Strengthening Highway Structures with *Rammed Aggregate Pier*^{TM} Elements

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Abstract: The construction of highway overpasses generally includes the placement of high embankments and walls to facilitate grade separations. When these embankments and walls are placed on top of weak and soft soils, the stability and settlement of the structures is of concern. Historical measures that have been used to reduce the severity of these problems include the construction of toe berms, which greatly increase the width of the embankment, and the use of surcharging techniques, which significantly increase the time of construction. Modern construction in urban and semi-urban environments often does not allow for the purchasing of large right-of-ways needed for toe berms or for construction solutions that drag out over a period of years.

Rammed Aggregate Pier^{TM} elements are used to reinforce weak and soft foundation soils prior to constructing earth embankments and walls. The elements increase the factor of safety against slope instability because of their high angle of internal friction. The elements reduce the magnitude and time rate of settlements by increasing the overall stiffness modulus of the foundation soils, by laterally prestressing the matrix soils, and by providing a drainage pathway for the dissipation of excess pore water pressure. Soil stabilization with the elements eliminates the need for wide toe berms and the long construction time associated with surcharging.

Rammed Aggregate Pier elements stabilize unstable slopes when highway construction proceeds within unforeseen weak geologic strata. The elements are also being used to reduce the settlement of highway embankment fills, to reduce earth pressures behind retaining walls, to support box culverts constructed on top of weak ground, and to support highway foundation systems.

Recently, *Rammed Aggregate Pier* elements have been used to reinforce soils for embankments, walls, and slopes constructed for a railroad spur and a highway in the Midwest, an earth retaining system in northern Virginia, and a highway in North Carolina. This paper presents methods used to design the soil reinforcing system as they apply to the subject case histories. This work is of particular significance because it provides design guidance for a rapidly growing technique used to strengthen highway structures.

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