cbecimat26
26° Congresso Brasileiro de Engenharia e Ciência dos Materiais
22 a 26 de novembro de 2026
Costão do Santinho
Florianópolis-SC

ESTIMATE OF THE DRY DENSITY OF COMPACTED SOILS USING ULTRASONIC PULSE VELOCITY AND MULTIPLE LINEAR REGRESSION MODELS

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Introduction

Ultrasonic testing has potential for non-destructive compaction control, but UPV in compacted soil is affected by both moisture and density. This study estimates dry density (DD) using moisture content (MC), UPV and soil physical indices.

Objectives

To investigate whether dry density of compacted lateritic clay can be estimated from ultrasonic pulse velocity combined with moisture content and physical indices.

Methodology

Lateritic clay was characterized and molded into 54 specimens across three compaction energies and six moisture contents. UPV was measured on specimen length and ultrasound wave propagation time. MLR models were then developed combining MC, UPV, and physical indices (voids index (e), porosity (P) or degree of saturation (DS)).

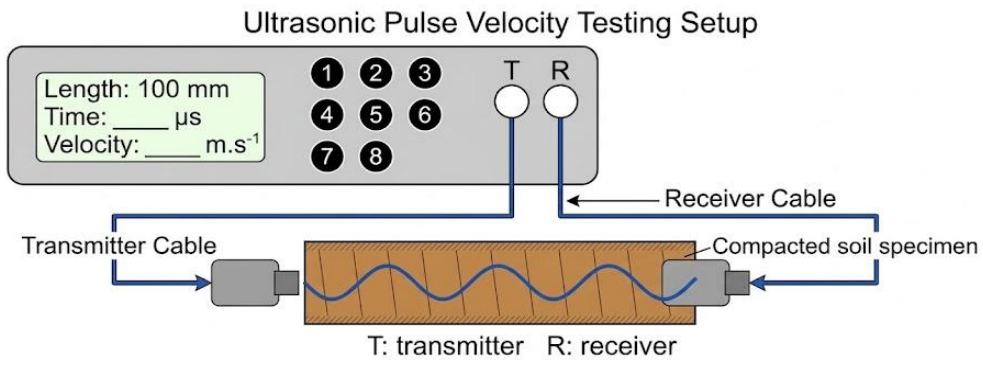
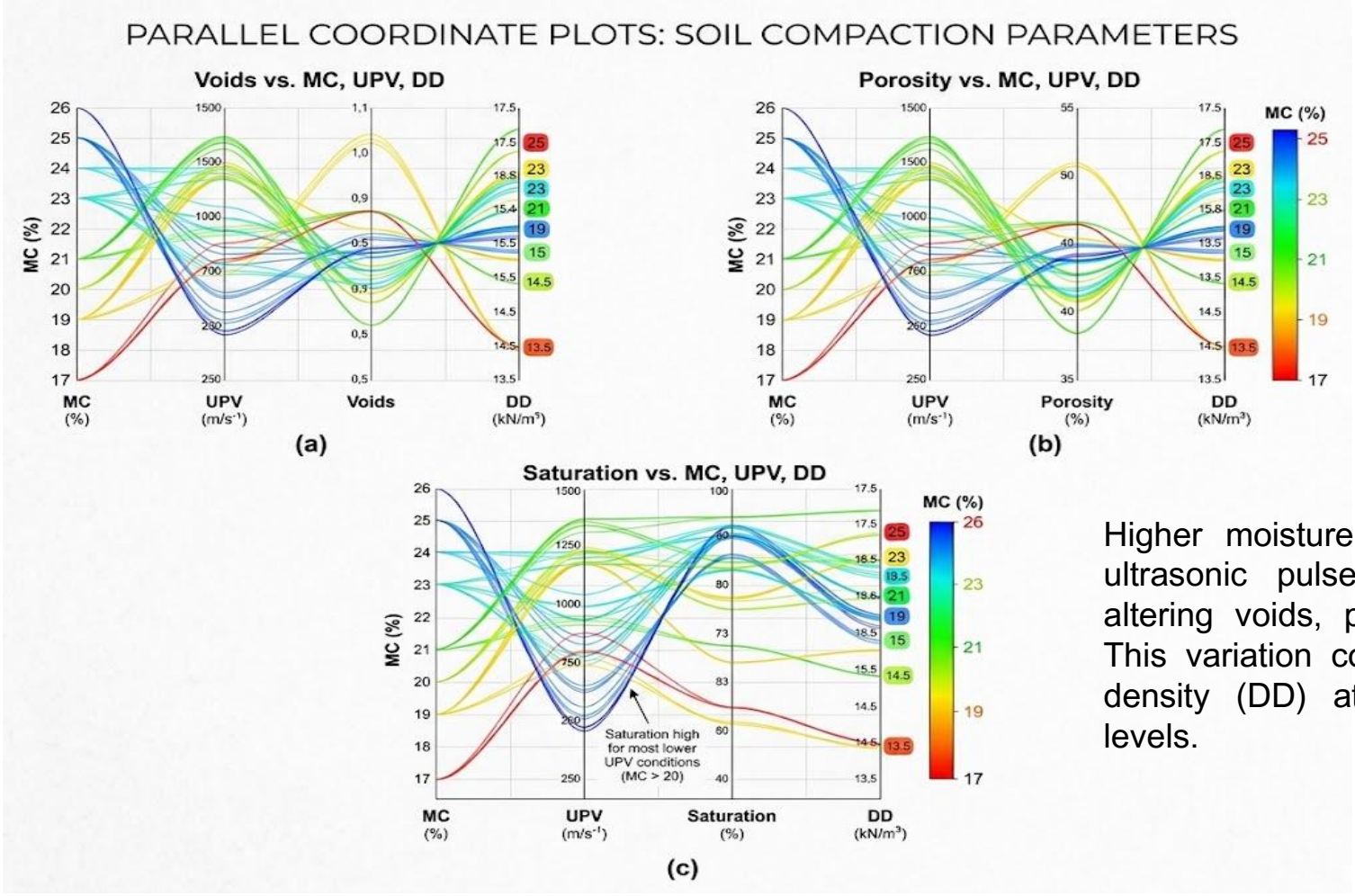


