



BY CONCRETE
NEW ZEALAND INC

Concrete formwork basics

Concrete can be formed into a variety of intricate shapes with interesting surface finishes, but this relies on quality formwork. Whether using traditional boxing or proprietary formwork, it's important to get the basics right.

FORMWORK must contain freshly placed and compacted concrete until it has gained enough strength to be self-supporting and to produce a concrete unit of the required shape and size with the desired finish.

Formwork is a significant part of the cost of structural concrete units. Speed of erection and stripping affects the rate of construction, and the contractor working with the project team needs to be skilled in its design and fabrication.

Design of formwork

In addition to vertical loads and horizontal pressures (from wet concrete), allowance must be made for the self-weight of the formwork, workers, materials and equipment and the impact of placing the concrete. It is usual to check that forms can sustain a point load. Actions that may produce load concentrations and uplift on sections of formwork must also be considered.

Concrete exerts strong horizontal pressures on the vertical surfaces of formwork. With self-compacting concrete, these horizontal pressures are much higher and must be considered during formwork design and erection.

However, as the workability of concrete reduces over time with the loss of water through cement hydration, concrete develops an increasing capability to be self-supporting.

Forms and shores (props) must be braced to resist all lateral loads, such as wind or other impacts – for example, starting and stopping equipment. Lateral bracing is very important to prevent misalignment and potential collapse.

Health and safety requirements must also be

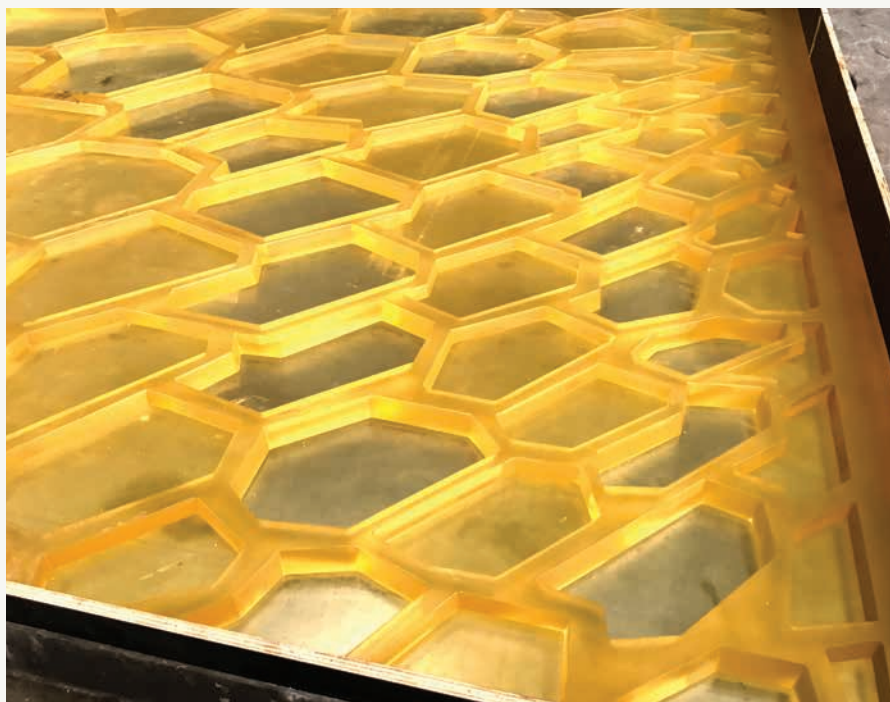


PHOTO – JACKSON INDUSTRIES

Formwork liners can leave interesting designs on the finished concrete.

considered during design, particularly if working at height. These would include enough walkway space, no obstructions or unnecessary overhangs and fall prevention.

Fabrication generally by contractor

The contractor will generally be responsible for planning and designing the formwork, unless it is a very complex structure. This is essential since the contractor can evaluate staffing, materials and equipment and arrive at a design that is structurally sound, can be erected and is suitable for concreting.

Traditional boxing used less

Traditional boxing for concrete construction consists of bespoke solutions assembled on site from timber supports – plates, braces, pegs, cleats, walings for tall walls – together with close-butted timber boards or plywood sheets to form the concrete against. Alternatively, standard shutters of timber frames and plywood are premade to suit with infill panels made to complete the boxing.

While steel forms are more durable, timber or plywood is simple to work with and lighter, and inserts can be easily fixed.



PHOTO – ACROW LTD

Proprietary formwork system.

Sheeting and decking

Sawn or dressed timber can be used as sheeting and decking. It can eliminate studs on slab work when supported on runners or stringers. Edges may be square cut or tongue and groove. To prevent grout loss, joints should be sealed with a flexible foamed strip.

The advantages of using exterior grade plywood as a form supported by timber framing include it:

- is rapidly fixed
- can provide large smooth surface areas without joints
- has high resistance to impact

- can be nailed close to the edge
- is stable when wet.

