鄰近垂直岩石界面對靜止土壓力之影響

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摘要

本論文探討鄰近垂直岩石界面對靜止土壓力之影響。在實驗中，本研究以氣乾之渥太華砂作為回填土，回填土高 1.5 公尺。量測於鬆砂(D_r = 35%)與緊砂(D_r = 72%)狀態下的側向土壓力值。本研究利用國立交通大學模型擋土牆設備來探討不同擋土牆與界面板間的距離d對土壓力造成的影響。為了模擬堅硬岩石界面，本研究設計並建造一塊表面鋪上防滑材料的界面板，以及其支撐系統。牆與界面板間的距離d有 1500、1100、900、700、500、400、300、200、100 與 50 公厘十種。根據實驗結果，獲得以下各項結論：

1. 鬆砂狀態下作用於牆上之側向土壓力σ_h 隨著牆與界面板之間的距離減少而減少。Jaky的理論解可視為鄰近垂直岩石界面土壓力分佈的極限值。
2. 擋土牆與界面板之間的距離 d 很短的時候($d \leq 300$ mm)，鬆砂狀態下量測到的土壓力值比 Rankine 主動土壓力小而且土壓力不再隨深度增加而變化。
3. Janssen 理論提供一套可以估計側向土壓力係數與預估牆底傾覆力矩的方法。
4. 夯實後的回填土頂部所量測到的土壓力值，與 Rankine 理論所估計的被動土壓力很接近。
5. 夯實後的側向土壓力值隨著牆與界面板間的距離 d 縮小而減少。擋土結構鄰近垂直岩石界面下，無適當理論可以估計作用在牆上的側向土壓力，因為這些理論都沒考慮到夯實效應。

Earth Pressure at-Rest near A Vertical Rock Face

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Abstract

This paper studies earth pressure at-rest near a vertical rock face. Dry Ottawa sand was used as backfill material. Horizontal earth pressures in loose (Dr = 35%) and compacted (Dr = 72%) soil mass were measured. The height of backfill is 1.5 m. The instrumented model retaining-wall at National Chiao Tung University was used to investigate the variation of earth pressure with different spacing d between model wall and interface plate. To simulate a vertical hard rock face, an interface plate covered with Safety-Walk (anti-slip material) and its supporting system were designed and constructed. The spacings between the wall and interface used are 1500, 1100, 900, 700, 500, 400, 300, 200, 100, and 50 mm. Based on the experiment results, the following conclusions are made.

1. The horizontal earth pressure σ_h for loose sand decreases with decreasing spacing d. Jaky's solution can be considered as the upper bound for estimating earth pressure near a vertical rock face.
2. When the spacing d is very small (d ≤ 300 mm), the measured earth pressure σ_h is even lower than Rankine's active pressure and appears not to change with depth.
3. Janssen's method provides the best estimation for $K_{o,h}$ coefficient under different wall-rock face spacing d. As for the factor of safety against overturning, Janssen's prediction is the best method to estimate the overturning moment (M_o) about the wall base.
4. The lateral stress measured near the top is almost identical to the passive earth pressure estimated with Rankine theory.

5. The pressure coefficient $K_{o,h}$ decreases with the decreasing of spacing d. None of the theories provide a good estimate of σ_h acting on a retaining structure with compacted backfill. Because these theoretical equations did not consider the effects of compaction.

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A	：	Area of horizontal cross section through the silo
C	：	Characteristic abscissa
C_u	：	Coefficient of uniformity
d	：	Distance between interface plate and model wall
D_r	：	Relative density
E	：	Young's modulus
e_{max}	：	Maximum void ratio of soil
e_{min}	：	Minimum void ratio of soil
f_i	：	Interface plate friction
f_w	：	Wall friction
Gs	：	Specific gravity of soil
H	：	Height of the wall
K_o	：	Coefficient of earth pressure at-rest
$K_{o,h}$	：	Coefficient of earth pressure at-rest near a rock face
M_o	：	Overturning moments
P_o	：	Horizontal resultant force
q	：	Static vertical pressure at depth Y
R	：	Hydraulic radius
S	：	Wall movement
U	：	Perimeter of horizontal cross section
u	：	Horizontal water pressure
V	：	Soil volume
W_s	：	Dry soil weight
Z	：	Depth
ϕ	：	Internal friction angle of soil
ϕ_{cv}	：	Constant-volume friction angle
δ	：	Friction angle
δ_i	：	Interface plate friction angle

δ_p	: Plastic sheets friction angle
δ_w	: Wall friction angle
$\Delta\sigma_{h,ci}$	: Peak compaction-influenced horizontal pressure
$\Delta\sigma_n$	: Lateral earth pressure increase resulted from the surface compaction loading the last backfill lift
γ	: Unit weight of soil
γ_d	: Dry unit weight of soil
γ_w	: Unit weight of water
ν	: Poisson's ratio
μ	: Coefficient of friction
σ_{cyc}	: Cyclic normal stress
σ_h	: Horizontal earth pressure
σ_n	: Normal stress
σ_v	: Overburden earth pressure
ε	: Strain