DEPARTMENT OF THE AIR FORCE
HEADQUARTERS AIR FORCE CIVIL ENGINEER SUPPORT AGENCY

FEB 1 2000

FROM: HQAFCESA/CES
139 Barnes Drive, Suite 1
Tyndall AFB FL 32403-5319

SUBJECT: **Engineering Technical Letter (ETL) 00-2: Inspection and Testing of Trim Pad Anchoring Systems**

1. Purpose. This ETL provides guidance and procedures for inspection and testing of trim pad anchor blocks. Tests can be conducted by base personnel; however, due to the cost of test equipment and safety precautions, recommend tests be conducted by the Air Force Research Laboratory (AFRL), Tyndall Air Force Base, Florida.

Note: Guidance within this ETL is not mandatory.

2. Application: All Air Force installations supporting flight operations.

2.1. Authority: AFI 32-1041, *Airfield Pavement Evaluation Program.*

2.2. Effective Date: Immediately.

2.3. Ultimate Recipients:

- Base Civil Engineers, Red Horse Squadrons, and other Air Force units responsible for design, construction, maintenance, and repair of trim pads.
- Corps of Engineers and Navy offices responsible for Air Force design and construction.

2.4. Coordination: MAJCOM Civil Engineers and functional staff.

3. Referenced Publications

3.1. Air Force:

- AFRL/MLQC Technical Report, *Aircraft Anchor Testing in Southwest Asia (SWA)*, March 1998
- WL/FIVCO (now AFRL/MLQC) Technical Report, *Aircraft Anchor Block Analysis*

3.2. U.S. Army Corps of Engineers (USACE):

- DG 1110-3-204/AFP 88-71, *Design Guide for Army and Air Force Airfields, Railroads, Pavements, Storm Drainage, and Earthwork* (will be superseded by AFMAN 32 1126(I))

3.3. Private Industry:

- ASTM-A588/A588MA-97, *Steel, Structural, High-Strength Low-Alloy with 50 KSI (345 MPA) Minimum Yield Point to 4 IN (100 MM) Thick*
- General Dynamics Corporation, Technical Report 16PR7084, Revision A, *Flight Line Run Station Aircraft Engine Run Tiedown Proof-Load Test,* by Basis A. Korolenko, 4 March 1998

4. Acronyms and Terms

AFRL/MLQC	–	Air Force Research Laboratory, Material Directorate/Air Base Environmental Division/Air Base Technology
BIP	–	black iron pipe
HRS	–	horizontal reinforcing steel
kip	–	a 1,000-pound (453.6-kilogram) load
TDY	–	temporary duty

5. Background. Most Air Force fighter aircraft use aircraft anchor blocks during power checks and routine maintenance procedures. Many existing aircraft anchor blocks were designed to withstand loads associated with F-4 operations, but are being used to support the operation of aircraft with higher thrusts, such as the F-15. While catastrophic failure of an anchor block has not been reported, the stability of the existing anchor block design under increased thrust from newer aircraft has been questioned, particularly with the introduction of the F-22 (see Table 1). Therefore, inspection and testing of anchor blocks is recommended.

Table 1. Nominal Values of Thrust for Various Aircraft.

Aircraft	Nominal Thrust (N[lb])
F-16	128,998 (29,000)
F-18	142,343 (32,000
F-4	160,136 (36,000)
F-15	209,066 (47,000)
F-22	311,375 (70,000)*****

***** Estimated as 311,375-newton class.

6. Anchor Block Descriptions. The Air Force uses two types of anchor blocks. Their designs were based on an applied load of 266,893 newtons (60,000 pounds).

6.1. Omnidirectional Anchor. This design comprises a steel rod, threaded at the top to accept a nut, embedded in a concrete block. The steel rod is 127 millimeters (5 inches) in diameter; the concrete block is 3.05 meters (10 feet) on each side and 0.9 meters (3 feet) thick. A steel collar, held in place by three washers and the nut, connects the aircraft to the anchor rod. Because the collar is free to rotate 360 degrees on the anchor rod, this type of anchor is omnidirectional, and the aircraft can be connected at any orientation to the anchor block.

6.2. Bidirectional Anchor. This design is bidirectional; i.e., the aircraft can pull only in one of two directions, which are 180 degrees apart (opposite). The nominal dimensions of the concrete block are the same as the omnidirectional anchor: 3 meters by 3 meters by 0.9 meters (10 feet by 10 feet by 3 feet). The steel portion of the anchor consists of a built-up beam section embedded in the concrete. A 64-millimeter- (2.5-inch-) diameter rod that bends 180 degrees at its center forms a loop with two legs that extend approximately 0.9 meters. A 152-millimeter- (6-inch-) wide, 25-millimeter- (1-inch-) thick steel plate is welded between the two legs to form the web, and two 102-millimeter- (4-inch-) wide, 25-millimeter-thick plates are welded to the outside edge of each leg to form the flanges. Although the concrete block can be either square or octagonal, the anchor itself is still bidirectional due to the orientation of the anchor loop.

