290

FALSEWORK
&
HEAVY TIMBER FRAMING

The Northern California

Pile Drivers

J.A.T.C

NORTHERN CALIFORNIA PILE DRIVERS J. A. T. C.

PILE DRIVER – BRIDGE BUILDER

Course of Instruction

Year	Quarter	Code	Title
1	1	278	Worker Safety & Tool Skills
	1	279	The Apprentice & The Trade, Construction Math
	2	280	Pile Driving Technologies: Tools, Equipment, Materials, & Rigging
	3	281	Concrete & Formwork
	4	282	Welding I • Plate (1F, 2F, 3F, 4F)
2	1	283	Pile Driving – Land & Water (Introduction)
	2	284	Welding II • Plate (1G, 2G)
	3	285	Pile Driving – Land & Water (Advanced)
	4	286	Wharfage & Marine Structures
3	1	287	Cranes & Welding III • Plate (3G,4G)
	2	288	Structural Blueprints & Layout Instruments (Introduction)
	3	289	Intro To Modern Bridge Building Methods & Advanced Structural Blueprints
	4	290	Falsework & Heavy Timber Framing
4	1	291	Advance Formwork & Shoring for Pile Driving & Bridge Building
	2	292	Welding IV • 3G & 4G Certification
	3	293	Dive Tending & Semi–Automatic Wire Feeders
	4	294	Welding V • Pipe (2G, 5G, 6G)

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UNIT 290 – FALSEWORK & HEAVY TIMBER FRAMING

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CLASS MATERIALS

Pile Driver Apprenticeship Class
NORTHERN CALIFORNIA PILE DRIVERS J.A.T.C.

UNIT 290 – FALSEWORK & HEAVY TIMBER FRAMING

The information below details the books, supplies and tools needed to participate in and complete this scheduled apprenticeship class.

➪ YOUR BOOKS & CERTAIN REQUIRED ITEMS MAY BE PURCHASED AT:

Carpenters Apprenticeship Training Center
2350 Santa Rita Rd., Pleasanton, CA
☎ (510) 462–9644

Mondays: 8:30 am – 12:00 noon
Tuesdays: 8:30 am – 10:00 am

➪ THE FOLLOWING BOOKS ARE REQUIRED TO COMPLETE ASSIGNMENTS:

1. ***Provided***

➪ YOU ARE REQUIRED TO BRING THE FOLLOWING TOOLS/SUPPLIES TO CLASS:

*1. Safety Glasses (OSHA Cert.) ($5.50)
2. Hard Hat, Work Boots & Clothes
3. Long–Sleeved Shirt
4. Pocket Tape (16′ long min.)
5. 22 oz. Rip Claw Hammer
6. 24″ – 30″ Level
7. Tri–Square/Combination Square
8. Framing Square
9. Chalk Box w/Chalk
10. String Line
11. Pumb Bob
12. Carpenter Pencil
13. 8 point Cross –Cut Saw
14. 24″ – 30″ Stripping Bar
15. "Cats Paw" Nail Puller
16. 8″ Side–Cutter Pliers
17. 12″ Adjustable (Cresent) Wrench
18. Carpenter's Locking Tool Box
19. Carpenters Coveralls (bib) and/or...
20. Nail Bags w/2 Pouches
*21. Calculator w/ √ (square root) Key

(* Available in Training Center Book Store...Mondays & Tuesdays only)

➪ WEAR CLOTHING THAT YOU WEAR TO WORK:

For your personal safety : tank tops or sleeveless shirts, shorts or cut–off pants, and soft topped or soft soled shoes are **not** permitted while attending classes. **Safety glasses are required** during all manipulative lessons.

PILE DRIVER - APPRENTICE TOOL LIST*

Minimum of tools required <u>before</u> dispatch as Pile Driver should include:

1. 20 or 22 oz. Straight Claw Hammer
2. Pocket Tape (16' long minimum)
3. 12" Adjustable Wrench
4. 8" Lineman's Pliers (side cutters)
5. Lumber Crayon/Keel/Carpenters Pencil
6. Pair Leather Palm Gloves
7. Rigging belt with appropriate tool holders or pouches similar to the following:
   - Spud Wrench or Wrench Holder
   - Hammer Holder
   - Tape Holder
   - Pliers Keeper
   - Nail Pouch
   - Utility Pouch

Optional tools for dispatch as Pile Driver:

1. Pair Bib Overalls (i.e. Carhartt™ or equal), may replace rigging belt
2. Fold-back Knife - "Buck™ " style, lock back
3. 12" Adjustable spud Wrench, may replace 12" adjustable wrench & bull pin
4. Torch Tip Cleaner
5. Torch Striker
6. Pair Rubber Rain Boots

Minimum of tools required <u>before</u> dispatch as Bridge Builder, Pile Driver/Framer, or Dock-Builder should include:

1. Tool Box
2. 8-Point Crosscut Saw
3. Framing Square
4. 24"-30" Level
5. Pocket Tape (16' long minimum)
6. 22 oz. Framing Hammer
7. 24"-30" Stripping Bar
8. Carpenters Bib Overalls or Carpenters Apron with leather pouch
9. 12" Adjustable Wrench
10. 8" Linemans Pliers (side cutters)
11. Carpenters Pencil
12. Chalk box with White Chalk
13. 100' (minimum) String Line
14. Cat's Paw Nail Puller
15. Combination Square

Optional tools for dispatch as Bridge Builder/Framer:

1. Set of Wood Chisels - ½", ¾", and 1 ½"
2. 100' Tape
3. 3/8" Ratchet-Socket Set
4. Hacksaw
5. Set Screwdrivers
6. Pair Pliers
7. Framing Axe
8. Pea Shooter
9. 5/16" Allen Wrench (for air drill chucks)
10. Slick (if available)
11. Adze (if available)

Minimum of tools required <u>before</u> dispatch as Welder:

1. Welding Hood (to fit Hard Hat) w/#10 Lens
2. Safety Glasses (OSHA Certified)
3. Welding Jacket or Cape Sleeves
4. Welding gloves (All Leather, Long Gauntlet)
5. Chipping Hammer
6. Wire Brush
7. Vice Grips (#11)
8. 12" Adjustable Wrench
9. Burning Goggles w/#5 Lens
10. Torch Striker
11. Torch Tip Cleaner
12. Tape Measure (20' long minimum)

Optional tools for dispatch as Welder:

1. Torch Tip Nips
2. 12" Layout Square
3. Bevel Square
4. Tri-Square or Combination Square
5. 24" Level
6. Torpedo Level
7. Wrap-Around (4" x 48")
8. Chalk Box with White Chalk

Failure on the part of the apprentice to obtain these <u>required</u> tools could result in:

1. A delay in wage re-rates until requirements are met.
2. Possible job termination for failure to supply proper hand tools.

*You are encouraged to purchase one (1) tool a week to spread out the cost. Tools required for specific classes (listed in class notice) are **mandatory** and must be in your possession.

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Form 139-PD

UNIT 290 – GRADING AND EVALUATION SCHEDULE

Grading

A uniform weighing system will be used as follows:

1. Class Participation and Attitude **5%**
2. Topic Quizzes **30%**
3. Manipulative Lessons **35%**
4. Final Exam **30%**

Assignment of grades will be as follows:

A = 100% – 92

B = 91 – 81

C = 80 – 73

D = 72 – 68

F = Less than 68%

Assignment of numerical evaluations will be as follows:

0 = Unsatisfactory

1 = Below Average

2 = Average

3 = Above Average

4 = Outstanding

5 = Excellent/Superior

Dot (•) Demerits valued at minus two (–2) points each will be assessed as follows:

17 = Repeating an unexcused class absence

17 = 4+ hours/week missed (+ repeat class)

10 = Unacceptable Brotherhood conduct

2 = Failure to make effort to perform

2 = Disruptive behavior

1 = Every 15 minutes of late arrival

Criteria for Evaluation

1. Safety
2. Accuracy
3. Following Directions
4. Fitting and Fastening
5. Speed
6. Plan Reading
7. Terminology
8. House Keeping

UNIT 290 – FALSEWORK & HEAVY TIMBER FRAMING

SEQUENCE OF INSTRUCTION

BOOKS: The following books/and or items will be required to complete this course:

Provided

TOOLS: You will be required to supply the following tools and/or equipment to complete this course.

1.* Safety Glasses (OSHA Cer.) ($5.50)
2. Hard Hat, Work Boots & Clothes
3. Long–Sleeved Shirt
4. Pocket Tape (16′ long min.)
5. 22 oz. Rip Claw Hammer
6. 24″ – 30″ Level
7. Tri–Square/Combination Square
8. Framing Square
9. Chalk Box w/Chalk
10. String Line
11. Pumb Bob
12. Carpenter Pencil
13. 8 point Cross –Cut Saw
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15. "Cats Paw" Nail Puller
16. 8″ Side–Cutter Pliers
17. 12″ Adjustable (Cresent) Wrench
18. Carpenter's Locking Tool Box
19. Carpenters Coveralls (bib) and/or...
20. Nail Bags w/2 Pouches
21. Pocket Calculator

(* Available in Training Center Book Store...Mondays & Tuesdays <u>only</u>)

AUDIO VISUALS: The following slide and/or video presentations will be featured in this class:

1. *"Shore–X®" Tubular Steel Tower Shoring,* (Video @ 9:00), The Superior Scaffold Co.
2. *"Shoring Safety – Do's & Dont's",* (54 Slides/Synced 14:00), The Scaffolding, Shoring, & Forming Institute (SSFI).

<u>FIRST DAY (MONDAY)</u> **Homework to be completed for Tuesday**

<u>TEXT/RESOURCE</u>	**<u>ASSIGNMENT</u>**
1) Unit 290 – Falsework & Heavy Timber Framing	Read: Chapters 1, 2 Be prepared for Chapter Tests 1, 2

8:00 a.m.	Registration – Orientation, Form 165 Review, Student Conduct, Rules & Regulations, Book Store Purchases
8:15 a.m.	Pre–Test 290, Administer & Correct
9:00 a.m.	**Lesson 1 – Erection of Shore "X" Tubular Steel–Framed Shoring**
12:00 noon	LUNCH

12:30 p.m.	**Lesson 1 – Erection of Shore "X" Tubular Steel–Framed Shoring (con't)**
3:30 p.m.	**Lesson 2 – Frame Fill Calculations**
4:30 p.m.	DISMISSAL

<u>SECOND DAY</u> <u>(Tuesday)</u> **Homework to be completed for Wednesday**

<u>TEXT/RESOURCE</u>	**<u>ASSIGNMENT</u>**
*1) **Unit 290 – Falsework & Heavy Timber Framing***	Read: Chapters 3, 4 Be prepared for Chapter Tests 1, 2, 3, 4

9:00 a.m.	**(Optional) Field Trip – Field Investigation of Heavy Timber Falsework & Tubular Shoring**
9:00 a.m.	**Or Lesson 3 – Construction of Heavy Timber Falsework Bents**
12:00 noon	LUNCH
12:30 p.m.	**Field Trip (con't)**
12:30 p.m.	**Or Lesson 3 – Construction of Heavy Timber Falsework Bents (con't)**
4:30 p.m.	DISMISSAL

<u>THIRD DAY</u> <u>(Wednesday)</u> **Homework to be completed for Thursday**

<u>TEXT/RESOURCE</u>	**<u>ASSIGNMENT</u>**
*1) **Unit 290 – Falsework & Heavy Timber Framing***	Read: Chapters 5, 6 Be prepared for Chapter Tests 5, 6

8:00 a.m.	Roll Call
8:05 a.m.	Discuss and correct Study Guides Chapters 1, 2, 3, 4
8:30 a.m.	Administer Chapter Tests 1, 2, 3, 4
10:30 a.m.	**Lesson 4 – Fabrication Procedures for Heavy Pipe Shoring**
12:00 noon	LUNCH
12:30 p.m.	**Lesson 4 – Fabrication Procedures for Heavy Pipe Shoring (Con't)**
4:30 p.m.	DISMISSAL

FOURTH DAY (Thursday) — Homework to be completed for Friday

TEXT/RESOURCE	ASSIGNMENT
1) Unit 290 – Falsework & Heavy Timber Framing	Read: Chapter 7 Be prepared for Chapter Tests 7 Be prepared for Unit 90 Final Exam

8:00 a.m.	Roll Call
8:05 a.m.	Discuss and correct Study Guides Chapters 5, 6
8:30 a.m.	Administer Chapter Tests 5, 6
9:00 a.m.	**Lesson 4 – Fabrication Procedures for Heavy Pipe Shoring (Con't)**
12:00 noon	LUNCH
12:30 p.m.	**Lesson 4 – Fabrication Procedures for Heavy Pipe Shoring (Con't)**
4:30 p.m.	DISMISSAL

FIFTH DAY (FRIDAY) — Study Assignment

none

8:00 a.m.	Roll Call
8:05 a.m	EDD Forms and Processing
8:30 a.m.	Discuss and correct Study Guides Chapter 7
8:45 a.m.	Administer Chapter Test 7
9:00 a.m.	**Lesson 4 – Fabrication Procedures for Heavy Pipe Shoring (Con't)**
10:30 a.m.	Review and prepare for Final Examination
11:00 a.m.	Administer **Unit 290 – Final Examination**
12:00 noon	DISMISSAL

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UNIT 290 – FALSEWORK & HEAVY TIMBER FRAMING

COURSE OBJECTIVES:

At the conclusion of this Unit the student should be able to gain skills helpful in the erection and disassembly of temporary (falsework) structures in accordance with the acceptable practices of the modern concrete bridge building industry. Emphasis will be placed on:

1. Assembly and dismantling of various patented, tubular, steel–framed tower shoring configurations for high–rise construction.
2. Staging and erection of heavy timber falsework bents for low–rise construction.
3. Fabricating and welding heavy–duty pipe shoring for mid to high–rise construction.

SPECIFIC OBJECTIVES:

At the conclusion of this unit, the student should be able to:

1. Understand basic theory and practice of modern falsework construction.
2. Understand what type of falsework is used for what situation.
3. How to manage and erect different types of falsework.
4. How to safely release falsework.

PRE–TEST UNIT 290 – FALSEWORK & HEAVY TIMBER FRAMING

This quiz is designed to focus attention on the unit of instruction to be studied during the next week. The questions are used as a means of testing for previously gained knowledge and to identify subject matter to be learned. You will not be graded for this exercise.

TRUE OR FALSE: Circle the *(T)* or *(F)* in front of the numbered statement to indicate that you believe the question to be true (correct) or false (incorrect).

T	F	1.	A shoring tower is a modular assembly of single or multiple–tiered pairs of frames connected by pivoted diagonal cross bracing.
T	F	2.	When stripping a shoring tower, all leg screws should be lowered simultaneously.
T	F	3.	Screw legs cannot be used on top and on the bottom of steel frame shoring.
T	F	4.	A shoring tower is a modular assembly of single or multiple–tiered pairs of frames connected by pivoted diagonal cross bracing.
T	F	5.	With 4 ft. wide frames having 4 ft. or longer brace lengths, towers should be tied to each other at a height of approximately 16 to 18 ft. from the base in line with the plane of the frames.
T	F	6.	Shoring frame stackup charts are sometimes available from manufacturers to aid the contractor in selecting combinations of frame stacks.
T	F	7.	When stacking frames for any required height, the combination having the least number of frames will be the most efficient.
T	F	8.	All vertical shoring equipment must be erected and kept plumb in both directions.
T	F	9.	All jobs requiring vertical shoring should have a drawing prepared or approved by a qualified person.
T	F	10.	Shoring layout drawings should be available at the jobsite and should be strictly adhered to.
T	F	11.	In tower leg loading, it is OK to load one leg of a frame or one ledger of a tower.
T	F	12.	Bridge footings do not require special attention; because they are placed rock.
T	F	13.	The maximum unsupported length of the timber post should be checked for buckling.
T	F	14.	Cross bracing of timber bents is important for it prevents a side sway force from causing a collapse of the bent.
T	F	15.	Runways and platforms are never built on top of new construction.

OVERVIEW:

This section (Part I) is intended to provide basic examples of the various types of shoring equipment available to the construction industry. This section also gives examples of efficient uses, advantages and disadvantages, and special considerations related to shoring methods. All types of shoring can be efficient and cost effective if matched to the proper job. Matching the most efficient shoring system to its most suitable application is the responsibility of the shoring layout design engineer.

All shoring erection must follow the shoring layout specifically and must be erected properly and in accordance with the layout. The student should keep in mind that safety requirements are of primary importance regardless of the type of shoring being used.

The following sections are intended as a general guide to the principles and procedures of safe shoring design and utilization. The manufacturer or agent should provide specific information on the characteristics and use of equipment. Under actual field conditions the manufacturer's design tables and instructions should be consulted and followed for the type of equipment in use.

FALSEWORK & HEAVY TIMBER FRAMING

PART ONE

FALSEWORK SHORING

CHAPTER 1. – "FUNDAMENTALS OF SHORING"

STEEL–FRAME SHORING

In the late 1930s and the 1940s welded–steel–frame scaffolding made its appearance as a more efficient and simpler replacement for the older, tube–and–coupler metal scaffolds. The concept of a welded frame taking the place of three or more pieces of tubing connected to each other by loose scaffold couplers changed the scaffolding practices in many areas of the world (see Fig. 1–1). Line drawings of tube–and–coupler scaffolding and frame–type shoring are shown in Figs. 1–2 and 1–3, respectively.

It was not until the 1950s that these labor–saving scaffolding "frames", as they generally were called, began to be used to provide vertical falsework/shoring support to horizontal formwork for slabs, beams, and other similar concrete construction. A frame width of 5 ft. became standard with 2 and 3 ft widths available on a more limited basis.

The earliest applications used wooden ledgers (stringers) seated directly on the top, or "header," bars of the frames. This method was not satisfactory or efficient since releasing the shoring loads after concrete, as shown in Fig. 1–4. For heights of one or two frames this was a passable but awkward process; for higher work requiring multiple tiers of frames (lifts) it was very difficult to safely release the threaded screw legs at the base of the scaffold.

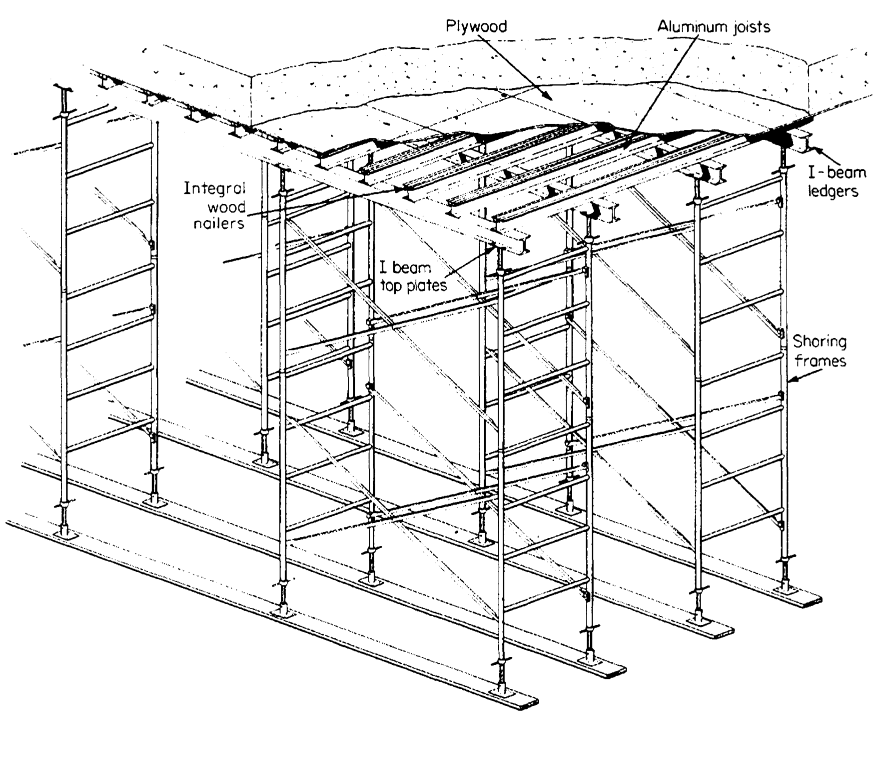


Fig. 1–1 Typical Modern Tubular, Steel–Framed Shoring

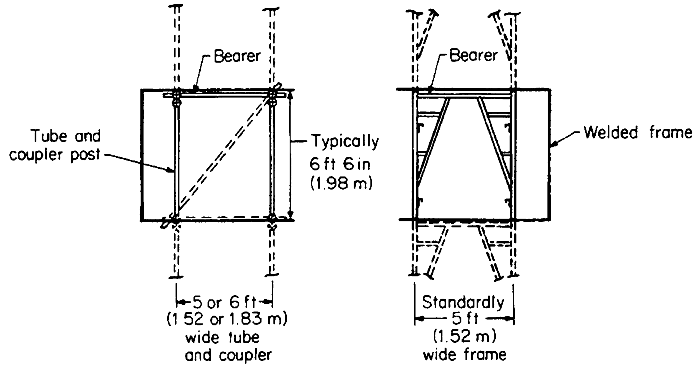


Fig. 1–2 Cross Section through Tube–and Coupler and Frame–Type Shoring

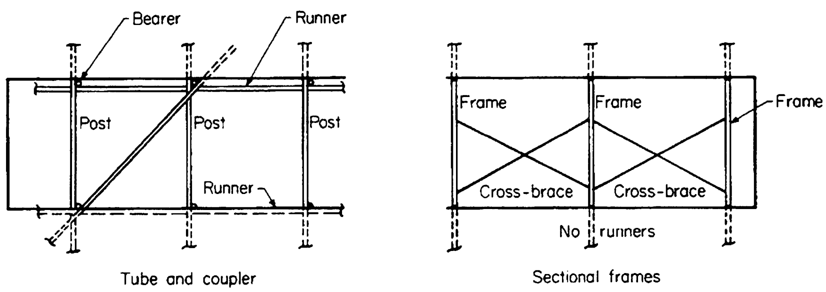


Fig. 1–3 Side View of Tube–and Coupler and Frame–Type Shoring

Attendant problems were soon discovered concerning the wooden ledgers. Unless 4–in. wood was used, the ledgers were laterally unsupported and could not be loaded to their full strength. Also, the header bars were insufficiently strong to efficiently develop the load capacity of the frame legs. Efforts to reinforce the header bars of the frames did not eliminate

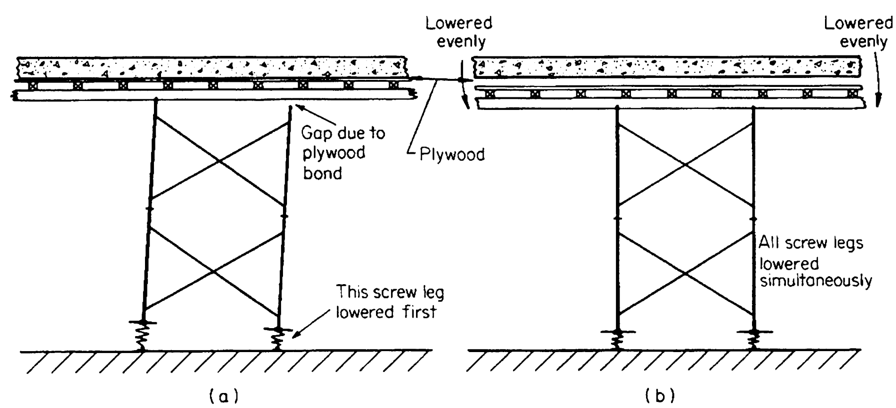


Fig. 1–4 Stripping a Shoring Tower: (a) Poor Method and (b) Better Method

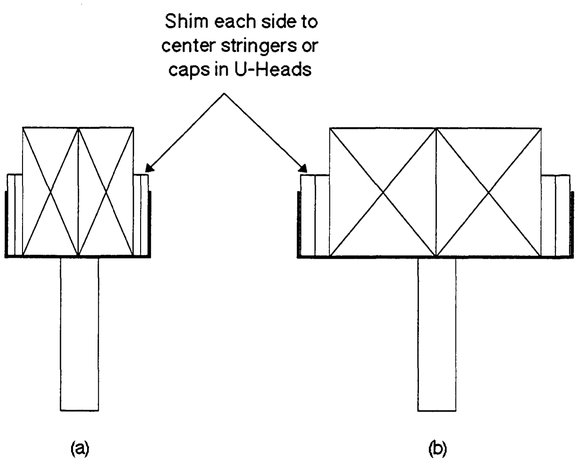


Fig. 1–5 Caps (Ledgers) in U–Heads; (a) two 2–in. (b) two 4–in.

the collateral problems of the local crushing of the lumber at bearing points on the tubular members. Reinforced or not, practical limitations resulted in the inability of the header bars to carry much more than the strength of *one* leg of the frames i.e., half–capacity leg loading. This resulted in requirements of up to twice as many frames as theoretically necessary to support any given concrete load. Fifty percent inefficiency with unnecessarily high costs was the result. Many concrete contractors were therefore reluctant to try this and were unwilling to make additional investments to purchase 4 x 8 to 4 x 10 in. ledgers which loaded the frames more efficiently. They were accustomed to using 3 x 4, 4 x 4, and 4 x 6 in. joists and ledgers in conjunction with wood or metal single–pole shores. The scaffolding industry was, and still is, a rental–oriented one, but logically, rental of wooden joists and stringers is impractical.

