Shoring and Scaffolding

In multistory work, the shoring which supports freshly placed concrete is necessarily supported by lower floors which may not yet have attained their full strength, and which may not have been designed to carry loads as great as those imposed during construction. Construction Loads may exceed design loads by an appreciable amount. (Ref: Grundy & Kabaila, ACI J., Dec. 63, pp. 1729-1738)

Therefore shoring must be provided for enough floors to develop the needed capacity to support the imposed loads without excessive stress or deflection. Whether permanent shores or reshores are used at the several required lower floor levels depends on job plans for reused of materials as well as the rate of strength gain in the structure.
Shoring

- There are several types of adjustable individual shores.

- The simplest of these, is based on clamping device which permits the overlapping of two 2x4 members.

A portable jacking tool is used to make vertical adjustments.

- Metal shore jack fittings are available to fit over the end of 4x4 or 6x6 wood shore, thus transforming the piece of lumber into an adjustable shore.

- These devices are capable of varying the shore height as much as 12 in.

A number of patented shoring systems have been developed with adjustable legs which eliminate cutting, close fitting, and wedging.
Shoring and Scaffolding

**Scaffold-Type Shoring**
- When tubular steel frame scaffolding was first introduced, it was designed to support the relatively light loads involved in getting workers to the work area.
- Later contractors began to try out the scaffolding as a support for formwork because of the apparent advantages of its modular assembly and system of jacks for leveling and adjusting elevations.

**Scaffold-Type Shoring**
- End frames assembled with diagonal braces to form typical shoring “tower”.

**Scaffolding**
- Scaffolding has been used for 5000 years to provide access areas for building and decorating structures taller than people who work on them.
  - Walk-through-type frames used by masons
The word “scaffolding” refers to any raised platform or ramp used for ingress and egress for pedestrian movement and/or the passage of building materials. Since the mid-1920s the concept of using steel pipes fastened together with metal-form or cast clamps (couplers) instead of poles and ropes was introduced.

Aluminum alloy pipes and couplers were developed for their lighter weight and speedier construction. Aluminum alloy is only two-thirds as strong as steel, but it is only one-third to one-half its weight. Because of the higher initial cost, aluminum is restricted mostly to building maintenance scaffolds and suspended platforms.

Commonly, all types of scaffold have incorporated in their design a minimum safety factor of 4. This means that scaffolds and their components shall be capable of supporting without failure at least 4 times the maximum intended load. To comply with this requirement, multiply the design load by 4 and derive the limiting strength of the component from the yield stress of the metal in accordance with acceptable engineering criteria and practices.
Scaffolding - Design Loads

- In accordance with OSHA and ANSI criteria and common practice for many years, design load ratings for scaffold platforms are as follows:
  - **Light-Duty Loading**: 25 lb/ft² maximum working load for support of people and tools (no equipment or material storage on the platform).
  - **Medium-Duty Loading**: 50 lb/ft² maximum working load for people and material restricted not to exceed this rating, often described as applying to bricklayers' and plasters' work.
  - **Heavy-Duty Loading**: 75 lb/ft² maximum working load for people and stored material often described as applying to stone masonry work.

These ratings assume uniform load distribution.

With the exception of the weight of stored materials, scaffold loads most often consist of personnel, both stationary and transitory.

It is important to remember that the OSHA and ANSI load-rating system is intended for guidance of field personnel in the construction and use of nonspecifically engineered scaffolding applications.

 Tube and Coupler Scaffolds

- Tube and coupler scaffolds are assembled from three basic structural elements:
  - the *uprights*, or *posts*, which rise from ground or other solid support
  - the *bearer*, which supports the work platforms and / or provide transverse horizontal connections between the posts;
  - the *runners*, which attach to the posts directly below the bearers and provide longitudinal connections along the length of the scaffold.
Temporary Structures

Tube and Coupler Scaffolds

- These three elements are usually connected with standard or fixed couplers which provide a 90° connection in two places.

The three elements (uprights, bearer, and runners) form the basic structure.

The basic assembly and components of tube and coupler scaffolds.

Diagonal bracing is used to stiffen the structure as necessary – most important in the longitudinal direction.

Bracing is generally connected to the posts with “adjustable” or “swivel” couplers which have the facility of adjusting a full 360°.

Diagonal bracing should always be attached to the posts as closely as practical to the “node” points formed by the runner-bearer connections.
Another important structural element is the building tie which connects the scaffold to the wall or structure and is needed to provide rigidity and anchorage of the scaffold in the transverse direction.

Scaffolds need to be laterally supported; otherwise, they are unstable because of their height-to-width ratio and have low strength to resist wind and other lateral forces.

Methods of stabilizing against a building (cont'd):

(a) Wall tie and anchorage

(b) Window reveal tube
Tube and Coupler Scaffolds

Methods of stabilizing against a building (cont'd): (c) Reveal between pilasters

Tube and Coupler Scaffolds

Application

Tube and coupler scaffolds can be assembled in numerous ways because of the flexibility of their assembly dimensions in the horizontal and vertical planes. Unlike sectional frame scaffolds they are not restricted by frame width in the transverse direction, by brace length in the longitudinal direction, or by frame height in the vertical direction. Consequently, they are preferred for access to workplaces having irregular dimensions and contours, e.g., churches, old auditoriums, etc.

Basic Configuration

The basic configurations are as follows:
1. Double Pole. Also called “independent” wall scaffolds, these are used for access to vertical surfaces for construction, alterations, or surface finishing and repair. They consist of repetitive pairs of posts along the length, connected by bearers and runners.
2. Single pole. Also called “putlog” wall scaffolds, these are used for the construction of masonry walls. They consist of single posts 3 to 5 feet away from the wall surface spaced at regular or varying intervals along the wall. The different feature of this type of scaffold is that the inside ends of the bearer are supported at joints or courses in the wall being built instead of the inside posts.
Temporary Structures

Shoring and Scaffolding

3. **Tower Scaffolds.** These consist of one or few bays in either horizontal plane, constructed to required height for access to ceilings or for specialized load support requirements not conveniently achievable with sectional frames. They may be mounted on casters and become mobile scaffolds or rolling towers.

- An application of tower scaffolds is to provide stair access to unusual structures such as cooling towers.

**Sectional Scaffolding**

- The construction principle of sectional scaffolding is shown below.

- The most common material used in the fabrication of steel frames is 1 5/8-in.- OD tubing with a wall thickness between 0.086 and 0.105 in.

- The most common grade of steel used for this purpose is AISI designation A1050, a high-carbon alloy having a minimum yield stress of 50,000 psi with a corresponding ultimate stress of over 75,000 psi.

- The higher carbon steel is generally preferred because its lower ductility and greater rigidity make it more resistant to damaging and bending of the members and because it has greater strength.