SAUDI ARAMCO®

SCAFFOLD SAFETY HANDBOOK

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This *Scaffold Safety Handbook* is the same as and is reprinted from Section II-9 of the Saudi Aramco *Construction Safety Manual*.

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9.0 ELEVATED WORK AREAS, LADDERS, AND SCAFFOLDS

9.1 Purpose

This section establishes the minimum safety-related technical requirements for temporary elevated work areas, ladders, and scaffolds.

9.2 Scope

A. This section applies to operations, maintenance, and construction activities of all Saudi Aramco proponent organizations and their contractors, at all Saudi Aramco onshore and offshore facilities and project sites.

B. Scaffold design, erection, inspection, use, alteration, and dismantling shall meet the requirements of GI 8.001, “Safety Requirements for Scaffolds.”

C. This section covers the design, erection, use, alteration, and dismantling of temporary elevated work areas, ladders, and supported or underhung scaffolds with fixed platform heights. The types of scaffolds covered in this section are those commonly used within Saudi Aramco, including tube and coupler, fabricated tubular frame, system, bracket, underhung, and manually propelled mobile scaffolds.

D. The following unusual scaffolds are *not* covered in this section (see GS 217/1994 or OSHA 1926.450 for definitions):

Adjustable and non-adjustable suspension scaffolds (sky climbers, swinging scaffolds, etc.)

Boatswain’s chairs

Bricklayers square scaffolds

Carpenters’ bracket scaffolds

Catenary scaffolds

Chimney Hoists

Float (ship) scaffolds

Form scaffolds

Horse scaffolds

Ladder jack scaffolds

Lean-to scaffolds

Outrigger scaffolds

Pump jack scaffolds

Repair bracket scaffolds

Roof bracket scaffolds

Shore scaffolds

Single-pole scaffolds

Step, platform, and trestle ladder scaffolds

Top plate bracket scaffolds

Window jack scaffolds

E. The erection of any of the above unusual scaffolds shall be in conformance with the most stringent requirements from GS 217/1994 or OSHA 1926.452. Per these standards, the use of shore and lean-to scaffolds is prohibited.

F. Aerial lifts (manlifts) shall meet the requirements of GI 7.030.

G. Manbaskets shall meet the requirements of GI 7.027.

9.3 Standards and References

Materials and equipment built to standards or references not listed below shall not be used without the expressed written concurrence of the appropriate Area Loss Prevention Division (ALPD).

9.3.1 Standards

The requirements of the following standards are mandatory. In case of conflicting requirements within these standards, the most stringent Saudi Aramco requirement shall apply.

Gulf Standard (GS):

GS 217/1994 (or later), *Industrial Safety and Health Regulations – Equipment: Scaffolding*

Saudi Aramco General Instruction (GI):

GI 2.100, *Work Permit System*

GI 6.020, *Personal Flotation Devices for Work Over, On or Near Water*

GI 7.027, *Crane Suspended Personnel Platform Operations (Manbasket)*

GI 7.030, *Inspection & Testing Requirements for Elevating/Lifting Equipment*

GI 8.001, *Safety Requirements for Scaffolds*

Saudi Aramco Engineering Standard (SAES):

SAES-A-112, *Meteorological And Seismic Design Data*

SAES-A-204, *Preparation Of Structural Calculations*

SAES-B-054, *Access, Exit, And Materials Handling For Plant Facilities*

SAES-M-100, *Saudi Aramco Building Code*

SAES-P-123, *Lighting*

9.3.2 References

The following resources are a basis for many of the requirements of this section and may be used for additional guidance and information.

American National Standards Institute (ANSI):

ANSI A10.8 (1988 or later), *Scaffolding - Safety Requirements*

ANSI A14.1 / ANSI A14.1a, *Ladders-Portable Wood-Safety Requirements*

ANSI A14.2, *Ladders - Portable Metal - Safety Requirements*

ANSI A14.3, *Ladders - Fixed - Safety Requirements*

ANSI A14.4, *Safety Requirements for Job-Made Ladders*

ANSI A14.5, *Ladders - Portable Reinforced Plastic - Safety Requirements*

ANSI Z359.1, *Safety Requirements for Personal Fall Arrest Systems, Sub-systems and Components*

American Society for Testing and Materials (ASTM):

ASTM A53, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*

ASTM A123, *Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products*

ASTM A370, *Standard Test Methods and Definitions for Mechanical Testing of Steel Products*

ASTM A500, *Standard Specification for Cold-Formed Welded and Seamless Carbon Steel Structural Tubing in Rounds and Shapes*

British Standards Institution (BS):

BS 1139: Part 1: Section 1.1: 1990 (or later), *Specification For Steel Tube*

BS 1139: Part 2: Section 2.1: 1991 (or later), *Specification For Steel Couplers, Loose Spigots and Base-Plates for Use in Working Scaffolds and Falsework Made of Steel Tubes*

BS 1139: Part 2: Section 2.2: 1991 (or later), *Specification for Steel and Aluminum Couplers, Fittings, and Accessories for Use in Tubular Scaffolding*

BS 2482: 1981 (or later), *Specification for Timber Scaffold Boards*

BS 5973: 1993 (or later), *Code of Practice for Access and Working Scaffolds and Special Scaffold Structures in Steel*

European Committee for Standardization (CEN), European Standard (EN):

EN 39: 2001 (or later), *Loose Steel Tubes for Tube and Coupler Scaffolds-Technical Delivery Conditions*

EN 74: 1998 (or later), *Couplers, Loose Spigots and Base-Plates for Use in Working Scaffolds and Falsework Made of Steel Tubes: Requirements and Test Procedures*

EN 10219-1: 1997 (or later), *Cold Formed Welded Structural Hollow Sections of Non-Alloy and Fine Grain Structural Steels: Part 1. Technical Delivery Requirements*

EN 10219-2: 1997 (or later), *Cold Formed Welded Structural Hollow Sections of Non-Alloy and Fine Grain Structural Steels: Part 2. Tolerances, Dimensions and Sectional Properties*

National Access and Scaffolding Confederation (NASC):

NASC Guidance Note SG4:00, *The Use of Fall Arrest Equipment Whilst Erecting, Altering, and Dismantling Scaffolding*

United States Code of Federal Regulations 29 CFR, Part 1910, Subpart D, "Walking-Working Surfaces", Occupational Safety and Health Administration (OSHA):

OSHA 1910.24, *Fixed Industrial Stairs*

OSHA 1910.28, *Safety Requirements for Scaffolding*

OSHA 1910.29, *Manually Propelled Mobile Ladder Stands and Scaffolds (Towers)*

United States Code of Federal Regulations 29 CFR, Part 1915, Subpart I, "Personal Protective Equipment," Occupational Safety and Health Administration (OSHA):

OSHA 1915.159, *Personal Fall Arrest Systems (PFAS)*

United States Code of Federal Regulations 29 CFR, Part 1926, Subpart L, "Scaffolds," Occupational Safety and Health Administration (OSHA):

OSHA 1926.450, *Scope, Application and Definitions Applicable to this Subpart*

OSHA 1926.451, *General Requirements*

OSHA 1926.452, *Additional Requirements Applicable to Specific Types of Scaffolds*

OSHA 1926.454, *Training Requirements*

OSHA 1926.450, *Appendices A, D and E*

United States Code of Federal Regulations 29 CFR, Part 1926, Subpart M, "Fall Protection," Occupational Safety and Health Administration (OSHA):

OSHA 1926.502*, Fall Protection Systems Criteria And Practices*

United States Code of Federal Regulations 29 CFR, Part 1926, Subpart X, "Stairways and Ladders," Occupational Safety and Health Administration (OSHA):

OSHA 1926.1050, *Scope, Application and Definitions Applicable to this Subpart*

OSHA 1926.1051, *General Requirements*

OSHA 1926.1052, *Stairways*

OSHA 1926.1053, *Ladders*

OSHA 1926.1060, *Training Requirements*

United States Department of Labor, Occupational Safety and Health Administration (OSHA):

OSHA 3146, *Fall Protection in Construction*

OSHA 3150, *A Guide to Scaffold Use in the Construction Industry*

9.4 Definitions

Where possible, the scaffold terminology used in this document is based on GS 217/1994, OSHA 1926.450, and ANSI A10.8. Equivalent BS 5973 scaffold terms, where an equivalent term exists, are shown in brackets. See Figure II.9.1.

* **Anchorage** Safe points of anchorage for lifelines or lanyards, which are part of a personal fall arrest system, including fixed, substantial structural members. Anchorage points shall be fixed and able to support a load of at least 2,260 kilograms (5,000 pounds).

Base Plate A steel plate providing a flat bearing surface with a spigot or screwjack for distributing the load from posts (standards). It has an integral spigot and fixing holes for use with sills. See Figure II.9.2 and Figure II.9.3.

Bearer (Transom) A horizontal transverse scaffold member, that may support platform units, and which is supported by at least two runners (ledgers) or connected directly to at least two posts (standards). See Figure II.9.1 and Figure II.9.3.

Board Bearer (Intermediate Transom) A horizontal transverse scaffold tube upon which the scaffold platform partially rests. Board bearers are supported by runners (ledgers) and are not installed near a transverse line of posts (standards). See Figure II.9.2 and Figure II.9.4.

Body Belt (Safety Belt) A strap with means both for securing it about the waist and for attaching it (with a lanyard) to a lifeline or anchorage. Used to provide personnel positioning limits against a fall (i.e., keep wearer away from edge of a roof). *Body belts shall not be used as part of a personal fall arrest system.*

Box Tie An assembly of tubes and couplers forming a frame around a column or other part of a building to provide an anchor point for scaffold tie tubes. Also known as a column box tie. See Figure II.9.19 and Figure II.9.21.

Brace A rigid connection of scaffold tubing that holds one scaffold member in a fixed position with respect to another member to give the scaffold rigidity.

> **Cross Bracing** Two diagonal braces joined at their center to form an “X.” Also called “X” bracing or cross braces. See Figure II.9.3.
>
> **Diagonal Brace** A scaffold tube placed diagonally with respect to the vertical and horizontal members of a scaffold and fixed to them to give the scaffold stability.
>
> **Longitudinal (Facade or Sway) Bracing** Diagonal braces installed in the plane of the longer dimension (length) of the scaffold. See Figure II.9.3 and Figure II.9.4.
>
> **Plan Bracing** Diagonal braces installed in a horizontal plane, particularly used in mobile and tower scaffolds. See Figure II.9.27.

* Denotes change

Transverse (Sectional or Ledger) Bracing Diagonal braces installed in the plane of the shorter dimension (width) of the scaffold. See Figure II.9.1 and Figure II.9.4.

Zig-Zag (Dog-leg) Bracing Diagonal braces placed end-to-end and that alternate back and forth. See Figure II.9.4.

Caster (Castor) A pivoting wheel, containing a wheel lock, which is attached to a vertical post (standard) of a mobile scaffold to allow for manual movement of the scaffold. See Figure II.9.30.

Coupler (Fitting, Clamp) A component or device used to fix scaffold tubes together. Types of couplers include:

Adjustable (Swivel) Coupler A device used for connecting two tubes together at an angle other than 90°. See Figure II.9.8.

Bearer (Single or Putlog) Coupler A device used for fixing a bearer (transom or putlog) to a runner (ledger), or to connect a tube used only as a guardrail to a post (standard). See Figure II.9.13.

Check (Safety) Coupler A Right-angle coupler added to a loaded joint on an underhung scaffold to give supplementary security against slip to the coupler carrying the load. See Figure II.9.34.

End-to-End (Sleeve) Coupler A device used for externally joining two (2) scaffold tubes co-axially end to end. The steel divider is located centrally to ensure equal insertion of each tube. See Figure II.9.9.

Girder Coupler A device used for connecting a scaffold tube to a steel wide-flange beam (I-beam). Girder couplers shall only be used in pairs, one on each opposite flange. Also called an “SK” (Steel-Klamp). See Figure II.9.16.

Right-Angle (Double, 90 Degree, Load Bearing, or Standard) Coupler A load bearing coupler used for connecting two tubes together at right angles. It is a critical component in the scaffold structure and must resist both slip and distortion. See Figure II.9.7.

Fabricated Scaffold Plank, Deck, or Platform A scaffold platform unit equipped with end hooks that engage the scaffold bearer (transom). See Figure II.9.17.

Failure Load refusal, buckling, breakage, slip, or separation of component parts. For a simply supported bending member (such as a bearer), load refusal may be taken as the point at which a full depth plastic hinge forms at the midspan (plastic moment = yield stress times plastic section modulus).

Full Body Harness A design of straps that may be secured about an individual in a manner to distribute the fall arrest forces over the thighs, pelvis, waist, chest and shoulders, with means for attaching it to other components of a personal fall arrest system.

Guardrail System A barrier consisting of toprails, midrails, toeboards, and supporting uprights, erected to prevent workers from falling off an elevated work area and to prevent objects from falling onto workers below. See Figure II.9.1. Consists of:

> **Toprail** The uppermost horizontal rail of a guardrail system.
>
> **Midrail** A horizontal rail approximately midway between the toprail of a guardrail system and the platform.
>
> **Toeboard** A barrier secured along the sides and the ends of a platform to guard against the falling of material, tools, and other objects.

Guys Tension members (i.e., wire ropes) used between the scaffold and the ground, building, or structure to enhance the scaffold's lateral stability.

Hanger Tube Vertical tube similar to and serving the same load-carrying purpose as posts (standards), except that hanger tubes are hung from an existing structure and loaded in tension. See Figure II.9.34.

Hot Surface The surface of a structure or equipment that is hotter than 70 degrees C or 160 degrees F.

Joint Pin (Expanding Spigot) An expanding fitting placed in the bore of a scaffold post (standard) to connect one post to another coaxially. This device is used to connect posts (standards) in tube and coupler scaffolds vertically and handles compression, but not tension, loads. See Figure II.9.14.

Ladder A device used for climbing vertically between levels, including:

> **Extension Ladder** A portable ladder that cannot support itself but can be adjusted in length. It consists of two sections that are arranged to permit length adjustment.
>
> **Straight Ladder** A portable ladder that consists of one section that determines its overall length. It cannot support itself or be adjusted in length.

Lanyard A flexible line with a positive means to lock end connections closed (i.e., locking type snaphooks or carabineers with a self-closing, self-locking keeper) that is used to secure the wearer of a full body harness to a lifeline or a point of anchorage.

> **Shock-absorbing Lanyard** A specially designed lanyard with a built-in shock absorber (to allow dissipation of energy) that elongates during a fall so that fall arresting forces are significantly reduced (by 65 – 80%) when compared to a traditional webbing or rope lanyard. A shock-absorbing lanyard limits the maximum arresting force on the individual to less than 8,000 Newtons (1,800 pounds).

Lifeline A component that consists of a flexible line that connects to an anchorage at one end to hang vertically (vertical lifeline), or that connects to anchorages at both ends to stretch horizontally (horizontal lifeline), and which serves as a method to connect other components of a personal fall arrest system to the anchorage. Lifelines are also called static lines, drop lines, safety lines, rat lines, scare lines, etc.

Lift The assembly of runners (ledgers) and bearers (transoms) forming a horizontal level of a scaffold. A lift is similar to a floor in a building. See Figure II.9.5.

> **Base Lift** A lift erected near to the ground consisting of the first set of runners (ledgers) and bearers (transoms). Also known as “foot lift”, “foot tie”, and “kicker lift.”

> **Lift Head Room** The clear distance between a platform and the tubular assembly of the lift above.

> **Lift Height** The vertical distance between two lifts and is similar to a story in a building.

Load Rating Live load for scaffold design and maximum intended loading shall be per the following categories:

> **Light-duty**: Scaffold designed and constructed to carry the weight of workmen only, with no material storage other than the weight of tools. Commonly used for inspection, painting, access and light cleaning. Uniformly distributed maximum intended load is 120 kg/m^2 (1.2 kN/m^2) (25 lb./ft^2). See Figure II.9.35.

> **Medium-duty**: Scaffold designed and constructed to carry the weight of light materials, tools and workmen. Scaffolds used for abrasive blast cleaning (“sandblasting”) shall be classified Medium-duty if there is potential for buildup of abrasive on the platforms (all platforms are not continuously cleaned of abrasive). Uniformly distributed maximum intended load is 240 kg/m^2 (2.4 kN/m^2) (50 lb./ft^2). See Figure II.9.36.

Special-duty: Scaffold specially designed and constructed to carry maximum intended loads *greater than* 240 kg/m^2 (2.4 kN/m^2) (50 psf), such as masonry work, piping or equipment, and is classified as a Special Scaffold.

Lower Level Areas below the level where a person is located and to which he could fall. Such areas include, but are not limited to, ground levels, floors, roofs, ramps, runways, excavations, pits, tanks, materials, water, and equipment.

Maximum Intended Load The maximum load of all persons, equipment, tools, materials, transmitted loads, and other live loads reasonably anticipated to be applied to a scaffold or scaffold component at any one time (does not include scaffold or plank self-weight).

Node Point The intersection point of a post (standard) and runner (ledger), or a post (standard) and bearer (transom). See Figure II.9.56.

Outrigger Beam (Thrustout) A cantilevered structural member that supports a scaffold where the point of attachment to the scaffold is out and away from the face of the structure or building.

Outrigger The structural members of a supported scaffold used to increase the base width of a scaffold in order to provide support for and increased stability of the scaffold. See Figure II.9.23.

Personal Fall Arrest System A system used to arrest an individual's fall. It consists of a substantial anchorage, connectors, full body harness, and may include a lanyard, deceleration device, lifeline, or suitable combinations of these (see CSM Chapter I, Section 9).

Plank (Scaffold Board) An individual timber board or fabricated component (without end hooks) that serves as a flooring member of a platform. See Figure II.9.17.

Platform An elevated work area composed of one or more platform units and a guardrail system. See Figure II.9.4.

Platform Unit An individual wood plank, fabricated plank, fabricated deck, or fabricated platform. See Figure II.9.17.

Post (Standard) Vertical scaffold tube that bears the weight of the scaffold. See Figure II.9.1.

Puncheon (False Upright) A vertical tube supported at its lower end by another scaffold tube or beam and not by the ground or deck. See Figure II.9.54.

Raker An inclined load bearing tube that braces the scaffold against the ground. See

Figure II.9.22.

Reveal Tie An assembly of a reveal tube, reveal pin, and pads, if required, fixed between opposing faces of an opening in a wall to provide an anchor point for scaffold tie tubes. See Figure II.9.21.

Reveal Pin A fitting used for tightening a reveal tube between two opposing surfaces. See Figure II.9.11.

Reveal Tube A tube fixed by means of a threaded fitting (reveal pin) between two opposing surfaces of a building or structure to form a solid anchorage to which a scaffold may be tied. See Figure II.9.20.

Runner (Ledger) A lengthwise horizontal scaffold tube that extends from post (standard) to post, that supports the bearers (transoms) and that forms a tie between the posts. See Figure II.9.1 and Figure II.9.3.

Safe Working Load (SWL) The manufacturer's specified maximum load to be applied to a scaffold component.

Scaffold A temporary elevated platform (supported or underhung) and its supporting components (including ties) used for supporting workmen, materials, or both. Types of scaffolds include:

Base-Supported Scaffold A scaffold with posts (standards) supported at their base (not underhung). See Figure II.9.1.

Birdcage Scaffold A scaffold with more than two lines of posts (standards) or hanger tubes (if underhung) across the width of the scaffold.

Bracket (Tank Builder's) Scaffold A scaffold supported by bracket straps welded to the tank wall. Upright brackets are hooked to the straps. See Figure II.9.26.

* **Fabricated Tubular Frame Scaffold** A scaffold consisting of platform(s) supported on fabricated end frames with integral posts. See Figure II.9.29.

Independent Run (Façade or Independent Tied) Scaffold A scaffold that has two lines of posts (standards), one line supporting the outside of the scaffold platform(s) and one line supporting the inside of the platform(s). The bearers (transoms) are not built into the wall of the building. It is usually tied to the building for stability. See Figure II.9.4.

Mobile Scaffold A rigid scaffold assembly supported by casters that can be manually moved horizontally. See Figures II.9.27, II.9.28 and II.9.29.

System Scaffold A scaffold consisting of posts (standards) with fixed connection points that accept runners (ledgers), bearers (transoms), and braces that can be interconnected at predetermined levels. See Figure II.9.31.

* Denotes change

Tower Scaffold A supported scaffold consisting of *only* four (4) posts (standards) connected together longitudinally with runners (ledgers) and bearers (transoms) at right angles to each other, forming a square or rectangular tower. A tower scaffold may be constructed of tube and coupler, fabricated tubular frame, or system scaffolding. See Figure II.9.33.

Tube and Coupler Scaffold A scaffold constructed of steel tubing that serves as posts (standards), runners (ledgers), bearers (transoms), braces, and ties; a base supporting the posts; and specially designed scaffold couplers that serve to connect the various members. See Figures II.9.3.

Underhung (Slung or Suspended) Scaffold A scaffold that is suspended by fixed length wire ropes (cables) or rigidly attached by scaffold tubes and load bearing couplers to an overhead structure directly above (not outrigger beams), and having a work platform that cannot be raised or lowered. See Figure II.9.34.

Scaffold Measurements Dimensions of a scaffold. See Figure II.9.6.

Bay The space between the centerlines of adjacent posts (standards) along the face of a scaffold.

Bay Length The horizontal, longitudinal distance between centers of two adjacent posts (standards).

Height The vertical distance between the scaffold base and the topmost assembly of runners (ledgers) and bearers (transoms).

Length The horizontal distance along the runners (ledgers) between the scaffold's extreme longitudinal posts (standards); sometimes designated by the number of bays.

Longitudinal The long direction of the scaffold, usually parallel to the scaffold's planks.

Transverse The short direction of the scaffold, usually perpendicular to the scaffold's planks.

Width The maximum horizontal transverse distance of a scaffold measured at right angles to the runners (ledgers) from center of the posts (standards) that are the farthest apart. Sometimes designated by the number of planks that can fit within the posts.

Screwjack A load-carrying device used at the base of the scaffold to compensate for variations in ground levels. See Figure II.9.10.

Sill (Sole Board or Sole Plate) A timber spreader used to distribute the load from a base plate to the ground. See Figure II.9.1 and Figure II.9.2.

* **Special Scaffold** A scaffold that meets any of the following conditions and for which a structural engineering review of the scaffold plan is required:

- higher than 38 meters (125 feet), or a tube and coupler scaffold that exceeds the maximum limits in Section 9.11, or
- cantilevered (extended outward) by more than 3 meters (10 feet), or
- over 30 sq. meters (320 sq. ft.) total platform area and supported by or hung from an existing structure or building (e.g., roof, pipe rack, offshore platform), or
- supporting loads greater than 240 kg/sq.m. (50 psf), including piping, equipment, masonry, new or existing structures, or loads other than workers and their materials, or
- supported by or hung from one or more outrigger beams, or
- supported by or hung from wind girders or roofs of floating roof tanks.

Spigot A pinned or bolted internal fitting to join one post (standard) to another coaxially. Used in system scaffolds. See Figure II.9.15.

Spigot Pin A pin or bolt placed transversely through the spigot and the scaffold post (standard) to prevent the spigot from pulling out of the tube. Also known as tension pin, dowel pin, and coupling pin. See Figure II.9.15.

Tie Scaffold components installed to provide an anchor point for a scaffold to a building or structure, including tie tubes attached to the scaffold. Used to provide lateral stability to the scaffold. See Figures II.9.18 - II.9.21.

Tie Tube A tube used to connect the scaffold to a tie anchor point (i.e., box tie, reveal tie, two-way tie). See Figure II.9.21.

Trapeze tube A horizontal scaffold tube measuring between 450 and 600 mm (1.5 to 2.0 * feet) in length and installed at the bottom portion of the hanger tubes approximately two feet beneath the runners (ledgers). It is used in erection, modification, and dismantling of an underhung scaffold. It also serves as a secondary support if the runner slips. See Figure II.9.34.

Two-Way Tie An assembly of scaffold components through an opening in a wall or other solid structure to provide an anchor point for scaffold tie tubes. Also known as a through tie. See Figure II.9.18.

Working Level An elevated platform supporting equipment, workmen and/or materials.

* Denotes change

9.5 Elevated Work Areas - General Requirements

9.5.1 Fall Protection

A. Each person who could fall more than 1.8 meters (6 feet) shall be protected from falling by a fall protection system. Fall protection systems include guardrail systems and personal fall arrest systems. Fixed fall protection, such as guardrails, are preferred over the use of personal fall arrest systems.

B. Each scaffold craftsman shall continuously wear a full body harness with a shock-absorbing lanyard while erecting, altering, or dismantling a scaffold. If possible to do so, each scaffold craftsman shall properly anchor his lanyard whenever he is not protected by a guardrail system and could fall more than 1.8 meters (6 feet). The lanyard shall be anchored to the scaffold only if it's not possible to anchor to a stronger anchorage (including a lifeline). NASC Guidance Note SG4:00 provides detailed information on proper fall protection techniques for scaffold craftsmen.

9.5.2 Guardrail Systems

A. Guardrail systems (consisting of toprails, midrails, toeboards, and support uprights) shall be installed on all open sides and ends of all elevated work areas (including scaffold platforms and stair landings) where a person could fall 1.8 meters (6 feet) or more.

B. The top edge height of toprails shall not be less than 0.95 meter (38 inches) and not more than 1.15 meters (45 inches) above the walking/working surface of a platform. See Figure II.9.1.

C. Midrails shall be installed approximately halfway between the walking/working surface and the toprail.

D. Toprails and midrails shall be securely fixed to the inside of vertical uprights (i.e., posts). Vertical uprights supporting guardrails shall not be spaced more than 2.7 meters (9 feet) apart.

E. Guardrail systems shall be able to withstand, without failure, a force of at least 90 kilograms (200 pounds) applied in any downward or horizontal direction at any point on the toprail or equivalent member.

F. Guardrail systems shall be installed before an elevated work area may be used by anyone other than the scaffold craftsmen.

G. The ends of all horizontal guardrails shall not overhang the end uprights except when such overhang does not constitute a projection hazard to workers.

H. Holes or gaps in elevated work areas shall have a guardrail system erected around them or they shall be securely covered with structurally substantial material.

I. Whenever the horizontal distance from the edge of an elevated work area (including scaffold platforms) to the face of the wall or structure exceeds 360 mm (14 inches), a guardrail system shall be erected along the edge or personal fall arrest systems shall be used.

J. At hoisting areas, a guardrail system at least 1.2 meters (4 feet) long shall be erected (if possible) on each side of the access point through which material is hoisted. A chain or gate shall be properly secured across the opening between the guardrail sections when hoisting operations are not taking place.

9.5.3 Personal Fall Arrest Systems

A. Where a complete guardrail system cannot be implemented, a personal fall arrest system shall be continuously used by anyone on an elevated work area or platform. A personal fall arrest system includes a full body harness, lanyard, substantial anchorage(s), and possibly a lifeline.

B. At no time shall body belts or safety belts be used as part of a personal fall arrest system.

C. Before each use, the user shall inspect all components of the personal fall arrest system he will be using.

D. Full body harnesses (including D-rings), lanyards (including snaphooks), lifelines, and
* other components of personal fall arrest systems shall be rated and labeled for a capacity of at least 2,260 kilograms (5,000 pounds) by the manufacturer.

E. When used, personal fall arrest systems shall be attached by lanyard to a vertical lifeline,
* horizontal lifeline, or overhead structural anchorage capable of supporting 2,260 kilograms (5,000 pounds).

F. Lanyards shall, if feasible, be tied-off to an anchorage point or lifeline that is high enough (preferably above shoulder height) to prevent the worker from free falling more than 6 feet (1.8 meters) or striking any lower level should a fall occur.

G. Lanyards shall have a maximum length of 1.8 meters (6 feet). Two or more lanyards may be connected together (hook to eye) provided the total possible free fall distance is not more than 1.8 meters (6 feet). However, self-retracting lanyards (inertia reels) are preferred for these situations.

H. Locking type snaphooks or carabineers with self-closing, self-locking keeper shall be attached to the end of each lanyard to prevent rollout. D-rings and snaphooks shall be compatible to prevent rollout.

* Denotes change

I. When lifelines are used, they shall be fastened to fixed safe point(s) of anchorage capable of supporting 2,300 kilograms (5,000 pounds), shall be independent, and shall be protected from sharp edges and abrasion. Safe points of anchorage may include structural members, but do not include guardrails, standpipes, vents, other small diameter piping systems, electrical conduit, outrigger beams, or counterweights.

J. Horizontal and vertical lifelines shall be made from 10 mm (3/8-inch) min. diameter wire rope. Other materials such as manila, nylon, or polypropylene rope shall not be used as a lifeline.

* K. Horizontal lifelines shall be installed at the highest feasible point, preferably above shoulder height. Horizontal lifelines shall be maintained with an unloaded sag at the center no greater than 300 mm (12 inches) for every 10 meters (33 feet) of lifeline length between attachment points.

L. Supervision shall ensure continuous monitoring of employees wearing a personal fall arrest system so that prompt assistance is possible in the event of a fall.

M. Personal fall arrest system components shall not be used for any other purpose and shall not be re-used after stopping a fall or if any component has any sign of damage.

9.5.4 Falling Object Protection

A. Toeboards shall be installed along all edges of elevated work areas (including scaffold platforms) more than 1.8 meters (6 feet) above lower levels, unless personnel access to the lower level under the elevated work area is physically prevented.

B. Toeboards shall conform to the following requirements:

- The vertical distance from the top edge of the toeboard to the level of the walking/working surface shall be at least 100 mm (4 inches).
- Wood toeboards shall be at least 25 mm (1 inch) thick.
- Toeboards shall be securely fastened in place along the outermost edge(s) of the platform and have not more than 6 mm (1/4-inch) clearance above the walking/working surface.
- Toeboards shall be solid and capable of withstanding, without failure, a force of at least 23 kilograms (50 pounds) in any downward or horizontal direction at any point along the toeboard.

C. Where tools, materials, or equipment are piled to a point higher than the top edge of the toeboard and where there is the danger of objects falling through guardrails and striking workers or equipment below, a protective screen consisting of a minimum No. 18 gauge wire with a maximum 13 mm (½-inch) mesh, shall be securely fixed to the toeboard, midrail, and toprail.

* Denotes change

D. In addition to wearing hardhats, additional protection from falling objects may be provided by:

- barricading the area below into which objects can fall and not permitting workers to enter the hazard area, or
- erection of debris nets, catch platforms, or canopy structures sufficient to catch falling objects.

E. A debris net, catch platform or canopy structure shall be strong enough to withstand the impact forces of potential falling objects.

F. Materials are not to be piled, stacked, or grouped unless they are stable and self-supporting.

9.5.5 Entry and Exit

A. A safe means of entry and exit shall be provided and used whenever the elevated work area or scaffold platform is 0.6 meters (2 feet) above or below a point of access. Ladders, stairs/stairways, ramps, or walkways shall be used.

B. Climbing of scaffold braces, runners, etc. is not permitted, except as required by scaffold craftsmen during scaffold erection, alteration, and dismantling.

* C. Whenever the horizontal travel distance to the nearest exit (i.e., ladder) exceeds 15 meters (50 feet), each elevated work area shall have at least two means of exit. A means of exit shall be provided at least every 30 meters (100 feet).

D. Except for scaffolds, the minimum clear headroom above walking/working surfaces, including stairways, shall be 2 meters (6.5 feet). The minimum clear headroom above scaffold platforms and landings shall be 1.8 meters (6 feet).

9.5.6 Temporary Stairways

A. Stairways that are not be a permanent part of the structure on which construction work is being performed shall be at least 560 mm (22 inches) wide.

B. Temporary stairways shall have landings at not more than every 3.7 meters (12 feet) of vertical rise. Such landings shall be at least 760 mm (30 inches) long, in the direction of travel, and be at least 560 mm (22 inches) wide.

C. A guardrail system, per Section 9.5.2, shall be installed on open sides and edges of landings where a person could fall 1.8 meters (6 feet) or more.

D. Temporary stairways shall be installed between 30 degrees and 50 degrees above the horizontal. A stair slope of between 30 and 35 degrees is preferred.

* Denotes change

E. For temporary stairways, riser heights shall not exceed 215 mm (8 inches) or be less than 150 mm (6 inches). Tread depths shall not exceed 280 mm (11 inches) or be less than 220 mm (9 inches).

F. Riser height and tread depth shall be uniform within each flight of stairs, including any foundation structure used as one or more treads of the stairs. In any stairway system, variations in riser height and tread depth shall not be over 6 mm (¼-inch).

G. Treads for temporary stairways shall be made of wood or other solid material, and shall be installed the full width of the stair.

H. Temporary stairways having four or more risers, or rising more than 760 mm (30 inches) in height, whichever is less, shall have a sloping handrail and midrail system on all open sides, or one (1) handrail on enclosed stairways on the right side descending.

I. The height of handrails for temporary stairways shall not be more than 940 mm (37 inches) nor less than 860 mm (34 inches) from the upper surface of the handrail to the surface of the tread, in line with the face of the riser at the forward edge of the tread. Midrails shall be located at a height midway between the handrail and the stairway steps.

J. Handrails shall provide an adequate handhold for workers grasping them to avoid falling. A minimum clearance of 80 mm (3 inches) shall be provided between the handrail and wall or other object.

K. Handrails and the toprail of stair guardrail systems shall be capable of withstanding, without failure, a force of at least 90 kg (200 pounds) applied in any downward or horizontal direction at any point along the handrail or toprail.

L. Where doors or gates open directly on a stairway, a platform shall be provided, and the swing of the door shall not reduce the effective width of the platform to less than 510 mm (20 inches).

M. All parts of stairways shall be free of hazardous projections, such as protruding nails or protruding handrails.

N. Stairs shall not be used if slippery conditions exist.

O. Spiral stairways are not permitted.

Note: Permanent stairways shall be constructed in accordance with SAES-B-054 and SAES-M-100, as applicable.

9.5.7 Temporary Ramps

A. Ramps and walkways 1.8 meters (6 feet) or more above lower levels shall have guardrail systems that comply with Section 9.5.2.

B. No temporary ramp or walkway shall be inclined more than a slope of one (1) vertical unit to three (3) horizontal units (20 degrees above the horizontal). A slope of not over 15 degrees is preferred.

C. If the slope of a ramp or walkway is steeper than one (1) vertical in four (4) horizontal, the ramp or walkway shall have cleats not more than 350 mm (14 inches) apart which are securely fastened to the planks to provide footing.

9.5.8 Slipping and Tripping

Good housekeeping shall be maintained to help prevent slipping, tripping, and falls. Oil spills, mud, scrap, and other debris shall be cleared up immediately. All cords, leads, hoses, etc. shall, if possible, be supported at least 2.4 meters (8 feet) above walkways and platforms by non-conductive material.

9.5.9 Roof Work

A. For work within 1.8 meters (6 feet) of the edge of a (flat or sloped) roof or for work at any location on roofs with a slope of 1:4 (vertical : horizontal) or greater, either installation of temporary (rigid or wire rope) guardrails (per Section 9.5.2) or use of a personal fall restraint system is required.

B. Roofs shall be reinforced where necessary to bear the load of workers and materials.

C. Workers shall not work on a roof that is exposed to the weather during storms or high winds (as defined in Section 9.5.11).

D. Materials shall not be stored within 1.8 meters (6 feet) of the roof edge unless a guardrail system, including toeboards, is erected along the edge.

9.5.10 Lighting

Every work area and every means of access to and exit from an elevated work area used during nighttime shall be provided with properly maintained and adequate lighting, according to SAES-P-123.

9.5.11 High Winds

Personnel shall not be on any scaffold or other temporary elevated work area during storms or high winds – sustained winds more than 65 kph (40 mph) - unless the scaffold or working level is indoors or otherwise unaffected by the weather conditions. Outdoor scaffolds or elevated work platforms shall not be used during thunderstorms or when there is likelihood of lightning.

9.5.12 Work Over Water

A. Where men work on, over, or near water, a guardrail system (per Section 9.5.2) shall be provided. Wherever a guardrail system is impractical, or when men are outside the protection of these safeguards, a personal fall arrest system (per Section 9.5.3) shall be worn.

B. An approved personal flotation device (life vest) shall be worn at all times by each person working above or near water. Personal flotation devices shall be inspected prior to each use.

C. Floatation rings shall be provided at intervals not greater than 15 meters (50 feet) apart when personnel are working above or near water. The number of floatation rings and the length of the rope depend on the location and the vertical distance above the water.

D. A continuous man-watch shall be provided when personnel are working above or near water.

9.5.13 Hot Surfaces

Suitable precautions shall be taken to prevent workers from coming into contact with any hot surface. Barriers shall be erected. Signs shall be posted warning: “Hot Surfaces.” If these are not possible, then a standby man shall be assigned to warn other workers of the hazard.

9.5.14 Unstable Buildings and Structures

No wall sector more than one story high shall be permitted to stand alone without lateral bracing, unless such wall was originally designed to be self-supporting and is in a safe condition. All walls shall be left in a stable condition at the end of each shift by bracing with support jacks, timbers and/or guy-wires, taking wind force and storm conditions into consideration.

9.5.15 Forklift-Supported Temporary Work Platforms

Forklifts shall not be used to support temporary work platforms, including scaffolds.

9.6 Portable Ladders and Stepladders

This sub-section contains requirements for portable ladders and stepladders, including job-made ladders.

Note**:** Permanent ladders shall be constructed in accordance with SAES-B-054 and SAES-M-100, as applicable.

9.6.1 Condition

A. All portable ladders and stepladders shall meet the applicable ANSI standard in Section 9.3.2 (or equivalent standard), and be maintained in good condition at all times. Joints shall be tight. All rungs, hardware and fittings shall be securely attached, and movable parts shall operate freely without binding or undue play.

B. Each portable ladder shall be examined before use. Any ladder that is damaged or weakened shall be immediately removed from Saudi Aramco property or project site. See Figure II.9.37. Examples of damage include:

- split or broken side rails
- missing or damaged rungs
- bent or missing hinges
- any other damage that hinders safe usage of the ladder.

C. Wood and aluminum ladders and stepladders shall not be painted.

D. Side rails shall have smooth surfaces (without slivers) with no projections.

E. Ladders shall have uniformly spaced rungs (all rungs shall be the same distance apart), between 250 mm (10 inches) and 360 mm (14 inches) on center. A rung spacing of 300 mm (12 inches) is preferable.

F. Minimum distance between side rails of a straight ladder, or any section of an extension ladder, shall be 300 mm (12 inches), except for tripod ladders.

G. The rungs of portable metal ladders shall be corrugated, knurled, dimpled, coated with skid-resistant material, or otherwise treated to minimize the possibility of slipping.

9.6.2 Position

A. Straight ladders and extension ladders shall be placed at a slope of 4:1 (for every 4 meters of vertical rise, the base set 1 meter out). See Figure II.9.38. Or, straight ladders and extension ladders may be placed vertically if both side rails are rigidly attached to a supporting structure (i.e. scaffold) at the top, middle, and bottom of the ladder.

B. All ladders shall extend at least 900 mm (3 feet) above the landing, platform, eave, or roofline. See Figure II.9.38.

C. The base supports of all ladders shall be equally supported on a firm level surface. Boxes, blocks, barrels, etc., shall not be used as a means of support.