However, some scaffolding manufacturers did make small I beams (I4 x 7.7) available for rental as an efficient substitute for 4 x 8 and 4 x 10 in. wood ledgers. While these became popular with many contractors and did expand the use of frame shoring, there still remained physical limitations and drawbacks such as necessary lateral overlapping of the beams that

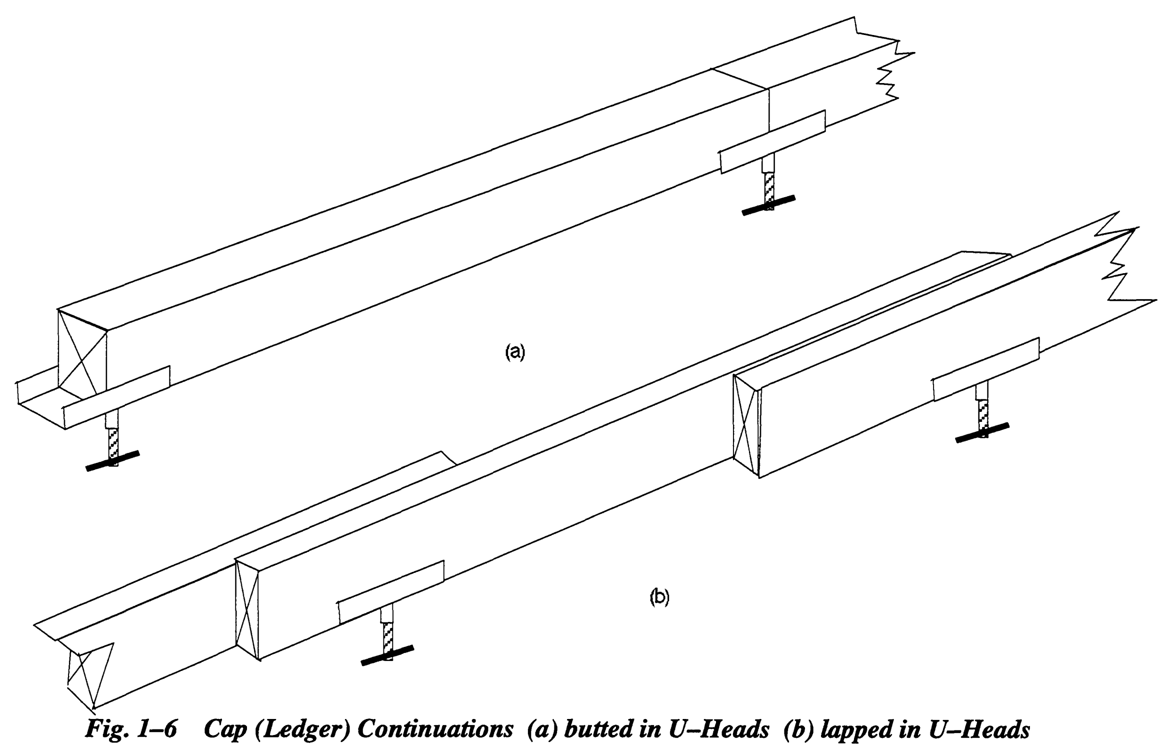


Fig. 1–6 Cap (Ledger) Continuations (a) butted in U–Heads (b) lapped in U–Heads

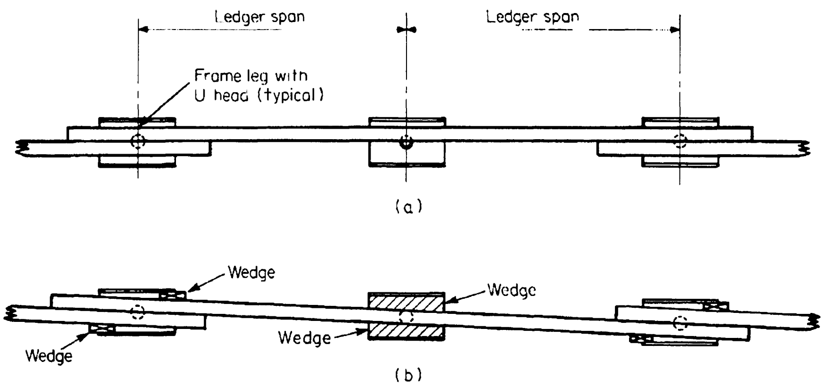


Fig. 1–7 Cap (Ledger) lapping: (a) incorrect lap – ecentric loading, (b) correct lap

made positions on the frame header bars inefficient by having to position the ledgers away from the frame legs. Also, careless placement of such beams subjected the header bars to bending stresses and thus again failed to achieve optimum leg–load capacities of up to 5000 lbs. per leg.

The solution

To realize the frames' full potential, the shoring loads had to be applied *concentrically* to the frame legs. Accordingly, the next development was a historic one for both the construction industry and the scaffold manufacturers: the design and manufacture of specialized shoring accessories for use in conjunction with the standard manufactured scaffolding frames. The components were U heads or channels (Figs. 1–5, 1–6, 1–7) to support and locate stringers or caps; adjustable threaded screw legs of up to 24–in. open adjustment (although 12 to 16 in. was normal), base plates with nail holes, and shorter diagonal bracing as small as 2 ft. between frames. As these components became more plentiful, huge numbers of standard access scaffolding frames for shoring became available having safe load capacities between 3000 to 5000 lbs. per leg. Thus shoring concrete with scaffold frames became an everyday event instead of an occasional one. (See Fig. 1–8)

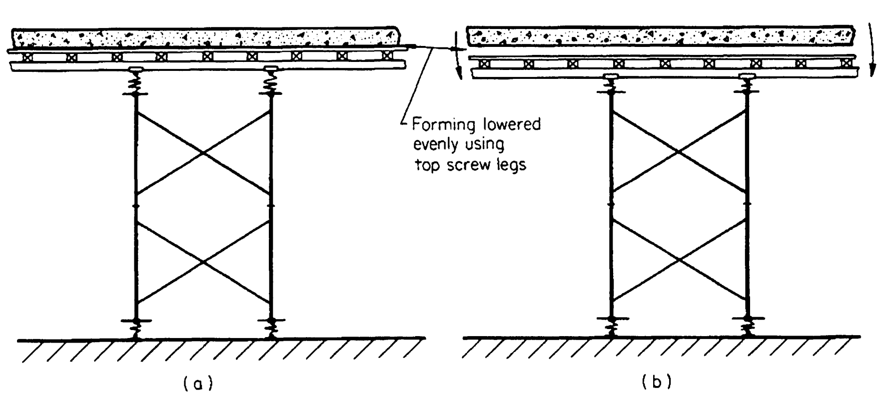


Fig. 1–8 Four–leg shoring tower with screw legs at top and bottom

HEAVY–DUTY SHORING FRAMES

The next step was another logical one: design frames *especially for shoring*. While doing this, why not also make them stronger?

Some premature efforts were made to manufacture frames with legs of nominal 1.9– or 2 in. –OD tubing. Unfortunately, the resulting load capacity of 5000 to 7000 lbs. per leg was not much greater than those obtainable with standard scaffolding frames. Frames generally had become standardized to use 1%–in–OD tubing with wall thicknesses of up to 0.125 in.

Subsequently, the heavy–duty shoring frame made its logical appearance with tubular legs of 2% or $2^{1}/_{2}$ in. OD and with design shoring load capacities of 10,000 lb. or more per leg. Fig. 1–9 shows typical heavy–duty shoring towers of various configurations.

The advantages and disadvantages of heavy–duty shoring frames were as follows:

Advantages	Disadvantages
Only one half the number of frames for a given shoring condition	Weight increased to 70 lb. (31.75 kg) for a 4x6 ft. (1.22 x 1.83) high frame
Use of standard cross braces	Short supply while inventories were being enlarged
Simpler design procedures	
Sturdier accessories for rough handling	Market saturation (mid–1970s) took many years

From then on, the staple of the industry were frames with capacities of 10,000 lb. per leg. The 5–ft width of the standard "access" scaffolding frames was changed to the more convenient modular 4–ft. width by 5 or 6 ft. high sizes; these quickly became the "bread and but-

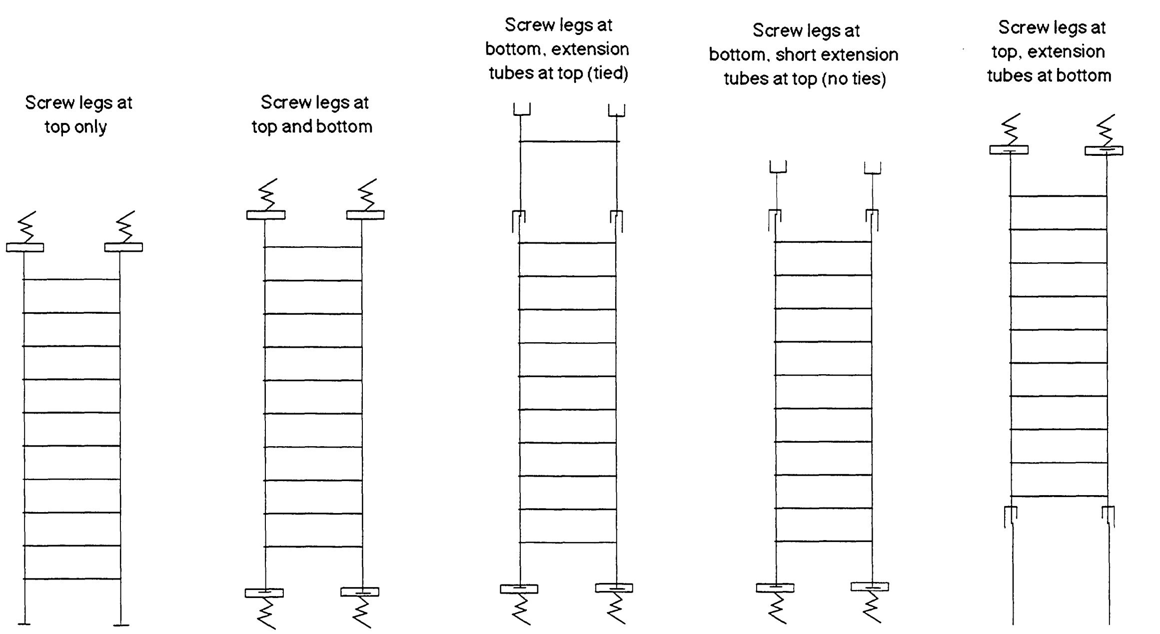


Fig. 1–9 Various frame shoring tower configurations

ter" items of shoring construction. Also, the shoring accessories were made of thicker and stronger materials to accept the larger vertical loadings involved with these heavy–duty frames. Larger U heads and screw legs and the availability of preexisting brace sizes made this type of shoring one of the most versatile and *adaptable* tools that the building contractor had ever known.

Another radical development was the telescoping tube used inside the frame leg. Its application was similar to that of a single–pole shore with a pin and pinholes for rough adjustment: it had an adapter with a short length of screw thread for fine adjustment. These telescoping tubes were named "extension" legs or tubes and had working lengths of up to 5 ft. With their rows of pinholes they were quickly christened "piccolos."

Today, there are many more types of equipment available for shoring, covered later in this chapter. However, the workhorse of the concrete construction industry is still the 4x5 or 4x6 ft. heavy–duty welded shoring frame.

Almost all makes of this frame are furnished with some form of quick–acting mechanical locking mechanism that enables fast attachment of the cross bracing to the frames. However, wing nuts, hand–turned on threaded studs welded to frame legs, are still being used by some.

SHORING TOWERS

A shoring tower is a modular assembly of single or multiple–tiered pairs of frames connected by pivoted diagonal cross bracing.

The historical importance of the scaffold shoring tower lies in the fact that it provided the facility of at least four single–pole adjustable steel shores with extremely rapid erection. Starting to shore a corner of an installation with single–pole shores puts great reliance on the moment strength of the ledger–shore top connection in which the only connection is nails. The use of wood bracing and lacing members to plumb vertical steel shores and tie them together in a time–consuming and difficult process for usually three or more workers if the shores are over hand–reaching height. A scaffold shoring tower, on the other hand, is quickly and safely erected by only one worker. The four legs of a tower give the equivalent facility of at least four shores, as mentioned, but they are usually of a higher load capacity, have built–in devices for each attachment of bracing, are quick and easy to plumb and level, and can be erected to great heights.

The use of two or more tiers of single–pole shores is prohibited by many states. However, Federal OSHA regulation (paragraph (d)(3) or Ref. 1) allows it, but requires design and inspection of such installations by a structural engineer. Sectional frame shoring does not have such a requirement unless called for by a state's OSHA regulations or if the job is unusually complex.

Design of frame shoring can often be done by trained and experiences drafters or graduate engineers without needing the services of an experienced professional engineer, except for layout approval or difficult design applications. Sectional frame shoring must be installed and used in conformity with a shoring layout, generally designed and furnished by the concrete contractors, the shoring manufacturers, or their agents and distributors.

As the use of shoring frames expanded, the applications became more sophisticated and generally served to further reduce the use of single–pole shores.

The scaffolding industry makes cross braces available for spans as short as 2 ft. and as long as 10 ft. between frames. When used with long–span horizontal shoring beams, bracing distances were expanded from 12 ft. up to 15 ft. Because of this, care must be taken to ensure that braces do not sag and pull the frames out of plumb. The combination of shoring frames and horizontal shoring beams is covered more fully later in this chapter.

Frame shoring towers are very flexible modules because they come in a wide range of bracing span lengths and frame widths. Although 4 ft. width is the standard—working nicely in conjunction with 4 ft. wide plywood sheets—frames 2 and 3 ft. wide are also popular because they are adaptable as shoring for beam soffits separately from slab shoring frames owing to soffit height differentials.

Demand and supply developed enormously, peaking out in the early 1970s as other, proprietary shoring systems, such as column– and/or wall–supported flying deck systems, large "tables" with trusses and room forms, also started to become popular. However, large shoring projects can require as many as 25,000 frames or more!

ACCESSORIES

By being able to combine various accessories and brace sizes, contractors now have more flexibility. Tower heights, taking advantage of standard 12– and 24–in. extra–length screw legs and piccolo extension tubes, can be easily assembled for any job height by using the relatively standard three frame heights of 4, 5 and 6 ft. with which most shoring heights can be reached. Others, such as 3 ft. 6 in. and 3 ft., are also available.

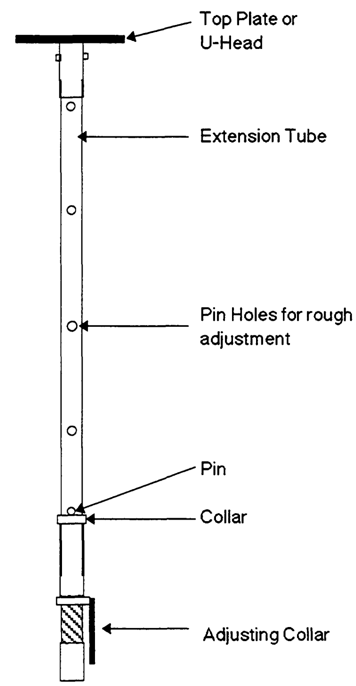


Fig. 1–10 Extension tube (piccolo) with screw Adjustment

Some typical accessories, as shown in Fig. 1–10, provide threaded adjustment on tops, bottoms, or both ends of the tower. U–heads are available for almost limitless ranges of size and types of ledgers, whether wood or steel. The vertical sides of the U–heads give support to wood ledgers during installation; however, they are not designed or intended to resist overturning of the ledgers under shoring loads.

A wide selection of steel I beams is popular and available for use as ledgers. These are generally used with "top plates" for attachment of the I beams to the frame legs. They are designed to permit lateral overlapping of ends of beams at frame leg junctions. Also available are rectangular top plates that permit attachment of other–sized I beams when the top plate is positioned at right angles to the normal.

One of these is shown in Fig. 1–11.

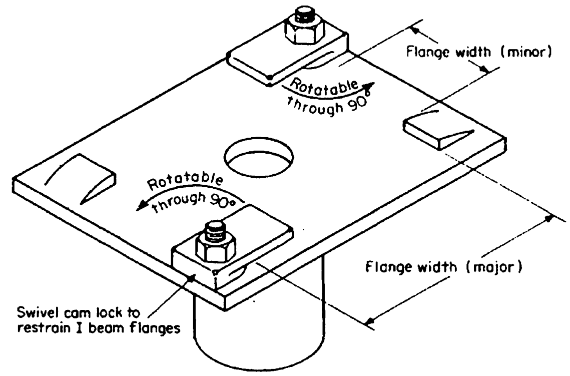


Fig. 1–11 Top Plate for securiong I–beam ledgers.

CHAPTER 1 – FUNDAMENTALS OF SHORING

STUDY GUIDE

INSTRUCTIONS: Determine the correct word for each numbered blank in the sentence and write it in the blank space provided.

1. All shoring erection must follow the shoring [1]____________________ specifically and must be erected properly and in accordance with the [2]____________________.

2. In the late [3]____________________ and the [4]____________________ welded–steel–frame scaffolding made its appearance as a more efficient and simpler replacement for the older, [5]____________________ – and – [6]____________________ metal scaffolds.

3. A frame width of [7]____________________ became standard with 2 and 3 ft. widths available on a more limited basis.

4. To realize the frames' full potential, the shoring loads had to be applied [8]____________________ to the frame legs.

5. Another radical development was the [9]____________________ tube used inside the frame leg. Its application was similar to that of a single–pole shore with a pin and [10]____________________ for rough adjustment.

6. The [11]____________________________ legs of a tower give the equivalent facility of at least [12]________________________________ shores, as mentioned, but they are usually of a higher [13]_______________________________ capacity, have built–in devices for each attachment of bracing, are quick and easy to plumb and level, and can be erected to great [14]______________________________.

7. Frame shoring towers are very [15]____________________________ modules because they come in a wide range of bracing span lengths and frame widths.

8. A wide selection of [16]__________________________________ is popular and available for use as ledgers.

NOTES:

CHAPTER 2. – "BASIC SHORING DESIGN & COMPONENTS"

STABILITY OF TOWERS

As a rule of thumb, any width–brace combination of tower size whose height is 4 or more times greater than its narrowest base dimension portends a stability hazard when not connected by ties to other towers; this hazard is substantially increased when people are working on the tower. Two–foot wide frames and multi-frame high towers having 2–, 3–, or 4–ft. bracing are similarly unstable is not laterally tied. The commonly accepted practice is to connect rows of towers to each other with tube and coupler horizontal lacing members, or where practical, with additional cross bracing so that rows of frames are continuously cross braced in one plane (Fig. 2–1).

With 4–ft. wide frames having 4 ft. or longer brace lengths, towers should be tied (laced) to each other at a height of approximately 16 to 18 ft. from the base in line with the plane of the frames. If substantially high towers are involved, repeat the lacing–bracing at every third frame in height as work progresses. Lumber is also used to effect lacing–bracing, utilizing specially spaced nailer plates (Fig. 2–2).

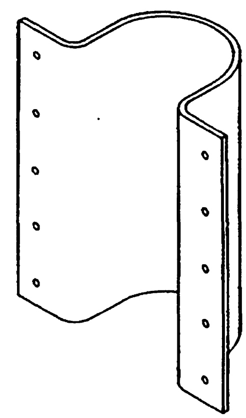


Fig. 2–2 Nailer plate fits around frame leg, nailed to lumber brace or tie.

Lacing and bracing with 2–in nominal tubing and $2^3/_8$ x 2 in. couplers affords a significant degree of moment connection. This lacing should be installed in both horizontal planes at each three–frame level in the tower, unless continu-

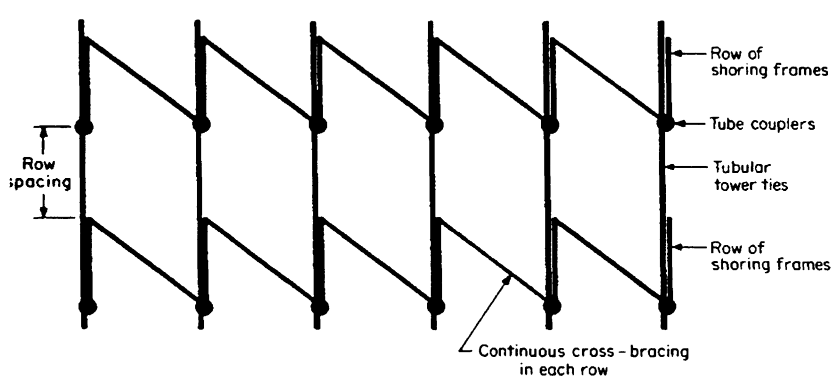


Fig. 2–1 Lacing of shoring towers in one direction, continuous cross bracing in the other direction.

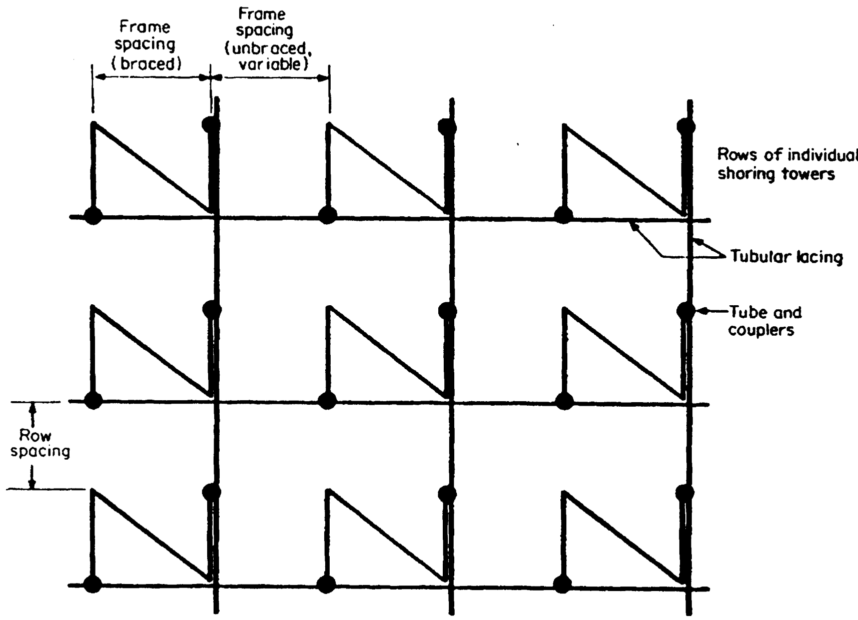


Fig. 2–3 Shoring towers laced in both directions.

ous cross bracing can be used in one direction (plane at right angles to frames).

