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Update of the manual on the use of rock in hydraulic engineering ('The Rock Manual')

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UPDATE OF THE MANUAL ON THE USE OF ROCK IN HYDRAULIC ENGINEERING ('THE ROCK MANUAL')

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Introduction

A new update of the *Manual on the use of rock in hydraulic engineering* is currently under development. This short paper summarises the reasons for the update, identifies key new information included in the manual and gives an overview of the structure and content of the manual.

The need for an updated manual

The CIRIA/CUR *Manual on the use of rock in coastal and shoreline engineering* (ref 1), commonly referred to as 'the Rock Manual' is widely recognised as a key reference document for engineers designing coastal rock works. An update in the Netherlands 1995 by CUR (ref 2) extended the scope to include river and closure works. In France *Les Enrochements* (ref 3) has been a key reference since its production by LCPC/CETMEF in 1989.

At the time of their writing, these documents set out recommended good practice for the use of rock in the hydraulic environment and presented for the first time guidance on how to specify rock for use in marine construction. In 2002 the European armourstone standard EN 13383 came into force, with mandatory requirements for specifying and testing rock that were effective from mid 2004. This European standard supersedes some of the guidance given in the earlier documents.

In the 15 years since the first publication of these documents, there has been significant research and development to improve understanding of rock properties and of the performance of rock structures in the hydraulic environment. Research studies have considered specific issues that have raised problems during design and construction, leading to new guidance for designers and contractors.

These advances and changing requirements have led to a need for an updated manual, to provide up-to-date guidance in light of these changes.

The new manual has been developed by a predominantly European team from the UK, Netherlands and France, with collaboration from both the public and private sectors. The project has also benefited from the inputs of a group of international expert reviewers to ensure that the updated edition provides guidance that is internationally relevant.

Scope of the manual

The scope of the manual has been extended (from the 1991 edition) to include rock works in rivers and canals and estuary and river closure works, as well as coastal rock works. It has also been extended to include large concrete armour units as it was recognised that these are often used as an alternative to rock, and that it was beneficial for the designer to have the information in a single document.

The updated manual provides guidance that starts from the stage in a project when a decision has been made to construct a structure, in a hydraulic environment, using rock as the only material, or the primary material where it is one of a combination of materials. Guidance is not provided on early feasibility studies etc.

The manual emphasises the need to consider the whole lifecycle of works from conception to decommissioning (if appropriate) when planning and designing rock structures. It is not only technical factors that should be considered; these should be integrated with other factors such as social, environmental or economic considerations.

The updated manual collates available research data and technical information together with practical experience gained by practitioners, and presents current good practice for design. In doing this, care has been taken to indicate current limitations in understanding of the processes involved and the ranges of applicability of design methods. Where new methods are available that have not yet been rigorously tried and tested, then this is made clear to the reader.

The manual covers the use of rock throughout the project lifecycle and therefore has a wide-reaching target audience. This includes consultants/designers, contractors, rock producers and suppliers, owners/clients and funders, as well as planners, developers, architects, building managers, facility managers, regulators and educational institutions. The manual is appropriate for the non-specialist in that it provides the reader with an understanding of the principles and procedures involved. It is, however, emphasised that the manual itself cannot convert the non-specialist into an expert and the guidance should not be used as a substitute for experience and judgement.

Key new information

The content of the manual has been significantly updated from the previous versions. Some of the key new information is as follows:

- cross-referencing to the new European Armourstone specification, EN13383, which supersedes guidance given in the previous manuals
- guidance on design and construction using concrete armour units where these are used as an alternative material to large armourstone, usually due to rock of sufficient size not being available
- an updated construction specification for rock structures
- new research on packing and placement, including guidance on practically achievable layer thicknesses and porosities and the influence on stability and hydraulic performance of rock structures
- new research on block integrity
- new research on predicting quarry yield and block size distributions
- updated guidance on hydraulic performance of rock structures, including wave overtopping, run-up and transmission
- updated guidance on wave height distribution in shallow waters
- new guidance on stability of rock-armoured slopes with shallow foreshores, crown elements, rear side armour and near-bed rockfill structures
- new guidance on design of statically stable berm breakwaters
- new guidance on structural response to ice loads
- revised chapters on construction and maintenance and management of rock structures.

The following changes or omissions from the earlier versions have been made in this update:

- gravel beaches have been omitted as these are covered in other reference texts on beach design
- detailed guidance on scour is omitted as this subject is well covered in other reference texts and manuals
- appendices on rock measurement, hydraulic and geotechnical data collection have been omitted.

Content overview

The structure of the manual closely follows that of the previous 1991 and 1995 versions. The chapters and linkages are summarised in Figure 1. The manual has been written with flow charts to aid usability and with reminders to the user that the design, construction and operation process is iterative, with a need to continuously revisit design assumptions and criteria, and hence to refer back to earlier sections in the manual (as shown in the figure).

