

# Hazards of double-deck single post shoring systems

*Inherent instability and faulty erection practices make these shoring systems vulnerable to failure*

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An accident waiting to happen. This double-decked wood post shore system, projecting as it does from the main building frame, should have been locked in or tied to solid construction on all four sides. The system is also vulnerable to any unexpected lateral forces because of insufficient X-bracing.

**T**he formwork trades refer to the practice of using single-post shores in two tiers as double decking; occasionally triple decking (three tiers) has been used. Over the past 30 years this characteristically unstable system has been the cause of innumerable formwork-shoring collapses. A hard look at the reasons for trouble suggests that double decking of single-post shores should not be permitted.

## Origins and history of the practice

The practice of erecting two levels of adjustable post shores, one above the other, for high ceiling formwork developed in the 1930s before tubular frame shoring towers were available to carry such formwork loads. Customarily the lower set of shores was erected and braced, then a level of intersecting stringers was set on top of them to serve as the base for the next level of shores. Even after scaffold-type shoring began to be manufactured in the 1950s, general contractors and forming subcontractors continued to use double decking for several reasons:

- Single-post steel or wood adjustable shores were plentiful in the contractors' existing inventories and could be readily "stacked" double height for high ceilings.
- Heavy and standard duty steel scaffold-type shoring usually had to be rented from a scaffolding and shoring firm, and the cost then was greater than using single-post shores available from stock on hand.

So double decking continued unabated. With insufficient attention to lacing and bracing, the system was dangerously unstable and many collapses resulted.

By the early 1970s, tubular frame shoring was plentiful and there was increased use of truss-supported flying deck forms. Many larger forming subcontractors fabricated their own heavy duty steel scaffold-type shoring. Use of the double-deck single-post systems then began to decrease as did the failures.

## Use by smaller forming subcontractors today

Today there are still many small forming subcontractors

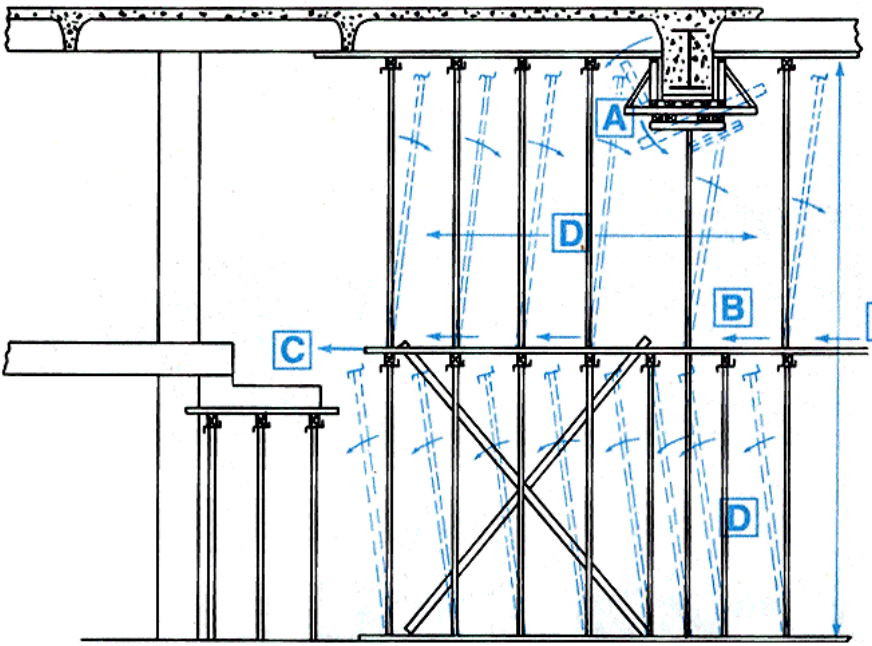


Figure 1. Diagram representing collapse of double-deck shoring shown in photograph. Lateral force at (A) started rotation of T-head shore (B) which had no X-bracing. Intermediate deck (C), acting as a hinge, moved in direction opposite to lateral force and triggered collapse of shores in opposite directions (D) on the two levels.

tors who use double-deck shoring for odd corners and small areas of high ceilings. And some of these subcontractors may occasionally try to shore a sizable floor area with double-deck shores. However, with the abundance of tubular frame shoring and lower rental costs, use of double decking is not generally economical. Tubular frame towers can generally be erected more quickly and economically with less-skilled labor. They are less sensitive to field errors, and they are usable over a greater height range.

### Extra precautions needed with double-decked shores

A double-deck system, by definition twice the height of ordinary shoring, is particularly vulnerable to lateral forces such as those induced by wind, moving equipment, or unbalanced loads of fresh concrete. Lack of rigid connections and adequate bracing—a common occurrence in formwork construction—makes it possible for the failure of a single shore to trigger collapse of the whole system (Figure 1).