D. The bottom rung of ladders shall not be more than 600 mm (2 feet) above the lower level used to mount the ladder.

E. The area at the base of a ladder shall be kept clear.

F. Ladders shall not be used in a horizontal position as platforms, walkways, or scaffolds.

G. Ladders shall not be supported on their rungs. Rungs shall not be used to support scaffold planks.

H. Both side rails of a ladder shall be evenly supported at the upper resting-place. Side rails should be securely tied off to prevent movement. Where secure fixing is impractical, other measures shall be taken to prevent movement by securing at the base, using side guys, or stationing a man at the base.

I. When a ladder could be struck by moving vehicles or equipment, a flagman shall be stationed to warn off drivers, or a substantial barricade with flashers erected around the ladder base.

J. If a ladder is erected near a doorway, the door shall either be locked shut, or secured in the open position with a man on guard to prevent anyone from using the door.

9.6.3 Clearances

A. Safe clearances shall be maintained to prevent workers from bumping into, or snagging onto, projecting objects while ascending or descending the ladder.

B. Ladders shall have a minimum clear perpendicular distance of 760 mm (30 inches) from the rungs to the nearest projecting object on the climbing side. When unavoidable obstructions are encountered, the minimum clearance distance may be reduced to 610 mm (24 inches) if deflector plates are provided.

C. The perpendicular distance from the face of the rung on the climbing side to the nearest fixed object on the back side of the ladder shall not be less than 250 mm (10 inches). When unavoidable, horizontal obstructions (e.g. beams, pipes, etc.) are encountered, the vertical toe clearances specified in 9.6.3(E) shall apply.

D. The minimum clearance to the nearest fixed object shall be 330 mm (13 inches) on each side of the centerline of single-rung ladders.

E. The minimum vertical toe clearance shall be 100 mm (4 inches) above the top edge of the rung.

F. The minimum clear distance between the sides of adjacent single-rung ladders or stepladders shall be 410 millimeters (16 inches).

9.6.4 Usage

A. Metal ladders, ladders with metal reinforced side rails, and ladders that are wet shall not be used near electrical equipment or while using electrical tools. Only wooden or fiberglass ladders shall be used for electrical applications. Portable metal ladders shall have a warning notice attached to guard against use near electrical equipment.

B. Aluminum ladders shall not be used where there is a likelihood of contact with materials that chemically react with aluminum, such as caustic liquids, damp lime, wet cement, acids, etc.

C. Do not splice, lash, or tie ladders or ladder sections together.

D. Before climbing a ladder, workers shall check that their shoes and the ladder are free from grease, oil, and mud.

E. Only one person shall be on a single-rung ladder at a time.

F. Workers shall not carry tools and materials in their hands when climbing a ladder. Tools may be carried in secure pockets or on special tool belts. Material or heavy tools shall be raised and lowered by rope.

G. If work is done while standing on a ladder and the worker is higher than 1.8 meters (6 feet) above the ground, either one hand shall remain on the ladder or a personal fall arrest system shall be used.

H. Work requiring lifting of heavy materials or substantial exertion shall not be done from ladders.

I. Ladders shall not be moved, shifted, or extended while occupied.

J. While climbing or descending, workers shall face the ladder and keep both hands on the ladder.

9.6.5 Stepladders

In addition to requirements stated above, the following apply to stepladders:

- Stepladders shall have folding cross-braces that are hinged. Both sections shall be fully opened with hinged braces flat and taut before use to ensure stability. Stepladders shall be faced with the steps facing the work location.
- Do not stand on stepladder top platform, top step, pail shelf, braces, or back section.
- Only one man shall be on a stepladder at a time.
- Do not use the top platform or top step to store tools and materials.
- Never leave a ladder unattended with tools or materials stored on it.
- Do not use a stepladder to gain access to roofs or other elevated surfaces.
- Never use a stepladder that is leaned against a wall or other support. Stepladders shall only be used when equally supported by all four legs.
- The length of portable stepladders shall not exceed 6 meters (20 feet).

9.6.6 Extension Ladders

A. Where an extension ladder is fully extended, the minimum overlap between ladder sections depends on the extension ladder length:
   - Up to and including 11 meters (36 feet) = 1.2 meters (4 feet) overlap
   - 11 to 14.6 meters (36 to 48 feet) = 1.5 meters (5 feet) overlap

B. Extension ladders shall be securely tied-off to a rigid structure.

9.6.7 Job-made Ladders

A. Job-made ladders shall not be used on scaffolds.

B. Single-rung job-made ladders shall not exceed 4.5 meters (15 feet) in length between supports (base and top landing). Nominal 2x4 lumber shall be used for side rails of single-rung ladders.

C. If a job-made ladder is to provide the only means of access and exit from a working area for 25 more workers, or if simultaneous two-way traffic is expected, it shall be a double-rung ladder.

D. Double-rung job-made ladders shall not exceed 4.5 meters (15 feet) in length. Nominal 2x4 or equivalent lumber shall be used for side and middle rails of double-rung ladders up to 3.6 meters (12 feet) in length. Nominal 2x6 or equivalent lumber shall be used for double-rung ladders from 3.6 by 4.5 meters (12 to 15 feet) in length.

E. Wood rungs shall have the minimum dimensions shown in Table II.9.1 and shall be made of wood that meets ANSI A14.4 requirements for job-made ladders.

Table II.9.1: Wood Rung Dimensions

LENGTH OF RUNG	THICKNESS	WIDTH
Up to and including 500 mm (20 inches)	20 mm (0.78 in.)	80 mm (3 in.)
Over 500 mm (20 in.) and up to and including 760 mm (30 in.)	20 mm (0.78 in.)	95 mm (3.75 in.)

F. Rungs shall be inset into the edges of the side rails 13 mm (1/2-inch), or filler blocks shall be used on the rails between the rungs. Rungs shall be secured to each rail with three 10d common nails, or other fasteners of equivalent strength.

G. Rungs shall be uniformly spaced at 300 mm (12 inches) from top of rung to top of the next rung.

9.7 Scaffold Components

9.7.1 General

A. The components used to assemble scaffolds shall be inspected before each use and shall conform to requirements of this section regarding materials, strength, dimensions, etc.

B. Scaffold components manufactured by different manufacturers shall not be intermixed unless the components are compatible (fit together without mechanical force) and the scaffold's structural integrity is maintained. Scaffold components manufactured by different manufacturers shall not be modified in order to intermix them.

C. Scaffold components shall be free from detrimental corrosion.

D. Any scaffold component that is obviously damaged, excessively corroded, defective, or does not meet the applicable codes and standards shall be marked with bright fluorescent orange paint and immediately removed from Saudi Aramco property or project site. See Figure II.9.39 and Figure II.9.41. Defective couplers shall be immediately destroyed and shall not be re-used on any Saudi Aramco property or project site. However, if possible, defective sections of planks or tubing may be cut off (see Section 9.7.3(H)). In this case, the plank or tubing may be reused.

E. Scaffold components made of dissimilar metals shall not be used together because of the potential for galvanic corrosion.

F. Scaffold components shall not be exposed to acids or other corrosive substances, unless adequate precautions have been taken to protect the scaffold from damage.

G. Where a built-in ladder is part of a scaffold system, it shall conform to the requirements for ladders.

H. Scaffold components shall be properly stored to prevent damage.

9.7.2 Scaffold Tubing and Fittings Specifications

A. Scaffold tubing shall be 48.3 mm (1.9 inch) nominal outside diameter.

* B. Scaffold tubing (for tube-and-coupler, system, and fabricated tubular frame scaffolds, etc.) shall be welded or seamless structural steel pipe fabricated in accordance with any of the following pipe fabrication specifications and as specified in this section:

- ASTM A500, Grade B; 290 N/mm^2 (42 ksi) (30 kg/mm^2) minimum yield stress; 3.4 mm or 3.76 mm nominal wall thickness.
- ASTM A53, Grade B; 240 N/mm^2 (35 ksi) (24 kg/mm^2) minimum yield stress; 3.68 mm nominal wall thickness.
- BS 1139, Part 1, Section 1.1; 235 N/mm^2 (34 ksi) (24 kg/mm^2) minimum yield stress; 4.0 mm nominal wall thickness (EN 39, thickness type 4, is equivalent).
- EN 10219; 320 N/mm^2 (46 ksi) (32 kg/mm^2) minimum yield stress; 3.2 mm nominal wall thickness (EN 39, thickness type 3, is **not** equivalent).

C. All tubing produced shall meet the testing and inspection requirements of ASTM A500, including flattening test.

D. Actual yield and tensile strengths shall be verified by Purchaser of scaffold tubing by: (1) receipt from Supplier and review of certified inspection test reports for each lot of tubing produced from the same heat of steel, **and** (2) by independent mechanical testing, per ASTM A370, of test specimens taken from two lengths of tubing for each lot of 500 lengths, or fraction thereof, received. All mechanical properties shall meet minimum requirements after galvanizing. All test reports shall be written in English.

* E. Each piece of scaffold tubing produced in accordance with the above specifications shall be clearly, continuously, and permanently marked to distinguish it from unacceptable, substandard tubing. All tubing shall be marked, prior to galvanizing, with the pipe manufacturer's name or logo, applicable pipe fabrication specification (including Grade and nominal wall thickness), and year of manufacture continuously along its full length, in a position remote from any electric resistance weld (ERW) seam, using a low stress rolling die embossed marking system. The marking interval shall not exceed 1.5 meter, with characters a minimum of 4 mm high and impression depth of at least 0.2 mm deep. Painted marking is unacceptable.

* Denotes change

F. Scaffold tubing conforming to other specifications may be used if approved by the Saudi Aramco Consulting Services Department (CSD), and if inspected and embossed as stated above.

G. Steel tubing for tube and coupler scaffolds shall be hot-dip galvanized (not painted) in accordance with ASTM A123. Steel tubing for system and fabricated tubular frame scaffolds may be painted.

H. Scaffold couplers shall be marked as conforming to either BS 1139, EN74, or Saudi Aramco approved equivalent specification. Couplers may be either pressed or drop-forged type. All fittings (including couplers, clamps, joint pins, etc.) shall be galvanized or zinc coated to resist corrosion.

I. Threaded parts of scaffold components and fittings shall be capable of attaining full thread engagement and shall be lubricated regularly.

J. Always install scaffold components and fittings per manufacturer's instructions.

K. Girder couplers shall always be used in pairs.

* L. Individual couplers shall comply with the rated safe working loads (SWL) in Table II.9.2. This shall be verified from the technical literature submitted by the manufacturer. Applied loads (unfactored) shall be less than 40% of the rated capacity (to ensure a safety factor of 4).

Table II.9.2: Safe Working Loads for Individual Couplers

TYPE OF COUPLER	TYPE OF LOAD	EN74 CLASS	RATED SAFE WORKING LOAD (SWL) * *
Right-angle Coupler, also known as Double or Load Bearing Coupler	Slip along a tube	B	SWL = 9.4 kN (2,100 lb.)
Adjustable Coupler, also known as Swivel Coupler	Slip along a tube	A	SWL = 5.3 kN (1,190 lb.)
End-to-End Coupler, also known as Sleeve Coupler	Tension Bending	B B	SWL = 3.0 kN (675 lb.) SWL = 0.59 kN-m (435 lb.-ft.)
Bearer Coupler, also known as Putlog or Single Coupler	Force to pull the tube axially out of the coupler	-	SWL = 0.53 kN (120 lb.)
Joint Pin	Tension	-	SWL=0 kN (0 lb.)

*** *** Ref. BS 5973: 1993, Table 17 (based on a slipping safety factor of 1.6).

* Denotes change

9.7.3 Platform Units

A. Scaffold platform units shall be either solid sawn wood planks, laminated veneer lumber (LVL) planks, fabricated planks, or fabricated platforms. See Figure II.9.17. All recommendations by the platform unit manufacturer or the lumber grading association or inspection agency shall be followed.

B. Solid sawn wood planks shall be of solid sawn timber and may be either 2x10 inch (nominal), 2x9 inch (rough), 38mmx225mm (basic), or 50mmx225mm (basic).

C. Solid sawn wood scaffold planks shall be of a "scaffold plank grade" and shall be certified by and bear the grade stamp of the West Coast Lumber Inspection Bureau (WCLB), Southern Pine Inspection Bureau (SPIB), or other lumber-grading agency approved by the American Lumber Standards Committee (See *Certified Agencies and Typical Grade Stamps*, published by the American Lumber Standards Committee).

D. Solid sawn wood scaffold planks conforming to and marked in accordance with BS 2482 are also acceptable.

E. Laminated veneer lumber (LVL) planks shall measure 38 millimeters (1-1/2 inch) thick by 225 millimeters (9 inches) wide, or larger.

* F. All laminated veneer lumber (LVL) planks shall have the words "PROOF TESTED SCAFFOLD PLANK" and "OSHA", or Saudi Aramco accepted equivalent, continuously embossed along at least one edge.

G. Solid sawn wood and LVL planks shall conform to the following (see Figure II.9.40):

- Plank ends shall not be split more than 25 mm (1 inch) without metal banding. Even with banding, plank ends shall not be split over 300 mm (12 inches).
- Planks shall not be twisted from end-to-end or curled from side-to-side more than 13 mm (1/2-inch).

H. Planks shall be inspected for defects, including damage, decay and warping, prior to each use. Planks that are split, warped, twisted (more than allowed above), saw-cut, drilled, worn, decayed, broken, or damaged shall not be used. See Figure II.9.41. However, the defective parts may be cut off to produce shorter planks. In this case, the cut end(s) shall be banded.

I. Planks shall not be painted, treated, or coated in any way (except at the ends) that could conceal defects or obscure the top or bottom surfaces.

J. Planks shall be properly stacked, off the ground, on a suitable foundation. Where the height of a stack exceeds 20 planks, measures shall be taken to tie or bond succeeding layers.

* Denotes change

K. Planks shall not be stood on end unattended.

L. Scaffold planks shall not be used as concrete forms, trench shoring, or as sills for scaffolds.

9.8 Requirements Common to All Scaffolds

9.8.1 Capacity

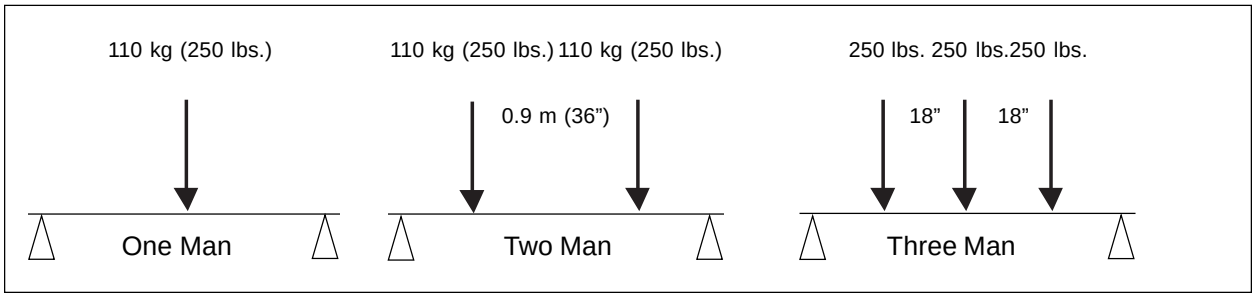
A. Every scaffold and scaffold component (including platform units) shall be capable of supporting, without failure, its own weight (dead load) and at least four (4) times the maximum intended load (live load) applied or transmitted to it (D+4*L). Self-weight of platform units (including planks) may be considered as dead load.

B. All scaffolds shall have a specified load rating, corresponding to the maximum intended load, of either Light-duty, Medium-duty, or Special-duty. For design, the maximum intended load (live load) shall be taken as the scaffold's load rating.

C. Scaffolds and scaffold components shall not be loaded in excess of their load rating.

D. The maximum allowable span for fabricated planks, fabricated platforms, and laminated veneer lumber (LVL) planks shall be determined by the manufacturer, and shall be the shortest simple span required to support, without failure, the platform unit's own weight and at least four times the most critical maximum intended load case shown in Table II.9.3.

Table II.9.3: Concentrated Load Cases for Platform Units



E. The maximum span for fabricated planks, fabricated platforms, and laminated veneer lumber (LVL) planks shall also not be less than what is required to support, without failure, the platform unit's own weight and at least four times the Light-duty (25 psf), Medium-duty (50 psf), or Special-duty (>50 psf) uniformly distributed load, as applicable given the scaffold's load rating. These uniformly distributed loads and the concentrated loads in Table II.9.3.are *not* additive.

F. The maximum deflection for platform units shall not exceed 1/60th of the span length when supporting any of the above (unfactored) concentrated or uniformly distributed maximum intended loads.

9.8.2 Foundations

A. Foundations shall be sound, rigid, and capable of carrying the scaffold self-weight plus the maximum intended load without settling or displacement. Unstable objects such as barrels, boxes, loose brick or concrete blocks shall not be used to support scaffolds, planks, or timber sills. See Figure II.9.42.

B. A sound base is essential. Therefore, the ground or floor on which a scaffold stands shall be carefully examined for its load-bearing capacity. Sand or made-up ground (fill) may need compacting to ensure there are no cavities. Such bases as floors, roofs, etc., may need shoring from underneath.

C. Timber sills (sole boards) at least 225 mm (9 inches) wide by 38 millimeters (1-1/2 inches) thick shall be used to spread the load on sand, made up ground, asphalt pavement, wooden floors, and other soft or slippery surfaces. The ground beneath sills shall be level and compact. A sill shall extend under at least two posts (standards), unless not feasible because of uneven or sloping ground. In this case, sills under individual posts (standards) shall be at least 765 mm (30 inches) long. Scaffold planks shall not be used as sills. See Figure II.9.43.

D. All scaffold posts (standards) shall be pitched on steel base plates at least 150 millimeters (6 inches) by 150 millimeters (6 inches) and 6 millimeters (1/4-inch) thick. See Figure II.9.3. For Special Scaffolds, the base plate shall be designed to support the maximum scaffold post (standard) load. Timber sills shall be used where base plates may be exposed to corrosive materials.

E. Screwjacks shall be used to compensate for variations in ground level. Screwjacks shall not be adjusted to more than two-thirds of the total length of the threaded section. Screwjacks shall be used and loaded in accordance with the manufacturer's specifications. See Figure II.9.44.

F. Front-end loaders, forklifts, or pieces of equipment shall not be used to support scaffolds.

G. Scaffolds shall not be hung from or supported by guardrails or handrails.

H. A crane or other lifting device shall not lift any scaffold, unless it's a Special Scaffold specifically designed for lifting and the scaffold plan was reviewed in accordance with GI 8.001.

9.8.3 Stability

A. Scaffold posts and frames shall be erected and maintained vertical and plumb and vertically braced in both directions to prevent swaying and displacement. Plumbness shall be checked using a spirit level, plumb bob, or by using vertical lines on an adjacent building or structure. See Figure II.9.45 and Figure II.9.46.

B. Where uplift or tension loads may occur in posts (standards) or frames (such as the back side of cantilevered scaffolds), they shall be locked together by pins (not joint pins), bolted or pinned spigots, end-to-end (sleeve) couplers, or equivalent means able to carry the tension loads.

C. Supported scaffolds with a height to the uppermost planked level that is over four times the minimum base dimension (over a 4:1 height-to-width ratio) shall be restrained from tipping by ties, guys, outrigger frames, or equivalent means. Upper section(s) of a stepped scaffold shall not have a height over four times the width of the scaffold at the base of that section, unless ties or guys are properly installed to ensure stability. See Figure II.9.74.

D. Ties and guys shall be installed as follows:

- Ties shall be connected to buildings or structures by connecting a tie tube to at least two posts (standards) or two horizontal members (i.e., runners) and coupling this to a two-way tie, column box tie, reveal tie, or an equivalent connection. See Figure II.9.21.
- Ties or guys shall be installed according to the scaffold manufacturer's recommendations.
- All tie connections shall be made with right-angle (double) couplers.
- Tie tubes or guys shall be installed at locations where runners (ledgers) and bearers (transoms) support the post (standard) in both directions. Tie tubes or guys shall be connected to posts as close as possible to the horizontal members, or connected to horizontal members as close as possible to the posts. See Figure II.9.21.
- Ties or guys shall be installed adjacent to transverse vertical bracing. See Figure II.9.47.
- The lowest level of ties or guys shall be installed at the lift located closest to the height of 4 times the minimum base dimension (4:1 ratio). See Figure II.9.47.
- The uppermost level of ties or guys shall be installed as close as feasible to the top of the scaffold.
- Ties or guys shall be spaced vertically every 8 meters (26 feet) (4 lifts) or less.
- Ties or guys shall be installed at both ends of the scaffold and at horizontal intervals not to exceed 9 meters (30 feet) measured from one end toward the other. See Figure II.9.47.
- Guys shall slope at approximately 45 degrees above the horizontal. The strength of guy wires and of the anchorage used shall be calculated, having due regard to the horizontal wind forces and other forces which may be applied to the scaffold. See Figure II.9.25.
- Guys shall be installed on opposite sides of the scaffold.

E. When used, reveal tubes shall be securely wedged, using reveal pins, between opposing surfaces on the building or structure and coupled to tie tubes. To ensure the security of reveal tubes, it is necessary to frequently check for tightness. Ties to reveal tubes shall not exceed 50% of the total number of ties used on the scaffold and shall be evenly distributed over the scaffold area. See Figure II.9.20 and Figure II.9.21.

F. When used, outrigger frames shall extend the base dimension(s) to more than ¼ of the scaffold height. See Figure II.9.23.

G. The stability of a scaffold may be achieved by the use of rakers only if it is impractical to provide ties, guys, or outrigger frames. Each raker shall be a single piece of scaffold tubing not more than 6.4 meters (21 feet) in length. Rakers shall not be joined (spliced) together. The raker angle above horizontal shall not be greater than 75 degrees (4:1) or less than 65 degrees (2:1). Only one additional lift may be installed on the scaffold above the raker tie-in point. The top of the raker shall be coupled to the scaffold no higher than the third lift. The bottom of the raker shall be coupled to a firmly anchored ground stake or otherwise well anchored against movement in all directions (including uplift). In addition, the bottom and midpoint of every raker shall always be tied back to the scaffold by horizontal tubes coupled to the raker and to at least two scaffold posts (standards). See Figure II.9.22.

H. When installation of ties, guys, or outrigger frames is not possible for scaffolds that exceed a 4:1 height to base width ratio, the bottom corners may be securely anchored against uplift. See Figure II.9.24. Such anchors shall be properly designed by a qualifed engineer, including consideration of the capacity of the soil or foundation to resist uplift. These calculations shall be reviewed by the Saudi Aramco Consulting Services Department (CSD) beforehand.

I. Ties, guys, or outriggers shall be used to prevent the tipping of supported scaffolds in all circumstances where an eccentric load, such as a cantilevered work platform, is applied or is transmitted to the scaffold.

J. Where the means of access to the working platform (i.e., ladder) is outside the scaffold structure, due consideration shall be given to the effect of such means of access on the stability of the scaffold.

K. All connections on a scaffold lift shall be made secure and fully tightened before assembly of the next lift.

L. When a scaffold is being dismantled, the components above each tie shall be dismantled or removed before the tie is removed. Stability shall be maintained while the scaffold is being dismantled.

9.8.4 Scaffold Platform Construction and Use

A. A complete guardrail system (per Section 9.5.2), including toeboards per Section 9.5.4, shall be installed around all open sides and ends of every planked/platformed level (even when not being used as a working platform) where a person could fall 1.8 meters (6 feet) or more. Toeboards shall not be nailed to scaffold planks.

B. If the front edge of a working platform is less than 360 mm (14 inches) from the face of the wall or structure, guardrails do not need to be erected along that edge. However, falling object protection shall be provided by covering the gap with planks or by using toeboards, nets, barricades, etc., as described in Section 9.5.4.

C. Every scaffold platform shall be closed planked or decked as fully as possible between the guardrails. (Exception: the requirement to provide full planking or decking does not apply to platforms and walkways currently being erected or used solely by workmen performing scaffold erection or dismantling).

D. For medium-duty and more heavily loaded scaffolds, at least one board bearer (intermediate transom) shall be used in every bay at each platform level.

E. The maximum span (distance between bearers/board bearers) for solid sawn wood planks and laminated veneer lumber (LVL) planks with a thickness of 38 mm (1-1/2 inches) shall not exceed 1.5 meters (5 feet), unless the manufacturer's identification mark is clearly visible on each plank and the manufacturer's published literature permits, in accordance with Section 9.8.1, longer spans for that plank. See Figure II.9.48 and Table II.9.3.

F. The maximum span (distance between bearers/board bearers) for solid sawn wood planks and laminated veneer lumber (LVL) planks with a thickness of 50 mm (2 inches) shall not exceed 2.4 meters (8 feet), unless the manufacturer's identification mark is clearly visible on each plank and the manufacturer's published literature permits, in accordance with Section 9.8.1, longer spans for that plank. See Figure II.9.49 and Table II.9.3.

G. Planks shall be secured at both ends to prevent vertical and horizontal movement, by using fiber rope or wire lashing, clamped toeboards, or other equivalent means. This is especially important for planks less than 1.8 meters (6 feet) long. See Figure II.9.50.

H. Ends of planks shall extend beyond the centerline of their end support bearer (transom) by at least 150 mm (6 inches), unless cleated or otherwise restrained by equivalent means. See Figure II.9.51.

I. Ends of planks shall not extend more than 300 mm (12 inches) beyond the centerline of their end support bearer (transom). See Figure II.9.51.

J. Plank overlaps shall occur only over supports (i.e., bearers or board bearers). Planks lap lengths shall not be less than 300 mm (12 inches). Planks shall not be nailed together. See Figure II.9.51.

K. Planks shall be laid flush side-by-side to each other on all scaffold platforms.

L. On platforms where scaffold planks are placed end-to-end, each end shall be independently supported. (Exception: this provision does not preclude the use of common support members, such as "T" sections, to support abutting planks, or hook-on platforms designed to rest on common supports).

M. At all points of a scaffold where the planks change direction, such as turning a corner, any planks that rest on a bearer (transom) an angle other than a right angle shall be laid first, and planks which rest at right angles over the same bearer (transom) shall be laid second, on top of the first plank.

N. Each platform unit (scaffold plank, fabricated plank, fabricated deck, or fabricated platform) shall be installed so that gaps between platform units are less than 25 mm (1 inch) wide. When larger gaps are unavoidable, they shall be covered as follows:

- Gaps less than 600 mm (2 feet) in width shall be covered with at least 20-millimeter (¾-inch) thick, exterior grade plywood. Such plywood coverings shall be overlapped at least the width of the gap, 300 mm (12 inches) minimum, on both sides of the opening and held in place with cleats.
- Gaps larger than 600 mm (2 feet) in width shall be covered with properly secured (not nailed) cross planks.

O. Platforms shall be kept free of obstructions, unnecessary materials, projecting nails and other unnecessary tripping hazards (including uneven decking). Adequate space for workers to safely pass shall be provided and maintained wherever materials are placed on platforms or if any higher platform is erected thereon.

P. Platform units that have become slippery with oil, sand, or any other substance shall be cleaned, or otherwise removed and replaced, prior to continuing use.

Q. The slope of scaffold platform units (i.e., planks) shall not exceed 1 vertical to 4 horizontal.

R. Scaffold platforms, landings, and walkways shall be at least 675 mm (27 inches) (3 planks) wide, including during scaffold erection, dismantling and alteration.

S. Precautions (such as covering planks with fire retardant blankets) shall be taken to prevent wood planks from coming into contact with welding slag or open flame. Whenever a scaffold is to be erected near a heat source (such as a heater) or process equipment containing hydrocarbon material above its auto ignition temperature, use of a system scaffold with compatible fabricated metal planks is preferred, instead of using wood planks.

T. When moving platforms to the next level, the existing platform shall be left undisturbed until the next lift has been fully installed and braced prior to receiving the new platforms.

U. Scaffold materials shall not be thrown or dropped from heights.

V. Safe landings shall be provided at the top of all ladders and at least every 9 meters (30 feet) of ladder height. Landings shall be closed planked and protected by a guardrail system. See Figure II.9.52.

W. If an internal ladder is used, the access opening in a landing or platform through which the ladder passes shall be at least 675 mm (27 inches) (3 planks) wide and not less than 900 mm (36 inches) deep. See Figure II.9.27 and Figure II.9.33. Access openings through working platforms shall be protected by a sturdy guardrail system with a self-closing drop bar (at toprail height). Or, a hinged cover (trapdoor) may be used. Hinged covers shall be kept closed at all times, except when workmen are passing through.

X. If an external ladder is used, a step-through opening in the guardrail system (protected by a self-closing drop bar at toprail height) is preferred, instead of workers having to climb over or through the guardrails. The width of step-through openings in a guardrail system shall not be less than 675 mm (27 inches) or more than 760 mm (30 inches). See Figure II.9.28 and Figure II.9.54.

Y. Ladders shall not be used on top of scaffold platforms.

9.8.5 Clearances

A. Scaffold operations adjacent to overhead power lines are prohibited unless one of the following conditions are satisfied:

   1. The power line has been de-energized, relocated, or protective coverings installed to prevent accidental contact with the lines. If the power line has been de-energized, positive means (lockout/tagout) shall be used to prevent the lines from being energized until the line has been relocated or protected.

   2. Scaffolds shall not be erected, used, dismantled, altered, or moved such that they or any conductive material handled on them (i.e., scaffold tubes) might come closer to exposed and energized power lines than as follows:

Table II.9.4: Clearances Between Scaffolds and Power Lines

Insulated Lines		
Voltage	Minimum Distance	Alternatives
Less than 300 volts	1 meter (3 feet)	2 times the length of the line insulator, but never less than 3 meters (10 feet).
300 volts to 50 kV	3 meters (10 feet)	
More than 50 kV	3 meters (10 feet) plus 100 mm (4 inches) for each 1 kV over 50 kV.	
Uninsulated Lines		
Voltage	Minimum Distance	Alternatives
Less than 50 kV	3 meters (10 feet)	2 times the length of the line insulator, but never less than 3 meters (10 feet).
More than 50 kV	3 meters (10 feet) plus 100 mm (4 inches) for each 1 kV over 50 kV.	

Reference: OSHA 3150, Revised 1998, *A Guide to Scaffold Use in the Construction Industry*

B. Bases of scaffolds shall be at least 1.5 times the depth of excavation away from edges of excavations (including trenches), unless adequate precautionary measures are taken to prevent the collapse of the excavation and ensure the integrity of the scaffold foundation.

9.8.6 Raising and Lowering Materials Using Gin Wheels

A. Gin wheels should be fixed to scaffolds for purposes of raising and lowering material during scaffold construction or use.

B. The gin wheel shall be mounted on a cantilever tube projecting outward from the scaffold and shall be kept to a minimum distance, not greater than 750 mm (30 inches). The horizontal tube holding the gin wheel shall be fixed with right-angle couplers to two scaffold posts (standards). See Figure II.9.53.

C. A ring-type gin wheel is preferable. If a hook-type gin wheel is used, it shall not be hooked through a coupler; but, it shall be lashed to the supporting tube and the hook moused. In either case, the gin wheel fixing to the tube shall be prevented from slipping toward or away from the scaffold by one coupler mounted on either side of the fixing. See Figure II.9.53.

D. Materials to be raised shall be firmly attached to the gin wheel rope and shall not exceed 50 kg. (110 lbs.). Gin wheel ropes shall be of the correct size to suit the gin wheel, usually 18-mm (3/4-inch).

9.9 Requirements Common to System and Tube and Coupler Scaffolds

9.9.1 Horizontal Members

A. Every line of posts (standards) shall have runners (ledgers) installed horizontally in continuous lengths along the entire scaffold length (longitudinally) and bearers (transoms) installed in continuous lengths horizontally across the entire scaffold width (transversely), at each lift.

B. No lift height shall exceed 2 meters (6.5 feet). See Figure II.9.5.

C. Board bearers (intermediate transoms) shall be installed as required to limit plank spans to the distances specified in Section 9.8.4 (see Figures II.9.48 and II.9.49), and where necessary to accommodate differences in plank lengths. These may be removed when no longer required to support planks.

D. Bearers (transoms) and board bearers (intermediate transoms) shall be installed on top of and not underneath supporting runners (ledgers). See Figure II.9.13.

E. Bridging of scaffolds shall be as conceptually shown in Figure II.9.64.

9.9.2 Bracing

A. Vertical bracing to prevent excessive sway is necessary in both the transverse and longitudinal directions of all system and tube and coupler scaffolds for the full height of the scaffold (see Sections 9.10 and 9.11).

B. Transverse (sectional) braces shall be connected to either posts (standards) or runners (ledgers). This connection shall be as close as possible to the intersection (node point) of the bearer (transom) and post (standard), not more than 300 millimeters (12 inches) from the node point. See Figure II.9.56.

C. Longitudinal (facade) braces shall be connected to posts (standards) as close as possible to the intersection (node point) of the runner (ledger) and post (standard), not more than 300 millimeters (12 inches) from the node point. See Figure II.9.59.

* D. Brace ends may be joined together with end-to-end (sleeve) couplers, not joint pins. Alternatively, for braces subject to large tension loads, brace ends shall be overlapped by at least 300 mm (12 inches) and joined with at least two adjustable (swivel) couplers. See Figure II.9.62.

9.9.3 Tools

Tools that are recommended by the scaffolding manufacturer shall be used during scaffold erection and dismantling.

9.10 System Scaffolds

A. All system scaffolds shall be erected per the manufacturer's published instructions and the requirements of this Manual. See Figure II.9.63.

B. Components from different scaffold manufacturers shall not be intermixed (except bracing as noted below).

C. Unless otherwise specified in manufacturer's instructions, all system scaffolds shall be vertically braced in both directions with diagonal braces (as close to 45 degrees as possible) to its full height for each 10 meters (33 feet) of run.

D. Bracing for system scaffolds shall be specially designed for the grid size of the scaffold. However, where specially designed system bracing cannot be used, tube and coupler scaffold components may be used for bracing of system scaffolds.

E. Connections shall be tightened with a single hammer blow to the wedge or cup to provide high degree of rigidity.

F. Unless otherwise permitted by Loss Prevention, posts (standards), runners (ledgers), and bearers (transoms) shall be connected by means of one of the following fastening methods:

- Captive wedge system (such as Saudi Scaffolding Factory "Kwikstage")
- Quick-fix system (such as Layher "All-round")
- Cup locking system (such as SGB "Cuplock")

G. The locking-pin type of system scaffold shall not be used. See Figure II.9.32.

H. Posts (standards) shall be connected by bolted spigots and shall be secured into place using two spigot pins for situations where uplift may occur. The upper post (standard) shall slide over the spigot. See Figure II.9.15.

I. Correct lengths of runners (ledgers), bearers (transoms), and lift heights shall be used as required for load rating of the scaffold. The applied loads on posts (standards), runners (ledgers), bearers (transoms), and diagonal braces shall not exceed the load carrying

capacity of the manufacturer's specifications.

J. Properly designed system scaffolds are suitable for Light-duty, Medium-duty, or Special-duty loading.

K. Unless otherwise justified and stated in writing by the system scaffold manufacturer, the maximum number of working levels and total planked levels shown in Tables II.9.7 and II.9.8 shall also apply to system scaffolds with the applicable load rating.

L. System scaffold components shall not be used to construct underhung scaffolds.

9.11 Tube and Coupler Scaffolds

9.11.1 Posts (Standards)

A. Joints in posts (standards) shall be staggered. Joints in adjacent posts shall not occur in the same lift height. See Figure II.9.65.

B. Joint pins or, preferably, end-to-end (sleeve) couplers shall be used for joints in posts (standards). However, joint pins are only designed for compression load. End-to-end (sleeve) couplers shall be used where tension (uplift) can be present in a post (standard) or other scaffold tube.

9.11.2 Runners (Ledgers) and Bearers (Transoms)

A. Runners (ledgers) and bearers (transoms) shall be securely fixed to the inside of each post (standard). See Figure II.9.2.

B. Runners (ledgers) shall be connected to posts (standards) only with right-angle (load bearing) couplers.

C. When bearers (transoms) are coupled to posts (standards), the bearer shall be connected to the posts only with right-angle (load bearing) couplers. The bearer's couplers shall rest directly on the runners' (ledgers') right-angle couplers.

D. When a bearer (transom) is coupled to a supporting runner (ledger), the coupler shall be as close as possible to the post (standard), never more than 300 mm (12 inches) from the post.

E. When bearers (transoms) and board bearers (intermediate transoms) are coupled to runners (ledgers) they shall always be installed on top of the supporting runners and shall not be installed to hang from the runners.

F. At lifts to be planked, right-angle (load bearing) couplers should *not* be used to attach bearers (transoms) or board bearers (intermediate transoms) to runners (ledgers), because the coupler bolts may interfere with proper placement of planks. Instead, bearer (putlog) couplers should be used. See Figure II.9.13.

G. Bearers (transoms), including board bearers (intermediate transoms), shall extend at least 100 mm (4 inches) beyond the runner centerline and shall provide full contact with the couplers.

H. The lowest runners and bearers (base lift) shall be located approximately 150 mm (6 inches) above the scaffold base, except where this is not possible. See Figure II.9.5 and Figure II.9.6.

I. Runners (ledgers) or bearers (transoms) shall not have more than one joint between adjacent posts (standards). Such joints shall be located as close as possible to a post (standard) and shall be staggered (adjacent joints shall not occur in the same bay). See Figure II.9.65.

J. End-to-end (sleeve) couplers may be used for joints in runners (ledgers) or bearers (transoms). In this case, the joint shall *not* be located more than 300 mm (12 inches) from a post (standard).

K. Alternatively, joints in runners (ledgers) or bearers (transoms) may be made by abutting the runner or bearer ends together and overlapping these ends with a separate parallel tube at least 600 mm (24 inches) long. This parallel tube shall be coupled to each abutted runner or bearer end with at least two equally spaced adjustable (swivel) couplers (min. four total couplers per joint). In this case, the joint shall *not* be located in the middle third of the runner or bearer span. See Figure II.9.67.

* L. Right angle (double) couplers shall be installed such that the load is against the hinge flap and not against the bolt. See Figure II.9.66.

M. Scaffold couplers shall be tightened to the torque as indicated by the manufacturer, preferably between 40 kg-m (30 ft.-lbs.) and 80 kg-m (60 ft.-lbs.). Only proper scaffold spanner wrenches shall be used. “Cheater bars” or longer handled wrenches shall not be used, as they give greater leverage than proper scaffold spanner wrenches and could damage the coupler.

9.11.3 Vertical Bracing

A. Transverse (sectional) “zig-zag” bracing: The first diagonal brace shall be installed from the base of the first post (standard) diagonally upward to the first lift at whichever post (standard) is required to make the angle of the diagonal brace be between 35 and 55 degrees (may be across two bays in one lift height). Additional diagonal braces shall then be installed in alternating directions (“zig-zag”) until reaching the top of the scaffold. For wide scaffolds, this transverse “zig-zag” bracing shall be repeated across the width of the scaffold such that no more than 3 adjacent bays are open without transverse bracing. This set of transverse “zig-zag” braces shall be installed at both scaffold ends and repeated along the length of the scaffold at least every third line of posts (standards). See Figures II.9.4, II.9.55, and II.9.56.