For relatively "clean" installations (i.e, having a flat, firm base), it is sufficient to attach these "lacing" members to the towers as continuous members with suitable scaffold couplers between the tubing and *one* leg of each tower, even though the tube will pass by a second leg of the tower without being connected. (See Fig. 3–2) Installations involving multivariable base and shoring height conditions should have each lacing member coupled to *two* legs of each tower that it passes. When shoring to or from sloping surfaces, each tower leg in contact with the forming of the sloping area should be tied to its adjacent, similar member with ties attached approximately parallel to the sloping surface(s). Figure 2–4 illustrates this, in addition

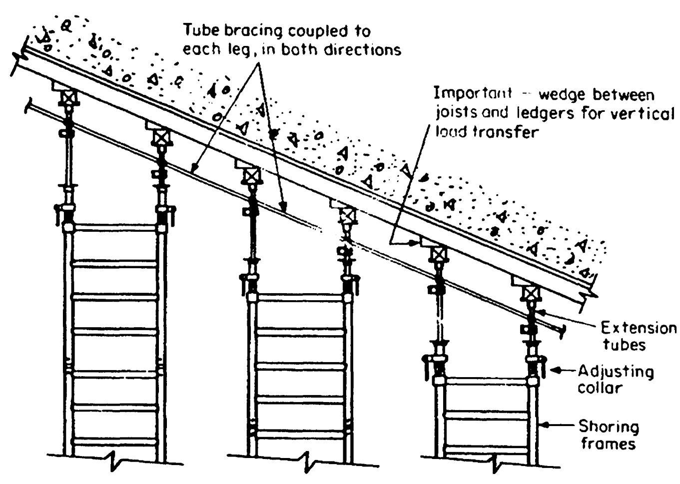


Fig. 2–4 Shoring sloping surfaces.

to showing some recommended ways of proper fastenings to avoid slippage of the members in contact.

Continuity of these lacing–bracing members is quite important to the stability of the installation as a whole since each two or more connections develop a rudimentary moment connection which is a valuable stabilization feature. Also, screw legs can be tied together by the lacing–bracing members, thereby distributing the tendencies of one or more legs to deflect from the vertical owing to lateral forces.

Indesigning a shoring system, it is very important that it be considered as a synergistic whole—possibly greater than the simple sum of its parts. The interface between ledgers–stringers and frame legs is an extremely important one and should take precedence over all considerations except overload of frame legs or ledgers. It is essential that ledgers be installed

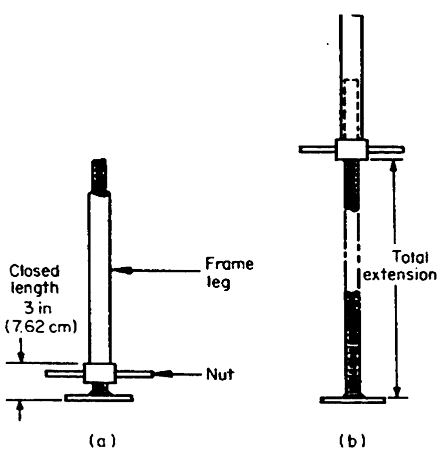


Fig. 2–5 Type A screw legs: (a) closed and (b) open.

so as to: (1) have maximum surface contact with the U head, (2) be suitably placed so that ledger reaction loads are transferred *concentrically* to frame legs by the use of centering wedges and other suitable measures as shown in Fig. 1–7, and (3) ensure that screw legs are not extended beyond the manufacturer's recommendations. Sloping ledgers must be wedged to provide a horizontal seating surface in the U had, as shown in Fig. 2–5.

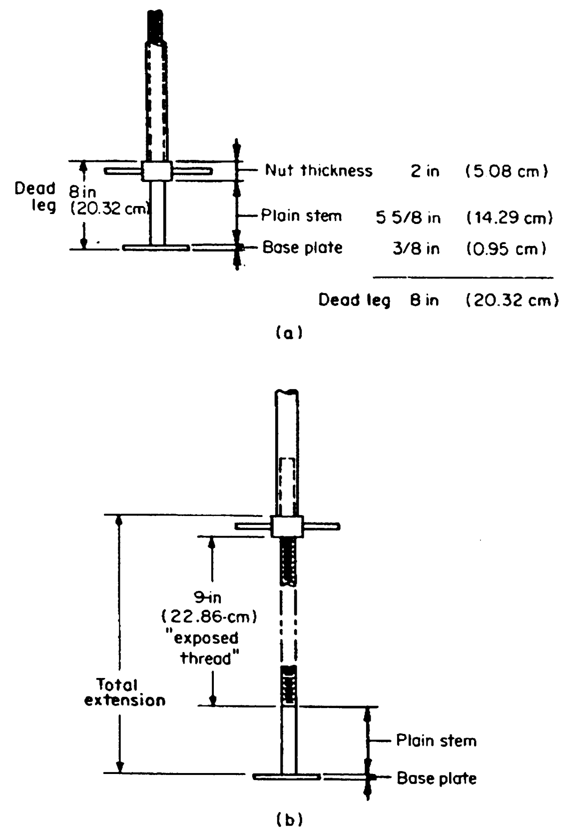


Fig. 2–6 Type B screw legs: (a) closed and (b) open. NOTE: Most manufacturers call out the type of leg and either the fully extended leg (extension) from the frame leg, or give the amount of extension in terms of "exposed screw thread"

SCREW–LEG EXTENSIONS

Frame–leg capacity is generally lowered when using long screw–leg extensions. Variations in manufacturer's designs preclude generalizations as to the degree of load reduction. When a screw leg, completely closed, is inserted in a

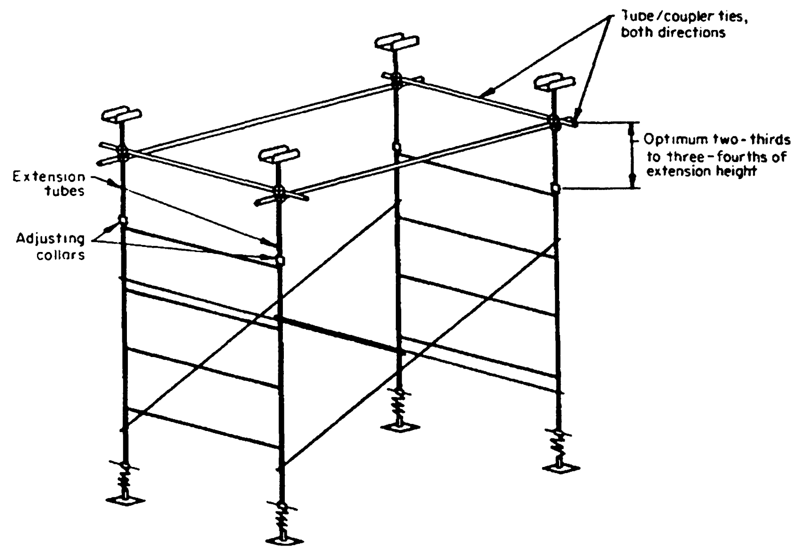


Fig. 2–7 Shoring towers wiyh braced extension tubes.

frame leg, it adds a certain, nonreducible extension to the leg. This is known as the "dead–leg" dimension and must be added to the frame and sprocket stack–up height before adding the required screw–leg adjustment range for the situation. Several common screw–leg configurations are shown in Figs. 2–5 and 2–6.

As for type A and type B conditions shown in these figures, similar conditions exist at the tops of the towers between screw legs and U heads or top plates.

Generally, total extensions up to 12 in. do not significantly decrease the loading. Above 12 in., the effect is variable and largely dependent on the unsupported column distance between the base of top plate and closest frame–leg structural connection, generally the cross–brace attachment. Based on this concept it is obvious that a type A screw leg will give a greater reduction of leg strength than a type B. Only the manufacturer will be able to give the precise allowable loading for various conditions of use for specific equipment.

EXTRA–LONG SCREW LEGS

Some manufacturers have available 24 in. and longer extension screw legs for use with heavy–duty frames. Sine proprietary equipment varies greatly, the specific manufacturer of any special legs should be consulted for allowable loads.

OTHER EXTENSION DEVICES

The previously mentioned piccolos, also known as extension tubes, shore staffs, etc., give great additional flexibility to the shoring tower. Piccolos are tubes, general 2 in. nominal OD and 5 to 6 ft. long, which telescope inside the frame legs. They give a larger range of adjustment than the threaded screw leg, having pinholes at frequent intervals (3, 4, or 6 in.) to accept a hardened steel pin usually of $^1/_2$ to $^5/_8$ in. diameter, a relatively short length of a screw–threaded adapter collar serving as a transitory connection between the extension tube and the frame leg. (See Fig. 2–7). Depending on total length and the size of frame used in conjunction, extension–tube shoring lengths vary from about 1 to 5 ft.

Certain proprietary manufacturers utilize a pair of extension tubes welded into a "head" frame (extension frame) configuration which can achieve high stability properties owing to the facility to brace the welded members together with pivoted cross bracing which is readily adaptable to the extension frame.

Another means of bracing is by horizontal tube and coupler ties connecting each of four legs of a tower together in tow planes. Where conditions allow, rows of towers can use long lengths of tubes in straight runs.

Nailer plates have also been developed to brace these legs with 2 x 4 in.. or 2 x 6 in. wood lacing and bracing. The moment strength of nailer plates is not high, and generally stronger bracing is achieved using cross braces with special adapters or tubes and couplers.

CHAPTER 2 – BASIC SHORING DESIGN & COMPONENTS

STUDY GUIDE

INSTRUCTIONS: Determine the correct word for each numbered blank in the sentence and write it in the blank space provided.

1. [1]______________________________ wide frames and multi–frame high towers having 2–, 3–, or 4–ft. bracing are similarly unstable if not laterally tied.

2. For relatively [2]______________________________ installation (i.e., having [3]________________________________), it is sufficient to attach these "lacing" members to the towers as continuous members with suitable scaffold couplers, between the tubing and [4]__________________________ leg of each tower, even though the tube will pass by a second leg of the tower without being connected.

3. In designing a shoring system, it is very important that it be considered as a [5]________________________________ whole–possibly greater than the simple sum of its parts.

4. Frame–leg capacity is generally lowered when using [6]____________________________ screw–leg extensions.

5. Some manufacturers have available [7]__________________ in. and longer extension screw legs for use with heavy–duty frames.

6. Piccolos are tubes, general 2 in. nominal OD and [8]___________________________ long, which telescope inside the frame legs.

7. Nailer plates have also been developed to brace these legs with 2 x 4 in. or 2 x 6 in. [9]__________________________ lacing and [10]__________________________.

CHAPTER 3. – BASIC SHORING CALCS

SELF–WEIGHT OF SHORING

The self–weight of heavy–duty shoring affects leg load design. Weights of frames, braces, and other appurtenances vary greatly among manufacturers. Taking an arbitrary heavy–duty shoring system, one section of a tower would weigh:

> 2 frames at 65 lb. each
> 4 coupling pins at 2 lb. each
> 2 cross braces at 20 lb. each
> Totaling 178 lb. per section
> A tower 10 frames high would weight 10 x 178 = 1780 lb.
> Dividing by 4, the load per leg = 445 lb.

It is a good rule of thumb that 5% or more should be deducted from the allowable leg for self–weight. Since 445 lb. is close enough to 5% of the 10,000 lb. allowable, it is recommended that design in this case be limited to 9500 lb. per leg. In general, for heavy–duty frames, deduct self–weight when towers are six or more frames high.

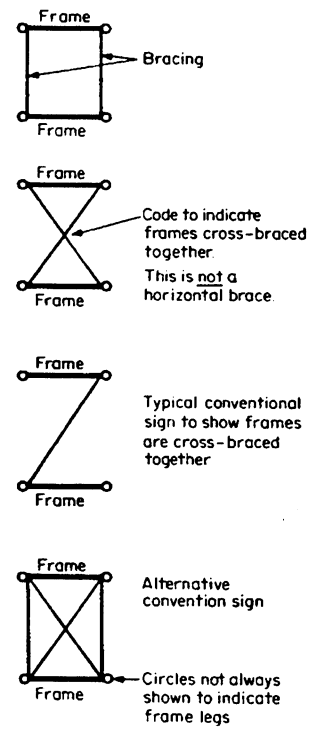


Fig. 3–1 Conventions for indicating shoring towers in plan .

FRAME LAYOUTS

Frame towers on layouts may be shown with or without circles to indicate frame legs. Conventional ways of indicating shoring towers in plans are shown in Fig. 3–1.

FRAME HEIGHT STACKUP

Let us assume that the shoring is to rise from consolidated stone fill (rough grade) and that the height from grade to slab soffit is 14 ft. 6 in.

The best way to determine frame combination is as follows:

1. Add up precise thickness of lumber. ($^{3}/_{4}$ in. for plywood + $5^{1}/_{2}$ in. for 4 x 6 joist + $7^{1}/_{4}$ in. for 4 x 8 ledger + 2 in. for sill = $15^{1}/_{2}$ in.)
2. Add to this the amount of "dead leg" in the screw legs and stack up. (Assume 6 in. at top + 6 in. at bottom = 12 in.)
3. Subtract this total from shoring height. (14 ft. 6 in. – 2 ft. $3^{1}/_{2}$ in. = 12 ft. $2^{1}/_{2}$ in.)

This is the height which must be filled by shoring frames plus variable adjustments on the screw legs. Let us assume that screw legs have a maximum of 10 in. extension each.

At this height, two frames are certainly needed:

1. Try two 6 ft. high frames + 1 in. coupling pins = 12 ft. 1 in. Subtract 12 ft. 1 in. from 12 ft. $4^1/_2$ in. = $3^1/_2$ in. adjustment called for. This will not be satisfactory unless one screw leg is dispensed with, not a practical solution since rough grade needs adjustment at the bottom for grade variations. At the top, at least 3 to 4 in. adjustment must *always* be left to allow easy stripping of the form lumber before dismantling the scaffold.

2. Try two 5 ft. frames + 1 in. coupling pins = 10 ft. 1 in. Subtract 10 ft. 1 in. from 12 ft. $4^1/_2$ in. = 2 ft. $3^1/_2$ in. adjustment needed. If screw legs are limited to 10 in. thread extension (two of them 1 ft. 8 in.), we do not have sufficient height.

3. Try one 6 ft. frame + one 5 ft. frame + 1 in. = 11 ft. 1 in. Subtract 11 ft. 1 in. from 12 ft. $4^1/_2$ in. = 1 ft. $3^1/_2$ in. adjustment needed. This combination leaves $15^1/_2$ in. for screw leg adjustment, say 8 in. for bottom legs and $7^1/_2$ in. for top legs. (Why should they be roughly equal? No reason except for symmetry.) A time–saving practice is to rough–set the screw legs before use (to approximately 8 in.). Use a measuring stick or spacer and adjust legs until there is 8 in. of screw leg extension showing between the underside of the handle nut and the base plate or head. It is faster to adjust the legs at ground level than while they are supporting the frames at the base and/or lumber at the top.

The average setting time is about 1 min. each for clean, lubricated legs. Therefore, for 280 heavy–duty legs, allow 4 to 5 man hours; for 432 standard legs allow 7 to 8 man hours.

There are two other items that should be considered: (1) grade settlement under load (should not exceed $^1/_2$ in.) and (2) compression of formwork lumber under load.

Grade settlement can be minimized using properly designed sills on compacted grade. Obtain from the soil consultant a ground settlement value for leg–base load intensity, or the per unit pressure that will be experienced.

If a rough stone grade or compacted subgrade will withstand these pressures, all that remains is to place the sills so that they are in full contact with both base plates and grade. If the leg loads cause high settlement (i.e., more than a nominal $^1/_2$ in), the sills must be designed for the actual conditions as described later in this chapter.

Consideration must also be given to local compression of the sills and form lumber. A good rule of thumb is to use $^1/_{16}$ in. for every lumber surface (see Fig. 3–2) in contact with another wood member or steel component loaded to more than 60% of capacity or allowable load; if loaded to less than 60% of capacity, use $^1/_{32}$ in. compression for each lumber surface in contact, except for plywood.

Shoring frame stackup charts are sometimes available from manufacturers to aid the contractor in selecting combinations of frame stacks. It should be noted that although6 ft. and 5 ft. high frames are well standardized in size, the smallest height frames vary with the manufacturer and may be 3 ft., 3 ft. 6 in., or 4 ft. high. The table gives heights for the median 3 ft. 5 in. high sizes; therefore; adjustment by ± 6 in. to the stackup heights in necessary in accordance with the size of frame to be used.

Adjustments may be made to the charts for use with extension tubes, extension frames, and

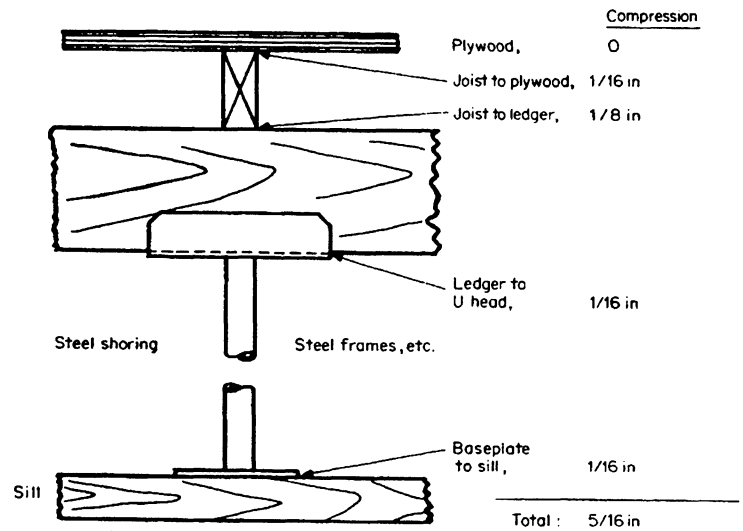


Fig. 3–2 Compression of lumbar surfaces in a shoring tower stackup.

similar accessories. Adjustments should be made to the dead leg lengths used in the charts for those corresponding to the design and/or manufacture of the shoring equipment being used.

For any required height, the combination having the least number of frames will be the most efficient. However, this must be balanced against sizes *available*. Generally, 3 ft and 3 ft. 6 in. high sizes are the least available; 4, 5 and 6 ft are readily available. It is noted that a 5 ft. or 3 ft. 6 in. frame takes approximately the same time to erect as the 6 ft. frame. It is also important to understand that when only one screw leg is required, the rule for using the screw legs at the top or at the bottom is of one's own choice.

Some combinations utilize one screw leg adjustment positioned at top or bottom of the tower. If support is from rough grade, the adjustment should be at the bottom. If support is from a prior concrete slab, use the single screw leg at the top since it makes for easier stripping. The third choice utilizes screw leg adjustment at both top and bottom. At this height economy would dictate use of the first or second choice, since the time needed to adjust screw legs is substantial and should be held to a minimum.

However, tower of *more* than two frames in height should always have adjustments both at top and bottom. Any irregularity in the support slab manifests itself as an "out–of–plumb" condition which becomes more serious with an increasing number of frames in the height. A $^1/_4$ in. floor deviation over the 4 ft. width of frame becomes $1^1/_4$ out of plumb at 20 ft. height. this is an insidious condition which can be remedied only by using hardwood shims or blocking and only if discovered early enough. Once the shoring is three or more frames in height, it is best to consider the lower screw legs as "spacers" merely for height attainment and do all the adjusting with the top legs. The stripping will also go faster if the form lumber is not "racked" by premature lowering of the bottom legs. Generally, *never change lower leg adjustment from beginning to end of a job*, unless different height conditions are experienced

MUD SILLS AND SHORING BASES

This is an area in which problems of excessive soil settlement often arise because of lack of specific instructions to field erection personnel. Without guidelines, there are often unforeseeable results despite workers doing their best based on prior experience.

When, after having layed out as sill system and having erected the shoring, it is decided that the sills need "beefing up," it is very expensive or even impossible to do so.

This section offers some practical means to predetermine the sill design for a given soil or foundation condition. It must be emphasized that the settlement of soil under loads is a very complicated and technical subject involving many variables and factors. The investigation and calculations should not be attempted by unqualified personnel and should be requested from the engineer having responsibility to the contractor.

The information needed by the sill designer is the allowable load per unit area of bearing surface that will give a specified amount of settlement over a specified time.

ERECTION TOLERANCES

All vertical shoring equipment must be erected and kept plumb in both directions. The maximum allowable deviation from the vertical is $^1/_8$ in. in 3 ft. and it should never exceed 1 in. in 40 ft. If this tolerance is exceeded, the shoring equipment should not be used until readjusted within this limit.

Eccentric loads on shore heads and similar members should be avoided. The capacity of a shoring leg or adjustable base is decreased by a large percentage when an eccentric load acts on it. (As an example, a jack that would support 33,000 lb. when loaded concentrically will bend at 11,000 lb. if the load is placed 2 in. off center.)

CHAPTER 3 – BASIC SHORING CALCS

STUDY GUIDE

INSTRUCTIONS: Determine the correct word for each numbered blank in the sentence and write it in the blank space provided.

1. It is a good rule of thumb that [1]____________________ or more should be deducted from the allowable leg for self–weight.

2. In general, for heavy–duty frames, deduct self–weight when towers are [2]____________ or more frames high.

3. The average setting time is about [3]____________ min. each for clean, lubricated legs. Therefore, for [4]_______________ heavy–duty legs, allow [5]_______________ man hours.

4. Grade settlement can be [6]________________________ using properly designed sills on compacted grade.

5. For [7]________________ required [8]__________________, the combination having the least number of frames will be the most efficient.

6. If support is from rough grade, the adjustment should be at the [9]______________. If support is from a prior concrete slab, use the single screw leg at the [10]______________ since it makes for easier stripping.

7. When, after having layed out a sill system and having erected the shoring, it is decided that the sills need [11]_________________________ it is very expensive or even impossible to do so.

8. [12]________________________ loads on shore heads and similar members should avoided.

NOTES:

CHAPTER 4. – UNDERSTANDING FALSEWORK DRAWINGS

FALSEWORK DRAWINGS

All jobs requiring vertical shoring should have a drawing prepared or approved by a qualified person. This drawing should have a complete plan of the area to be shored along with elevations showing the makeup of the shoring equipment. Unusual conditions such as heavy beams, ramps, and cantilever slabs should be covered in detail to assure a safe and proper installation. A copy of the drawing should be available and used on the jobsite at all times.

Shoring layout drawings should be available at the jobsite and should be strictly adhered to. All shoring layouts include general comments which provide additional information. Examples of these notes follow.

General Notes

This drawing is provided as a service to illustrate the assembly of the manufacturer's products only. It is not intended to be fully directive nor cover engineering details of such products or equipment or materials not furnished by the manufacturer nor the interconnection therewith. Inasmuch as the manufacturer does not control jobsite assembly or procedures, grade, or quality of materials or equipment supplied by others, it is the responsibility of the contractor to integrate this drawing into a composite drawing suitably complete for construction purposes consistent with safe practice and overall project objectives. The following points should be covered:

1. All dimensions and details shown on this layout must be checked and verified by the contractor before proceeding with the work.
2. The concrete supported by the shoring shown on the layout is assumed to weigh __ lb./ft^3
3. The design layout includes a live load (including forms) of ___ lb/ft^2 which does not include provisions for motorized concrete equipment. If motorized equipment is used, add 25 lb/ft^2 to the above figure.
4. Approximate amounts of screw jack extensions have been noted. These extensions may require adjustment due to field conditions. However, the maximum screw jack extensions for this layout are limited to __ in. top and __ in. bottom.
5. The contractor will design and provide suitable sills to properly distribute imposed shoring loads.
6. All stringers, ledgers, or other members resting on the manufacturer's equipment must be centered directly over the shoring legs.
7. Splicing of ledgers must occur at the centerline of jack screws.
8. Ledgers where supported by U heads will be equally packed or wedged.
9. In setting elevations, allow for lumber and soil compression.
10. **Timber Notes**

    a. Timber calculation and design criteria are based on dressed sizes conforming to the American Softwood Lumber Standard, Voluntary, Product Standard

20–70, U.S. Department of Commerce, National Bureau of Standards, and to the *National Design Specifications for Stress–Grade Lumber and Its Fastenings*, 1968 edition, revised November 1970.

b. The timber falsework details shown are manufacturer's suggestions and for: Douglas fir–larch No. 1 stress graded 1500 (per National Forest Product Association) size classified 2 to 4 in. thick by 6 in. and wider with a 25% increase for short duration loading 10% for *E*.

Fiber stress in bending1500 lb./in.^{2} (1034 N/cm^2) (Engineered Use)	1800 lb/in^{2}1
Horizontal shear 95 psi (65.5 N/cm^2) (If checks are not in excess of width of piece, allow 33% increase to 126 lb/in^2 (86.9 N/cm^2)	150 lb/in^2
Compression perpendicular to grain	480 lb/in^2
Modulus of elasticity *E*	1.76x10^6 lb/in^2

c. Plywood design is based on American Plywood Association technical data (Concrete Formwork Brochure No. S71–90, January 1971). Grains of face piles are perpendicular to the supports. Plywood continuous over two or more spans. Values are for B–B plyform class I (exterior type), deflection limited to L/270. If B–B plyform class II is used, increase thickness of plywood shown on layout by $^1/_8$ in.

