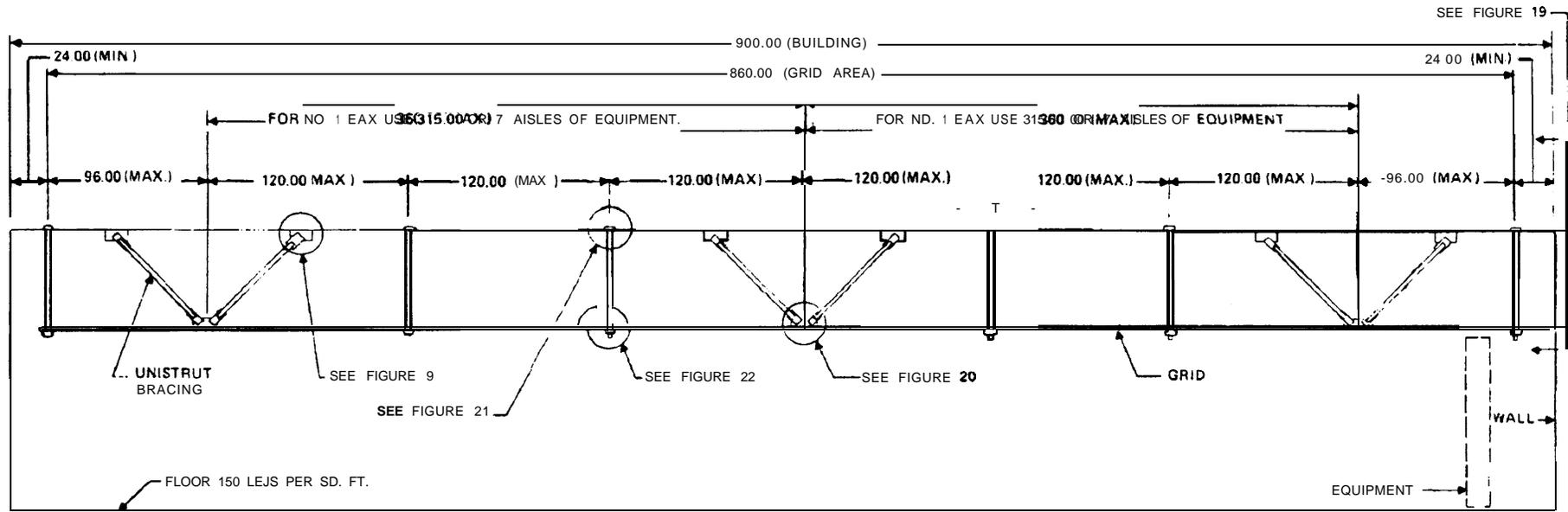


Figure 17. Typical Truss Assembly Two-Channel, Lower-Junction Method of Fastening.



NOTE:
 FOR A **GRIDDED** AREA WITH A DISTANCE AT RIGHT ANGLES TO **EQUIPMENT** FRAMES OF
 UP TO 45' . 0" USE **TWO** SETS OF BRACES
 46' . 0" TO 70' . 0" USE **THREE** SETS OF BRACES
 71' . 0" TO 95' . 0" USE **FOUR** SETS OF BRACES
 96' . 0" TO 120' . 0" USE **FIVE** SETS OF BRACES
 121' . 0" TO 148' . 0" USE **SIX** SETS OF BRACES

Figure 18. Typical Cable Grid Bracing Layout.

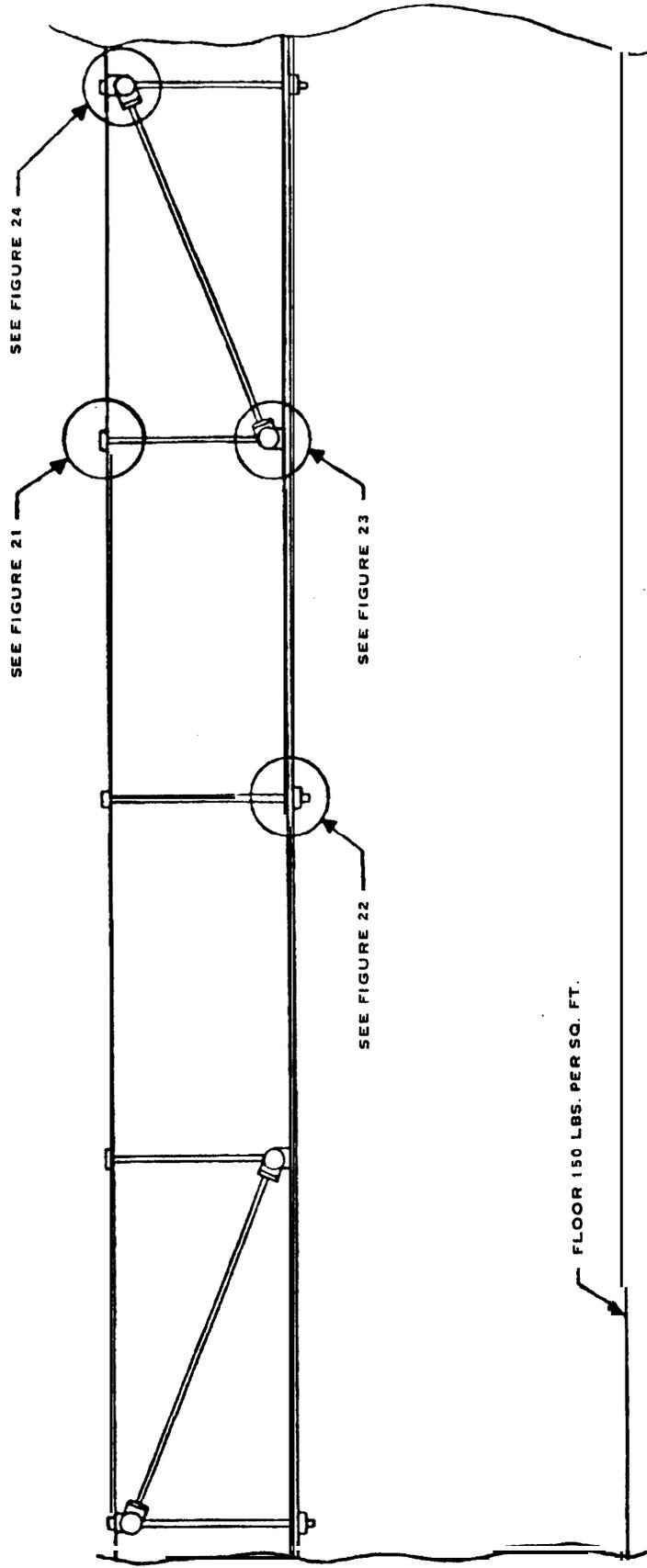


Figure 19. Typical Cable Grid Truss Layout.

