

# Contents

|                                                                        |            |
|------------------------------------------------------------------------|------------|
| <i>Preface to the Second Edition</i>                                   | <i>vii</i> |
| <i>Preface to the First Edition</i>                                    | <i>ix</i>  |
| <b>1. Introduction</b>                                                 | <b>1</b>   |
| 1.1 History of Engineering Geology                                     | 1          |
| 1.2 Importance of Engineering Geology in Development                   | 4          |
| 1.3 Area Covered by Engineering Geology                                | 5          |
| 1.4 Basic Study Required by Engineering Geologists                     | 5          |
| <i>Questions</i>                                                       | 5          |
| <i>Bibliography</i>                                                    | 5          |
| <b>2. Basic Terminology of Geology and Geotechnical Engineering</b>    | <b>6</b>   |
| 2.1 Rock                                                               | 6          |
| 2.2 Soil                                                               | 6          |
| 2.3 Basic Geological Terminology                                       | 8          |
| 2.4 Basic Geotechnical Terminology                                     | 11         |
| 2.5 Important Geological and Geotechnical Indian Standard Code (IS)    | 14         |
| <i>Questions</i>                                                       | 18         |
| <i>Bibliography</i>                                                    | 18         |
| <b>3. Engineering Properties of Soil and Rock</b>                      | <b>19</b>  |
| 3.1 Engineering Properties of Soil                                     | 19         |
| 3.2 Engineering Properties of Rock                                     | 21         |
| 3.3 Engineering Properties of Building Stones, Concrete and Aggregates | 21         |
| 3.4 Methods for Measuring Engineering Properties of Soil and Rock      | 23         |
| <i>Questions</i>                                                       | 34         |
| <i>Bibliography</i>                                                    | 34         |
| <b>4. Rock-Mass Classification</b>                                     | <b>35</b>  |
| 4.1 Parameters to Estimate the Rock Quality in the Rock-Mass           | 35         |
| 4.2 Rock-Mass Classification                                           | 39         |
| 4.3 Geological Mapping                                                 | 61         |

|                                                                                                                                                                |     |            |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------|-----|------------|
| Questions                                                                                                                                                      | 64  |            |
| Bibliography                                                                                                                                                   | 64  |            |
| <b>5. Geology and Civil Engineering Projects</b>                                                                                                               |     | <b>66</b>  |
| 5.1 Excavation                                                                                                                                                 | 66  |            |
| 5.2 Underground Caverns                                                                                                                                        | 78  |            |
| 5.3 Reservoirs                                                                                                                                                 | 81  |            |
| 5.4 Dams and Barrage                                                                                                                                           | 84  |            |
| 5.5 Highways                                                                                                                                                   | 92  |            |
| 5.6 Bridges                                                                                                                                                    | 96  |            |
| 5.7 Coastal Geotechniques and Shorelines                                                                                                                       | 98  |            |
| 5.8 Underground Transport System (Metro Project)                                                                                                               | 103 |            |
| 5.9 Resource Evaluation of Construction Materials                                                                                                              | 107 |            |
| 5.10 Environmental Considerations Related to Civil Engineering Projects                                                                                        | 109 |            |
| Questions                                                                                                                                                      | 111 |            |
| Bibliography                                                                                                                                                   | 112 |            |
| <b>6. Geological Hazards and Engineering Geology</b>                                                                                                           |     | <b>113</b> |
| 6.1 Mitigation Measures                                                                                                                                        | 114 |            |
| 6.2 Landslide                                                                                                                                                  | 116 |            |
| 6.3 Earthquake                                                                                                                                                 | 120 |            |
| 6.4 Climate Change and Engineering Geology                                                                                                                     | 126 |            |
| Questions                                                                                                                                                      | 127 |            |
| Bibliography                                                                                                                                                   | 127 |            |
| <b>7. Major Projects in India: Case Studies</b>                                                                                                                |     | <b>128</b> |
| 7.1 Tehri Dam                                                                                                                                                  | 128 |            |
| 7.2 Koyna Dam                                                                                                                                                  | 131 |            |
| 7.3 Nathpa Jhakri Hydroelectric Project                                                                                                                        | 135 |            |
| 7.4 Rangit II Hydroelectric Project                                                                                                                            | 138 |            |
| 7.5 Konkan Railways                                                                                                                                            | 145 |            |
| 7.6 Jammu-Udhampur-Srinagar-Baramulla Rail Link Project                                                                                                        | 147 |            |
| 7.7 Jammu-Udhampur-Banihal-Qazigund National Highway NH-44, J&K                                                                                                | 149 |            |
| 7.8 Hill Slope Failure During the Development of Infrastructure Projects in Himalaya: Case Study of Udhampur-Ramban National Highway, Jammu and Kashmir, India | 159 |            |
| 7.9 Optimization of Efficiency of Rock Breaker Using Geological Data: Reference to Mumbai, Maharashtra, India                                                  | 179 |            |
| Questions                                                                                                                                                      | 187 |            |
| Bibliography                                                                                                                                                   | 187 |            |