* Denotes change

B. Transverse (sectional) “X” bracing: The first two diagonal braces are installed forming an “X” shape. Thus, the first brace is installed from the base of the first post (standard) diagonally upward to the first lift at the post (standard) required for the brace to be between 35 and 55 degrees (may be across two bays in one lift height). The second brace is installed from the base of this same post (standard) diagonally upward to the first post (standard). This “X” bracing should be repeated up the height of the scaffold at least every third lift (two adjacent open lift heights permitted). For wide scaffolds, such transverse “X” bracing shall be repeated across the width of the scaffold such that no more than 3 adjacent bays are open without transverse bracing. This set of transverse “X” braces shall be installed at both scaffold ends and repeated along the length of the scaffold at least every third line of posts (standards). See Figures II.9.3, II.9.57, and II.9.58.

C. Longitudinal (facade) bracing for a scaffold whose length is greater than its height: A diagonal brace shall be installed from the base of the first end post (standard) diagonally upward, at between 35 and 55-degrees, to the extreme top of the scaffold. This longitudinal bracing shall be repeated along the length of the scaffold at least every 5th post (standard). See Figure II.9.59. This longitudinal (facade) bracing shall be installed, in opposite directions, along the front (inner) and rear (outer) lines of posts (standards).

D. Longitudinal (facade) bracing for a scaffold whose length is less than its height: The first diagonal brace shall be installed from the base of the first end post (standard) upward, at between 35 and 55 degrees, along the entire length of the scaffold to the last end post (standard). Additional diagonal braces shall then be installed, at between 35 and 55 degrees, in alternating directions (“zig-zag”) across the entire scaffold length until reaching the top of the scaffold. See Figure II.9.60. This set of longitudinal (facade) braces shall be installed along the front (inner) and rear (outer) lines of posts (standards).

E. Interior longitudinal “zig-zag” bracing for a scaffold with multiple bays across its width (“birdcage” scaffold): The first diagonal brace shall be installed from the base of the first post (standard) diagonally upward, at between 35 and 55 degrees, to the second post (standard) at the first lift (across one bay in one lift height). Additional diagonal braces shall then be installed in alternating directions (“zig-zag”) until reaching the top of the scaffold. Such longitudinal “zig-zag” bracing shall be repeated along the length of the scaffold such that no more than 4 adjacent bays are open without longitudinal braces. This set of longitudinal “zig-zag” braces shall be repeated across the width of the scaffold at least every third line of posts (standards). See Figure II.9.61.

9.11.4 Light-duty Tube and Coupler Scaffolds

A. For Light-duty tube and coupler scaffolds constructed entirely of tubing manufactured and embossed (stamped) in accordance with Section 9.7.2, the permitted transverse post spacing (bearer/transom span) and corresponding maximum longitudinal post spacing (runner/ledger span) shall be as shown in Table II.9.5. See Figure II.9.68 and Figure II.9.69.

Table II.9.5: *Embossed* Light-duty Tube and Coupler Scaffold Post Spacing

Embossed Tubing	Number of 225mm (9") wide planks per bay width	Transverse Post Spacing (Bearer/Transom Span)	Longitudinal Post Spacing (Runner/Ledger Span)
Option 1	4	1.0 m (3.25 ft.)	2.7 m (9.0 ft.) max.
Option 2	5	1.2 m (4.0 ft.)	2.4 m (8.0 ft.) max.

B. For Light-duty tube and coupler scaffolds constructed using any tubing which is NOT embossed (stamped) in accordance with Section 9.7.2, the permitted bearer (transom) spans and the corresponding maximum runner (ledger) spans shall be reduced and shall be as shown in Table II.9.6. See Figure II.9.70 and Figure II.9.71.

Table II.9.6: *Non-Embossed* Light-duty Tube and Coupler Scaffold Post Spacing*

Non-embossed Tubing	Number of 225mm (9") wide planks per bay width	Transverse Post Spacing (Bearer/Transom Span)	Longitudinal Post Spacing (Runner/Ledger Span)
Option 1	4	1.0 m (3.25 ft.)	2.3 m (7.5 ft.) max.
Option 2	5	1.2 m (4.0 ft.)	1.8 m (6.0 ft.) max.

* Based on 48.3 mm O.D., 3.2 mm wall thickness, Fy=235 N/mm^2 (34 ksi), steel tubing.

C. Larger post spacing may be used if justified (per Section 9.8.1) by structural calculations or load tests submitted for review per GI 8.001, along with material tensile/yield stress test reports for the specific scaffold tubing to be used.

D. All Light-duty tube and coupler scaffolds may have a maximum of three working levels in use at any one time only when there are no additional levels where platform units (i.e., planks) are installed. The maximum total number of levels that can be planked at one time depends on the number of working levels simultaneously being used by workers and shall be as shown in Table II.9.7. The maximum uniformly distributed load on each working level shall be 120 kg/m^2 (1.2 kN/m^2) (25 lb./ft^2).

Table II.9.7: Light-duty Tube and Coupler Scaffolds

Maximum Number of Working Levels	Max. Total Number Planked/Platformed Levels	Maximum Scaffold Height
1	9	38 m (125 ft.)
2	6	38 m (125 ft.)
3	3	28 m (91 ft.)

Reference: GS 217/1994, Table 8.

E. Light-duty tube and coupler scaffolds requiring more than the above working or planked levels, or over the maximum heights shown in Table II.9.7, shall be classified as a Special Scaffold and shall be properly designed and reviewed per GI 8.001. Preferably, a properly designed system scaffold should be used instead of tube and coupler construction for scaffolds over 38 meters (125 ft.) tall.

9.11.5 Medium-duty Tube and Coupler Scaffolds

A. All tubing used to construct Medium-duty and more heavily loaded tube and coupler scaffolds shall be manufactured and embossed (stamped) in accordance with Section 9.7.2. Scaffold tubing that is not properly embossed shall not be used for Medium-duty or more heavily loaded tube and coupler scaffolds.

B. For Medium-duty tube and coupler scaffolds constructed entirely of tubing manufactured and embossed in accordance with Section 9.7.2, the maximum transverse post spacing (bearer/transom span) is 1.2 meters (4 feet) and the maximum longitudinal post spacing (runner/ledger span) is 1.8 meters (6 feet). See Figure II.9.72.

C. Larger post spacing may be used if justified (per Section 9.8.1) by structural calculations or load tests submitted for review per GI 8.001, along with material tensile/yield stress test reports for the specific scaffold tubing to be used.

D. At least one board bearer (intermediate transom) shall be installed in each bay of every platform (planked) level. Alternately, double bearers may be used only if the maximum allowable plank spans in Section 9.8.4 are not exceeded. See Figure II.9.72 and Figure II.9.73.

E. Medium-duty tube and coupler scaffolds may have a maximum of two working levels in use at any one time only when there are no additional levels where platform units (i.e., planks) are installed. However, when only one working level is being used, a maximum of six additional levels may be planked if they are not being used at the same time. The maximum distributed load on each working level shall not exceed 240 kg/m^2 (2.4 kN/m^2) (50 lb./ft^2).

Table II.9.8: Medium-duty Tube and Coupler Scaffolds

Maximum Number of Working Levels	Max. Total Number Planked/Platformed Levels	Maximum Scaffold Height
1	7	38 m (125 ft.)
2	2	24 m (78 ft.)

Reference: GS 217/1994, Table 9.

F. Medium-duty tube and coupler scaffolds requiring more than the above working or planked levels, or higher than the maximum heights shown in Table II.9.8, shall be classified as a Special Scaffold and shall be properly designed and reviewed per GI 8.001. Preferably, a properly designed system scaffold should be used instead of tube and coupler construction for scaffolds over 38 meters (125 ft.) tall.

9.12 Mobile and Tower Scaffolds

9.12.1 Mobile and Tower Scaffold Construction

A. Mobile and tower scaffolds shall be plumb, level, and square and be horizontally and vertically braced (in both directions) by diagonal braces. See Figures II.9.27, II.9.28, II.9.29, and II.9.33.

B. Plan (horizontal) bracing shall be installed at the base, at the top, and at least every third lift of all mobile and tower scaffolds to prevent racking (twisting). See Figure II.9.27 and Figure II.9.33.

C. Light-duty tube and coupler mobile and tower scaffolds (used only for personnel access and inspection) that are one bay long by one bay wide (only 4 posts) and constructed entirely of steel tubing manufactured and embossed per Section 9.7.2 shall have a maximum post spacing of 2 meters (6.5 feet) in both directions. In this case, at least two equally spaced board bearers (intermediate transoms) shall be used.

D. Light-duty tube and coupler mobile and tower scaffolds that are one bay long by one bay wide (only 4 posts) and constructed with steel tubing that is NOT manufactured and embossed per Section 9.7.2 shall have a maximum post spacing of 1.7 meters (5.5 feet) in both directions.

E. Medium-duty tube and coupler mobile and tower scaffolds that are one bay long by one bay wide (only 4 posts) shall be entirely constructed of steel tubing manufactured and embossed per Section 9.7.2 and shall have a maximum post spacing of 1.5 meters (5 feet) in both directions.

F. For mobile scaffolds, an internal ladder with a cover (preferably hinged) over the access hole in the platform is preferred over an external ladder. If an external ladder must be used, it shall be installed vertically on the narrow side of the scaffold (to minimize the potential for overturning) and a step-through opening in the guardrail system (protected by a self-closing drop-bar at toprail height) shall be provided, instead of workers having to climb over the guardrails.

G. Where leveling of a mobile or tower scaffold is necessary, screwjacks shall be used.

H. Mobile scaffolds rated for Light-duty shall have steel casters not less than 120 mm (5 inches) in diameter.

I. Mobile scaffolds rated for Medium-duty shall have heavy-duty steel casters not less than 170 mm (7 inches) in diameter.

J. All casters shall be fitted with a positive wheel lock (which cannot be accidentally released) to prevent movement while the mobile scaffold is being used. See Figure II.9.30.

K. Casters shall be securely fixed to the base of scaffold posts or screwjacks by locking pins.

L. The working area of any platform shall not extend outside the scaffold base dimensions. Cantilevered working areas are not permitted for mobile or tower scaffolds.

M. Platform units (planks) shall be securely fixed in position.

N. The uppermost work platform height shall not exceed 4 times the minimum base dimension of any mobile or tower scaffold. Where the basic scaffold does not meet this requirement, outriggers shall be installed on the scaffold to achieve this least base dimension, or provisions (such as guys, ties, or rakers) shall be taken to stabilize the scaffold against tipping.

O. A complete guardrail system shall be provided at every platform, per Section 9.5.2.

9.12.2 Mobile Scaffold Operation

A. A mobile scaffold shall only be used and moved on surfaces sufficiently firm and level to ensure stability. Where the scaffold is to be used on an elevated floor or roof, it shall be designed to apply loads no greater than the capacity of the floor or roof.

B. A mobile scaffold shall be moved only by manually pushing or pulling at the base. Force shall not be applied at a height greater than 1.5 meters (5 feet) above the supporting surface.

C. No men, equipment, or materials shall be on the working platform or elsewhere on the scaffold while it is in motion.

D. Casters shall be locked at all times except during scaffold movement.

E. Temporary foundations or tracks shall be properly set in place on soft or uneven ground to facilitate movement of the mobile scaffold. The temporary foundation or track shall be level and properly secured.

9.13 Fabricated Tubular Frame Scaffolds

A. All fabricated tubular frame scaffolds shall be erected per the manufacturer's published instructions and the requirements of this Manual.

B. Fabricated tubular frame scaffolds shall not be used for a loading greater than a Light-duty loading of 120 kg/sq.m (1.2 kN/m^2) (25 lb./ft^2).

C. The maximum height of fabricated tubular frame scaffolds shall be 6 meters (20 feet).

D. Components from different scaffold manufacturers shall not be intermixed.

E. Each frame must have flip-lock fittings, in good condition, for the attachment of horizontal members (i.e., guardrails) and diagonal members (i.e., bracing).

F. Scissor (cross) bracing shall be installed on both sides in every bay between each lift.

G. A complete guardrail system shall be provided at every platform, per Section 9.5.2.

9.14 Bracket Scaffolds

9.14.1 Brackets and Straps

A. Brackets and bracket straps shall be constructed and erected in accordance with the manufacturer's instructions and this Manual, using the minimum dimensions shown in Figure II.9.26.

B. Bracket scaffolds shall only be used to support a Light-duty loading of 120 kg/sq.m. (1.2 kN/sq.m) (25 pounds/sq.ft.).

C. Brackets, bracket straps and other associated structural members shall be free from detrimental corrosion, damage, or defects.

D. Bracket straps, welded to the tank wall, shall be at least 250 mm (10 inches) wide x 75 mm (3 inches) high x 10 mm (3/8-inch) thick, with bends at the center for inserting brackets. The gap created by the bent section of the bracket strap must be compatible in size with the bracket to be inserted, with a 3 mm (1/8-inch) maximum clearance on the front or back faces.

E. Bracket straps shall be welded to the tank shell for a length of at least 150 mm (6 inches) along the top edge of the strap (two 75 mm welds min.) and down 25 mm (1 inch) along each side of the strap, with a 5 mm (3/16 inch) fillet weld. No weld is required along the bottom edge of the bracket straps. See Figure II.9.26.

F. If 38 mm (1-1/2 inch) thick wood planks are used, the maximum circumferential distance between brackets shall not be more than 1.5 meters (5 feet) on center. Except as noted in the following paragraph, if 50 mm (2-inch) thick wood planks are used, the maximum circumferential distance between brackets shall not be more than 2.4 meters (8 feet) on center.

G. Only if all brackets (frames), platform units (planks), etc. are certified to meet all requirements in OSHA 1926.450, Appendix A, Section 2(z), “Tank builder’s scaffold,” the maximum circumferential distance between brackets may be 3.2 meters (10’-6”) on center. In this case, planks shall be full-dimensioned 50 mm (2-inch) thick by 300 mm (12-inch) wide Douglas Fir or Southern Yellow Pine of Select Structural Grade or Scaffold Grade.

H. Brackets shall be installed vertically.

I. Only welders certified by Saudi Aramco shall weld bracket straps to the tank wall.

J. Prior to welding on any tank, approval of welding procedures and verification of tank integrity is required from the Proponent’s Engineering Unit.

K. Prior to attaching the bracket, completed bracket strap welds shall be inspected and approved by a welding inspector who is certified by Saudi Aramco.

L. Brackets shall be inspected prior to installation by scaffold craftsmen and prior to each use by scaffold users. Damaged or defective brackets shall be removed from service.

9.14.2 Guardrails and Platforms for Bracket Scaffolds

A. A continuous guardrail system shall be provided along the outside platform edge.

B. A guardrail system shall be provided on the inside platform edge wherever the gap between the platform and the tank exceeds 360 mm (14 inches).

C. Guardrails for bracket scaffolds shall be constructed using either wire rope or steel tubing. Wire rope guardrails shall be 10 mm (3/8-inch) diameter and shall be securely fixed and kept tight (i.e., by the use of turnbuckles). Steel tubing shall meet the capacity requirements of 9.5.2(E) and there shall be no end-to-end connections occurring anywhere but at the guardrail support uprights.

D. Guardrail support uprights shall be made of scaffold grade tubing or structural angles. Preferably, these uprights are to be permanently welded to the brackets. However, an acceptable alternative is for each upright to be firmly secured into a 150 mm (6-inch) minimum high sleeve or spigot pin, either of which is welded to the bracket.

E. Guardrails and support uprights that are certified to meet OSHA 1925.450, Appendix A, Section 1(d) may be used for bracket scaffolds.

F. Guardrail support uprights shall be constructed to such that the toprail is at least 0.95 meter (38 inches) and not more than 1.15 meters (45 inches) above the walking surface.

G. In addition to wearing hardhats, each person shall be provided with additional protection from falling objects through one or more of the following means:

- barricading the area below into which objects can fall and not permitting workers to enter the hazard area, or
- installing toeboards with or without screens, or
- erection of debris nets, catch platforms, or canopy structures sufficient to catch falling objects.

H. Toeboards, where used, shall be installed per Section 9.5.4. Toeboards shall not be nailed into scaffold planks.

I. All working levels shall be fully planked. Working levels shall be at least 2 planks but not more 3 planks wide.

J. Planks shall overlap in one direction only and the minimum overlap shall be 230 mm (9 inches).

K. Platform units and planks shall be secured to the brackets in a manner that will prevent movement.

L. The area below bracket scaffolds shall be barricaded and warning signs posted.

9.15 Underhung Scaffolds

9.15.1 Criteria for Underhung Scaffolds

A. All underhung scaffolds shall be hung from structures capable of supporting at least 4 times the load imposed on them by the scaffold.

B. A guardrail system shall be provided per Section 9.5.2.

9.15.2 Underhung Scaffolds Suspended by Tubes and Couplers

A. Suspension points of hanger tubes shall be securely fixed to prevent their being dislodged by all potential forces acting upon them.

B. When a hanger tube is coupled to a horizontal tube that is placed across the top of a supporting beam, a second horizontal tube shall be attached underneath the supporting beam with a pair of girder couplers. Both horizontal tubes shall be attached to the hanger tube with right-angle couplers. See Figure II.9.34.

C. Check (safety) couplers shall be installed at the tops and bottoms of all hanger tubes. Check (safety) couplers shall also be installed directly beneath all trapeze tubes. See Figure II.9.34.

D. Whenever possible vertical hanger tubes should be in one length. Where joints are necessary, the tubes should be single lapped using at least four couplers. See Figure II.9.34.

E. Trapeze tubes shall be installed approximately 600 millimeters (2 feet) below the runners (ledgers) to assist in erection, modification and dismantling, and also to serve as a secondary support should the runner slip. See Figure II.9.34.

F. Runners (ledgers) and bearers (transoms) shall be coupled to hanger tubes using right-angle (not adjustable) couplers.

G. Hanger tube spacing shall comply with the tube and coupler post spacing requirements for the load duty of scaffold (see Sections 9.11.4 and 9.11.5).

H. At least one board bearer (intermediate transom) shall be installed when the hanger tube spacing is more than 1.5 meters (5 feet) apart in the longitudinal direction.

I. Only drop-forged girder couplers shall be used for the support of hanging scaffolds. Pressed girder couplers shall not be used for the support of hanging scaffolds.

9.15.3 Underhung Scaffolds Suspended by Wire Rope

A. A working platform shall have at least six suspension points evenly spaced and kept taut, and shall be tied or otherwise secured to prevent it from swaying.

B. Each wire rope or cable suspending an underhung scaffold, including connecting hardware, shall be capable of supporting, without failure, at least 6 times the maximum intended load applied or transmitted to that rope.

C. Wire suspension ropes shall be minimum 9 mm (3/8-inch) diameter.

D. When an underhung scaffold is suspended by wire rope, such wire rope shall be wrapped at least twice around the supporting members and twice around the bearers (ledgers) of the scaffold.

E. Softeners shall be used to prevent rubbing action between wire suspension ropes and supporting members and to protect supporting members.

F. Splices in wire ropes used to support an underhung scaffold are not permitted.

G. The use of repaired wire rope to suspend an underhung scaffold is prohibited.

H. Wire ropes shall be inspected for defects prior to each workshift and after every occurrence, which could affect a rope's integrity. Wire ropes shall be replaced, including if any of the following conditions exist:

- Any physical damage that impairs the function or strength of the rope.
- Abrasion, corrosion, scrubbing, flattening or peening which has caused loss of more than one-quarter of the original diameter of the outside wires.
- Heat damage caused by a torch or any damage caused by contact with electrical wires.

I. Spacing of wire ropes used to carry the scaffold load shall comply with the post spacing requirements for the duty of scaffold (see Sections 9.11.4 and 9.11.5).

J. Suspension wire ropes shall be shielded from heat-producing processes. When acids or other corrosive substances are used on a scaffold, the ropes shall be shielded, treated to protect against the corrosive substances, or shall be of a material that will not be damaged by the substance being used.

K. Underhung scaffolds supported by wire ropes shall be tied or otherwise secured to prevent them from swaying.

9.15.4 Use of Wire Rope Clips

A. There shall be a minimum of 3 clips installed at the load end and 3 clips installed at the attachment end of each wire rope. Clips shall be spaced a minimum of 6 rope diameters apart.

B. Clips shall be installed according to the manufacturer's recommendations. Clips shall be retightened to the manufacturer's recommendations after initial loading.

C. Clips shall be inspected and retightened to the manufacturer's recommendations at the start of each work shift thereafter.

D. When wire rope clips are used, the U-bolt shall be placed over the dead end of the rope, and the saddle (bridge) shall be placed over the live (loaded) end of the rope. ("Don't saddle a dead horse.")

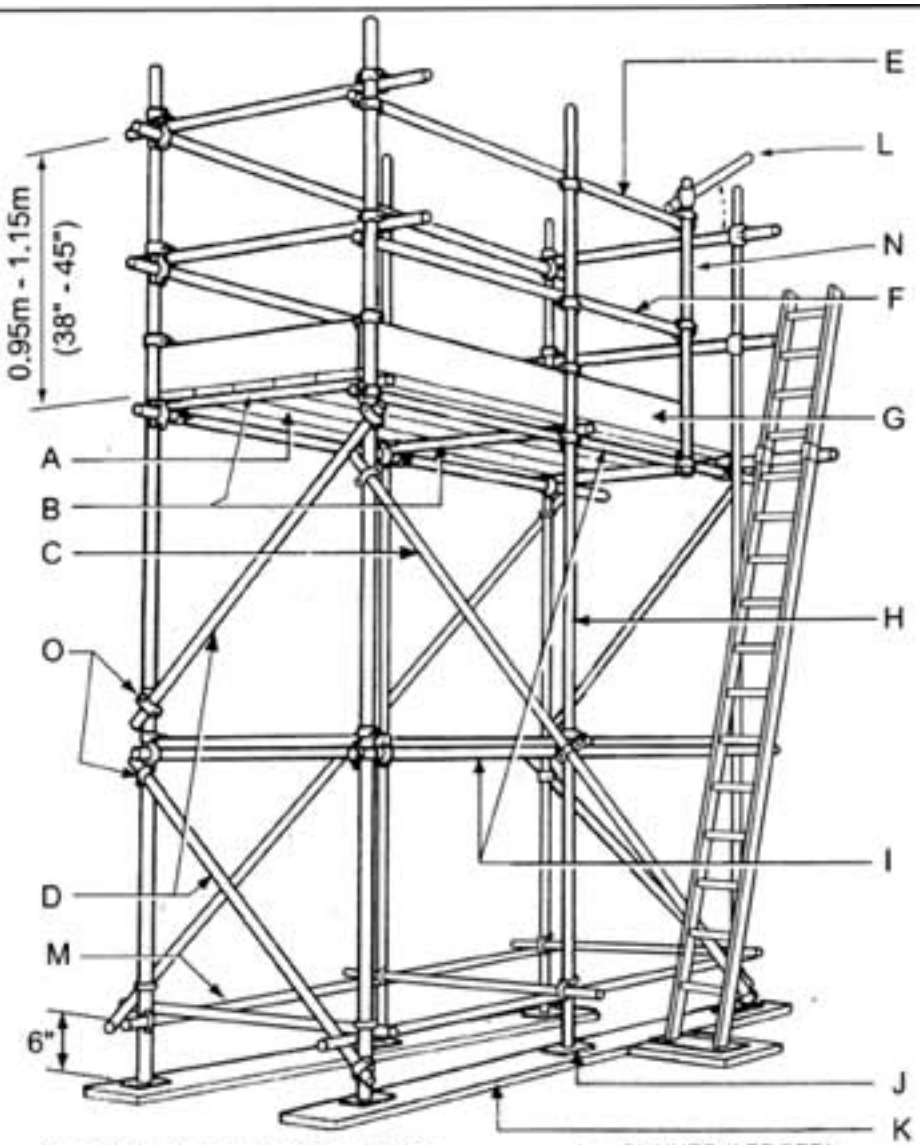
9.15.5 Welding From Underhung Scaffolds Suspended by Wire Ropes

To reduce the possibility of welding current flowing through the suspension wire rope when performing welding from underhung scaffolds, the following precautions shall be taken, as applicable:

- An insulated thimble shall be used to attach each suspension wire rope to its support. Additional independent lines to provide grounding shall be insulated.
- All suspension wire rope shall be covered with insulating material extending at least 1.2 meters (4 feet) above the working platform.
- In addition to a work lead attachment required by the welding process, a grounding conductor shall be connected from the scaffold to the structure. The size of this conductor shall be at least the size of the welding process work lead, and this conductor shall not be in series with the welding process or the work piece.
- If the scaffold grounding lead is disconnected at any time, the welding machine shall be shut off.
- An active welding rod or uninsulated welding lead shall not be allowed to contact the scaffold or its suspension system.

Note: Some of the Figures herein have been reproduced, with permission, from *A Guide to Practical Scaffolding*, published by the Construction Industry Training Board (CITB).

END OF SECTION



A) SCAFFOLD PLANKS (BOARDS)
B) BEARER (TRANSOM)
C) LONGITUDINAL (FACADE) BRACING
D) TRANSVERSE (SECTIONAL) BRACING
E) TOPRAIL
F) MIDRAIL
G) TOEBOARD
H) POST (STANDARD)
I) RUNNER (LEDGER)
J) BASE PLATE
K) SILL (SOLE BOARD)
L) SELF-CLOSING DROP BAR (INSIDE POSTS)
M) BASE LIFT (KICKER LIFT)
N) FALSE UPRIGHT (PUNCHEON)
O) COUPLER

