Journal of China University of Geosciences, Vol. 19, No. 3, p. 298–306, June 2008 *ISSN 1002-0705*
Printed in China

Compacting Deformation Engineering Characteristics of Weathered Soft Rock Mixture in Subgrade

Li Xiaoqing* (李小青), **Jin Qingping** (金清平)
School of Civil Engineering & Mechanics, *Huazhong University of Science & Technology*, *Wuhan* 430074, *China*; *Hubei Key Laboratory of Control Structure*, *Huazhong University of Science & Technology*, *Wuhan* 430074, *China*

ABSTRACT: The engineering characteristics of weathered soft rock are important contents of soft rock mechanics. They also play a significant role in compacting deformation, which has been known to exert a significant amount of influence on the stability of highway filling subgrade engineering. In an effort to investigate this aspect of the problem, compacting tests and unconfined compressive strength tests have been carried out on weathered argillaceous slate and pelitic siltstone rocks, which are broken and graded before the test. The testing results indicate that the relationships of both between stress and strain and between axial strain and tangent modulus are exponential relationships; the size of the grain plays some influence on the deformation modulus, whereas the water content impacts the compressive strength greatly, which shows quadratic function; the unconfined compressive strength is linear with the dry density of loose soft rock mixtures. Therefore, the water content must be controlled in both the design and the construction of subgrade engineering of soft rock filling, and at the same time some effective measures should be taken to reach the requirement of compaction.

KEY WORDS: subgrade, weathered soft rock, mixture, compaction deformation, engineering characteristics.

INTRODUCTION

The weathered soft rock is one of the rock types encountered frequently in geotechnical engineering, which is widely distributed and covers about 40% of the earth's surface area (Liu and Lin, 2001). Similar to its mother rock, the weather resistance, water resistance, and deformation resistance of discarded soft rock pieces are unstable and variable, and the strength reduces sharply after they are soaked and weathered (Zheng, 2001). Subgrade settlement and slope collapse will occur if filling soft rock subgrade is not properly designed and constructed. There are both successful experiences and engineering problems in the existing subgrade projects filled with soft rock (Liu et al., 2006a; Sun et al., 2005). However, there are seldom problems for subgrade projects filled with gravel and subgrade constructed with Cretaceous soft rock, if special experimental research, strict construction techniques and quality control are performed. Nevertheless, a large deformation appears where the subgrade is filled with argillaceous slates, muddy shales, Paleogene muddy stones,

This article is supported by Key Science and Technology Planning Project by Science & Technology Department of Hubei Province (No. 2004AA101C92).
*Corresponding author: lixiaoqing108@163.com

Manuscript received November 13, 2007.
Manuscript accepted January 11, 2008.

Carboniferous marls, carbonaceous shales, and other soft rocks.

Above 50% of the pelitic siltstones and argillaceous slates formed in the Paleogene, Cretaceous, and Proterozoic, under the substrate of a highway, are severely or thoroughly weathered (Qing et al., 2005). If these soft rocks are used for filling a subgrade, not only will it save a great deal of investment and earthwork, but also substantial social, economic, and environmental benefits will be achieved (Liu et al., 2006b). Combined with the highway project of soft rock filling subgrade engineering, the compacting deformation of a soft rock mixture is studied and its characteristics are also analyzed in this article, which can provide scientific results for the design and construction of a soft rock subgrade.

PHYSICAL AND MECHANICAL CHARACTERISTICS OF SOFT ROCK

Although most of the soft rocks along the highway are severely or thoroughly weathered, their characteristics are different even with the same weathering degree because of the differences in their composition, hydrological and geological location, and the degree of development of structural joints and fractures (Bai et al., 2002). Various specific forms of geological interfaces, such as deposition layer, weak interlayer, joint plane, discontinuous cranny surface, arrangement and connection of granules and grain clusters, micropores and microcracks, have their own unique characteristics and forming processes.

Physical Characteristic Indexes of Soft Rock

Table 1 shows the physical characteristic indexes of two kinds of soft rocks measured by experiments. The pelitic silt has slight porosity, high specific gravity, and a compact microstructure, whereas, the argillaceous slate has great porosity and low specific gravity. The result indicates that argillaceous slate has a well-developed weathering cranny, sparse structure that is cracked, which can be easily incised to pieces. The mixture of pelitic siltstone has a higher liquid limit than that of other fresh rock samples and shows characteristics of silty clay and silt. Fine-grained soil in fresh rock samples of argillaceous slate is clay with a low liquid limit.

Table 1 Physical characteristic indexes of soft rocks

Indexes	Argillaceous slate	Pelitic siltstone
Natrual water content (%)	8.2–9.5	5.5–6.8
Natural density (g/cm^3)	2.18–2.23	2.48
Dry density (g/cm^3)	1.95–1.98	2.33–2.36
Void ratio	0.32–0.37	0.17–0.20
Porosity (%)	24.2–27.4	14.1–16.8
Specific gravity	2.71	2.77
Saturation (%)	67.5–78.5	84.4–87.8
Liquid limit (%)	35.6–36.8	25.8–26.9
Plastic limit (%)	26.7–27.3	21.1–21.7
Plastic index	8.9–9.5	4.7–5.2

Granulometric Composition of Soft Rock

To study the grain composition of soft rock fillings, the sieving test is performed after soft rock samples are crushed, until the maximum diameter is no greater than 60 mm according to the standard. The results of the sieving test are shown in Table 2 and Fig. 1. Argillaceous slate has a wide particle scope and good size distribution (Cu=42.9, Cc=1.19), whereas, pelitic siltstone has a poor size distribution (Cu=45, Cc=0.13). Cu and Cc are abbreviations of nonuniformity coefficient and curvature coefficient, respectively, and can be calculated from Table1 and Fig. 1.

Table 2 Results of sieving test of the soft rock mixture (%)

Types of soft rock	Coarse gravel (mm)		Medium gravel (mm)		Fine gravel (mm)	Coarse sand (mm)		Medium sand (mm)	Fine sand (mm)		Silt and clay (mm)
	60–40	40–20	20–10	10–5	5–2	2–1	1–0.5	0.5–0.25	0.25–0.1	0.1–0.075	<0.075
Argillaceous slate	4–9	14–17	13–15	13–21	7–12	2–4	4–5	1–3	2–3	1–2	6–8
Pelitic siltstone	6–9	5–10	3–7	5–8	7–10	4–10	3–8	10–16	12–19	7–12	3–6