Formwork for basement walls

CRITICAL FACTORS

Strength and stiffness of formwork
Efficiency of erection
Number of reuses obtainable

Prefabricated forms are widely used for basement walls. They have several advantages:

- ready assembly into almost any size or shape from standard components
- minimal amount of skilled labor required to erect them
- versatility of combining into a large segment for one job or using individually for another
- reduction of clutter from discarded formwork components of miscellaneous sizes, made possible by the large number of reuses

Job-built formwork is commonly made of 4- by 8-foot sheets of plywood secured to 2 by 4 studs; form ties are run through drilled holes. The plywood is usually secured to wales made of double 2 by 4's running horizontally at 2-foot centers behind these studs. Snap ties are widely used.

There is a single-wale method that utilizes sheets of plywood and single 2 by 4's with a snap bracket that fits the wale. Another method utilizes 2- by 8-foot sheets of 1⅛-inch plywood held at the bottom by a strap-like bracket that attaches to the footing and serves also as a tie. The bracket is left in the concrete. The same kind of bracket is used in the reverse position at the top and recovered when the forms are stripped. A similar system utilizes such brackets with 4- by 8-foot (plywood sheets of only ¾-inch thickness and a single wale with snap brackets at the 2-foot height.

The preference of some contractors for job-built forms depends on the low initial cost of materials and

Photo courtesy of Gates & Sons Inc.

Although relatively simple to form, basement walls have led to a considerable amount of innovation in the forming field:

These lightweight aluminum forms require a substantial initial investment but are virtually indestructible.

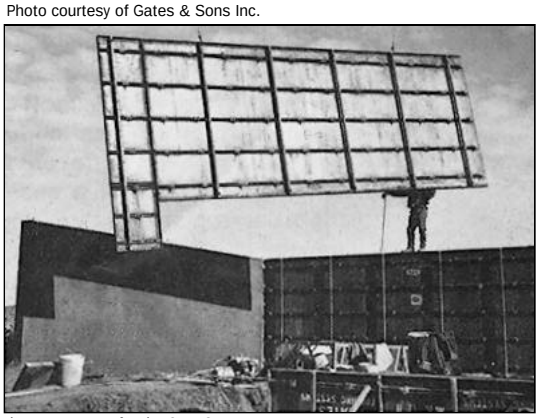
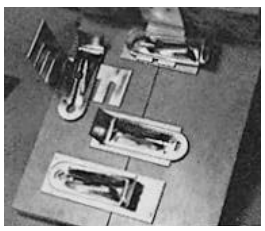


Photo courtesy of Kuhn-Oury Concrete Forms Inc.

Gang forming, although tending to limit flexibility, lowers costs substantially in carefully planned use on multiple units in housing tracts.

At the other end of the spectrum this system which uses no fixed hardware allows almost total flexibility.



their workmen's familiarity with it.

Choice of formwork, however, is a matter of economics. Prefabricated systems offer unusual economy in labor for erection and most provide a great number of reuses. There is little defacing of the surface because ties are inserted through dadoes or slots provided in the side rails.

Kinds of prefabricated forms

There are several types of prefabricated forming systems:

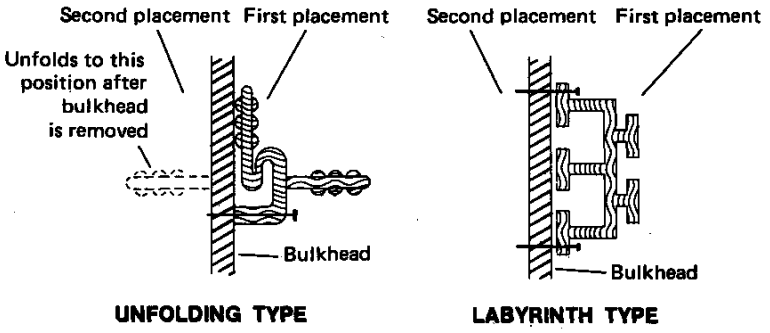
- unframed 1⅛-inch plywood panels for which the manufacturer supplies the necessary locking and ties and, for some designs, metal bracing attached on the back
- steel channel frames 3 to 5 inches deep with any of several kinds of faces:
  (a) ¼-inch steel plate**
  (b) ½- to 1 ¼-inc) fancy high strength imported plywood
  (c) ½- to 1-inch Plyform, plain or plastic coated
- aluminum frames with plywood facing†
- cast or rolled aluminum facing, plain or textured, with integrally cast or bolted aluminum framet

The various kinds of prefabricated forms are convenient to use, relatively low in cost and readily available. Steel-faced panels are convenient and slightly less susceptible than are plywood-faced panels to damage on faces, but they must be protected from rusting by prompt cleaning after use and retreating with a form release agent containing rust inhibitor. Forms with aluminum facings are commonly embossed to simulate brick-like, adobe or other patterns and textures where a decorative effect is wanted. Aluminum forms have a big advantage in their lightness in weight. Sizable pieces can be readily handled by one person.

