Attachment 12

TIEDOWNS, MOORING, AND GROUNDING POINTS

A12.1. Types of Equipment:

A12.1.1. Mooring and Grounding Point. A mooring and grounding point is a mooring casting with a grounding rod attached. Aircraft mooring and grounding points are used to secure parked aircraft and also serve as electrodes for grounding connectors for aircraft. Combined mooring and grounding points have previously been used by the Army, but are not currently used as they do not meet mooring and grounding design loads required by TM 1-1500-250-23, *General Tie-Down and Mooring on all Series Army Models AH-64, UH-60, CH-47, UH-1, AH-1, OH-58 Helicopters.*

A12.1.2. Mooring Point. A mooring point is a mooring casting without a grounding rod attached, used to secure parked aircraft. Mooring points are used by the Army.

A12.1.3. Static Grounding Point. A static grounding point is a ground rod attached to a casting. The casting protects the ground rod but does not provide mooring capability. Static grounding points are used by the Army in aprons and hangars.

A12.1.4. Tiedown. A tiedown is a 3-meter [10-foot] rod with a closed-eye bend. The tiedown is intended to secure parked aircraft but may also serve as an electrode connection for static grounding of aircraft. Tiedowns are used by the Air Force.

A12.1.5. Tiedown Mooring Eye. A tiedown mooring eye is a mooring casting with a grounding rod attached. They are similar to the mooring and grounding point discussed above. Tiedown mooring eyes are used by the Navy and Marine Corps.

A12.2. Mooring Points for Army Fixed- and Rotary-Wing Aircraft:

A12.2.1. Type. A mooring point consists of a ductile iron casting, as shown in Figure A12.1. The mooring casting is an oval-shaped casting with a cross-rod to which mooring hooks are attached.

A12.2.2.. Design Load. Unless specifically waived in writing by the facility Commander, all new construction of Army aircraft parking aprons will include aircraft mooring points designed for a 67,800 Newtn [15,250 pound] load, as specified in TM 1-1500-250-23 and applied at 19.15 degrees (19.15°) from the pavement surface, as illustrated in Figure A12.2.

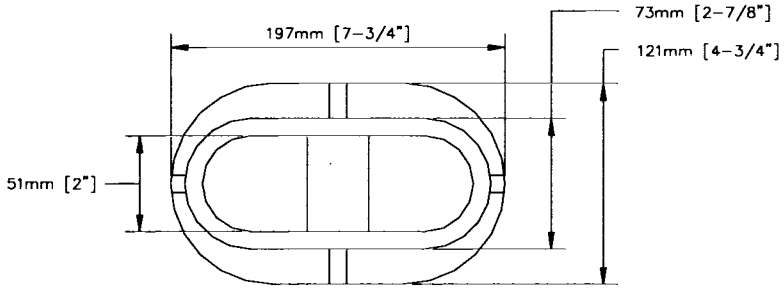
A12.2.3. Layout:

A12.2.3.1. Fixed-Wing Aprons. Mooring points should be located as recommended by the aircraft manufacturer or as required by the base.

A12.2.3.2. Rotary-Wing Aprons:

A12.2.3.2.1. Number of Moored Parking Spaces. Moored parking spaces will be provided for 100 percent of the authorized aircraft. The combined total of apron parking space and hangar parking space should provide sufficient parking for wind protection for all facilities' authorized aircraft and typical transient aircraft. Additional parking spaces with mooring points may be added as necessary to ensure wind protection for all aircraft. The locations of these additional mooring points can be on pavements other than parking aprons. Prepared turf surfaced areas are acceptable for rotary-wing aircraft mooring locations.

Figure A12.1. Army Mooring Point.



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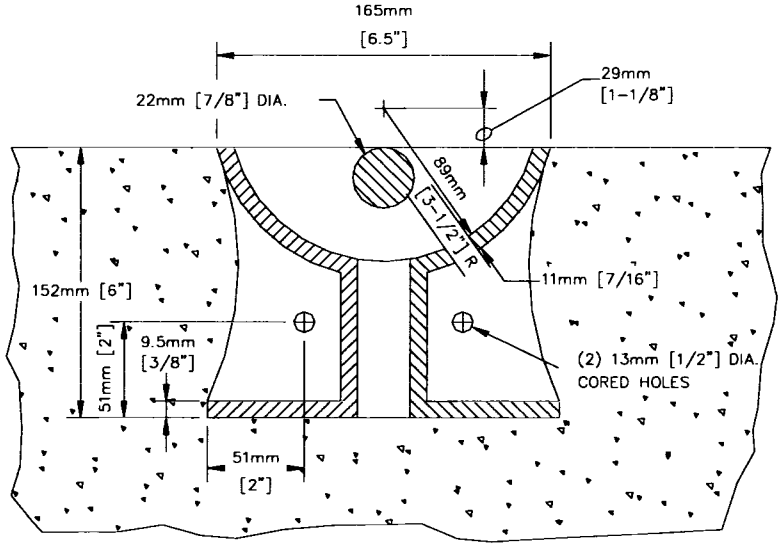

SECTION
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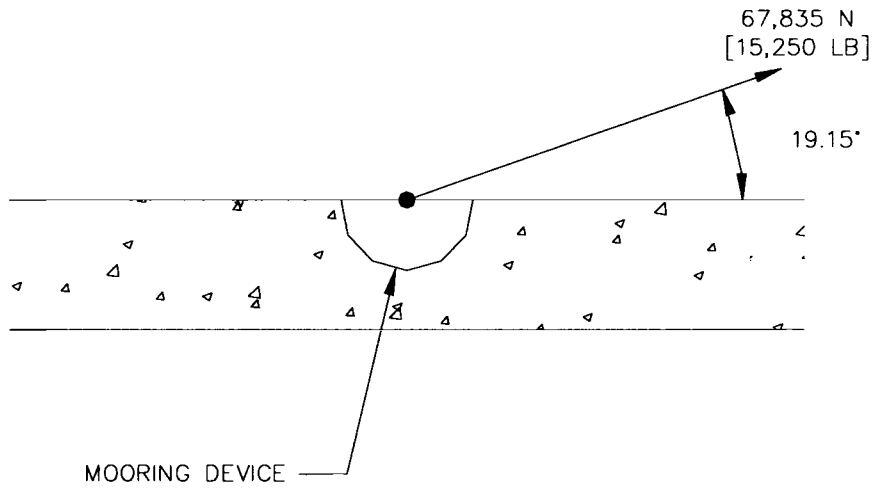
NOTE
MOORING DEVICE TO BE CAST IN DUCTILE IRON 80-55-06 OR EQUAL.

