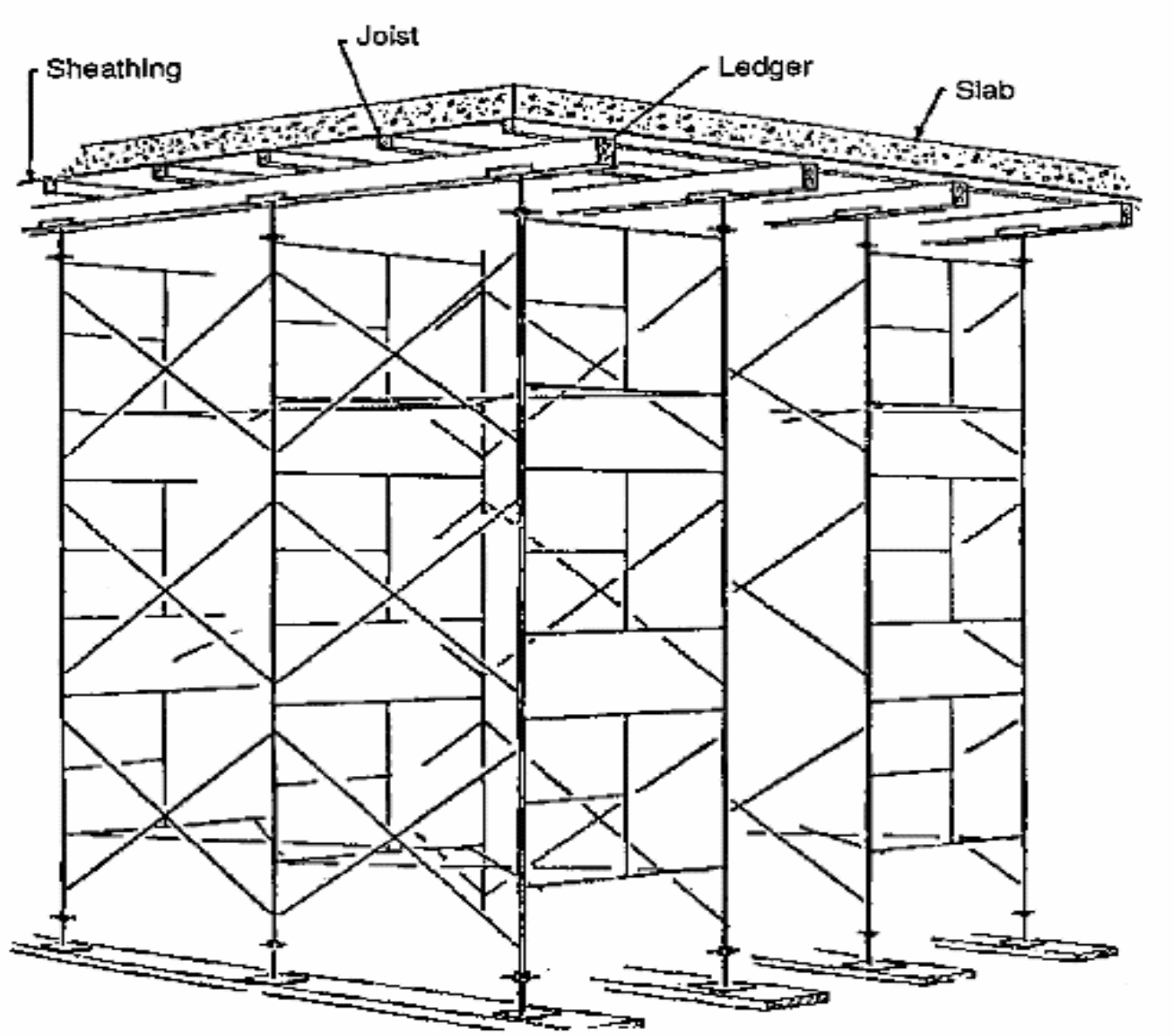
GUIDELINES ON FALSEWORK/FORMWORK



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Preface

This guideline has been developed to provide information to engineers; contractors and others involved in the design, erection and use of false work and Formwork.

For specific regulatory requirements regarding false work and framework, please consult the Construction Safety Regulations, adopted under the Workplace Safety and Health Act.