11. The final responsibility for the formwork design and placement remains with the concrete contractor.

12. The shoring system,as shown, is designed on the assumption that formwork will be restrained from lateral movement by the contractor. Sufficient lateral support must be provided where necessary to prevent the imposition of lateral loads on the shoring system.

13. Shoring equipment should be erected and used per published safety rules and regulations of the Scaffolding, Shoring, and Forming Institute, Inc.

14. The print is the property of the manufacturer and is furnished for the exclusive use of the customer on the condition that it is not to be copied or used by others without written consent.

15. All steel beams must be secured to U heads with beam clamps or by another approved manner, as they are installed.

16. All lower frames of a tower must be plumb and level before erecting the remainder of the tower. Check again for plumbness prior to placement of concrete.

17. Reshoring design and procedures are the responsibility of others and should be thoroughly checked by the architect and/or engineer to determine proper placement and that sufficient capacity exists to support areas being reshored.

18. Tower leg loading should be uniformly distributed as possible. Never load only one leg of a frame or one ledger of a tower.

19. Horizontal Shore Notes

a. Job architect or engineer is to determine that the structural steel beams supporting horizontal shoring beams are capable of carrying construction loads during placement of concrete.

b. An intermediate shore must never be placed under the lattice section of the horizontal shoring beam.

c. An allowance of up to $^5/_8$ in. must be made for the depth of the horizontal shoring beam bearing prongs, in order to determine the correct elevation of the ledger.

d. Do not nail horizontal shoring beam prongs to ledger.

e. Care must be taken to follow the designed allowable clear span of the horizontal shoring beam.

f. Beam hangers must be designed and loaded in accordance with manufacturer's specifications and designed to fit the shape of the horizontal shoring beam bearing prongs.

g. All beam sides supporting horizontal shoring beams must have a minimum of a 2 x 4 in. vertical stud directly under each horizontal shoring beam or a design which takes horizontal shoring beam concentrated loads into consideration.

h. The manufacturer assumes no responsibility for placement of beam ties or kickers for beamside forming.

20. Post shores, if shown, are to be the manufacturer's post shores. Any substitutions of other post shores are to be approved by the supplier.

21. The manufacturer does not provide all items illustrated on these drawings. Those items not supplied should be erected according to drawings furnished by their manufacturer or supplier. The final responsibility for design and placement of these items remains with the contractor.

22. No deviation from these drawings is permitted without written consent of the manufacturer.

23. The customer or lessee bears the sole responsibility for ensuring that any erection or use of the goods shown on these drawings conforms to all laws, ordinances, and local codes and for checking the accuracy of field details and dimensions.

CHAPTER 4 – UNDERSTANDING FALSEWORK DRAWINGS

STUDY GUIDE

INSTRUCTIONS: Determine the correct word for each numbered blank in the sentence and write it in the blank space provided.

1. All jobs requiring vertical shoring should have a drawing prepared or approved by a [1]________________________ person.

2. Inasmuch as the [2]________________________________ does not control jobsite assembly or procedures, grade, or quality of materials or equipment supplied by others, it is the responsibility of the [3]______________________________ to integrate this drawing into a composite drawing suitably complete for construction purposes consistent with [4]____________________ practice and overall project [5]_________________________.

3. The contractor will design and provide suitable sills to [6]____________________________ distribute imposed shoring loads.

4. The final responsibility for the formwork design and placement remains with the concrete [7]__________________________.

5. The shoring system, as shown, is designed on the assumption that formwork will be restrained from [8]______________________ movement by the contractor.

6. No deviation from these drawings is permitted without [10]___________________________ consent of the manufacturer.

OVERVIEW:

The planning of access is basic to the completion of every construction project. City traffic most coexist with construction projects and trenches must be covered during peak traffic periods. Trucks must be provided ramps or runways to load and unload materials. Cranes require platforms within the construction project in order to maintain clear streets for material deliveries and to provide safe reach fro the crane.

The purpose of these chapters is to present some of the pertinent considerations that must be evaluated when designing or building a support system for construction access.

FALSEWORK & HEAVY TIMBER FRAMING

PART TWO

HEAVY TIMBER FRAMING

"INTRODUCTION"

DEFINITIONS

A ramp is a sloped surface which joins different levels. It is utilized on a construction project to provide access between a foundation or basement and the street level.

A runway is a strip of level road which forms a track for wheeled vehicles. It is a narrow extension out into the construction site.

A platform is a raised horizontal surface of wood or steel used by cranes and vehicles to bring materials into construction projects.

DESIGN AND RESPONSIBILITIES

The designs of ramps, and platforms are often left to the contractor. The consulting engineer will often require that plans for temporary structures be submitted for examination. The responsibility for the design of the temporary structure remains with the contractor, the logic being that only the contractor could be aware of the problems and needs of the construction crews. Government authorities tend to agree that access and supplies during construction operations are best planned for by the contractor's personnel. The contractor as a major participant in the building team is willing to accept this charge and often will retain or employ professional engineers to plan for access to the construction project.

In order to properly plan for access, the constructor must segregate the job into building blocks and realistically grasp the magnitude of the problem. A high–volume traffic access might be approached on a different level from a rarely used secondary emergency approach.

The physical conditions of ramps, runways, and platforms might be considered similar in that each structure must be designed for the worst condition; however, a single–usage design might be supplemental by specific controls, such as a flagman, whereas a highly trafficked approach might require wider access and higher safety factors.

The engineer responsible for the design of temporary ramps, runways, and platforms must understand the physical conditions that could lead to failure of the structure. Only by having a clear understanding of the weakest link in the support chain can the professional plan to overcome the condition that could cause collapse.

The cost of construction is increasing; the cost of a construction failure is excessive and avoidable. Good training and quality control can reduce the cost of failures in terms of human life and monetary considerations. It is up to the construction industry team to provide the expertise required to meet the challenge for safe and efficient access passageways.

The basic human factor in the construction industry is the civil engineer, employed or retained by contractors, design consultants, and by government. The civil engineer's responsibilities include the design and supervision of the installation of ramps, runways, and platforms. Too often so–called professionals will delegate the responsibility for important structures to construction craftsmen rather than to trained professionals. This leads to sloppy practices that may cause failures.

NOTES:

CHAPTER 5. – TIMBER TRESTLE BRIDGES

The timber trestle bridge is one of the simplest types of bridges. Spans are usually limited to 25 ft. using timber stringers. The stringers rest on trestle bents and abutments. Figs. 5–1 and 5–2 illustrate the various components of timber trestle bridges.

The first priority is to classify the loading limitations that are expected. An error in judgment regarding weight limitations can be avoided by clearly marking the safe capacity of the bridge. Many construction engineers overlook the standard requirement; they design and construct a bridging system with a certain crane as the design model. A new or rented crane requires a structural support revision that all too often is never carried out. A bridging failure often leads to loss of life and serious injury. The design is usually limited to a single lane approach by a concrete truck or by a crane. The driver or operator must be limited as to the rate of speed while on the vehicular bridge and must be cautioned regarding sudden stops.

A major hazard regarding the construction of temporary bridging is the tendency of spiked

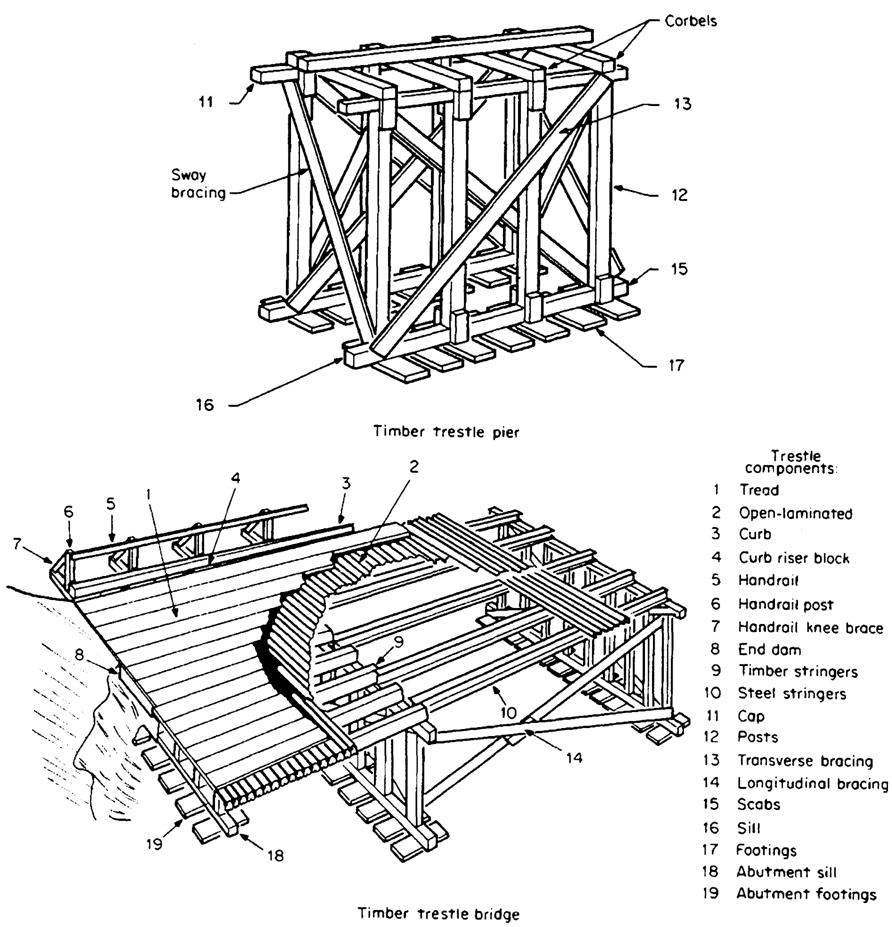


Fig. 5–1 Typical Timber Trestle Pier and Bridge

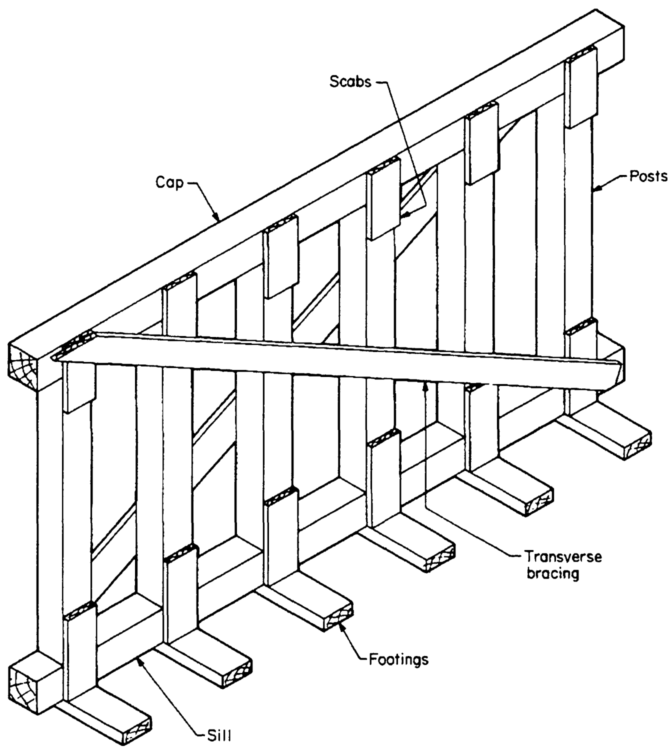


Fig. 5–2 Typical Timber Trestle Bent

timbers to loosen. A daily engineering inspection of a heavily trafficked bridge is recommended during the initial break–in periods. Loose spikes and timbers must be tightened and secured. Main supporting stringers must be tightened and secured. Main supporting stringers must be reviewed regarding bearing surfaces. Stringers have a tendency to move with the load and will often creep off the cap support. Overlapping stringers provide adequate support, but a bolted or spiked connection will often be preferable. A substantial end dam or heel will prevent this tendency for horizontal shifting.

The thread and the decking can often be combined. Common sizes of components of timber bridges are shown in Fig. 5–1.

A 4 in. x 12 in. plank laid on the flat will usually provide the required strength for construction equipment. Bridge footings require special attention; on permanent structures they are often driven to rock in order to provide a secure support.

On temporary structures the tendency is to overlook the need for adequate bearing for the footing timbers. The 4 in. x 12 in. planks used as footings are really only leveling sills, and if a site investigation leads the engineer to suspect the bearing capacity of the underlying soils during rains or other adverse weather conditions, then a separate soils analysis is in order. Investigations of this nature must be based on boring's and other specific data.

Usually a temporary structure will not have the benefit of a detailed soils analysis and the construction engineer will be required to visually judge the proper bearing capacity. Sands might fall in the 3 ton/ft^2 capacity area while a silty clay or organic meadow mat might be incapable of providing any worthwhile support without excessive settlements. Piles may have to be driven or a raft or floating support system may have to be designed. These are judgments that must be made on site observations and investigations.

In most cases the stringer design is the most critical member of the bridge; however, a check should be made of the capacity of the posts and the cap beams. A 12 in. x 12 in. post is not normally designed to carry a load of more than 36 tons. The maximum unsupported length of the post should be checked for buckling. Gross bracing of bents is important, for it prevents a side–sway force from causing a collapse of the bent.

CHAPTER 5 – TIMBER TRESTLE BRIDGES

STUDY GUIDE

INSTRUCTIONS: Determine the correct word for each numbered blank in the sentence and write it in the blank space provided.

1. A [1]________________________ is a sloped surface which joins different levels.

2. A [2]________________________ is a strip of level road which forms a track for wheeled vehicles.

3. A [3]__________________________ is a raised horizontal surface of wood or steel used by cranes and vehicles to bring materials into construction projects.

4. The responsibility for the design of the temporary structure remains with the [4]_________________________, the logic being that only the contractor could be aware of the problems and needs of the [5]_____________________________ crews.

5. The timber trestle bridge is one of the [6]_________________________ types of bridges. Spans are usually limited to [7]_____________________ using timber stringers. The stringers rest on trestle bents and [8]_______________________________.

6. A major hazard regarding the construction of temporary bridging is the tendency of spiked timbers to [9]______________________________.

7. On temporary structures the tendency is to overlook the need for [10]___________________ bearing for the footing timbers.

8. In most cases, the stringer design is the most [11]____________________________ member of the bridge; however, a check should be made of the capacity of the [12]_______________ and the [13]____________________ beams.

CHAPTER 6. – FOUNDATION RAMPS

Office building foundations normally require the use of ramps for access during construction.

Shallow basements (one and two levels) are normally approached by means of earth fill. Deeper excavations might require timber or steel ramps. The basic rule is that ramps must not exceed a 15% slope for the most powerful 10–wheel trailers. Errors in the slope can be very costly with an expensive installation that requires winches to assist trucks in and out of the cut. This, of course, defeats the beneficial advantages of a construction ramp.

Timber and steel ramps are preceded by earth or fill ramps. The excavating machines must dig their own ramps as the work progresses; it is only after the excavation has reached subgrade that a steel or timber ramp can be constructed.

One–Basement Structure

In this case excavation is less than 15 ft. Earth or fill ramps are usually excavated by the equipment as it progresses toward subgrade. Earth ramps may be totally unsatisfactory from a traction standpoint and for this reason they are often topped with loose building bricks. The rough edges of the brick form high spots for the truck tires to grab on when utilizing the ramp access. The brick topping should form a blanket at least 12 in. in depth in order to minimize repairs. The topping must be maintained in order to preclude the forming of potholes. A ready supply of brick or even stone aggregate is necessary in order to assure continuous operation. The existence of fine silts or clays on the ramp will lead to a loss of traction for the trucks. These materials, when wetted, are slow to dry and are known to form slipping planes.

The key ingredient of a good earth ramp is drainage. The surface must be easily drained with materials that are heavy enough to resist erosion during heavy rains. Rutted roads make poor transportation and an unusable ramps can cause serious construction delays.

Heavy snows or freezing rains will prevent the utilization of ramps, as is the case with all roads. A ramp, however, is limited in length, and most contractors will find it advantageous to maintain an ice– or snow–free ramp. This is accomplished by removing large accumulations of snow with a machine, possibly a front–end loader, and by blowing the remaining snow off to the side of the ramp using compressed air flow pipes. These are 6 ft. long $^{3}/_{4}$ in. pipes hooked to the air lines and having a hand–operated shutoff valve. A ready supply of salt or calcium chloride will often provide the final determining factor as to whether a contractor operates during cold or icy conditions.

Two–Basement Excavations

Two–basement excavations (approximately 30 ft.) are similar to one–basement excavations. However, the need for prior planning of access is more urgent. An error in judgment could require considerable effort to revise the access.

Fig. 6–1 indicates some of the typical features of a timber ramp with steel stringers. The surface decking will usually consist of 4 in. x 12 in. rough planking which rests on a series of steel stringers interwoven with 12 in. x 12 in. timbers. For simplicity and uniformity, the steel stringers are normally 12 in. in depth. Fig.

6–1 indicates the typical ramping detail, which is, or course, similar in style and appearance to the temporary bridging discussed earlier.

The steel stringers are utilized to support the actual wheel loads of the vehicles utilizing the ramp. Great care must be exercised to route the vehicle in a manner that is safe for the designed trespass; 8 in. x 8 in. guide blocks or curbs are often utilized to maintain the vehicular access in a path that is fully supported by the stringers.

Walkways are usually positioned along the edge of the ramp, and they are provided with secure rails, all in accordance with OSHA requirements.

A ramp is a sturdy bridging system that must meet stringent quality controls. The ramp must be planned simply and it must be constructed in a secure fashion in order to meet the requirements of daily use. Like all bridges, it must be secured in place; the likelihood of horizontal movement is great due to the laterally induced forces. The standard method of resisting these thrusts is to secure the toe and the cap of the ramp against movement.

The design of the cap footing will depend on the bearing value of the surface soils and muse be carefully examined; often it is necessary to continue the footing until firm bearing is established, possibly even to rock. However, most often it is advantageous to increase the pad size in order to lower the required bearing value.

Fig. 6–1 Construction ramps are usually fabricated using a combination of steel and timber

CHAPTER 6 – FOUNDATION RAMPS

STUDY GUIDE

INSTRUCTIONS: Determine the correct word for each numbered blank in the sentence and write it in the blank space provided.

1. The basic rule is that ramps must not exceed a [1]____________________ slope for the most powerful 10–wheel trailers.

2. [2]____________________ and [3]____________________ ramps are preceded by [4]____________________ or [5]____________________ ramps.

3. The existence of fine [6]____________________ or [7]____________________ on the ramp will lead to a loss of traction for the trucks. These materials, when wetted, are slow to dry and are known to form slipping planes.

4. [8]____________________–basement excavations (approximately 30 ft.) are similar to one–basement excavations. However, the need for prior planning of access is more [9]____________________.

5. A [10]____________________ is a sturdy bridging [11]____________________ that must meet stringent quality controls. The ramp must be planned simply and it must be constructed in a secure fashion in order to [12]____________________ the requirements of daily use.

NOTES:

CHAPTER 7. – RUNWAYS AND PLATFORMS

Construction runways are normally utilized on facilities where the construction proceeds in a horizontal rather than a vertical direction. The runway is built on top of the new construction, utilizing the walls and grade beams as supports.

Figs. 7–1 and 7–2 give some important details regarding the construction of a crane runway and platform over a newly constructed sewage channel and over concrete girders, respectively.

The positions for lifting must be carefully shored, for it is when the crane is swinging over a single outrigger that the maximum stresses are induced into the shoring members. Turn-offs or additional spans may be added to provide for special lifts.

Platforms are sometimes required in order to provide access for structural–steel erection. The placement of timber mats and shores may be utilized to strengthen existing or new construction.

The width of the support system is determined on the basis of the widest vehicle use. A crane runway must be wide enough for the placement of outriggers, while a truck runway need only be the standard 12.5 ft. clear. The length of a ramp or runway will be determined by the physical characteristics of the project, such as its depth or its size.

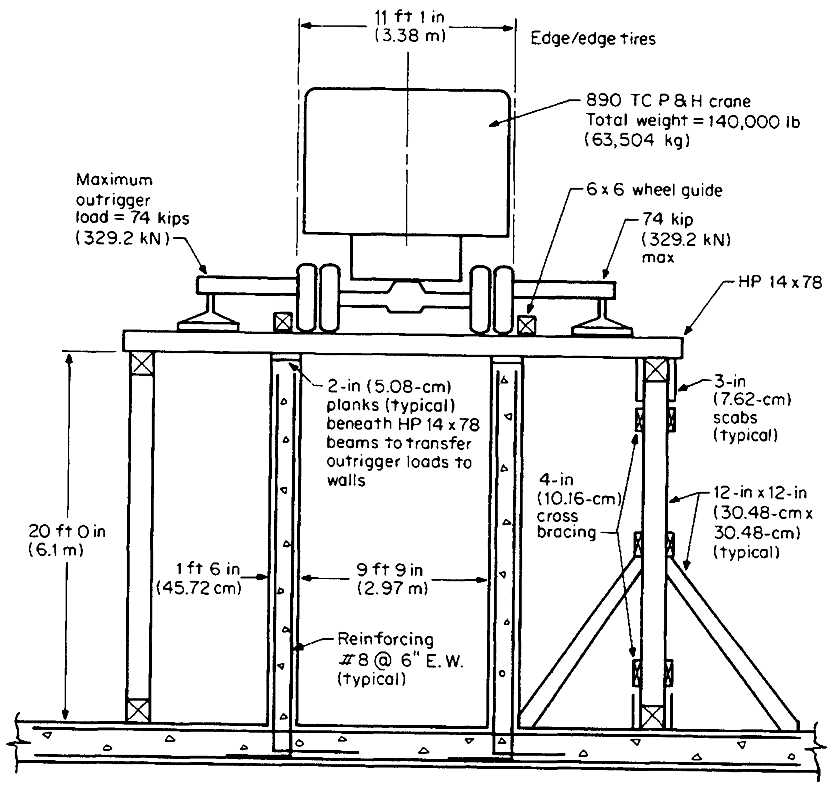


Fig. 7–1 Typical Cross Section of Working Platform

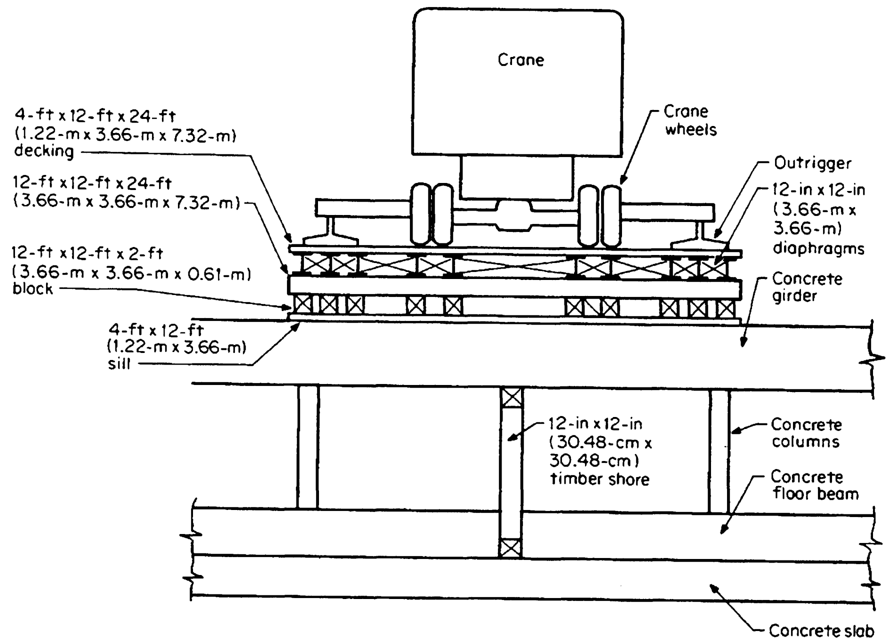


Fig. 7–2 Typical Cross Section of Crane Platform

The City of New York requires that a crane permit be obtained from the city before establishing a crane within the city's limits. The firm seeking the crane permit must have a professional engineer's certification that the site has been examined and found to be suitable for supporting the crane during its intended use. The engineer's examination must include an appraisal of the probable bearing value of the subsoil, a statement regarding the presence of vaults under the bearing pads, and calculation showing the intended use and loadings.

