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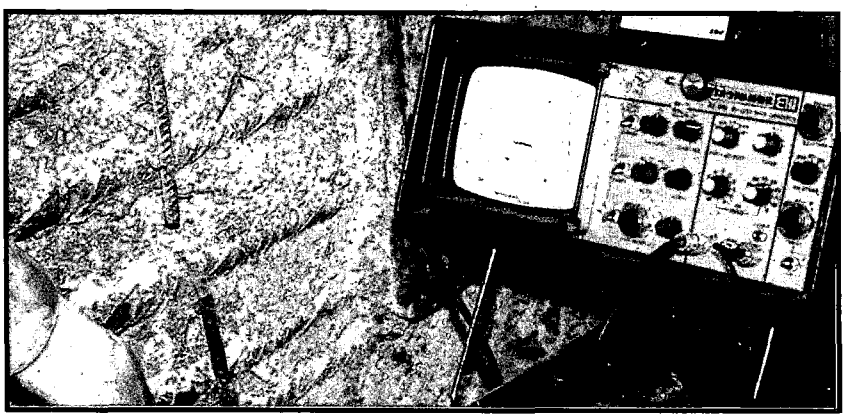
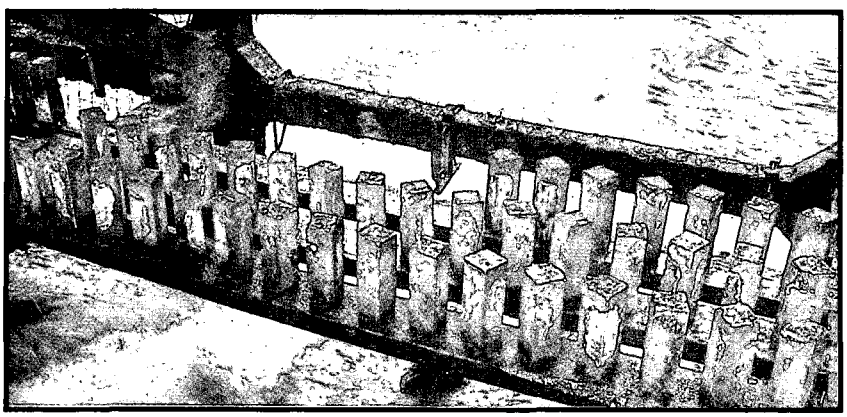
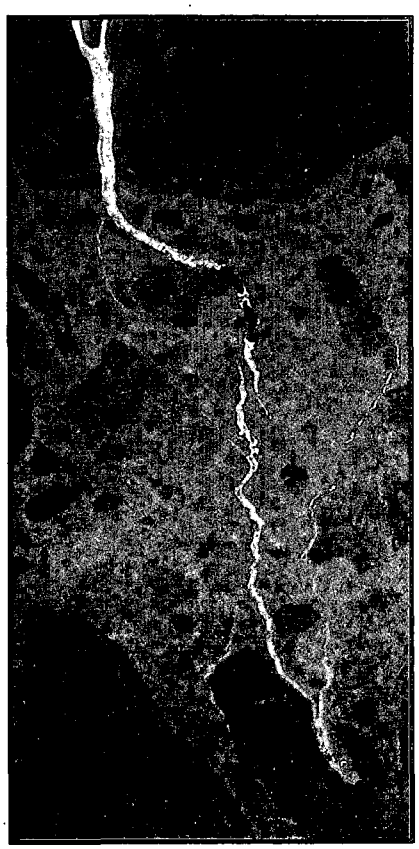
The influence of methods and materials on the durability of repairs to concrete coastal and offshore structures







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THE INFLUENCE OF METHODS AND MATERIALS ON THE DURABILITY OF REPAIRS TO CONCRETE COASTAL AND OFFSHORE STRUCTURES

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THE RESEARCH AND INFORMATION GROUP FOR THE UNDERWATER AND OFFSHORE ENGINEERING INDUSTRIES
A PART OF CIRIA – THE CONSTRUCTION INDUSTRY RESEARCH AND INFORMATION ASSOCIATION

FOREWORD

This report is the result of a UEG Project Definition Study to examine the arguments for and against durability testing of repairs to concrete in a marine environment and to make appropriate recommendations for further work.

The study was carried out under contract to UEG by M B Leeming of Arup Research and Development under the supervision of T P O'Brien. The UEG Research Manager for the study was R W Barrett.