Wales and bracing

Wales are used on prefabricated or patented forms to align them and gather the load. They are usually but not always used on one side only. Stock sizes of lumber may be used, usually double, in long lengths, with joints staggered to provide continuous alignment. Steel channels may also be used. For low walls or single lifts the wales are located 6, 12 or 18 inches below the top of the forms, depending on where the connection can be made.

On high walls wales should be located at about the same place on each lift or else close to the form joint. They should be used at the bottom also to maintain proper alignment. It may be necessary to use bracing on high walls to hold them straight and plumb.



These are two types of waterstop that are easily installed by nailing to the concrete side of the bulkhead.

Bulkheads

When for any reason it is necessary to interrupt concrete placing, a bulkhead is required. It is usually made by nailing in vertically a 2-inch plank or piece of ¾-inch plywood. Holes can be drilled as needed for rebars or dowels. It is good practice to attach a waterstop vertically on the bulkhead to form a permanent watertight seal between this section of wall and the one to be cast later as shown in the Figure.

Planning

Drawings of walls and elevations are useful in planning the positioning and combinations of formwork and the locations of hardware connections and ties. The literature supplied by manufacturers of formwork and accessories can be used to determine the spacings required to sustain the considerable loads exerted by the fresh concrete. Forms will flex and bulge, and in bad circumstances fail, if ties are too far apart.

When stepped footings are to be built they should be planned to increase in even increments such as 6, 12 or 18 inches to facilitate connecting the adjoining forms without special or job-built fillers.

Erection of prefabricated formwork

The erection of formwork normally begins at a corner, starting with either the inside or outside form and setting it to a chalk line. Alternatively a 2 by 4 kicker plate can be set to the chalk line on the footing using concrete nails and the formwork can then be attached to it.

The first panel is set, plumbed and braced. Additional panels (and fillers where needed) are set in sequence. Ties are ordinarily inserted as the first side is erected, starting at the first joint. Wales are attached to provide alignment and additional bracing is supplied as needed. Window and door bucks and boxouts should then be located and built. In setting the opposing forms care is needed to ensure alignment of joint lines so ties can be connected properly.

Job-built forms

Job-built forms can be built inex-

pensively of plywood. On some work it is an advantage that single sheets cover 4- by 8-foot areas and consequently minimize the number of joint lines that show; tie-hole marks will show, however. Modern plywoods are available with waterproof or moisture-resistant glues that prevent delamination from prolonged contact with moist concrete.

Plywood and lumber

For most job-built forms 4- by 8-foot sheets are used in thicknesses of ⅝ or ¾ inch, more often the latter. Sheets of other dimensions, such as widths of 5 feet and lengths from 8 to 35 feet as well as other thicknesses, are available for more special purposes.

Either interior or exterior grades of plywood can be used for formwork but the exterior type is used when maximum reuse of forms is wanted. Both types include grades of veneer from A to D that indicate the degree of freedom from knots. Grade B-B, which contains B-grade veneer on both surfaces, is commonly used for formwork. Overlaid plywood is a superior type made with resin-impregnated fiber faces permanently fused under heat and pressure at the factory to obscure the grain and produce a gloss on the concrete. (It should be distinguished from plywood that has been plastic-coated on the job without application of heat.) Overlaid plywood obtains many reuses. An excellent 32-page booklet on the selection and use of plywood for formwork, "Plywood for Concrete Forming," is available from the American Plywood Association, 1119 A Street, Tacoma, Washington 98401. Manufacturers of forming systems utilizing plywood or plywood facings can also provide useful literature.

Department of Commerce standards require that form grade plywood be edge sealed and mill oiled. Edge sealing protects the glue line from moisture. Unoiled plywoods are also available. Mill oiling produces a plywood that gives better service than one which is job-treated only, but this does not eliminate the need for reoiling or recoating on the job. Some lacquer-type form coatings are incompatible with oils; if these are to be used an unoiled grade of plywood should be obtained.