Figure II.9.1
SCAFFOLD TERMINOLOGY

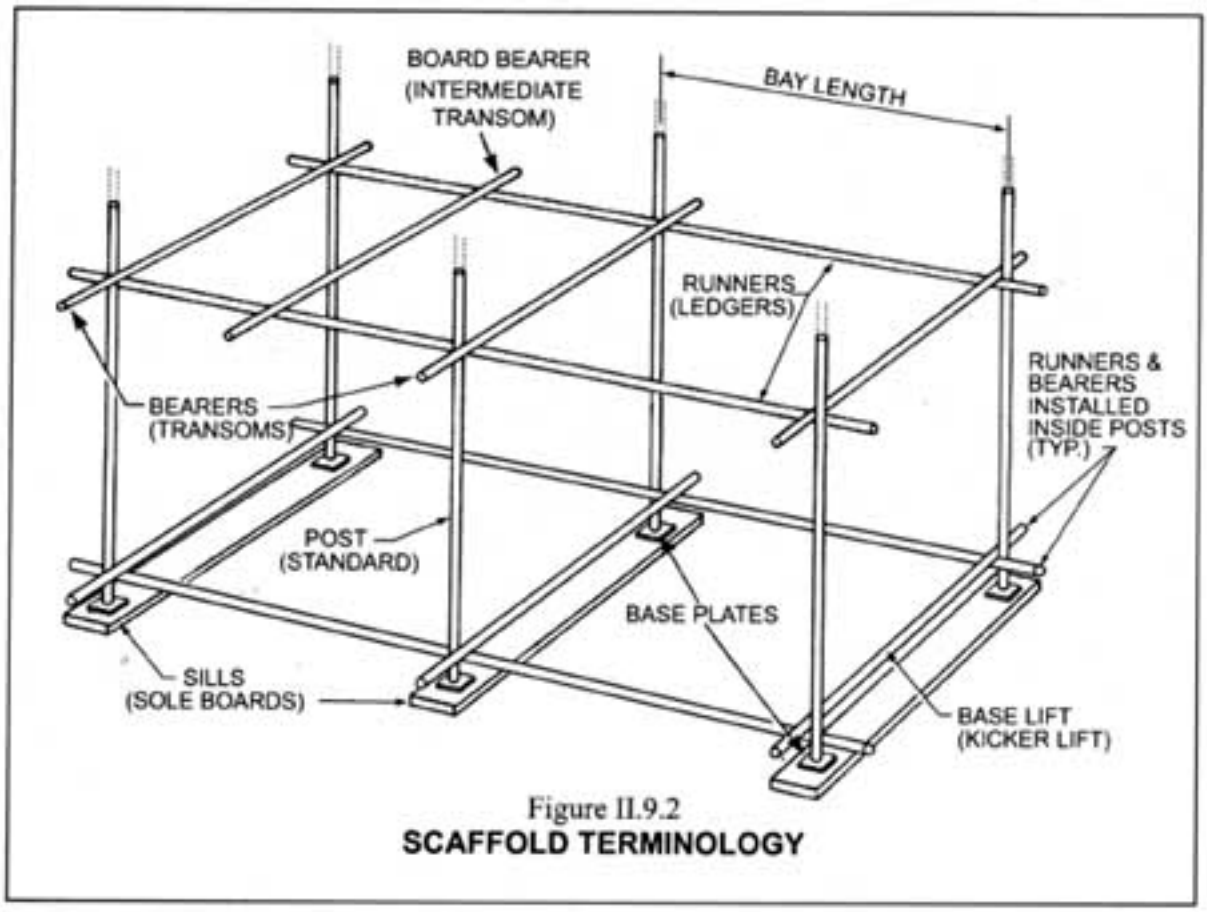


Figure II.9.2
SCAFFOLD TERMINOLOGY

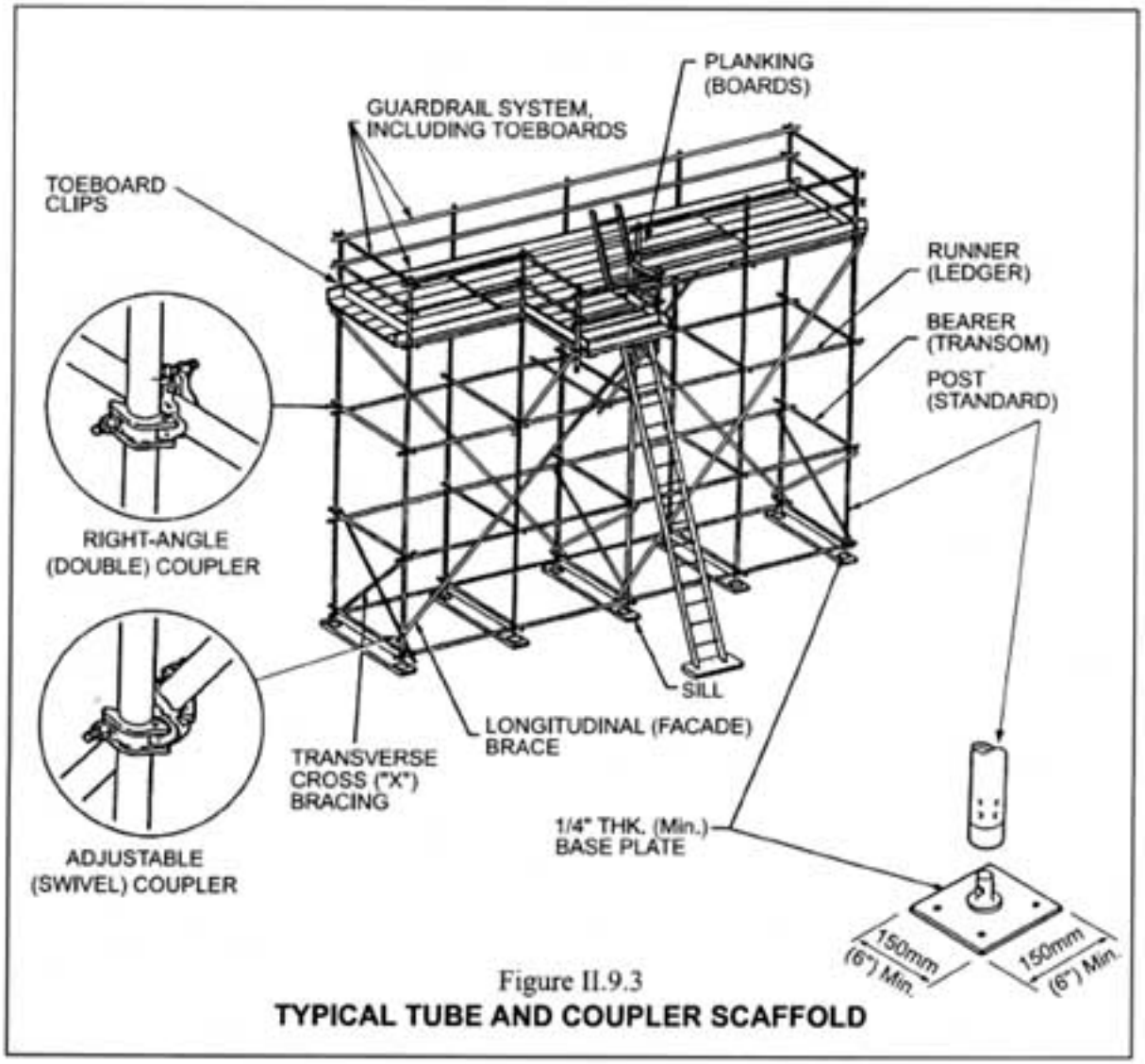


Figure II.9.3

TYPICAL TUBE AND COUPLER SCAFFOLD

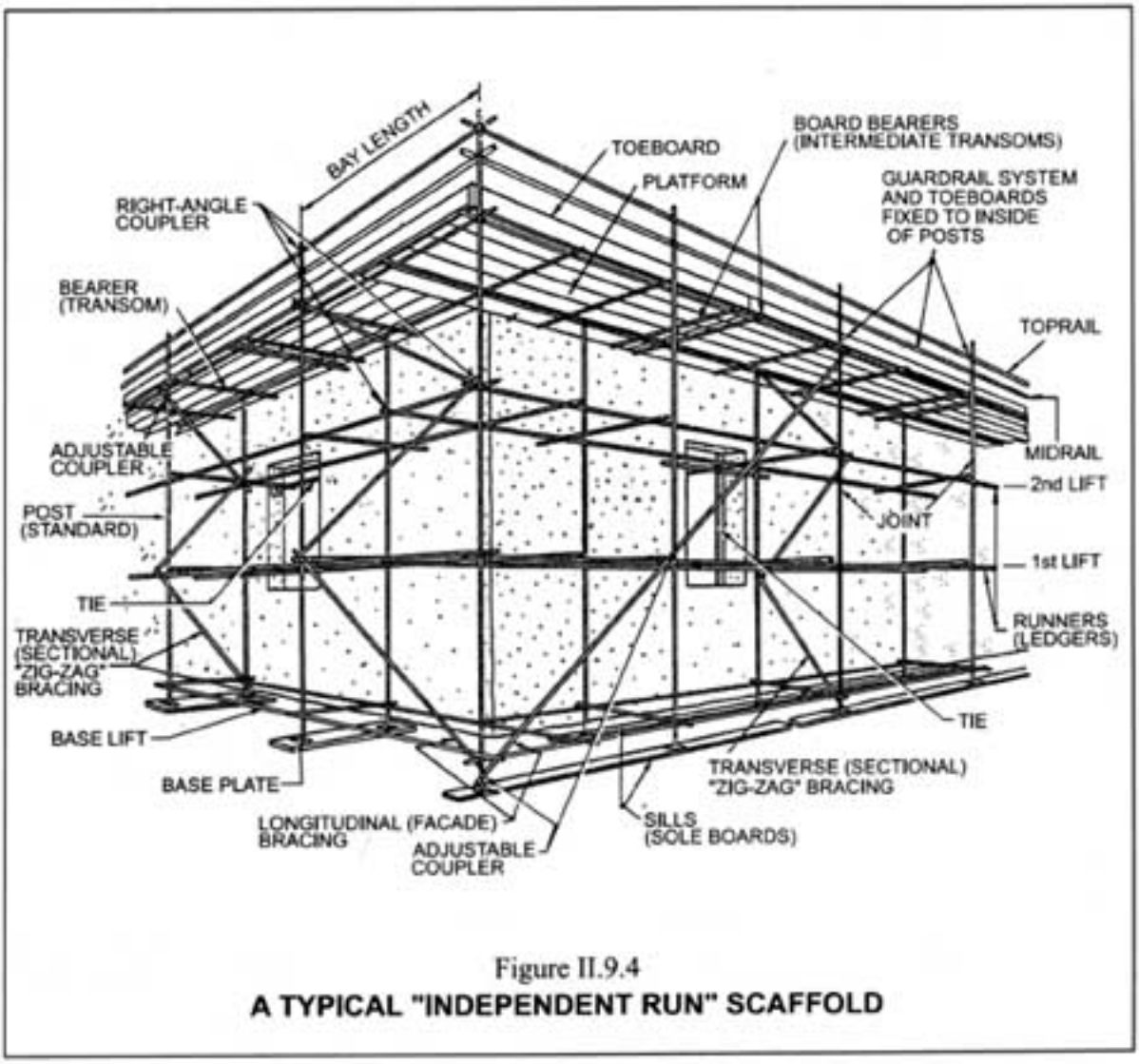


Figure II.9.4
A TYPICAL "INDEPENDENT RUN" SCAFFOLD

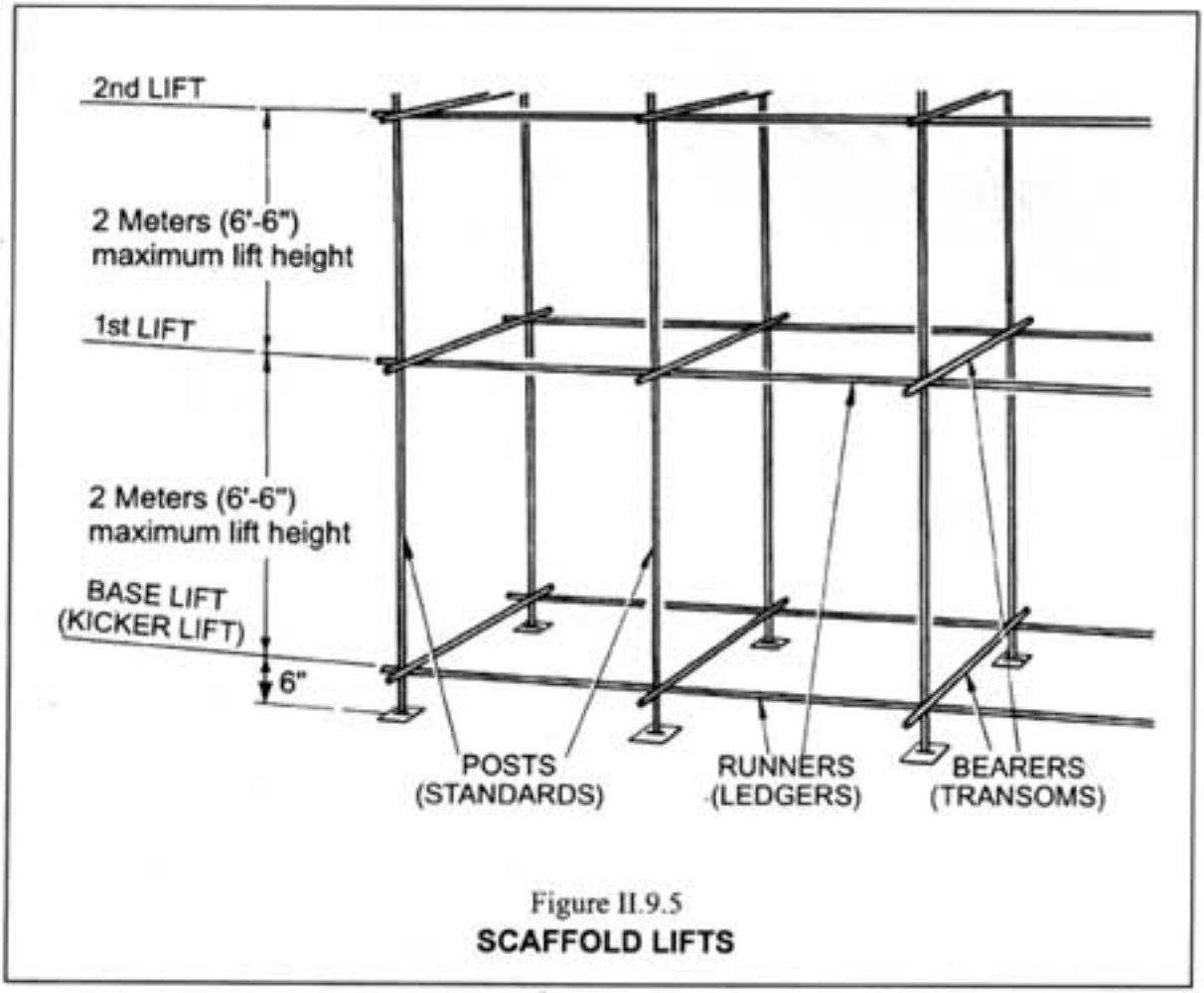


Figure II.9.5
SCAFFOLD LIFTS

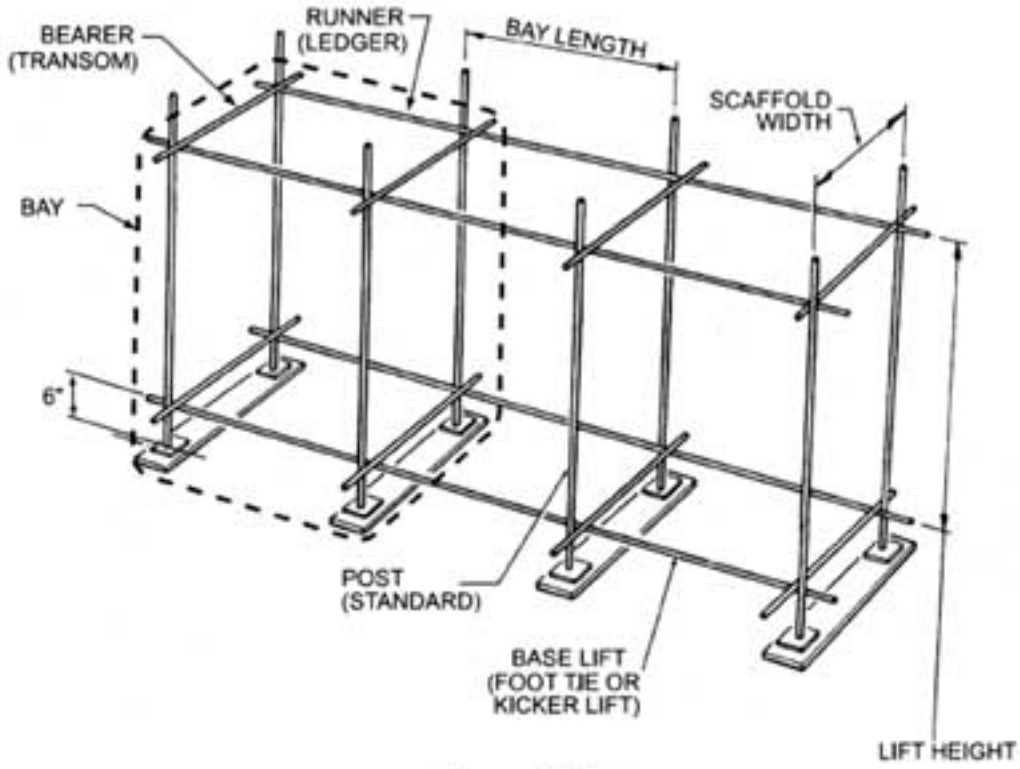


Figure II.9.6
SCAFFOLD MEASUREMENTS

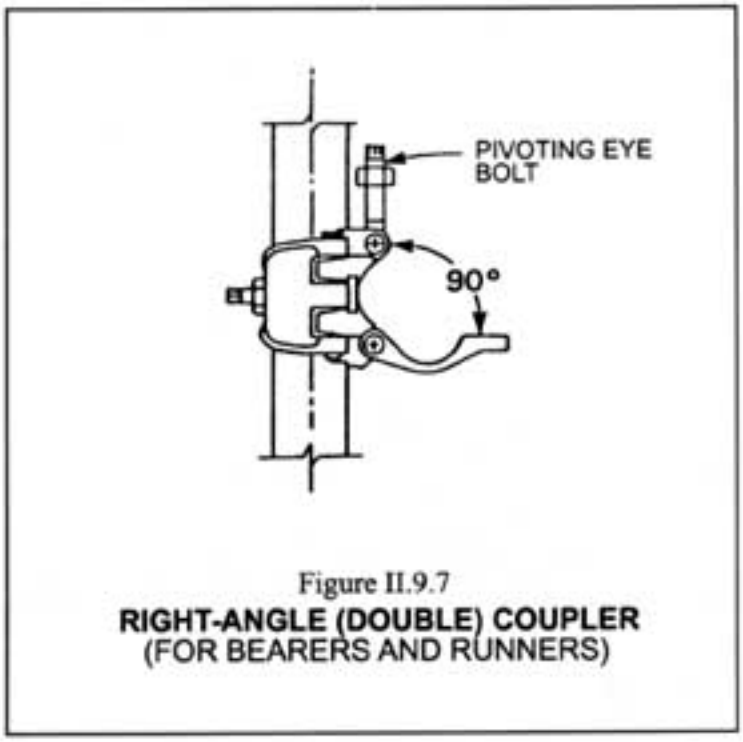


Figure II.9.7
RIGHT-ANGLE (DOUBLE) COUPLER
(FOR BEARERS AND RUNNERS)

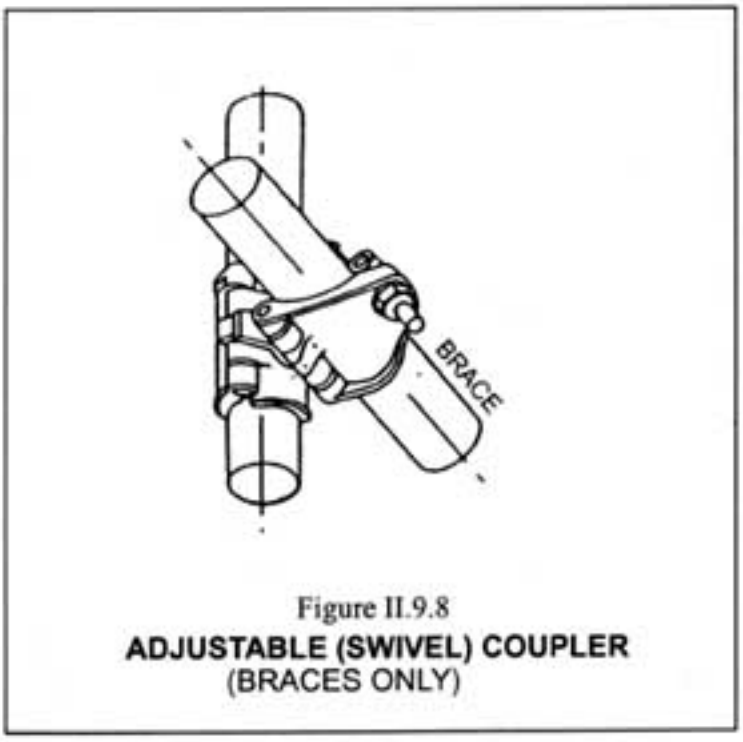


Figure II.9.8
ADJUSTABLE (SWIVEL) COUPLER
(BRACES ONLY)

Figure II.9.9
TYPICAL END-TO-END (SLEEVE) COUPLER

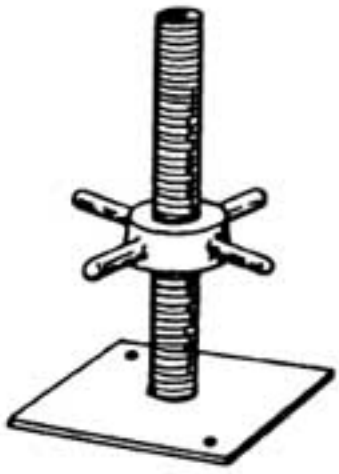


Figure II.9.10
TYPICAL SCREWJACK

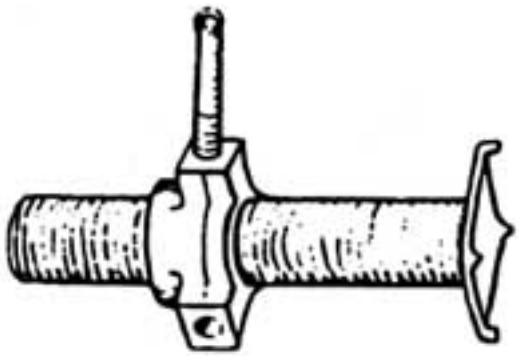


Figure II.9.11
TYPICAL REVEAL PIN

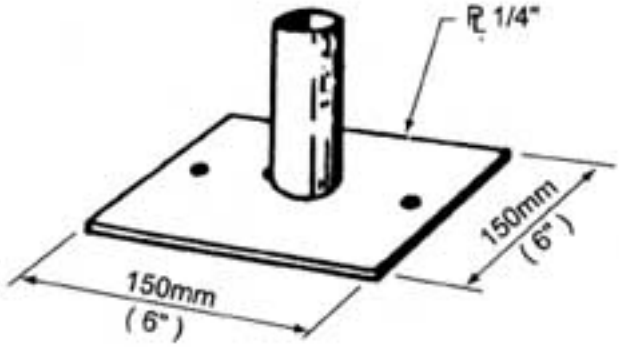


Figure II.9.12
TYPICAL BASE PLATE

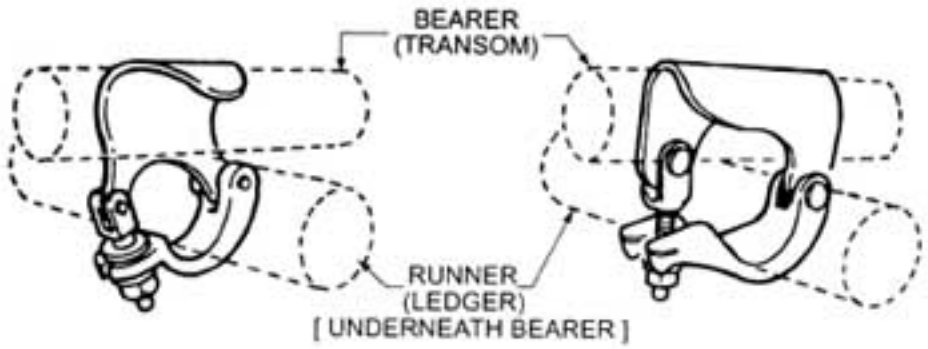


Figure II.9.13
BEARER (PUTLOG) COUPLERS

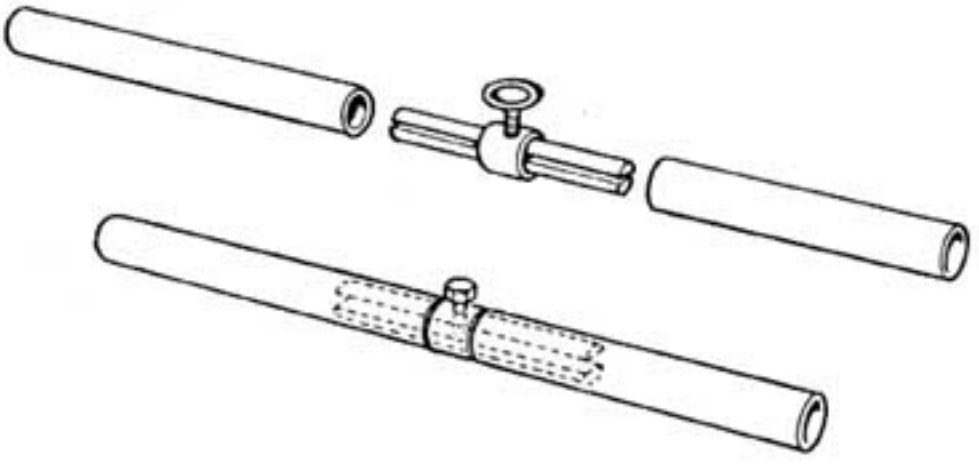
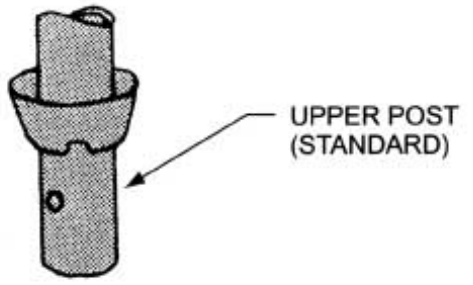
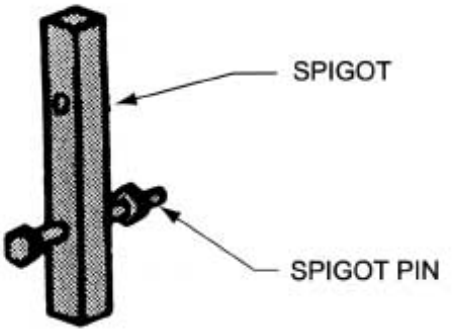


Figure II.9.14
JOINT PIN
(EXPANDING SPIGOT)





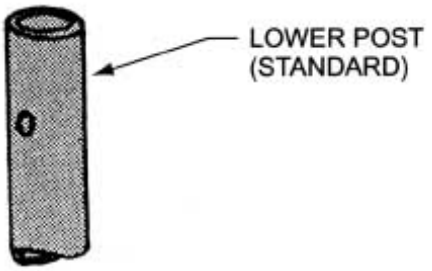


Figure II.9.15
BOLTED SPIGOT

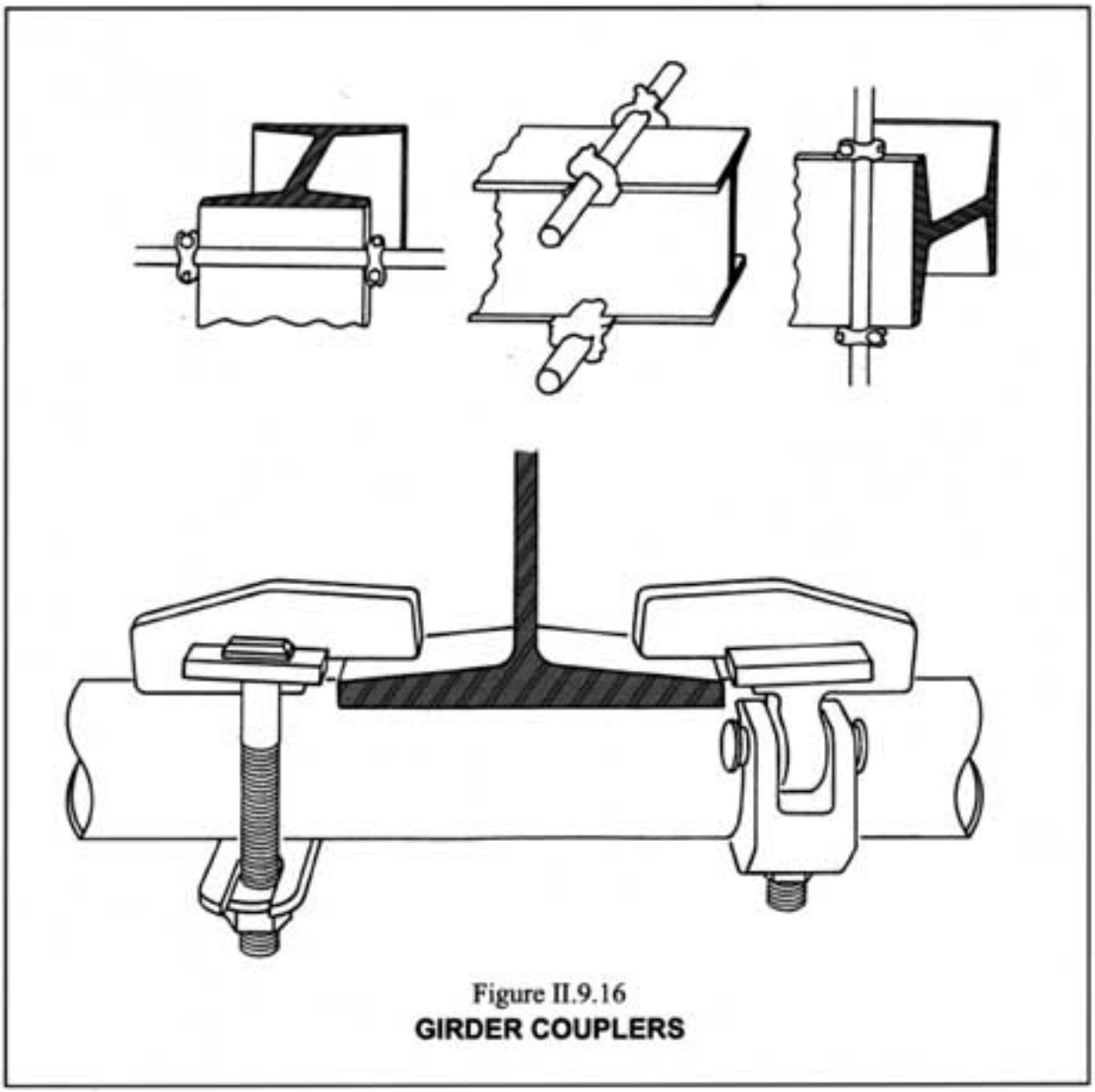


Figure II.9.16
GIRDER COUPLERS

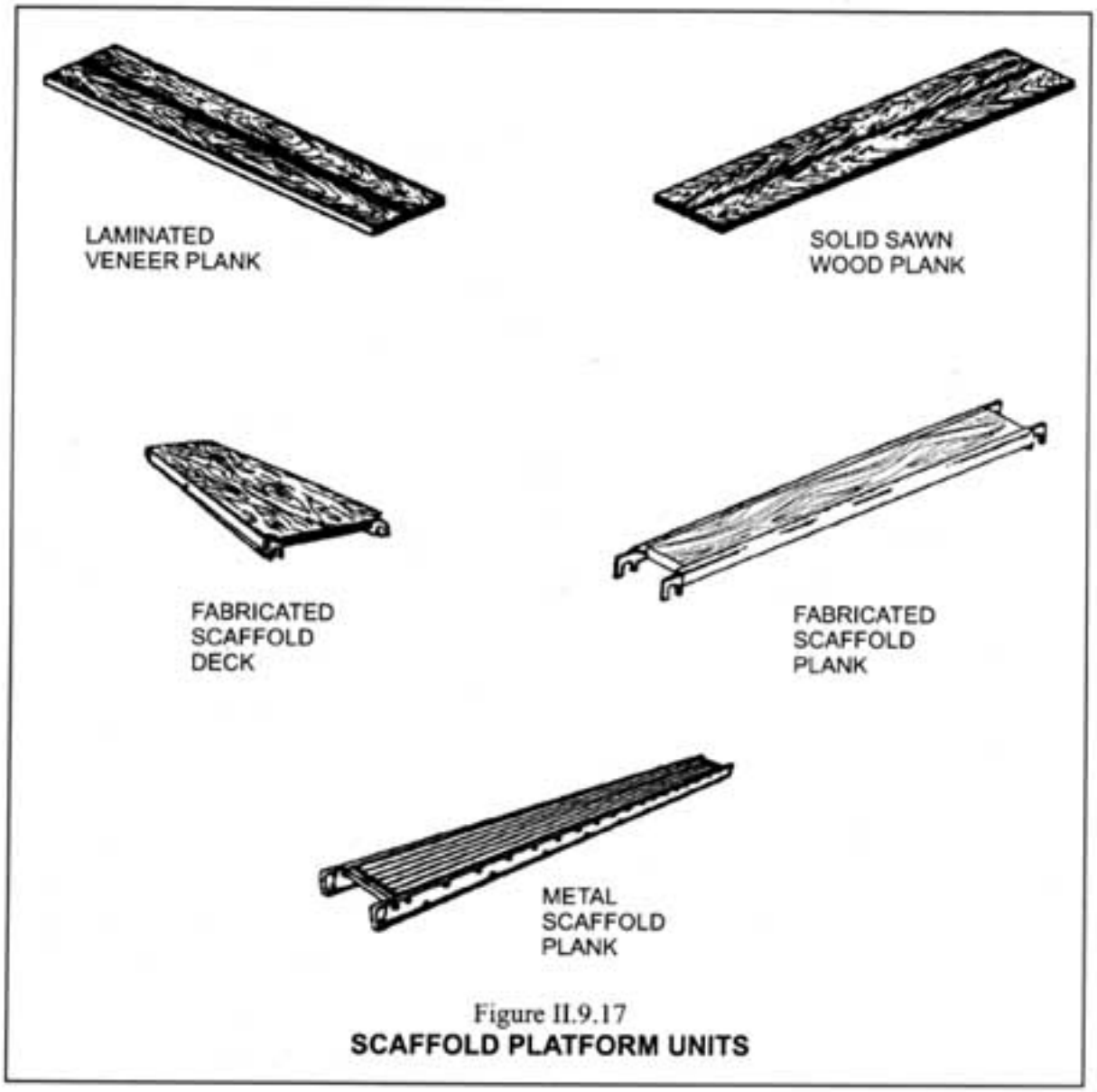


Figure II.9.17
SCAFFOLD PLATFORM UNITS

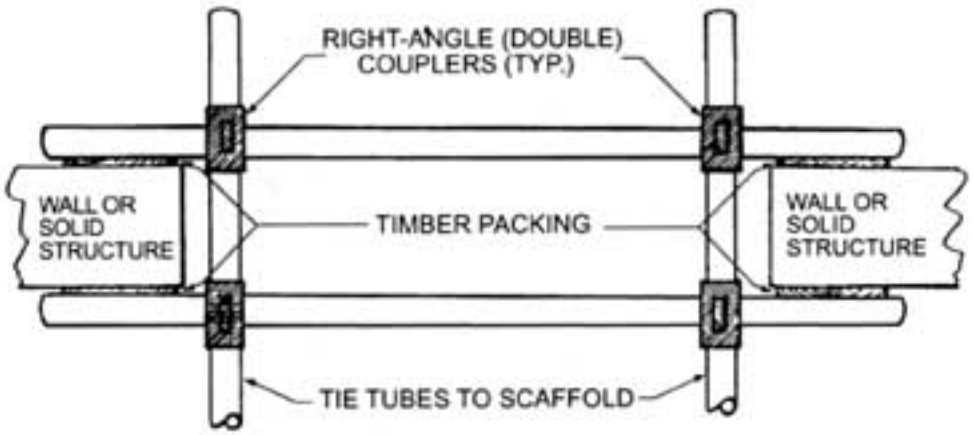


Figure II.9.18
PLAN VIEW OF TWO-WAY TIE

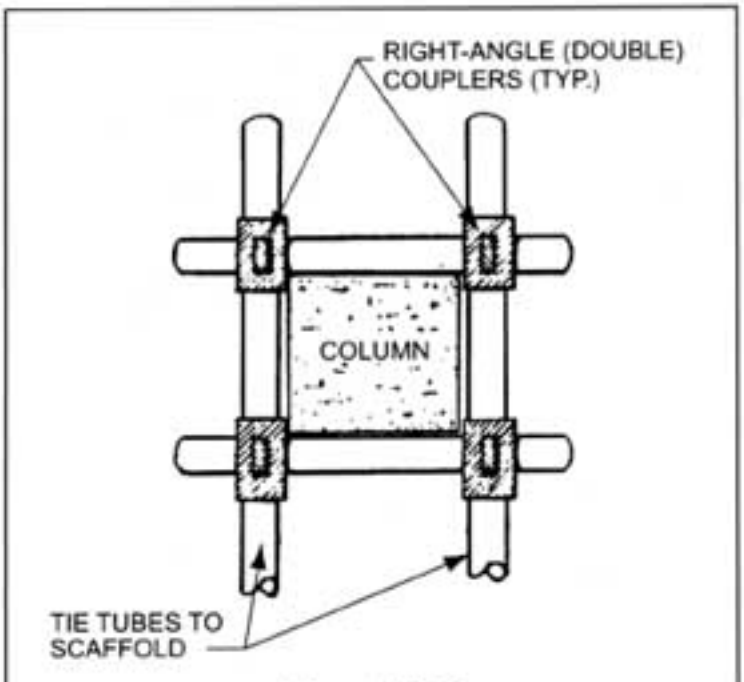


Figure II.9.19
PLAN VIEW OF COLUMN BOX TIE

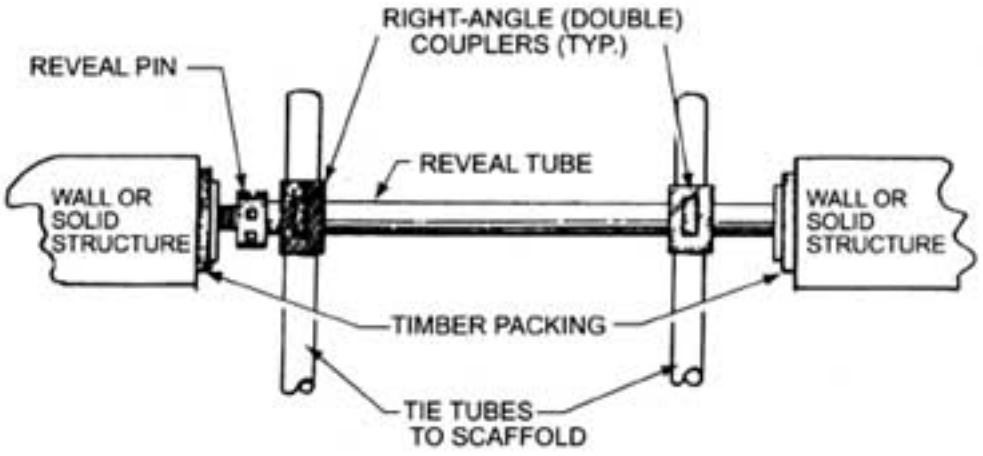


Figure II.9.20
PLAN VIEW OF REVEAL TIE

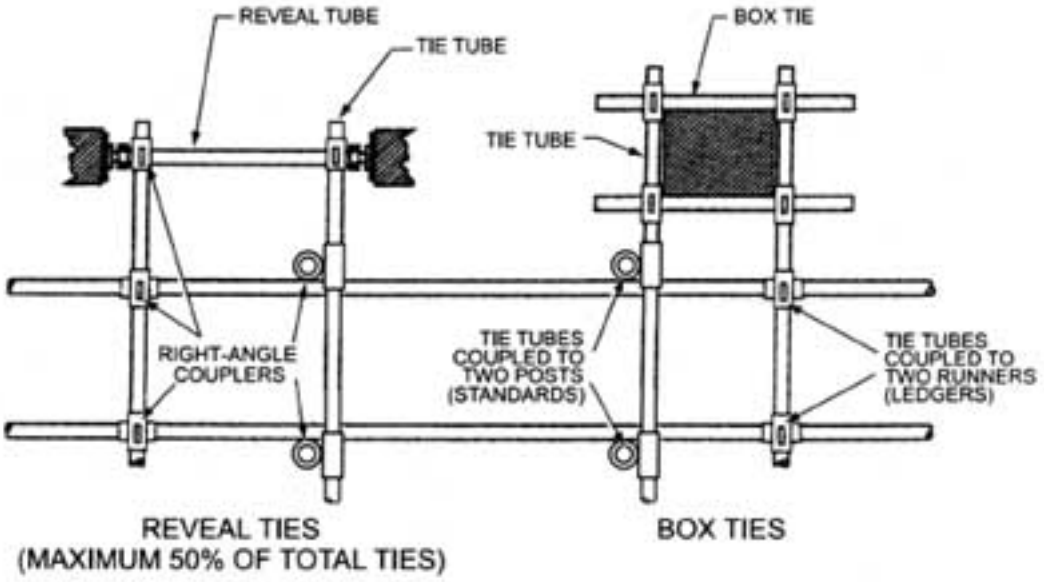


Figure II.9.21
SCAFFOLD TIES

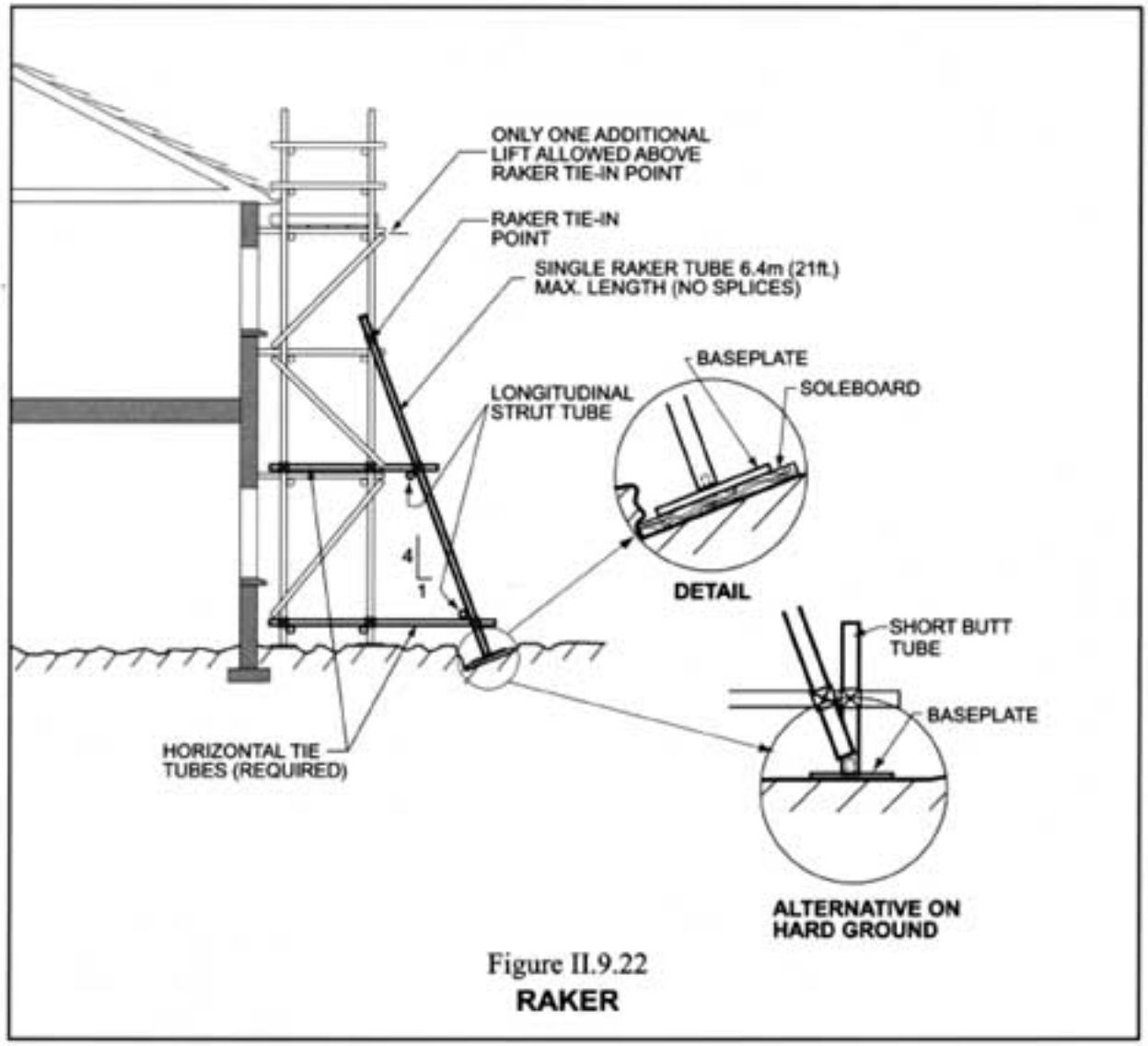


Figure II.9.22
RAKER

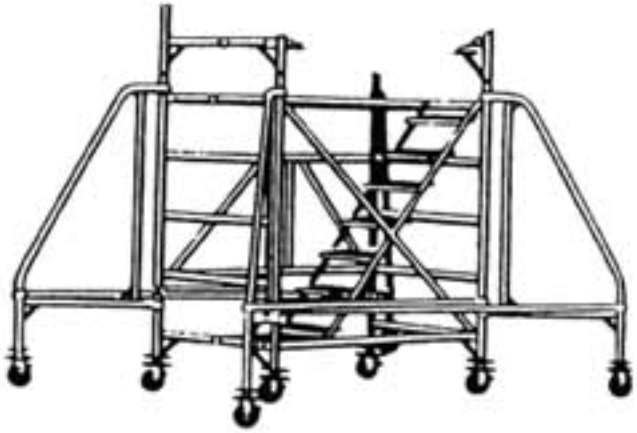


Figure II.9.23
OUTRIGGERS

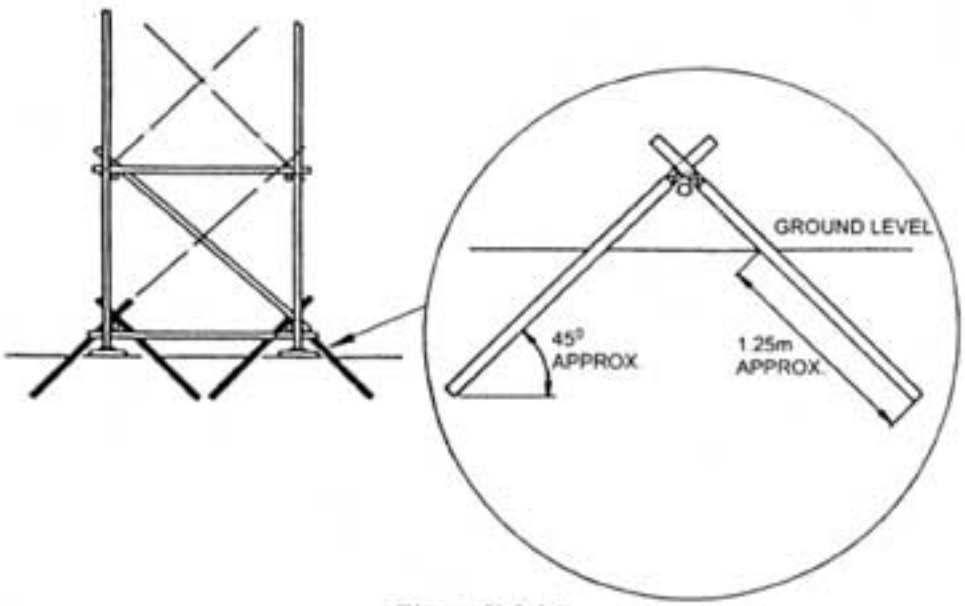


Figure II.9.24
CROSS TUBE ANCHOR

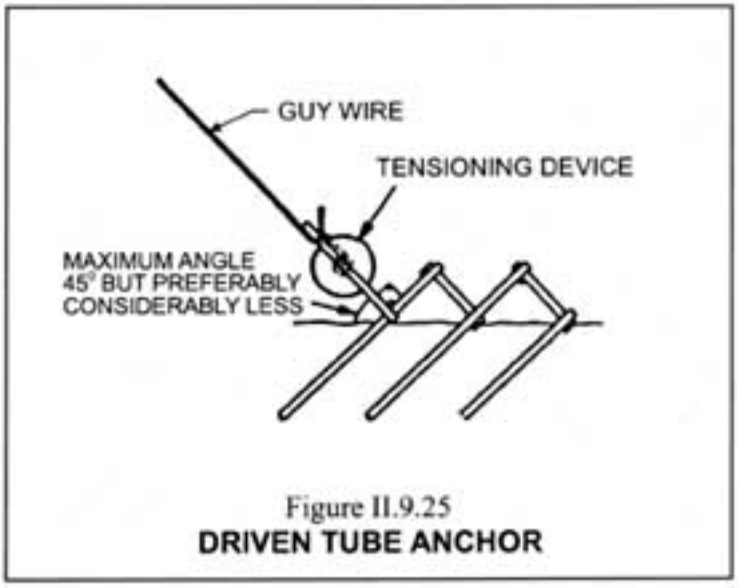


Figure II.9.25
DRIVEN TUBE ANCHOR

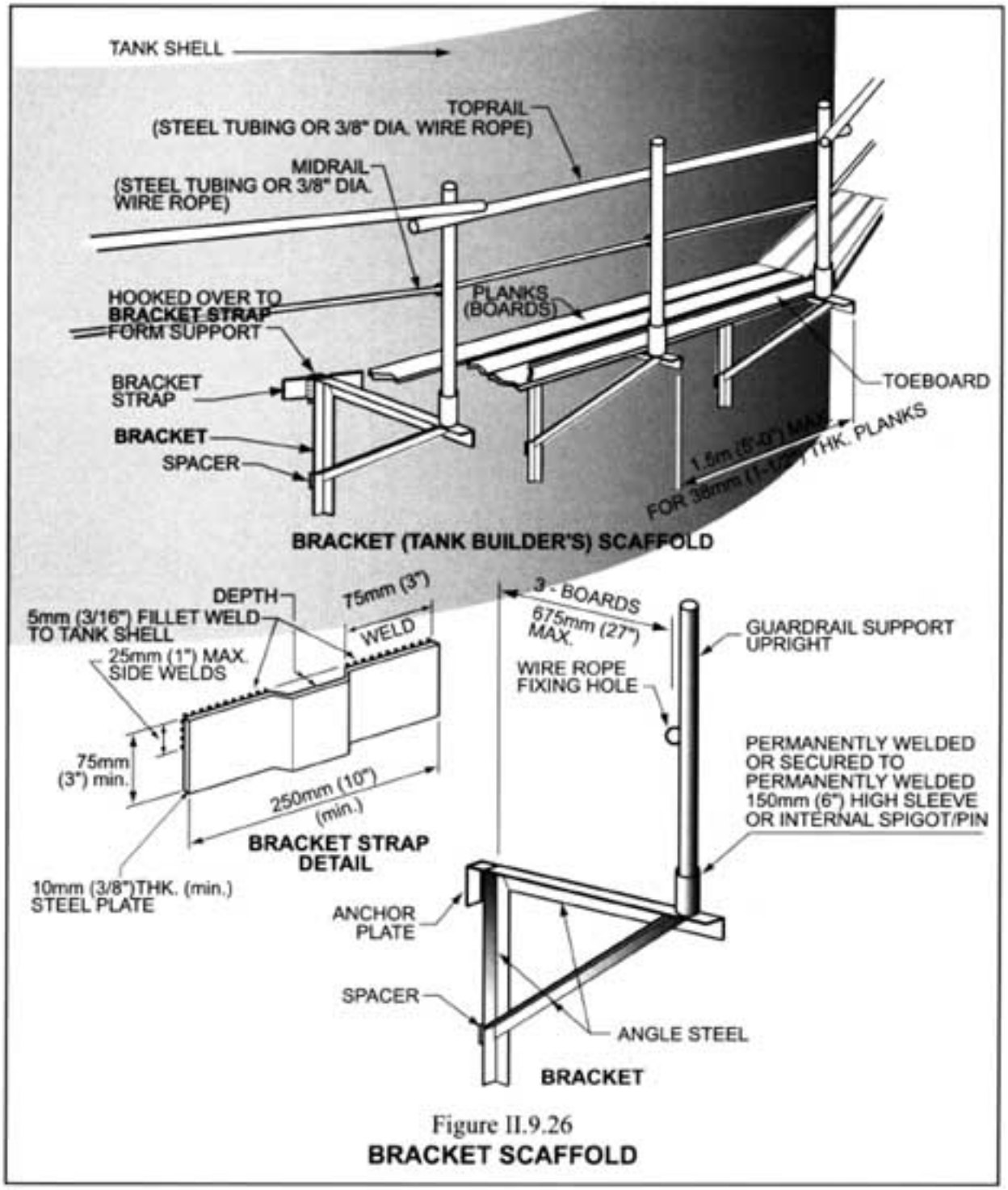


Figure II.9.26
BRACKET SCAFFOLD

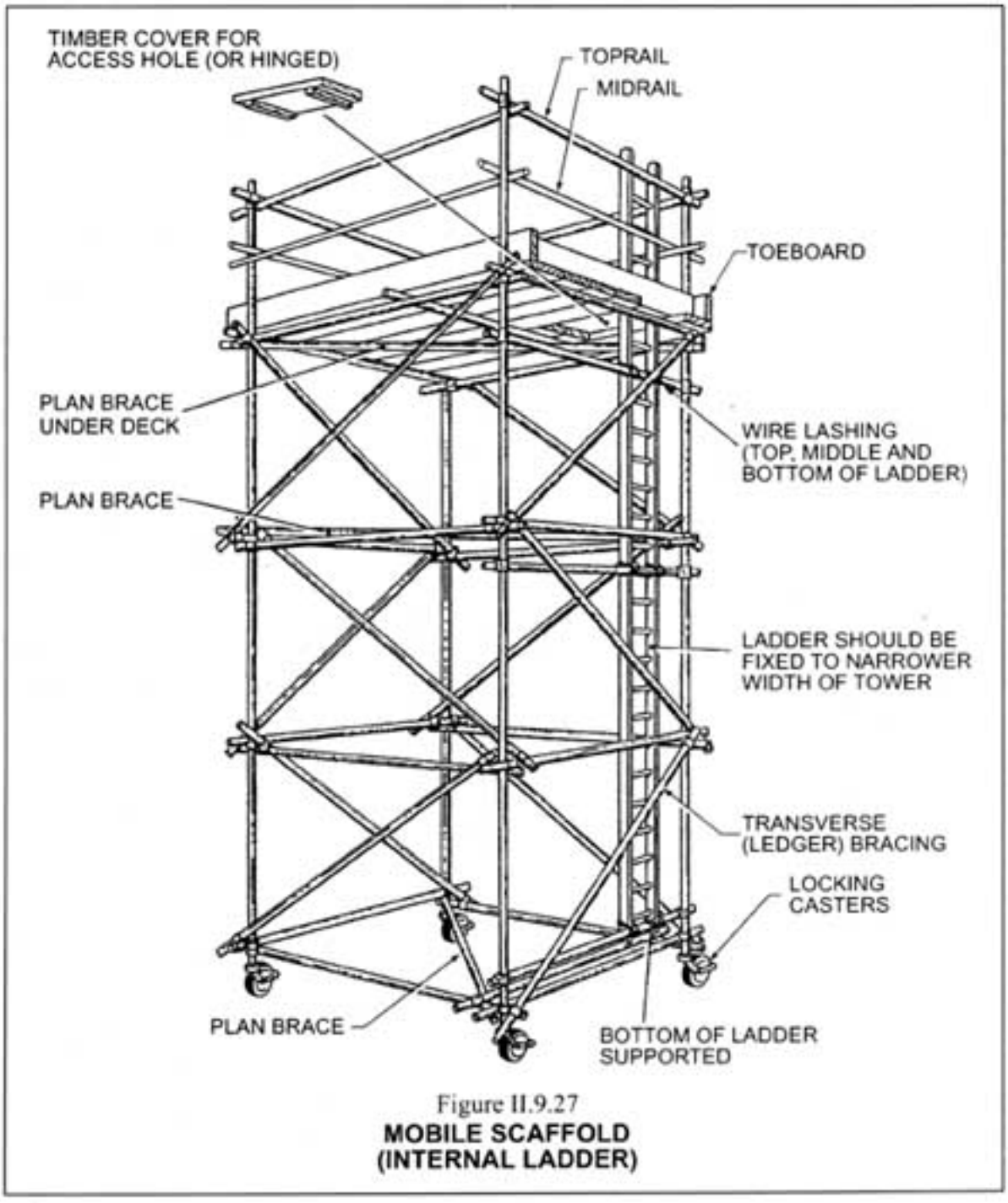


Figure II.9.27
MOBILE SCAFFOLD
(INTERNAL LADDER)

