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Assessing slope protection methods for weak rock slopes in Southwestern Taiwan

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Abstract

Failures of *weak-rock* slopes adjacent to roadsides in southwestern Taiwan most often occurred during or immediately after heavy rainfall. Field survey of weak rock slopes along the national South-2 Freeway conducted in this study showed that the slope protection methods employed in the study areas mainly included vegetation (82.0%), prestressed rock anchors with vegetation (6.8%), grille beam (5.9%), rock anchors with grille beam (3.6%). The highest failure rate occurred in the slopes that were protected by the vegetation method. The most frequently encountered weak rock formation along the South-2 Freeway is the alternating sandstone–shale formation (36.3%), followed in sequence by sandstone (24.4%), conglomerates (21.9%) and mudstone (17.4%). The field survey also found that the mudstone slopes present the highest failure rate among all rock types, and the most commonly encountered modes of failure were surface erosion and shallow slides. Factors affecting slope failure include inadequate drainage of storm water runoff, disparate rock types and vegetation on slope surfaces, slope angles and heights. This paper presents results of the field survey of the rate of failures of weak rock slopes in Southwestern Taiwan and examines the attributes of slope failures and the effectiveness of commonly used slope protection methods in the region. Requirements or essential features of an effective slope protection method are then presented along with the preliminary results of its field implementation.

Keywords: Weak rock; Mudstone; Slope failure; Slope characteristics; Slope protection methods

1. Introduction

Weak rock or soft rock is a geological material harder and stronger than engineering soils, but not behaving as a hard rock. Whether a rock is a weak rock is commonly judged with the rheological properties of the rock, namely, the deformability, the uniaxial compressive strength and shear strength and its time dependency (Oliveira, 1993).

Mudstone is a poorly indurated weak rock having the texture and composition of shale, but lacking its fine lamination and fissility. According to Goodman (1993), mudstone is the preferred name for a silt/clay sedimentary rock that lacks lamination or fissility, although the name of mudrock is popular in many parts of the world (Cripps and Taylor, 1981; Dick and Shakoor, 1992). Durability is the most important property of mudrocks in projects that involve exposure of mudrocks to

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weathering. The presence of nondurable mudrocks in an environment of severe weathering is generally recognized as the main reason for the instability problems of mudrock slopes (Dick and Shakoor, 1992). Physical and engineering properties of mudstones have been studied and reported in many parts of the world (Dick and Shakoor, 1992; Chang et al., 1996).

This paper presents the results of field study involving the collection of geological data along the South-2 (S-2) Freeway in the southwestern region of Taiwan detailing the effectiveness of existing slope protections. Because of the scarcity of land for economic development in southwestern Taiwan, the S-2 Freeway and its network highways were routed through unstable weak rock foothills, characterized by geological deposits consisting mainly of Neogene debris sedimentary rock (Fig. 1). The rock types along the S-2 Freeway, to the south of Meishan, mainly consist of sandstone, alternating sandstone–shale formation, and mudstone. These weak rocks pose a significant challenge in terms of hillside roadway maintenance. Sandstones are loosely cemented, mudstone can easily be softened and slaked when it gets wet, and alternating sandstone–shale formation is geologically unstable (Lee et al., 1996). The

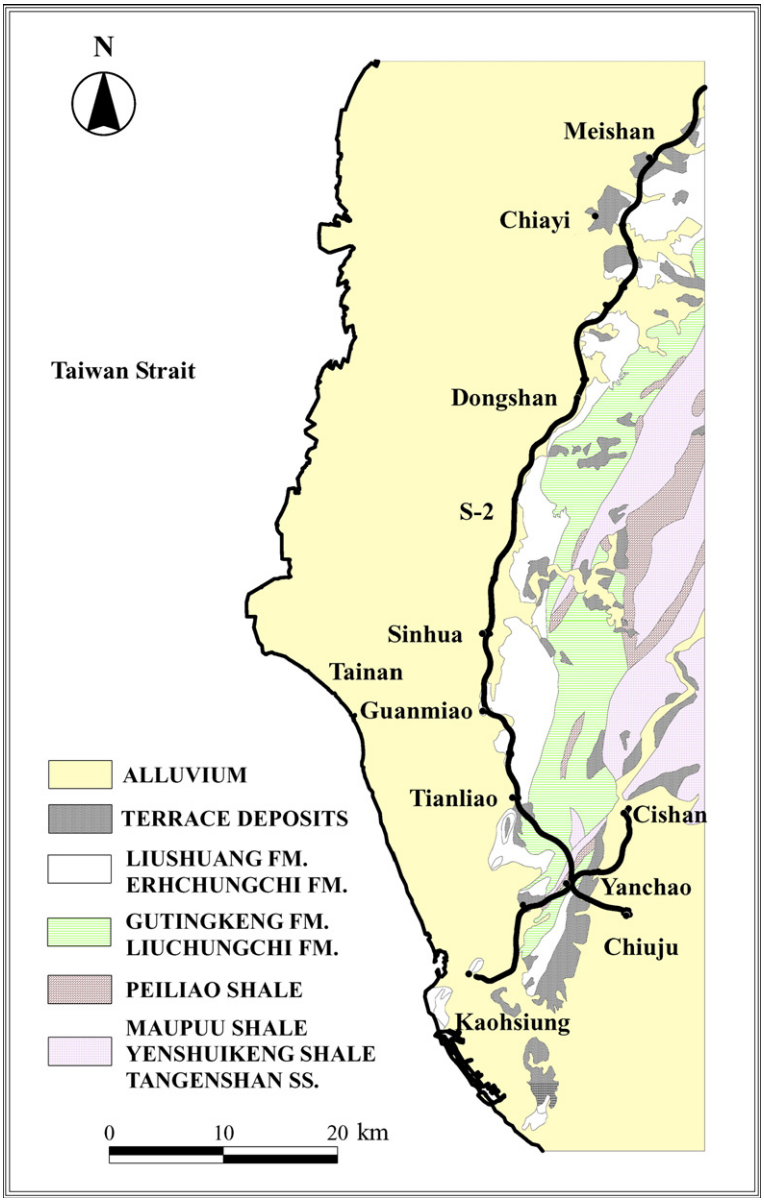

Fig. 1. Geological map along S-2 Freeway Central Geological Survey, MOEA (2000).