Acknowledgement

Workplace Safety and Health Division wishes t acknowledge the Workers Compensation Board of British Columbia for its kind permission to use some of the material in this guideline.

Engineering Design Requirements

Contractors must determine if form work/false work that is to be used on a project requires design work by an engineer. The following types of concrete Formwork and false work require the provision at the job-site of design and erection drawings and necessary supplementary information signed and sealed by a professional engineer. (E.g. see Appendix C)

- Fly forms
- gang forms
- slip forms
- suspended slab forms
- beam forms
- jump forms
- single-sided forms
- cantilever forms
- arch forms
- bridge deck forms
- shaft-lining forms
- wall and column forms (of non-standard construction or non-standard height in conventional buildings)
- tunneling forms
- Other types of Formwork - the failure of which could, in the opinion of a Safety and Health Officer cause injury to a worker.

Some engineers may choose to design only the Support false work portion of a form work system or a specific portion of the whole project. This must be made clear to contractors and so specified in all relevant drawings and documents. Statements such as "THIS IS NOT A FORMWORK DRAWING REQUIRED BY W.S.H. MR 189/85 " written in the large print of a drawing should prevent the possibility of any misunderstanding. False work and Formwork design drawings need not be submitted to the Branch for approval or retention, but must be available at the project site.

The design engineer must authorize any revisions or changes to a false work structure. The engineer should ensure that written authorization is immediately available at the job-site, to be followed by proper documentation as soon as practicable.

Codes and Standards

CSA Standard S269.1 "False work for Construction Purposes" deals only with the design and erection of false work and specifically excludes forms.

The practice of noting on the drawings: "FORMWORK IS THE RESPONSIBILITY OF CONTRACTORS," or "BLOCKING BY OTHERS," is not acceptable. Form work designers are expected to show details of forms and all associated connections, blocking, braces and ties that are necessary to ensure form work integrity during erection and concrete placement.
The CSA Standards 086, S16, S157 and A23 continue to provide the basis for Formwork compliance. ACI Sp4 and ACI Standard 347 are recommended as reference and guides for form work designers.

Where there are discrepancies between the regulations and the standards, the overriding or qualifying requirements of the regulations prevail.

Coordination

- If two or more engineers are involved in Formwork and false work design on a project, each must check with the others to ensure that all aspects of the work are covered, and everyone clearly understands their respective responsibilities.

- The false work/form work design engineer must work closely with the contractor and the crew, whose knowledge, experience, preferences and equipment dictate, to a large extent, the type of form work to use, and how it is to be erected.

- The engineer must also consult the project structural engineer regarding the Formwork, construction load, shoring and re-shoring.

Design Considerations

Contractor Responsibilities

Contractors are responsible under the Workplace Safety and Health Act for worker safety including the safety of partially assembled false work/ Formwork structure and components. An engineer must, during the designing stage, carefully consider the effects on safety due to the choice of a particular design, equipment and methodology for the erection, use and dismantling of form work and false-work. Engineers must therefore compare the merits of the preferred design, equipment and methodology against all available alternatives, prior to making final decisions.

Work Platforms

Forms that require work platforms must have these included in the design drawings. The work platforms must be provided with worker protection, including guardrails or fall protections systems as required. The designer must take into consideration where the forms are going to be used, so that proper safety measures are included.

Concrete Placement

The method, sequence and rate of pour must be specified, taking into consideration the ambient temperature and type of concrete used. This becomes more crucial for vertical pours, tunnel and other forms, especially during cold weather.

Overhangs

Many engineers choose to have joists extending excessively beyond the main beam or stringer supports due to either the fixed width of shoring frames used, limiting deflection criteria, or limited equipment availability. Such excessive overhangs often cause the uplifting of the joists, when subjected to loading during construction and/or concrete placement. Overhangs must be kept as short as possible.

Pre-manufactured Items

Prior to using any pre-manufactured items, such as shore posts or scaffolding frames, the engineer must ascertain that their capacities have previously been determined by proper analysis or tests as required by the CSA Standards. Such items must be properly identified in the drawing

to enable accurate field assembly. Inability to provide such essential information by the equipment supplier or contractor justifies rejection of their use in the false work/form work system.