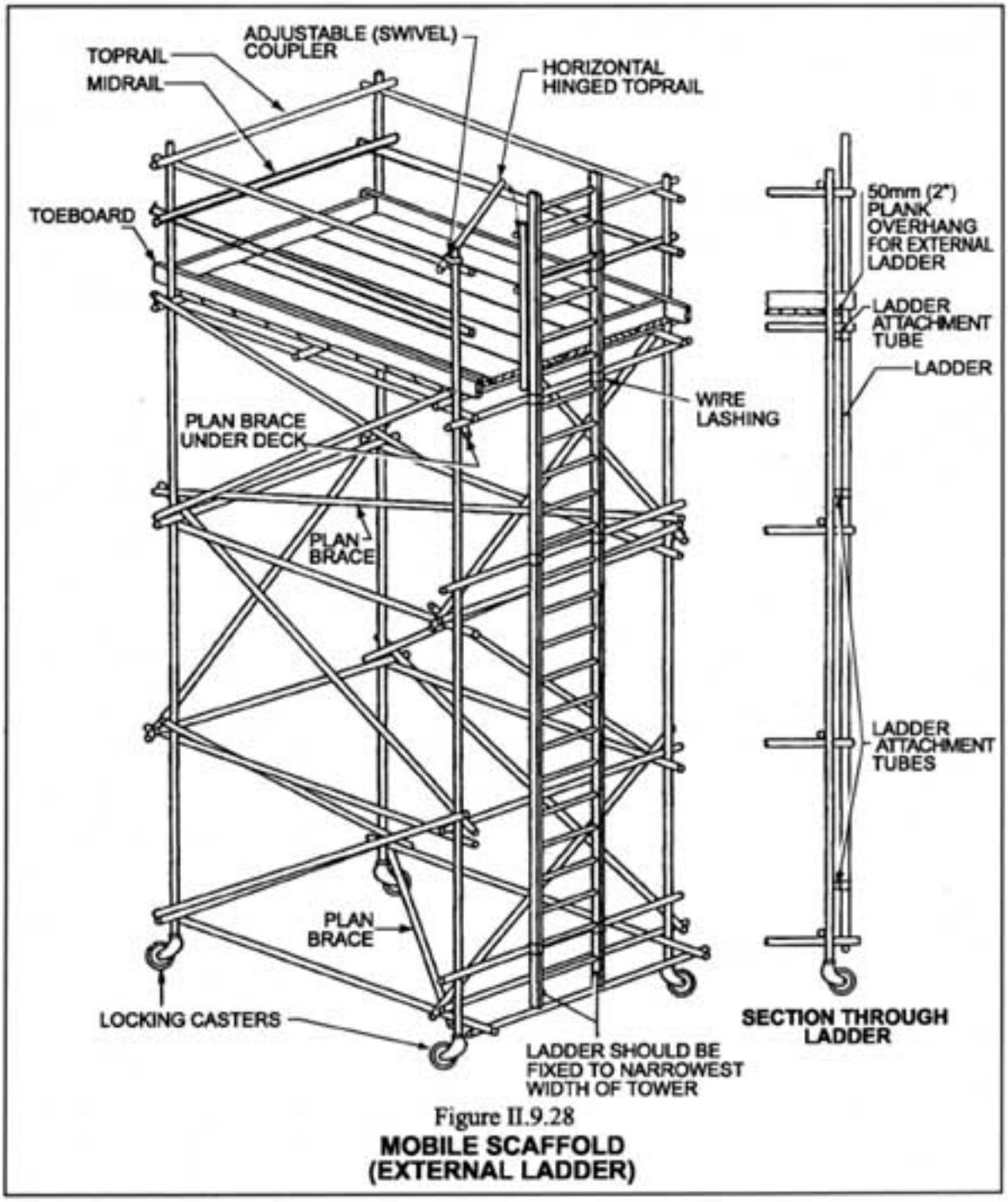


Figure II.9.28
MOBILE SCAFFOLD (EXTERNAL LADDER)

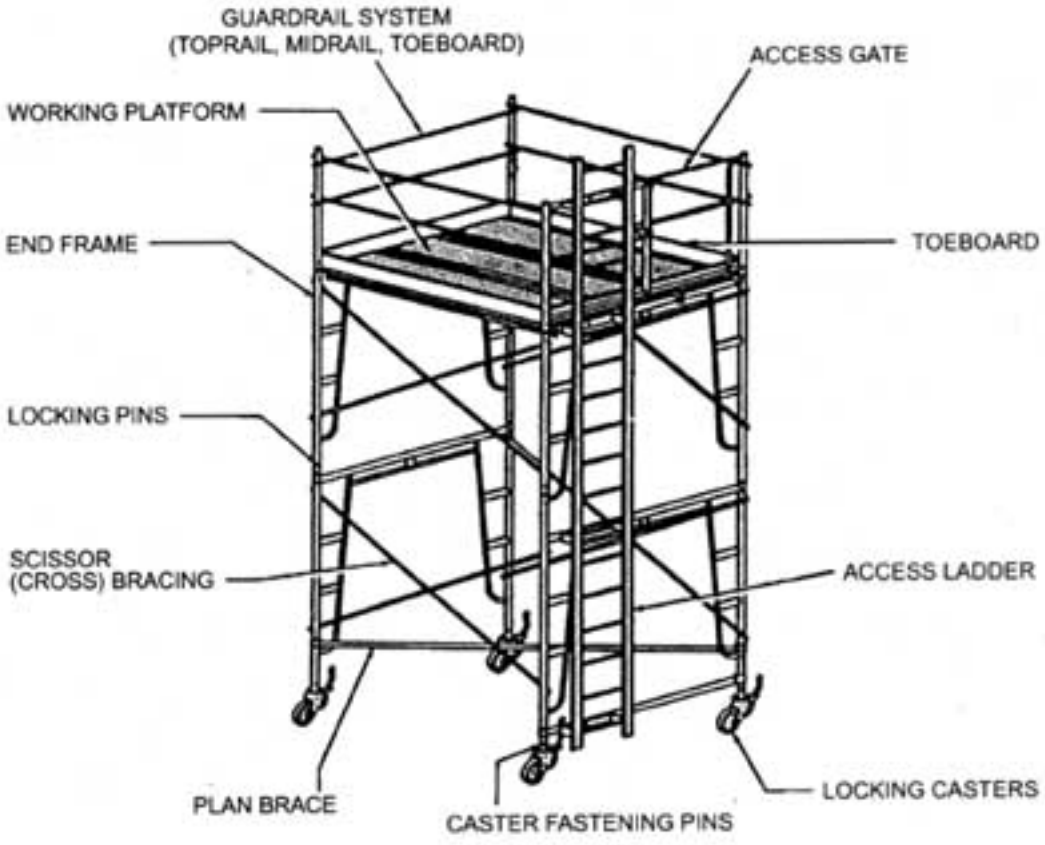


Figure II.9.29
FABRICATED TUBULAR FRAME MOBILE SCAFFOLD

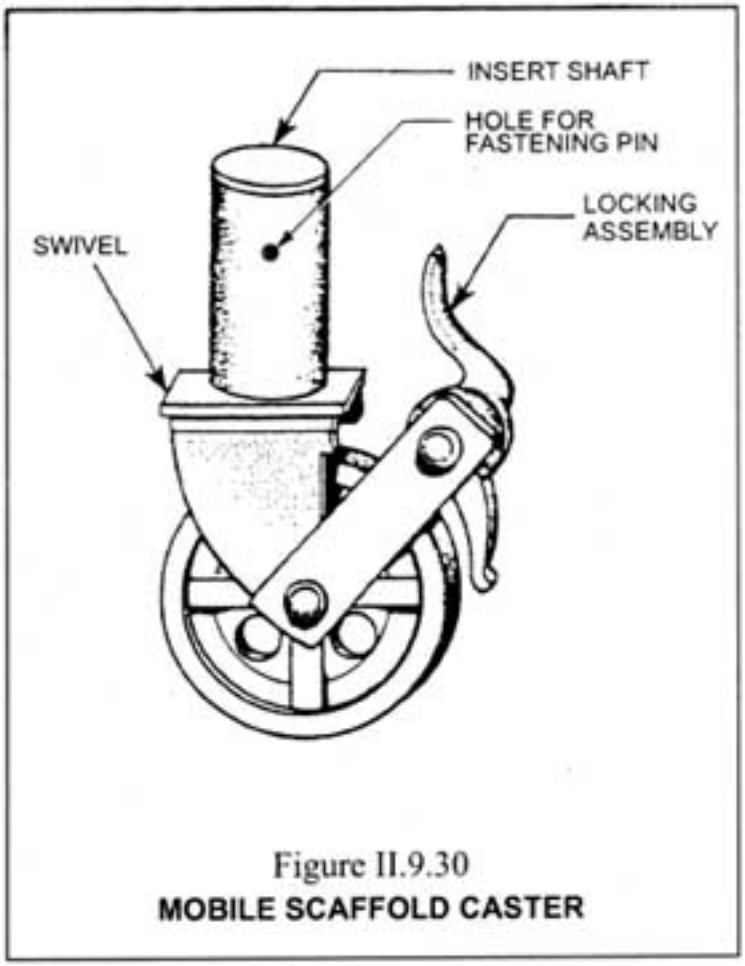


Figure II.9.30
MOBILE SCAFFOLD CASTER

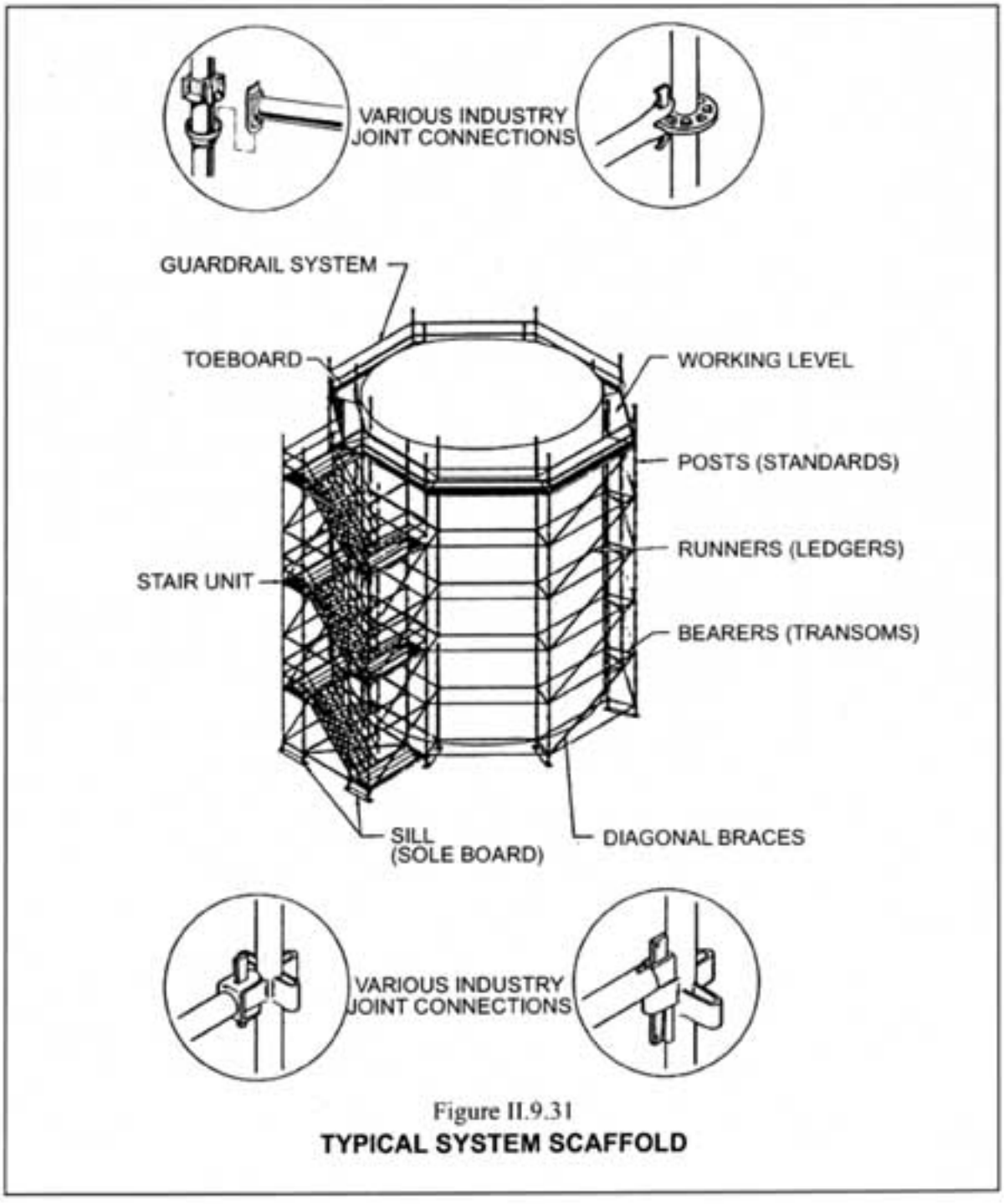


Figure II.9.31
TYPICAL SYSTEM SCAFFOLD

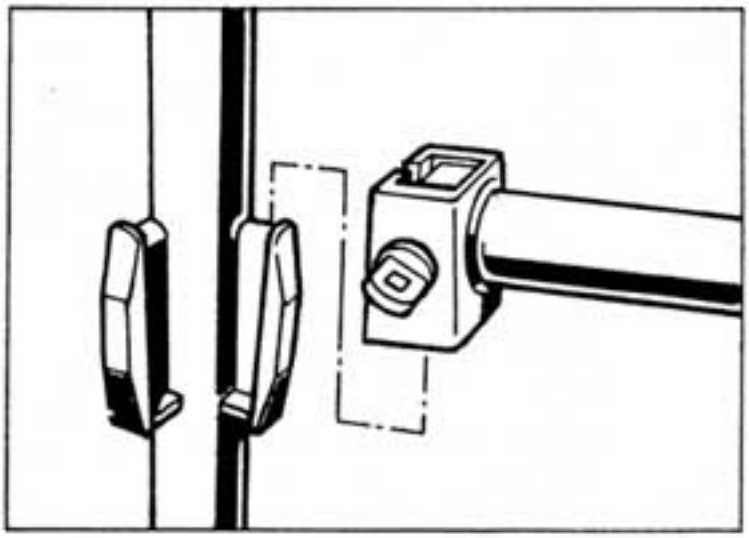


Figure II.9.32
LOCKING-PIN TYPE OF SYSTEM SCAFFOLD (PROHIBITED)

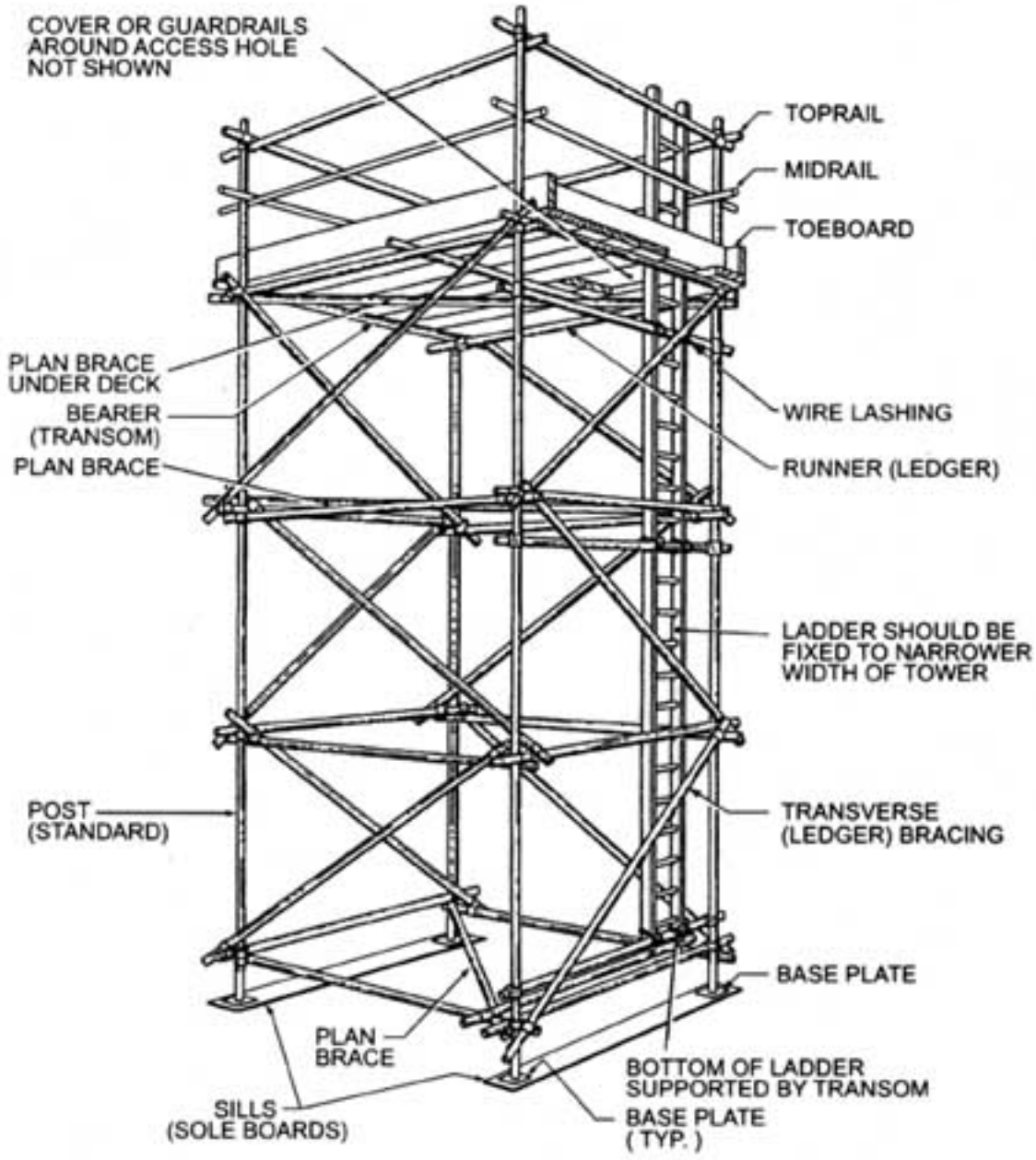


Figure II.9.33
TOWER SCAFFOLD

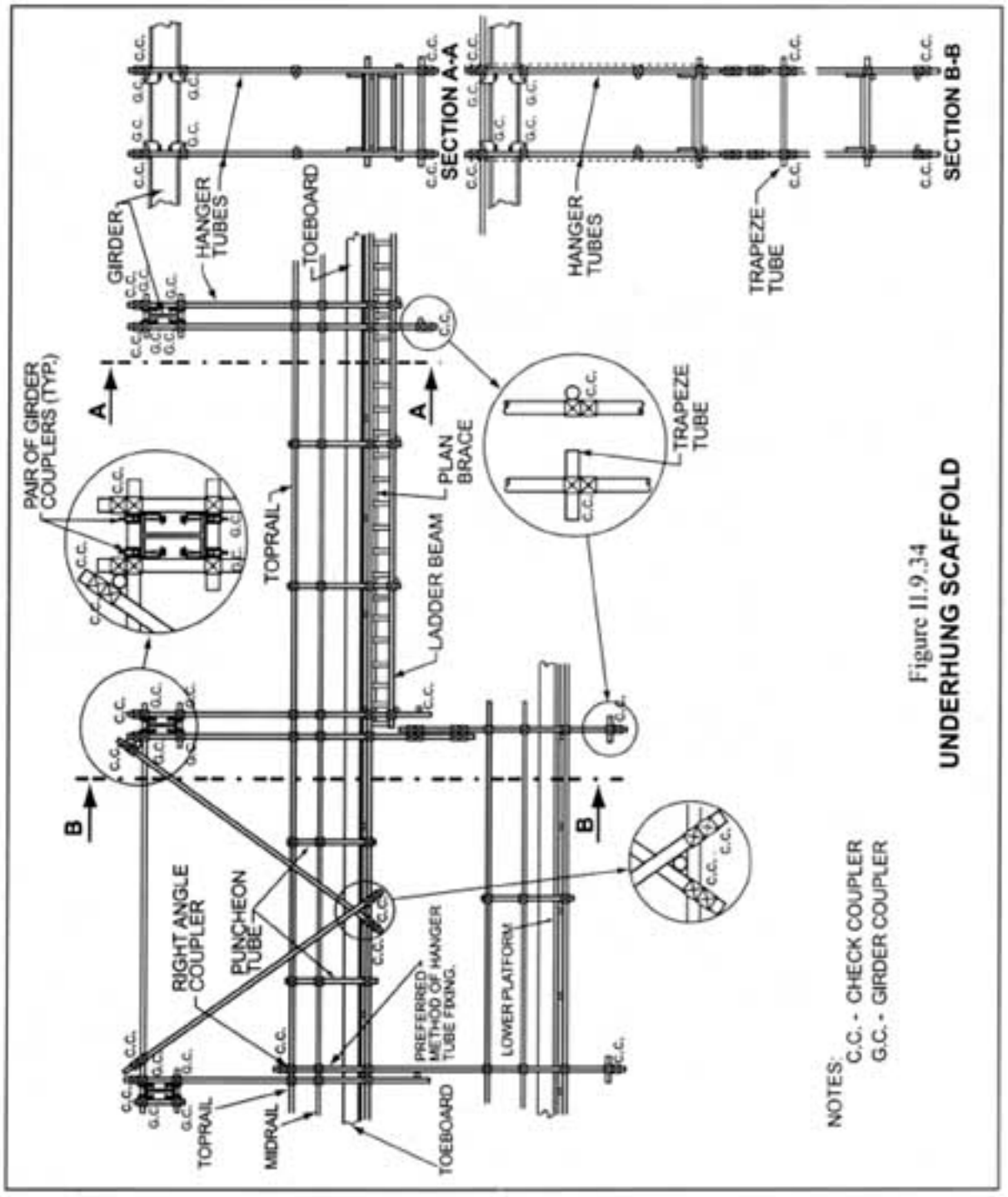


Figure 11.9.34
UNDERHUNG SCAFFOLD

Figure II.9.35

ONE MAN AND 20kg MAX. PER SQ. METER
MAX. TOTAL LOAD 120 KG
PER SQ METER (25 PSF)

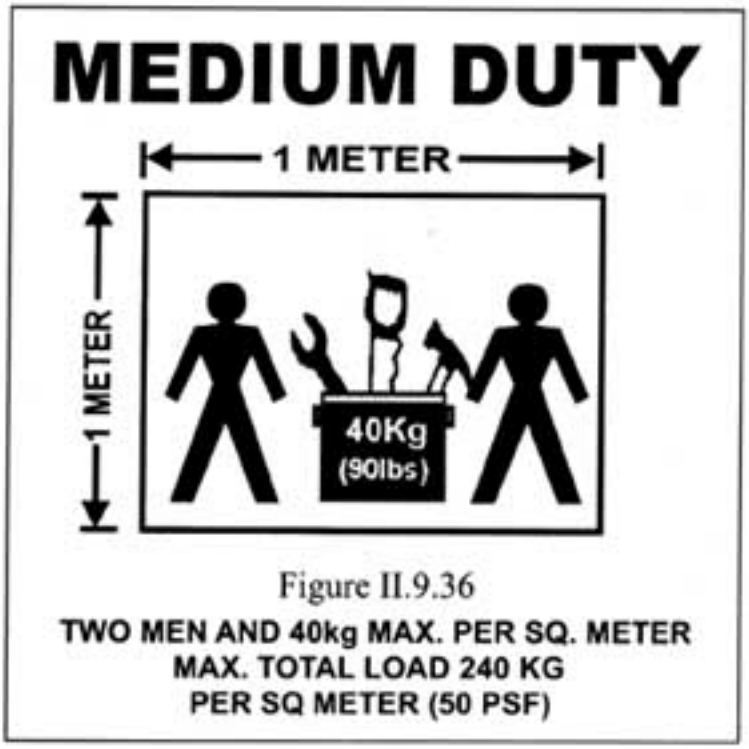


Figure II.9.36

TWO MEN AND 40kg MAX. PER SQ. METER
MAX. TOTAL LOAD 240 KG
PER SQ METER (50 PSF)