7. Failure Modes Analysis

Table 2. Failure Modes.

Site	Cause
Connecting Hardware	Shear Bearing Tensile Yielding
Steel Anchor Components	Shear Bending
Concrete Anchor Block	Bearing
Concrete Slabs	Compression Buckling
Steel-Concrete Interface	Pullout (Shear Failure)
Anchor-Slab Interface	Rotation (Shear Failure)

7.1. Failure of the aircraft anchors can result from material failure in the steel connecting hardware (anchor-to-aircraft), the steel components that transfer the load to the concrete anchor, the concrete anchor itself, or the adjoining concrete slabs. In the connecting hardware, failure could result from tensile yielding, shear, or bearing failure. The steel anchor components could fail in shear or bending, or combined shear and bending. The concrete anchor could fail in bearing as a result of the compressive stress imparted by the steel anchor components. The adjoining slabs could fail in compression or by buckling when loaded along the edge by the anchor block.

7.2. In addition to material failure in the individual components, the entire anchor block could be unstable and fail as a unit by rotation or horizontal translation. A shear failure at the material interfaces may also occur. At the steel-concrete interface, this failure could result in pullout of the steel anchor component, leaving the concrete anchor block in place. At the anchor block-slab interface, the failure could result in rotation of the entire anchor block unit.

7.3. A theoretical analysis was conducted for each anchor type, using conservative assumptions and calculated factors of safety for each failure mode (reference AFRL/MLQC Technical Report, *Aircraft Anchor Testing in Southwest Asia (SWA))*. These analyses are described below. Factors of safety for the F-4, F-15 and F-22 are shown in Tables 2, 3, and 4.

7.3.1. Omnidirectional Anchor

7.3.1.1. Connecting Hardware (Collar) – Shear. A 51-millimeter- (2-inch-) thick collar connects the aircraft to the anchor. Although the dimensions are not clear on the design drawings, it was assumed that the collar is 51 millimeters thick and 229 millimeters (9 inches) wide at its widest point, which is at the centerline of the 127-millimeter- (5-inch-) diameter hole. For double shear at the back of the collar, the total shear area is conservatively assumed to be 330,322 square millimeters (8 square inches). For ASTM 588 steel with a yield stress (σ_y) of 344.7 megapascals (50 kip per square inch [ksi]), the yield stress in shear (τ_y) can be conservatively assumed as 172.4 megapascals (25 ksi). The load at which the collar begins to yield in shear is then approximately 890 kilonewtons (200 kip). For an applied load of 311.4 kilonewtons (70 kip), the factor of safety against shear failure in the collar is then 2.9.

7.3.1.2. Connecting Hardware (Collar) – Bearing. The bearing area for the anchor rod on the collar is 6452 square millimeters (10 square inches). Using the yield stress as the ultimate bearing stress, the ultimate bearing force for the collar is 2224 kilonewtons (500 kip), and the factor of safety for a 311.4-kilonewton- (70-kip-) load is 7.1.

Note: Bearing stress on the collar at the front connector will be more critical if the hole is smaller. Check this area if a smaller diameter connector is used for the connection to the aircraft tailhook.

7.3.1.3. Connecting Hardware (Collar) - Tensile Yielding. The least cross-sectional area for tensile yielding of the collar is conservatively estimated at 5161 square millimeters (8 square inches). For a yield stress of 344.7 megapascals (50 ksi), the yield load in tension would be 1779.3 kilonewtons (400 kip). For an applied load of 311.4 kilonewtons (70 kip), the factor of safety against tensile failure in the collar would then be 5.7.

7.3.1.4. Steel Components (Bar) – Shear. The cross-sectional area of the steel bar is 12,664.5 square millimeters (19.63 square inches). Assuming the yield stress under pure shear (τ_y) is approximately 158.6 megapascals (23 ksi), the yield shear load would therefore be 2010.6 kilonewtons (452 kip). For an applied load of 311.4 kilonewtons (70 kip), the factor of safety against shear failure in the bar is 6.5.