Tower Crane Shoring
Where tower cranes are used, care must be taken to ensure that adequate shoring around the crane mast-openings is provided so that all loads are transmitted to the structure/foundation safely.

Problem Areas

Rotation of Joists & Beams

As rotation of joists and beams is one of the main causes of false work collapses, the maximum permissible depth/width ratio (which should be under 2.5 for unrestrained members) must be checked carefully. U-heads with wedges are desirable in all cases and their use is preferred where possible, to develop good restraint at bearing points. Toe nailing alone at bearing, offers little resistance against lateral rotation.

Inadequate Bracing

Inadequate bracing, lacing or ties and their connections to the main members is another problem which may be overlooked, but which often results in form work failure. Details of such ties and their connections must be properly shown and specified in the drawings. The slenderness ratio of all wood bracing lacing and ties should be kept below 50.

Proper Foundation

Employers must give attention to mudslides, splicing and connections between members.
A proper foundation is essential to ensure necessary support of false-work/form-work.

Pre-manufactured Items

Pre-manufactured items must be used with care, and only after being properly engineered.

Single Post Shores

Many collapses are caused by instability associated with single post shores, especially those supporting beams with flat heads, the use of which should be carefully scrutinized due to the inherent tendency of the supported beams to rotate under impact loads or vibrations. They must be properly restrained and braced to prevent movement.

Sloping Members

Shores sitting on ramps or supporting Sloping slabs must be treated with great care, as improper wedging under or above such Sloping members can result in failures.

Fly-forms

The requirements for fly-forms are specific, and clearly stated in the construction regulations MR189/85 Contractors must give due attention to inadvertent mix-ups, panel rotations, and poor rigging arrangements and other field problems. The designer, or another engineer designated by the designer, should witness the first flying cycle to ensure compliance with the instructions, and to rectify any unforeseen problems.

Form Multiples

The use of standard form multiples that require custom-built filler sections, demands careful specifications as to their exact construction, locations and connections. Mistakes or mix-ups can take place on the project, with disastrous results.

Plumb-ness

Variation from plumb for vertical members varies considerably between engineers' specifications. Whenever possible, use the tolerances given in the CSA Standard, S269.1

Stripping and Re-shoring

Instructions regarding proper timing, sequence and method in form Stripping for re-shoring and for form removal must be specific and clearly stated, referencing the expected concrete strength, curing time and temperature, design load and other specifications.

Where re-shoring is required, proper drawings and specific instructions must be provided instead of using such loose specifications as 50% or 70% re-shoring, in note form. Re-shoring plans should be submitted to the structural engineer of the permanent structure for consideration

Inspection

The responsible contractor must personally inspect form work/ false work prior to placing concrete. The inspection record must be issued only after the Formwork has been completed, and is erected in accordance with the design. It must not include a partial list of items that still require further upgrading or changes. An inspection conducted 24 hours-or-less, prior to the pour, is the general rule-of-thumb. All changes to the original design drawing must be signed and sealed by the engineer. (A sample inspection record is attached in Appendix B.)

Appendix A

Common causes of form work failure
(Usually due to Combination of factors)

- rotation of stringers, beams or joists
- deficient connections
- inadequate or defective bracing or ties
- single post shores (usually with flat heads)
- shores on slopes or supporting sloping slabs
- untested or misused proprietary components
- unauthorized variations/poor work practices
- defective equipment
- differential settlement
- cantilever loading
- vibration and impact
- excessive rate of placing of concrete
- improper sequence Of placing of concrete
- inadequate design

Appendix B

Formwork/Falsework Inspection
MR 189/85, Sec. St

Date of inspection_____ Time_____

Contractor_____ Office tel._____

Project and location_____

Site tel._____ Superintendent_____

Date of latest F/W erection drawing_____

Form work area inspected_____

_____

Is re-shoring in place according to the design? _____

_____

Scheduled date of concrete placement_____

Concrete curing time prior to stripping and re-shoring_____

Remarks (not to be used as a deficiency list)_____

_____

Certification:

This is to certify that the above-noted form work and re-shores have been inspected and found to be in accordance with the latest approved erection drawings and all supplementary information and are ready for placement of concrete.