The bearing value of the soil is not to be assumed greater than 1500 lb/ft^2 unless the engineer has specific knowledge regarding the nature of the subsurface soils. Borings and soil–testing programs are not usually carried out for simple temporary crane installations; therefore, most engineers rely on a visual inspection of the soil bearing value and assign a value of 1500 lb/ft^2 unless the subsoil appears to be incapable of providing even this minimum level of support.

A standard rubber–tired crane has four outrigger pads whose bearing surfaces are 4 ft^2 each for a total of 16 fy^2. A loading of 60,000 lb. per outrigger is common, and therefore a footing must be provided to distribute this loading over a larger area. Typically each outrigger will be placed on a timber crib consisting of 12 in. x 12 in. beams bolted together to form a mat of approximately 40 ft^2.

The question of subsurface vaults is often more difficult to solve, for urban construction sites may have had a history of four or five earlier buildings whose drawings are not known and whose construction may have included a sidewalk vault for storage. These nineteenth–century vaults are usually massive brick arches supported by piers and they are normally of a greater strength than the minimum assigned to street bearing levels. However, in the interest of public safety, it is mandatory that a responsible engineer investigate and determine the safe bearing values before a crane is permitted to function in a crowded metropolitan area like New York City.

CHAPTER 7 – RUNWAYS AND PLATFORMS

STUDY GUIDE

INSTRUCTIONS: Determine the correct word for each numbered blank in the sentence and write it in the blank space provided.

1. Construction [1]______________________________ are normally utilized on facilities where the construction proceeds in a [2]______________________________ rather than a [3]________________________ direction.

2. The positions for lifting must be carefully [4]_________________________, for it is when the crane is swinging over a single [5]____________________________ that the maximum [6]________________________ are induced into the shoring members.

3. The width of the support system is determined on the basis of the [7]__________________ vehicle use.

4. A standard rubber–tired crane has four outrigger pads whose bearing surfaces are [8]_________________________ each for a total of [9]________________________.

NOTES:

LESSONS IN THE ERECTION OF:
Shore "X" Patented, Tubular, Steel–Framed Falsework Shoring

Following is a series of lessons with calculation exercises designed to help you build a better understanding of the previous several topics. You will have an opportunity in class to complete the lessons.

FALSEWORK & HEAVY TIMBER FRAMING

LESSONS

LESSON 1 – ERECTION OF SHORE "X" TOWERS

- .... Section 1. – Design Check
- .... Section 2. – Site Preparation
- .... Section 3. – The Shore "X"® System & Components
- .... Section 4. – Layout and Placement of Sills or Pads, Including Grade Hubs
- .... Section 5. – Equipment Handling
- .... Section 6. – Placement and Erection of Shore "X" Components
- .... Section 7. – Erection and Grading of Caps
- .... Section 8. – Set Stringers, Joist, Plywood Deck and Final Grade
- .... Section 9. – Stripping Soffit & Falsework
- .... Section 10.– Erection of Three Frame Towers or Double Frame Towers
- .... Section 11.– Frames on Slopes
- .... Section 12.– Bracing High–Rise Towers
- .... Section 13.– Unbalanced Tower Loading
- .... Section 14.– Screw Jack Adjustments
- .... Section 15.– Frame End Cross Braces
- .... Section 16.– Adapter Pins
- .... Section 17.– Miscellaneous Hardware
- .... TWELVE SAFETY CHECKS FOR SHORE "X"

LESSON 2 – FRAME FILL CALCULATIONS FOR SHORE "X" TOWERS

- .... Section 1. – Compute shoring fill on outboard towers.
- .... Section 2. – Computing shoring fill on intermediate (interior) towers

LESSON 3 – HEAVY TIMBER FRAMED FALSEWORK AND BENTS

- .... Section 1. – **TO BE DEVELOPED**

LESSON 4 – FABRICATION PROCEDURES FOR HEAVY PIPE SHORING

- .... Section 1. – **TO BE DEVELOPED**

LESSON 1. Erection of Shore "X" Towers

INTRODUCTION:

Shore "X" patented, tubular, steel–frame modular shoring has become the standard shoring system of the commercial concrete and bridge structure industry. Originally developed and patented by the Superior® Scaffold & Shoring Co. this product line (or a similar manufactured copy) can be found in the equipment fleet of virtually every bridge building contractor in California. The versatility, durability, and ease of erection of this system has revolutionized the whole bridge building industry. The system contains two separate falsework range capacities – heavy duty and extra–heavy duty.

In the heavy duty range is the original 11K (kip*), or 11,000 pounds–per–leg Shore "X" and the 25K (kip), or 25,000 pounds–per–leg Shore "X".

In the extra–heavy duty range is the 60K (60,000 pounds–per–leg) Super Shore "X" and the 100K (100,000 pounds–per–leg) Super Shore "X". The 100K (kip) Super Shore "X" will provide a fully braced tower with a capacity of up to 400,000 pounds.

*** A KIP is an engineering measurement unit equivalent to 1,000 pounds.**

LESSON:

The following lesson borrows almost exclusively from the work of Dave Wilson, a pioneer in the field of mechanical shoring systems. Dave has been instrumental in not only the design of modular falsework, but also in the industry–wide promotion and acceptance of this equipment.

In this lesson you and your assigned partner(s) will erect and disassemble a tubular falsework tower from 11K Shore "X" utilizing all the proper safety precautions and assembly procedures.

The assembled towers of all students will then be inter–braced to form a patterned shoring configuration.

> ***SAFETY ALERT!!!: Tubular falsework becomes extremely unstable when erected "out–of–plumb". Take extreme care to plumb and re–check your base unit in both directions before mounting tower units...REMEMBER: The maximum allowable deviation from vertical is 1/8" in 3 ft. to 1" in 40 ft.***

APPLICATION IN THE FIELD:

Modern bridge building operates in a high–cycle production mode. The remarkable contribution that patented shoring systems brought to the building industry is the increased amount of shoring that can be erected per man–hour. Your ability to become fluent in these erection processes insures the success of the work production curve.

OBJECTIVES:

To introduce you to the Shore "X" patented shoring system including all the attendant assembly components and the safe assembly and disassembly procedures.

REFERENCES:

1. Provided

STUDENT TOOLS

1. Full tool belt for framing plus tool box with framing tools.

EQUIPMENT (Total class)

1. 6′ x 4′ 11K Shore "X" Base Frames
2. 5′–4″ x 4′ Extension Frames
3. 4′ Frame Cross Braces
4. Swivel Screw Jack Bases
5. "J" Head Screw Jacks
6. Telescoping Frame Pins
7. Bar Braces
8. Timber Bracing Clamps
9. Graded Scaffolding Planks

MATERIAL

1. 2 x 12 x 16′–0″ D.F. S4S Sill Plates
2. 2 x 6 x 16′–0″ D.F. S4S Tower Bracing

PROCEDURES (Total class)

1. Design Check

<u>All plans and layouts must be carefully checked and approved by the general contractor. Check all codes.</u>

The check should include consideration of the following:

*A. Soil conditions.

B. Tower loadings.

C. Stringer, joist and cap sizes.

2. Site Preparation

*A. Clear the shoring areas of <u>all</u> <u>obstructions</u> well ahead of erection.

*B. Level and compact ground if necessary.

*C. To obtain proper bedding of the pad or sill, sand may be required at influenced areas.

3. The Shore "X"® System & Components

The SHORE "X"® system has been designed to simplify the shoring of construction projects. The primary advantages of the SHORE "X" system are its extra carrying capacity, complete range of height adjustments, the need for fewer types and sizes of components, and maximum flexibility to meet varying job conditions.

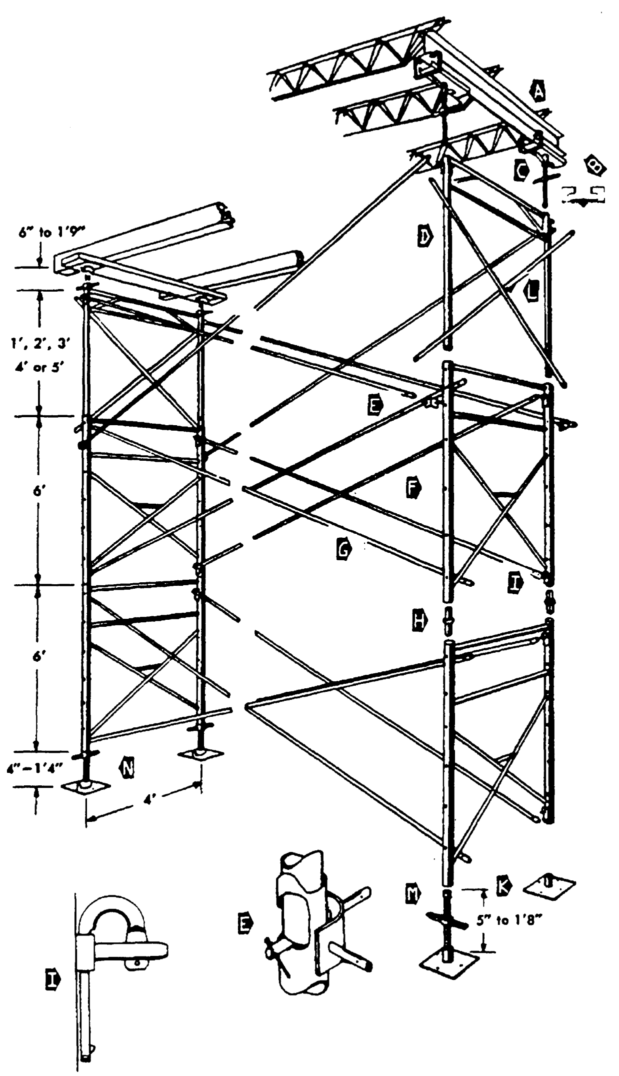
Fewer types and sizes of components. Only Base and Extension Frames are used with same size crossbrace to erect a tower of any height. The Extension Frame, which adjusts at one foot intervals, eliminates odd size frames and crosses – cutting total number of component sizes 40%.

Increases efficiency of horizontal shoring. 11K allows the towers to be of the size (i.e., 4′ x 10′) best suited for the efficient span of the horizontal beam. The towers are spaced to insure economic loading. This enables the contractor to take full advantage of both horizontal and vertical shoring systems.

Lower labor costs. The flexibility of SHORE "X" reduces the man–hours required to design, lay out, supervise and erect the shoring. Fewer towers means less labor. Since all height adjustments are made with top frames and screw jacks, crews can proceed with erection without being concerned with sorting the many combinations of frame sizes and crosses required with other methods.

Reduces cartage and maintenance costs. The reduced number of components used with SHORE "X" 25K lowers cartage and warehousing costs.

Use it on all those tough–to–shore jobs—bridges, beams, slopes, slabs, commercial, industrial—where you need a shoring that carries 25,000 lb./leg frame



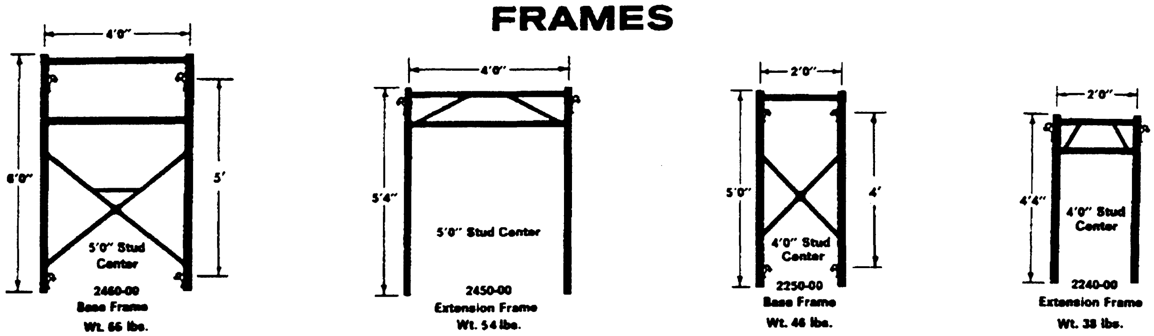
SHORE "X" 11KIP SYSTEM

The Fully Braced Adjustable Shoring system

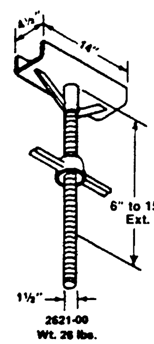
- **A** **4" x 8" Steel Junior Beams.**
- **B** **Beam Clamps** (4447-00) secure the beam to the "J" head.
- **C** **"J" Headed Screw Jacks** (2621-00) give easy height adjustment.
- **D** **Extension Frames** (2450-00—4′ x 5′4") telescope into Base frames to give height adjustments of 1 ft., 2 ft., 3 ft., 4 ft.—and 5 ft. This adjustability eliminates the need for 2 ft., 3 ft., 4 ft., and 5 ft. frames, their various cross sizes, and extension sleeves.
- **E** **Adapter Pins** (2001-00) fit into holes on legs of Base Frames, support the Extension Frames at the desired height adjustment, and provide attachment points for crosses.
- **F** **Base Frames** (2460-00—4′ x 6′) "X" braced design. Holes in legs receive Adapter Pins at any desired level of adjustment.
- **G** **Cross Braces.** Only one size of side cross braces is required for both Base and Extension Frames.
- **H** **Coupling Insert Pins** (2023-00) provide alignment of Base Frames and can be bolted through holes in legs of Base Frames to permit hoisting of assembled towers.
- **I** **Speed-Locks** provide fast, trouble-free attachment of cross bracing.
- **K** **End Cross Brace** (2045-00) always used at 3′-0", 4′-0", 5′-0" Extension. 4′-0" Frame only.
- **L** **The Cap** (2623-01) combined with the collar on the jack handle, provides positive alignment in the legs of the Base Frames.
- **M** **Swivel-Based Screw Jacks** (2619-00), with 8 inch by 8 inch swivel plates, compensate for uneven ground conditions, eliminating wedging, and give easy 12 inch height adjustment. (Add 2623-01 when used with 2⅜" frame.)

3. The Shore "X"® System & Components (Con't)

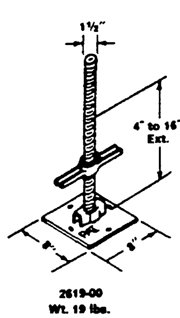
FRAMES



"J" HEAD SCREW JACK



SWIVEL SCREW JACK



Aligning caps must be used when jacks are inserted in either top or bottom of Base Frames.

Adapter pins and side crosses must be used at all times with Extension Frames. Side crosses assure proper position of adapter pins. Pin must be held in position with an 8d duplex nail. Both legs of Extension Frames must rest on Adapter Pins.

Side Crosses assure proper placement of adapter pins. Side crosses must be placed at all times including one foot extension of extension frames. End crosses must be placed when extension frame is extended 3', 4', or 5'.

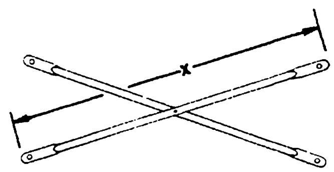
"J" HEAD SCREW JACKS

Beam placement. 4 x 8 junior beams must be butted within 2" of the center of the "J" Head. Maximum space between butted beams must not exceed 4".

Beam Clamp placement. Clamps must be placed on each end of the beam. When horizontal Quickbeams are placed on only one side of beam, beam clamps must be placed on every jack screw to minimize possibility of beam rotation.

Horizontal Quickbeam bearing prongs must bear fully on the 4 x 8 Junior Beam.

CROSS BRACES

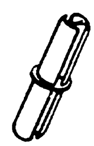


4' WIDE FRAMES

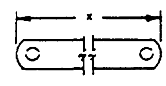
Part No.	Size	X	Wt. (lbs.)
2045-00	4'x5'	78¹³⁄₁₆	10
2065-00	6'x5'	95¹¹⁄₁₆	12½
2085-00	8'x5'	115⅞	15½
2105-00	10'x5'	136⅛	18

COUPLING INSERT PIN

2023-00
Wt. 2 lbs.

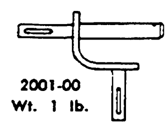


BAR BRACE



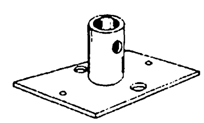
8½" #2850-00

ADAPTER PIN

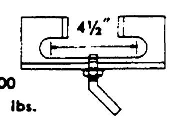


2001-00
Wt. 1 lb.

BASE PLATE
2088-00



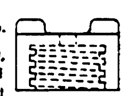
BEAM CLAMP



4447-00
Wt. 2½ lbs.

SCREW JACK ALIGNMENT CAP

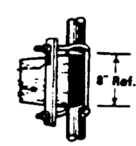
Wt. ½ lb.
Converts 2621-00, 2619-00 & 2600-21 Screw Jacks to fit 2⅜" tube.



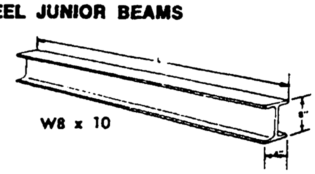
2623-01

TIMBER BRACING CLAMP

2230-00
Wt. 2½ lbs.



STEEL JUNIOR BEAMS



Part No.	L	Wt. (lbs.)
2004-00	4'	40
2006-00	6'	60
2008-00	8'	80
2010-00	10'	100
2012-00	12'	120
2014-00	14'	140

SAFETY RECOMMENDATION

Follow local codes, ordinances and regulations pertaining to shoring and steel forms. Inspect all equipment before using. USER IS RESPONSIBLE for equipment damaged in handling, overloading or misuse in any way whatsoever. Do not exceed manufacturer's recommended safe working loads for both shoring and forms. Special consideration must be given to the proper design of footing support for these towers. Engineer should check wind load.

4. Layout and Placement of Sills or Pads, Including Grade Hubs.

*A. Erect as large an area (i. e., 2 or 3 spans) as available, to allow systematic progress.

*B. Layout (See Fig. 1–1) (Use shoring drawing)

*1. Set sills or pads on center line of tower legs **1**.

*2. Mark center line of girder on sills or pads **2**.

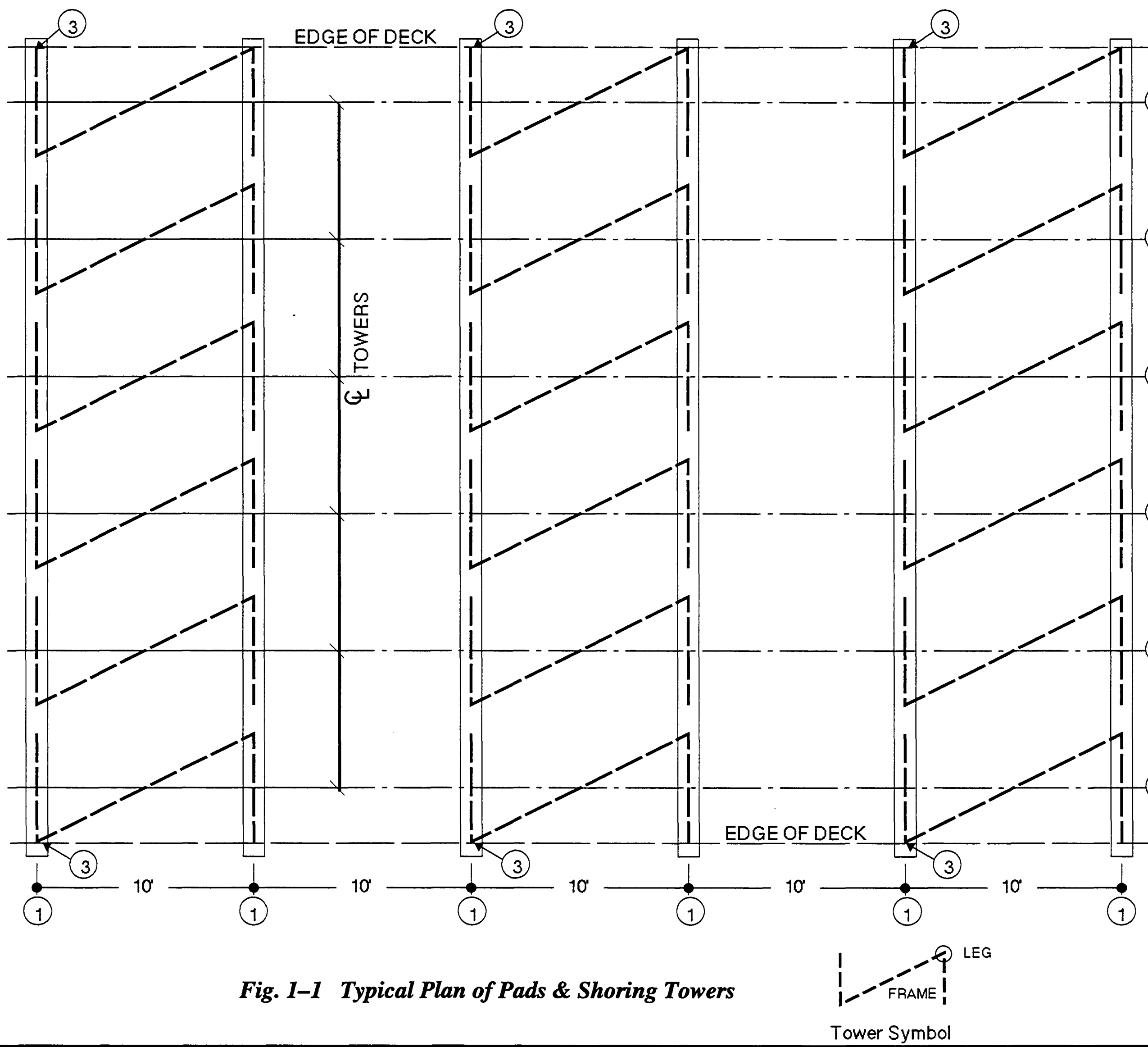


Fig. 1–1 Typical Plan of Pads & Shoring Towers

3. Set grade hubs using deck contour drawings. These grades should be located at each end of transverse row of towers at outside edge of deck on top of sills or pads **3**. Set these grades on the uphill end (higher pad) of the Shore "X" tower. The tower end can then be jacked or blocked, if required, to bring the tower horizontal for plumbing.

4. If a break in grade occurs, an additional grade should be shot on the break in grade line or nearest jack.

*NOTE: Continuous sills or individual pads must be of sufficient size to support leg loads as required by soil conditions.

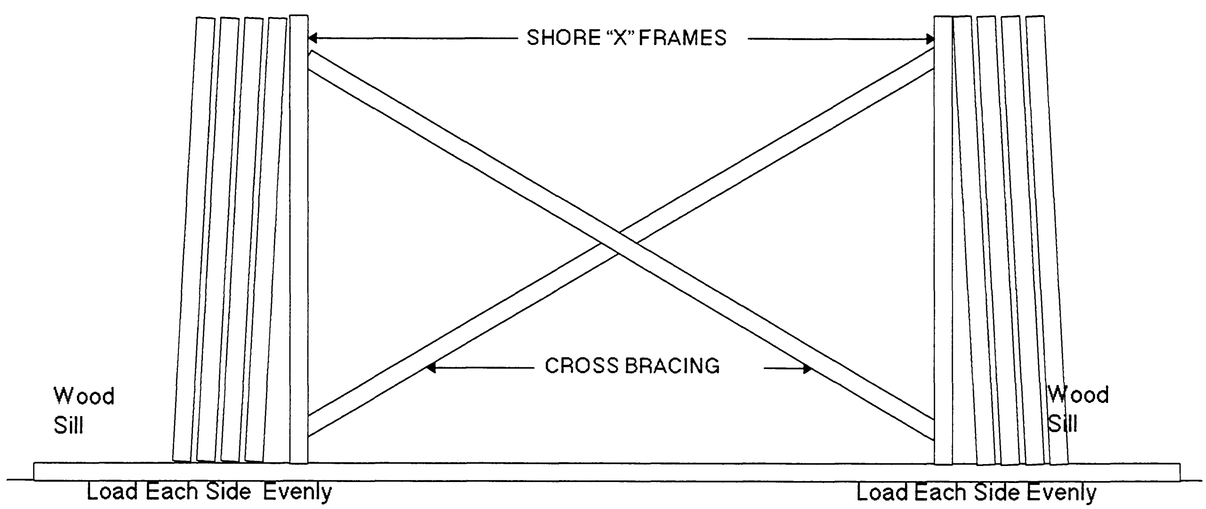


Fig. 1 – 2 Erect Base Unit First & Use For Support To Stack Frames

5. **Equipment Handling** (See Fig. 1–2)

A. Distribute components within a few feet of outside limits of falsework.

B. If frames are not palletixed, unload in vertical position on wood planks. Do not stack frames on ground or allow mud to fill ends of tubing.