Figure A12.2. Army Load Testing of Mooring Points.



NOTES

1. MOORING TESTS SHOULD BE ACCOMPLISHED USING A HYDRAULIC RAM OR SIMILAR DEVICE AND AN APPROPRIATE REACTION (HEAVY VEHICLE, ETC.) THAT IS CAPABLE OF APPLYING A TENSILE LOAD OF 71,172 N [16,000 LB]

2. THE LENGTH OF MOORING CHAIN AND CONNECTING SHACKLE SHOULD BE SELECTED IN SUCH A WAY THAT AN ANGLE OF 19.15° FROM THE PAVEMENT SURFACE (SEE ABOVE FIGURE) CAN BE MAINTAINED DURING LOAD TESTING.

3. APPROPRIATE SAFETY PRECAUTIONS SHOULD BE TAKEN AT ALL TIMES DURING LOAD TESTING OPERATIONS.

4. THE MOORING POINTS SHOULD BE LOADED IN 1,130 kg [2,500 LB] INCREMENTS UP TO 44,482 N [10,000 LB] AND IN 4,448 N [1000 LB] INCREMENTS UP TO 71,172 N [16,000 LB] WITH EACH LOAD INCREMENT HELD FOR AT LEAST 60 SECONDS.

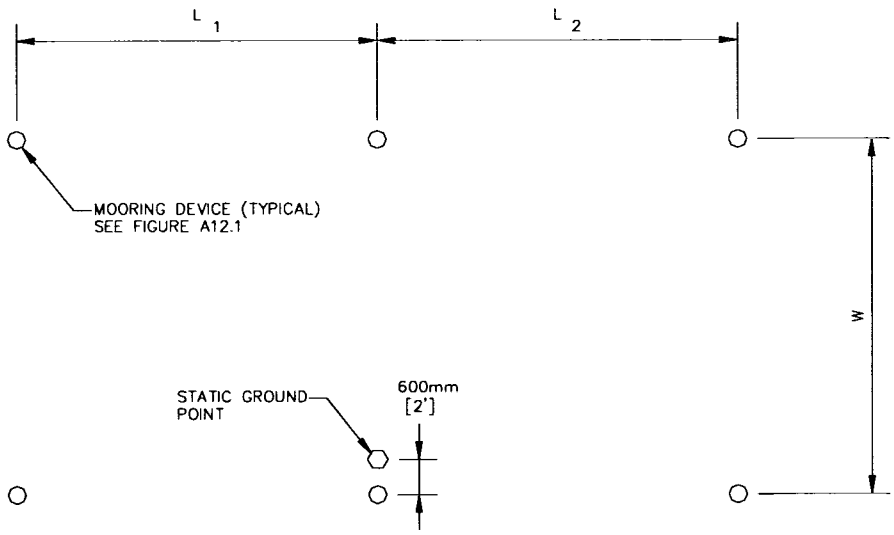
5. TO PASS TEST REQUIREMENTS, MOORING POINTS SHALL NOT DEFORM PERMANENTLY UNDER 71,172 N [16,000 LB] LOAD.

A12.2.3.2.2. Number of Mooring Points at Each Parking Space. Each rotary-wing aircraft parking space location will have six mooring points. Although some rotary-wing aircraft only require four mooring points, six may be installed to provide greater flexibility for the types of rotary-wing aircraft which can be moored at each parking space. The largest diameter rotor blade of the facilities' assigned aircraft will be used for locating the mooring points within the

parking space. The allowable spacing and layout of the six mooring points is illustrated in Figure A12.3. Parking space width and length dimensions are presented in Table 6.2 of Chapter 6.

A12.2.3.2.3. Mooring Points on a Grid Pattern. A 6 meter by 6 meter [20 foot by 20 foot] mooring point grid pattern throughout the apron for mass aircraft parking aprons will not be authorized, unless economically and operationally justified in writing by the installation Commander. Figure A12.4 provides the recommended pavement joint and mooring point spacing should grid pattern mooring be utilized.

Figure A12.3. Army Rotary-Wing Allowable Mooring Point Spacing.



PLAN VIEW
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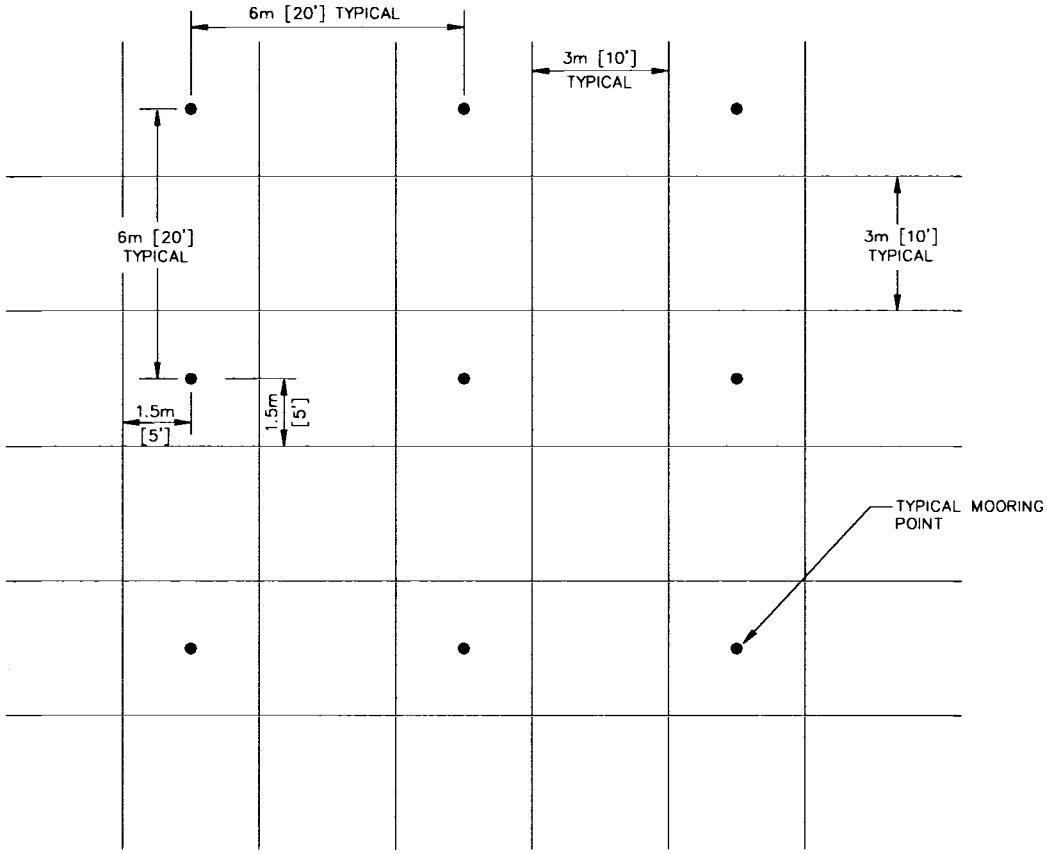
NOTES

