Session No.653

Introduction to Basic Scaffold Safety

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Introduction

A scaffold is defined as any temporary elevated work platform (supported or suspended) and its supporting structure (including points of anchorage) used for supporting employees or materials or both. Note that there are three main points to the definition: it is elevated, it is temporary, and it supports either personnel or materials or both.

Scaffolds are divided into two main categories, those supported from underneath, or those suspended from above. OSHA has specific rules for 25 different types of scaffolds in 29CFR 1926.452. This paper is a short overview of some of the general requirements for supported scaffolds.

When planning a scaffold job, one of the first considerations is training of personnel. All personnel who will use a scaffold must have User training, covering such topics as fall protection, loading, electrical safety, material handling, falling object protection and safe work practices (1926.454(a)). All personnel involved in inspecting, erecting, or modifying scaffolds must be trained in scaffold hazards, assembly procedures, design criteria, loading, OSHA regulations, and manufacturer's recommended assembly instructions as applicable to the type of scaffold being used. (1926.454(b)). A *Competent Person* must supervise erection and perform inspections every work shift (1926.451(f)(7) and 1926.451(f)(3).

WARNING: *SERIOUS INJURY OR DEATH CAN RESULT FROM IMPROPER ERECTION OR USE OF SCAFFOLDING EQUIPMENT. ERECTORS AND USERS MUST BE TRAINED IN, AND MUST FOLLOW SAFE PRACTICES, PROCEDURES, AND SPECIFIC SAFETY RULES.*

A *Qualified Person* should design the scaffold job (1926.451(a)(6)). Since each jobsite presents unique conditions, the following items must be considered:

a. Proximity of electric lines 1926.45 (f)(6), process piping or overhead obstructions.
b. Adequate access to the job site.
c. Weather conditions and wind/weather protection.
d. Openings, pits and ground conditions.
e. Adequate foundations of sufficient strength to support scaffolds from a sound, stable surface that assures support of the intended loads.
f. Interference with other jobs or workers.
g. Environmental hazards.
h. Proper bracing that is rigid in all directions.
i. Safe and easy means of access and egress to the platform.
j. Fall protection for workers using the scaffold.
k. Adequate decking materials and overhead protection, where required.

l. Falling object protection of people passing, working near or underneath the scaffold.
m. Planning for the loading (weight) on the scaffold.

Loading on the scaffold is a major item to consider when planning a scaffold job. Historically, the scaffold structure loading calculations have been based on one of three anticipated load ratings. Light duty is the term for up to 25 pounds per square foot. Medium duty is the term for up to 50 pounds per square foot. Heavy duty is the term for up to 75 pounds per square foot. The user should know how much weight they will place on the platform with workers, tools, materials, and plan for the corresponding rating. The anticipated loading should be communicated to the erector. Consult the manufacturer of the specific equipment for allowable load limits.

Planning for Fall Protection is extremely important in planning, erecting, and using a scaffold. By definition, a scaffold platform is elevated. Consequently both scaffold users and erectors are exposed to fall hazards.

For most supported scaffolds, the guardrails are the fall protection system for the user. If the guardrails are installed, a personal fall arrest is not required. If the guardrails are not in place, then a personal fall arrest system must be employed. For boatswain's chair, cantenary, float, needle beam or ladder jack scaffold, a personal fall arrest system is required (instead of guardrails). For single point or two point suspended scaffolds, both guardrails and a personal fall arrest system are required. On suspended scaffolds, a vertical lifeline in combination with a rope grab is used. The anchorage point for the vertical lifeline system must be separate from the anchorage used for the scaffold support lines.

Inspecting Equipment. Scaffolds are often used on construction sites, in industrial settings, and in other harsh environments. As a result the equipment may be subject to damage during use as a result of erection, dismantling, handling, transporting, or environment conditions.

