BOOK REVIEW

DISPERSIVE SOILS – PROCESSES, IMPACT AND MANAGEMENT

By: Pichu Rengasamy and Ehsan Tavakkoli

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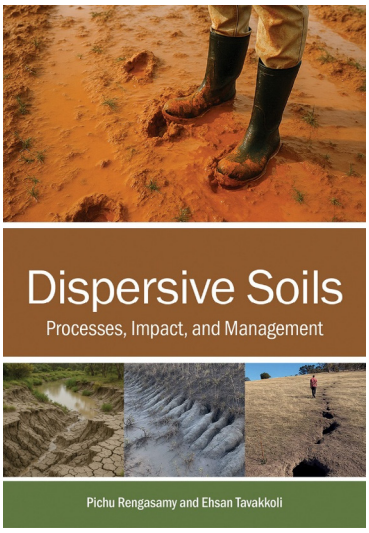
When asked to review this book, I was pleased and keen to do so. My professional engineering geology background includes research into modified and stabilised clay soils, which means I have a good understanding of clay mineralogy, cement chemistry and soil science, including dispersive soils. Over the past 15 years or so I have dealt with dispersive soils in earthworks in QLD, specifically their identification and potential remediation as well as being involved from a client's perspective. However, I have tried to review "Dispersive Soils" from the perspective of a practising, generalist geotechnical engineer or engineering geologist without a deep understanding of soils science and dispersive soils chemistry.



Scope and structure

The book is split into a preface and eight chapters, each one with a comprehensive list of references.

The Preface contains the Authors' purpose of the book, which is "both a synthesis and a call to action", with the aim of resolving the "long-standing conundrum of sodic/dispersive soils - to clarify their chemical dynamics, connect these to their physical expressions and provide practical, sustainable remediation strategies'.

Chapter 1 clearly distinguishes between sodic soils and dispersive soils; sodic soil is defined as a soil with a high proportion of sodium ions relative to other cations on the soil's exchange sites (i.e. chemical), whereas a dispersive soil is defined by its behaviour when wetted (i.e. physical). The opening chapter focuses on this difference in detail and discuss the rationale for a dispersive, rather than sodic, soil focus. According to the authors the academic and professional soil community has increasingly embraced this change in recent years, and revised soil classification schemes now emphasise dispersion characteristics alongside or in place of traditional sodicity classes.

Chapter 2 outlines the key processes involved in the formation of dispersive soils beginning with an examination of natural and anthropogenic salinization processes. The chapter also introduces the physio chemical basis for clay dispersion, differentiates between dispersive saline and saline soils, and provides an overview of the global distribution and mapping limitations of dispersive soils with particular emphasis on Australian landscapes.

Chapter 3 discusses the soil chemistry principles relevant to clay dispersion from soil aggregates, the mechanisms of clay dispersion from soil aggregates, the physical behaviour of dispersive soils, and the impact on soil mechanics and engineering properties. The content of this chapter is most pertinent to the geotechnical professional even though the details are, understandably, "chemistry heavy". Discussions around exchangeable cations, the development and ionicity and covalency indices for clay cation bonds, the concept of dispersive potential, and the mechanisms of flocculation of soil aggregates in dispersive soils are covered in detail. Some mention is made of the impact of dispersive soils on soil shear strength and bearing capacity, in terms of shrink swell behaviour, foundations and road subgrades. The influence of dispersive soils on Atterberg limits is also briefly discussed.

Chapter 4 describes impacts on agriculture and management of dispersive soils. The text begins by stating dispersive soils represent a major challenge to sustainable agriculture landscape stability and environmental resilience across vast agricultural regions, and continues to talk about constraints to crop production, yield reduction and the principles of managing dispersive soils. A handy table (Table 4.1) which summarises key problems and management principles for dispersive and saline-dispersive soils across different pH conditions, and a second table summarising the key amelioration methods for managing dispersive and sodic soils, including their expected outcomes and practical limitations (Table 4.2), are provided. This chapter elaborates on chemical amendments to soils including gypsum, lime, organic amendments with chemical properties, calcium chloride and other salts, and emerging materials (e.g. phosogypsum, nano-gypsum, chelated calcium compounds and various others). Mechanical interventions, biological approaches and water management are also discussed.

Chapter 5, titled "Irrigation and Dispersive Soils", explores how irrigation practises contribute to the formation and intensification of dispersive soils, and critically examines the metrics and indices used to evaluate and manage irrigation water quality in such systems. This chapter, like Chapter 3, contains detailed descriptions of soil chemistry and cation exchange. Chapter 5 concludes that the quality of irrigation water is a critical determinant of soil structural stability and long-term productivity in irrigating systems.

Dispersive soils represent a significant challenge for environmental sustainability, ecological function, and resilience of civil infrastructure, so say the Authors, and this is discussed in Chapter 6 which focuses on the broader ecological, environmental, and infrastructural consequences of dispersive soils and considers both the mechanisms of degradation and possible avenues for mitigation. Descriptions of the mechanisms of various types of soil erosion are provided, including tunnel erosion, sinkholes, sheet erosion, rill and gully erosion, with some interesting black and white photos. Damage to civil engineering infrastructure is briefly discussed, including piping in earth dams, dispersive soils and landslides, quick clays and impacts to soil strength and bearing capacity. The chapter also briefly discuss the amelioration of soil dispersivity for engineering purposes.

Chapter 7 is titled "Identification of Dispersive Soils" and provides a comprehensive guide to identifying dispersive soils, beginning with traditional physical tests (the crumb, pinhole, and double hydrometer methods), followed by chemical indices (exchangeable sodium percentage (ESP), sodium adsorption ratio (SAR) as well as cation ratio of soil structural stability (CROSS) and its recent refinement, cationic charge ratio for soil structural stability (CROSSc). Emerging techniques and integrated approaches in dispersivity identification are also discussed including AI based predictive models, dielectric and geophysical assessments, remote and proximal sensing, and others. The main takeaway from the Authors, as a geotechnical practitioner, was that the identification of dispersive soils should not be constrained to isolated one-off tests (e.g. crumb tests). Instead, an evolving toolkit of laboratory, geospatial, and AI enabled methods should be used to support integrated multiscale diagnostics.

Chapter 8 outlines the critical knowledge gaps and innovation priorities that should be addressed to manage dispersive soils effectively. Building on the classification, mechanisms, and management strategies previously covered in the book, this final chapter moves from a national to a global perspective, drawing on recent advances in diagnostic tools, biological restoration, eco engineering and digital monitoring.

Overall Assessment

To conclude, I found the book "Dispersive Soils" by Pichu Rengasamy and Ehsan Tavakkoli to be useful and informative. In my opinion, the book's target audience are those operating in agricultural and soil science, rather than civil or geotechnical engineering. The important distinction between sodic and dispersive soils is clearly defined, and tables relating to key problems and management principles for dispersive soils may be of use to some. This book would be most useful for geotechnical practitioners with an interest in soil science and regular interaction with dispersive soils.

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