1. THE PREFERRED MOORING POINT SPACING FOR EACH AIRCRAFT PARKING POSITION IS $L_1=L_2=W=6m$ [20.0']
2. IN NEW OR EXISTING RIGID PAVEMENT, THE MOORING POINTS WILL BE AT LEAST 600mm [2'] AWAY FROM ANY PAVEMENT JOINT OR EDGE. TO MISS THE PAVING JOINTS, THE SPACING OF THE MOORING POINTS MAY BE VARIED AS FOLLOWS:
   A. W, L_1 AND L_2 MAY VARY FROM 5 TO 6m [17 TO 20'].
   B. W, L_1 AND L_2 NEED NOT BE EQUAL.
3. THE CONSTRUCTION TOLERANCE ON MOORING POINT LOCATION SHOULD BE 50mm [±2"]

Figure A12.4. Army Rotary-Wing Mooring Points Layout.



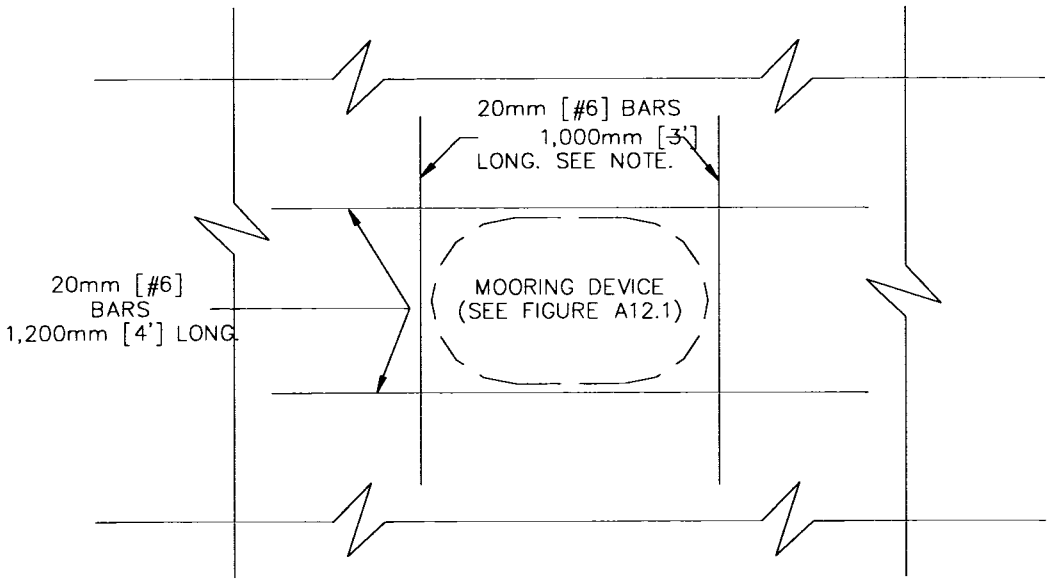
NOTE

THIS IS THE RECOMMENDED JOINT SPACING FOR NEW CONCRETE PAVEMENT WHERE MOORING DEVICES ARE JUSTIFIED AND AUTHORIZED THROUGHOUT THE APRON. OTHER JOINT SPACINGS MAY BE USED AS LONG AS MOORING DEVICES ARE SPACED AS SHOWN IN FIGURE K.3.

A12.2.4. Installation.

A12.2.4.1. Mooring Points for New Rigid Pavement Equal to or Greater Than 150 Millimeters [6 Inches] Thick. Mooring points for new rigid pavements will be provided by embedding the mooring devices in fresh Portland cement concrete (PCC). The layout of points is shown in Figure A12.3 with mooring points at least 600 millimeters [2 feet] from the new pavement joints. This spacing will require close coordination between the parking plan and the jointing plan. Mooring points should be located a minimum of 600 millimeters [2 feet] from any pavement edge or joint and should provide proper cover for the reinforcing steel. Reinforcing bars should be placed around the mooring points as illustrated in Figure A12.5.

Figure A12.5. Slab Reinforcement for Army Mooring Point.



PLAN VIEW
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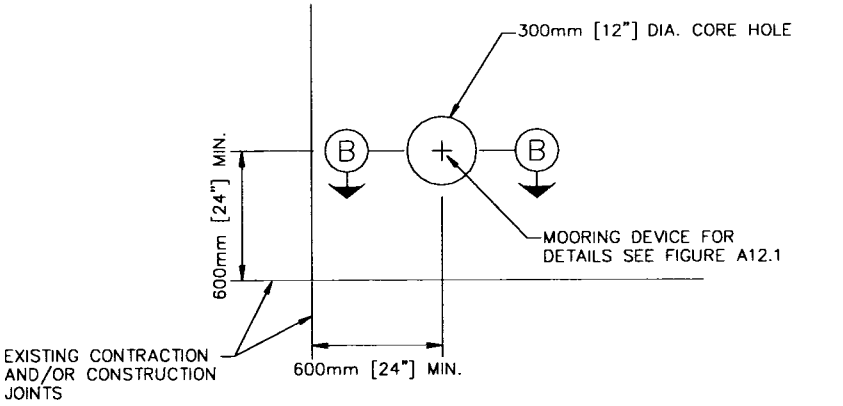
NOTES

1. THESE #6 REINFORCING BARS SHOULD BE PLACED 75mm [3"] FROM MOORING DEVICE AND 75mm [3"] BELOW PAVEMENT SURFACE.
2. THE ENDS OF REINFORCING BARS SHOULD BE PLACED 75mm [3"] FROM PAVING JOINTS TO PROVIDE COVER.

A12.2.4.2. Mooring Points for Existing Rigid Pavement Equal to or Greater Than 150 Millimeters [6 Inches] Thick and In An Uncracked Condition. The following method should be used to provide mooring points for existing rigid pavement that is in an uncracked condition. The pavement should have only a few slabs with random cracks and must not exhibit "D" cracking. Mooring points should be provided by core-drilling a 300 millimeter [12 inch] diameter hole through the pavement and installing a mooring point as illustrated in Figure A12.6.

Figure A12.6. Mooring Point for Existing Rigid Pavement for Pavement Thickness Greater Than 150 Millimeters (6 Inches).



