

Preface

In the current construction practice, reinforcing the soil is an effective and reliable ground improvement technique for increasing the strength and stability of the soil in various applications, including retaining structures, embankments, foundations, slopes and pavements. The concept of reinforcing the soil with natural materials was originated in ancient times; however, the galvanized steel strips, having a high tensile modulus, are the earliest modern form of soil reinforcement developed in 1966 in France. Later, the use of polymeric products, called the *geosynthetics*, started as the soil reinforcement along with several other applications of specific geosynthetics to achieve different functions as separation, filtration, drainage, fluid barrier and protection. In the noncritical structures, natural products, called the *geonaturals*, are also used as the soil reinforcement. Unlike the metal strips, in general, the geosynthetic and geonatural reinforcements have a much lower tensile modulus. Geosynthetic reinforcements (woven geotextiles, geogrids, some geocomposites, etc.) as well as geonatural reinforcements (bamboo, geocoir, geojute, etc.) are generally used in the form of flexible sheets/mats/meshes. The subject of geosynthetics and geonaturals and their applications are called the *geosynthetic engineering*, and there are some textbooks and reference books available on this subject.

Reinforcing the soil with flexible, discrete fibres is not a new technique in civil/geotechnical engineering. However, as the fibre inclusions bring several technical, economic and environmental benefits, in recent years, a great deal of interest has been created worldwide on the potential applications of fibres within the soils and other similar materials, such as coal ashes and mine tailings. Fibres are generally available in large amounts in natural and waste forms. In many countries, waste fibres (plastic waste fibres, old tyre fibres, etc.) have been creating disposal and environmental problems. Utilization of these fibres in constructions can solve the disposal problems in a cost-effective and environmentally friendly manner.

Over the past 30–35 years, the laboratory and field research studies have shown that the use of natural, synthetic and waste fibres as a tension-resisting element and/or an admixture causes significant modification and improvement in the

engineering properties (strength, stiffness, permeability, compressibility, etc.) of soils and other similar materials. The soil reinforced randomly with short, discrete fibres is basically a composite material and is called the *randomly distributed fibre-reinforced soil*, or simply the *fibre-reinforced soil*. The studies indicate that a fibre-reinforced soil exhibits greater extensibility and a smaller loss of post-peak strength; that is, compared to soil alone, the fibre-reinforced soil is more ductile. Soils, especially cohesionless soils, can also be reinforced by the continuous fibres/yarns. In this reinforcing system, a single monofilament is spun or injected in a random pattern simultaneously with the deposition of soil in a specific application.

This book presents the fundamentals of the fibre-reinforced soils within five chapters as an engineering subject, called the *fibre-reinforced soil engineering*. No complete book is currently available on this subject. The book is primarily designed and developed as a textbook as well as a student-centred learning resource for a one-semester course for senior undergraduate and postgraduate students as a part of a geotechnical/civil engineering programme. This course may be offered to students as an elective in the universities/institutes/colleges. The material in all the chapters of this book is presented clearly in simple and plain English and includes the optimum amount of text, illustrations, tables, examples and questions for practice. Each chapter includes many useful references, quoted in text and listed at the end of the chapter, for further study. As the practical solution to an engineering problem often requires the application of engineering judgement and experience, which can be acquired by regular professional practice and self-study, an attempt has been made to provide the practical experience, including the field application guidelines and some case studies. The chapter summary presented at the end of each chapter may help the readers in getting some key learning points easily. Through this textbook, the readers can learn the subject without any major assistance, and some readers can learn the subject even by self-reading only. Apart from students, researchers and teachers, this textbook will be a valuable learning resource for the practising engineers dealing with utilization of fibres in constructions and infrastructure developments worldwide.

For a better learning of the concept of fibre-reinforced soils, it is important to have an understanding of the basic soil properties and core principles of soil mechanics, as presented in Chap. 1, along with the basic description of soil reinforcement. Chapter 2 provides the basic details of fibre-reinforced soils, focusing on fibres and their types, and phase concept along with a brief introduction to the soil reinforced with continuous fibres and multioriented inclusions. Chapter 3 deals with the engineering behaviour of fibre-reinforced soils as reported by various researchers based on their experimental investigations and analyses of test results. Chapter 4 focuses on presenting the reinforcing mechanisms, the models of fibre-reinforced soils and findings of some numerical studies. Chapter 5 covers the details of field applications of fibre-reinforced soils, emphasizing on analysis and design concepts, and field application experience and guidelines. The key research developments have been included as required throughout the book.

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Finally, I welcome suggestions from the readers and the users of this textbook for improving its content in future editions.

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