

FATIGUE LIFE OF  
OFFSHORE STEEL STRUCTURES  
UNDER STOCHASTIC LOADING

by

JAN BEHRENDT IBSØ & HENNING AGERSKOV

## CONTENTS

|   | Page |
|---|------|
| SYNOPSIS  | 3    |
| 0. PREFACE  | 4    |
| 1. INTRODUCTION   | 5    |
| 2. EXPERIMENTAL INVESTIGATION                               | 7    |
| 2.1 Experiment Design and Test Specimens                    | 7    |
| 2.2 Materials of Test Specimens                             | 9    |
| 2.2.1 Tubular Joint Test Specimens                          | 9    |
| 2.2.2 Welded Plate Test Specimens                           | 10   |
| 2.3 Test Specimen Fabrication                               | 11   |
| 2.3.1 Tubular Joint Test Specimens                          | 11   |
| 2.3.2 Repair-welding of Tubular Joints                      | 12   |
| 2.3.3 Welded Plate Test Specimens                           | 13   |
| 2.4 Control of Test Specimens                               | 14   |
| 2.5 Test Equipment and Test Procedures                      | 14   |
| 2.5.1 Test Equipment  | 14   |
| 2.5.2 Test Procedures for Plate Specimens                   | 16   |
| 2.5.3 Test Procedure for Tubular Joints                     | 19   |
| 2.6 Variable Amplitude Loading                              | 22   |
| 2.6.1 The Markov Matrix                                     | 22   |
| 2.6.2 Determination of the Markov Matrix                    | 24   |
| 2.6.3 Spectral Description                                  | 24   |
| 2.6.4 Equivalent Stress Range and Truncation                | 34   |
| 3. STATIC TEST RESULTS FOR TUBULAR JOINTS                   | 38   |
| 3.1 Determination of Stresses and Deformations              | 38   |
| 3.2 Measured Stresses and Deformations                      | 40   |
| 3.3 Comparison of Test Results with Usual Design Procedures | 44   |

|   |    |
|---|----|
| 4. FATIGUE TEST RESULTS                   | 46 |
| 4.1 Test Series on Welded Plate Specimens | 47 |
| 4.1.1 Constant Amplitude Tests            | 47 |
| 4.1.2 Variable Amplitude Tests            | 48 |
| 4.2 Test Series on Tubular Joints         | 57 |
| <br>                                      |    |
| 5. FATIGUE TEST OBSERVATIONS              | 63 |
| 5.1 Test Series on Welded Plate Specimens | 63 |
| 5.2 Test Series on Tubular Joints         | 70 |
| <br>                                      |    |
| 6. CONCLUSIONS                            | 72 |
| <br>                                      |    |
| 7. ACKNOWLEDGMENTS                        | 74 |
| <br>                                      |    |
| 8. REFERENCES                             | 75 |
| <br>                                      |    |
| 9. NOTATION                               | 77 |
| <br>                                      |    |
| APPENDIX A. FATIGUE TEST RESULTS          | 79 |