7.3.1.5. Steel Components (Bar) – Bending. The bending moment and shear forces in the rod will be a function of the applied load as well as the distribution of reaction stress from the concrete along the length of the bar. Finite element analyses of the entire block indicate that practically all of the reaction occurs within a few millimeters of the embedded depth of the rod in the concrete block; and likewise, the bending moment rapidly decreases. By conservatively assuming a moment arm of 102 millimeters (4 inches), the factor of safety against yielding the bar under bending alone would then be approximately 2.2.

7.3.1.6. Concrete Anchor – Bearing. Finite element analyses indicated that practically all of the reaction occurs within the first few inches of the imbedded depth of the bar. The finite element models did not include the 2.5- by 28- by 30-centimeter (1- by 11- by 12-inch) plates shown in the drawings because it was unclear how the load would be transferred to the concrete block. Without the plates, stress concentrations near the top surface were close to the compressive strength of the concrete. For concrete, the ultimate bearing stress is typically 85 percent of the compressive strength, or approximately 23,442 kilopascals (3400 pounds per square inch) for concrete with a compressive strength (f_c') of 27,579 kilopascals (4000 pounds per square inch). If this plate is effective in distributing the lateral load to the concrete anchor block, up to a depth of 7.6 centimeters (3 inches), (as was noted in the finite element models), the resulting factor of safety, based on an averaged stress against bearing failure in the concrete anchor block, would be approximately 1.6.

7.3.1.7. Concrete Slabs – Bearing. For an adjoining slab that is 254 millimeters (10 inches) thick and 3.05 meters (10 feet) wide, the bearing stress on the slab edge will be approximately 414 kilopascals (60 pounds per square inch) for a horizontally applied load of 311 kilonewtons (70 kip). This estimate is conservative, since it ignores the contribution of the underlying soil to the sliding resistance of the anchor block. For concrete, the ultimate bearing stress is typically 85 percent of the compressive strength, so this mode of failure is not of concern. If the slabs consist of concrete with a compressive strength (f_c') of 27,579 kilopascals (4000 pounds per square inch), the factor of safety against bearing failure along the slab edge will be 55.

7.3.1.8. Concrete Slabs – Buckling. A simple but conservative analysis of the buckling of the concrete slab indicates that it is not a significant design concern.

7.3.1.9. Steel-Concrete Interface - Pullout (Shear Failure). A simple but conservative analysis of the steel-concrete interface indicates that pullout is not a significant design concern.

7.3.1.10. Anchor-Slab Interface - Rotation (Shear Failure). The rotation of the entire anchor block would require a shear failure at the connections to the adjacent concrete slabs. These slabs are tied to the anchor block with #8 tie bars, which are 25 millimeters (1 inch) in diameter, 0.61 meters (2 feet) long, and spaced at 305 millimeters (12 inches) on center. Ignoring any shear resistance due to aggregate interlock, and considering only the tie bars on the edges perpendicular to the direction of pull, the total shear area is 10,135 square millimeters (15.71 square inches). Assuming ultimate shear strength of 207 megapascals (30 ksi) for the tie bars, the ultimate resisting couple due only to the tie bars is 3194.7 kilonewton meters (28,275 kip·inches). Assuming that the anchor block is 0.9 meters (3 feet) thick, the maximum moment about the center of gravity due to a load of 311.4 kilonewtons (70 kip), applied at the surface, is 142.4 kilonewton meters (1260 kip inches). Therefore, the factor of safety against rotation of the entire anchor block is 22. The contribution of the underlying soil to the overturning resistance has been ignored, since including the contribution of the soil will increase the stability against overturning of the anchor block.

7.3.2. Bidirectional Anchor. The forces imposed on the anchor block by the aircraft are a function of the thrust of the aircraft and the direction of pull on the anchor. Figure 1 shows the geometry of a typical anchor, with the angle β representing the angle between the horizontal and the direction of the applied force P. Given the typical geometry of the anchor block, adjoining slabs, and the aircraft tailhook, the angle β is not likely to exceed 20 degrees (0 degrees < β < 20 degrees). The angle of application that is most critical depends on the mode of failure being investigated, so the most critical case (within this range) for each mode of failure was used in each analysis.

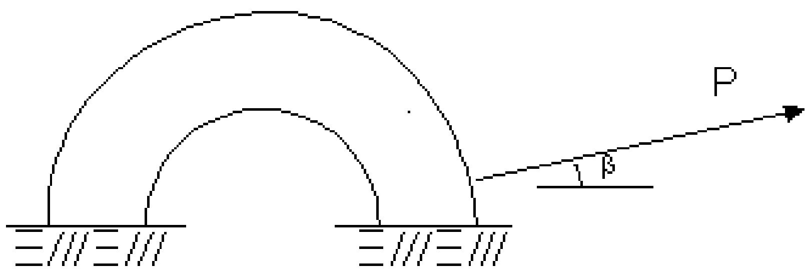

Figure 1. Geometry of Anchor Connection.