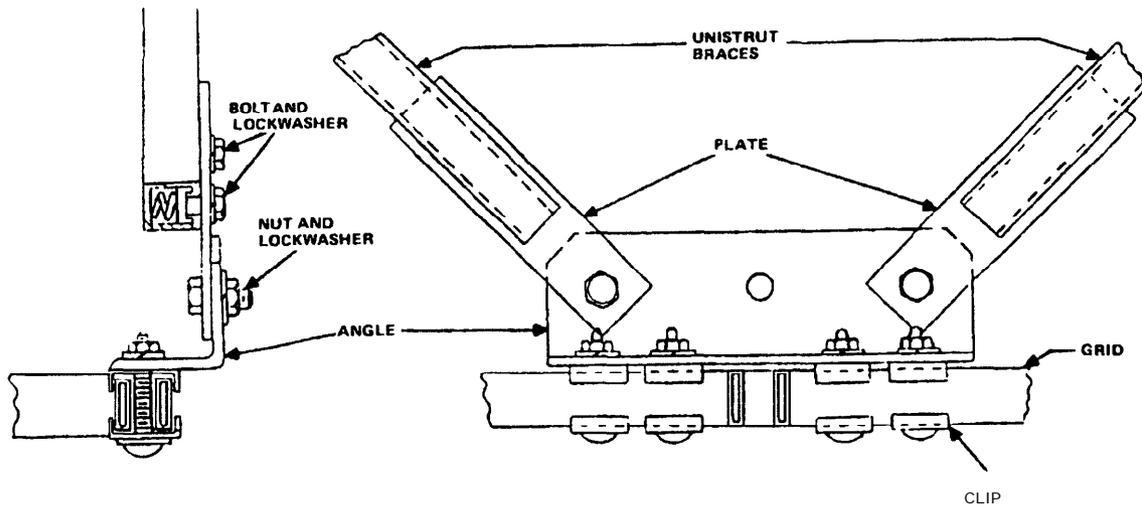


Figure 20. Typical Lower-Junction Method of Fastening to Cable Grid.

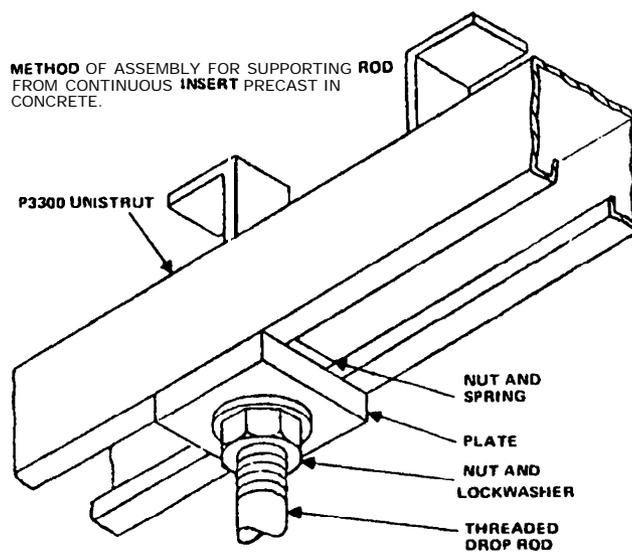


Figure 21. Typical Method of Fastening Drop Rod to UNISTRUT Insert.

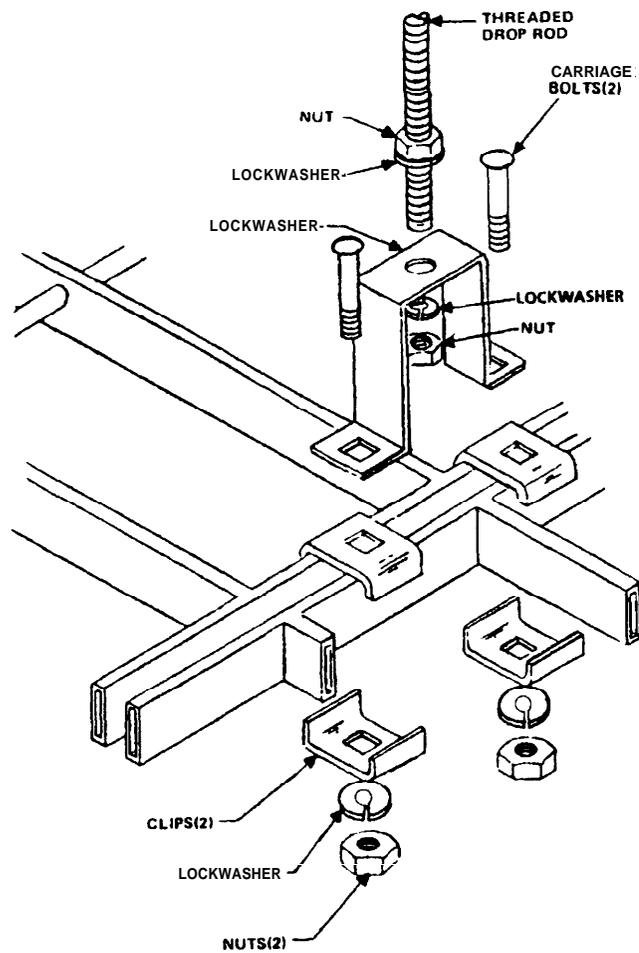


Figure 22. Typical Method of Fastening Drop Rod to Cable Grid.

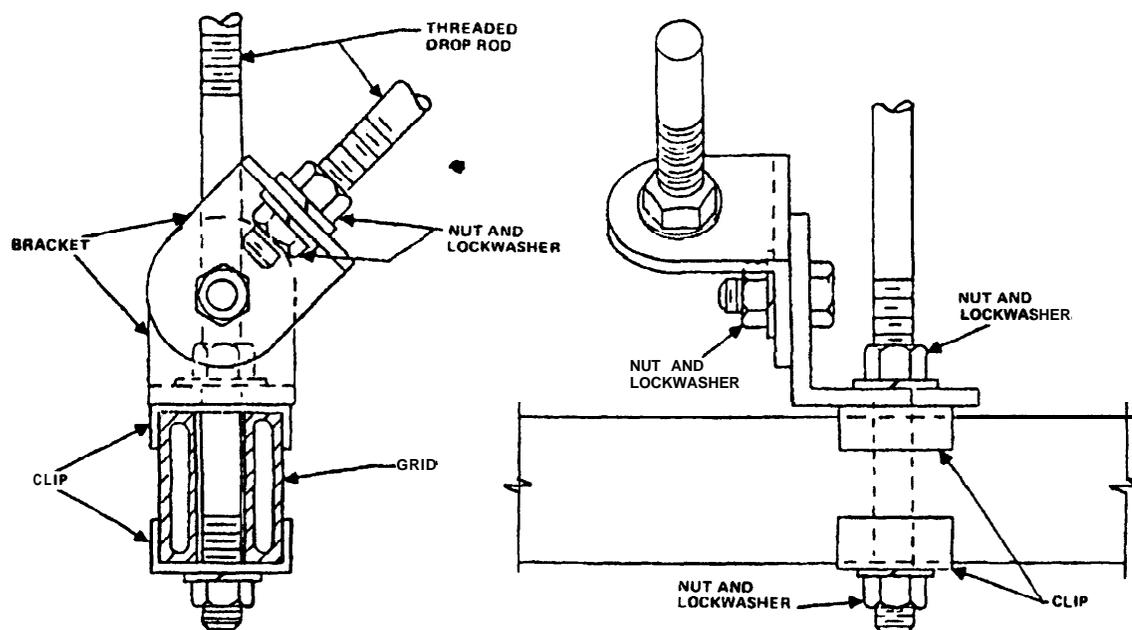


Figure 23. Typical Truss Assembly Lower-Junction Method of Fastening to Cable Grid.