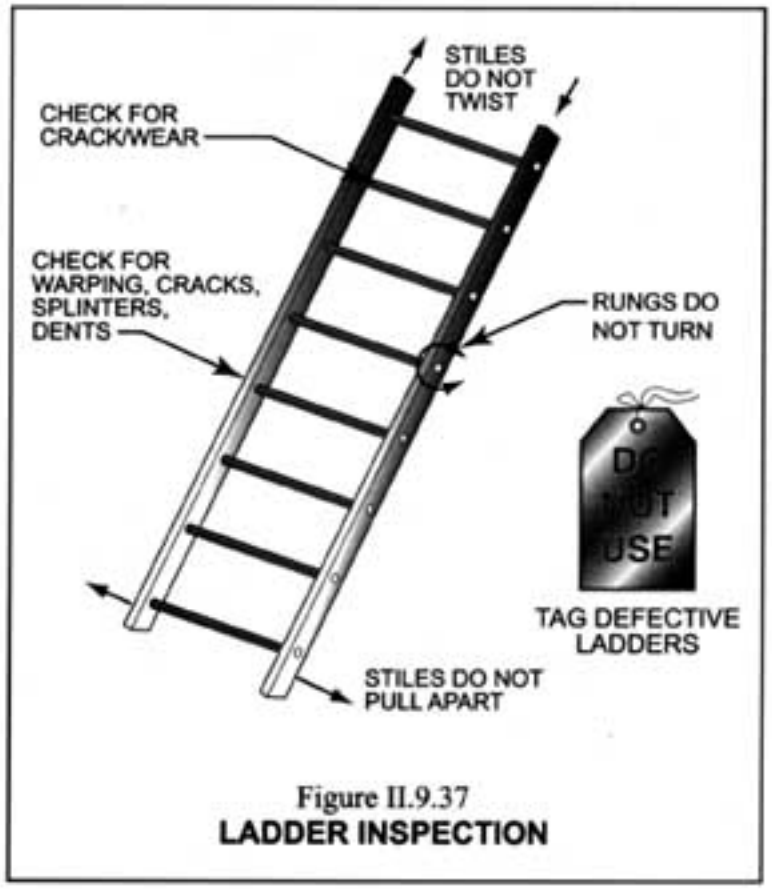


Figure II.9.37
LADDER INSPECTION

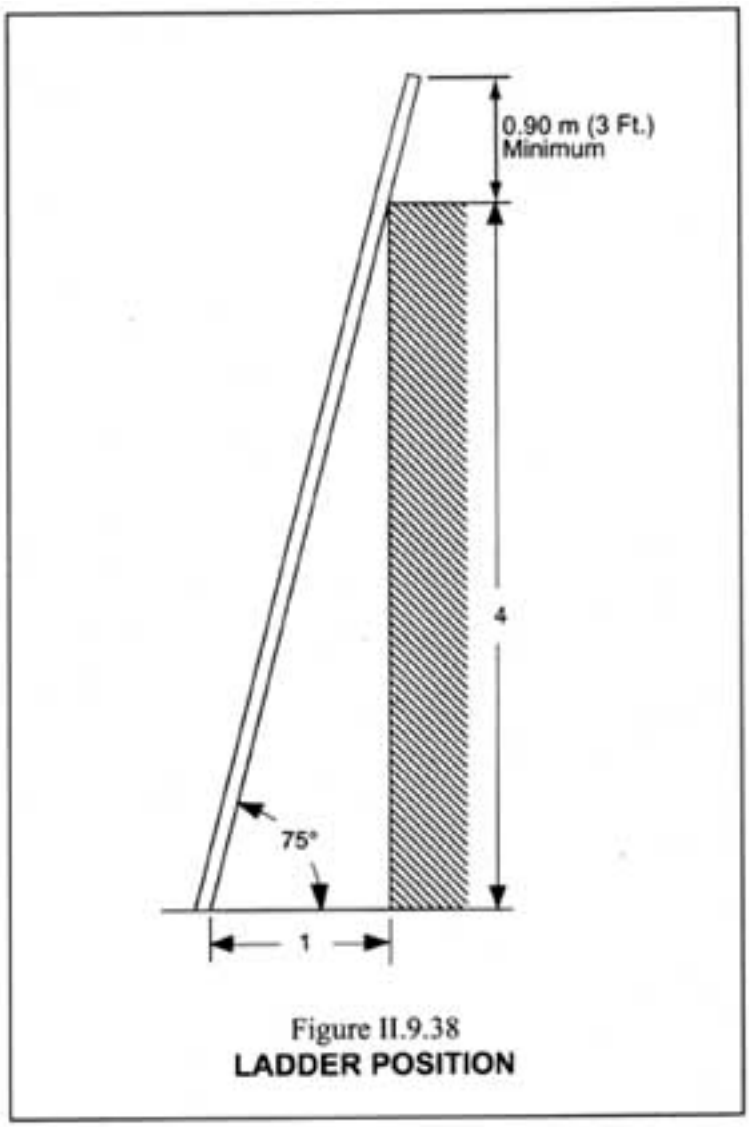


Figure II.9.38
LADDER POSITION

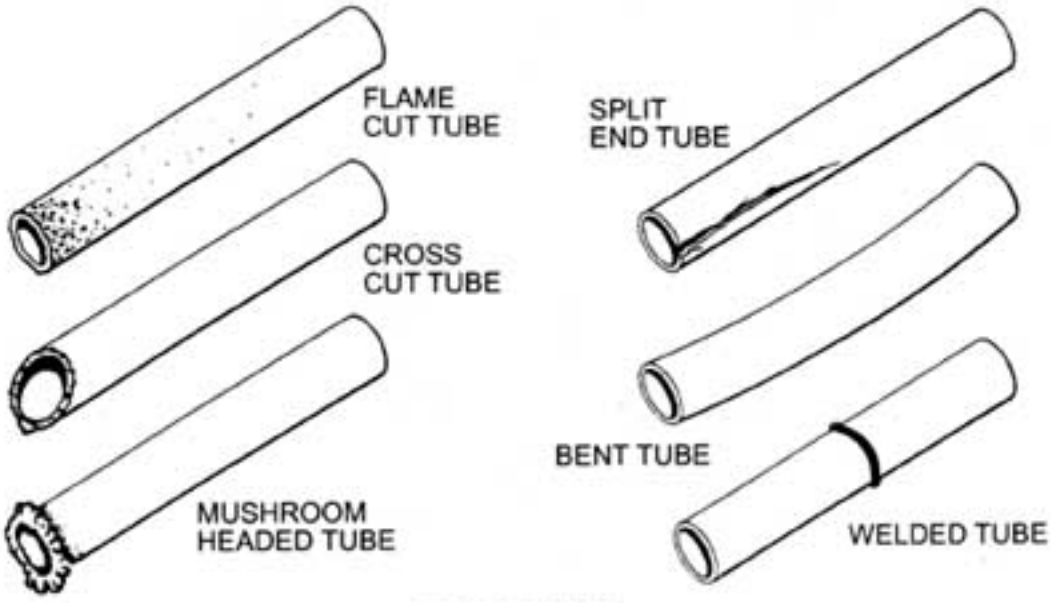


FIGURE II.9.39
DAMAGED TUBES

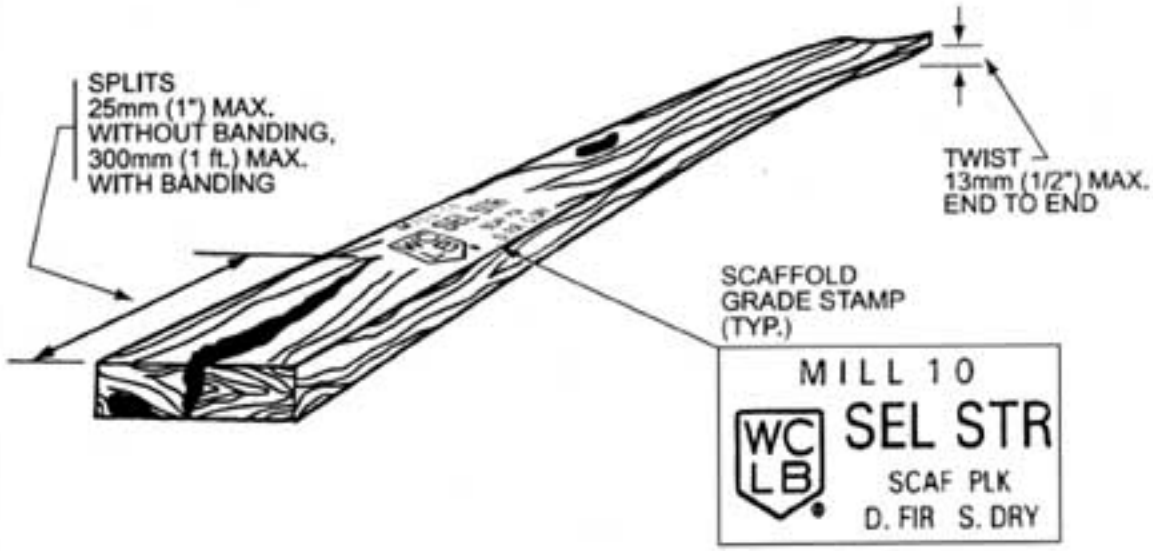


Figure II.9.40
PLANK INSPECTION

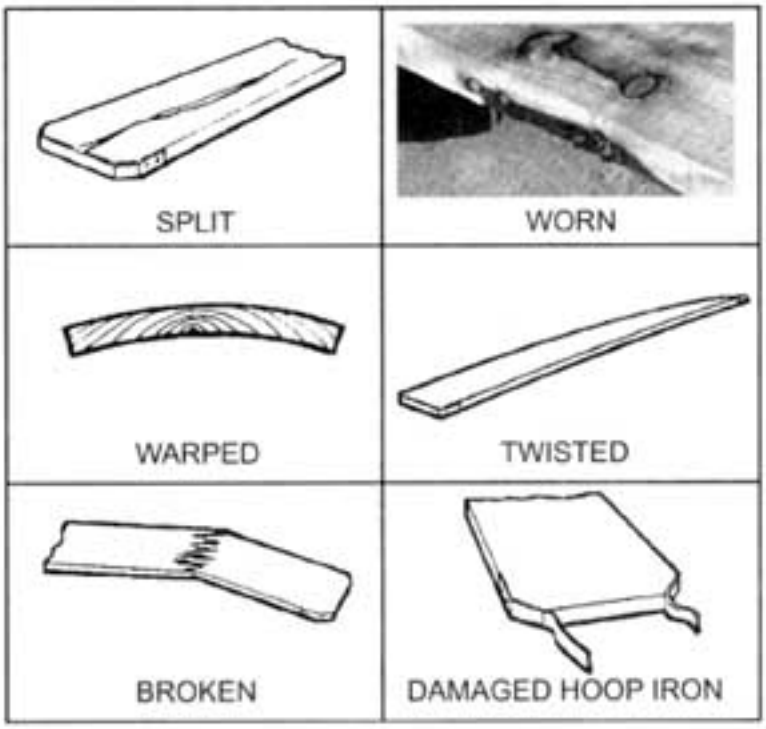


Figure II.9.41
PLANK INSPECTION

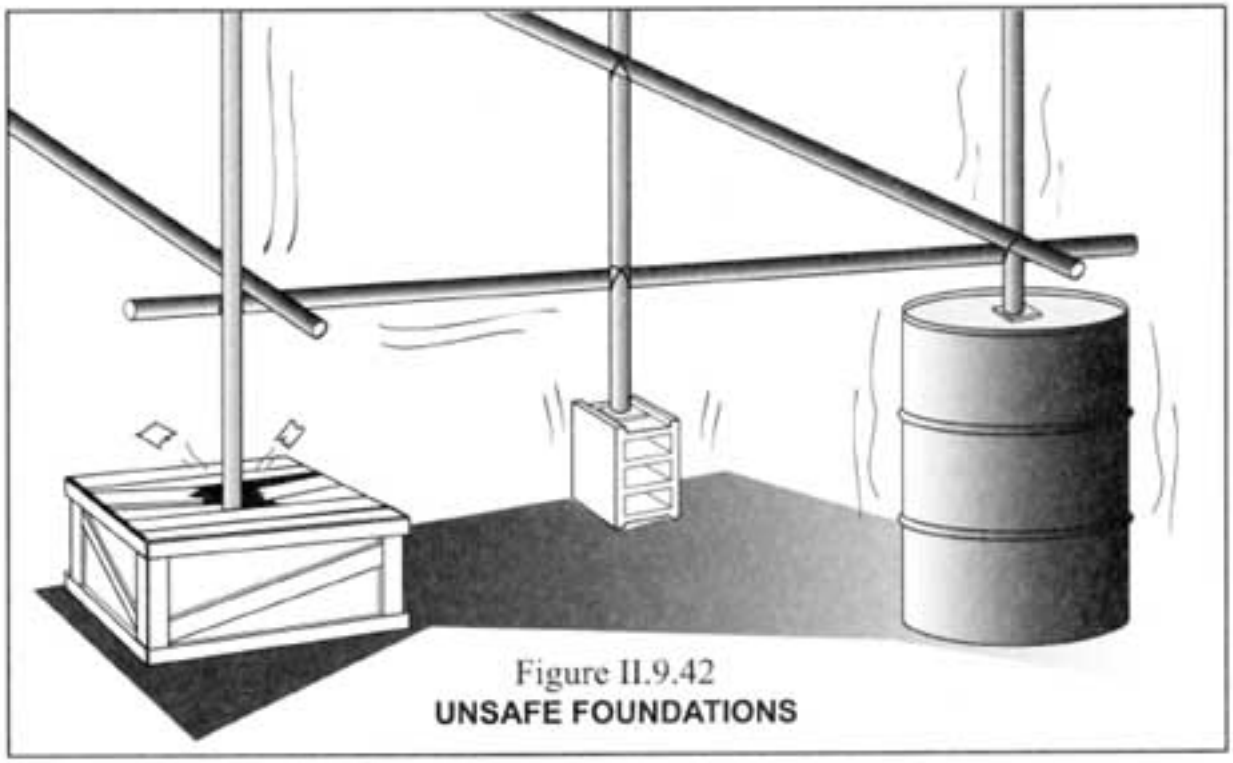


Figure II.9.42
UNSAFE FOUNDATIONS

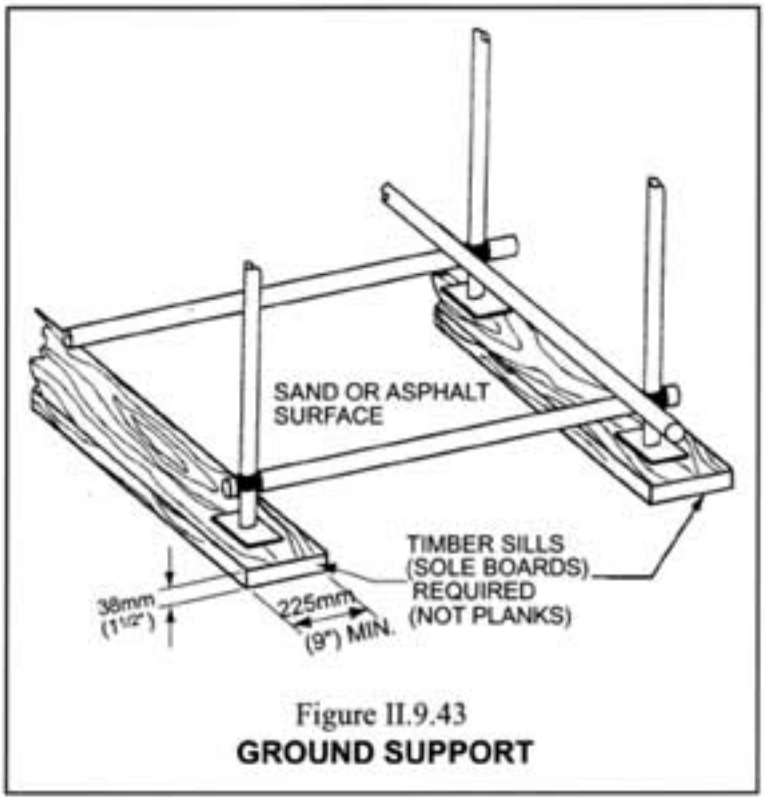


Figure II.9.43
GROUND SUPPORT

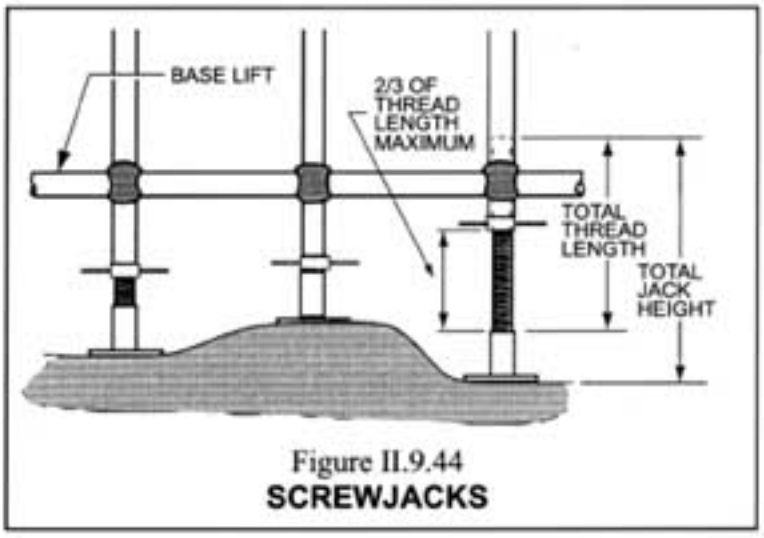


Figure II.9.44
SCREWJACKS

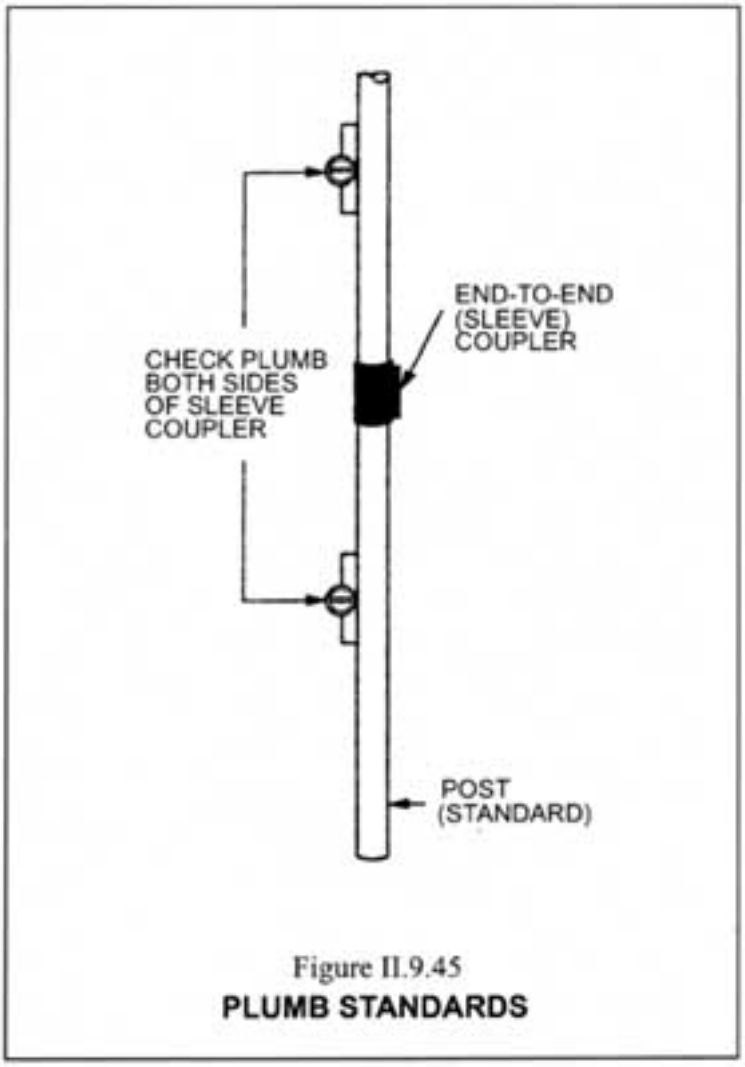


Figure II.9.45
PLUMB STANDARDS

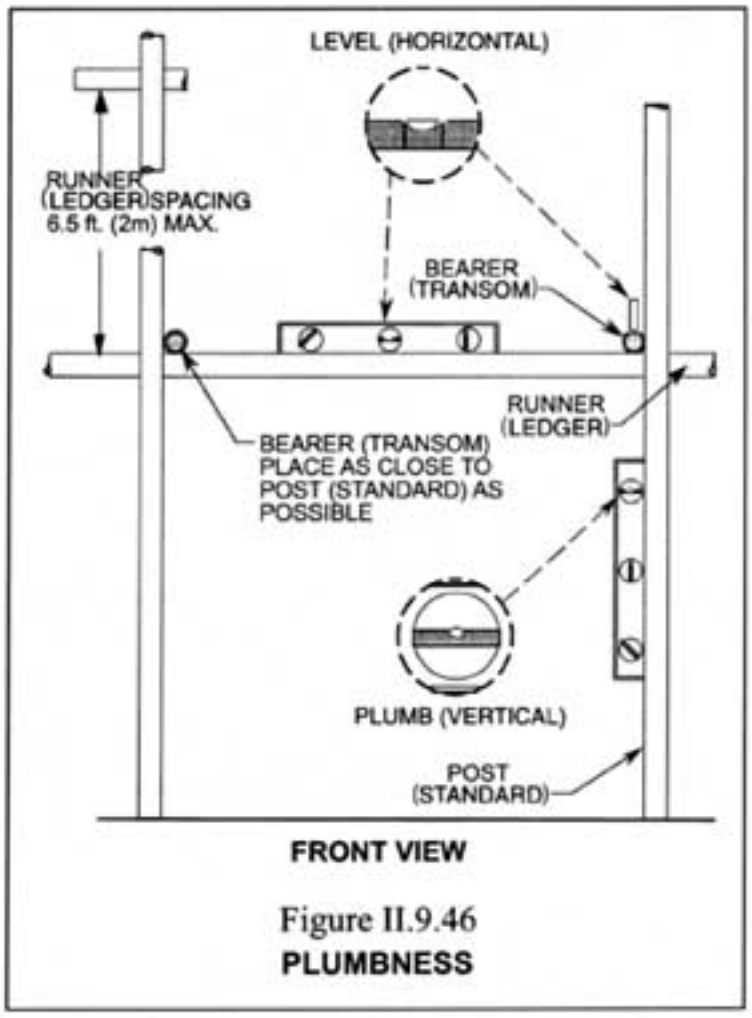


Figure II.9.46
PLUMBNESS

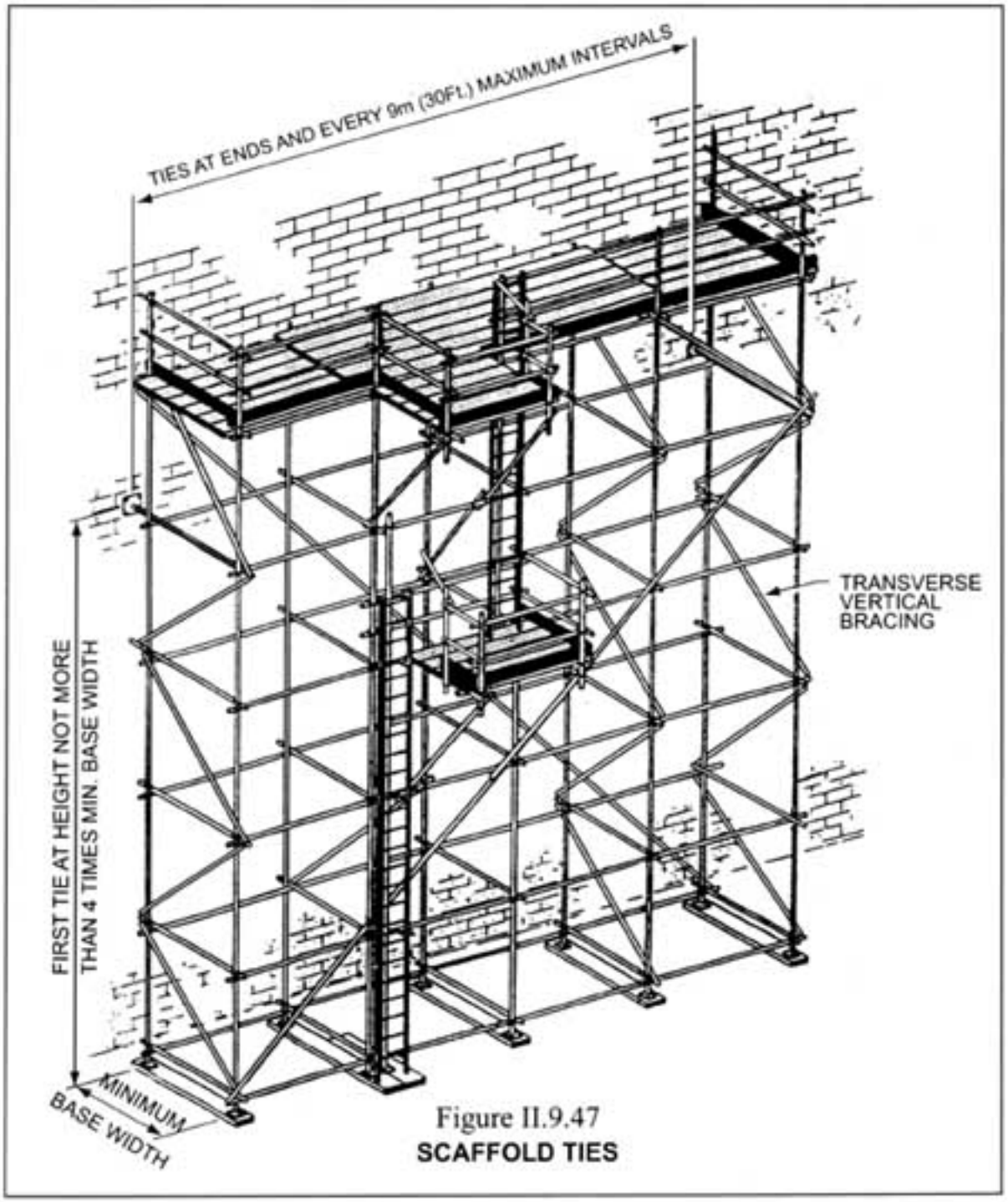


Figure II.9.47
SCAFFOLD TIES

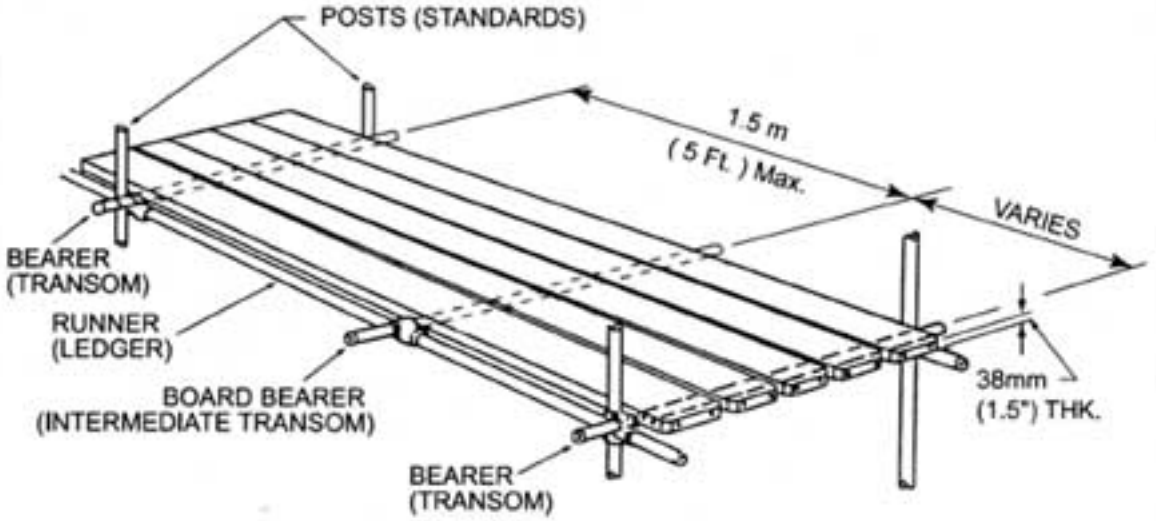


Figure II.9.48
SUPPORT SPACING FOR PLANKS (BOARDS)
38mm (1-1/2") THICK

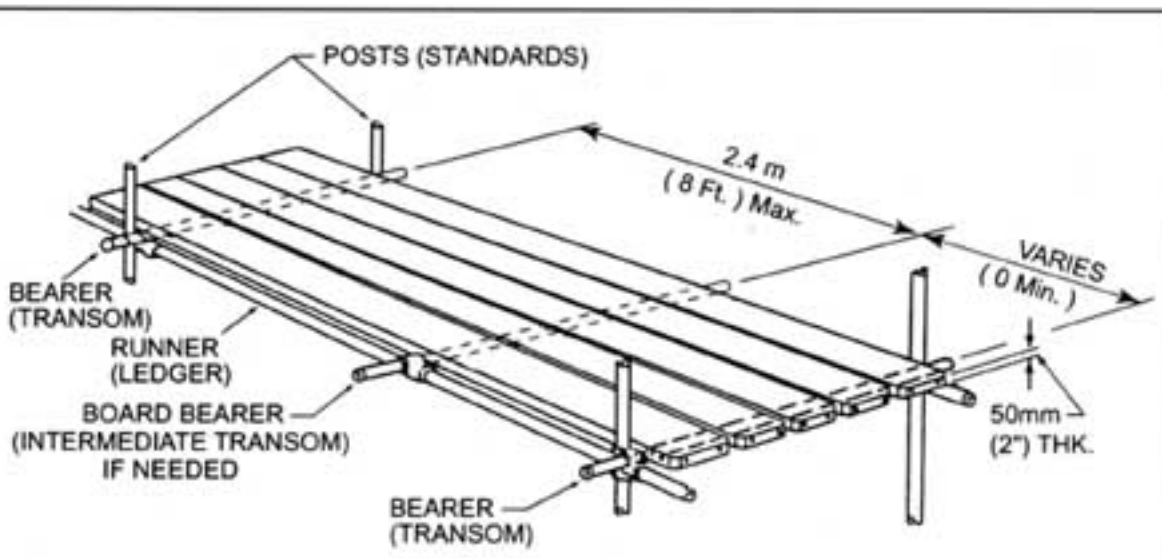


Figure II.9.49
SUPPORT SPACING FOR PLANKS (BOARDS)
50mm (2") THICK

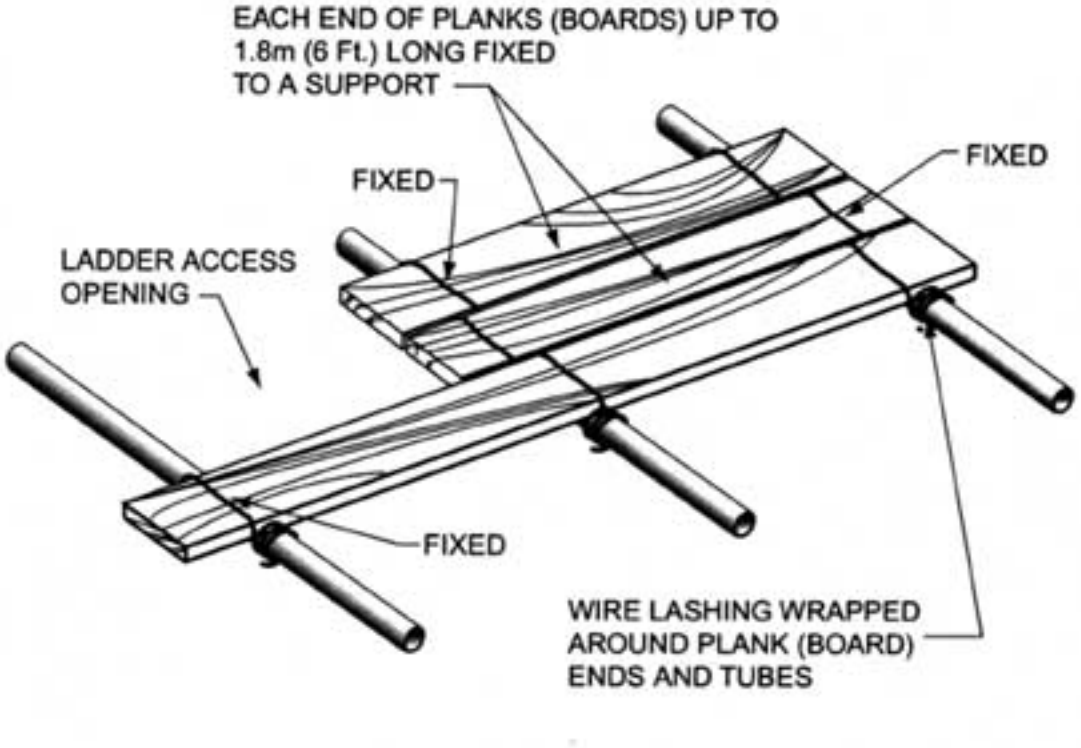


Figure II.9.50
SECURING PLANKS

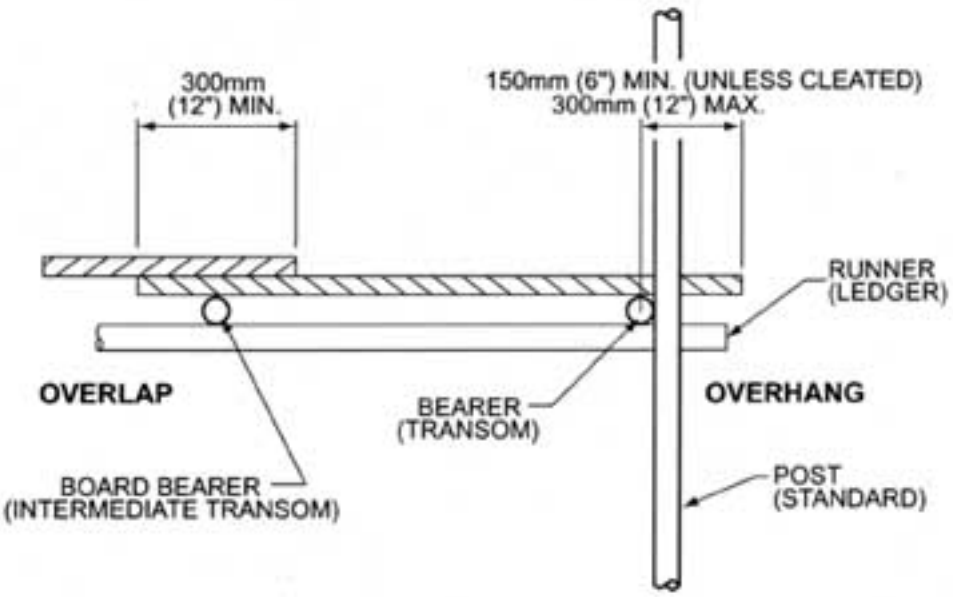


Figure II.9.51
PLANK OVERLAP AND OVERHANG

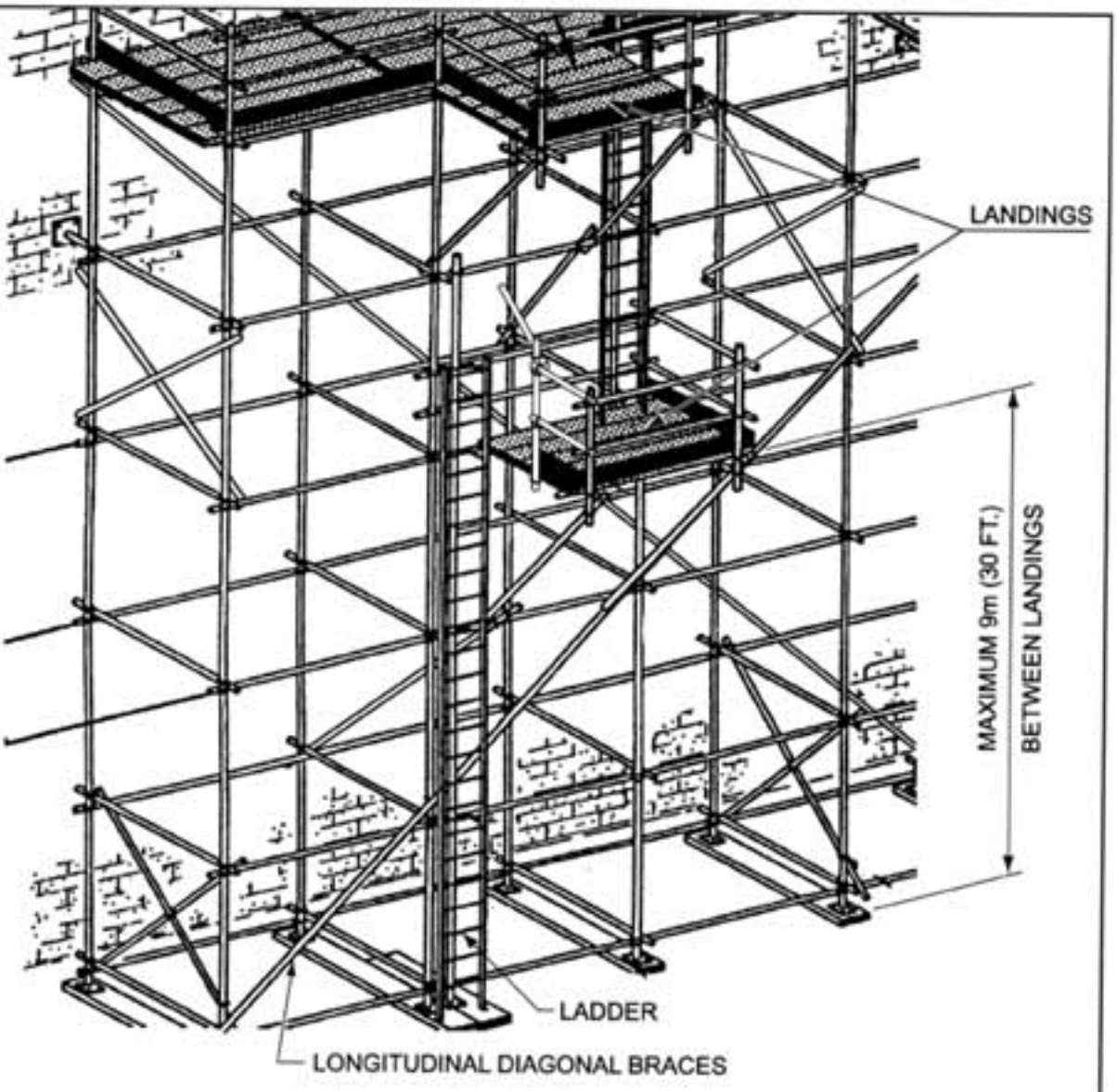
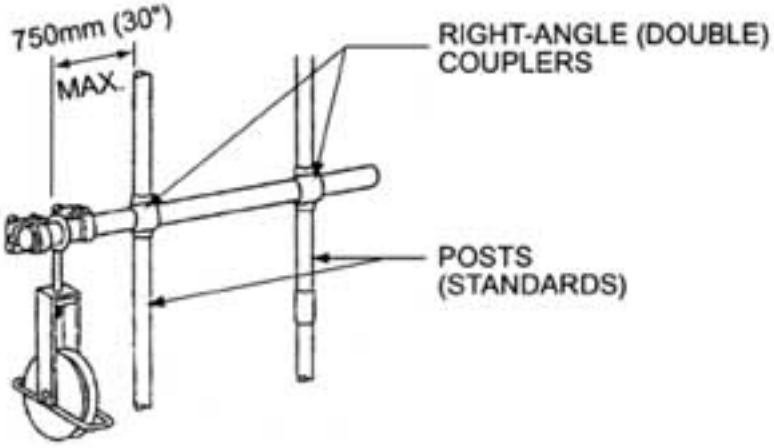


Figure II.9.52
LANDING



RING TYPE GIN WHEEL (PREFERRED)