7.3.2.1. Connecting Hardware (Link) – Shear. A 51-millimeter- (2-inch-) diameter wire rope link is used to connect the aircraft to the anchor. The cross-sectional area is 2026 square millimeters (3.14 square inches), and for double shear, the total shear area is 4052 square millimeters (6.28 square inches). Assuming that the wire rope link has yield strength of 482.6 megapascals (70 ksi), the shear load for the link to yield is 978.6 kilonewtons (220 kip). For an applied load of 311.4 kilonewtons (70 kip), the factor of safety against shear failure in the connector link is 3.1.

7.3.2.2. Connecting Hardware (Link) - Bearing (Contact Stress Analysis). For the bidirectional anchor, the connection to the aircraft is made via a 51-millimeter- (2-inch-) diameter wire rope link. A theoretical analysis of the contact stresses that will develop between the link and the 64-millimeter- (2.5-inch-) diameter steel anchor loop was performed. The results indicate that extremely high contact stresses are a result of the small contact area between the steel anchor loop and the wire rope link. In reality, the double curved steel components probably are not manufactured to tolerances that so small a contact area would result. Even if these tolerances were achieved, it seems likely that these stress concentrations would result in limited plastic yielding at the initial contact point, but that stress redistribution would bring the contact stresses within an acceptable range. Accurate representation of this behavior is not possible without more information about the contact mechanism and a detailed nonlinear finite element analysis. For this reason, a factor of safety is not calculated.

7.3.2.3. Connecting Hardware (Link) - Tensile Yielding. The cross-sectional area of the 51-millimeter- (2-inch-) diameter wire rope link is 2026 square millimeters (3.14 square inches). Assuming that the wire rope link has a yield strength of 482.6 megapascals (70 ksi), and that both legs of the link carry load equally until yielding, the tensile load for the link to yield would be 1957.2 kilonewtons (440 kip). For an applied load of 311.4 kilonewtons (70 kip), the factor of safety against tensile failure in the connector link is 6.3.

7.3.2.4. Steel Components (Loop) – Shear. The maximum shear force in the steel loop is equal to the applied load if the direction of the applied load is horizontal (β=0). The shear force in the steel loop cannot exceed the applied load, so for shear, the critical case is a horizontally-applied load. The diameter of the steel loop is 63.5 millimeters (2.5 inches), so the cross-sectional area is 3167 square millimeters (4.91 square inches). Using high tensile strength steel alloy with a yield strength (σ_y) of 482.8 megapascals (70 ksi) would correspond to a factor of safety against shear failure of 2.5.

7.3.2.5. Steel Components (Loop) - Bending (Curved Beam Analysis). The bending stresses in the steel loop that is exposed above the surface of the concrete were estimated by performing a curved beam analysis of the steel loop. In this analysis, the loop was assumed to be rigidly anchored into the concrete (no displacement). The resulting stresses can be calculated for any angle θ and any angle of application β.

(a) The tensile stress in the steel loop is a function of both the normal force and the bending moment in the loop. The maximum normal force in the loop occurs at the surface of the concrete, and increases as the angle β increases. For $\beta = 20°$, the maximum normal force is 94.7 kilonewtons (21.3 kip). The maximum moment in the steel loop also occurs at the surface of the concrete, and increases as the angle β increases in the range between 0 degrees and 20 degrees. For $\beta = 20°$, the maximum moment is 7.3 kilonewton meters (64.8 kip inches).

(b) The diameter of the steel loop is 63.5 millimeters (2.5 inches), so the cross-sectional area is 3167 square millimeters (4.91 square inches). The moment of inertia for one leg of the loop is 798,123 millimeter^4 (1.9175 inch^4). Thus, the maximum tensile stress in the steel loop is 321 megapascals (46.6 ksi). Using yield strength of 482.8 megapascals (70 ksi), would result in a factor of safety against failure in bending for the steel loop of 1.5.

(c) The built-up beam section has a cross-sectional area of 15,368 square millimeters (23.82 square inches) and a moment of inertia of 203,120,728 millimeter^4

(488 inch^4), not including any welds. Since the area and moment of inertia of the built-up section are much greater than those for the loop, the bending in the loop will be more critical.