C. Stack base frames and extension frames separately.

D. If screw jacks are not palletized, set screw jacks in upright position for ease of handling and to help keep threads clean.

E. A portion of Step V can be accomplished at this time if sills or pads are laid prior to unloading of equipment.

6. Placement and Erection of Shore "X" Components

STEP 1. – Erection of base unit.

Base unit components:

4 each Screw Jacks	4 each Screw Jack Alignment Caps
2 each Punched Cross Braces	2 each Base Frames

1. Distribute base frames of each tower for entire area between bents before erection is started – – 1 man operation. (See Fig. 1–3).
2. Adjust Screw Jack handle to approximate required height (1/2 "J" or 1′ 1″...see Section 14).

TRADE TIP: ***At this point, adjust screw jacks to closest permanent position. It is quicker and easier to make adjustment before tower load is on jack. The manufacturer requires using Screw Jack Alignment Caps on bottoms or tops of Base Frames.***

3. Insert the jacks **1** into the bottom legs of base frames **2** and **4** while frames are on the ground. Be sure screw jack alignment caps (part # 2623–01) are on the screw jacks.

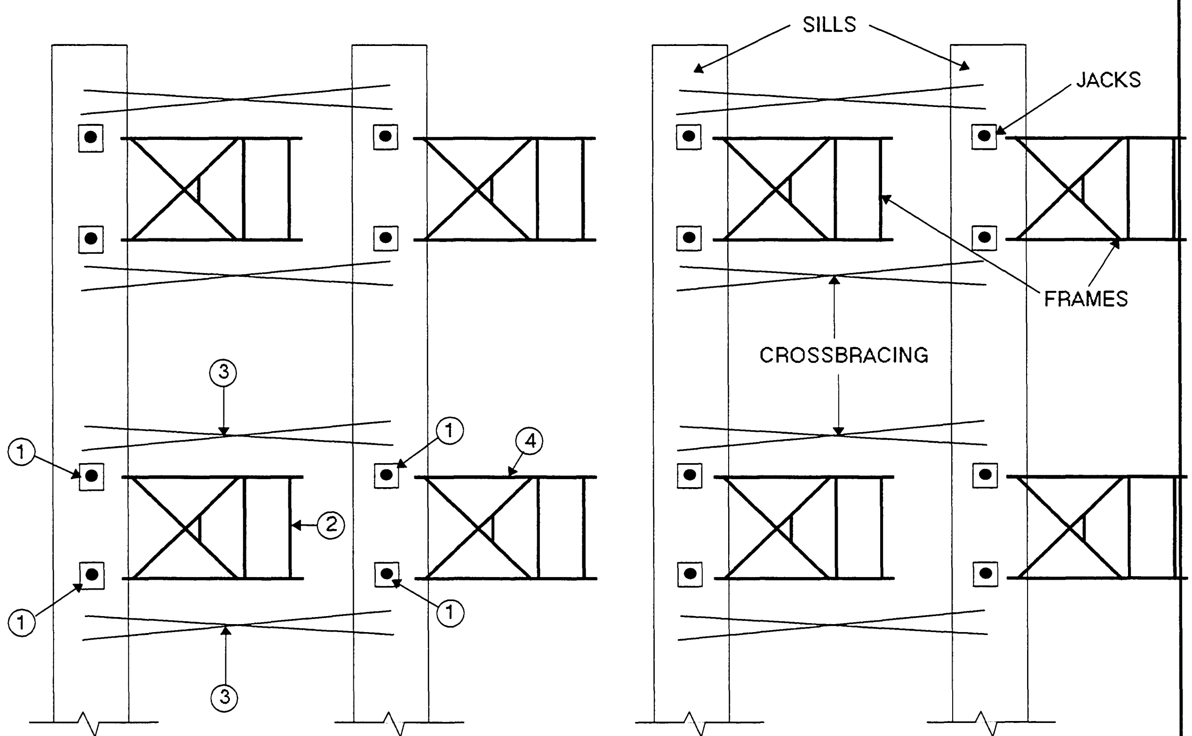


Fig. 1 – 3 Erect Base Unit First & Use For Support To Stack Frames

4. Erection of base unit – – 1 man operation. (See Fig. 1–4)
Raise frame **2** on sill and install one cross **3**. Allow end of cross brace to rest on opposite sill. Raise frame **4** on sill and attach free end of cross brace **3**. Install 2nd cross brace **3** to frames **2** and **4**.

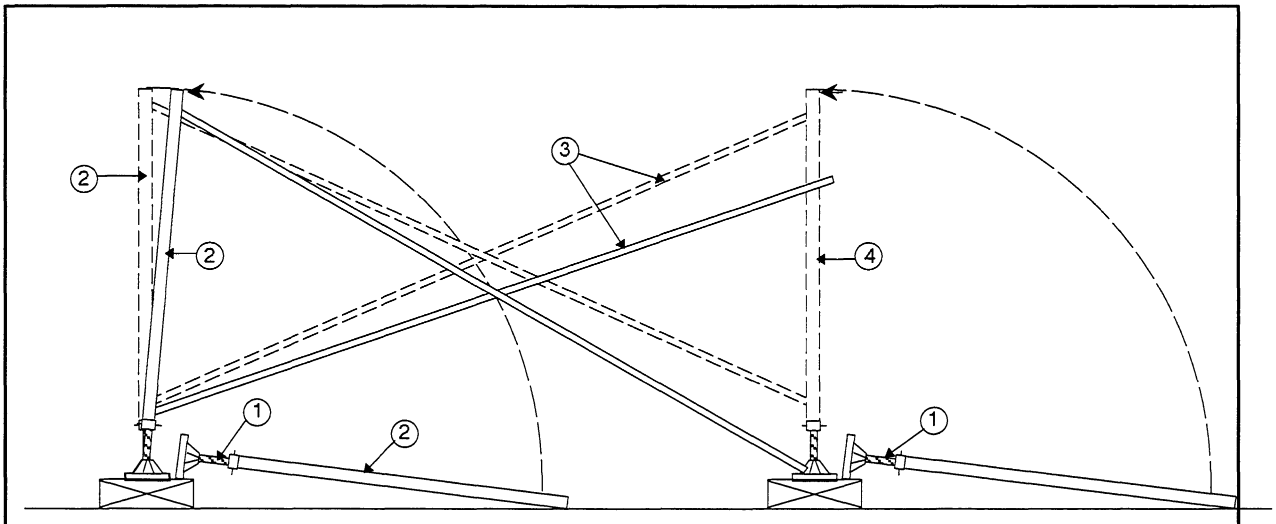


Fig. 1 – 4 Erection Sequence of Base Unit

5. Plumb tower with hand level – – 1 man operation. (See Fig. 1–5)
   a. Check to see that Screw Jacks are exactly spaced 10′ center to center (or applicable distance, depending upon cross size.)
   b. Plumb with bottom jacks (top jacks are used for grading the deck). One complete turn of the jack handle equals 1/4″ up or down.
   c. Plumbing sequence.
      1. Plumb leg **1** of frame **A**.
      2. Plumb leg **2** of frame **B**.
      3. Plumb leg **3** of frame **B**.
      4. Check leg **4** of frame **A**.

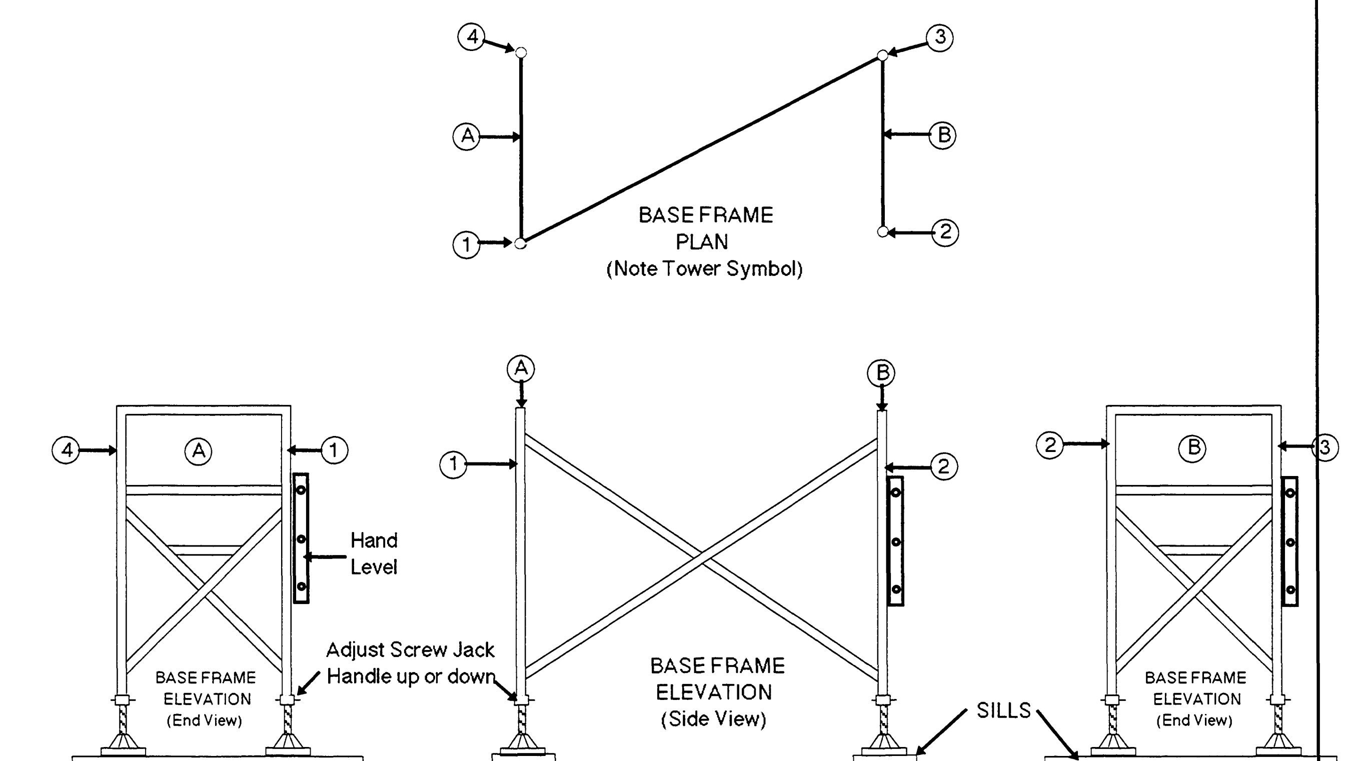


Fig. 1 – 5 Plumbing Base Tower

STEP 2. – Erection of 2nd lift of frames – – 1 man operation. (2 base frames and 1 extension frame towers – – 13′ 8″ – 19′ 8″ swivel jack to swivel jack height).

2nd and 3rd lift components:

2 each Base Frames	2 each Extension Frame
4 each Punched Cross Braces	2 each Punched Cross Braces (end crosses)
4 each Coupling Insert Pins	4 each Adapter Pins
2 each 12′ Planks	

1. Distribute 2nd and 3rd lift components (See Fig. 1–6)

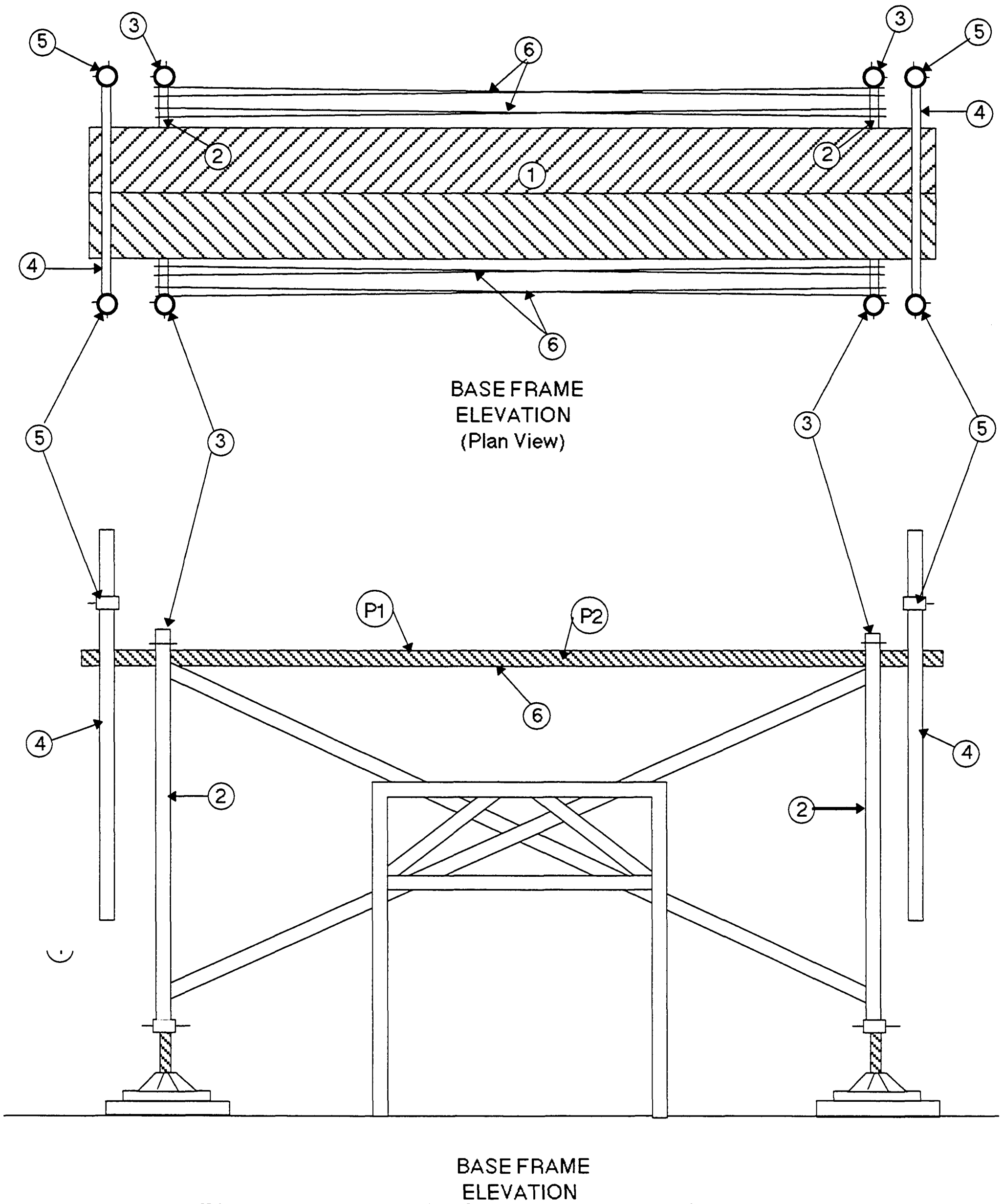


Fig. 1 – 6 2nd & 3rd Lift Components Distribution

a. Place 2 – 12′ planks **P1** and **P2** on tower across top rung of erected base frame **2**.

b. Insert coupling pins **3** in top of base unit legs.

c. Place cross braces **6** across top rung of erected base tower.

d. Hang base frames **4** on end of planks.

e. Place adapter pins **5** in desired hole of base frame **4**.

2. Erection of 2nd lift of base frames – – 1 man operation. (See Fig. 1–7)

a. Raise base frames **A** and **C** and install.

b. Install cross braces **B**

c. Raise remaining two cross braces **D** to top rung of 2nd lift frames and raise plank **P1**.

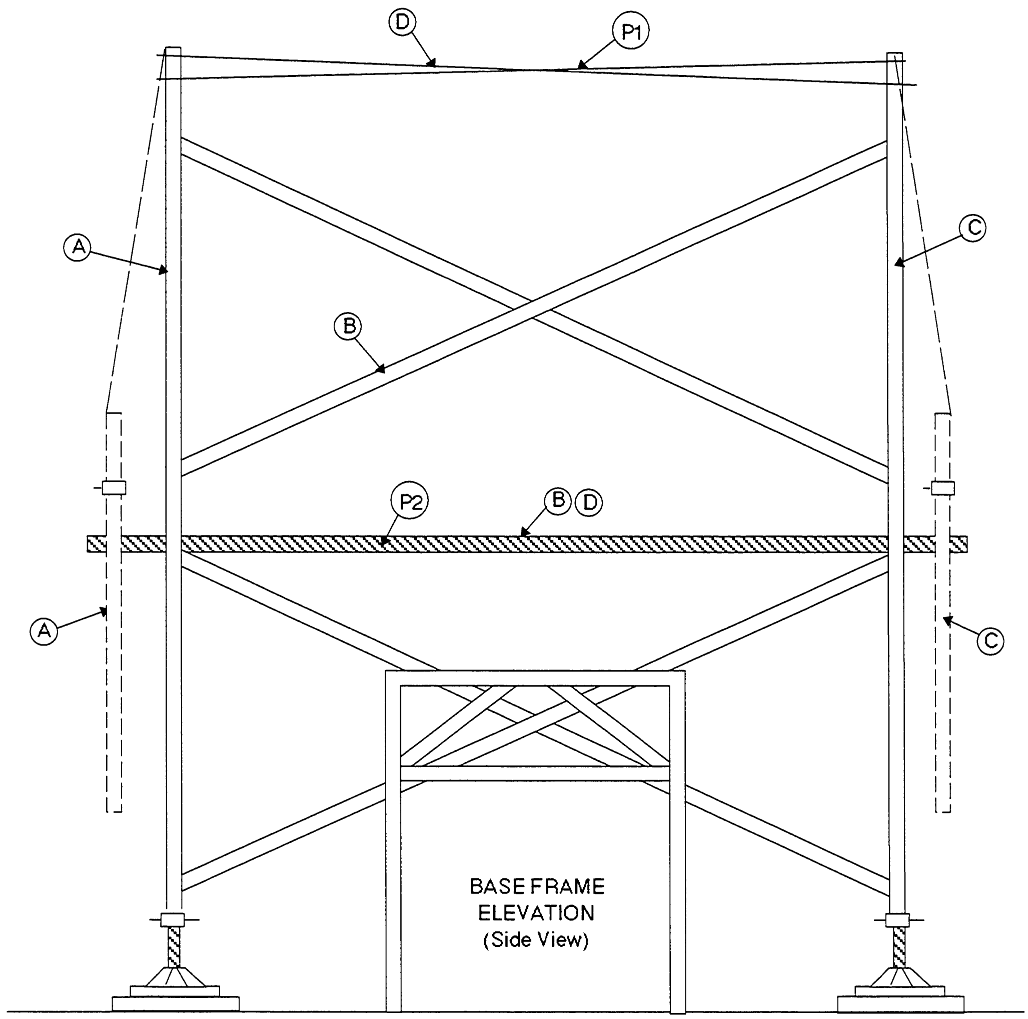


Fig. 1 – 7 Erection of 2nd Lift of Base Frame

STEP 3. – Erection of 3rd lift or Extension frames – – 2 man operation.

3rd lift extension frame components:

2 each Extension Frames	2 each Cross Braces
2 each Cross Braces	4 each Adapter Pins
2 each 12′ Planks	

1. Distribute 3rd lift components.
   a. Components distributed with 2nd lift components.
2. Erection of 3rd lift extension frames – – 2 man operation.
   a. 2 men on plank **P1** raise plank **P2** and place in center of tower across top rung of 2nd lift frames **B** and **C.** (See Fig. 1–8)

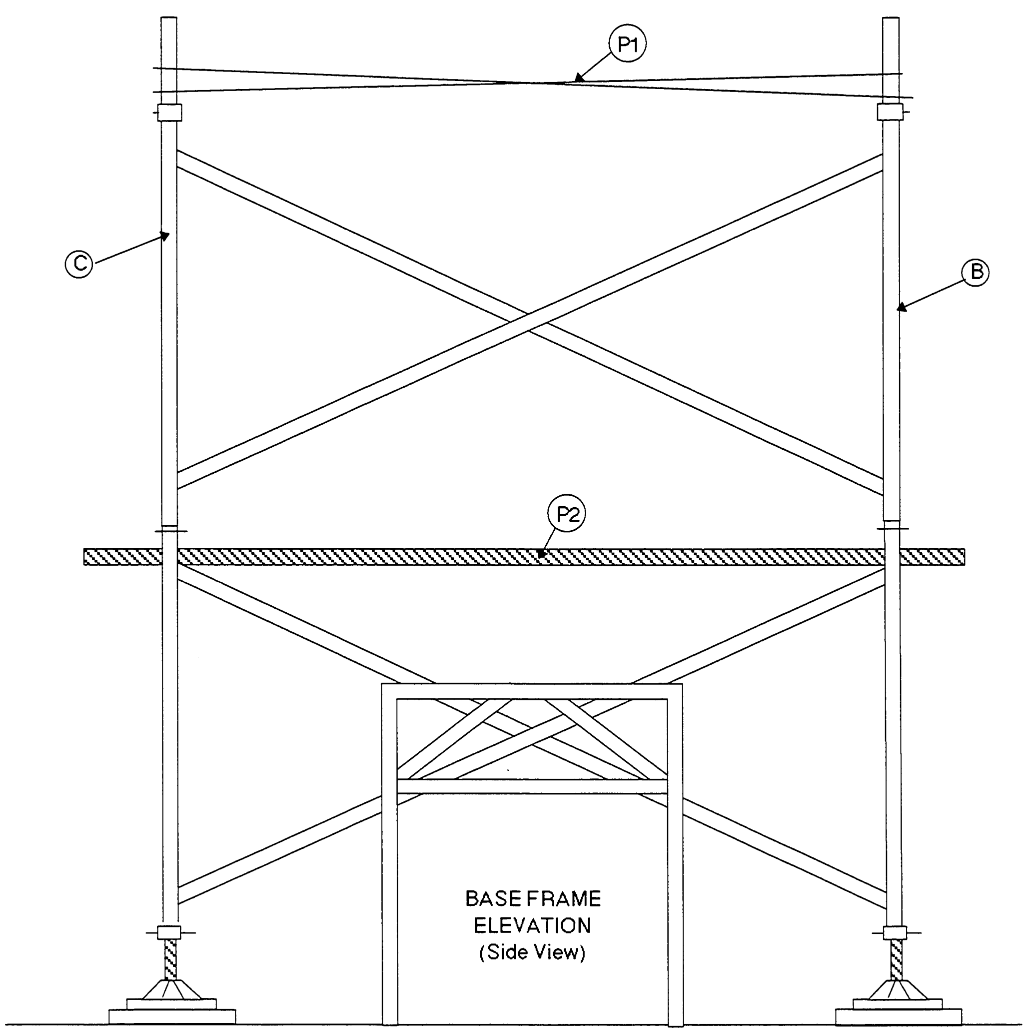


Fig. 1 – 8 Erection of 3rd Lift of Base Frame or Extension Frame

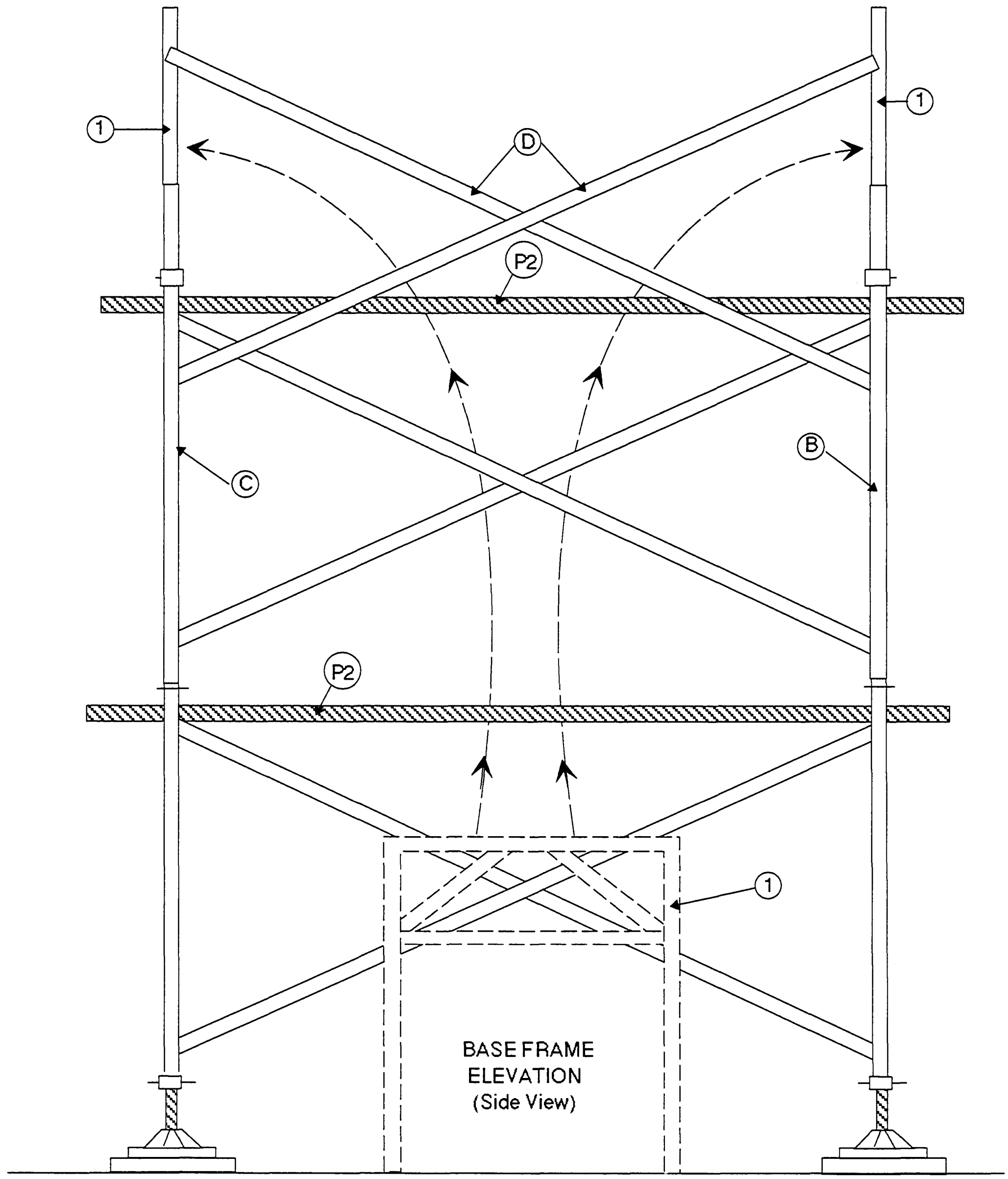


Fig. 1 – 9 Erection of 3rd Lift of Base Frame or Extension Frame Completed

b. 2nd man on plank **P1** hands frames or extensions **1** to man on plank **P2** for setting. (see Fig. 1–9)

c. Install two cross braces **D**

d. End cross braces, screw jacks and wood caps can now be installed.

