

## 不同垂直荷重对风化砂改良膨胀土抗剪强度影响研究

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## EFFECTS OF DIFFERENT VERTICAL LOADS ON SHEAR STRENGTH OF WEATHERED SAND MODIFIED EXPANSIVE SOIL

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**摘要** 本文以风化砂改良膨胀土的抗剪强度指标为研究对象,通过室内直接剪切试验,研究了在不同垂直荷重作用下,不同掺砂比例及不同含水率对改良膨胀土抗剪强度指标 $c$ 、 $\varphi$ 值的影响规律及各种不同垂直荷重下的 $\sigma$ - $\tau$ 关系。影响直接剪切试验结果的两个关键因素是试验时的垂直荷重和剪切速率,而现行规范对剪切速率是有明确规定的,但对垂直荷重只有一个推荐性的取值。本文对膨胀土掺入了10%、20%、30%、40%、50%的风化砂,分别配以6%、8%、10%、12%、14%的水,然后在I级垂直荷重(12.5~50kPa)、II级垂直荷重(62.5~100kPa)、III级垂直荷重(100~400kPa)作用下,进行剪切试验。通过试验研究得知:垂直荷重对改良后膨胀土抗剪强度指标影响较大,随着垂直荷重的减小,掺砂后的膨胀土内摩擦角逐渐增大,黏聚力逐渐减小;在各级垂直荷重下,在同一含水率状态下,黏聚力均随着掺砂比例的增大而逐渐减小,而内摩擦角均是先增大后减小;在同一掺砂比例下,黏聚力及内摩擦角均随着含水率的增大而先增大后减小。本试验的研究成果为风化砂改良膨胀土用作公路路基填料提供了试验依据。

**关键词:** 垂直荷重 膨胀土 掺砂比例 含水率 抗剪强度

**Abstract:** This paper examines the expansive soil shear strength improved with weathered sand by indoor direct shear test. It studies the modified expansive soil shear strength parameters and the the relationship of the normal stress  $\sigma$  and the shear stress  $\tau$  under different vertical loads, different sand proportions and different moisture contents. The two key factors that affect the direct shear test results is the vertical load and shear rate test. Existing norms of the shear rate is clearly defined, but the vertical load only a recommended value. The expansive soils were mixed with 10%, 20%, 30%, 40%, 50% of the weathered sand, respectively and matched with 6%, 8%, 10%, 12%, 14% water contents. They were loaded under the level I (12.5~50kPa), level II (62.5~100kPa), or level III (100~400kPa) of vertical loads for the shear test. The test results give the following findings. Vertical load has a high impact on the improved expansive soil shear strength parameters. When the vertical load is reduced, the angle of the soil internal friction gradually increases but its cohesion gradually decreases. At all the levels under the vertical load and the moisture content in the same condition, the cohesive force gradually decreases with the increase of the mixed sand ratio, and the angle of internal friction initially increases and then decreases. In the same sand proportion, the cohesive force and angle of internal friction first increase and then decrease as the moisture content increases. The research results provide a test basis for using weathered sand to improve expansive soil for highway roadbed filler.