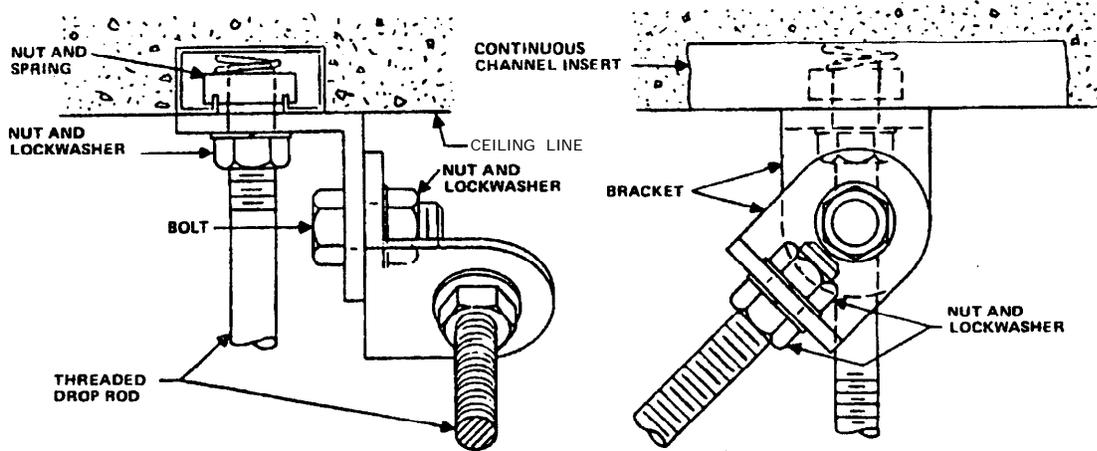


Figure 24. Typical Truss Assembly Upper-Junction Method of Fastening to Cable Grid.

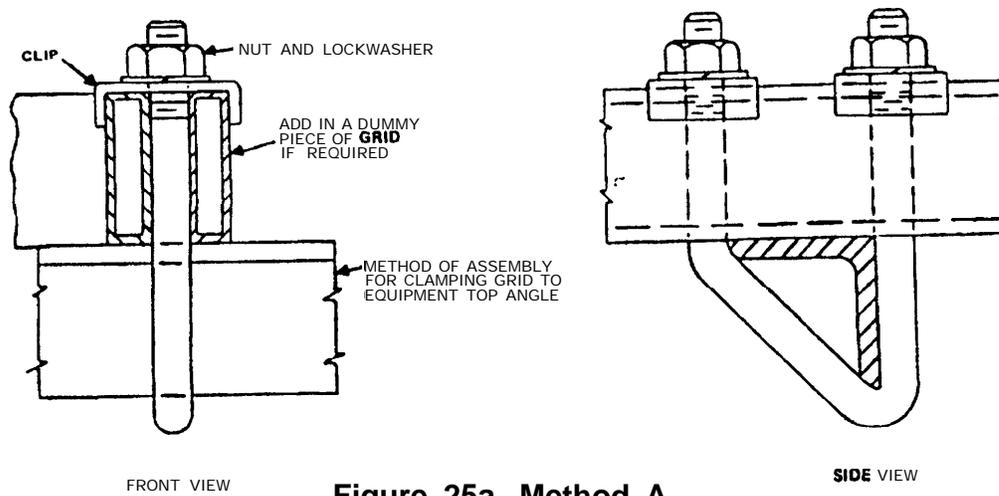
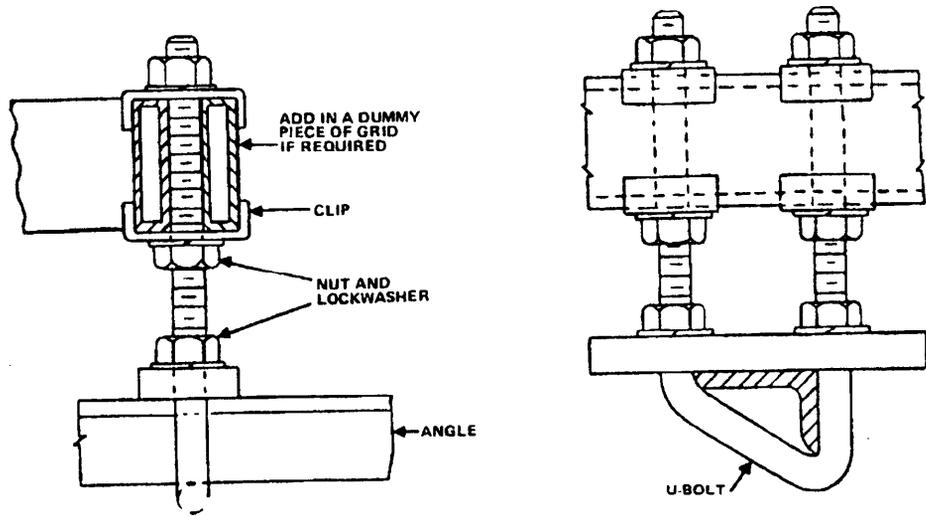


Figure 25a. Method A.

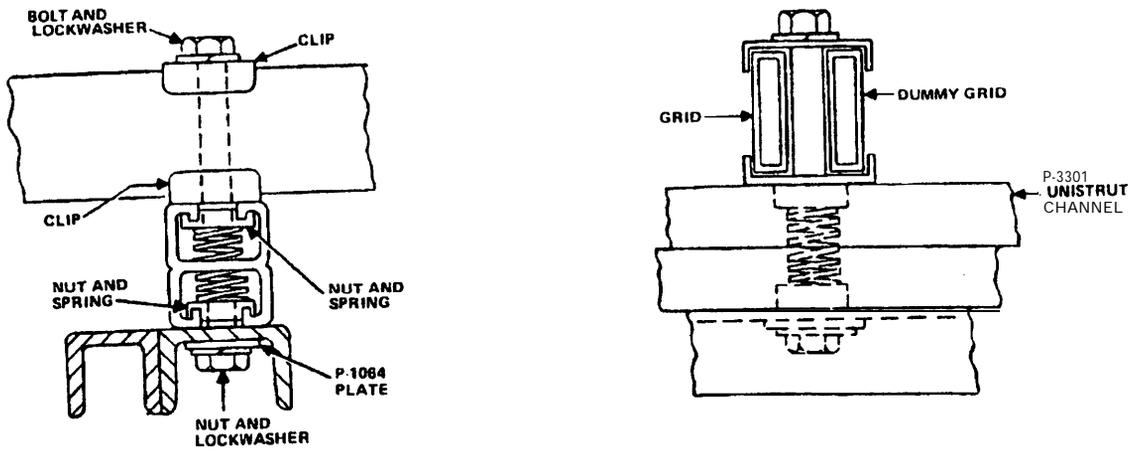
Figure 25. Methods of Fastening Cable Grid to Racks Without Two Channels.



FRONT VIEW

Figure 25b. Method B.

SLOE VIEW



FRONT VIEW

Figure 25c. Method C.

SIDE VIEW

Figure 25. Methods of Fastening Cable Grid to Racks Without Two Channels (Continued).

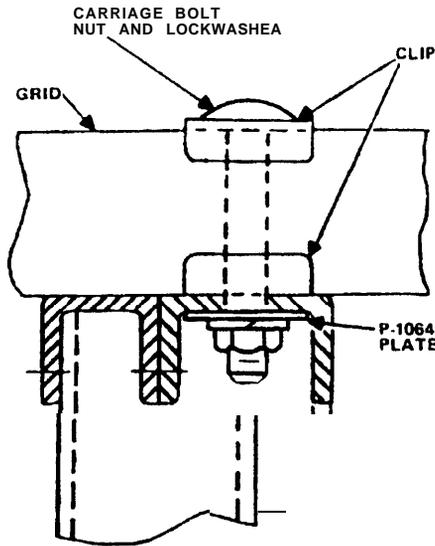


Figure 25d. Method D.

Figure 25. Methods of Fastening Cable Grid to Racks Without Two Channels (Continued).

6. GTE CALIFORNIA STANDARDS

6.01 Parts 7 and 8 present the current earthquake bracing standards preferred by GTE California.

7. TELEPHONE EQUIPMENT BRACING

Seismic Coefficient Method

7.01 Seismic effect must be considered in designing equipment bracing to protect telephone equipment in the event of an earthquake. The seismic load has a horizontal and a vertical component. Since a structure must withstand its own weight, there is usually an adequate degree of resistance to force in the vertical direction.