Figure 1. Operation and execution of the ultrasound test

Results and Discussion



Higher moisture content (MC) reduces ultrasonic pulse velocity (UPV) while altering voids, porosity, and saturation. This variation converges to a peak dry density (DD) at intermediate moisture levels.

Figure 2. Relationship between physical index (Voids index (a), Porosity (b) and Saturation (c)), UPV, MC and DD

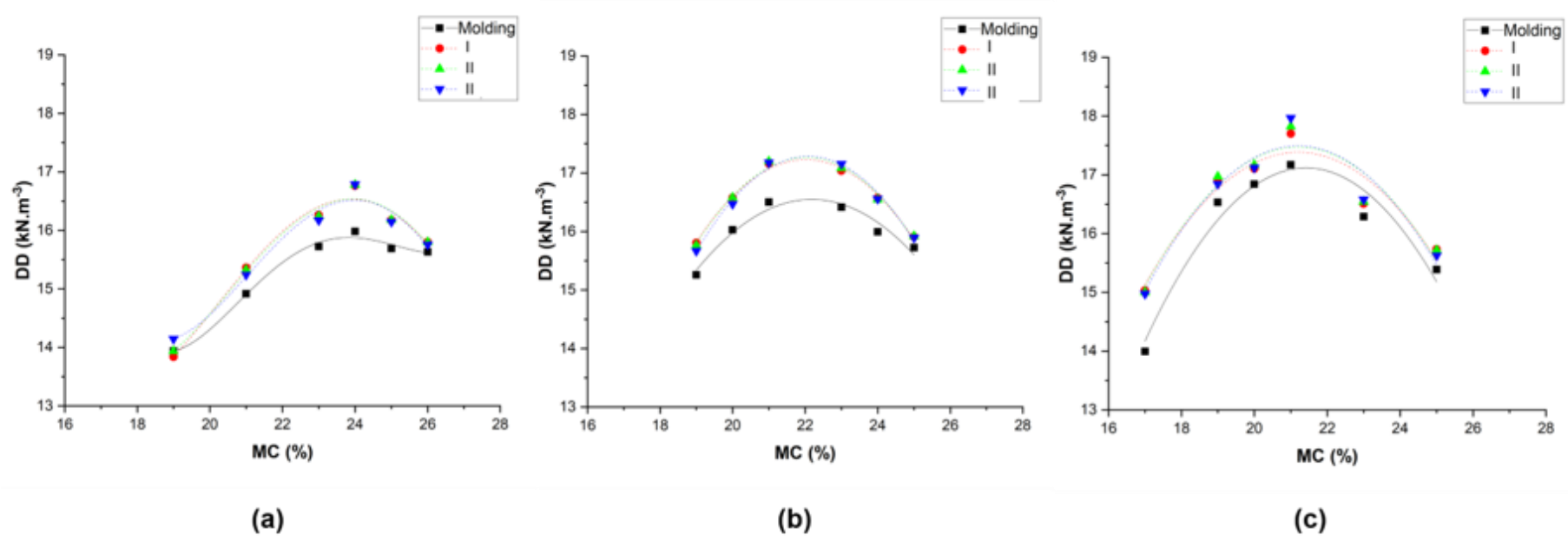


Figure 3: Relationships between residual errors and order (a) and between residual errors and predicted value (b) of equations of model I, II and III.

Conclusion

Simple UPV correlations were insufficient (UPV–MC R = 0.534; UPV–DD R = −0.479). The three MLR models explained 94–97% of the observed DD variation. Model I, using voids index, reached R = 0.97, RMSE = 0.52 and MAPE = 2.90%. Estimated DD differed from target values by about 0.4 kN/m³ and approximately ±3%.

References and Acknowledgments

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Acknowledgments: CNPq (Proc. 405929/2016-1), CAPES/FT/FECFAU/UNICAMP, FAEPEX–UNICAMP.