All scaffolding equipment must be carefully inspected before use to insure that it is serviceable and in good condition. Damaged or deteriorated equipment must be removed from service.

a. Do not use scaffold equipment or accessories that are obviously damaged.
b. Do not use rusty or corroded scaffold equipment. The strength of rusty, corroded equipment is unknown. If any areas show pitting, flaking, powdering, or excessive rust, discard the equipment. Certain atmospheric conditions (such as might be present in industrial plants) may corrode steel after short exposure. This corrosion may appear to be rust, only brighter in color.
c. Check for bent components, in particular where the tube is kinked, flattened, or crushed.
d. Check for cracks around welds, joints, or around the circumference.
e. Look inside the tube and inspect for rust.
f. Check moving parts such as gravity locks for freedom of movement.
g. Check for brackets with deformed attachment hooks.
h. Check the holes in cross braces for splitting out.
i. Check manufactured planking for missing hooks, locks, missing rivets, bent siderails, or damaged walking surface. If the surface is plywood, check for rotten areas.
j. Check castors for damaged brakes, axles, or stems.
k. Look for any painted areas which appear blistered, cracked, or crazed which may indicate prior damage.

l. When in doubt about the condition of scaffold equipment, either discard the component, or consult your scaffolding supplier. Do not take chances with potentially defective equipment. Remember that scaffolding components are relatively inexpensive commodities to replace, especially compared to the cost of an accident.

Foundation. Mud sills must be sized to distribute scaffolding loads to the ground or support structure. The following may be used to determine the size pads needed. First, calculate the weight imposed by the scaffold leg on the sill (leg load). Then divide that number by the square footage of the sill to determine the PSF imposed on the soil. Plan for a large enough sill to reduce the PSF imposed on the soil to match the soil capacity. The soil capacity should be determined by a competent person using guidelines from 29CFR1926 (Subpart P). Don't use unstable objects, loose bricks, etc., as a sill.

Base plates with screw jacks should always be used so that you will be able to make leveling adjustments later.

a. Start at high ground try to keep screw jack extension to a minimum. While some jacks may extend to 18", the capacity decreases as extension increases.
b. Make sure the jack handles firmly contact the frame leg. Settling or uneven leg loading may cause a leg to "raise up" off the handle slightly. In this case, recheck the level on the other legs as well. Check manufacturer's recommendations.

Tieing the Scaffold to a Structure

The scaffold must be secured to prevent it from tipping. This may be accomplished by tieing the scaffolding to an adjacent structure, using guy wires, or increasing the base width. The narrower the scaffold, the more likely it is tip over. It is less stable in the narrow direction. Consequently, the vertical location of the first tie-in is a factor of the minimum base width (the narrower direction). As the scaffold rises, the first tie must be no higher than four (4) times the minimum base width. For example, if the scaffold is 5' wide and 21' long, the first tie should be at 20' (4 times 5).

Note: California requires stability bracing when the scaffold height exceeds three (3) times the minimum base width.

a. 1) After securing the first tie-in at an elevation of four times the minimum base, two separate requirements are given for the next interval up.
    a. If the scaffold is wider than 3', subsequent tie-ins must be secured to the building or structure at intervals no greater than 26 feet vertically.
    b. If the scaffold is less than 3' wide, the subsequent tie-ins must be at no greater than 20' maximum vertical intervals.
    2) Ties should be placed as close as possible to the top of the scaffold, but no further down from the top as four times the minimum base dimension.
b. These ties must be placed at both ends and every 30' horizontally. For example, if the scaffold were 120' long, the ties would be at 30', 60', 90', and at both ends.
c. Ties should be installed during the erection process and should not be removed until the scaffold is dismantled to that height.
d. Anchoring, guying, tying off or bracing of scaffolds must be affixed to structurally sound components. It is crucial that the tie be properly attached and able to carry the tension and compression loads. If guying is necessary, have an engineer design the guy system.

e. Overturning forces are imposed by side brackets, hoist arms, cantilevered platforms, and machinery in use (e.g. hydro- blasting). Additional ties may be required. Consult an engineer for a design on enclosed scaffolds.
f. Circular scaffolds that are erected completely around or inside a structure may be prevented from tipping by installing “stand off” braces.

Wind Force

Wind can generate tremendous forces of scaffolds, especially on a scaffold enclosed by tarps, poly wrap, or other covering. Consult an engineer for a design on enclosed scaffolds.

Guying

When there is no structure available for anchor ties, guy cables may be used to provide lateral stability.

a. Guying is not a substitute for vertical or horizontal bracing.
b. Guying requires careful analysis and design which should be performed by a competent engineer. Unanticipated forces can easily overstress scaffold components.
c. Use the proper size wire rope or cable for guying.
d. Three clips should be used to make each cable connection. When tying to a structure, make sure the structure is adequate to withstand the loads.
e. Provide guys to ensure stability as the scaffold is erected. Remove all slack from the cables; but, do not overtighten them.