7.02 The horizontal component of the seismic force is adopted as the load acting on a structure during an earthquake. The telephone industry's method for dealing with this seismic load is the seismic coefficient method. This method consists of reducing the dynamic forces acting on a structure during an earthquake into static horizontal loads and designing or using

existing superstructure or earthquake bracing to withstand these loads.

7.03 The seismic coefficient method is based on the following assumptions:

- (a) The seismic force acts as a static external load on the mass of each element of the structure.
- (b) The seismic force acts in a horizontal direction. Its magnitude is proportional to the mass, the proportionality constant divided by the gravitational acceleration.
- (c) The seismic coefficient is derived through historical experience on the basis of structure type; its value may be updated regularly to reflect recent accumulated experiences.

California Standard

7.04 The Structural Engineers Association of California has used this method in developing its lateral force requirements. It recommends that buildings and similar structures withstand all lateral forces greater than $V = ZIKCSW$

where

V = Total lateral force or shear at base.

Z = Coefficient, depending upon zone seismic zone.

Zone 3- $Z = 3/4$

Zone 4- $Z = 1$

I = Occupancy importance factor.

K = Seismic coefficient, depending upon the type of construction.

C = Seismic coefficient, depending upon the vibration period of the structure.

S = Numerical coefficient for site-structure resonance.

W = Total dead load.

8. BRACING APPLICATION

Primary Superstructure

8.01 The most efficient method of bracing is to the ceiling. So for any given building, the use of the primary superstructure is the most economical. For a new building, continuous P-3000 series channel with lugs, or its equivalent, is cast directly into the underside of the ceiling parallel to the equipment lineup. This same P-3000 series channel without lugs can be welded with the inclusion of a reinforcing plate and a new or existing ceiling or roof deck.

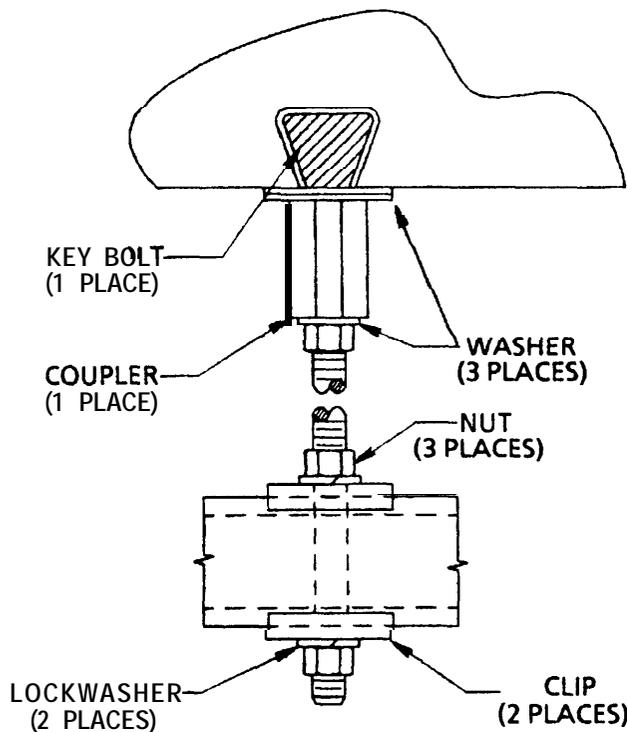


Figure 26. Typical Threaded Rod from Two-Bar Channels to Keystone Ceiling.

8.02 This primary superstructure must be specified in the PS drawing and its direction parallel to the equipment lineups must be ensured. UNISTRUT P-3000 channel is

preferred because it allows for channel interchange.

8.03 Figure 26 shows the method of fastening a typical drop rod to the primary superstructure, in this case, keystone decking. (See paragraph 5.04.)

8.04 Figure 27 shows single V-bracing using threaded rod and TELSPAR to support the two-bar channel from keystone decking.

8.05 Figure 28 shows double V-bracing using threaded rod and TELSPAR to support the two-bar channel from keystone decking.

8.06 Figure 29 shows corner V-bracing using threaded rod and TELSPAR to support two-bar channel from keystone decking.

Equipment Bracing Considerations

8.07 Each installation must be custom designed to fit the room and equipment. Some general considerations relating to the equipment must be made. All types of equipment bays and relay racks that have a height greater than one and one-half times the smaller floor dimension must be anchored to the floor. Use 3/8-inch bolts at all corners of each frame, with 4,825 pounds pullout and 3,943 pounds shear.

NOTE: Do not secure frames to the floor with double-sided tape, even for temporary periods.

8.08 Existing slip joint UNISTRUT type earthquake bracing must be converted to a shear system by the following procedure:

- (a) On each brace shoe location, mark the location of the show holes on the brace.
- (b) Remove the brace and drill 17/32-inch holes in the back of the brace.

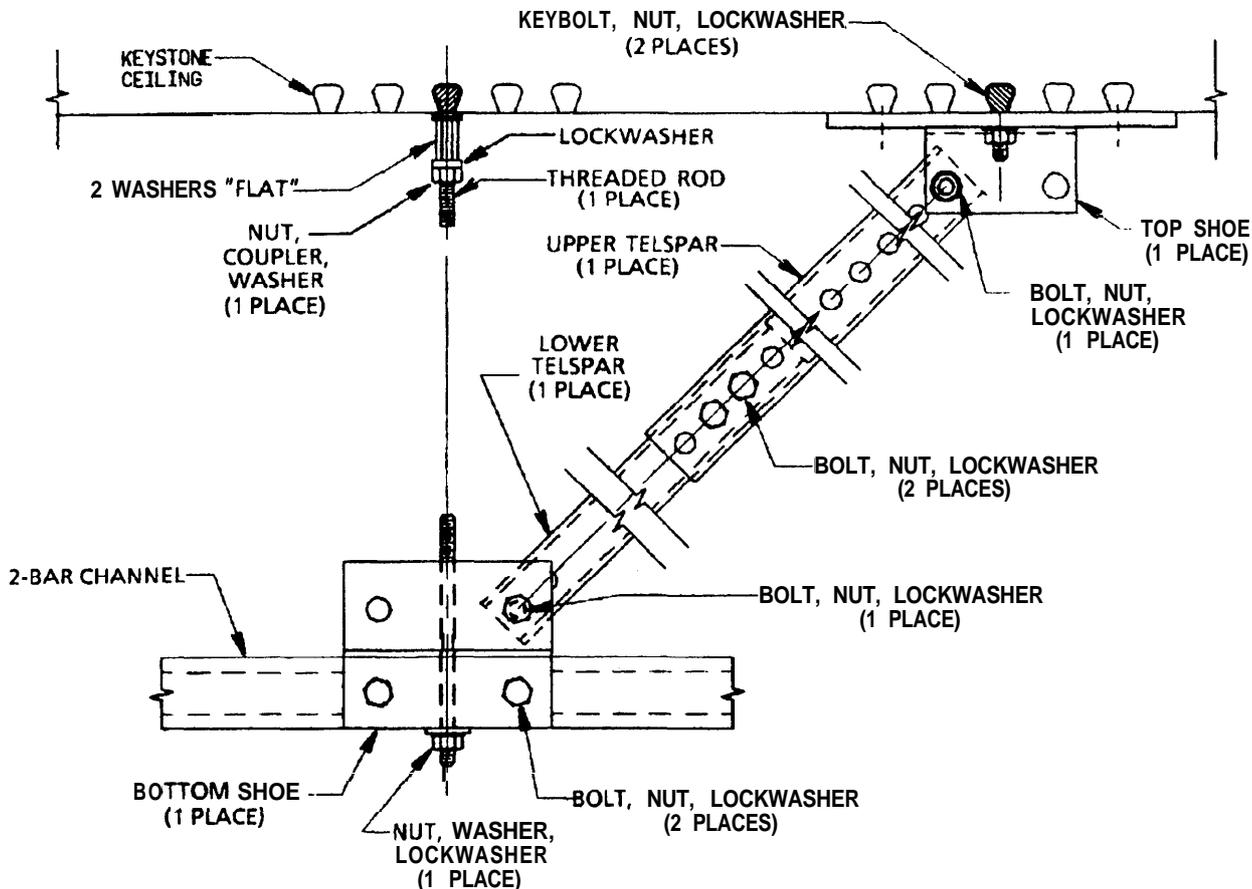


Figure 27. Single V-Bracing With Thread Rod and TELSPAR Assembly.