If for some reason single-post shores must be double decked, I recommend the following precautions:

1. Design and inspection of the system should be done by a professional structural engineer and qualified formwork designer. If the structural professional is not also a qualified formwork designer, he should secure the help of someone who is.

2. A complete floor should be erected between tiers of the system, fully stabilized against lateral movement.

Some of the design and construction practices that will improve the strength and stability of a double-tier shoring installation include:

- Make each shore on the top tier concentric with the corresponding shore on the bottom level.
- Erect diagonal (X) bracing on both the upper and lower levels of shores throughout the layout in both directions.
- Install horizontal lacing to reduce the slenderness ratio of the shoring, as required by standard column design procedures for the loads being supported.
- If wood single-post shores are used, toenail every shore in the top tier to the sill, stringer, or soffit that it rests on. Otherwise, vibration from any source may cause the top shores to move off the sills and remove support from the deck above. Metal single-post shores have a bottom plate with corner holes that can be efficiently nailed to the intermediate sill.
- Lock in, brace, or stabilize the intermediate deck on all four sides to prevent it from floating or acting as a moving hinge when unsymmetrical loads are applied to the top deck. This can be done with guy wires, struts, diagonal bracing or other ties to solid construction. Columns cast ahead of the deck improve stability.

Added complications may occur because a double-deck system gives the general contractor an opportunity to double deck single-post shores under beam forms on the slab form contractor's forming-shoring system. Beam shoring and slab shoring then are part of the same system, and any failure in one may trigger failure of the entire system. Responsible general contractors increasingly are prohibiting double-deck installations by their subcontractors because they don't want to accept liability for this often hazardous practice.

## Safety rules restrict use of double decking

Because of the great potential for failure if a double-deck system of single-post shores is not designed and built with the greatest care, some safety professionals would like to restrict or even outlaw the practice. This thinking is reflected in provisions of several codes and standards.

**OCCUPATIONAL SAFETY AND HEALTH ACT:** OSHA's current regulations (Reference 1) state: "Whenever single-post shores are used in more than one tier, the layout shall be designed and inspected by a structural engineer." The pending proposed OSHA revision (September 1985) contains essentially the same wording.

**AMERICAN NATIONAL STANDARDS INSTITUTE:** The A 10.9-1983 safety requirements for concrete and masonry work (Reference 2) do not make any special provision for double-tier shoring, but they reference ACI 347-78 (see below). Shoring and formwork are required to be designed by a "qualified designer."

**NATIONAL SAFETY COUNCIL:** "Vertical Shoring of Concrete Formwork" (I-628-Rev.81, Reference 3) says that "Single-post shores should not be used more than one tier high, unless there is a full floor between tiers that has a stability equal to that of the supports on which the first tier is resting."

**THE SCAFFOLDING, SHORING AND FORMING INSTITUTE:** Safety rules for single-post shores (Reference 4) indicate that "Single-post shores more than one tier high should not be used."


**AMERICAN CONCRETE INSTITUTE:** The ACI 347-78



Figure 2. Formwork for concrete cast around steel girder remains in place, suspended from the girder (see cross section in Figure 1) while double-deck shoring has toppled to the ground. Metal post shores were used on this job, but similar difficulties with double-decked wood shores have been experienced when proper bracing has been neglected.

formwork standard (Reference 5) provides that "Multi-tier shoring assemblies supporting forms for high stories must be set plumb and the separate parts of each shore located in a straight line over each other, with two-way horizontal bracing at each splice in the shore unless the entire assembly is designed as a structural framework or truss. Particular care must also be taken to transfer the horizontal loads to the ground or to completed construction of adequate strength." A pending revision of the standard proposes to state: "Multi-tier shoring is not recommended and is considered a dangerous practice."

## Recommendations

Double-tier shoring requires much special attention to both design and construction in order to create a stable system. Thus there is considerable risk that errors or omissions can leave an unsafe formwork-shoring assembly. If a double-tier system is erected properly, the extra labor needed is considerable and costs escalate in proportion. I believe the interests of safety and economy can best be served by outlawing such systems totally. 

## Editor's note

Author Charles W. Borden, who retired recently, is a certified safety professional as well as a consulting engineer.

## References

1. Federal Occupational Safety and Health Act, Part 1926, "Occupational Safety and Health Regulations for Construction," Federal Register, Part II, V.39, Number 122, June 24, 1974; now issued as Department of Labor "Safety and Health Regulations for Construction," 29CSR, Part 1926.
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3. "Vertical Shoring of Concrete Formwork," Data Sheet 1-628 Rev.81, National Safety Council, 444 North Michigan Avenue, Chicago, Illinois 60601.
4. "Single-Post Shore Safety Rules," Scaffolding, Shoring, and Forming Institute, 2130 Keith Building, Cleveland, Ohio 44115.
5. "Recommended Practice for Concrete Formwork (ACI 347-78)," American Concrete Institute, Box 19150, Detroit, Michigan 48219.

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