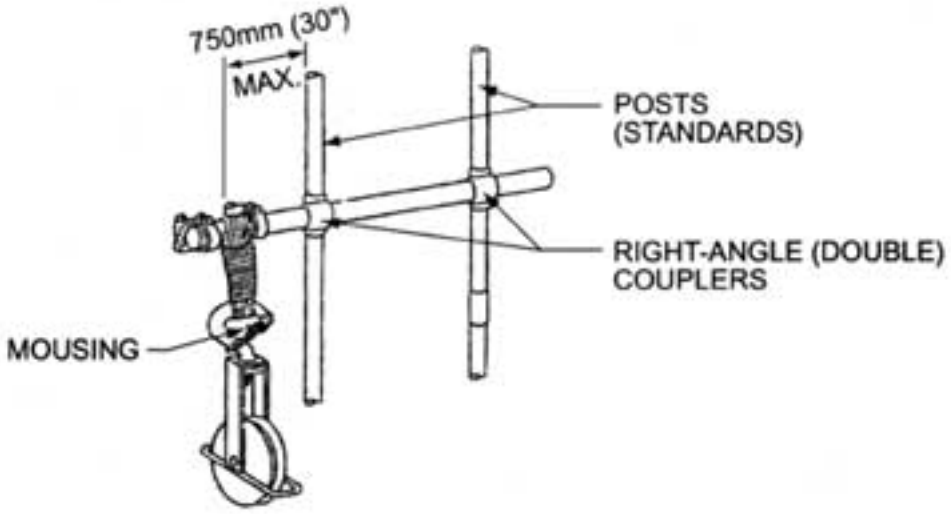


Figure II.9.53

HOOK TYPE GIN WHEEL

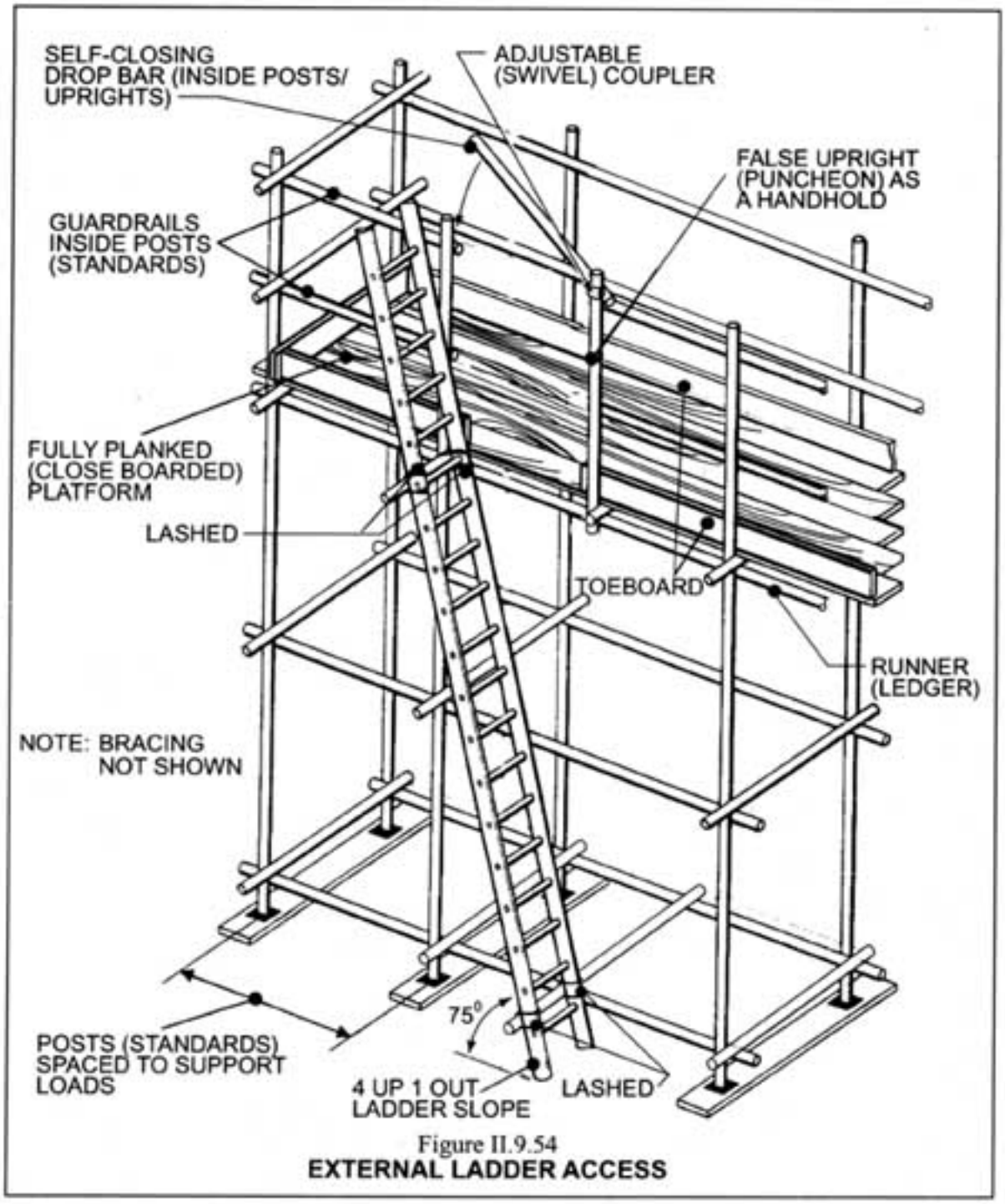


Figure II.9.54
EXTERNAL LADDER ACCESS

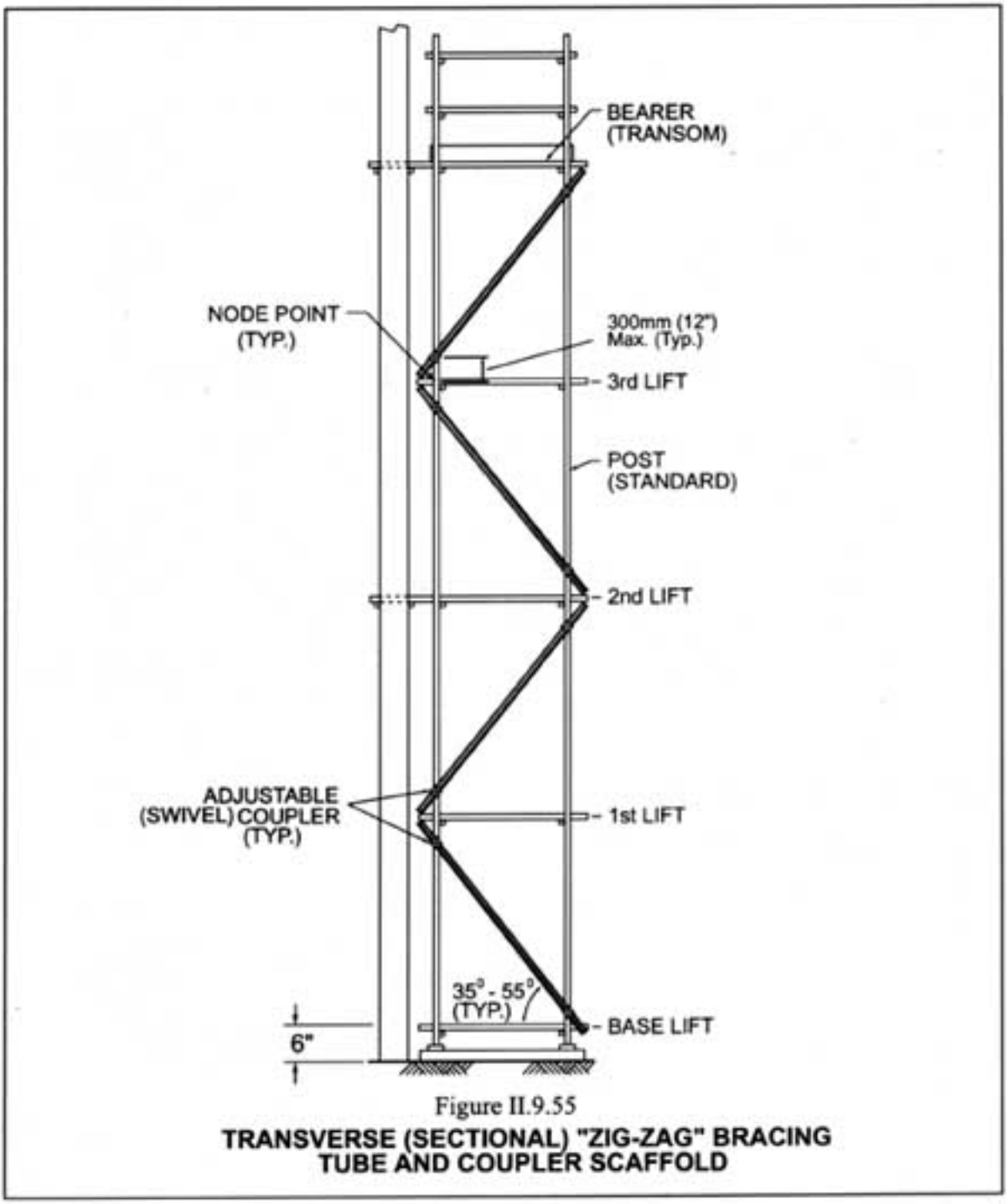


Figure II.9.55

TRANSVERSE (SECTIONAL) "ZIG-ZAG" BRACING TUBE AND COUPLER SCAFFOLD

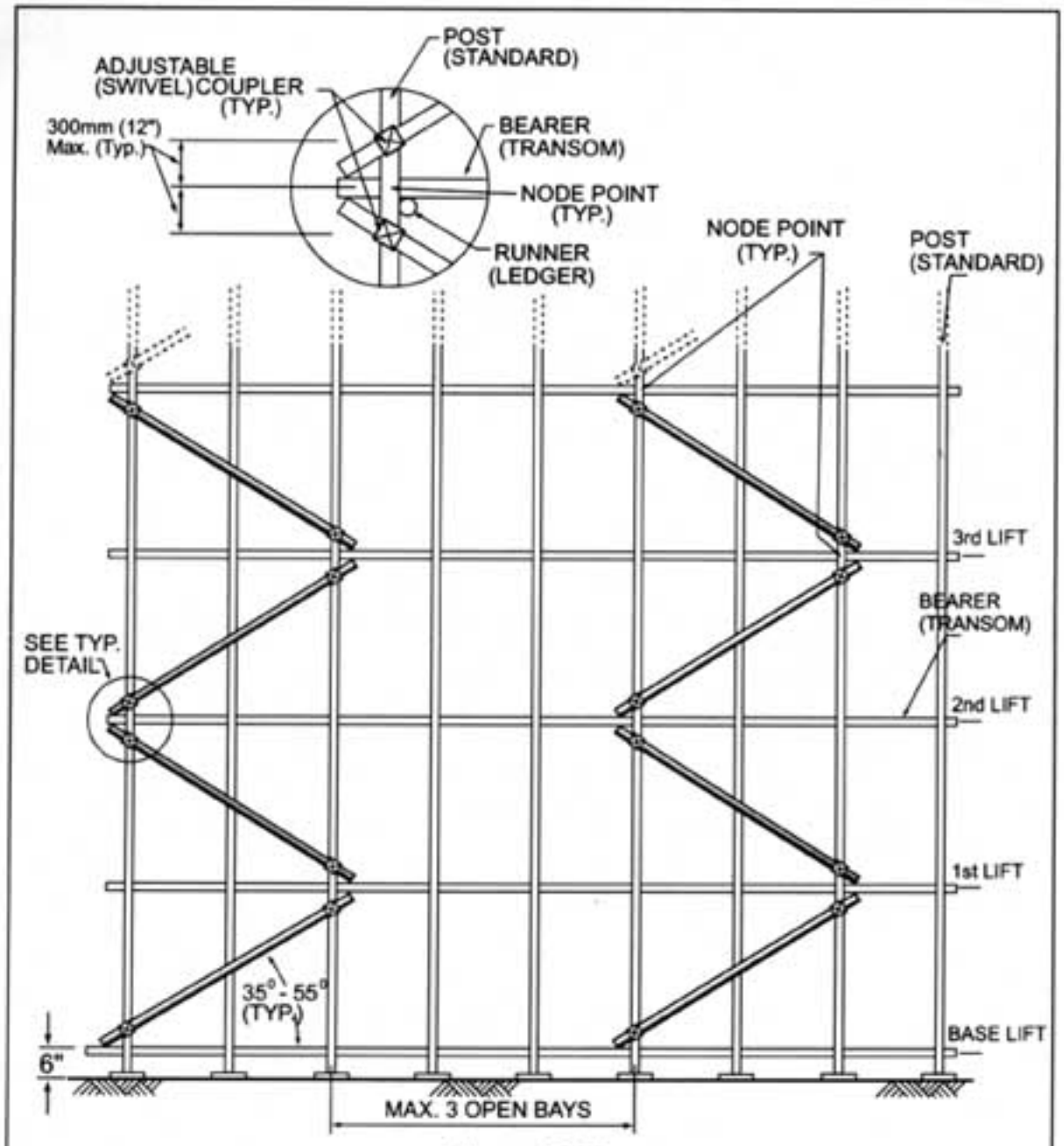


Figure II.9.56

TRANSVERSE (SECTIONAL) "ZIG-ZAG" BRACING TUBE AND COUPLER SCAFFOLD

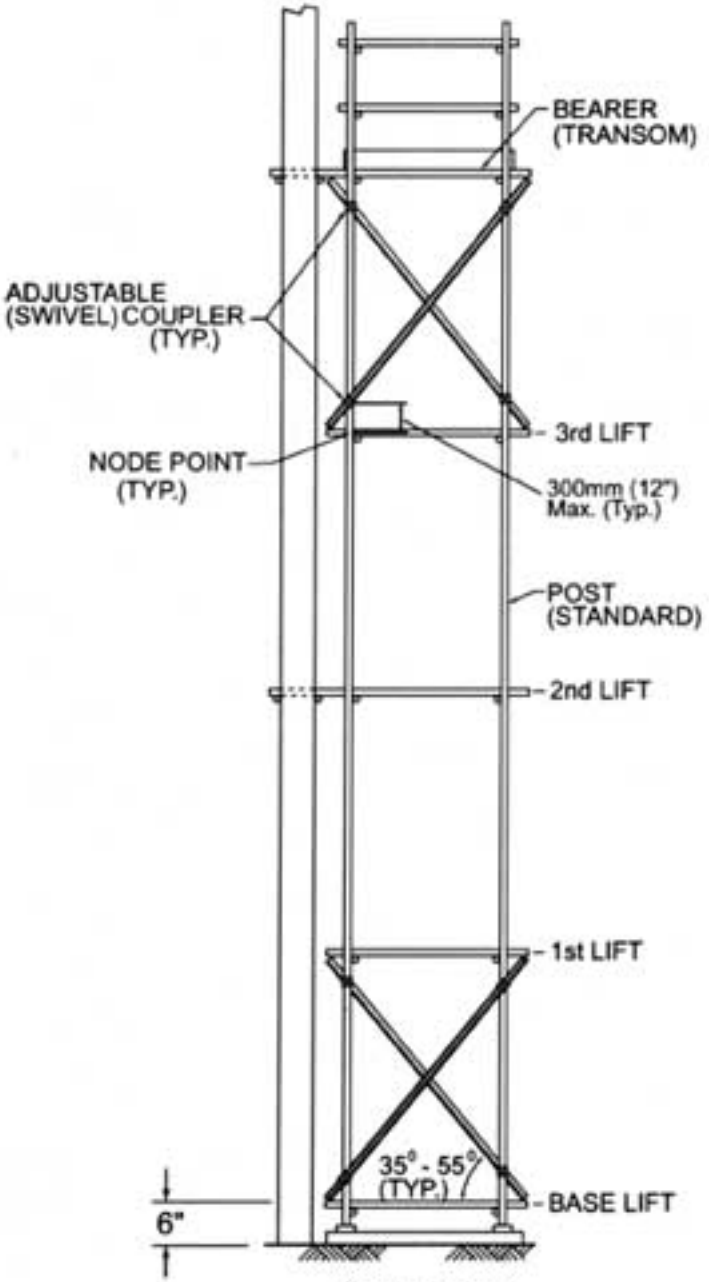


Figure II.9.57

TRANSVERSE (SECTIONAL) "X" BRACING
TUBE AND COUPLER SCAFFOLD

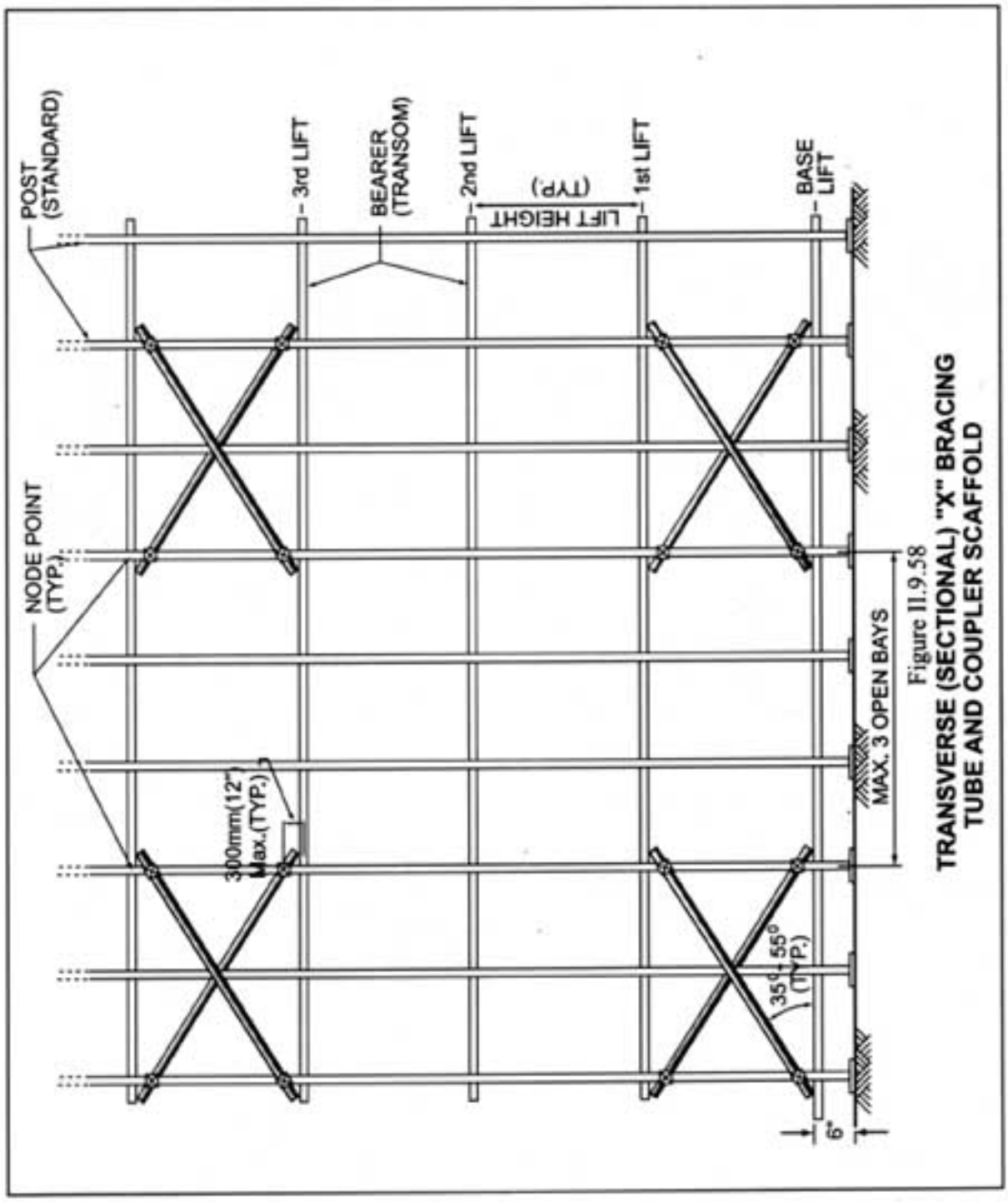


Figure 11.9.58
TRANSVERSE (SECTIONAL) "X" BRACING TUBE AND COUPLER SCAFFOLD

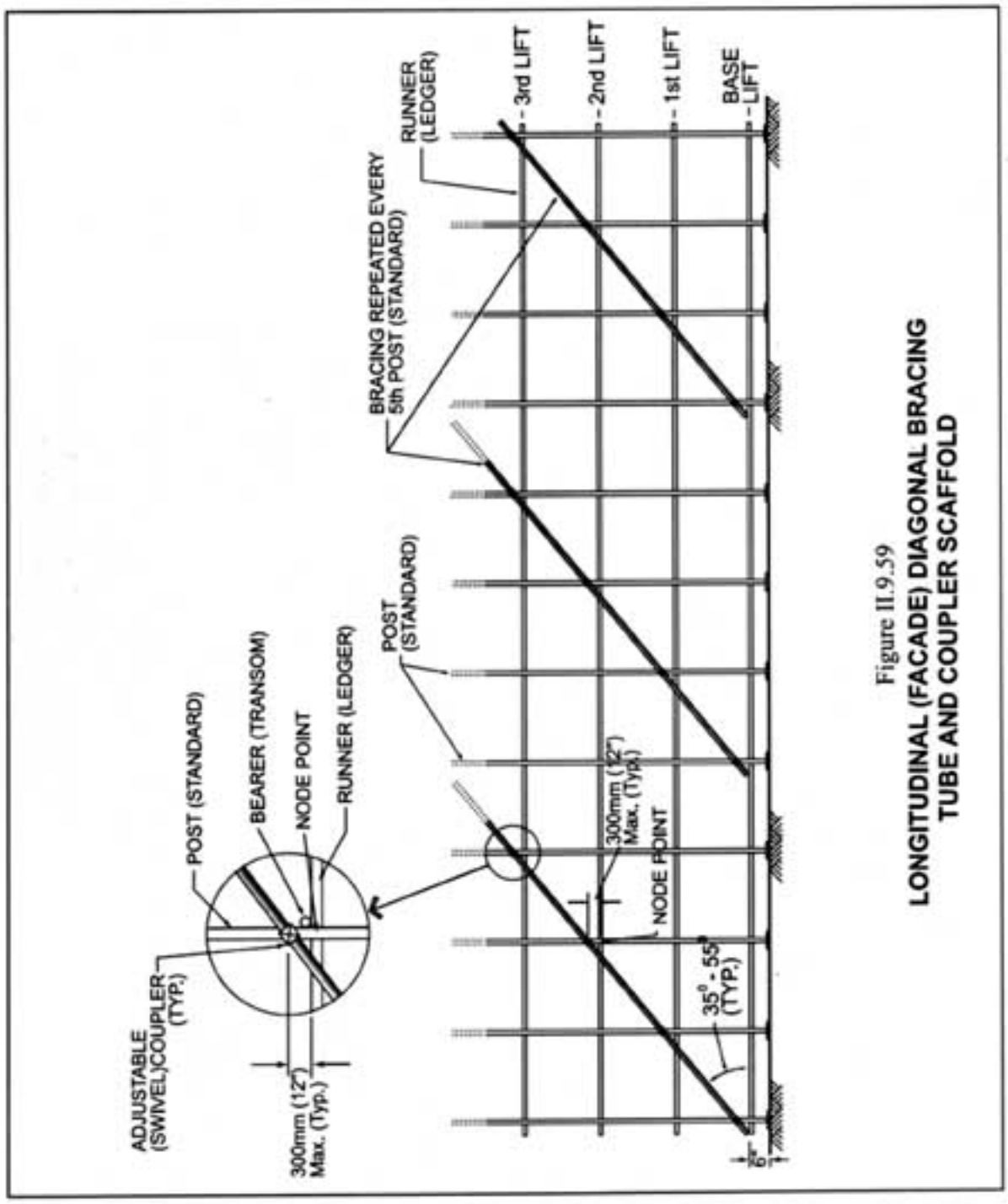


Figure II.9.59
LONGITUDINAL (FACADE) DIAGONAL BRACING TUBE AND COUPLER SCAFFOLD

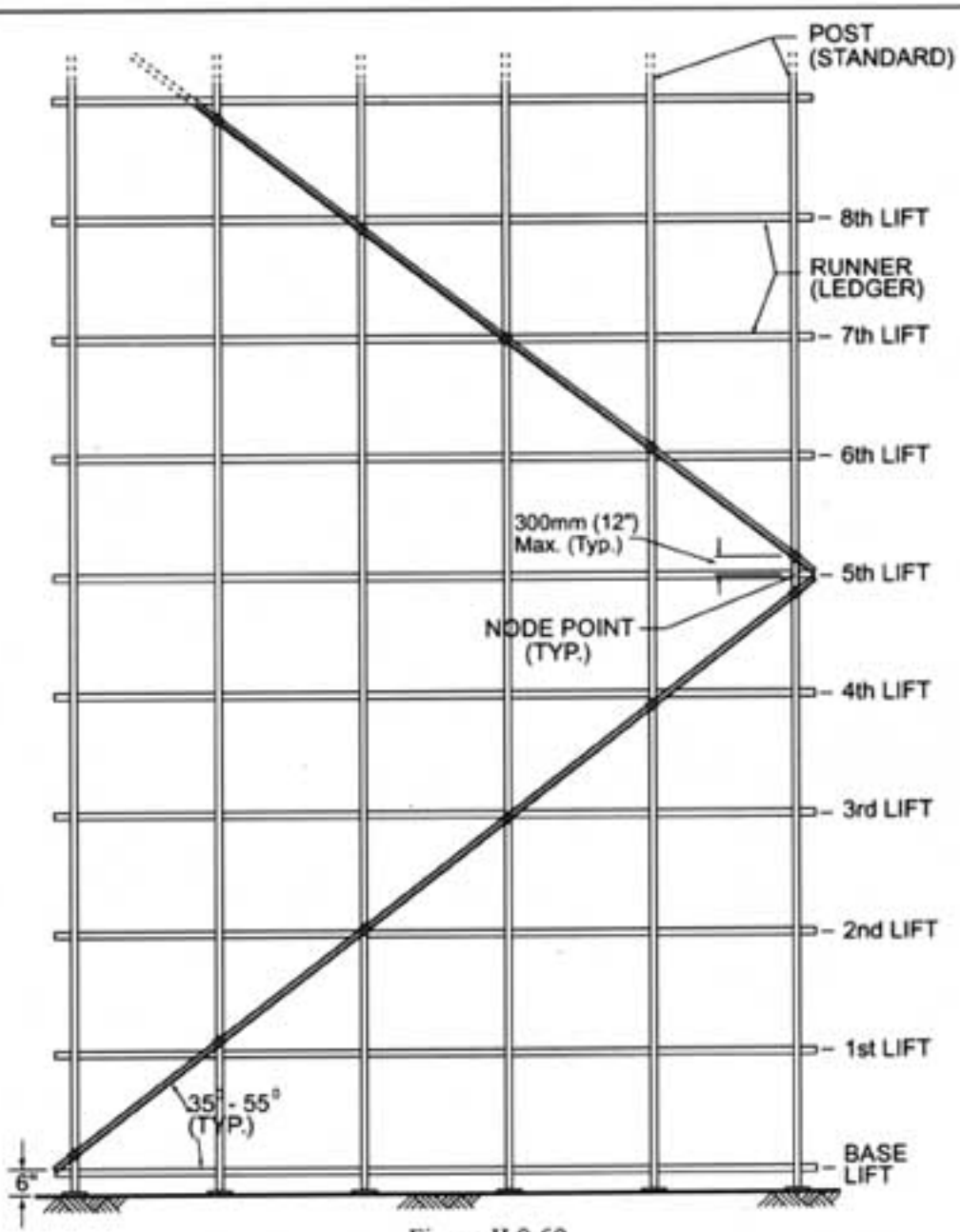


Figure II.9.60

LONGITUDINAL (FACADE) DIAGONAL BRACING
TUBE AND COUPLER SCAFFOLD

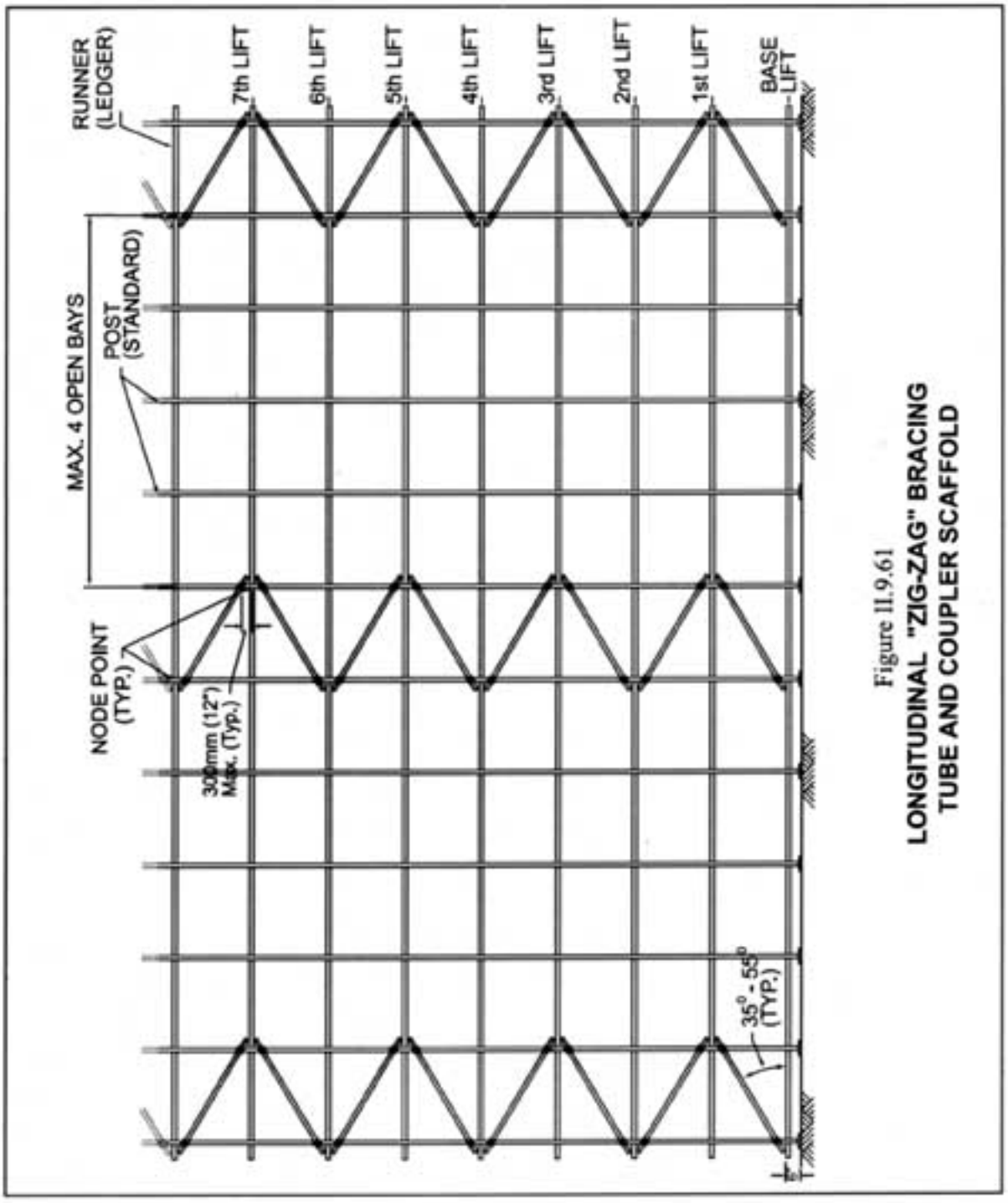


Figure 11.9.61
LONGITUDINAL "ZIG-ZAG" BRACING TUBE AND COUPLER SCAFFOLD

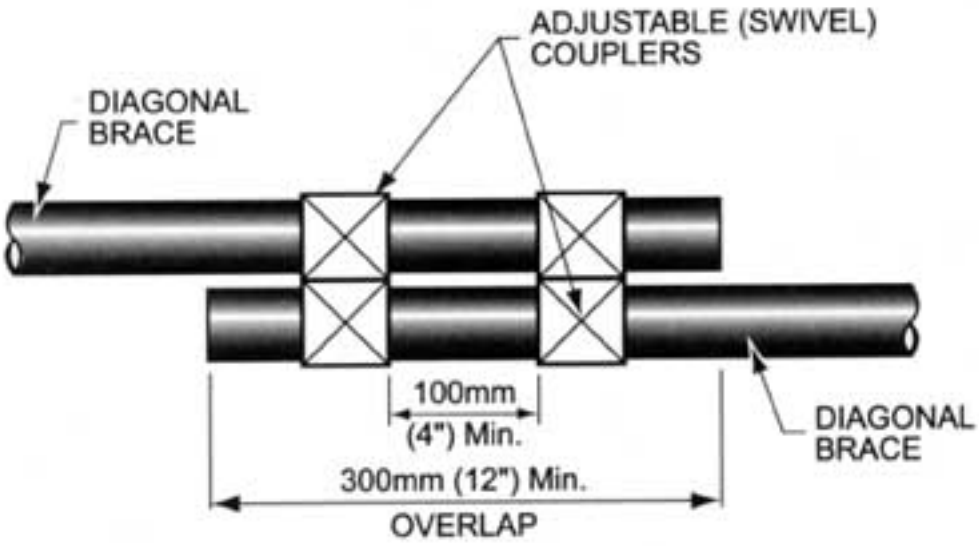
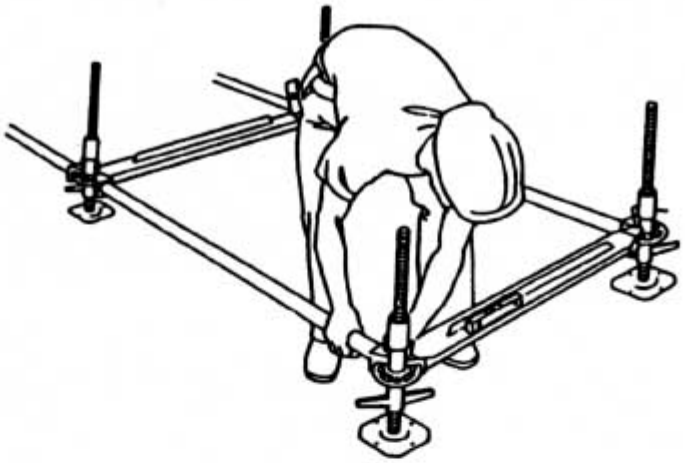
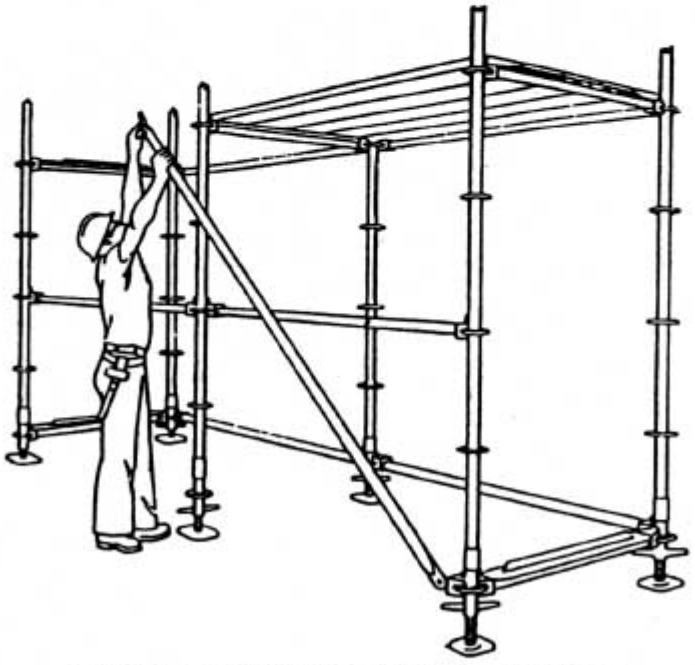


Figure II.9.62
BRACE SPLICE

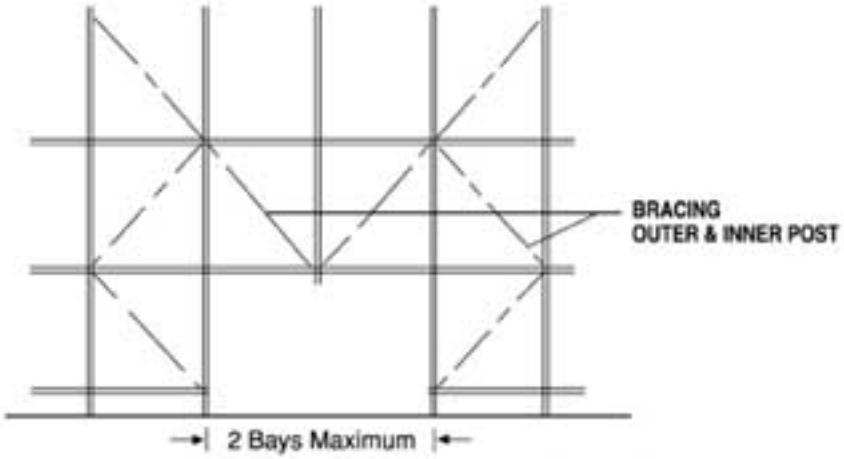


TYPICAL SYSTEM SCAFFOLD BASE IN THE PROCESS
OF BEING ASSEMBLED AND LEVELLED

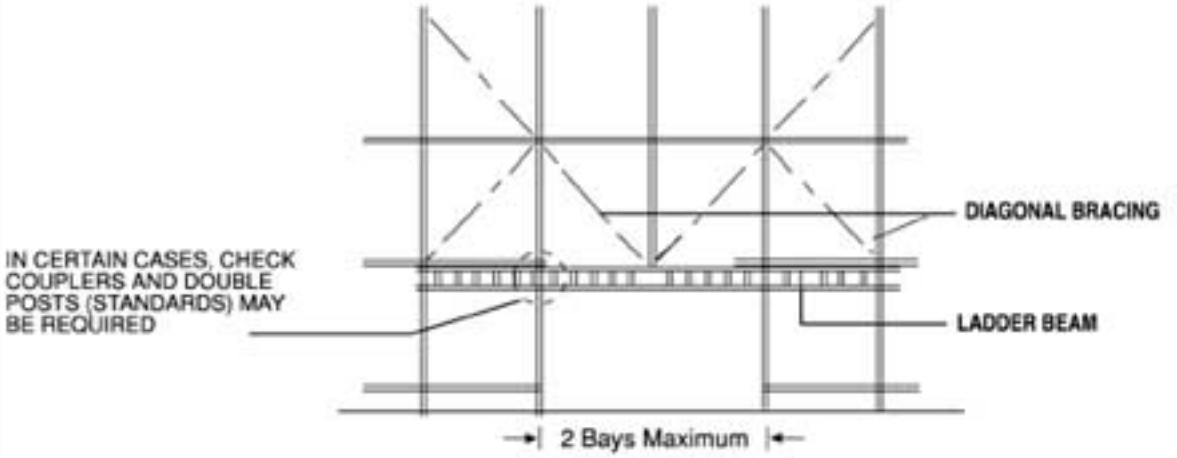


TYPICAL SYSTEM SCAFFOLD BEING ASSEMBLED

Figure II.9.63
SYSTEM SCAFFOLD ERECTION



TYPICAL BRIDGING FOR 2 BAYS, LIGHT-DUTY SCAFFOLD



TYPICAL BRIDGING FOR 2 BAYS, MEDIUM-DUTY SCAFFOLD

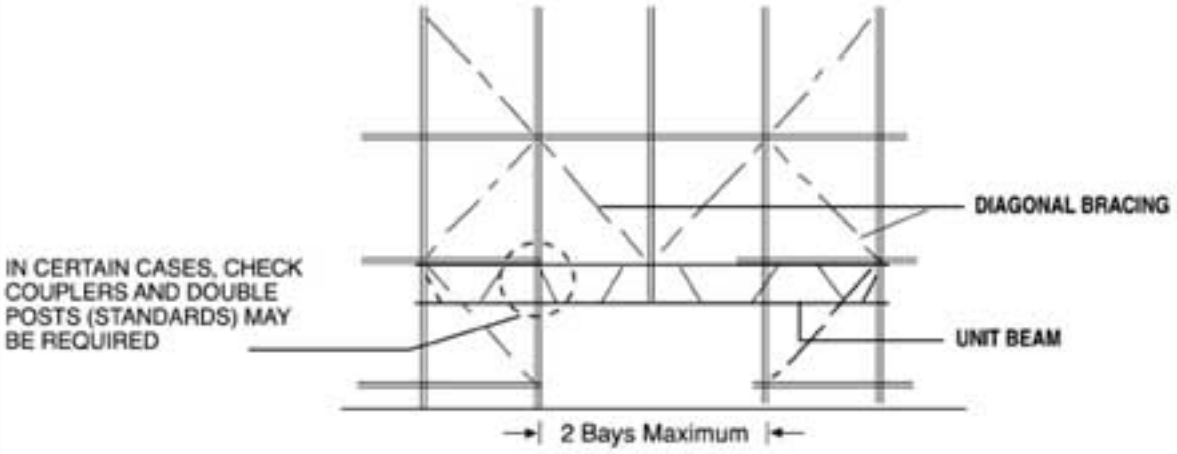


Figure II.9.63 •

TYPICAL BRIDGING

Denotes change

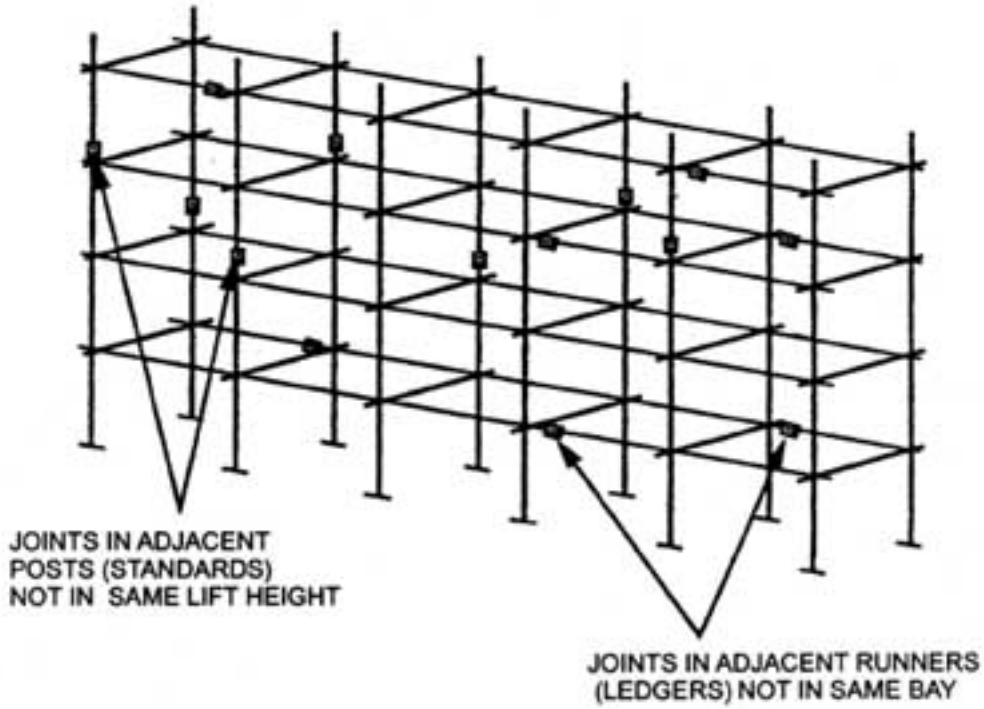


Figure II.9.65
SCAFFOLD JOINTS

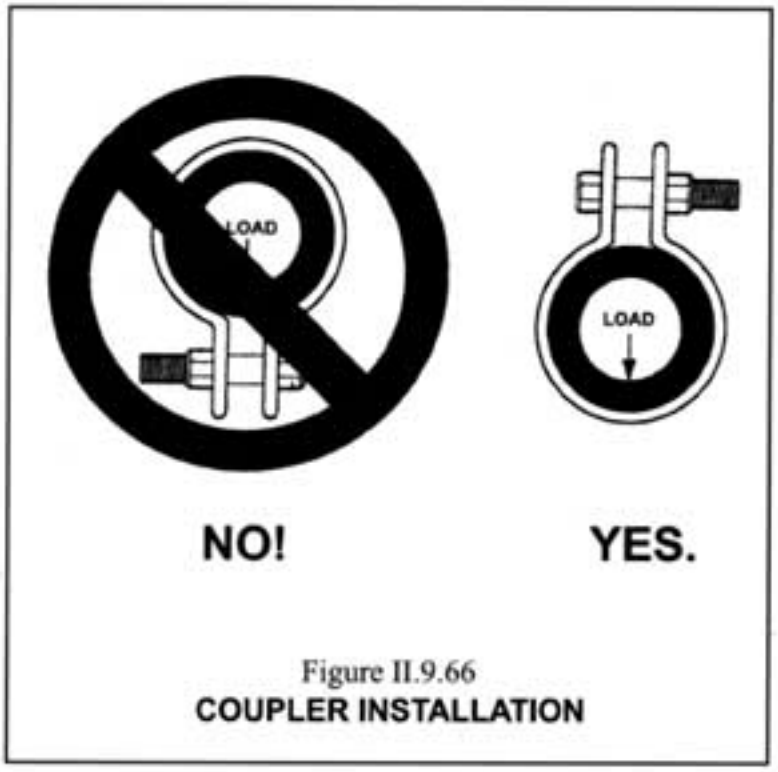


Figure II.9.66
COUPLER INSTALLATION

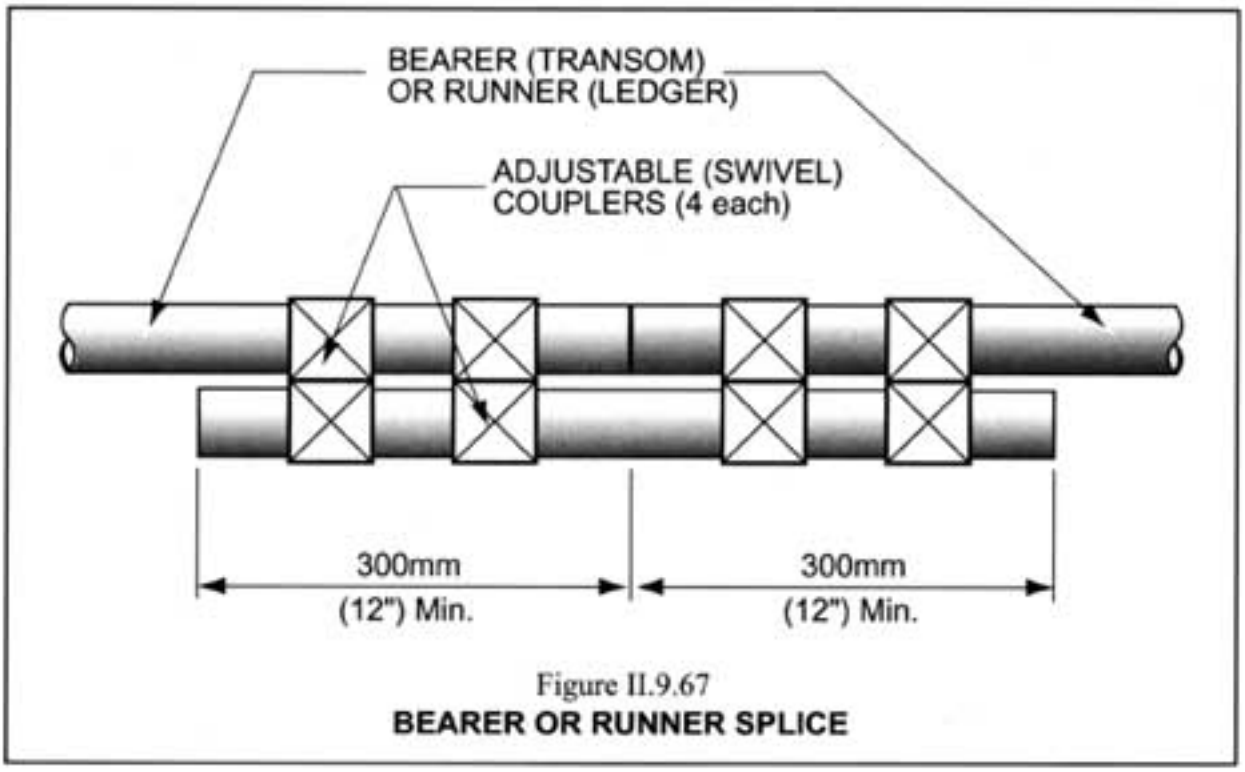


Figure II.9.67
BEARER OR RUNNER SPLICE

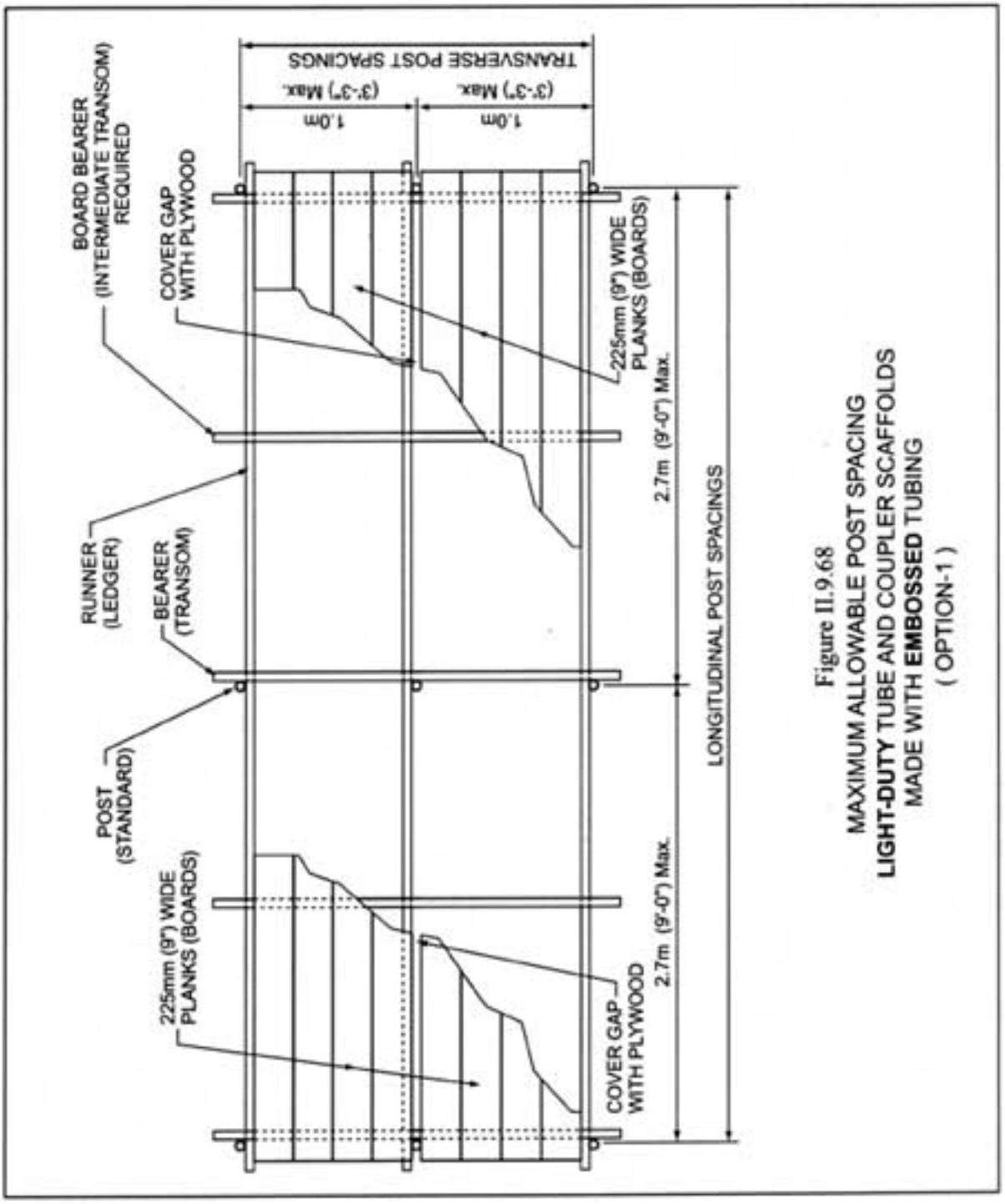


Figure II.9.68
MAXIMUM ALLOWABLE POST SPACING
LIGHT-DUTY TUBE AND COUPLER SCAFFOLDS
MADE WITH **EMBOSSED** TUBING
(OPTION-1)