7.3.2.6. Concrete Anchor – Bearing. The front face of the built-up beam section is 102 millimeters (4 inches) wide and 0.61 meters (2 feet) long. A finite element model was used to determine the reaction stresses between the concrete and steel interface. The bearing stresses observed indicate that most of the reaction results in the top few inches of concrete with a maximum bearing stress of approximately 20,684 kilopascals (3000 pounds per square inch). For concrete, the ultimate bearing stress is typically 85 percent of the compressive strength, or approximately 23,442 kilopascals (3400 pounds per square inch) for concrete with a compressive strength (f_c') of 25,579 kilopascals (4000 pounds per square inch). Using this value and the finite element results, the factor of safety against bearing failure in the concrete anchor block would be 1.1. If higher strength concrete is used for the anchor block, the factor of safety will increase proportionally.

7.3.2.7. Concrete Slabs – Bearing. For an adjoining slab that is 254 millimeters (10 inches) thick and 3.05 meters (10 feet) wide, the bearing stress on the slab edge will be approximately 413.7 kilopascals (60 pounds per square inch) for a horizontal applied load of 311.4 kilonewtons (70 kip). This estimate is conservative, since it ignores the contribution of the underlying soil to the sliding resistance of the anchor block. For concrete, the ultimate bearing stress is typically 85 percent of the compressive strength, so this mode of failure is not of concern. If the slabs consist of concrete with a compressive strength (f_c') of 27,579 kilopascals (4,000 pounds per square inch), the factor of safety against bearing failure along the slab edge will be 55.

7.3.2.8. Concrete Slabs – Buckling. A simple but conservative analysis of the buckling of the concrete slab indicates that it is not a significant design concern.

7.3.2.9. Steel-Concrete Interface - Pullout (Shear Failure). For the built-up steel anchor to pull out of the concrete anchor block, three failures must occur. First, the three horizontal bars that pass through the grout holes in the web of the built-up beam must fail in shear. Second, the welds that attach the base plate of the built-up section must fail. Third, the maximum shear resistance between the steel and the concrete must be exceeded along the interface.

(a) The horizontal bars are No. 8 rebar and are 0.61 meters (2 feet long), and pass through the web section, which is 25 millimeters (1 inch) thick. The cross-sectional area of each bar is 510 square millimeters (0.79 square inches).

(b) Each bar is loaded in double shear, so the total shear area in the rebar is 3039 square millimeters (4.71 square inches). The ultimate shear strength of the rebar is approximately 206.8 megapascals (30 ksi). The ultimate shear force, then, is 627.2 kilonewtons (141 kip). For an applied load of 311.3 kilonewtons (70 kip) at 20 degrees to the horizontal, the vertical pullout force is 106.8 kilonewtons (24 kip), so the factor of safety against pullout is 5.9.

7.3.2.10. Anchor-Slab Interface - Rotation (Shear Failure). The rotation of the entire anchor block would require a shear failure at the connections to the adjacent concrete slabs. These slabs are tied to the anchor block with No. 8 tie bars, which are 25 millimeters (1 inch) in diameter, 0.61 meters (2 feet) long, and spaced at 305 millimeters (12 inches) on center. Ignoring any shear resistance due to aggregate interlock, and considering only the tie bars on the edges perpendicular to the direction of pull, the total shear area is 10,135 square millimeters (15.71 square inches). Assuming ultimate shear strength of 206.8 megapascals (30 ksi) for the tie bars, the ultimate resisting couple due only to the tie bars is 3194.7 kilonewton meters (28,275 kip·inches). Assuming that the anchor block is 0.9 meters (3 feet) thick, the maximum moment about the center of gravity, due to a load of 311.4 kilonewtons (70 kip) applied at the surface, is 142.4 kilonewton meters (1260 kip inches). Therefore, the factor of safety against rotation of the entire anchor block is 22. The contribution of the underlying soil to the overturning resistance has been ignored, since including the contribution of the soil will increase the stability against overturning of the anchor block.

Table 3. Factors of Safety for the F-4.

Failure Mode	Factor of Safety	
	Omnidirectional	Bidirectional
Connecting Hardware		
Shear	5.6	6.0
Bearing	13.8	**
Tensile Yielding	11.1	12.2
Steel Components		
Shear	12.6	4.9
Bending	4.3	2.9
Concrete Anchor Bearing	3.1	2.2
Concrete Slabs		
Compression	*	*
Buckling	*	*
Pullout at Steel-Concrete Interface	23.6	11.5
Rotation at Anchor-Slab Interface	44	44

***** Very large factor of safety was calculated.
****** Reliable factor of safety cannot be calculated.

Table 4. Factors of Safety for the F-15.