(c) Remount the brace to the shoes with 1/2-inch by 13 x 1-1/8 inch HHCS, nut and lock washer.

8.09 Use U-bolts or shear-type bolt fasteners at all ironwork intersections and at the top of equipment bays. Specify high-strength bolts for all equipment installations.

8.10 Tapered or lockwashers are necessary at tapered sections of ironwork to prevent the bending of bolts when tightening. Any cap screws or nuts 1/2-inch by 13 or larger must be tightened to 45 foot-pounds torque.

NOTE: Mark the torque mark line for the nut and bolt with a dark felt-tipped ink pen after tightening.

8.11 Power Room Bracing. Secondary two-channel supporting bus bar requires

cross (opposing) earthquake braces. Cross earthquake braces (rod or TELSPAR) are not normally used except in power rooms, where all bracing is to the ceiling members.

8.12 Wall Bracing. Fastening to walls or columns (Figure 30) is not recommended and should only be used in remote unit applications. If it does become necessary, however, it should first be brought to the attention of the building engineering department for concurrence.

8.13 Battery Frame Bracing. Battery frames must be earthquake braced (Figure 31). Battery frames should be anchored to resist 1,000 pounds per upright.

8.14 Batteries must be anchored to the frames and joined together with UNISTRUT channel or its equivalent. Adequate bracing must be ensured in each direction.

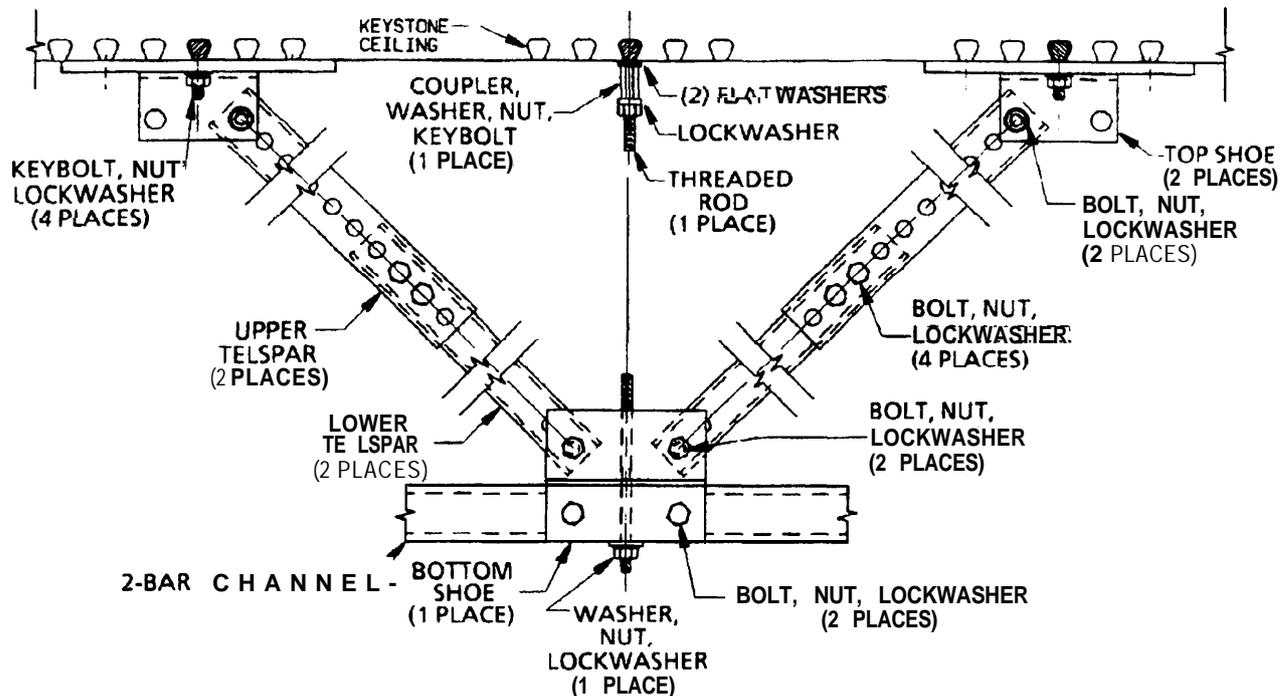


Figure 28. Typical V-Bracing with Thread Rod and TELSPAR Assembly.

CAUTION

USE SPLIT RING LOCKWASHERS ONLY ONCE. DO NOT ATTEMPT TO RETORQUE. WHEN SPLIT RING LOCKWASHERS ARE LOOSENED, THEY LOSE THEIR SHARP EDGES AND THEIR RESISTANCE TO LOOSENING.

8.15 **Distributing Frame Bracing.** The Combined Distributing Frame (CDF), Main Distributing Frame (MDF), and other distributing frames must be earthquake braced in the manner similar to that for battery frames (Figure 31).

8.16 **Power Board Bracing.** All power boards must be earthquake braced using swivel bracket assemblies and threaded rods from two-bar channel down to the power board (Figure 32).

8.17 **Charger Bracing.** All charger cabinets must be earthquake braced using swivel bracket assemblies and threaded rods from two-bar channel down to the charger (Figure 33).

8.18 **Junctioning Two-Bar Channels End-to-End.** Figure 34 shows the method for junctioning two-bar channels end-to-end. Two-bar channel must have separators to prevent deformation due to compression force in the horizontal plane.

8.19 **Fastening Perpendicular Two-Bar Channel.** Figure 35 shows the method for fastening perpendicular two-bar channel to frame module 2 x 4, when equipment frames exist. Figure 36 shows the method for fastening perpendicular two-bar channel to frame module 2 x 4, when equipment frames do not exist.