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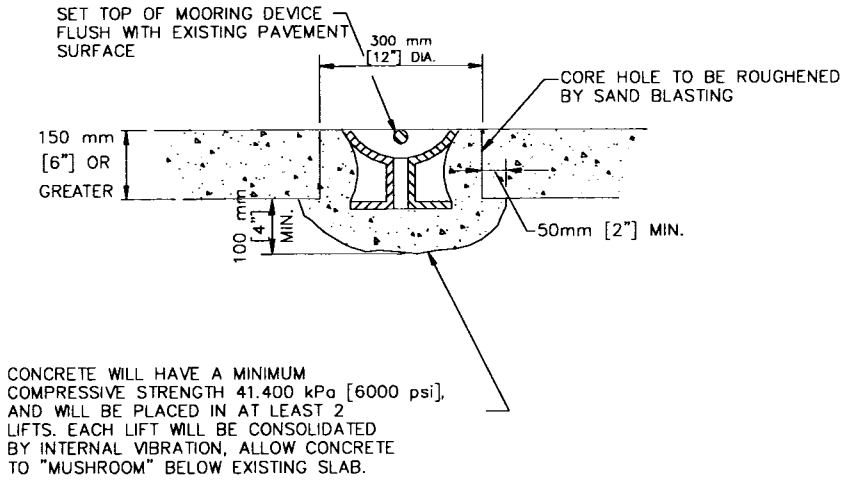

SECTION B
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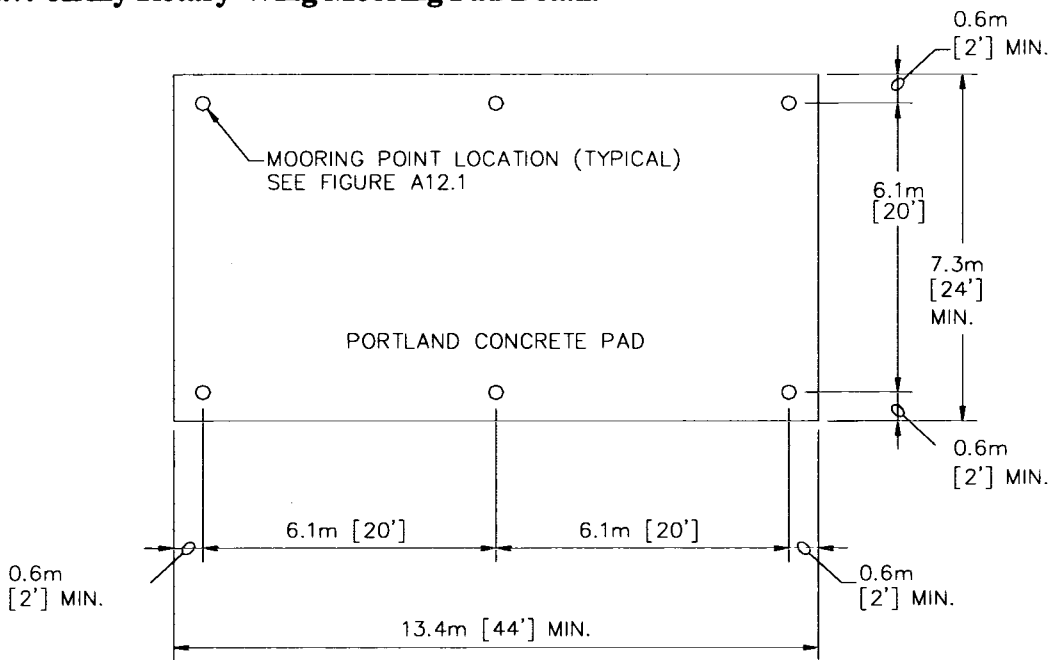
NOTE

EXISTING CONCRETE SHOULD HAVE
ONLY A FEW SLABS WITH CRACKS
IF THIS OPTION IS TO BE USED.

A12.2.4.3. Mooring Points for Areas Not Covered Above. The following installation options should be used to provide mooring points for rotary-wing aircraft parked on the following pavements: existing rigid pavement less than 150 millimeters [6 inches] thick; existing rigid pavement in a cracked or deteriorated condition; new or existing flexible pavement; turfed areas; and other areas where appropriate.

A12.2.4.3.1. Installation Option 1, Mooring Pad. This option is the preferred installation method, and allows for placement of a new concrete pad with a minimum thickness of 200 millimeters [8 inches]. The size of the pad should be a minimum of 7.3 meters [24 feet] wide by 13.4 meters [44 feet] long. The length and width may be increased to match the existing concrete joint pattern. The mooring pad, with six mooring points, is illustrated in Figure A12.7. The mooring devices should be installed as illustrated in Figure A12.1, and the concrete reinforced as illustrated in Figure A12.5.

Figure A12.7. Army Rotary-Wing Mooring Pad Detail.



PLAN VIEW
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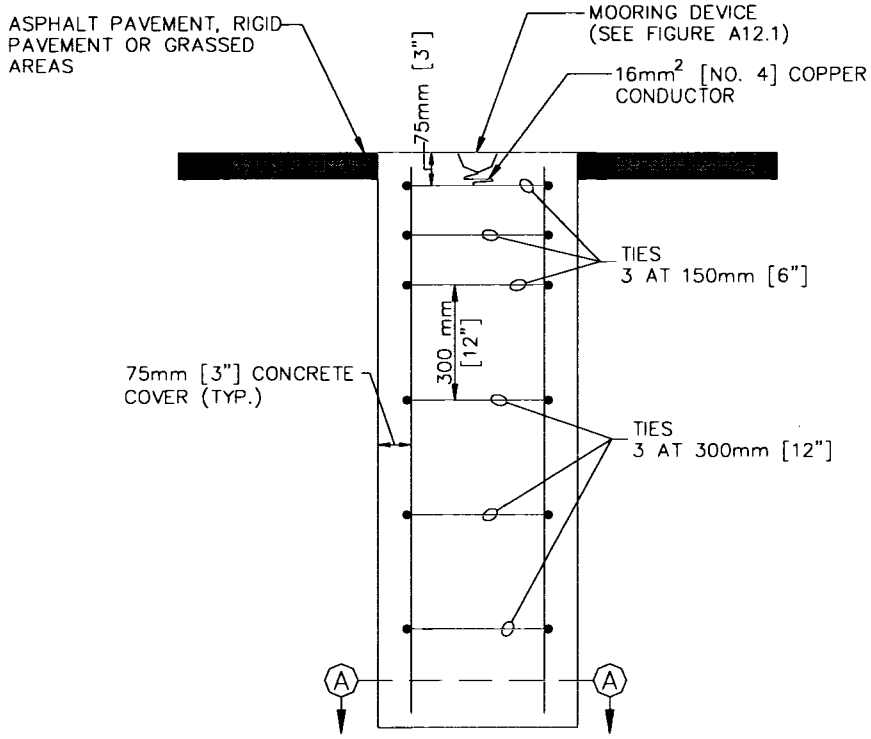
NOTES