Failure Mode	Factor of Safety	
	Omnidirectional	Bidirectional
Connecting Hardware		
Shear	4.3	4.6
Bearing	10.6	**
Tensile Yielding	8.5	9.4
Steel Components		
Shear	9.7	3.7
Bending	3.3	2.2
Concrete Anchor Bearing	2.4	1.7
Concrete Slabs		
Compression	*	*
Buckling	*	*
Pullout at Steel-Concrete Interface	18.1	8.8
Rotation at Anchor-Slab Interface	33	33

Table 5. Factors of Safety for the F-22.

Failure Mode	Factor of Safety	
	Omnidirectional	Bidirectional
Connecting Hardware		
Shear	2.9	3.1
Bearing	7.1	**
Tensile Yielding	5.7	6.3
Steel Components		
Shear	6.5	2.5
Bending	2.2	1.5
Concrete Anchor Bearing	1.6	1.1
Concrete Slabs		
Compression	*	*
Buckling	*	*
Pullout at Steel-Concrete Interface	12.1	5.9
Rotation at Anchor-Slab Interface	22	22

***** Very large factor of safety was calculated.
****** Reliable factor of safety cannot be calculated.

8. Inspection and Testing

8.1. Safety Precautions

8.1.1. Test Setup Assembly. All components of this test setup are heavy and cumbersome. Ensure personnel are briefed on proper lifting techniques. Pinching and cuts caused by exposed metal surfaces are also hazards. As a minimum, personnel should wear safety shoes and gloves.

8.1.2. Aircraft Tiedown Failure. All aircraft and equipment must be removed from the run area before testing. Establish a 15.2-meter- (50-foot-) radius clear zone.

8.1.3. Test Setup Failure. All components in the test setup have been rated for at least 45,359 kilograms (100,000 pounds) of load. However, as a precaution, the system should not be loaded beyond 31,751 kilograms (70,000 pounds).

WARNING

Do not load the system beyond 31,751 kilograms (70,000 pounds). Test personnel should work behind a “shield” vehicle.

8.2. Inspection. Check the steel parts for rust, deformation, cracks, or anything that reduces the cross-sectional area. This could significantly change the factor of safety. Check the concrete for spalling around the anchor bolt and cracks through the slab. Check the dimensions of the slab to ensure it meets design size. AFRL/MLQC inspected several anchors and talked with their users. The users indicated that the most common problem while testing was cracking in the connections near the aircraft tailhook, rather than the anchor block.

8.3. Testing.

8.3.1. Background. The following test procedure was modified from General Dynamics Technical Report 16PR7084, Revision A (see paragraph 3.3). This report established a test setup and procedures for aircraft anchor testing that proved successful over dozens of tests in the late 1980’s and early 1990’s. Several phone conversations with Lockheed-Martin (who now owns General Dynamics’ F-16 plant) revealed the mothballed test kit was missing several components. Therefore, after analysis, AFRL/MLQC fabricated its own systems, and some modifications of the General Dynamics design. This procedure has been used successfully by AFRL/MLQC on several occasions.

8.3.2. Requirements. A typical anchor test can be completed in one full day. A team can usually prepare and test three anchors and outbrief in a normal five-day workweek. Equipment and supplies require a $12,000 initial investment (list available from AFCESA or AFRL; see paragraph 9 for points of contact). Maintenance and calibration will also be necessary to accomplish safe, accurate tests.

8.3.3. Procedure:

(a) Clear aircraft anchor area of all unnecessary personnel. Place warning flags, chains, or cones to establish a minimum radius of 15.2 meters (50 feet) from any of the components under tension.

(b) Attach one end of a 45,359-kilogram (100,000-pound) working load round-sling to the aircraft anchor to be tested using a collar assembly. (Figure 2 shows a typical layout.)

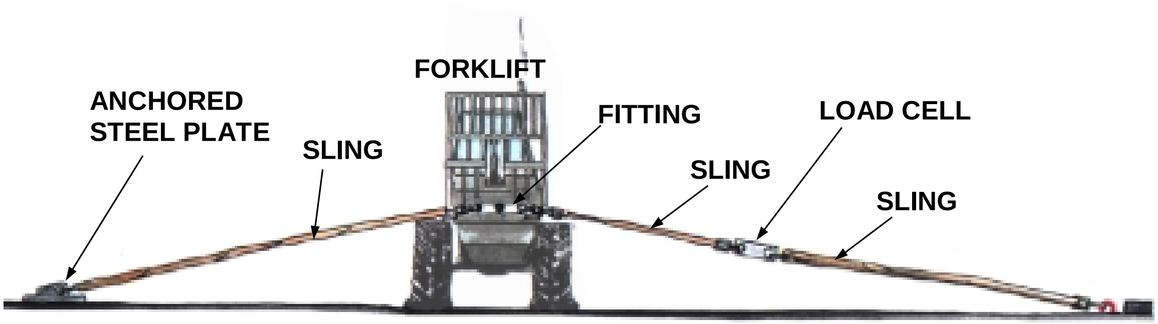

Figure 2. Layout With Forklift.

