PRACTICAL FORMWORK AND MOULD CONSTRUCTION

Second Edition

PRACTICAL FORMWORK
and
MOULD CONSTRUCTION

SECOND EDITION

（内部交流）

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PREFACE TO SECOND EDITION

During the years that have elapsed between the publication of the first edition and this edition, the author has come to realise the need for specialisation particularly where such a broadly based topic as formwork is concerned. Each person is an expert in his own particular field, be it where a person is employed on a simple column and beam form system as constructed on site, or where another person works on a massive section of *in situ* concrete as required within a heavy civil engineering project.

Materials technologists, mechanical designers, formwork and falsework engineers as well as manufacturers and users of formwork, all seek at some time some particular information regarding formwork design, production and usage.

Thus whilst the author has set the scene and described formwork and mould arrangements within his own personal experience, he has also invited contributions from selected specialists on topics that include slipforms, special formwork, plastics and form construction.

In this way the scope of the book has not only been enlarged but has been updated. The original edition found acceptance among the more practically minded of those concerned with forming and moulding concrete, and it is hoped that this edition will continue to maintain that trend.

During the course of this revision the author has taken the opportunity to provide new and different illustrations related to formwork construction and practice and has added a bibliography, thus presenting the reader with an opportunity to increase further his knowledge of this important subject.

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Chapter 1

DEFINITION OF DESIGN AND THE APPROACH TO FORM AND MOULD CONSTRUCTION

1.1 INTRODUCTION

In dealing with the design and construction of moulds and formwork for reinforced concrete it becomes necessary at an early stage to define the word design. It is not the intention of this book to instruct the reader in pure mechanical design, product of formulae and calculation, the fine approach of the engineer to problems of forces and moments, but rather to deal with the practical design of a mould or form for a given application. A design should be based on the constructional aspects, the choice of materials, the methods of incorporating them into moulds and the form systems in such a way that the materials fulfill the many requirements of the specification and the practical demands of use and re-use.

While the preparation of a design is frequently the province of the drawing office staff, much useful constructive design work is carried out on site or in the works itself. Practical arrangements for a mould or unit are frequently devised by those people who are engaged in utilising an existing system, with a view to improving methods employed in later stages of a project or on subsequent contracts.

At the design stage, when consideration is being given to the practical methods and the construction of the mould and formwork components, a bad decision may result in poor surface finishes and deformed concrete or units, or possibly damaged moulds, any of which can prove expensive if not dealt with at an early stage in the course of construction. Good mould and formwork design allows

sound construction of a concrete structure or unit. Lack of attention to details such as striking or removing forms from concrete, or concrete from a mould, can destroy all the care and attention that has been expended on the gauging of the concrete mix, or the placing and compacting of the concrete within the form. A badly designed mould or form, although only a small part of the whole contract can, through lack of care, mar the completed work and upset the results of many other trades.

When sufficient attention has been given to the construction of a mould or system of formwork, and once the initial problems that can arise out of the first uses of what is probably a new and unusual approach to a problem have been solved, the mould or form system can be organised into a series of economic re-use operations. These operations can be designed to be carried out by operatives trained in a method of working in such a way, that the requirements of all who are concerned with the finished product are satisfied.

Provided that the construction is sound, and the members employed are mechanically correct, the system should lend itself to refinement and modification so that a complete form or mould system will have been attained.

In the succeeding chapters the many interesting facets of form construction will be examined, and a variety of methods of casting concrete will be discussed, although, of course, they present but a small proportion of the methods available to the constructor. It is the remarkable scope for invention and ingenuity, with rarely the same problem arising in the same way in similar work, that provides the interest in the subject.

A remarkable diversity of opinion is expressed regarding methods of carrying out the various operations and it is interesting to note that though there are certain accepted practices and specified methods, the approach to a given problem varies from person to person and from manufacturer to contractor. This book will describe accepted practice and mention possible innovation.

Craftsmen dealing with a trade use their knowledge of construction principles and skills which have been developed during years of fellow tradesmen's experience. As yet in mould and formwork there is little by way of a Code, and there are few set solutions to which reference can be made and carried into practice. Mould and formwork is a modern craft in which large volumes of plastic material are moulded and formed while hardening takes place and the material

takes on a structural capacity, a comparatively new problem to those involved in building and civil engineering operations. The casting of metals has been carried out for centuries, the principles involved in providing a negative form or mould being shared with concreting. Here the similarity ends. The casting of steel or alloys has generally been regarded as a means of providing an approximation of a given shape for subsequent fettling.

In some instances expensive patterns are used and a fair copy of the given pattern is produced in the casting. In concrete work, however, it is normally impracticable to employ a pattern, the negative mould being constructed in the first instance and tolerances are laid down for the finished product. The work is frequently left with the face finish imparted by the mould or formwork thus providing a direct reflection of the ability and craftsmanship of those concerned in constructing the mould. The art of forming concrete is an exact one as exhibited in many structures, particularly those involving modern precast and prestressed concrete where individual units are cast to extremely fine limits.