STEP 4. – Erection of more than 3 frames – – 3 man operation.

1. If only 4 frames high, erect the entire tower, then brace. If 4 frames high or more, erect to 3 frames high and install bracing to stabilize the towers. (see Section 10).

SAFETY ALERT!!!: All towers of 4 or more lifts must be braced for stabilization!!!

Frame Erection by Hand Operation

1. Stack the frames for completion at the end of the tower as well as the cross braces. Place coupling pins in all but the top frames (usually extension frames). The frames which take extension frames in them (next to the top) require the adapter pins.
2. One man gets on the tower with a rope and hook. A ground man hooks the frames which are then lifted and placed. He raises his plank as he goes up until he completes the tower. The screw jacks and wood cap can also be placed at this time.
3. One ground man can usually service two men on towers, if the towers are adjacent.
4. A chain of men can also be used, one at each frame level.
5. The men in the chain move from tower to tower as each lift is added.

Frame Erection by Crane Operation

1. Sections two frames high (4 frames) are assembled on the ground adjacent to the bridge and lifted into place with a 4 line sling attached to bottom frames.
2. Top section with extension frames, screw jacks, wood caps and stringers can be placed in the same way.

SAFETY ALERT!!!: Crane erection does not eliminate the need for bracing towers as erection proceeds. But absolutely certain of tower stability before cutting loose from the crane!!!

7. Erection and Grading of Caps

A. Install adjustable "J" Head screw jacks **1** into top of extension frame **2** (see Fig. 1–10).

SAFETY ALERT!!!: Screw Jack Alignment Caps (Part #2623–01) must be used when jacks are inserted in either top or bottom of Base Frames!!

B. Distribute wood caps – – one man operation.

1. Distribute 2 each wood caps to each tower. Use 4 x 8, or heavier wood cap if required. Heavier wood caps are required if stringers do not bear directly over jacks.
2. Adjust screw jack handles to approximate required height ($^1/_2$ of "J" or 1′ 1″...see Lesson 2 section A for detailed explanation on Jack & Frame adjustments).

C. Install wood caps – – two man operation.

1. Man on ground using rope and hook attaches rope to 4 x 8 wood cap.
2. Second man on top plank pulls up wood cap (or raised from man to man) and drops hook to ground.

3. While second man installs wood cap into saddle of "J" Head Screw Jack **1** on top of extension frame **3**, man on ground attaches rope to second wood cap.
4. Man on plank repeats his operation #2 and #3.

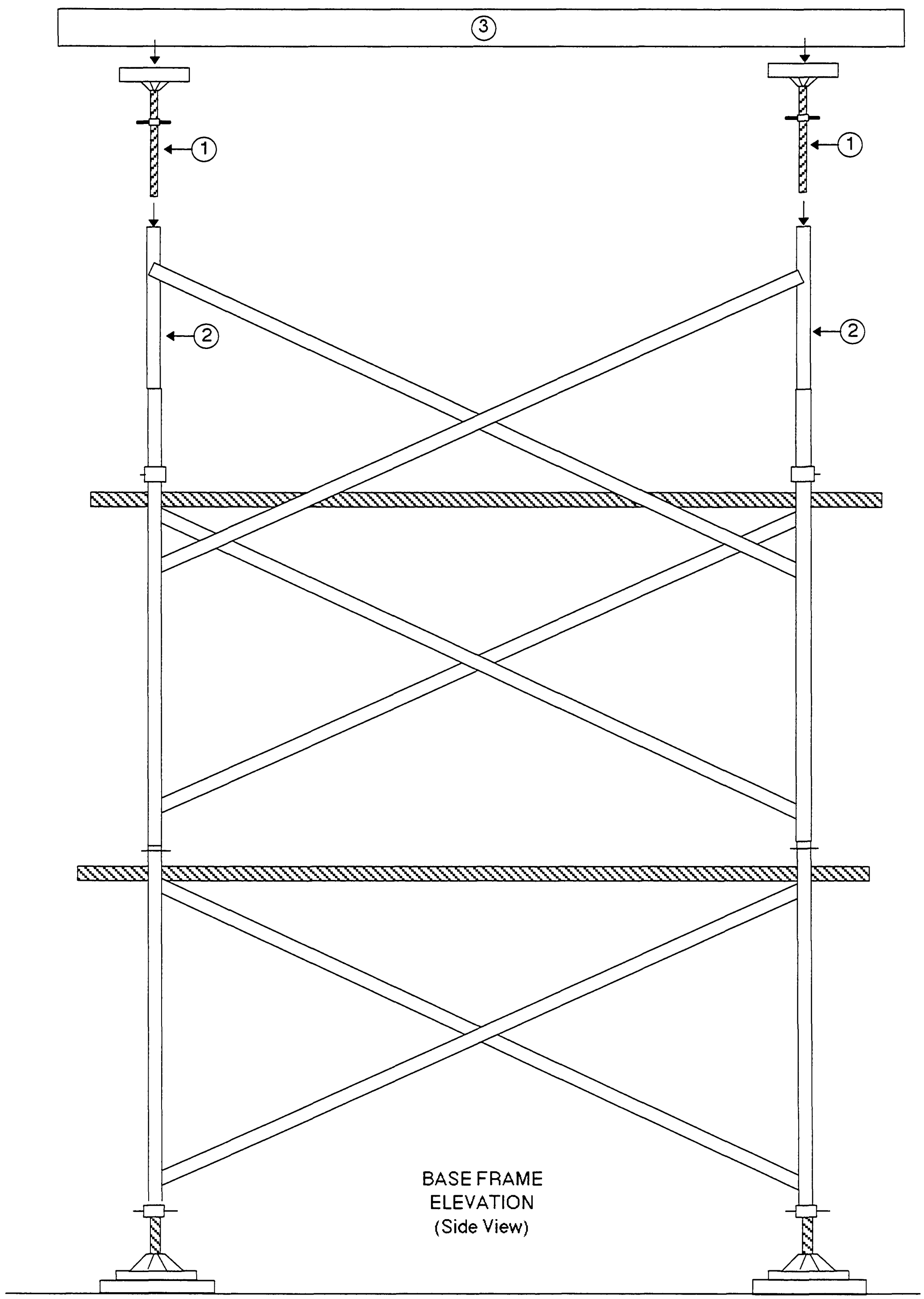


Fig. 1 – 10 Installation of "J" Head Screw Jacks & Wood Caps

7. Erection and Grading of Caps (Continued)

5. Both men repeat operation on remaining towers.

NOTE: Wood caps and jacks are placed in top frame prior to hoisting if crane is used.

D. Rough grading of wood caps.

1. After all wood caps have been placed, adjust caps at point **3** (see Fig. 1–1) to rough grade using tape and grade hubs previously placed on sills.
2. Using string line, stretched from point **3** to point **3** adjust all remaining wood caps in both directions.

8. Set Stringers, Joist, Plywood Deck and Final Grade

A. Stringers can be placed two at a time, or preferably in groups of 4 or 6. They are placed on the wood caps and then handled into position.

B. Final grade – – (After Soffit deck is placed).

1. Final grade can be accomplished most efficiently by having instrument man relay instructions on raising or lowering of deck in number of turns of the screw jack handle. One complete turn of the screw jack handle makes a $^1/_4$ inch change in elevation.

TRADE TIP: Final grade is set with top screw jacks only.

2. Fine grade only exterior towers, and center row towers if necessary, with instrument, then bring other towers to finish grade by string line or eyesight.
3. Normal settlement and take–up after pouring concrete is $^3/_8''$ to $^5/_8''$, depending on ground conditions.

9. Stripping Soffit & Falsework (Rope off area!)

SAFETY ALERT!!!: Rope–off stripping area first. This will eliminate overhead hazard!!!

A. Releasing falsework screw jacks.

1. Releasing should be done by the **bottom jacks**, thus eliminating the climbing of the towers. Releasing must start at mid–span shoring due to the structure's dead weight and camber.
   Release all bottom screw jacks in a span one turn ($^1/_4''$), then proceed at mid–span to release the load off of the towers.

NOTE: All screw jacks on a tower should be released uniformly so tower remains plumb.

2. The top screw jacks can then be lowered to facilitate the removal of the deck soffit materials.

9. Stripping Soffit & Falsework (Con't)

> ***SAFETY ALERT!!!: Do not remove bracing on towers until disassembling towers!!!***

B. Twisting joist and removing deck plywood.

1. The simplest way to separate the plywood and joist is to use a long a stripping bar.
2. The plywood is then slid out to each side of bridge and placed on the top deck or on the ground.
3. Joists are also slid out to each side of bridge.

C. Remove stringers

Stringers may be turned on side and carefully dropped on end between towers or by mechanically lowering to ground. Dropping stringers on end does relatively little damage if due care is used.

> ***SAFETY ALERT!!!: Do not drop material on screw jack handles!!!***

D. Disassembly of Shore "X" Towers

1. Use only one man to dismantle a tower and one man on ground to carry away and stack components.
2. Three frame high towers or lower can be dismantled without the use of rope. The components can be manually handed down.
3. A hook and rope should be used to lower frames and wood caps on towers four frames or more high.
4. Coupling pins and cross braces can be dropped short distances with care, but frames, screw jacks or wood caps with jacks attached must be handed down or lowered by hook and rope. Do not drop frames!

> ***SAFETY ALERT!!!: Do not drop Frames. Bent or damaged frames are a collapse hazard!!!***

5. The components should be carried away from the falsework area as rapidly as they come down. They should be stacked, pattetixed (ie. placed on pallets), or metal banded for easy handling, loading or distributed for future erection at this time. (See 15–D)

10. Erection of Three Frame Towers or Double Frame Towers

A. Erection of three frame towers and doubled frames can be done in the following sequence. (See Fig. 1–11)

1. Erect base unit of 2 frame towers and plumb.
   Erect normal 2 frame tower **A** as previously outlined.

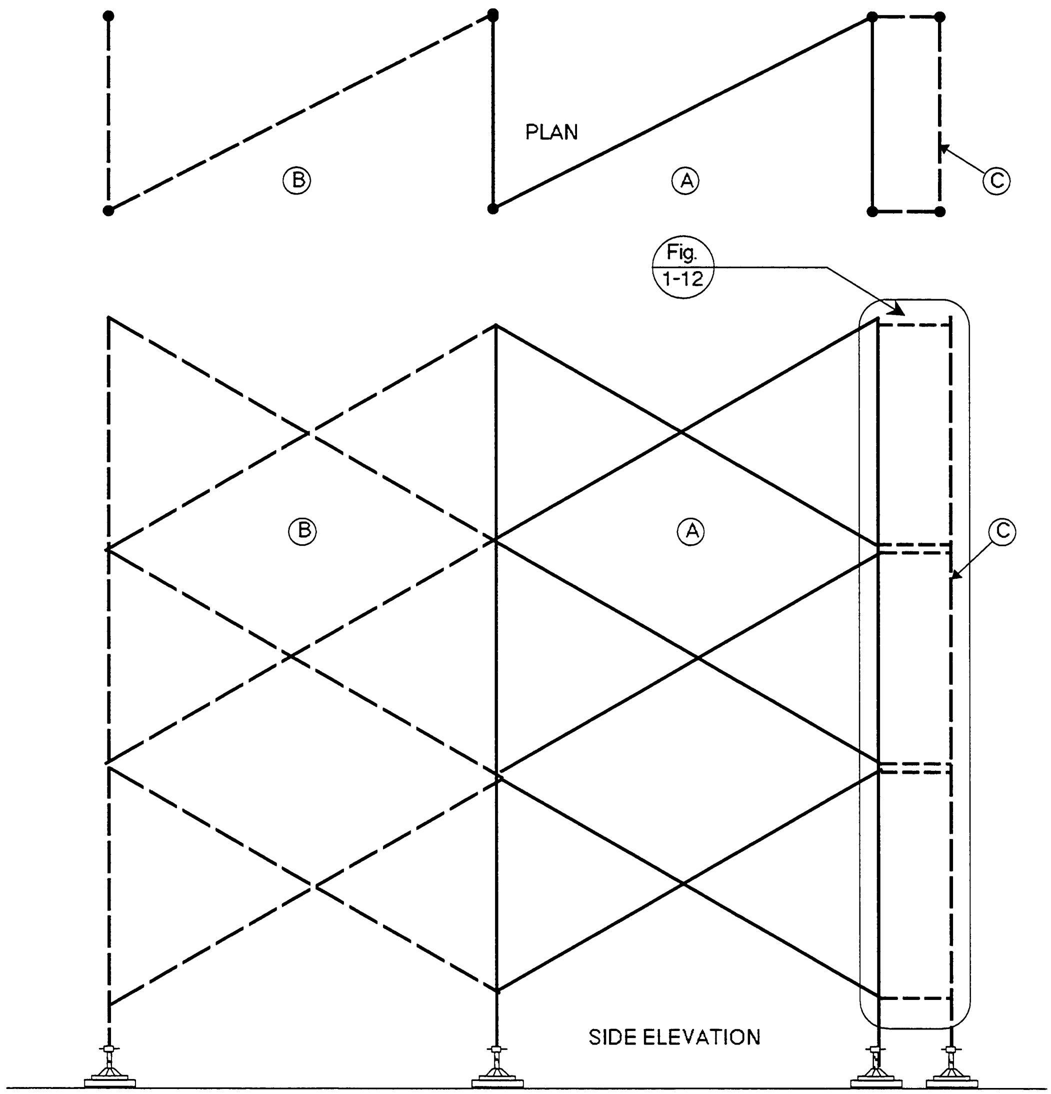


Fig. 1 – 11 Installation of high rise, attached towers

2. Add 3rd frame **B** or **C** after step "1" above and plumb to tower **A**.
3. Proceed with erection of additional frames.

B. Doubled frame bracing 8 1/2″ or 15″ spacer/brace bars (part # 2850–00. (See Fig. 1–12)

1. Doubling the frames allows double the load to be applied through a proper wood cap.
2. Minimum quantity of metal straps are as shown in Fig. 1–12.

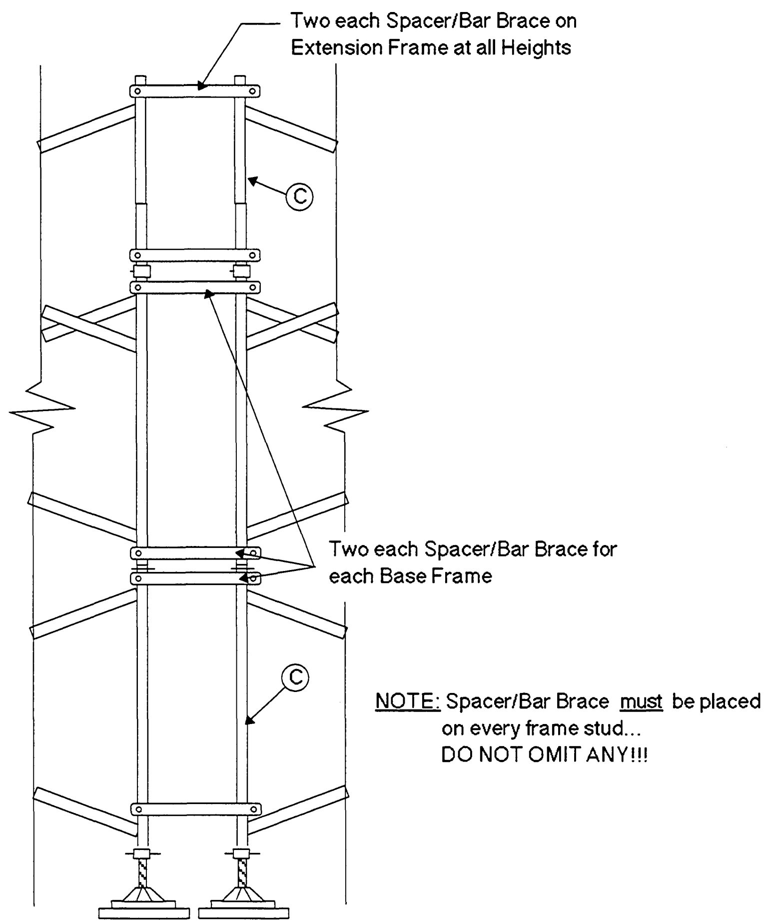


Fig. 1 – 12 Installation of spacer/brace bars on attached frames

11. Frames on Slopes

A. Placing Frames on slopes using inverted extension frames.

Extension frames can be inverted and placed into the bottom of the base frames. This gives considerable flexibility in meeting slopes and uneven ground situations. (See Fig. 1–13)

1. Range of adjustment for inverted extension frames: 1′ 8″ – 2′ 8″ – 3′ 8″ – 4′ 4″.
2. Adapter pins must be placed in same hole on both frames of the tower (A & B)
3. Cross brace is <u>not</u> unfolded and is placed from B to C. This provides the cross bracing.

> ***SAFETY ALERT!!!: End cross braces must always be placed on inverted extension frames!!!***

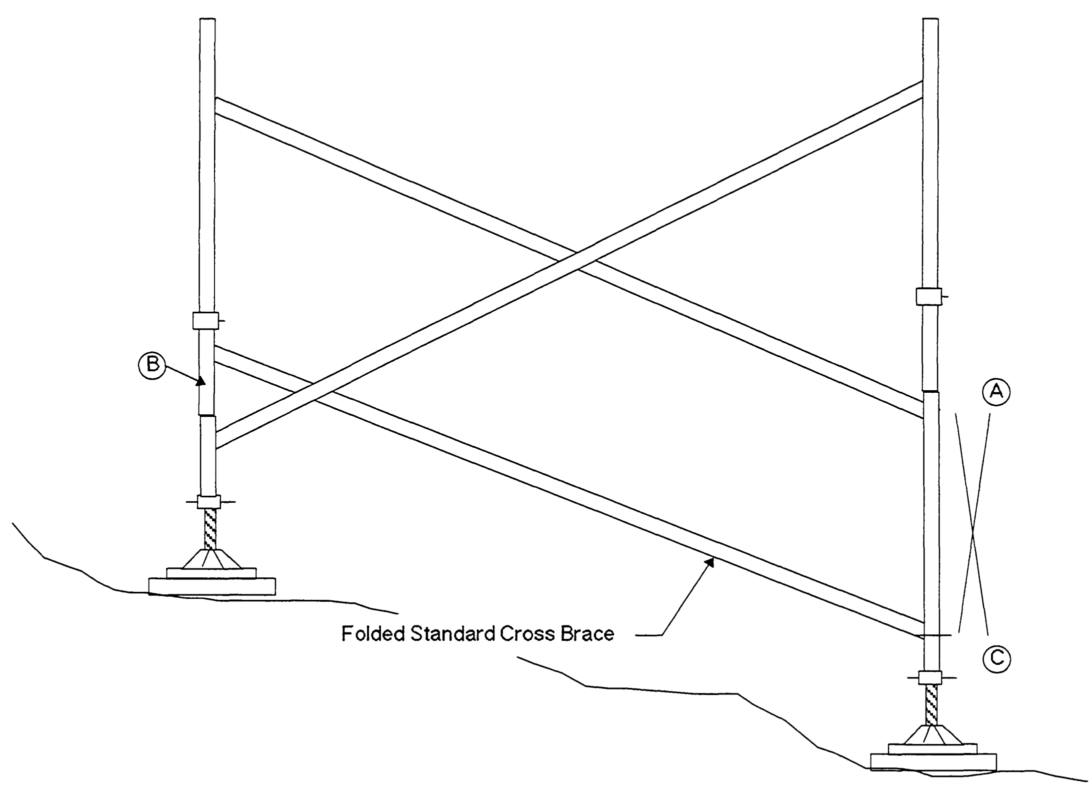


Fig. 1 – 13 Typical Frame installation on slopes

12. Bracing High–Rise Towers

A. Tower bracing

1. Horizontal and diagonal bracing transverse to bridge. No horizontal or diagonal bracing is required on towers less than four frames high. On towers four frames high, one horizontal brace on each end of the tower is recommended, preferably located on the third frame. On towers above four frames in height, we recommend a horizontal and one diagonal brace every 18 feet in height on each end of the tower. This recommendation assumes the tower crosses are running parallel with the bridge.

