fundamentals of precasting

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1. INTRODUCTION

Concrete is used in either a 'precast' or an 'in-situ' state. Precasting is the process whereby concrete is cast into elements (units) prior to their integration into a structure. From the precasting process comes precast concrete formed in the image of its mould to be used as an element of architectural design, whether structural, functional or decorative.

2. APPLICATIONS

Examples of precast concrete are numerous and as it will be seen from the following description, 'precast concrete' needs to be an applied term for it to have a useful descriptive meaning. Precasting may take place as either an on-site or a factory operation. However, in New Zealand the greatest emphasis is on factory precasting.

2.1 On-Site Precasting

On-site precasting may be established for one or more of the following reasons:

(i) Where it is uneconomic to transport the unit(s) because of distance or awkward shape.

(ii) Where factory quality controls are not warranted.

Elements particularly suited to on-site precasting are:

(a) Large wall panels - poured on floor slab and tilted into final position.

(b) Lift slab constructions - heavy roof or floor slabs poured on preceding floor and jacked into position.

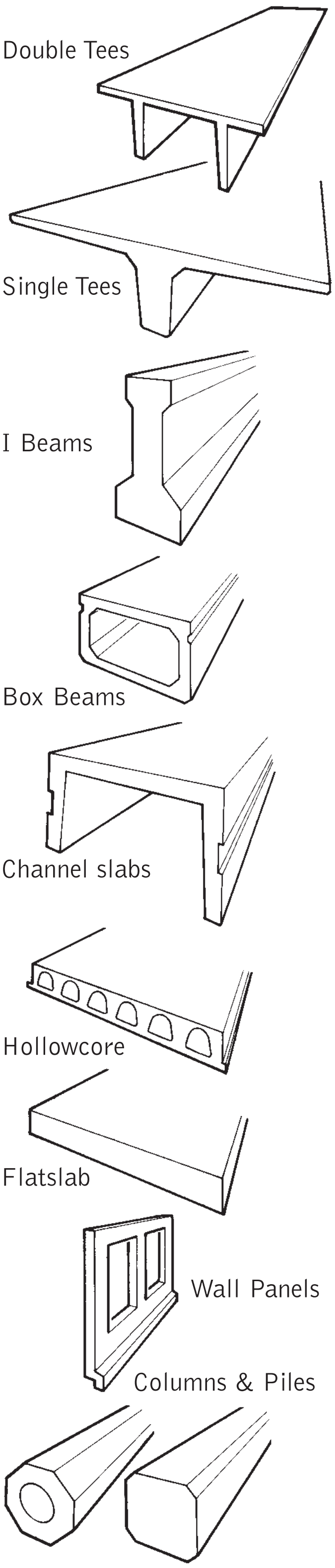
2.2 Factory Precasting

Factory precasting embodies greater quality control and expertise than is possible in in-situ placement or on-site precasting of concrete. The four main categories of factory precasting are:

(a) Civil engineering Components: For bridges, reservoirs, wharves etc.

(b) Floor slabs/joists: A wide range of standard floor units are available today. These have been successfully integrated with steel frames, reinforced masonry, reinforced concrete and prestressed concrete structures.

(c) Structural frames: Much scope exists in New Zealand for prestressed multi-frame design. Prestressed structural



TYPICAL PRECAST PRODUCTS

frames can be produced with a high standard of finish, which permit a designer to express the frame to best advantage. Concrete frames, unlike steel, are fire resistant.

(d) Architectural concrete: The architectural applications of precast concrete are extensive. With few limitations on shape and a wide range of finishes and mould textures at their disposal the designers can express their own style and give character to their designs. Architectural precast concrete is employed as decorative wall panels, window frames, stairs or feature walls (structural), non-structural wall panels, and in fact all exterior concrete that contributes to the visual effect of the building. This concrete can range from the lower cost plain panels to the more expensive textured or exposed aggregate faced units.

3. ADVANTAGES

Maximum advantage from precast concrete can be achieved when consideration is given to its potential at an early stage in design. Factory precasting offers real advantages:

- Enables use of pre-tensioning techniques, reducing cost and increasing available spans.
- Improves handling ability of product.
- Economy in formwork by repetitive use of a small number of superior, accurately made moulds which may be constructed of various permanent materials depending on the number of uses planned.
- Particular effects of form and colour.
- Speed of production from rationalisation and standardisation of design.
- Greater quality control in all facets of production, because work takes place under cover allowing optimum and shorter concrete curing conditions independent of climate.
- Shorter on-site times as factory production proceeds ahead of site construction.
- Partial elimination of wet trades.
- Dimensional accuracy.
- Precast elements may be prestressed to achieve greater strength requirement and load bearing capacity.

4. LIMITATIONS

There are also limitations, all of which are amenable to solution. Careful design, sensible handling procedures and proper factory to site co-ordination overcome virtually all constraints.

5. PRECAST CONCRETE

5.1 Finishes

Precast concrete is a versatile material in the hands of an imaginative designer. With skillful use of various surface finishes and colours available, the variety and appearance of precast concrete is almost unlimited. Surface finishes may range from rough textures - achieved by exposure of the aggregate - to high quality F5 finish. By using colour or exposed aggregates almost any colour combination is possible. Surface texture and colour can be achieved by exposing selected aggregates such as quartz, granite, marble or various ceramic materials. Textured finishes can be achieved by the use of mould liners such as plywood, shaped plastic or polystyrene, rubber or rope. Applied finishes and high build paints are available in a wide range of colours and textures. These proprietary finishes may need specialist applicators.