The problems which provide the interest to the subject are rarely insurmountable and can, with the observance of sound construction principles, be solved in diverse ways. No writing on the subject should be considered as being complete since the ultimate in method to one person may prove to be the starting point from which another may begin to evolve a completely different solution or way of approach. Any one of a dozen methods while efficiently meeting the requirements of a particular authority, can also be more economical or quicker to construct.

This book can only outline the observations of the author which have been made while engaged on several sections of a lively and growing industry. By making clear the reasons for the adoption of any of the methods described, it is intended that a basis should be presented for sound mould and form construction and planning.

In order to consider the problems presented by a particular casting operation or the detailing of a system of mouldwork or formwork it is necessary to consider the authorities that govern the execution of the work. Each professional member or tradesman has a particular approach when laying down his requirements, whether it be by drawing or writing of a specification, and these must be borne in mind when the casting methods and formwork systems are designed.

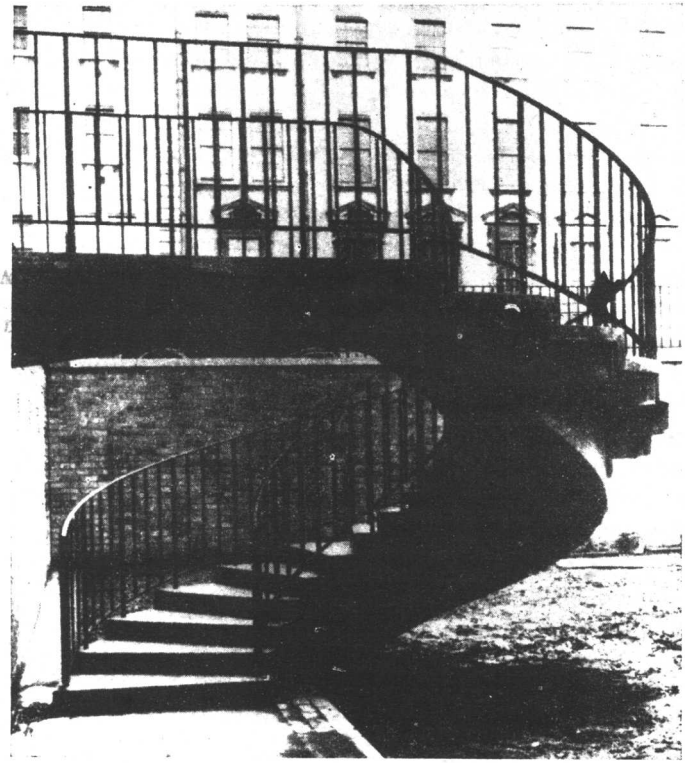

FIG. 1.1. All the skills of the formwork designer and formwork carpenter are called into play when geometrical work and special features are incorporated by the architect and engineer.

1.2 THE ARCHITECT

The architect is primarily concerned with the aesthetic aspects of any project. Until quite recently, concrete was regarded as a material economically suited to the formation of foundations or heavy structural work, which could be suitably concealed by facings or dressing. Now the architect uses the material in functional and decorative roles, and frequently directs that the concrete be left as struck from the moulds or forms to provide some desired effect. The architect may express large areas of concrete in walls and columns, or alternatively he may incorporate a light precast and prestressed

concrete skeleton, which can provide a delicate supporting medium for modern lightweight flooring and cladding systems. He can demand glasslike finishes to the concrete face or take advantage of the techniques of exposed aggregate work to provide ruggedly textured finishes. Concrete is essentially a functional material and it is not unknown for architects to require that the marks produced by the casting face of the mould or form be emphasised to add to the functional effect resulting from the use of large areas of the material. A smooth, even texture or featured surface may be specified to offset some other material incorporated in the design. Architects frequently turn to concrete to take advantage of the ease with which it can be moulded to provide the shapes and profiles of contemporary design, quite apart from its pure structural value.

In modern commercial architecture, concrete is the foremost constructional material and generally the specification will call for high quality surface finishes, which can be produced by the use of wrot timber, or ply sheathing or clean steel panels that constitute the face materials of the mould or form. Where large areas of concrete occur such as in silos, chimneys and similar structures, the architect may well call for modular features to be applied to, or recessed into the face of the concrete. Such features while undoubtedly complicating the formwork do much to enhance the appearance of the structure. Where decorative panels are required or exposed aggregate finishes are specified a variety of techniques can be used to express the exotic aggregates used within the concrete mix. Grit blasting, the use of retarders and washing techniques will still demand excellent formwork in the initial stages of construction. Precast concrete walling panels which are employed as permanent formwork may be used to enhance the colour and architectural form in the concrete structure.

In the design of schools and public or industrial buildings, architects are now taking advantage of the shell forms of concrete construction to provide large areas which are uninterrupted by supporting columns. Lattice frame forms of precast and prestressed concrete construction also achieve the same result. Concrete structures can be designed which give scope for large areas of glazing or light screening, and the degree of accuracy of the structural components obtainable through the use of carefully constructed forms and moulds are obviously of great interest to the architect. Modular cladding and glazing units can only be used successfully when the