(c) Attach the other end of the sling to one end of the 45,359-kilogram (100,000-pound) load cell using a collar assembly.

(d) Attach another sling to the opposite end of the 45,359-kilogram load cell using a collar assembly. Attach this sling to the lifting head (Figure 3) using a collar assembly.

(e) Attach the sling coming from the lifting head to the steel plate (Figure 4) using a collar assembly.

(f) After removing all slack from the system, anchor the steel plate to concrete pavement using 19-millimeter (0.75-inch) diameter, 152-millimeter (6-inch) long steel bolts. Use 254-millimeter (10-inch) long bolts to anchor in asphalt pavement (not preferred).

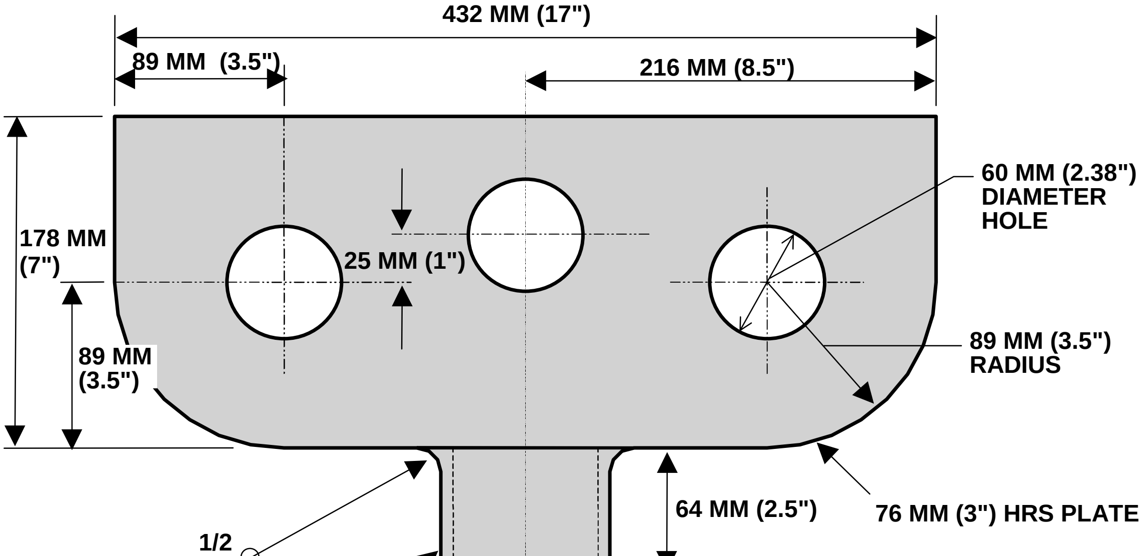

Figure 3. Lifting Head.

(g) Place a vehicle on top of the anchored steel plate if anchoring in asphalt or concrete pavement. The front tire should sit at the base of the "eye" that protrudes upward from the plate.

(h) Connect the remote readout cable to the load cell.

(i) Relocate monitoring personnel behind a vehicle placed between them and the test setup.

(j) Load the system by raising the lifting head using a 9979-kilogram (22,000-pound) forklift (preferred), or a crane. The engineering technician operating the forklift raises the lifting head until he reaches the load increment designated by the supervising engineer. The load is held for two (2) minutes. The supervising engineer records the deflection measurement provided by the second technician and checks the test assembly.

(k) Increase the load sequentially until the desired ultimate load is reached.

WARNING

Do not load the system beyond 31,751 kilograms (70,000 pounds).