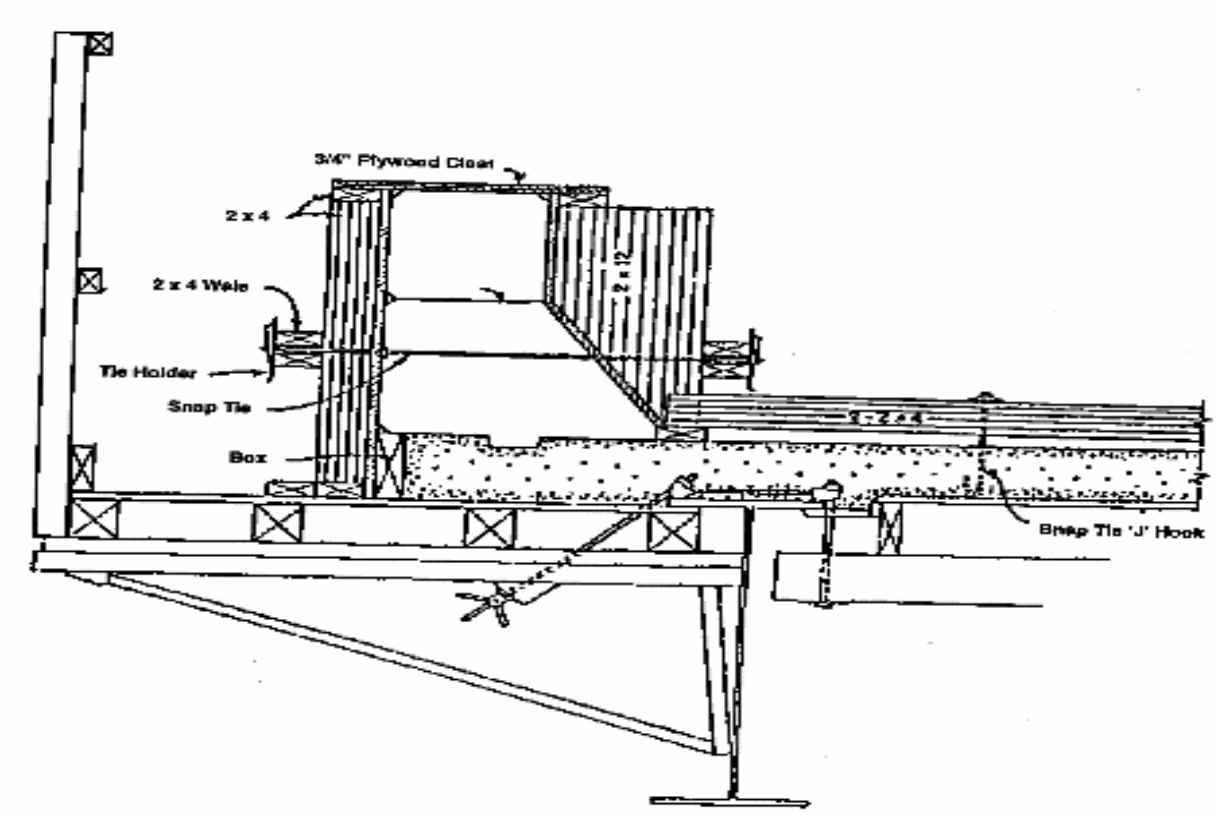
Inspected and approved by:

_____
Name (print)

_____
Signature

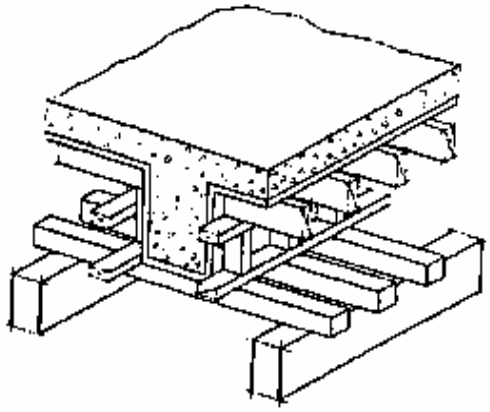
_____
Date

Bridge Deck Forms

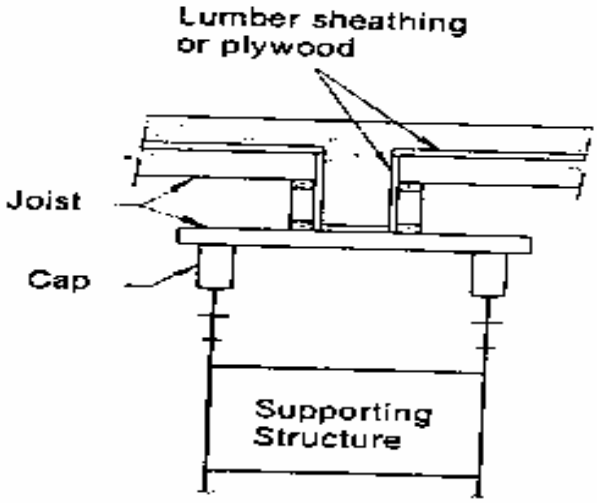


Appendix C

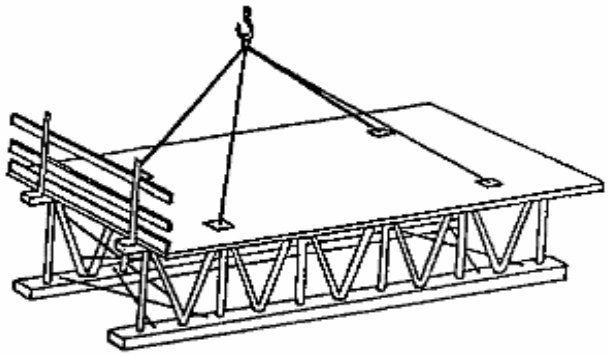
Examples of False work



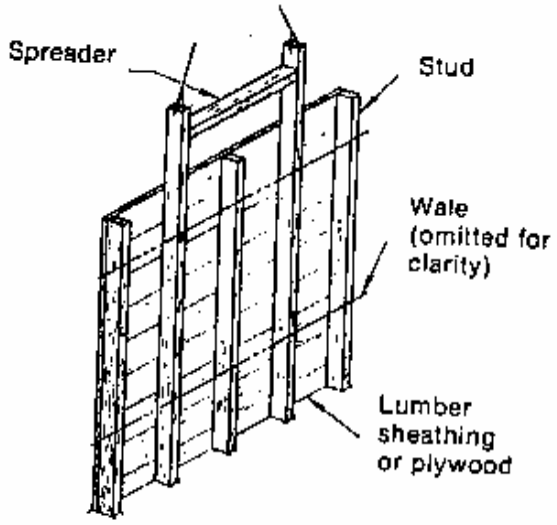