1. THIS MOORING PAD IS THE PREFERRED METHOD OF PROVIDING MOORING POINTS IN GRASSED AREAS AND IN FLEXIBLE PAVEMENTS. FOR RIGID PAVEMENT APPLICATIONS, THE SIZE OF THE PAD SHOULD BE INCREASED TO MATCH THE EXISTING JOINT PATTERN.
2. THICKNESS OF THE PAD SHOULD BE DESIGNED TO CARRY THE EXPECTED AIRCRAFT LOADS, BUT NOT LESS THAN 200mm [8"].
3. THE SLAB SHOULD BE DESIGNED AS A REINFORCED SLAB SO THAT PAVEMENT JOINTING WILL NOT BE REQUIRED. IF JOINTED PAVEMENT IS DESIRED, JOINT SPACING SHOULD BE ADJUSTED SO THAT MOORING POINTS ARE A MINIMUM OF 0.6m [2'] FROM PAVEMENT JOINTS.
4. SEE FIGURE A12.6 FOR REINFORCING ADJACENT TO MOORING DEVICE.
5. TYPICAL PREFERRED SPACING BETWEEN MOORING DEVICES IS 6.1m [20']. SEE FIGURE A12.3 FOR ALLOWABLE MOORING AND STATIC GROUND POINT SPACING.

A12.2.4.3.2. Installation Option 2, Piers. This option allows the use of individual concrete piers for each mooring point as shown in Figure A12.8. The diameter and length of the pier must be based on the strength of the soil. This is presented in Table A12.1.

Figure A12.8. Army Mooring Point for Grassed Areas, Flexible Pavement ,or Rigid Pavement - Thickness Less Than 150 Millimeters (6 Inches).



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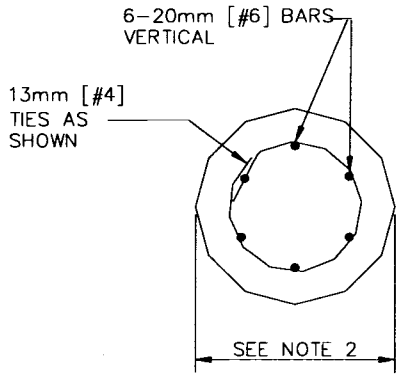

SECTION (A)
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NOTES

1. CORE DRILL ASPHALT PAVEMENT. FOR PIER LENGTH AND DIAMETER, SEE TABLE A12.1
2. SPIRAL REINFORCEMENT EQUIVALENT TO THE 13mm [#4] TIES MAY BE USED.
3. SEE FIGURE A12.3 FOR ALLOWABLE MOORING AND STATIC GROUND POINT SPACING

Table A12.1. Army Pier Length and Depths for Tiedowns.

Cohesive Soils				
Unconfined Compressive Strength [q_u in kg/m^2 [lb/ft^2]]	Pier Diameter		Pier Length	
	Meters	Feet	Meters	Feet
$q_u < 5{,}000$ kg/m^2 [$q_u < 1{,}000$ lb/ft^2]	600 mm	2.0 ft	1,800 mm	6.0 ft
$5{,}000 < q_u < 19{,}500$ kg/m^2 [$1{,}000 < q_u < 4{,}000$ lb/ft^2]	500 mm	1.5 ft	1,800 mm	6.0 ft
$q_u > 18{,}500$ kg/m^2 [$q_u > 4{,}000$ lb/ft^2]	500 mm	1.5 ft	1,200 mm	4.0 ft

Cohesionless Soils				
Friction Angle ∅ in Degrees	Pier Diameter		Pier Length	
	Meters	Feet	Meters	Feet
$\varnothing < 20°$	600 mm	2.0 ft	2,100 mm	7.0 ft
$20° \leq \varnothing \leq 30°$	600 mm	2.0 ft	1,800 mm	6.0 ft
$\varnothing > 30°$	500 mm	1.5 ft	1,800 mm	6.0 ft

A12.3. Existing Mooring Points for Army. Existing mooring points will be tested for structural integrity and strength as detailed in figure A12.2. If the existing mooring fails to meet the structural requirements listed herein, replacement of the mooring structure is required.. If the existing mooring point has an attached ground rod, its electrical resistance value must be measured. If it fails to meet resistivity requirements, a new static ground rod is required.

A12.3.1. Evaluation of Existing Mooring Points for Structural Adequacy:

A12.3.1.1. Adequate Mooring Points. Existing 19 millimeter [0.750 inch] diameter bimetallic copper covered steel rods, 1,800 millimeters [6 feet] long are considered adequate for immediate aircraft protection provided the following conditions are met:

A12.3.1.1.1. The existing rods are installed in rigid pavement.

A12.3.1.1.2. The existing rods do not show signs of deformation or corrosion.

A12.3.1.1.3. The existing rods are inspected for deformation and corrosion at least once a year and after each storm event with winds greater than 90 kilometers per hour [50 knots].

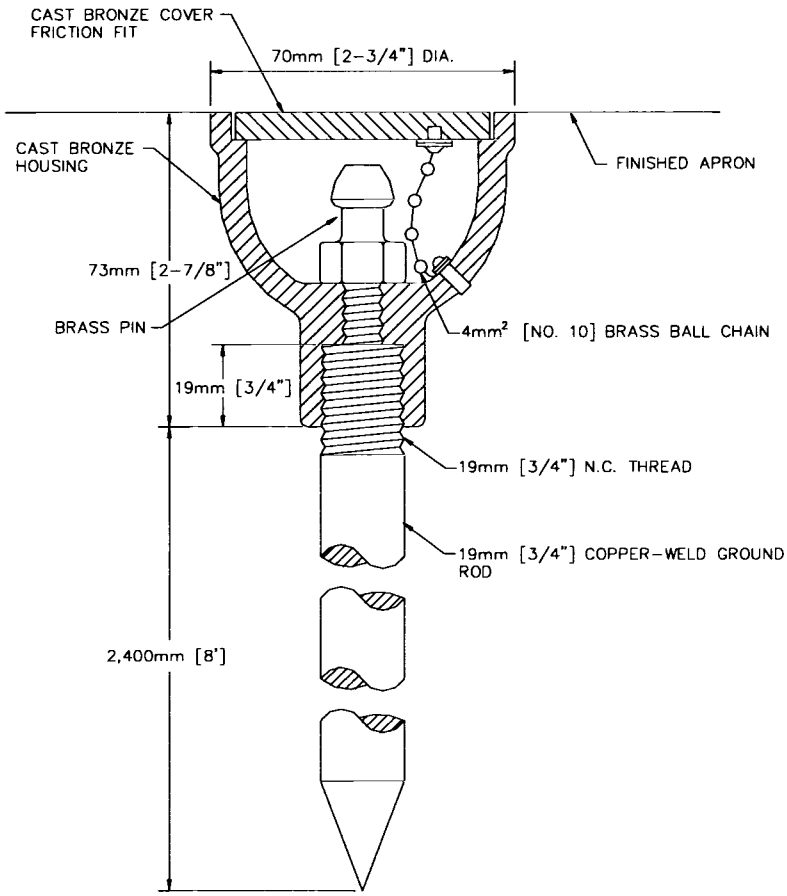
A12.3.1.2. Inadequate Mooring Points. At Army facilities, any existing rods that exhibit deformation or corrosion will be considered inadequate and require replacement. All existing 19 millimeter [0.750 inch] diameter, 1,800 millimeter [6 foot] long rods in flexible (asphalt) pavement, including those with a Portland cement concrete block at the surface, require replacement.