6. MANUFACTURE AND MATERIALS

6.1 General

To meet the demands of the specification for reliably high quality production to fine tolerances, and to ensure economic production methods, precast concrete work has become a specialised field. If or when the precast units are in any way complex the designer should discuss his ideas with a manufacturer to achieve a rational, and thus economic, mould arrangement. Most manufacturers have standard products, e.g. Unispan. These will always be much more economical and satisfactory than special units if they can be used. The economic manufacture of precast concrete depends mainly on the full utilisation of factory methods and the employment of the minimum amount of skilled labour. Most plants employ production line methods with batch controlled concrete delivered to the moulds by the most economic means. The concrete is systematically placed and vibration compacted. Filled moulds are cured, usually with heat overnight, to develop early high strength and then the units are drawn from the mould to be stored awaiting transport to the building site. Twenty-four hour turn-round of moulds is essential.

6.2 Tolerances and Quality

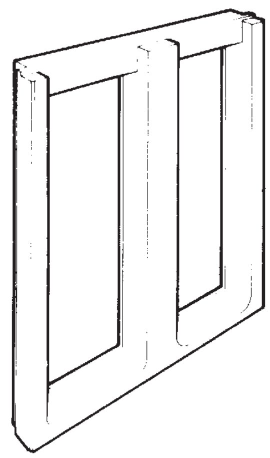
A rational approach must be taken to the determination of tolerances both for manufacturing and construction. The finer the tolerances required the more elaborate the mould must be and hence the higher the cost of the finished unit. Tolerance costs for each unit could, in extreme cases, represent a major proportion of the total cost of the unit.

Designers are recommended to consider "Guidelines for the Use of Precast Concrete in Buildings", Centre for Advanced Engineering, 1999 University of Canterbury, a handbook for manufacturers, designers and builders and bear in mind the principles of modular co-ordination when establishing tolerances. Similarly, standards of quality of finish should be kept realistic. The specifying of fine finishes completely free of pin holes, for example, is impossible and unnecessary as the building is not going to be scrutinised close up, but viewed as a whole from a distance.

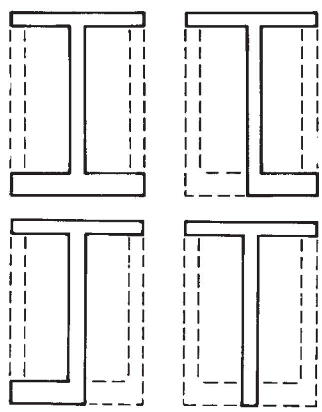
7. DRAWING AND DETAILING

It is common for architects and engineers to tag their designs with notes such as "the contractor shall check the accuracy of all dimensions on the

MASTER MOULD CONCEPT is based upon fabricating one master mould (with appropriate additional tooling) which allows a maximum number of casts per project. Units cast in the mould need not be identical provided changes in the units can be accomplished as pre-engineered mould modifications.



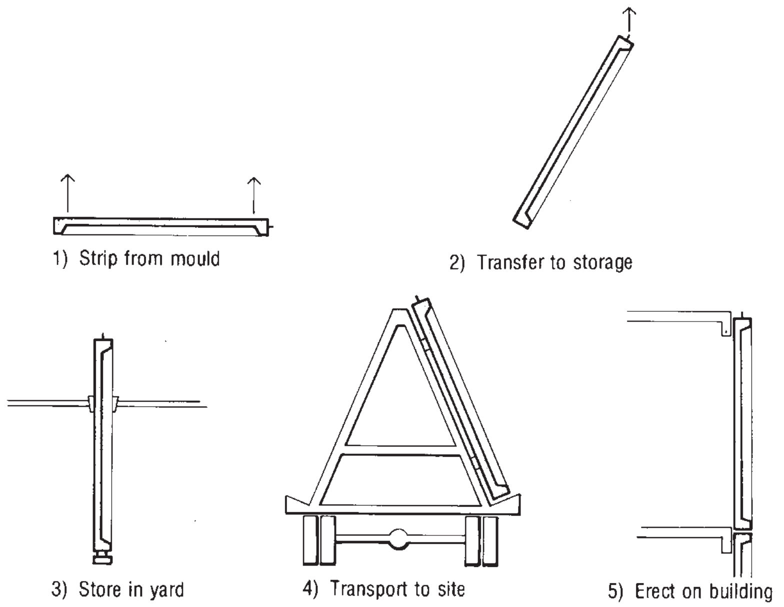
This typical panel may become:



job." While this may prove satisfactory for in-situ work, it is not possible for precast work, which may be under way, and in production before there is even a set out or building frame on which to measure for these precast units. It should be the designer's responsibility to check the feasibility of the design in manufacturing terms and to ensure the necessary degree of accuracy by appropriately detailing the positions of reinforcing, lifting points, tolerances, permitted deviations and overall dimensions.

8. CARTAGE, HANDLING AND ERECTION

Few problems arise in the carting, handling and erection providing early consideration is given to sizes and the engineers design considers the handling and erection loads.



OPTIMUM HANDLING SEQUENCE OF PRECAST WALL UNITS

TYPICAL TERMINOLOGY FOR PRECAST UNITS