C&CAA T41
SAA HB64—2002

Guide to Concrete Construction

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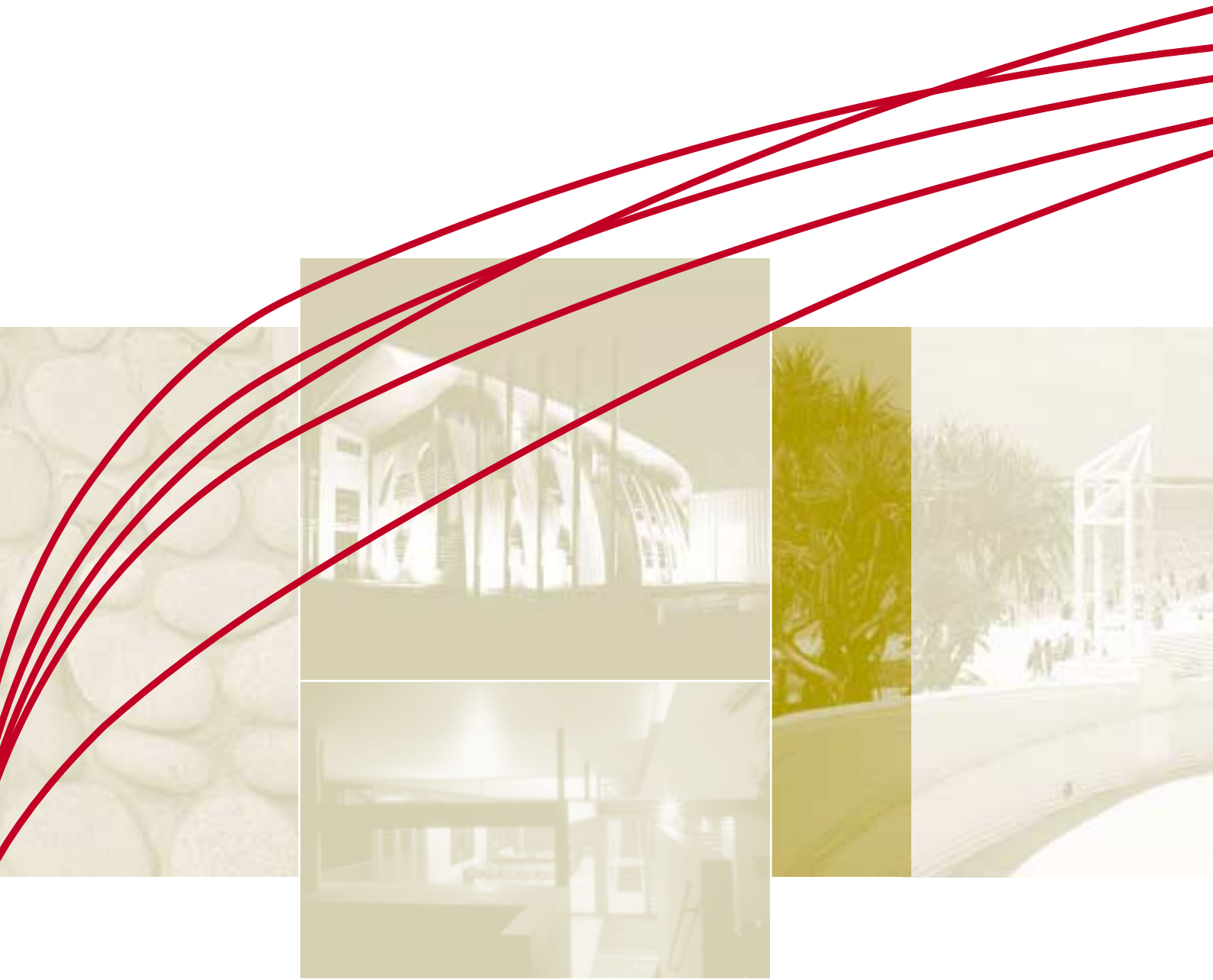

top: Science and Health Building, Edith Cowan University, WA
architect: Jones Coulter Young
photographer: Patrick Bingham-Hall

above: House at Whale Beach, NSW
architect: Craig Rosevear
photographer: Brett Boardman

right: Kings Beach Redevelopment
project architect: Ralph Bailey
architects in association for the whole project:
Guymer Bailey Architects Pty Ltd, Briggs Petersen & Buhr Pty Ltd
photographer: Alan Jones

Guide

Guide to Concrete Construction

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The Cement and Concrete Association of Australia is a not-for-profit organisation established in 1928 and committed to serving the Australian construction community.

The Association is acknowledged nationally and internationally as Australia's foremost cement and concrete information body – taking a leading role in education and training, research and development, technical information and advisory services, and being a significant contributor to the preparation of Codes and Standards affecting building and building materials.

The Association's principle aims are to protect and extend the uses of cement, concrete and cement-based products by advancing knowledge, skill and professionalism in Australian concrete construction and by promoting continual awareness of products, their energy-efficient properties and their uses, and of the contribution the industry makes towards a better environment.

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Preface

Ever since it was first published in 1975 (with the word 'Basic' starting the title), *Guide to Concrete Construction* has been the definitive text on the subject.

Apart from appropriate updating, the only significant change to this second edition under the shortened title is some rearrangement of the content, including splitting up of some chapters and amalgamation of others. The chapters have then been sequenced more logically and grouped as shown in the content list to facilitate finding the information sought.

Since compliance with various Australian Standards has a significant influence on concrete construction, this guide makes extensive reference to the relevant Standards.