Beam and Slab Form



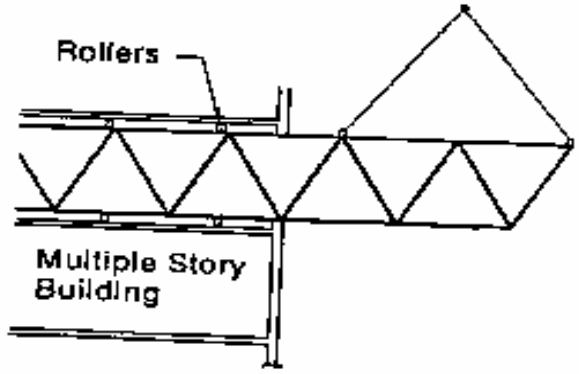
Cross Section — Beam and Slab Form



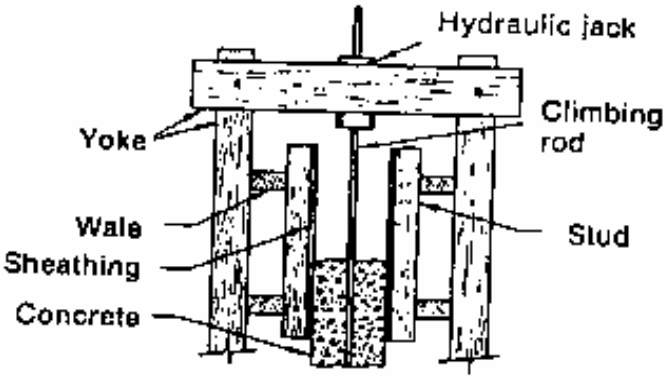
Flying Form



Gang Form

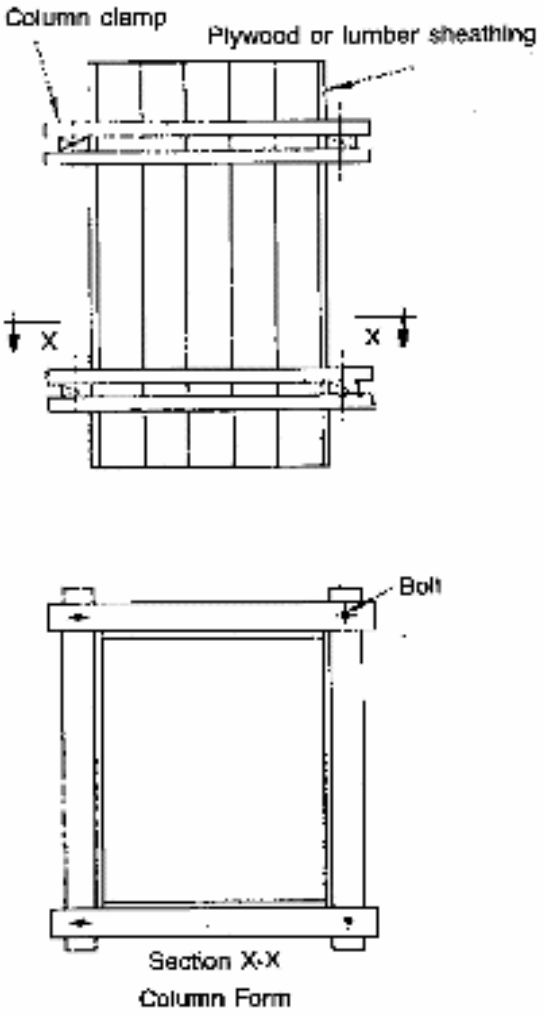


Elevation — Flying Form