2. Horizontal and diagonal bracing parallel to the bridge. We recommend one horizontal brace on one side of each tower on towers six frames high, preferably placed on the fourth frame. On towers above six frames high, we recommend a horizontal brace on every fourth frame, exclusive of the last three to four frames, which will be tied together by the stringers (i.e., a 12 frame high tower would have horizontal bracing at the 4th and 8th frames). (see Fig. 1–14)

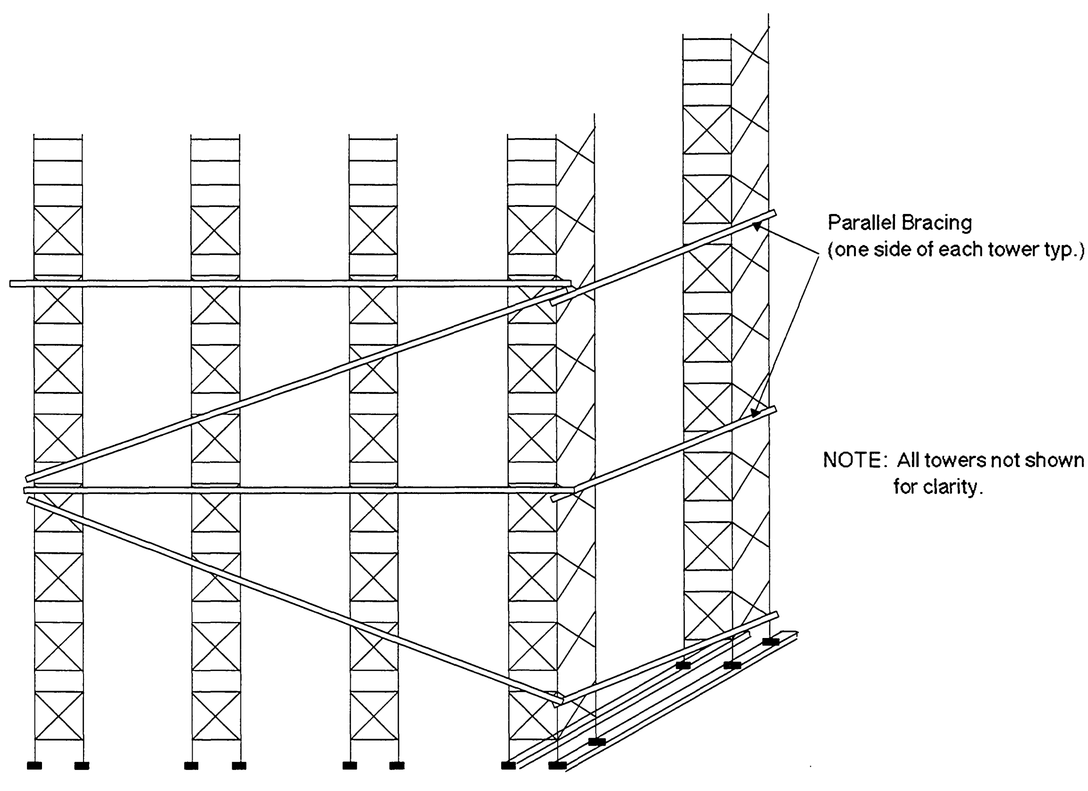


Fig. 1 – 14 Typical 2 x 6 Bracing on High–Rise Frames

3. Horizontal loads imposed by super–elevations of 6% or more. Screw Jacks have been specially hardened to resist horizontal forces. In addition to the bracing outlined in 1. and 2. above, we recommend that a horizontal brace be placed across the top frames to distribute the horizontal forces that may be imposed.

4. Special loading conditions or soil conditions may increase above minimum requirements.

13. Unbalanced Tower Loading

A. Avoiding unbalanced tower loadings

1. Tower loading should be as uniformly distributed as possible. Loading only one leg of a frame, or one frame of a tower, can cause failure. (See Fig. 1–15)

2. The individual legs of a frame, or frame of a tower, should carry at least 25% of the load imposed on the opposite legs.

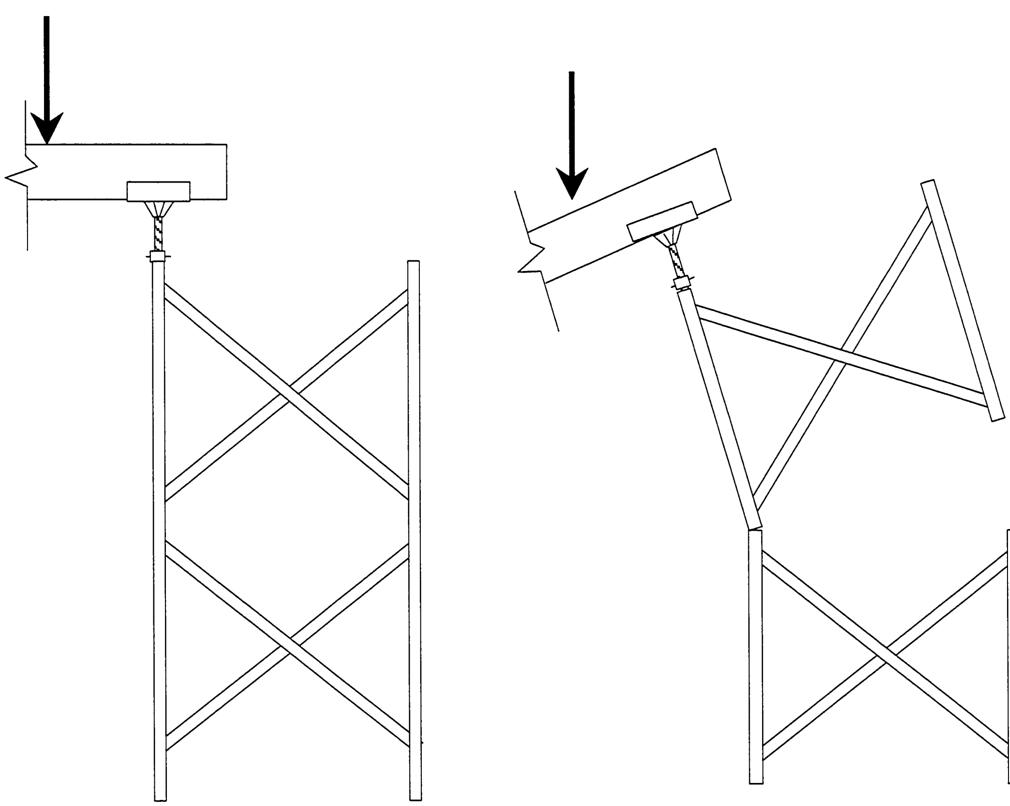


Fig. 1 – 15 Avoid Unbalanced Tower Loading

14. Screw Jack Adjustments

B. Screw jack adjustment range. (See Fig. 1–16)

1. Swivel – twelve inches (12″) is the maximum thread extension, or sixteen inches (16″) overall extension.
2. Fixed – fifteen inches (15″) adjustment or nineteen inches (19″) overall extension.

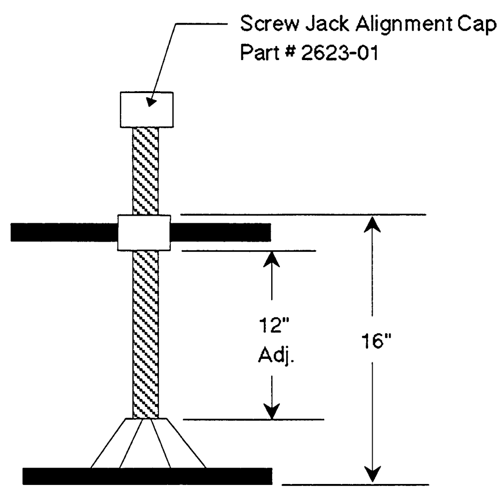


Fig. 1 – 16 Typical Bottom Screw Jack

3. When more extension is required, block at the base only to reduce the extended length.
4. Screw jack must be plumb in all cases.

SAFETY ALERT!!!: Caps must be on all jacks when used in Base Frame (top or bottom)!!!

15. Frame End Cross Braces

A. Placement of end cross braces (IMPORTANT!!)

1. **The end cross brace must always be placed on extension frames extended three, four or five feet,** and when soil conditions warrant.
2. On bridges with super–elevations of more than 8% the end cross must be placed when extension frame is extended two feet or more.

3. The end cross must always be placed on inverted extension frames.

TRADE TIP: Placing the end cross inside the tower is more convenient and removes this cross from interfering with timber bracing.

16. Adapter Pins

A. Placement of adapter pins

1. **Adapters must be used at all times with extension frames.**
2. Side crosses assure that adapter pins are properly placed.
3. Adapter pins have a nail hole for receiving an 8d nail. The nail keeps the pin from being knocked out of hole. Nail should be inserted from top.

17. Miscellaneous Hardware

A. Plank

Suggested plank size 2 x 12 – – 12′ long and requirement:

1. 3 frame high tower – – 2 each/tower.
2. Leave top plank in tower for grading and stripping. Move second plank to bridge alleys between towers to provide complete access for grading.

SAFETY ALERT!!!: Plank should be scaffold grade and sound!!!

B. Lowering Hook (See Fig. 1–17)

1. Use $^5/_8''$ 3–strand rope to lower frames and accessories to the ground with damage.

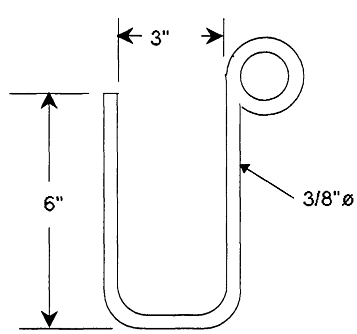


Fig. 1 – 17 Lowering Hook (fabricated)

C. Frame Skid (See Fig. 1–18)

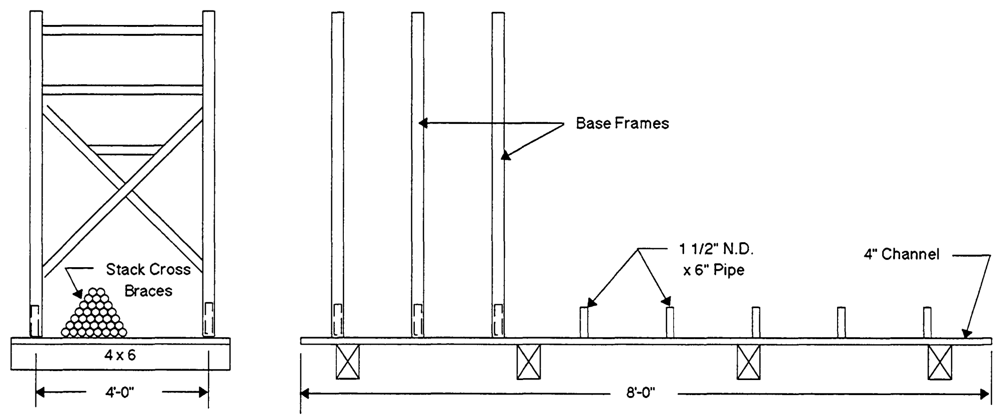


Fig. 1 – 18 Frame Skid Protects and Organizes Frames & Components

TWELVE SAFETY CHECKS FOR SHORE "X"

1. **Design Check**

   A. Do not start erection until design has been checked for proper tower loadings and lumber stresses and all codes.

   B. If any field deviation is necessary, the project engineer should be consulted.

2. **Ground**

   A. Sills must be adequate to support loads imposed by falsework design.

   B. Special consideration should be given to back filled or weak bearing soils, wet or muddy soil conditions and slopes.

   C. Check also for possible washouts due to rain.

3. **Equipment Check**

   A. All equipment must be checked to see that it is in proper working condition.

4. **Screw Jacks**

   A. Screw jacks must always be plumb and straight.

   B. Aligning cap (caps) must be used when jacks are inserted in either top or bottom of base frames.

   C. All screw jacks must be seated securely against the legs of the frame.

5. **Adapter Pins**

   A. Adapter pins must be used at all times with extension frames. Side crosses assure proper position of adapter pins. Pins should be held in position with an 8d duplex nail.

6. **Cross Bracing**

   A. Cross braces must be properly attached to all bracing points. No braces should be left out. End cross braces must be placed as required.

7. **Extension Frames**

   A. Extension frames must rest on adapter pins. Side cross braces assure proper placement of adapter pins. Side cross braces must be placed at all times, including on the extension frame at all extensions.

8. **Plumbness**

   A. Shoring towers must be plumb in both directions.

9. **Wood Caps and Stringers and Formwork**

   A. Check to see that lumber used is equal to that specified (in size and quality).

   B. Stringers should be placed directly over jacks unless wood cap has been designed to carry high shear loads.

   C. Unusual design features of structure must be considered and reviewed to be sure formwork is adequate.

10. **Timber Bracing and Guy Lines**

   A. Bracing should be as specified and secured tightly.

   B. Care should be taken that timber bracing does not interfere with plumbness or spacing of towers.

11. **Stripping of Falsework**

   A. Premature releasing or stripping of forms can be a cause of failure.

   B. See Erection Procedures (Page 12) for screw jack release sequence.

12. **Reshoring**

   A. Reshoring procedures should be specified by a qualified engineer.

CONCLUSION

Do not do sloppy work...your grade and elevation shots will decide on how well your portion of the structure will turn out.

LESSON 2. Frame Fill Calculations for Shore "X" Towers

INTRODUCTION:

Frame fill calculations are one of the primary considerations for building a structure which uses elevated formwork. The singular, most prominent application for supproted formwork in the Pile Driving – Bridge Building Industry is, of course, on Caltrans structures.

Frame fill can be described as the number of vertically stacked, tubular frame shores plus the thickness of wood shoring members (ie. caps, joists, plywood, etc.) that are required to fill the gap between the top of the ground and the bottom of concrete (soffit plane). One of the beneficial characteristics of modern tubular shoring is the flexibility to accommodate substantial vertical height adjustments using adjustable extension frames in combination with bottom and top screw jacks.

One of the objectives of frame fill calculations is to have the shoring mobilization and erection process pre–planned for smooth implementation. One of the other objectives is to know the precise number, combination, and pre–adjustment of base and extension frames needed at each designated point along the structure. The primary goal here is to anticipate extension frame and screw jack adjustments whcih will meet the height requirements at various points. This, in turn, will help avoid exceeding allowable capacities by stretching out frames using unacceptably long jack adjustments.

LESSON:

In this lesson you will have an opportunity to calculate a variety of frame fill problems. You will be given an established opening in a structure (ie. the vertical distance between the bottom of the structure and the top of the ground) from which you will calculate the combinations of base frames, extension frames, extension frame/jack adjustments, and material thicknesses needed to gap the opening.

APPLICATION IN THE FIELD:

Developing the ability and confidence needed to accurately assemble multiple tower shoring will insure your future in the Bridge Building Industry.

OBJECTIVES:

To introduce you to the Shore "X" patented shoring system including all the attendent assembly components and to calculate frame fill problems based on these components..

REFERENCES:

1. Provided

STUDENT TOOLS

16. Paper
17. Pencil

3. Pocket Calculator

EQUIPMENT (Total class)

1. None

MATERIAL

1. None

PROCEDURES (Total class)

Introduction to Basic Shoring Calculations

Typical Component Dimensions (Vertical):

1.) Base Frame – 6′ – 0″ **2.)** Extension Frame – 1′, 2′, 3′, 5′ Extension.

3.) Swivel Screw Jacks – 4″ to 16″ Overall (use 8″ to 10″ extension to allow for up and down adjustment 4″ to 20″ for fixed jack adj.)

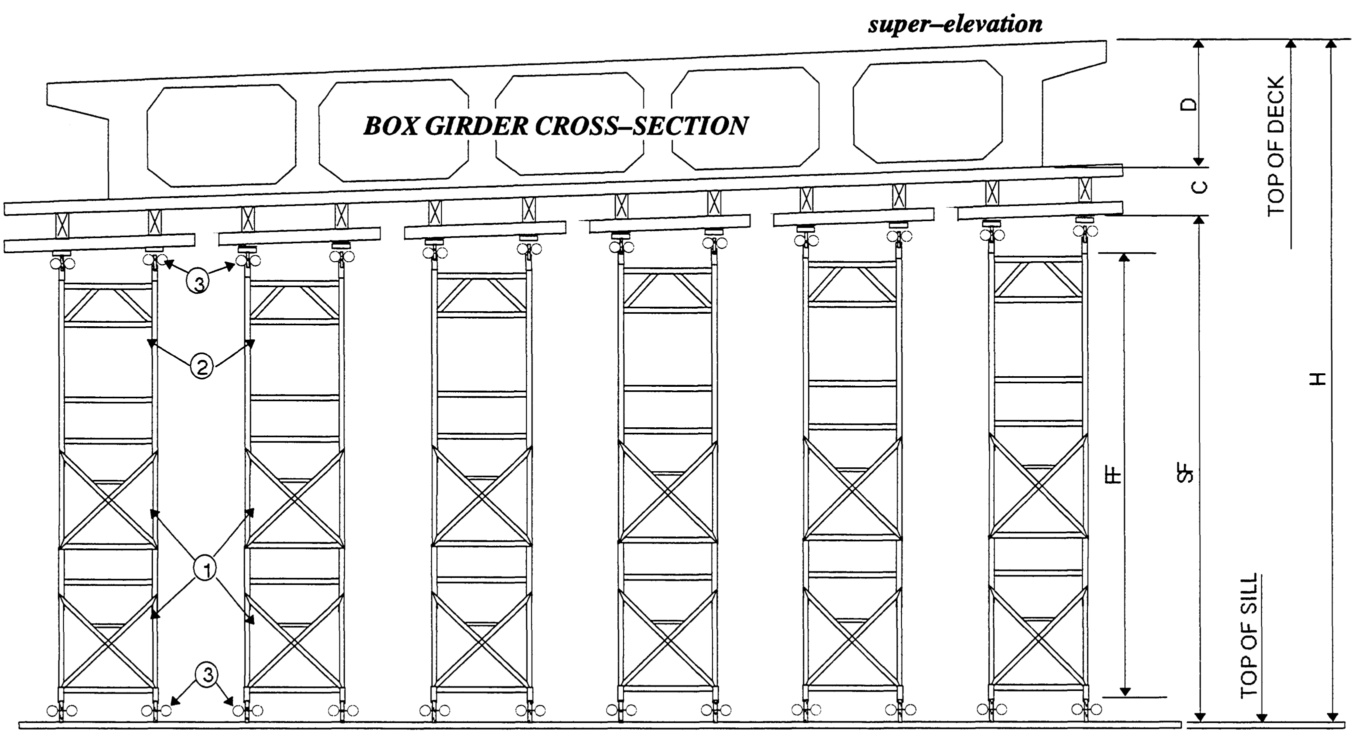


Fig. 2 – 1 Calculations for Shoring Fill on Outboard (Exterior) Towers

1. Compute shoring fill on outboard towers. (see Fig. 2–1)

The illustration above shows how to determine the number of base frames, the extension of extension frames, and screw jack adjustment for a typical bridge.

Example:

H	**Total height of sill to top deck**	**=**	**24′ –10″±**
D	**Depth bridge**	**=**	**5′ – 0″**
C	**Caps, stringers, joist, and plywood**	**–**	**1′ –8″±**
SF	**Shoring fill**		
J	**Top and bottom jack allowance to nearest 2′–0″ (1′–6″ to 2′ – 5″)**		
FF	**Frame fill**		

Then:

H	**=**	**24 ′–10″**
minus C + D	**=**	**–6′ – 8″**
SF	**=**	**18′ – 2″**
minus J	**=**	**–2′ – 2″**
FF	**=**	**16′ – 0″**

Therefore:

1. **Set bottom jack at approximately ½ J or 1′ –1″**
2. **Compute frames required for frame fill (FF) = 16′ –0″**

That is: 2 each base frames – 6′ x 2	**=**	**12 feet**
1 each exten. frame at 4′ exten.	**=**	**4 feet**
FF (frame fill)	**=**	**16 feet**

2. Computing shoring fill on intermediate (interior) towers. (See Fig. 2–2)

After the outside rows of towers are set and plumbed, the intermediate tower shoring fills may be field figured by stretching a string line from an adapter pin, properly set in the left tower, to an adapter pin set in the right tower. This string will lie on the approximate desired slope of the soffit and, thus, is the desired slope of the top of the steel. Adjusting the adapter pin holes of the intermediate towers to this string line is all that is required. This is done by jacking the tower up or down evenly. If the jacks do not have enough

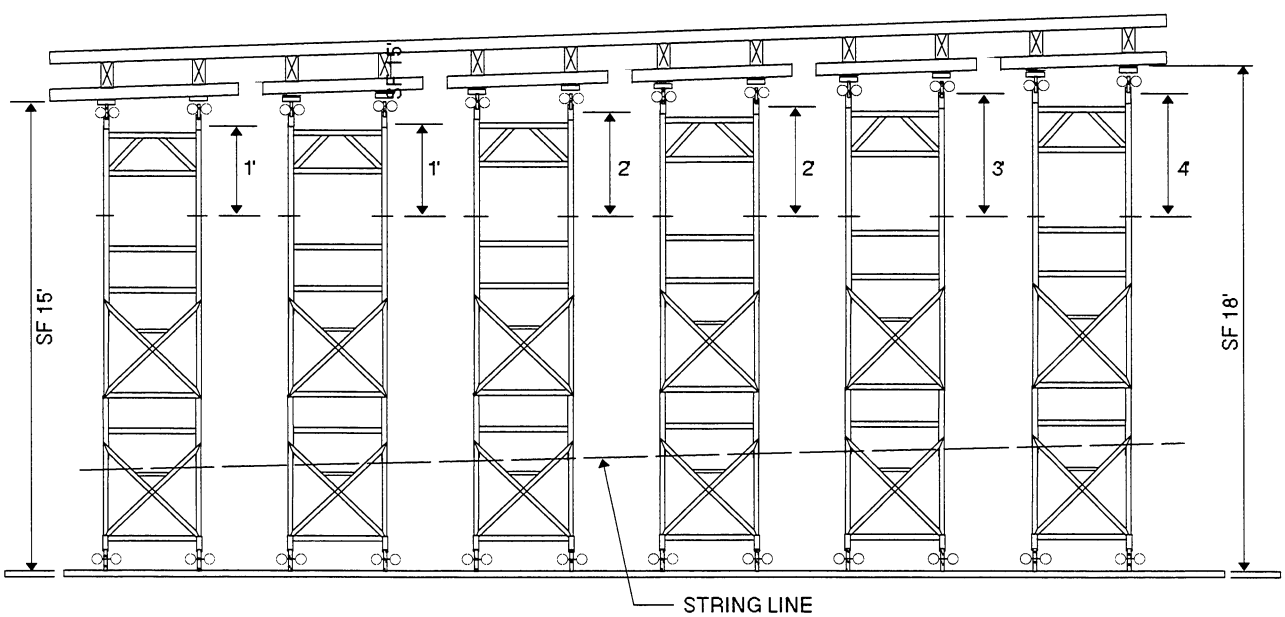


Fig. 2–2 Calculations for Shoring Fill on Intermediate (Interior) Towers

adjustment, move to the next closest hole; this will require a different extension of the extension frame.

C. Break in deck grade.

If a break in deck grade occurs, an additional grade should be shot on the break in grade line or the nearest jack. Proceed as above by string.

LESSON 3. HEAVY TIMBER FRAMED FALSEWORK AND BENTS

INTRODUCTION:

TO BE DEVELOPED

NOTES:

BIBLIOGRAPHY

THE SCAFFOLDING, SHORING, AND FORMING INSTITUTE, INC.

In 1959, a group of scaffolding manufacturers got together and created an association with a mandate to promote safety and the safe use of their products by construction and other industries.

The Scaffolding, Shoring, and Forming Institute, Inc. published safety rules for the majority of uses of almost all types of scaffolding and shoring products. It also has available a series of booklets of safety requirements for major types of scaffolding. Another series of hip–pocket–sized booklets deals with how to erect steel frames (scaffolding and shoring) safely. Also available are a number of wall–poster sized illustrations of various hazards and their prevention. Three groups of color slides are available at nominal cost; they come with descriptive booklets exhibiting do's and dont's for scaffolding, shoring, and suspended powered scaffolds. The address of the Institute is 1230 Keith Building, Cleveland, Ohio 44115.

REFERENCES

1. Federal OSHA Regulation 29 CFR, part 1926. 701 Subquart Q.
2. Wilson, Dave, *Erection Information for Shore "X"® Towers,* Construction Enterprises, Inc.
3. *Lessons from Failures of Concrete Structures,* ACI monograph No. 1, American Concrete Institute.
4. Grundy, P., and A. Kabaila: *"Construction Loads on Slabs with Shored Formwork in Multistory Buildings," ACI Journal,* December 1963, pp. 1729–1738.
5. *Recommended Practice for Concrete Formwork,* ACI Standard 347–68, American Concrete Institute, Detroit, 1968.
6. Ratay, Robert T., *Handbook of Temporary Structures in Construction,* McGraw–Hill, New York, 1984.
7. *Falsework Manual,* State of California Dept. of Transportation (Caltrans) – Office of Structure Construction, State of California, January 1988.
8. *Misc. Falsework Drawings,* PDCA, CEA, CECE Contractors.

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