To ensure maximum reuse of plywood, seal sheet edges, use thin but wide wedges when stripping, coat sparingly before each use with a form-release agent and clean down immediately after use.

Options for sheeting or form liners against which the concrete is placed:

- Steel sheet typically incorporating steel angle supports to keep the form straight.
- Proprietary lightweight flexible or rigid interlocking PVC planks.
- Hardboard – this has a limited reuse and must be tempered to provide resistance to moisture. Sheets should be centre pinned to sheeting material to reduce buckling. Clean before re-rolling for reuse.
- Textured rubber linings that can be used with any formwork system. It is essential to ensure the rubber is well fixed to the backing. Using the correct release agent is also important.
- Thin plastic sheeting requiring backing support can be used to produce a smooth surface finish. Many uses can be achieved. However, the impervious face of the liner can trap air bubbles and so form blow holes.

Release agents

Most form materials require the application of a release agent to the surfaces that will be in contact with the concrete to make removal of the formwork easier. As well as effecting release, release agents can also influence the concrete surface appearance and durability.

When selecting the release agent, consider the

type of surface (absorbent or non-absorbent), type of concrete, quality of finish and ease of application as well as any finish that might be applied to the concrete, such as tiles or paint.

Include striking strips

Formwork reuse relies on being able to remove the shutters easily and quickly. There must be room to move the shutter in two directions before attempting to lift them clear from the surface. The usual way to do this is to include some striking pieces or wrecking strips.

The time of striking is normally specified in the construction documents, otherwise the requirements of NZS 3109:1997 *Concrete construction* should be applied. The requirements for beam sides and walls are 2–6 days depending on temperature conditions, but this may vary. Removal of any soffit formwork is related to structural propping and should be covered in the specification to allow the concrete's required strength.

Proprietary systems

As many formwork requirements are common across projects, a number of reusable proprietary formwork systems have been developed.

These mostly modular systems are designed for speed and efficiency, with health and safety built in. There are a variety of main systems:

- Table form/flying form – large preassembled units, often creating an entire bay of a suspended floor slab, offer mobility and rapid erection for projects with consistent or repetitive layouts. ➤



PHOTO – BANMAN CONSTRUCTION

A wall formwork system.

- System column formwork – these are modular, allowing quick installation of column forms on site and are available in a variety of materials. This type of formwork comes with different internal surfaces depending on the finish required.
- Horizontal panel systems – these lightweight modular systems provide versatile solutions on site and can be used for most types of construction. They are generally made from aluminium, high-tensile steel or fibreglass.
- Vertical panel systems – these crane-lifted modular panel systems are commonly used on building sites to form vertical elements and usually consist of a steel frame with plywood, steel, plastic or composite facing material.
- Jump form – not reliant on support from other parts of the building or permanent works, this system supports itself on the concrete cast earlier and is suitable for construction of multi-storey vertical concrete elements.
- Slip form – these are like jump form, but the formwork is continuously raised vertically to extrude a reinforced concrete section and is suitable for construction of core walls in high-rise structures.

Other developments include:

- lightweight, adjustable formwork metal/plywood interlocking forms that can incorporate handrails and full access platforms to give a complete formwork/shuttering and access solution
- proprietary metal boxing brackets to support wide horizontal planks for slab edge formation
- proprietary one-piece adjustable brackets that incorporate locating pins specifically design for use with polystyrene pod slabs on ground
- proprietary interlocking aluminium panels supported by galvanised steel pipes that are clamped together to provide a slab edge form.

Permanent formwork

Permanent formwork remains in place after the concrete has gained adequate strength. It may contribute to the load-carrying capacity of the structure or simply contain the concrete while it is being cast and gaining its initial strength.

Permanent forms for suspended floors are typically:

- interlocking long-span profiled metal trays installed over a supporting structure – the floor slab is then cast over the metal form
- timber infill between spanning precast concrete beams (rib and infill) over which

is placed the slab, which then ties the floor elements together.

Permanent formwork is not restricted to horizontal surfaces. Systems are available that make it possible to pour vertically and create walls. Insulating concrete formwork (ICF) is a type of vertical permanent formwork made of expanded polystyrene blocks into which reinforcing steel and concrete are placed.

Slab on grade

There are polystyrene and plastic dome systems available for residential or light commercial slab on grade and are sometimes referred to as permanent formwork, although the slab edging tends to be formed using timber or steel formwork. However, there are slab edge-forming systems available that incorporate bracing elements to eliminate form deflection.

Pay attention to the details

Time spent before placing concrete to ensure the exactness of formwork design and fabrication details is never wasted. In addition to health and safety considerations, design and fabrication shortcuts can prove troublesome and costly, with significant hours and money required to remedy defects. ◀