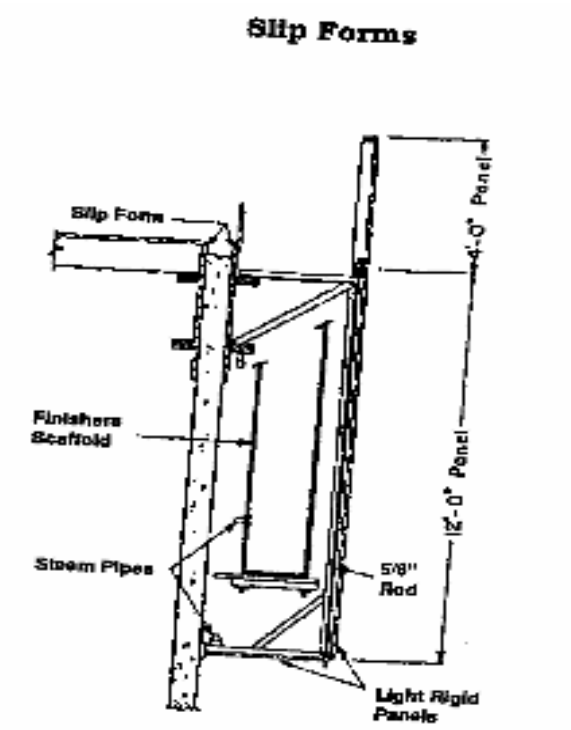


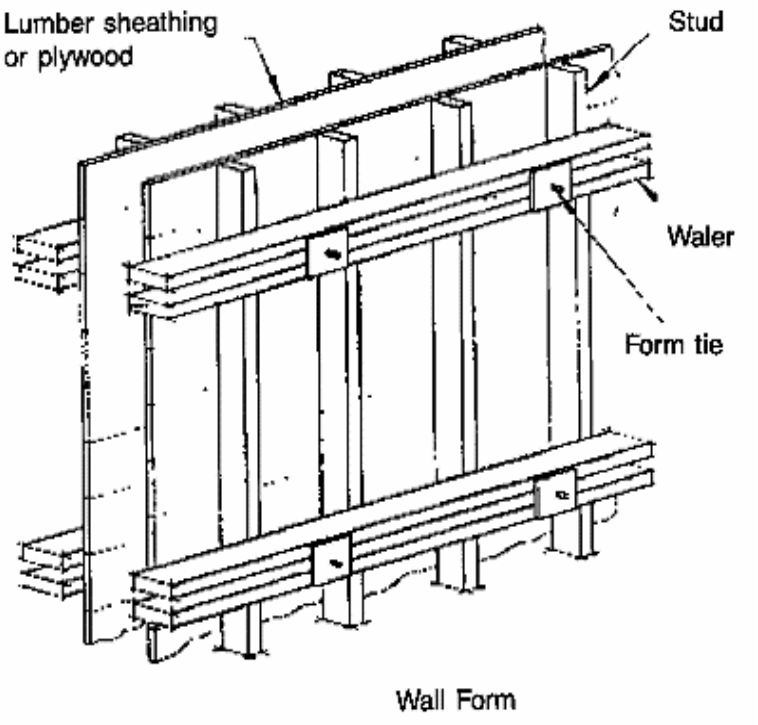
Sliding Form

Examples of False work



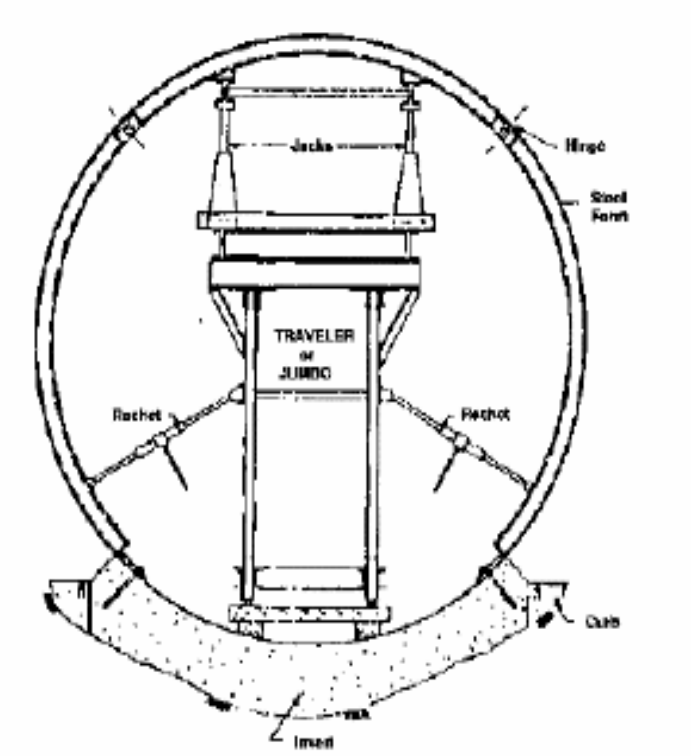
Column Form

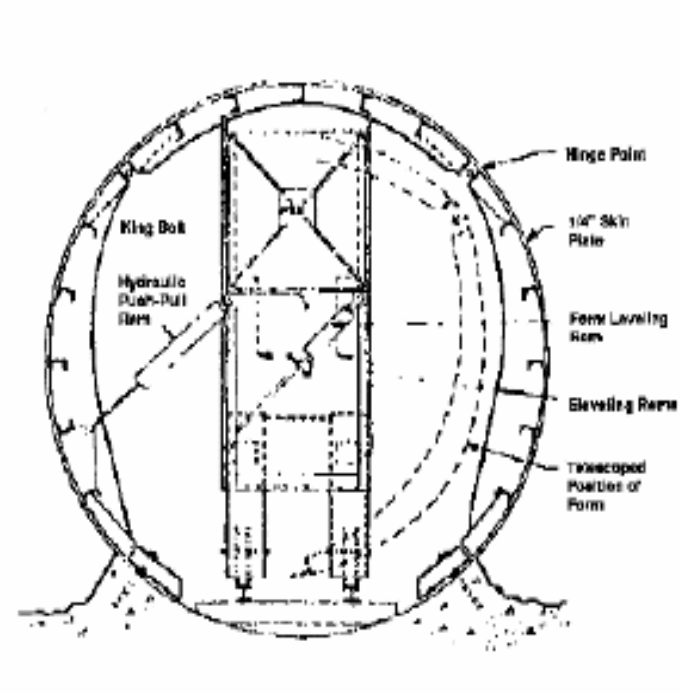




Wall Form

Tunnel Lining Forms





Cantilever Forms