A12.3.2. Evaluation of Existing Mooring Points for Resistance. The maximum resistance measured, in accordance with IEEE Standard 142, Recommended Practice for Grounding of Industrial and *Commercial Power Systems*, of existing grounding points, will not exceed 10,000 ohms under normally dry conditions. If this resistance cannot be obtained, an alternative grounding system will be designed.

A12.4. Static Grounding Points for Army Fixed- and Rotary-Wing Facilities.

A12.4.1. Type. A static grounding point for Army facilities is a 3 meter [10 feet] rod with a closed eye (see Air Force Tiedown, figure A12.12) except when installed in a hangar. Inside hangars, the static ground point consists of a copperweld rod, attached to a bronze casting with a threaded connection, as shown in Figure A12.9.

Figure A12.9. Army Grounding Point Inside Aircraft Hangars.



A12.4.2. Layout:

A12.4.2.1. Fixed-Wing Layout. Static grounding points for fixed-wing aircraft will be located on the parking apron as recommended by the aircraft manufacturer or as required by the facility. Typically, one static grounding point is provided for every two parking spaces, and is located between the parking spaces.

A12.4.2.2. Rotary-Wing Layout. One static grounding point will be provided at each rotary-wing aircraft parking space, as shown in Figure A12.10.

A12.4.3. Installation. Static grounding points can be installed in new concrete or asphalt. New grounding points placed in turf areas will be constructed in an 12,000-square-millimeter [18-square-inch] concrete pad flush with existing ground. Static grounding points for turf areas are shown in Figure A12.11.

A12.4.4. Grounding Requirements. The maximum resistance measured, in accordance with IEEE Standard 142, of new grounding points will not exceed 10,000 ohms under normal dry conditions. If this resistance cannot be obtained, an alternative grounding system will be designed.

A12.5. Air Force Tiedowns:

A12.5.1. Type. For Air Force, tiedowns will be a 3 meter [10 foot] rod with a closed eye. The 3 meter [10 foot] rod will have a diameter of not less than 19 millimeters [0.75 inches], and the top will be bent with a closed eye (often referred to as a shepherd's crook bend), having an inside diameter of not less than 40 millimeters [1.5 inches] as shown in Figure A12.12. The rod will be copper, copper-clad steel, galvanized steel, or copper-zinc-silicone alloy. The Air Force tiedown is a mooring point and may be used as a static ground, but not an electrical ground.

Figure A12.10. Mooring and Ground Point Layout for Rotary-Wing Parking Spaces.

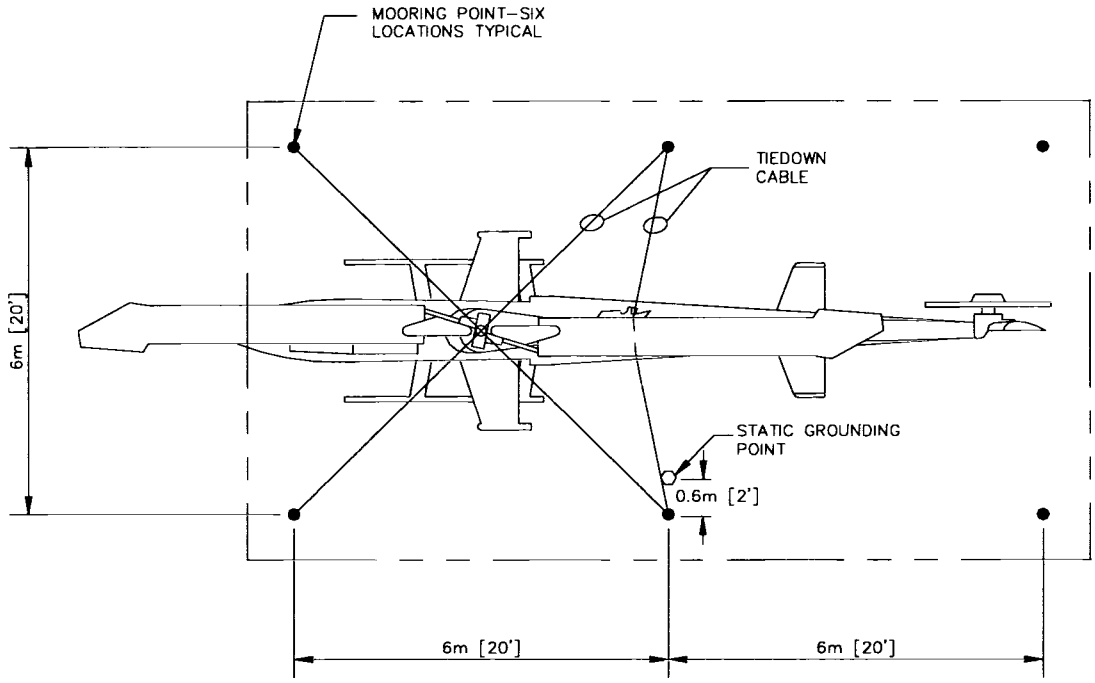


Figure A12.11. Army Grounding Point for Turf Areas.