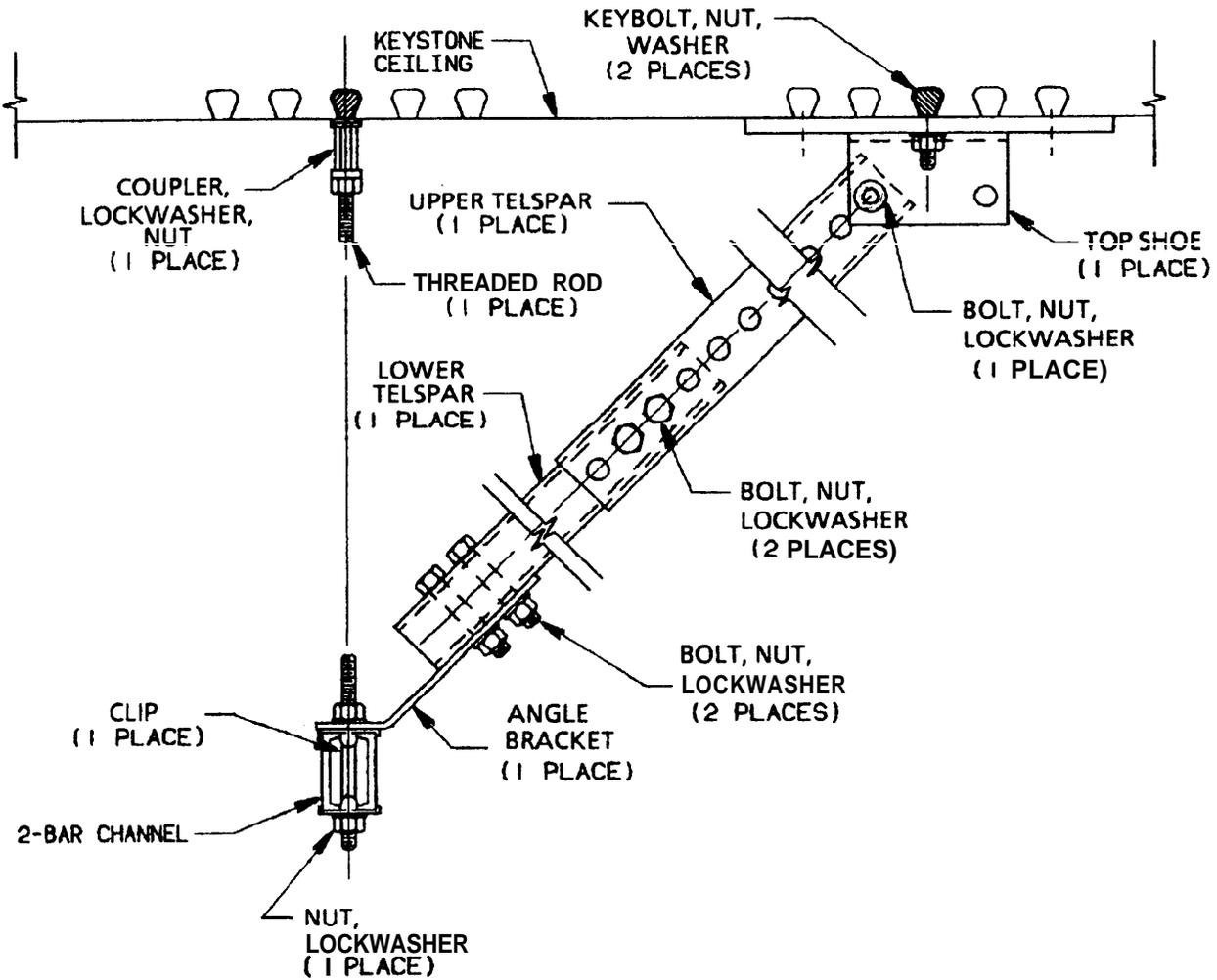


Figure 29. Typical Perimeter Corner Single Bracing TELSPAR With Thread Rod.

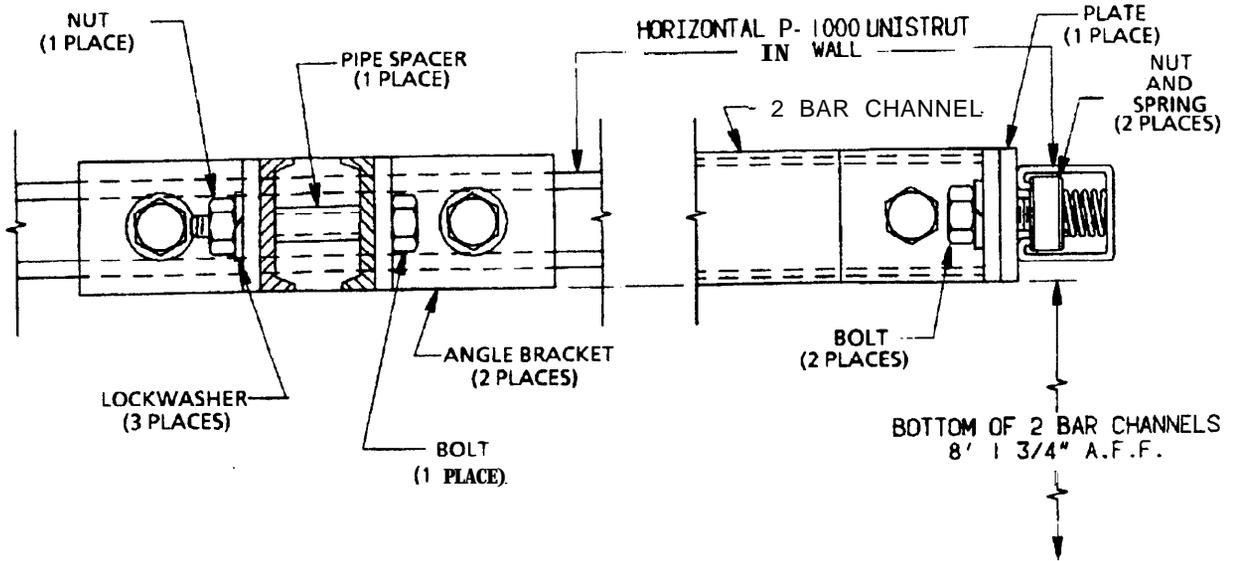


Figure 30. Typical Two-Bar Channel to Wall Support (UNISTRUT).

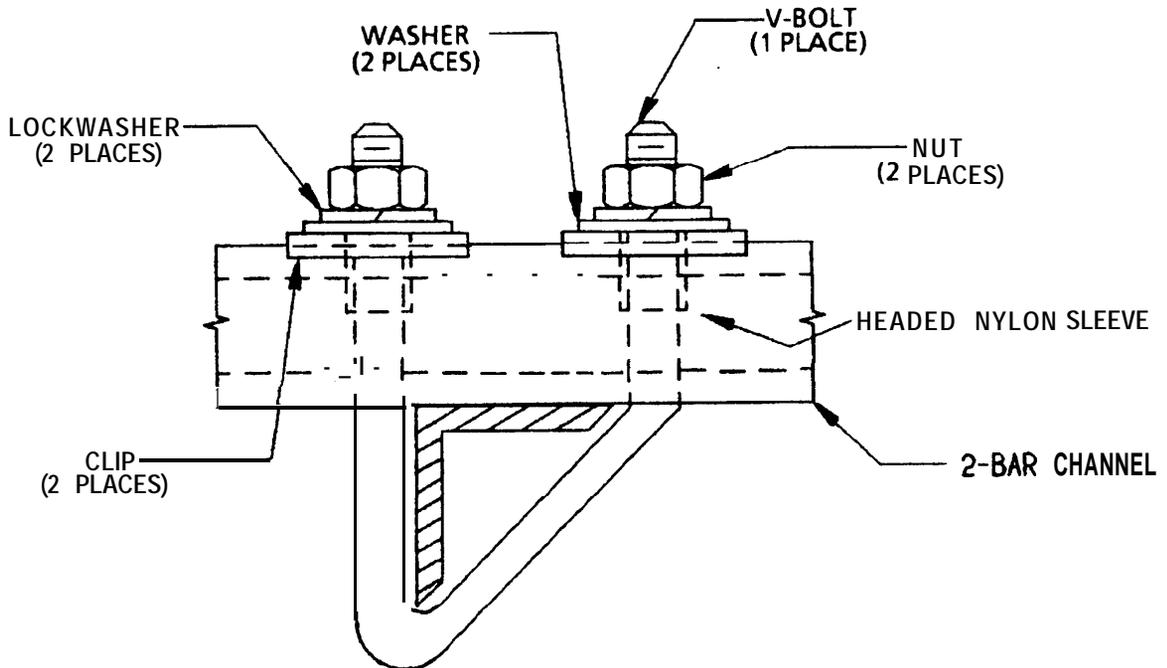


Figure 31. Typical Two-Bar Channel to Angle Iron to Battery and Distributing Frame.

