

Interpreting Field Behaviors of Embankment on Estuarine Clay

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ABSTRACT

In this paper, field behaviors of two trial embankments in Australia are presented. The first case study has a trial embankment which is approximately 90m in length and 40m in width, and has two sections with vertical drain installed, and a no drains section. The second case study gives detail of a trial embankment with stone column, and incorporated 3 separate sections (2 sections with stone columns, and a section without stone column), and is constructed on soft estuarine clay with high sensitivity. The trial embankments were constructed to evaluate the effectiveness of ground improvement techniques on the soft clays in this region. This paper interprets the findings obtained from the field observations during the construction phase.

KEY WORDS: Soft clay; trial embankment; stone columns; vertical drains.

INTRODUCTION

Soft clays are found in many projects in Australia, and they pose difficult problems in the design and construction of roads, expressways and motorways. By definition, soft clays are of low shear strength and high compressibility. Generally, they are sensitive and their strength is readily reduced by disturbance during sampling and testing. Such sub-soil conditions can have considerable implications on the design of embankments and structural foundations. This is due to both low shear strength and a tendency to deform with time. The simplest solution to such unfavorable soil conditions is to find an alternate alignment, although this can be costly and impractical. As an economic alternative to structural foundations, ground improvement techniques are becoming more prevalent. Ground improvement in Australia primarily encompasses the use of stone columns, surcharge with vertical drains, and chemical stabilization.

This paper presents the soil characteristics of a trial site located in Gold Coast (Southeast corner of Queensland). Included in this paper are the in-situ conditions before the embankment was constructed and the

subsequent conditions after the embankment was built. The vertical settlement, horizontal settlement profile, and lateral displacement plots, determined from the in-situ field equipment, are provided.

Further, this paper also presents the laboratory results and field behaviors of alluvial soft clay found in Sunshine Coast of Southeast Queensland. The second test embankment presented in this paper was fully instrumented to measure the settlements, lateral movements and the development of excess pore pressures and their dissipation with time under the embankment load. Also, ground improvement technique using prefabricated vertical drains (PVD) was also evaluated for their potential applications.

EMBANKMENTS WITH STONE COLUMN

Site and Soil Condition

Soft estuarine clay in Southeast Queensland has wide varying engineering properties, depending largely on the deposit's depth below the ground surface and the proximity to the water table. Based on the field shear vane tests conducted on the test site, the undrained shear strength of very soft/soft clays is around 5-20 kPa (as shown in Figure 1). Natural moisture contents commonly vary between 60 and 120%. The liquidity indices are generally in the range of 1.5 - 2.5, displaying high sensitivity. Compressibility as high as $C_c/(1 + e_o) = 0.4 - 0.5$ has been observed in the laboratory. At this high compressibility, strain rate effects can be significant.

The trial embankment (approximately 90m in length and 40m in width) was built along the deepest section of the very soft to soft organic clay layer, which extended to a maximum depth of 13.5m. Underlying this layer is a moderately dense to dense sandy sediment strata. On either side of these strata are stiff-hard clay/silty clay. The trial embankment was divided into three sections – section (1) contained no stone column, section (2) had stone columns at 2m spacing, and section (3) had stone columns at 3m spacing. The stone columns were constructed in a square pattern with column diameter of 1m and column length of 16m.