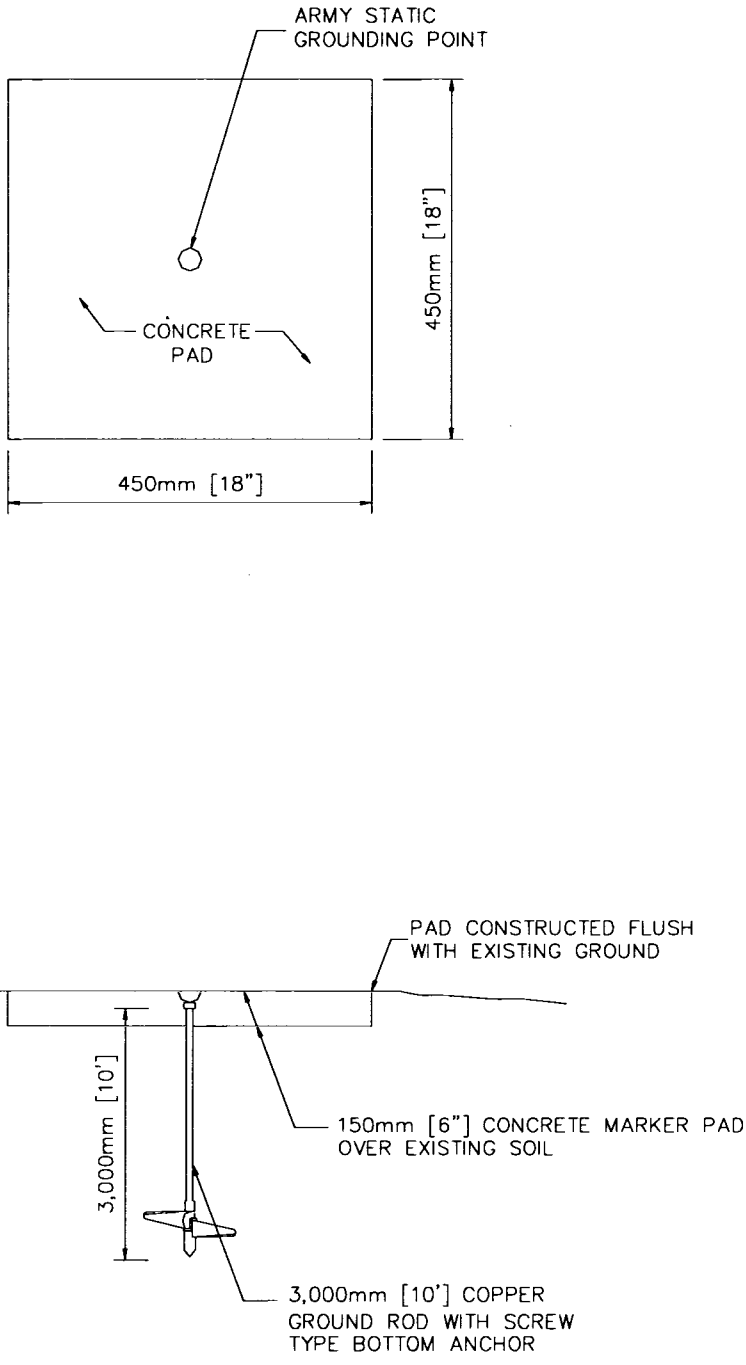
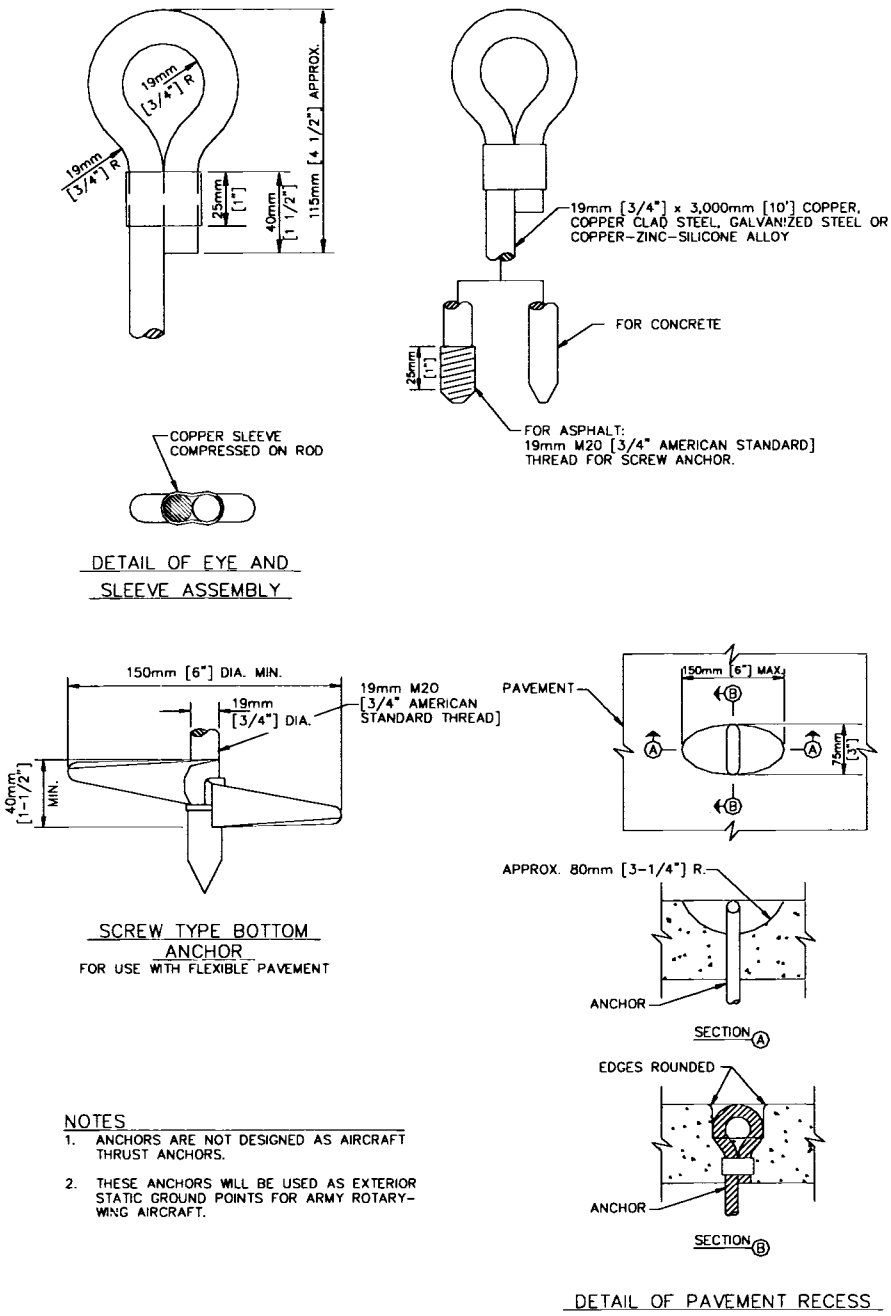


Figure A12.12. Air Force Tiedown and Static Ground.