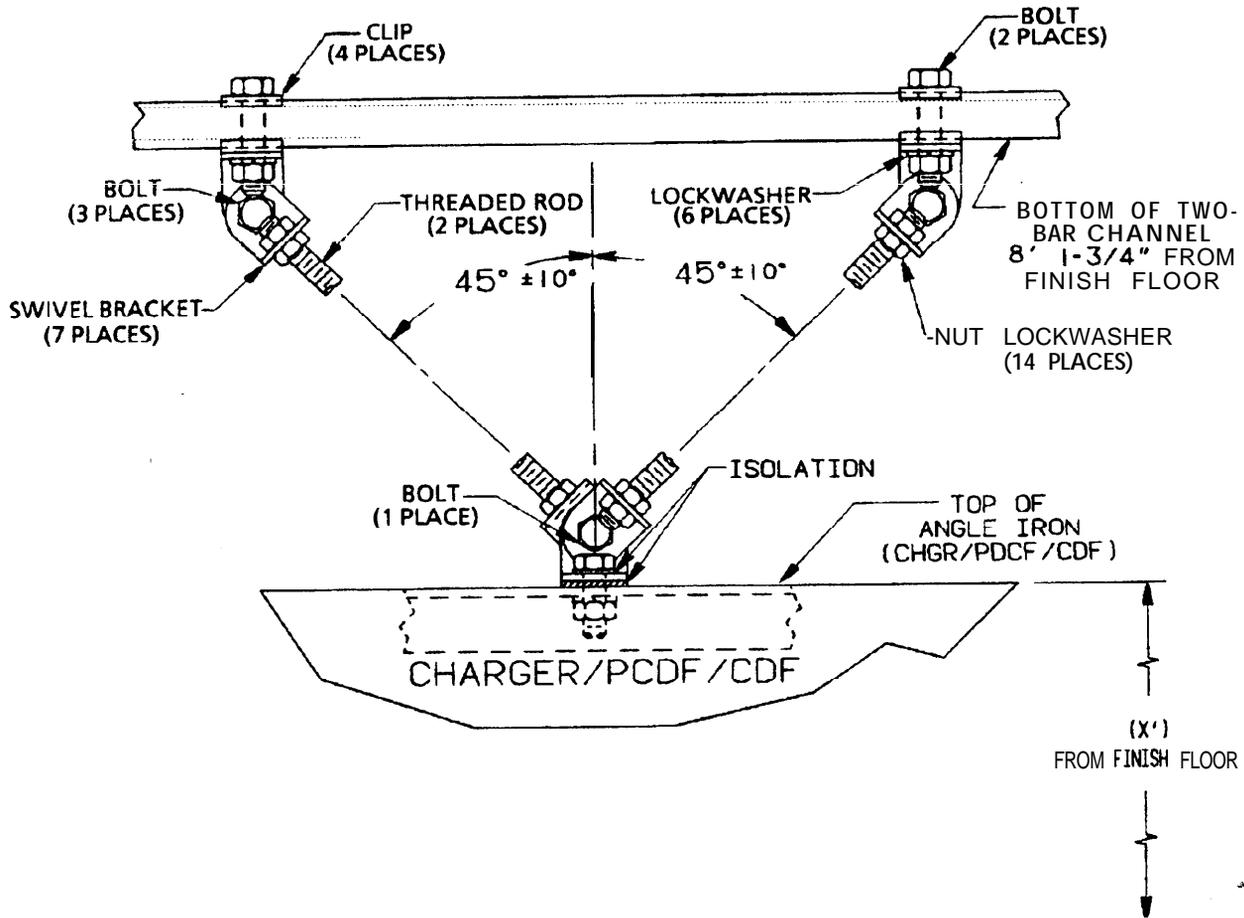
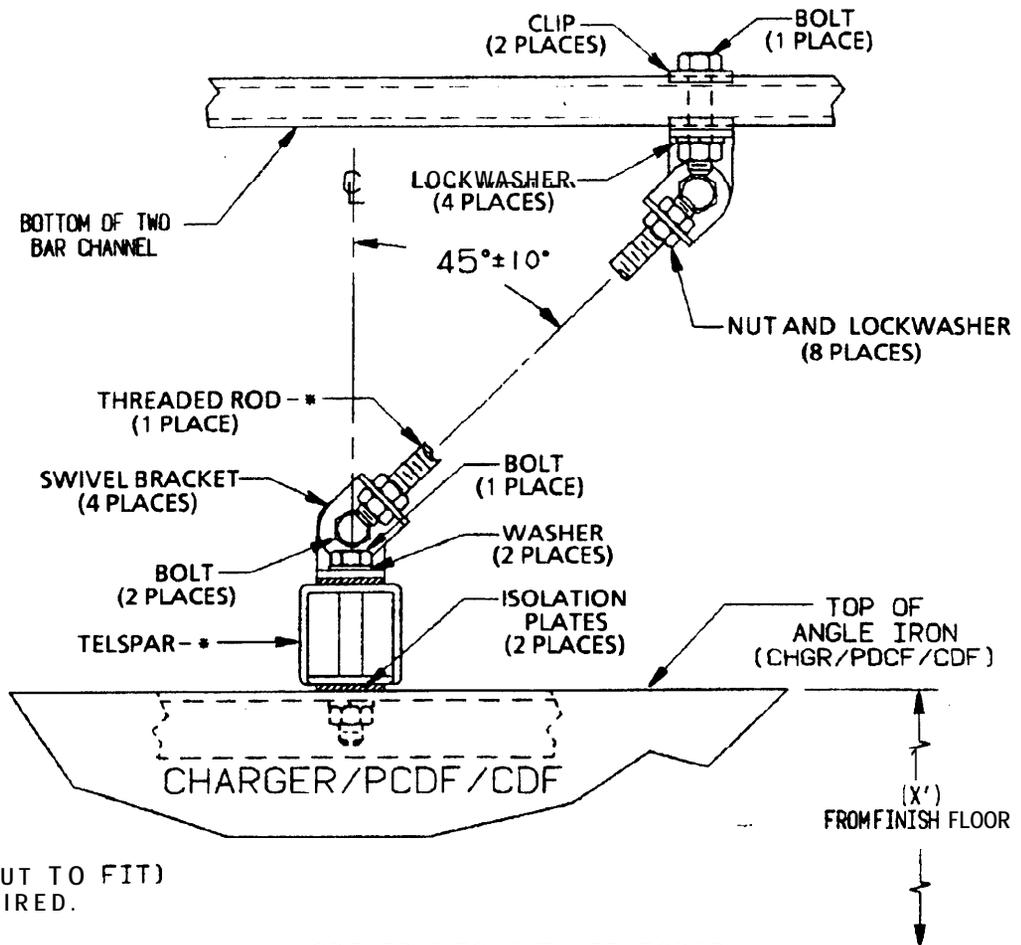


Figure 32. Typical Earthquake Bracing for Power Frames.



* DENOTES (CUT TO FIT)
AS REQUIRED.

EQB FOR POWER & CDF FRAMES WITH TELESAR

Figure 33. Typical Earthquake Bracing for Power Frames With TELESAR.