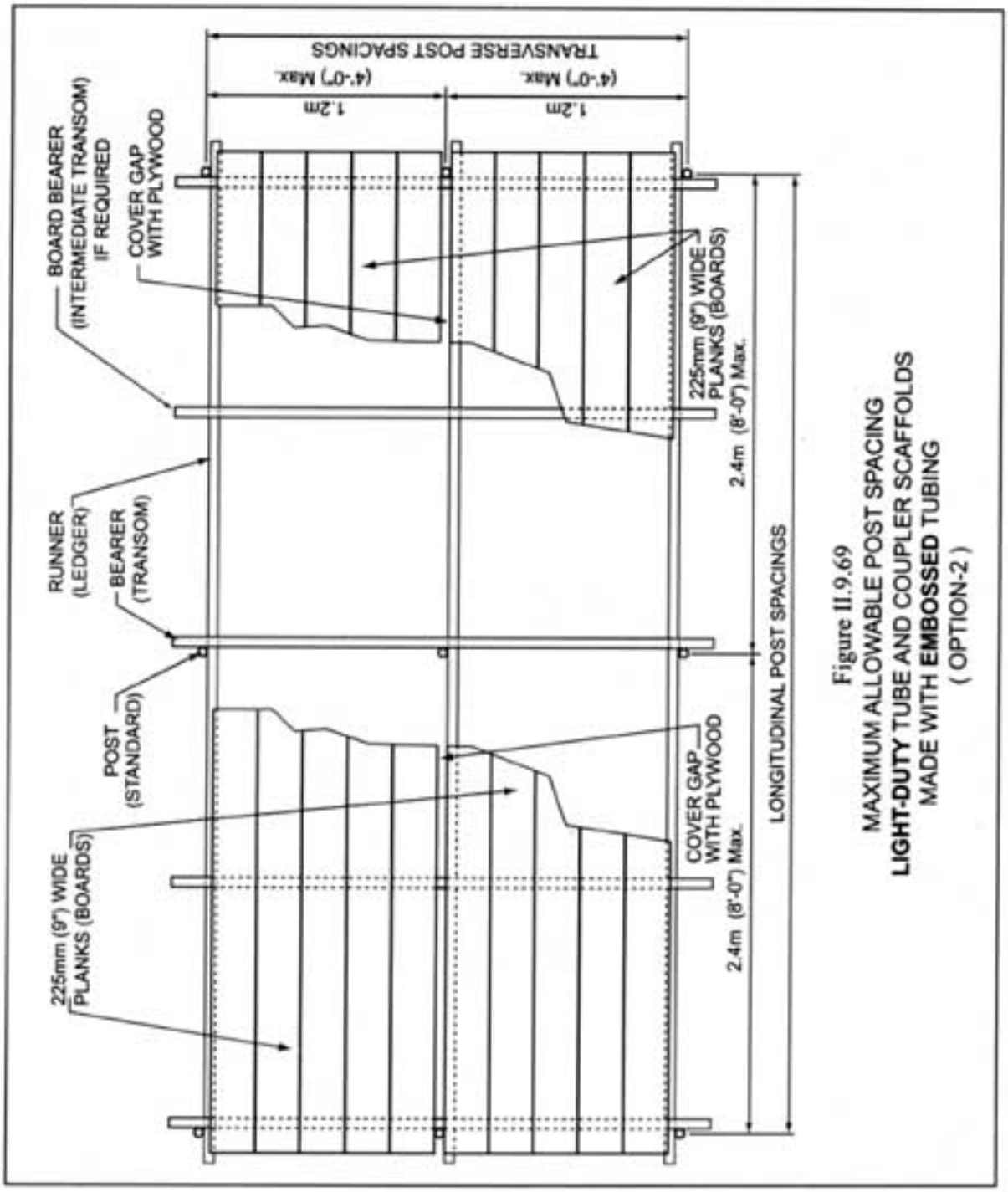


Figure II.9.69
MAXIMUM ALLOWABLE POST SPACING
LIGHT-DUTY TUBE AND COUPLER SCAFFOLDS
MADE WITH **EMBOSSED** TUBING
(OPTION-2)

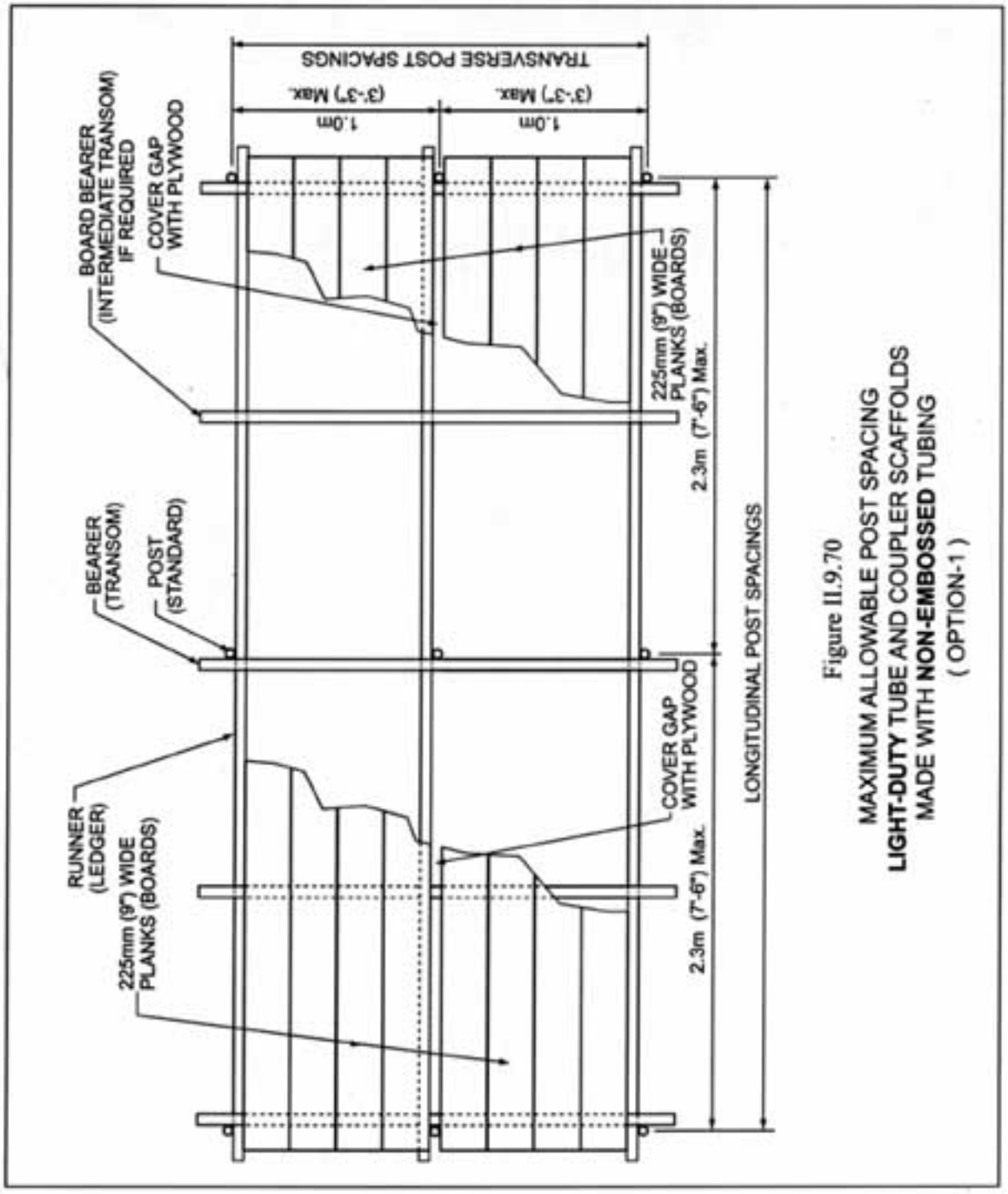


Figure II.9.70
MAXIMUM ALLOWABLE POST SPACING
LIGHT-DUTY TUBE AND COUPLER SCAFFOLDS
MADE WITH **NON-EMBOSSED** TUBING
(OPTION-1)

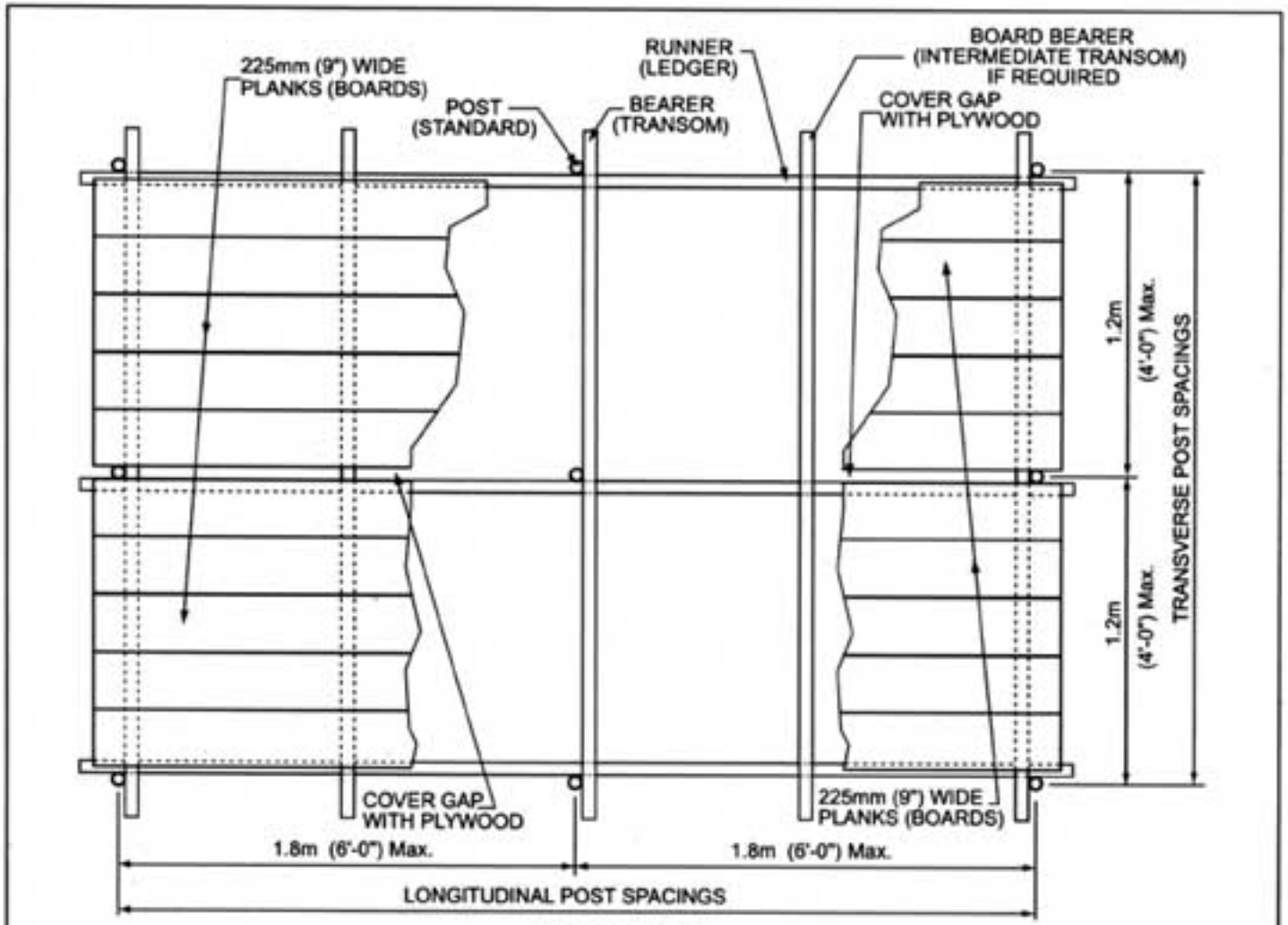


Figure II.9.71
MAXIMUM ALLOWABLE POST SPACING
LIGHT-DUTY TUBE AND COUPLER SCAFFOLDS
MADE WITH **NON-EMBOSSED** TUBING
(OPTION-2)

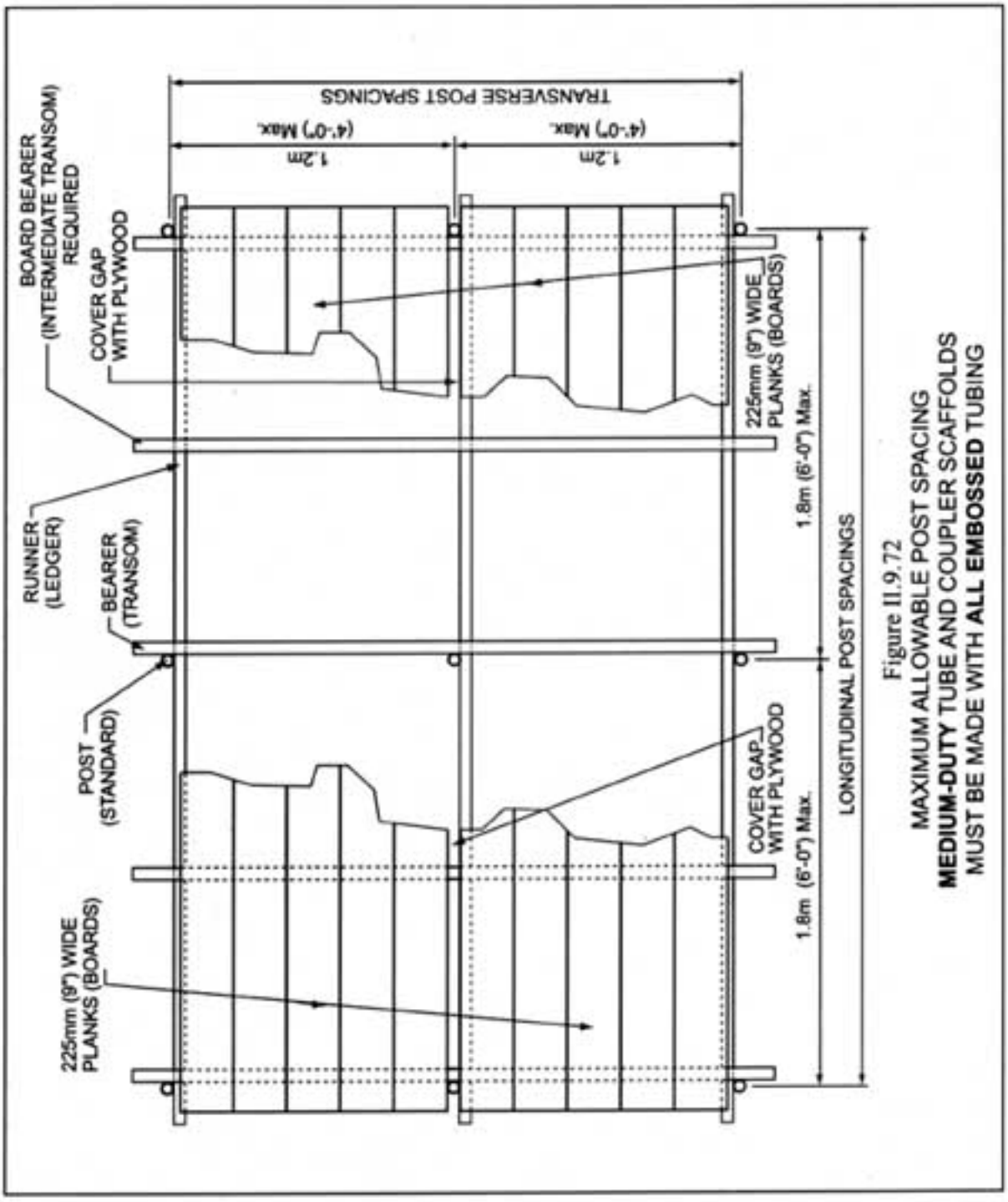


Figure II.9.72
MAXIMUM ALLOWABLE POST SPACING
MEDIUM-DUTY TUBE AND COUPLER SCAFFOLDS
MUST BE MADE WITH **ALL EMBOSSED** TUBING

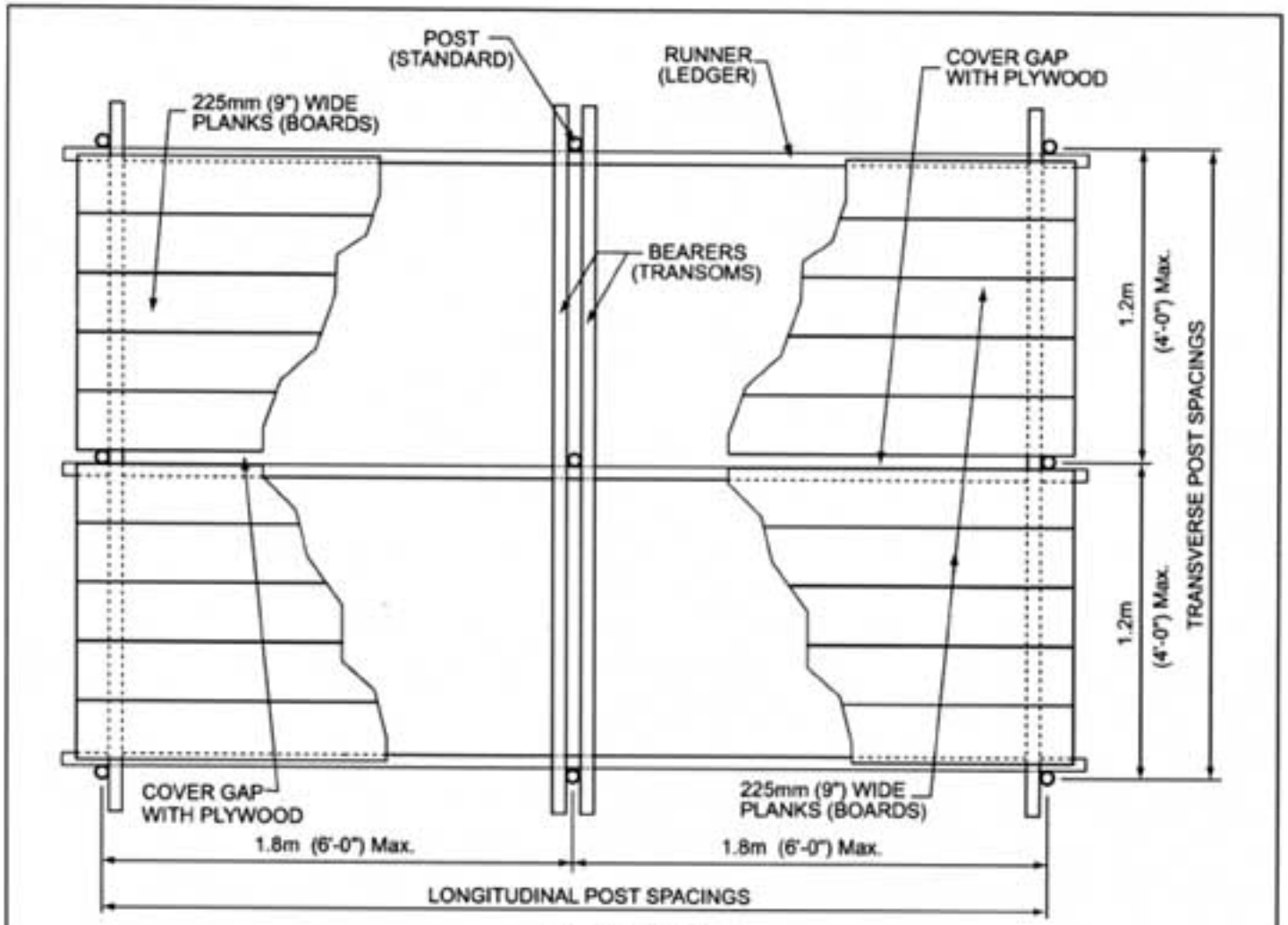


Figure II.9.73

MAXIMUM ALLOWABLE POST SPACING
MEDIUM-DUTY TUBE AND COUPLER SCAFFOLDS
MUST BE MADE WITH **ALL EMBOSSED** TUBING

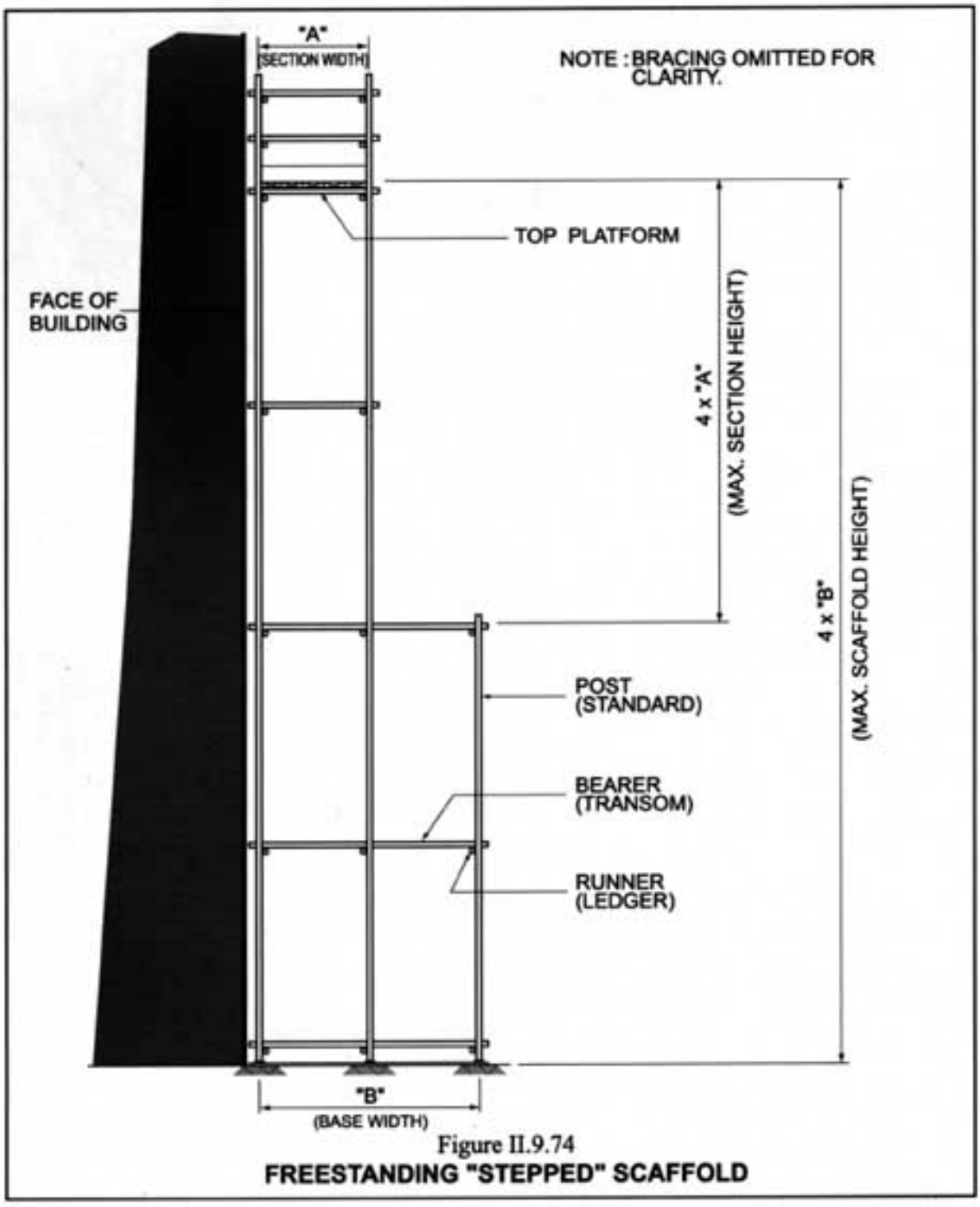


Figure II.9.74
FREESTANDING "STEPPED" SCAFFOLD

Saudi Aramco

Scaffold Safety Handbook

Addendum #1

January 15, 2002

Para. 9.14.1(E) Brackets and Straps

Exception: If the type of bracket strap shown in the following Figure is used, it is not necessary to have 25 mm (1 inch) welds down the sides of the bracket strap.

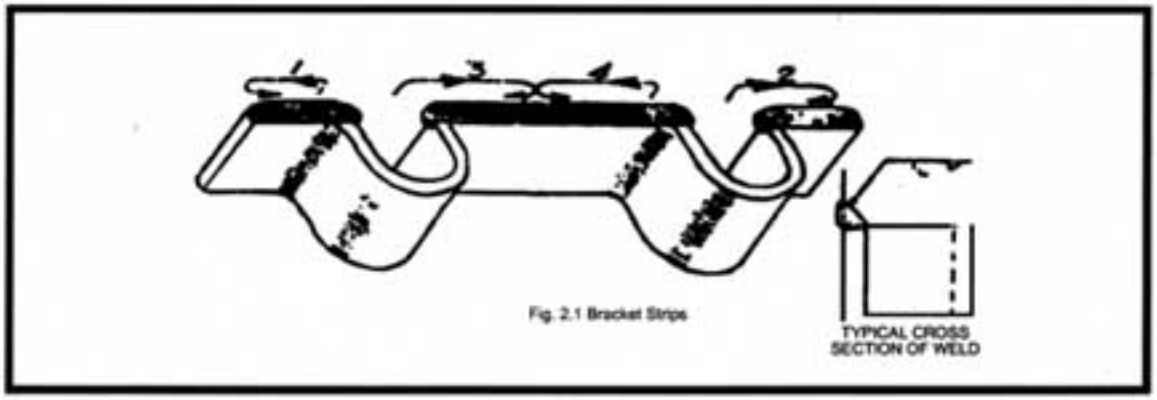


Fig. 2.1 Bracket Strips

Para. 9.14.2(D) Guardrails and Platforms for Bracket Scaffolds

Exception: A sleeve or spigot pin, welded to the bracket and used to anchor a guardrail support upright, may be 100 mm (4 inch) high only if the upright is firmly secured to the stub sleeve or pin with a steel hairpin to prevent the upright from coming loose, as shown in the following Figure.

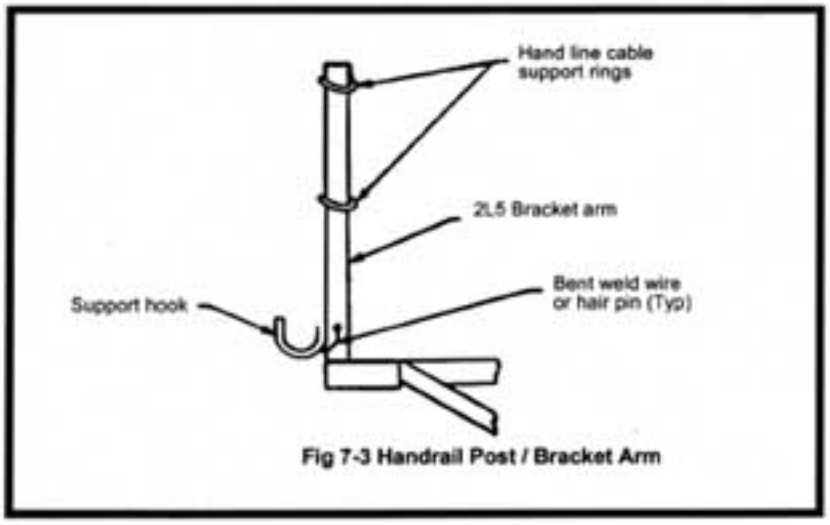


Fig 7-3 Handrail Post / Bracket Arm

Addendum #2
Access Scaffolding (Not Formwork) Structural Design Criteria

June 1, 2003

1. Basic Structural Criteria: Saudi Aramco's *Scaffold Safety Handbook* (SSH), Sec. 9.8.1

   Dead Loads + 4 Live Loads < Failure

   Failure: defined in SSH, Page 8

2. Materials

   Cold-formed steel exhibits average yield strength in excess of the specified minimum. Therefore, for scaffolding materials, Strength Increase Factor (SIF) is as follows:

Normal Case	SIF = 1.0	
Maximum	SIF = 1.10	(Requires vendor verification by yield strength test data)

3. Flexural Elements (Runners & Bearers)

   $M(D+4L) < Mf$ where $Mf = SIF * Fy * Z$

   Where:

   M = simple span (pinned ends) moment (unless agreed to by LPD-TSU & CSD-CEU)

   Fy = *minimum specified* yield stress per the specification for which the pipe has been fabricated (see SSH 9.7.2)

   Z = Plastic Section Modulus. For pipe, $Z = (d^3/6) - (d_i^3 / 6)$, where d = OD, d_i = ID

4. Compression Elements (Posts & Braces)

4.1 Compression - Gravity Loads Only:

$P(D+L) < Pf / 4$ where $Pf = Ag * Fa$

Compression to be checked for working/planked level options in SSH Table II.9.7 & II.9.8.

Using Allowable Stress Design (ASD) formulas from the AISC ASD Manual (9th Edition):

For $Kl/r < C$:

$Fa = [1 - ((Kl/r)^2 / 2C_c^2)] * Fy * SIF$ AISC ASD Eqn. E2-1 W/O Safety Factor

For $Kl/r > C_c$:

$Fa = \pi^2 E / (Kl/r)^2$ AISC ASD Eqn. E2-2 W/O Safety Factor

Where:

$C_c = SQRT((2\pi^2 E) / (Fy * SIF))$

K - 1.0

However K = 0.85 (min.) may be permitted if justified by system scaffolding mfg. test data and agreed to by LPD-TSU & CSD-CEU.

Addendum #2
Access Scaffolding Structural Design Criteria (page 2 of 2)

- Wind Loading

For individual scaffolds, the following loading combinations shall also be checked and not produce failure of any scaffold element, especially posts and braces:

i. Dead Load + 4 times Live Load + Service Level Wind Load

ii. Dead Load + Maximum Wind Load

Service Level Wind Load shall be determined using a wind speed of 65 kph (40 mph), as per 9.5.11 of the SSH.

Maximum Wind Load shall determined using the 3-second gust wind speed appropriate for the location, as shown in SAES-A-112.

All wind loads calculations, including shape factors for round and flat surfaces, shall be in accordance with ASCE 7-98 for wind loads on "Other Structures." An Importance Factor of 1.0 shall be assumed.

Wind loads shall be calculated at various heights for tall scaffolds, including the highest point, to enable the wind load to be more accurately assessed.

For tube and coupler scaffolds, tributary wind areas shall be increased an additional 10% to allow for fittings, overlaps, etc.

Wind shielding shall not be allowed anywhere on the scaffold.

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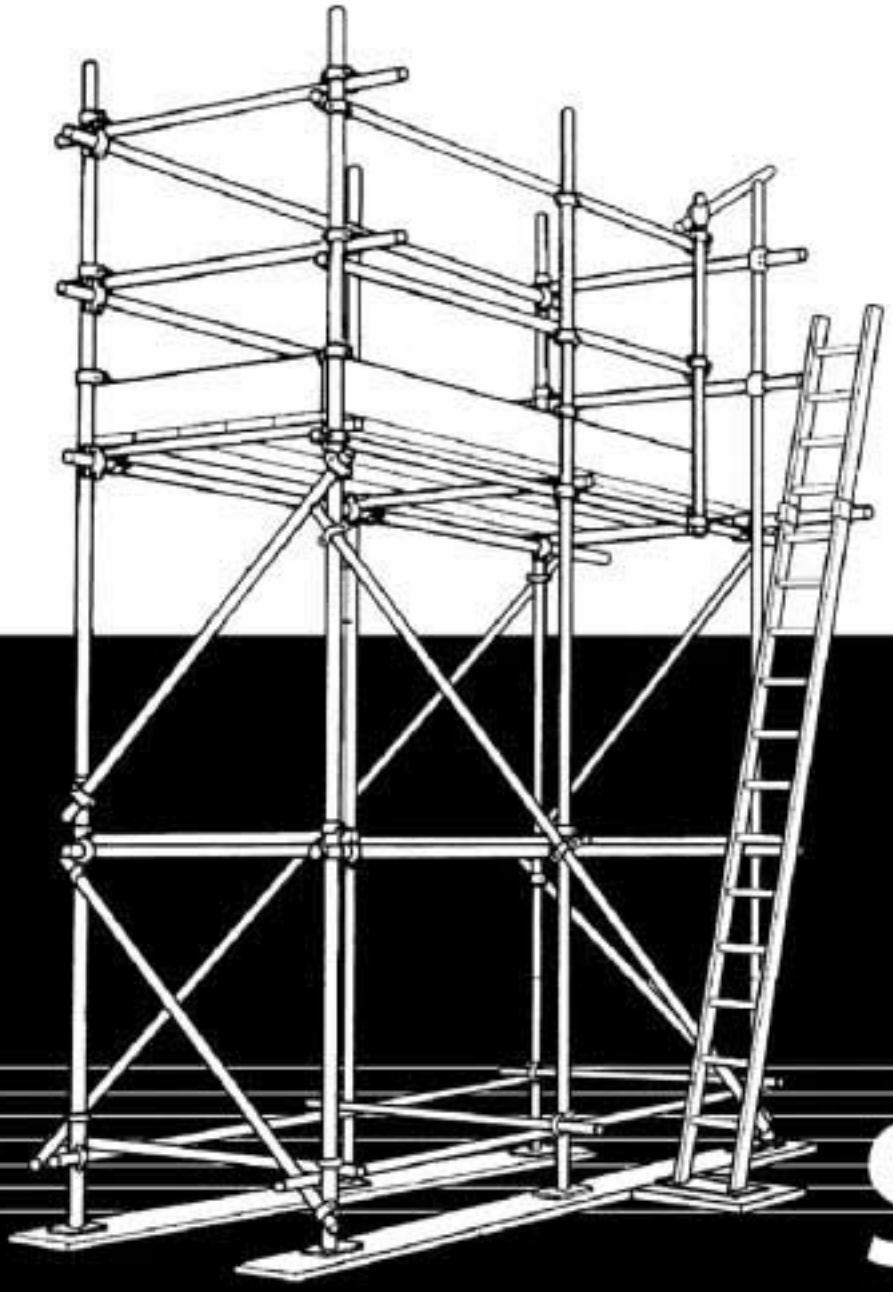
Saudi Aramco



Scaffold Safety Handbook