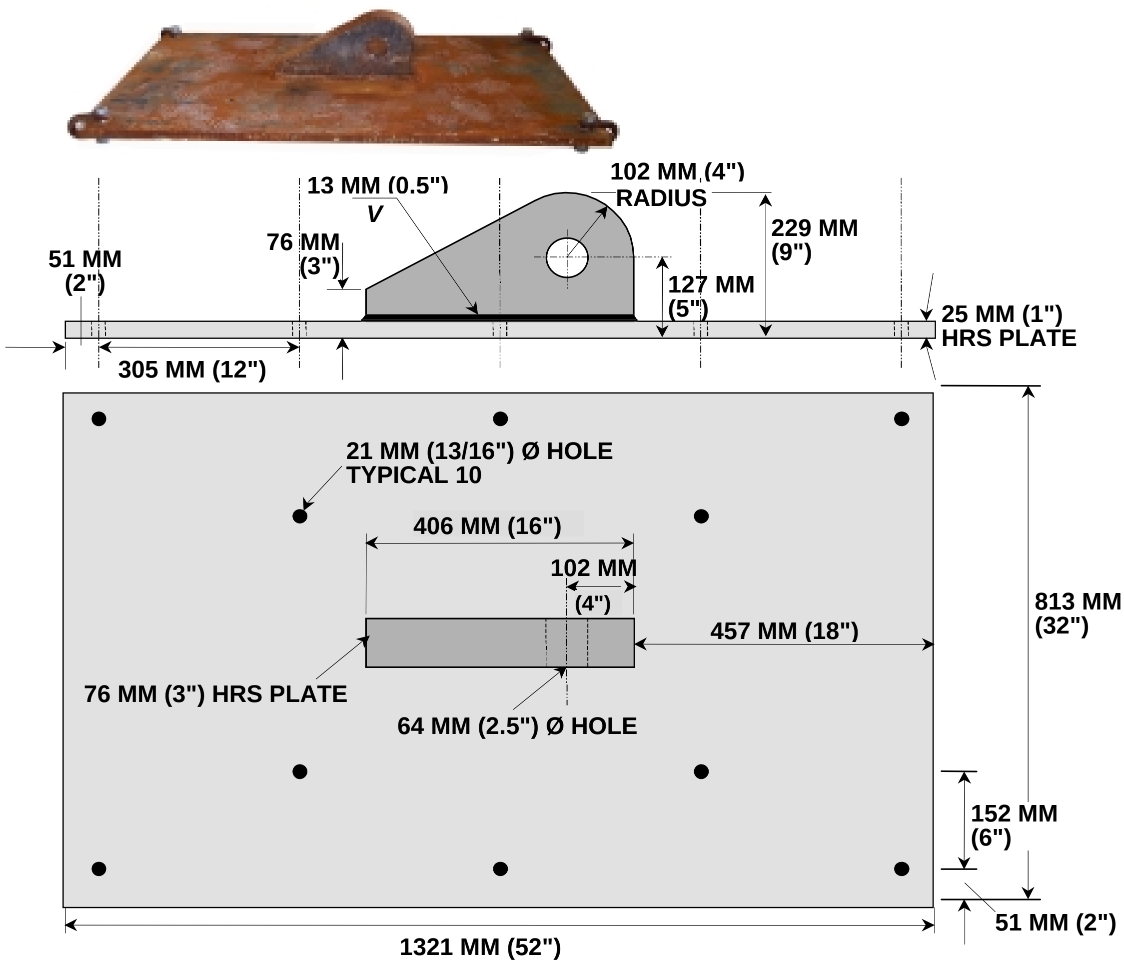

Figure 4. Steel Plate.

(l) Maintain the desired ultimate load for five (5) minutes. During this five-minute period, the supervising engineer and the second technician measure:

- Vertical distance from the pavement to the apex of the assembly.
- Horizontal distance from the “eye” of the steel plate to the apex.
- Horizontal distance from the “eye” of the steel plate to “eye” of the anchor.

(m) Following the five minutes holding at desired ultimate load, slowly lower the lifting head to unload the system.

(n) AFTER ALL TENSION IS RELEASED FROM THE SYSTEM, inspect the aircraft anchor carefully for damage or deformation and take a final deflection measurement.

(o) Disassemble the test setup in reverse order from the assembly process.

8.4. Reimbursement. AFRL provides testing of aircraft anchor systems on a reimbursable basis. They provide personnel, the testing system, and a detailed report with this service. For planning purposes, a two-person AFRL team costs approximately $1,000 per day for each day of Temporary Duty (TDY), plus associated travel cost and per diem. A three-person team (includes an equipment operator) costs approximately $1,500 per day for each day of TDY, plus associated travel cost and per diem. They will provide a detailed estimate prior to testing. The three-person team is fully self-sufficient with the exception of the base-provided 9979-kilogram (22,000-pound) forklift required for testing.

9. Points of Contact: Mr. Jim Greene, HQ AFCESA/CESC DSN 523-6334, commercial (850) 283-6334, Internet James.Greene@tyndall.af.mil, FAX (850) 283-6219; Dr. Jon Porter, AFRL, DSN 523-3073, commercial (850) 283-3073, FAX DSN 523-4932.

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Director of Technical Support

Atch 1
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