Caution: Overtightening the cables can pre-load the legs and cause failure.

Access

A platform should not be installed on a scaffold without a safe and easy means of access. An access ladder or equivalent safe access must be provided for any platform more than 2 feet above a lower level.

Access may be provided by ladders specifically made for scaffold access by scaffold manufacturers, portable ladders, stair towers, stairway-type ladders, ramps, walkways, integral prefabricated rungs in the frame, or direct access from another structure.

a. Cross-braces shall not be used as a means of access.
b. Follow the manufacturer's recommendations for ladders that are specifically manufactured for scaffold access and egress.
c. Attachable ladders made specifically for scaffolding must meet the following:
    1. Be positioned so as not to tip the scaffold.
    2. Have the lowest rung within 24" of the lower level.
    3. If higher than 35', have a rest platform 35' maximum.
    4. Have a horizontal rung length of at least 11 1/2".
    5. Have a maximum vertical rung spacing of 16 3/4". Note: Most manufacturers set the vertical spacing at 12", to conform to fixed ladders.
    6. Most manufacturers’ recommend that the ladder extend 3 feet above the platform level. Ladders vary in strength of material and standard length. Consult the manufacturer for maximum ladder extension above the top of tube & coupler or system scaffold posts.

d. Stair-towers, when used, shall meet the criteria in 1926.451(e)(4).
e. Ramps, when used, shall meet the criteria in 1926.451(e)(5).
f. Stairway-type ladders must meet the criteria in 1926.451(e)(3).
g. Most frames should not be climbed. However, some frames do have integral prefabricated scaffold access rungs and must meet the following criteria:
    1. Must be specifically designed by the manufacturer as a ladder rung. Note: most horizontal members found on frames are intended for structural bracing or shelving platforms, not as ladder rungs.
    2. Have a rung length of at least 8".
    3. Be uniformly spaced.
    4. Not be used as a work platform.
    5. Have a rest platform available at maximum 35' intervals
    6. Have maximum vertical spacing of 16 3/4". Note: This rules out climbing the end horizontals of most mason style frames.

Selecting planks. Planks may be solid sawn wood, manufactured wood, or manufactured steel or aluminum planks. If solid sawn is used, it must be of a specific grade as determined by a certified grading association or agency. The most popular solid sawn is southern pine. The minimum grade is Dense Industrial 65 as determined by the Southern Pine Inspection Bureau.

Steel hook-on type planks are available for system scaffolds from many manufacturers. These are made in various lengths to fit the runner length of the system. Most are approximately 9" - 10" in width, similar to a standard wood plank.

Aluminum hook-on planks are also very popular. These are often used with fabricated frame type scaffolding. The plank may be all aluminum, or it may have an aluminum frame with plywood deck. Some have other types of composite decks. The most common lengths are 7' and 10'. Most of these are the width of two regular wood planks, approximately 19". Therefore three aluminum planks fill out a 5' wide scaffold, as opposed to six wood planks.

Manufactured wood planks are also available.

Longer aluminum planks and modular truss planks are also available. Single planks may be over 30' in length. Modular truss planks may be connected up to 80'. Consult the manufacturer for specific assembly, use, and loading instructions for these longer planks.

Wood Scaffold Plank (extracted from 29 CFR 1926 Subpart L Appendix A).
(b) Solid sawn wood used as scaffold planks shall be selected for such use following the grading rules established by a *recognized lumber grading association* or by an *independent lumber grading inspection agency*. Such planks shall be identified by the *grade stamp* of such association or agency. The association or agency and the grading rules under which the wood is graded shall be certified by the Board of Review, American Lumber Standard Committee, as set forth in the American Softwood Lumber Standard of the U.S. Department of Commerce.