The publication will be of interest and value to anyone involved, or likely to become involved, in the specification or use of concrete in projects of any size. For some readers, it will provide all the information they will need; for others, it will serve as a sound introduction to the subject prior to undertaking a more comprehensive study of particular aspects. Site personnel benefit since it explains fully *why* various procedures (eg compacting, curing) are important, as well as making recommendations on *how* they should be carried out.

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Guide to Concrete Construction

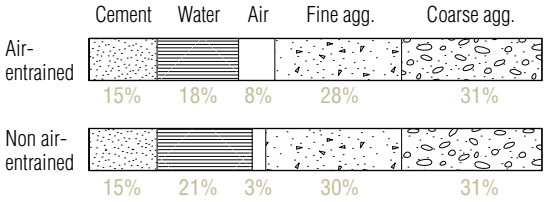
In its most basic form, concrete is a mixture of cement (portland or blended), water, and fine and coarse aggregates (sand and crushed rock or natural gravel), which is plastic when first mixed, but which then sets and hardens into a solid mass. When plastic, it can be moulded or extruded into a variety of shapes. When hardened, it is strong and durable, able to support substantial loads and, at the same time, resist the effects of fire, weather, wear, and other deteriorating influences. It is, therefore, a construction material of great versatility and wide application.

The properties of concrete in both the plastic and the hardened states are dependent on the physical characteristics, the chemical composition, and the proportions of the components used in the mixture. Hardened-state properties must be appropriate to the purpose for which the concrete is to be used; ie it must be strong enough to carry the loads imposed on it, and durable enough to resist the deteriorating influences of wear and weather. Plastic-state properties must also be appropriate; in this case, to the methods of handling, placing, compacting and finishing to be used in the job.

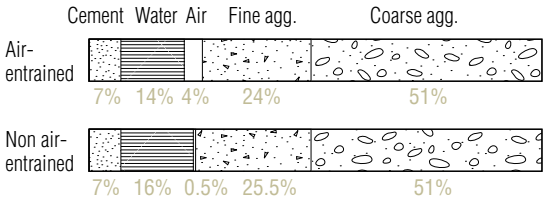
If not properly placed and compacted, concrete will not achieve its potential strength and durability. It is important, therefore, that when delivered to the construction site, concrete be sufficiently workable for it to be placed and compacted by the means available.

Workability is achieved by having sufficient cement paste (cement and water) in the mixture to lubricate the particles of aggregate and allow them to move freely as the concrete is placed and compacted.

Generally, the greater the volume of cement paste in the mixture, the more workable will be the concrete; although, as will be seen later, it is the volume of water in the paste which tends to be the dominant factor – the more fluid the paste, the more workable the concrete.



SMALL AGGREGATES IN RICH MIX (High Proportion of Cement Paste)



LARGE AGGREGATES IN LEAN MIX (Low Proportion of Cement Paste)

NOTE: *Although each mix has a similar slump, it can be seen how smaller size aggregates require more cement and water than larger size aggregates*

Typical range of concrete mix proportions

Achievement of many of the desirable hardened-state characteristics of concrete, particularly its strength and durability, depends to a great extent on the development of physical and chemical bonds both within the cement paste as it hydrates, ie reacts chemically with water, and between the cement paste and the aggregate particles as the concrete hardens.

For a given mixture, maximum bond development will occur when the water content of the cement paste is at a minimum and all air is expelled from the system. In this respect, cement paste is like any other glue – excessive dilution will weaken it.

There is always present, therefore, in the proportioning of concrete mixes, something of a conflict. The addition of water tends to increase the workability of the concrete, but it also dilutes and weakens the cement paste. It is the aim of concrete mix design, or proportioning, to strike a balance between the need for concrete to be workable so that it can be placed and finished, and the need for it to be strong and durable.

To aid in achieving this aim, concrete technologists have at their disposal a range of materials other than cement, water and aggregates with which to modify the properties of concrete. These include pozzolanic and other cementitious materials, chemical admixtures, and, sometimes, special aggregates. The properties of these materials, and their effects on the properties of concrete, are discussed in subsequent chapters. At this point, their widespread use should be noted as they modify some properties of concrete in quite significant ways.

The chemical reaction between cement and water (hydration) takes time. Concrete must therefore be kept moist (ie cured) for a time to ensure that hydration continues and that the concrete achieves its potential strength and durability.

To summarise: good concrete, ie concrete which will achieve the properties specified for it, depends first of all on the selection and proportioning of its component materials, and then on the methods used to handle, place, compact, finish and cure it.

However, we seldom build using just plain concrete. Generally the structures will be constructed of reinforced or prestressed concrete and the strength, serviceability and durability of the structure will depend on the performance of the reinforced or prestressed members. The satisfactory performance of the completed structure depends on appropriate decisions being made throughout the whole design and specification process and all aspects of the construction being carried out properly. The creation of a structure that performs satisfactorily throughout its design life is complex, as illustrated opposite.

The purpose of this Guide is to provide guidance on concrete technology and appropriate construction techniques and processes used in concrete structures. It should be emphasised at the outset that seldom is there a unique solution to achieving a satisfactory structure. Each case needs to be considered individually. The choice of materials will be influenced by local availability, while the techniques employed to carry out the various processes, eg curing, will be influenced by the construction processes chosen. In every case, consideration needs to be given to the ease with which the process can be carried out on site. It is a truism that designing structures to be buildable goes a long way to ensuring that the structure will achieve its design potential and perform appropriately throughout its design life. Thus designers no less than construction personnel need to understand the construction processes by which concrete structures are created.