The study was financed through UEG by a joint venture of 13 organisations, indicated by an asterisk in the list below. The resulting report was prepared under the guidance of a Steering Group which comprised invited specialists and representatives of participating organisations:

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Part I of this report is aimed at readers with a general interest in the subject and contains: the main arguments for and against doing further research into the durability of repairs to marine concrete; and the conclusions and recommendations. Part II is more specific and contains the background information on which the conclusions are based.

Cover pictures courtesy of Sir Robert McAlpine & Sons Ltd and the Building Research Establishment.

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SUMMARY

This report examines the arguments for and against durability testing of repairs to concrete in a marine environment. Current techniques and materials used for the repair of concrete are reviewed. The need for repair and the factors that will influence the subsequent durability are discussed. The choice of materials, type of testing and costs of research in relation to the repair market are examined. The report considers the durability of repairs to concrete in the marine environment both above and below water in the area of the North West European Continental Shelf. Possible research projects covering the main research strategies are defined and a minimum viable research programme is suggested.

PART I

1. INTRODUCTION

The excellent durability to date of existing concrete structures is mainly due to the high quality of design, materials and workmanship. Yet inevitably there will be areas which will need some repairs during the lifetime of the structures, if only because of mechanical damage. It is necessary that these repairs be of adequate quality so that the operational life of the parent structure is not affected. The problems of access and the difficulty of carrying out repairs to marine structures mean that it is necessary to take special care to avoid the need to repair the repairs.

1.1 Background

In 1982, when the contributors to the Concrete in the Oceans Programme started to consider some additional work to be undertaken in parallel with Phase II of the Programme, the highest priority topic was the question of the durability of repairs to concrete in a marine environment. For organisational reasons, it was considered inappropriate to undertake any such work within the Concrete in the Oceans Programme as this Programme was scheduled to end before any long-term durability testing of repaired concrete could have been completed.

1.2 The pros and cons of durability testing

Supporters of the proposal, that some durability testing of concrete in the marine environment be undertaken, felt a need for guidance on: the durability of materials; the effect of repair methods on durability; any other factors that might affect their decisions about how to repair damaged concrete in a marine environment.

Those doubting the usefulness of such an exercise felt that it would not be cost-effective to test several currently available repair materials, it would be almost impossible to select generic materials for test and, even if it were possible, the repair materials available at the end of any testing programme could be very different from those actually tested. They contended that only the relative merits of a few currently available materials would be obtained and this information would not actually help the selection of materials for repair when the durability testing programme came to an end.

A meeting was held to discuss both contentions and it was agreed that, as an initial approach, a Project Definition Study should be undertaken to examine the arguments in more detail, bring together in one volume a succinct summary of all the techniques and materials available, including published test data, and, if appropriate, make proposals for further work.

1.3 Objectives

The objectives of the study leading to this Report were:

a) to undertake a brief state of the art review of current techniques and materials used for repair of concrete in the marine environment

b) to identify any durability test data relating to repaired concrete which is openly available and to identify any conclusions that can be drawn from the work

c) to examine the arguments for and against a programme of durability testing of repaired marine concrete

d) to make recommendations on the need for and/or usefulness of any durability testing programme or any other appropriate further work

e) to prepare outline proposals for any recommended further work.

1.4 Scope

The study leading to this Report covered the repair of all types of concrete structures directly exposed to the marine environment e.g. offshore oil and gas platforms, offshore loading facilities, jetties, lighthouses, coastal and harbour works, and subsea pipelines. In this context marine is defined as 'in contact with seawater or in an environment dominated by seawater'. Structures can be defined as coastal where 'there is relatively easy access from the land' as opposed to offshore structures which 'require a substantial voyage by sea or air to gain access'.

In assessing the need for or value of undertaking any durability testing programme, the study has taken careful account of the rate of advance in repair materials technology and the difficulty of selecting generic materials for testing.

The study was to some extent limited by budget and timescale and it was felt that the objective of undertaking a brief state of the art review could most economically be achieved by using the Report by the Concrete Society Working Party on the Repair of concrete damaged by reinforcement corrosion [1] as the foundation and extending it particularly into the area of repairs to structures in the marine environment. Reference is made to that Report throughout this document.

This Report is aimed at those with some knowledge of repair methods and attempts to provide the reader with sufficient information to assess the relevance of any further research proposed.

The Report covers the durability of repairs to concrete in the marine environment both above and below water and is confined to the North West European Continental Shelf. Arctic and tropical considerations are outside the scope of the study.

The detailed scope of the study, as approved by the Steering Group, is set out in Appendix 1.