**Key words:** Vertical load Expansive soil Sand Moisture content Shear strength

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- [1] 寸春发, 鲍峰, 赵勇顺, 等. 攀枝花地区冰期膨胀土的工程特性研究[J]. 工程地质学报, 2011, 19 (2): 254~261. 浏览  
Cun Chunfa, Bao Feng, Zhao Yongshun, et al. Engineering properties of expansive soil formed during glacial period at PanZhiHua area. Journal of Engineering geology, 2011, 19 (2):254~261.
- [2] Cai Yuan, Pei Shenghu, Ding Rongfu. The influence of direct quick shear test conditions on shear strength. West-China exploration engineering, 2003,(12): 40~42.
- [3] 谭松林, 黄玲, 李玉花. 加石灰改性后膨胀土的工程性质研究[J]. 工程地质学报, 2009, 17 (3): 421~425. 浏览  
Tan Songlin, Huang Ling, Li Yuhua. Study on the engineering properties of modified expansive soil mixed with lime. Journal of Engineering Geology, 2009, 17 (3):421~425. 浏览
- [4] 李庆鸿. 新建时速200km铁路改良膨胀土路基施工技术[M]. 中国铁道出版社, 2007, 13~19.
- [5] Li Qinghong. The railway construction of expansive soil subgrade on speed of 200km. China Railway Press, 2007,13~19.
- [6] 刘清秉, 项伟, 崔德山. 离子固化剂对膨胀土结合水影响机制研究[J]. 岩土工程学报, 2012, 10 (34): 1887~1895.  
Liu Qingbing, Xiang Wei, Cui Deshan. Effect on ionic stabilizer on bound water of expansive soils. Chinese Journal of Geotechnical Engineering, 2012, 10 (34):1887~1895.
- [7] 张晨辰, 刘斯宏, 张学峰. 膨胀土水泥改性掺灰量测定的龄期效应研究[J]. 南水北调与水利科技, 2012, 5 (10): 76~79.  
Zhang Chenchen, Liu Sihong, Zhang Xuefeng. Age effects on EDTA titration in Detecting cement content for treatment of expansive soil. South-to-North Water Transfers and Water Scientific & Technology, 2012, 5 (10):76~79. 
- [8] 缪林昌, 刘松玉. 论膨胀土的工程特性及工程措施[J]. 水利水电科技进展, 2001, 21 (2): 37~40.  
Miao Linchang, Liu Songyu. Engineering characteristics of expansive soil and engineering measures. Water Conservancy and Hydropower Science and Technology Progress, 2001, 21 (2):37~40.
- [9] 魏永耀, 孙树林, 郑华章. 膨胀土-胶粉(ESR)强度特性室内试验研究[J]. 工程地质学报, 2010, 18 (4): 543~547. 浏览  
Wei Yongyao, Sun Shulin, Zheng Huazhang. Laboratory tests on uniaxial of compressive strength of expansive soil rubber. Journal of engineering Geology, 2010, 18 (4):543~547.
- [10] 李振, 刑义川, 周俊. 膨胀土2种不同条件下抗剪强度比较[J]. 水力发电学报, 2009, 28 (1): 165~170.  
Li Zhen, Xing Yichuan, Zhou Jun. Comparison with shear strength of the expansive soil under two different conditions. Journal of Hydroelectric Engineering, 2009, 28 (1):165~170.
- [11] 王亮亮, 杨思果. 红黏土抗剪强度与影响因子作用机理分析[J]. 铁道科学与工程学报, 2009, 6 (6): 44~48.  
Wang Liangliang, Yang Siguo. Effect mechanism analysis of red clay between shear strength and influential factors. Journal of Railway Science and Engineering, 2009, 6 (6):44~48.
- [12] Zheng Jianlong, Yang Heping. Highway expansive soil engineering. Beijing: China Communication Press, 2009.
- [13] 谭罗荣, 孔令伟. 膨胀土的强度特性研究[J]. 岩土力学, 2005, 7 (7): 1009~1013.   
Tan Luorong, Kong Lingwei. The research on strength characteristic of expansive soil. Rock and Soil Mechanics, 2005, 7 (7):1009~1013.
- [14] 黄志全, 王安明, 姜彤. 膨胀土的现场抗剪试验研究[J]. 工程地质学报, 2005, 13 (3): 361~366. 浏览  
Huang Zhiquan, Wang Anming, Jiang Tong. Experimental study of expansive soil shear. Journal of Engineering Geology, 2005, 13 (3):361~366. 浏览
- [1] 曾召田, 吕海波, 赵艳林, 蒋文字. 膨胀土干湿循环效应及其对边坡稳定性的影响[J]. 工程地质学报, 2012, 20(6): 934-939.
- [2] 王银梅, 高立成. 黄土化学改良试验研究[J]. 工程地质学报, 2012, 20(6): 1071-1077.
- [3] 简文星, 童龙云. 川东天台乡滑坡滑带特征及其工程意义[J]. 工程地质学报, 2012, 20(5): 774-780.
- [4] 唐朝生, 施斌, 刘春. 膨胀土收缩开裂特性研究[J]. 工程地质学报, 2012, 20(5): 663-673.
- [5] 宋继宏, 胡明鉴, 付克俭, 阿颖. 宜巴高速岩堆不同密实度大型直剪强度特性[J]. 工程地质学报, 2012, 20(5): 687-692.
- [6] 殷杰, 苗永红. 重塑黏性土固有压缩特性的探讨[J]. 工程地质学报, 2012, 20(3): 403-409.
- [7] 张丹, 徐洪钟, 施斌, 刘亮亮. 基于FBG技术的饱和膨胀土失水致裂过程试验研究[J]. 工程地质学报, 2012, 20(1): 103-108.
- [8] 闫亚景, 文宝萍, 计博勋. 基质吸力对非饱和重塑黄土抗剪强度的贡献[J]. 工程地质学报, 2011, 19(6): 865-874.
- [9] 包惠明, 魏雪丰. 干湿循环条件下膨胀土裂隙特征分形研究[J]. 工程地质学报, 2011, 19(4): 478-482.
- [10] 宋日英, 黄志全, 陈宇. 密度及水分状态对黄土状粉土变形特征的影响[J]. 工程地质学报, 2011, 19(4): 492-497.
- [11] 冉龙洲, 宋朝东, 唐朝生. 干燥过程中膨胀土抗拉强度特性研究[J]. 工程地质学报, 2011, 19(4): 620-625.
- [12] 李志清, 余文龙, 范林峰, 付乐, 胡瑞林, 林杜军, 王艳萍. 改良黄土强度特性与工程处置试验研究[J]. 工程地质学报, 2011, 19(1): 116-121.

- [13] 董晓宏, 张爱军, 连江波, 郭敏霞. 长期冻融循环引起黄土强度劣化的试验研究[J]. 工程地质学报, 2010, 18(6): 887-893.
- [14] 高玉佳, 王清, 陈慧娥, 宋晶. 温度对季节性冻土水分迁移的影响研究[J]. 工程地质学报, 2010, 18(5): 698-702.
- [15] 魏永耀, 孙树林, 郑华章. 膨胀土-胶粉 (ESR) 强度特性室内试验研究 [J]. 工程地质学报, 2010, 18(4): 543-547.

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