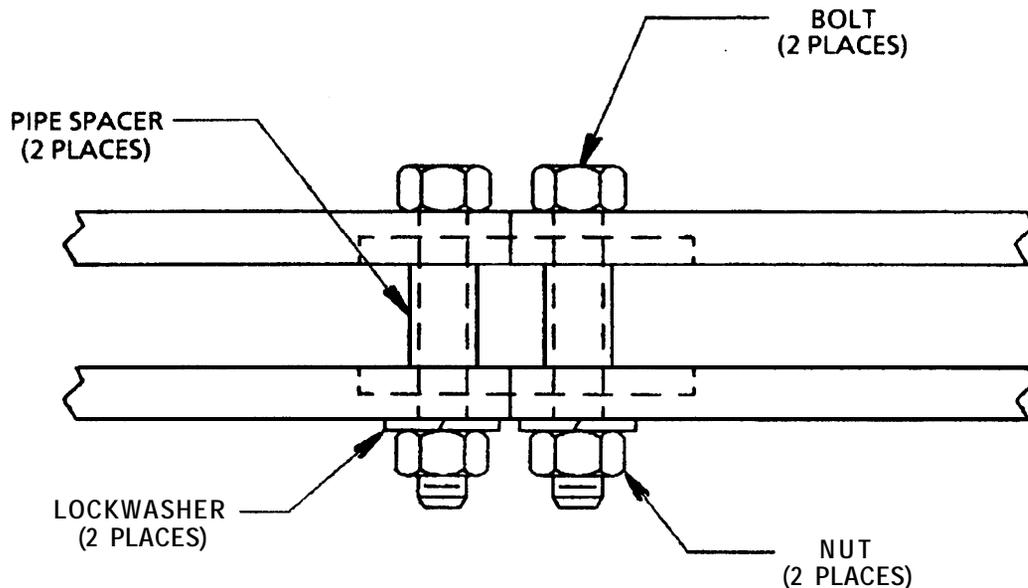


Figure 34. Typical Two-Bar Channel Junctioned End-to-End.

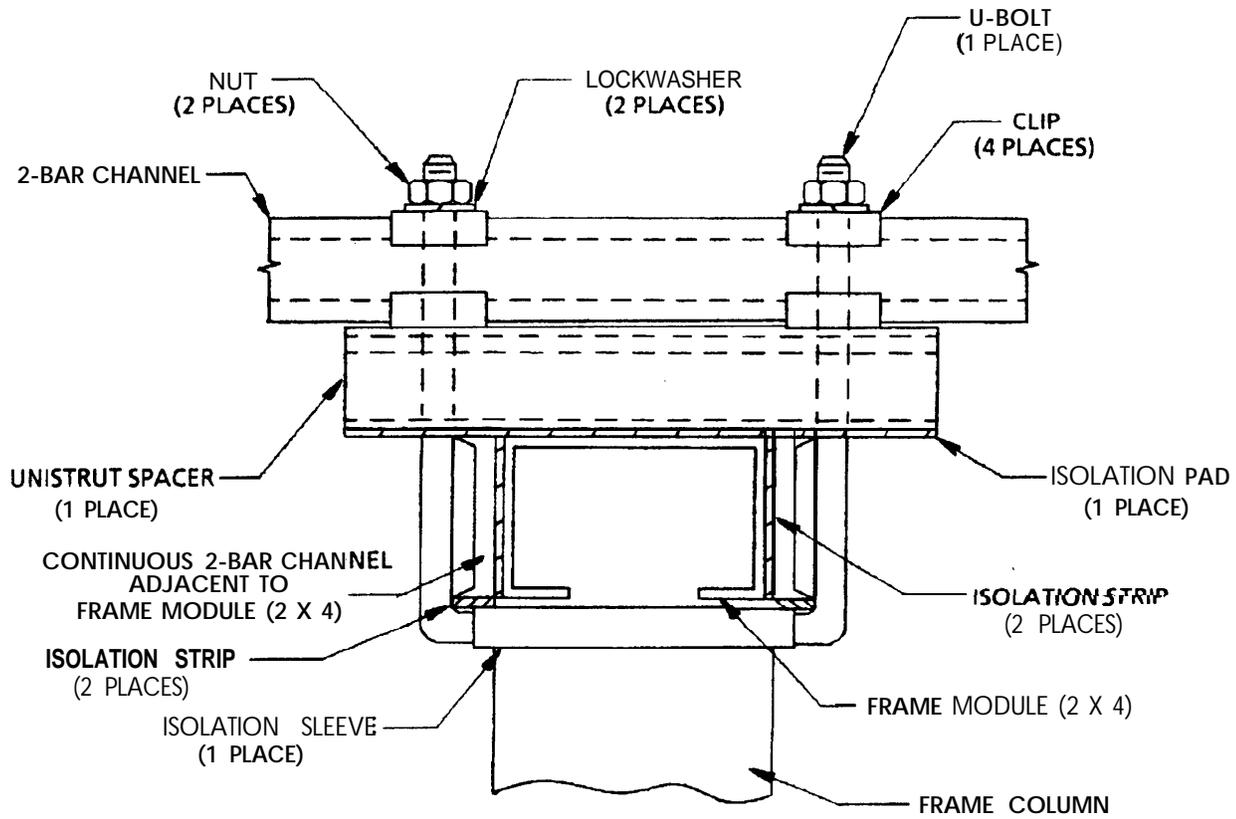


Figure 35. Typical Two-Bar Channel to Frame Module.

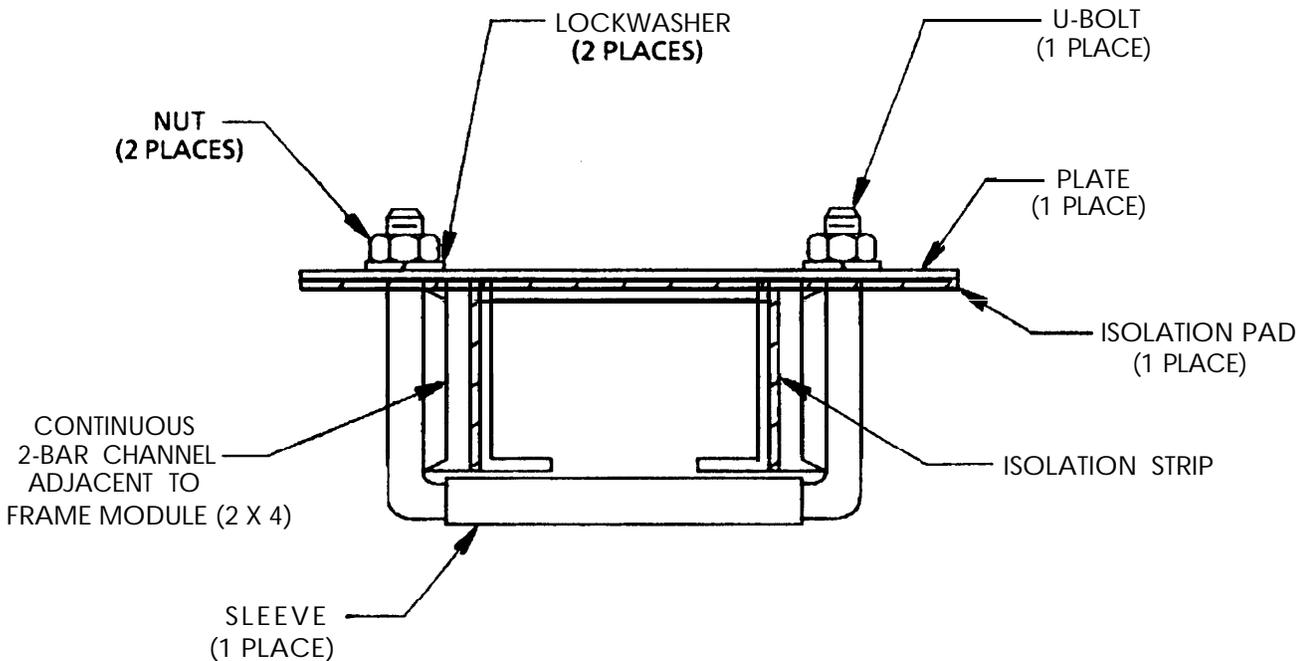


Figure 36. Typical Two-Bar Channel to Module Without Frame.