Hardboard (panels of felted wood fibers) is also useful for formwork surfaces. So-called tempered hardboard, a material impregnated with drying oils or resins and stabilized by heating, is used to make form hardboard by applying a plastic coating at the factory to seal out concrete alkalies, make it more abrasion-resistant and give it longer life.

Hardboard is not a structural material like plywood or lumber and should only be used over a supporting backing of either 5/8-inch (16) plywood or lumber at least 4 inches(17) wide and spaced no more than 3 _ inches(18) apart. Instead of being tightly butted, adjoining sheets should be separated by a space of about the thickness of a U.S. dime(19) to prevent buckling from swelling. Sheets for formwork should be ¼ inch thick. They come in widths of 4 feet and lengths of 4 to 16 feet.

Lumber for formwork facing or for studs and wales is usually made from one of the following kinds of softwood:

Douglas fir, Oregon pine, southern yellow pine (seasoned to overcome the large shrinkage), western hemlock, eastern hemlock, northern white pine, Idaho white pine, sugar pine, ponderosa pine, and, when of adequate grade, Norway pine or eastern spruce.

All of these are suitable for structural forms but the pines and eastern spruce are too expensive. The same is true for studs and wales. For architectural concrete and milled forms all of these woods are suitable except eastern hemlock.

In designing and constructing forms the actual size of the lumber and not the nominal dimensions should be used. Tongue-and-groove boards are useful for sheathing where smoothness of the surface is important. Shiplap boards, also used, have the advantage that there is less chance of splitting the edges when stripping, but the finished surface is not as smooth. Square-edged boards are used where the line between boards is wanted for its effect on the finished surface. Such boards permit some leakage of mortar during the concreting operations. A 12-page booklet, "A Product Use Manual," gives tables and guides for selecting grades of lumber for forming and other uses; it is available from Western Wood Products Association, Yeon Building, Portland, Oregon 97204. Other useful literature on woods for formwork is available from manufacturers of wood-faced prefabricated formwork.

Nails and hardware

Common nails are used in form panels intended for multiple use or where the nail need not be removed during stripping. Box nails are used for built-in-place forms because their shank is thinner than that of common nails and will pull loose more easily. Double-headed nails are used for kickers, blocks, braces and wales to provide a combination of good holding power and easy removal. Wood screws, bolts, lag screws and other connectors are used for heavier duty connections.

Form ties

A variety of ready made ties is available with various safe load ratings. For residential construction the ties used are usually a continuous single member that includes a tensile unit at the center and a holding device for securing it to the outside of the form. Some such ties may be pulled out of the concrete after hardening. Others are broken back a short distance into the concrete at a weakened section of the tie that facilitates snapping. Some are designed to be snapped while the brackets are still in place, thus snap-

ping the tie and loosening the bracket simultaneously. Ties that are cut off flush with the concrete surface are satisfactory for places above grade where discoloration from rust is of no consequence and where there is little likelihood for leakage to develop.

Several manufacturers supply flat ties more economically in double or triple lengths which are broken on the job to the length required. For example, a triple 8-inch tie would be 24 inches long and could be used as a 24-inch tie, or broken into one 16-inch and one 8-inch or three 8-inch ties.

Patterned and textured walls

It is often advantageous to provide a patterned or textured surface on the interior of a basement wall as well as the exterior portion above grade. Builders are finding that the use of the same material— concrete —for both structure and finish provides an inexpensive means of producing long-lasting, low-maintenance finishes that add greatly to the appearance and value of the house. There has recently been increasing use of brick-like and other patterned forms and form liners for this purpose and it seems certain that the future will see more and more decorative concrete used for both exterior and interior residential walls above grade.

The production of such surfaces does require careful planning, preparation and familiarity with the essential techniques without which the effort can fail. It is recommended that anyone undertaking to produce patterned, textured or exposed aggregate finishes familiarize himself with the forming materials and the concreting and finishing methods required for successful work. These are covered thoroughly in the reprint collection titled "Site-cast Architectural Concrete," available from Concrete Construction Publications for $2.00.

**Although relatively durable, once the plate has been damaged it is very costly to repair.

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† In salt air environments aluminum is highly susceptible to corrosion.

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