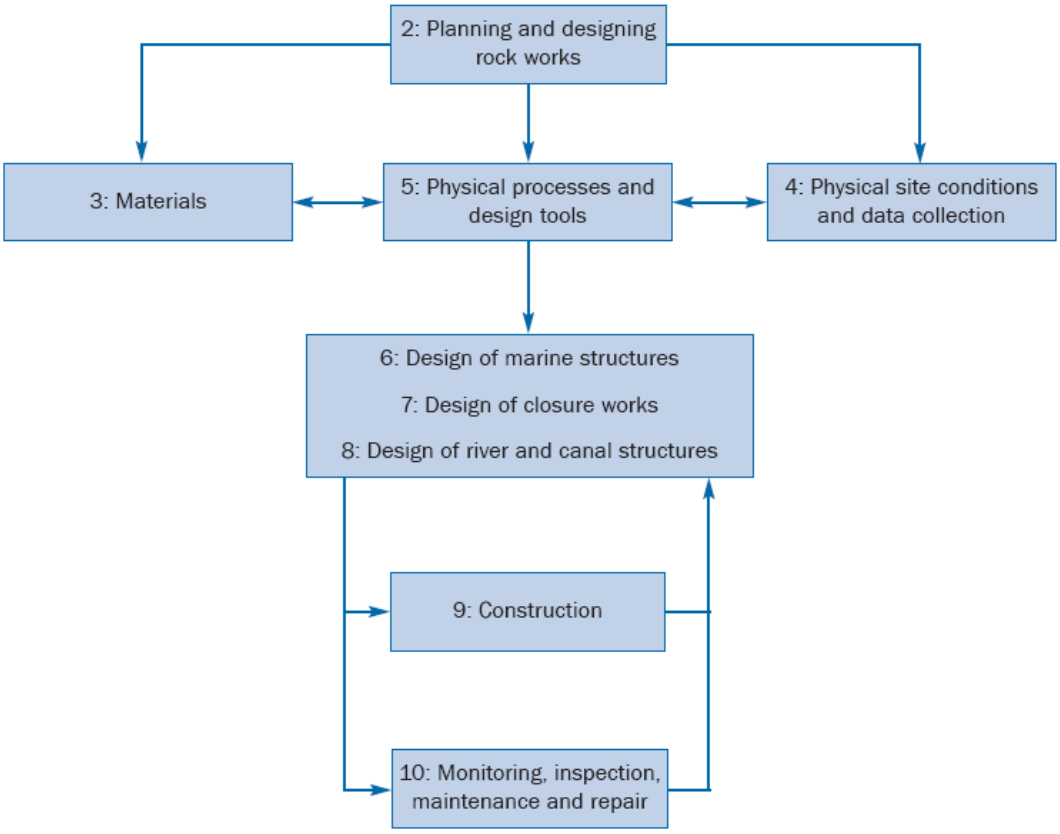

Figure 1 Flow chart of chapters and linkages

The content of each of the chapters is summarised as follows:

Chapter	Scope
1 Introduction	philosophy of the manual, key features of the update, structure of the contents, readership and how to navigate
2 Planning and designing rock works	aide memoire of key issues for a rock project in the hydraulic environment, including technical, environmental, economic and social issues
3 Materials	sourcing, quality, properties and delivery of rock and other materials; summary of rock testing methods and cross-reference to European Armourstone Specification EN13383
4 Physical site conditions and data collection	derivation of hydraulic and geotechnical conditions and data collection; provides input parameters to design

	equations and on environmental conditions for construction operations
5 Physical processes and design tools	design methods and equations for rock structures in marine and fluvial environments; includes hydraulic performance, structural stability and geotechnical behaviour; parameters derived in Chapter 4 are key inputs
6 Design of marine structures	practical guidance for the design of specific types of structures - uses the outputs from equations in Chapter 5 and provide guidance on dimensions and details of structure cross-sections, considering constraints such as buildability, access, availability of resources
7 Design of closure works	
8 Design of river and canal structures	
9 Construction	construction aspects including commonly used equipment and transport, site preparation, survey and measurement techniques, quality control in rock structures including placing and packing, construction risk and safety
10 Monitoring, inspection, maintenance and repair	guidance on maintenance and management issues, including monitoring techniques, appraisal of structure performance, repair and rehabilitation

Structures covered by the manual

Chapters 6, 7 and 8 provide guidance for the design of a range of the following rock structures:

Chapter	Structure Type
6 Marine structures	Breakwater
	Rock protection to port structures
	Revetment
	Seawall toe protection
	Groynes and artificial headlands
	Detached or reef breakwater
	Sill or berm
	Rock protection for pipelines / cables
	Scour protection of slender structures eg monopiles
	Scour protection for large (eg concrete gravity) structures
7 Closure works	River closures
	Reservoir dams
	Rockfill dams
	Rock protection to barriers, sills, weirs, barrages, diversion dams, spillways
8 River and canal structures	Bank protection
	Bed protection
	Spur-dikes
	Longitudinal dikes (also called guide banks or guide bunds)
	Bridge scour protection

Publication

The updated manual will be titled *The Rock Manual* and subtitled*The use of rock in hydraulic engineering (2nd edition)*. The new edition will be published in English and French and will be available in paper and electronic format. The manual will be available in English from CIRIA at the end of 2005 and in French from CETMEF early 2006.

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3. Laboratoire Central des Ponts et Chaussées (LCPC), (1989). Les enrochements. Ministère de l'Équipement, LCPC: Paris. 106 p.

NOTES

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