Platform Planking

Work platforms must be tightly planked for the full width of the scaffold. Edges must be close together (maximum 1" gap). If the last plank next to the posts will not fit completely, OSHA does allow a gap on the side next to the posts of up to 9 1/2" (1926.451(b)(ii). If a pipe or line extends

vertically up through the deck, 3/4" plywood may be used to cover the gap, up to 18". The plywood should extend all the way across the adjacent planks.

a. If an overhead hazard above the platform exists, overhead protection must be provided.
b. All planking should be scaffold grade or equivalent manufactured planking.
c. All platforms must be at least 18" (two boards) wide.
d. The author recommends that planks and/or platforms should be fastened to the scaffold as necessary to prevent uplift or displacement due to wind or other job conditions. A common way to accomplish this is by wiring the toeboard down and nailing the toeboards to the planks. The toeboards are cut to fit with the long toeboard running across the ends of the planks and abutting the posts. On overlapped planks, a common practice is to "toenail" the planks together so that a tripping hazard is not created. However, OSHA does not require the planks to be secured, as long as the following provisions are met.
    1. Planks shall extend at least 6" beyond their support unless cleated or secured.
    2. Planks that are shorter than 10' may extend no more 12" unless the platform is guard railed to prevent access to the cantilevered area. Planks that are longer than 10' may extend no more than 18" unless the platform is guard railed to prevent access to the cantilevered area.
    3. Planking on runs of scaffold must overlap a minimum of 12 inches.
e. Any damaged or weakened planks must be immediately removed and replaced.
f. Any spills or slippery conditions on the planking must be eliminated as soon as possible after they occur.
g. Where the scaffold changes points of direction such as at a corner, the planks which would lie across the bearer at other than a right angle shall be laid first. The planks which lay at a right angle are then laid on top. The result is end of the top planks form a straight line rather than saw-toothed, and reduces the tripping hazard. It also ensures that the bottom planks overlap the bearer.
h. Scaffold platforms and planks shall not be painted to obscure the top or bottom as this might hide a defect.
i. Scaffold plank spans should be in accordance with the following: When using ***nominal thickness*** planking the maximum span is 8' for normal 25PSF loading, or 6' for 50PSF loading.

    When using ***full thickness (rough cut)*** lumber, the maximum span is 10' for 25PSF loading, 8' for 50PSF loading, and 6' for 75PSF loading.
    1. As a general guideline, STI recommends loads on an individual plank should not exceed one worker or 250 pounds per board. (Some species may be rated to carry 500 pounds). The total platform load is limited by the uniform loading (e.g. 25 PSF). Consult the manufacturer for allowable loads on manufactured planks such as 7' aluminum boards. Most are rated for 75PSF.
    2. Loads on the planks should be evenly distributed when possible.
    3. Try to stand on two boards whenever possible.
    4. Do not overload individual planks or use them on too long of a span. Do not overload the platform as a whole.
    5. Plank the platform all the way across so the planks are secure when loaded.

Falling Object Protection must be provided as follows:

1. Toeboards must be installed on the open sides when the platform is over 10' off the ground. Toeboards must be at least 3 1/2" in height with a maximum 1/4" gap to the platform. Toeboards must be secured to withstand 50# applied in a downward or horizontal direction.

2. If materials are piled higher than the toeboard, paneling or screening must be installed from the platform to the handrail.
3. Barricading the area below and not permitting employees to enter the area is given in the standard as an alternative to toeboards. This option should be used only in select areas.
4. Canopies, debris nets, or catch platforms may be alternatives in some areas.

GUARDRAILS AND MIDRAILS must be installed on all open sides (open sides are defined as more than 14" from a solid faced structure) of scaffold platforms more than 10 feet in height (CAL OSHA 7 1/2').

a. Guardrails should be strong enough to withstand 200# applied in a downward or horizontal direction.
b. Guardrails manufactured or placed in service prior to January 01, 2000 may between 36" and 45". After January 01, 2000 the minimum is 38" to 45" in height. (CalOSHA requires the rails at 42" to 45").
c. The midrail is installed halfway from the platform to the guardrail.
d. Wire rope may be used as a guardrail but must not deflect more than the allowable heights.
e. Guardrails shall be smooth surfaced to prevent lacerations. Steel or plastic banding shall not be used as a guardrail.
f. On frame scaffold intermediate levels where cross braces are present, STI recommends that both guardrail and midrail be installed in addition to the crossbrace. However, OSHA does allow the cross brace to be substituted for either the guardrail or midrail depending on the height of the crossbrace center point and other provisions (see 1926.451(g)(xv)).

Conclusion

This proceeding paper is intended only as a brief introduction into some of the basic safety elements of supported scaffolds. It is not intended as a comprehensive review.