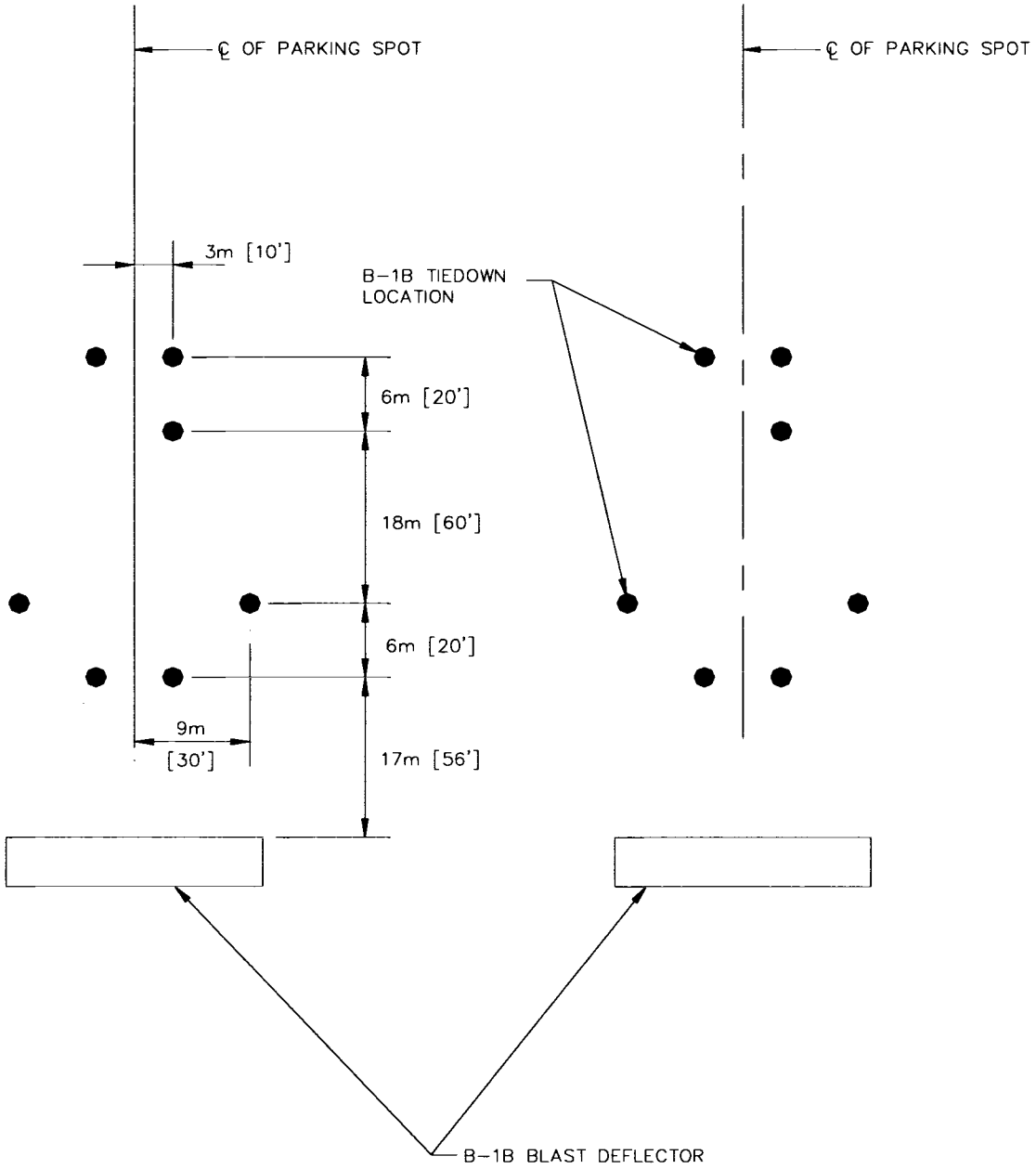


NOTES

1. ANCHORS ARE NOT DESIGNED AS AIRCRAFT THRUST ANCHORS.
2. THESE ANCHORS WILL BE USED AS EXTERIOR STATIC GROUND POINTS FOR ARMY ROTARY-WING AIRCRAFT.

A12.5.2. Layout. Tiedowns will be configured and spaced in accordance with the requirements of the mission aircraft and will vary from aircraft to aircraft. An example of a multiple fixed-wing aircraft tiedown layout is shown in Figure A12.13.

Figure A12.13. Example of Air Force Multiple Tiedown Layout for Fixed-Wing Aircraft.



NOTE: THIS IS AN EXAMPLE FOR ONE AIRCRAFT (B-1B). FOR SPECIFIC AIRCRAFT DIMENSIONS REFERENCE THE AIRCRAFT TECHNICAL ORDER (T.O.) (AVAILABLE FROM MAINTENANCE ASSISTANCE PROGRAM OFFICE).

A12.5.3. Installation:

A12.5.3.1. Rigid Pavement Tiedowns. Where the tiedowns are to be constructed in rigid pavement, the rods may be installed without bottom anchors. Tiedowns should be a minimum of 600 millimeters [2 feet] from any pavement edge or joint.

A12.5.3.2. Flexible Pavements Tiedowns. Where flexible pavement is to be constructed on frost susceptible soil, the rods will be equipped with a screw-type bottom end having a wing diameter of not less than 150 millimeters [6 inches] as shown in Figure A12.12 The rod will be threaded to permit attachment to the bottom anchor.

A12.5.3.3. Pavement Recess Design. The top of the tiedown will be set at pavement grade or not more than 6 millimeters [0.25 inches] below grade. A smooth rounded edge recess 75 millimeters [3 inches] wide and not more than 150 millimeters [6 inches] long will be provided in the pavement around the eye for accessibility and attachment of grounding cables. This is shown in Figure A12.12.

A12.5.4. Grounding Requirements. The maximum resistance of new tiedowns, measured in accordance with ANSI/IEEE Standard 142, should not exceed 10,000 ohms under normal dry conditions. If this resistance cannot be achieved, an alternative grounding system should be considered.

A12.6. Tiedown Mooring Eyes for Navy and Marine Corps. Requirements, layout, and installation details for Navy and Marine Corps tiedown mooring eyes are found in MIL-HDBK-1021/4, *Rigid Pavement Design for Airfields.* Requirements, layout, and installation details for Navy and Marine Corps grounding arrangements are found in MIL-HDBK 274, *Electrical Grounding for Aircraft Safety.*