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A STUDY RELATION BETWEEN SOIL AND CANTILEVER SHEET PILE. A MODEL OF THEORY AND DESIGNING

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ABSTRACT

This study the theories and modelling methods of relation between the soil and embedded cantilever sheet pile structure. The backfill material that constitutes the earth retained by the pile wall plays an important role in determining the behavior of these structures. . One typically Rankine or coulomb earth stress theories to expect the earth pressure exerted by soil on the sheet pile wall. Additionally, the look at considers the contribution of numerous soil parameters within the interaction and the volume of reaction in phrases of conduct, deformation, and stress distribution. It is found that the true behavior and magnitude of deformation and stress distribution is generally depends upon the modelling and designing techniques.

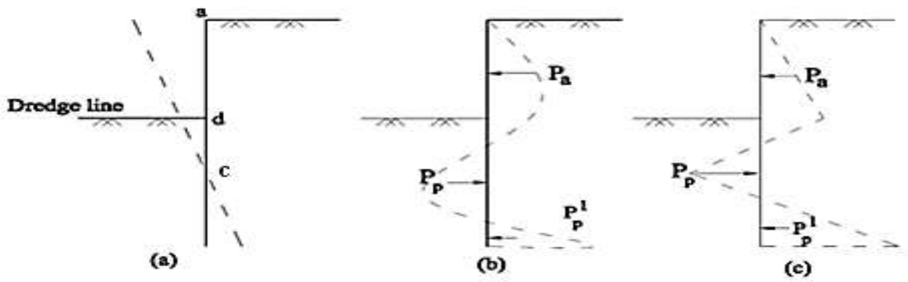
KEYWORDS: Soil, Cantilever sheet pile, Retaining wall, backfill of soil and soil parameters.

INTRODUCTION

Cantilever sheet pile wall is one of the maximum well-known flexible retaining structure. A Cantilever sheet pile wall derives its stability entirely from the lateral resistance of the soil into which it's far pushed and calls for enough embedment in soil. It is therefore economical only for moderate heights of earth fill to be retained for which the depth of embedment required is not too large. Cantilever sheet pile analysis two specific cases have been considered.

Case 1:- Cantilever sheet pile embedded in granular soil.

For experimentally investigations it is discovered that, the earth pressure advanced have a tendency to motive rotation of the wall about a pivot (point c) below the dredge level as shown in Fig1 (a) and the likely earth pressure distribution will be as shown in Fig1 (b). But the traditional design of cantilever sheet pile wall is based on the simplified pressure distribution shown in Fig1(c).



(Source: - http://nptel.ac.in/courses/105108069/mod05/lec05.pdf)
Fig 1: evaluation of cantilever sheet pile wall embedded in granular soil.

In the Fig 1.1, H is the height of fill above dredge line and D is the depth of embedment. Assuming that the soil properties are the same above and below the dredge line, we make the following computations.

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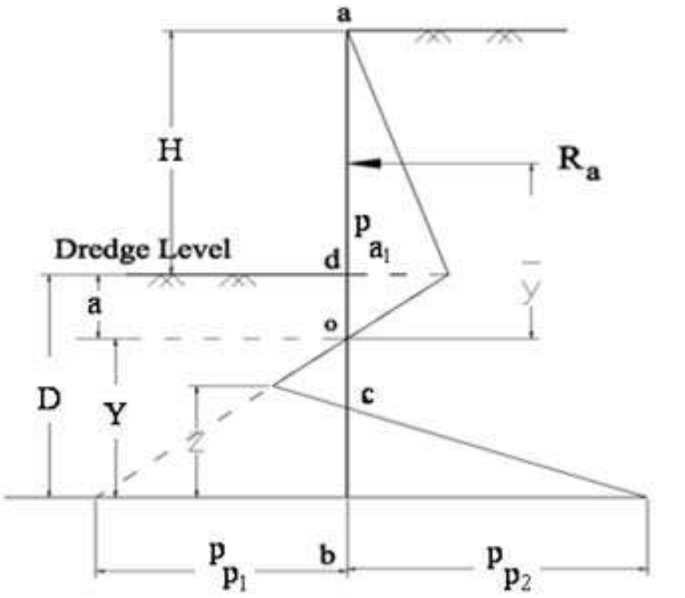
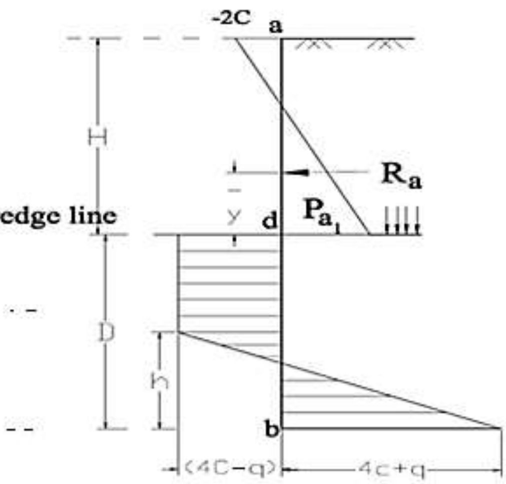


(Source: - http://nptel.ac.in/courses/105108069/mod05/lec05.pdf)
Fig. 1.1: Pressure distribution diagram in the case of cantilever sheet pile wall in granular soil.

Case 2) Cantilever sheet pile wall embedded in cohesive soil.
In the Fig 2, H is the height of wall above dredge line and D is the depth of embedment. The soil is considered to be purely cohesive both above and below the dredge line.



(Source: - http://nptel.ac.in/courses/105108069/mod05/lec05.pdf)
Fig 2: Cantilever sheet pile wall in cohesive soil

THEORIES AND MODELLING TECHNIQUES

Model type
Various kinds of soil – sheet pile models and techniques are now a days in use, commonly, the Mohr-Coulomb model and cap model with both models having advantages and associated limitations depending on the application.

Mohr-Coulomb Version:
The Mohr-Coulomb failure criterion takes into shear strength of soil (τ).
MOHR-COULOMB Failure Criteria:

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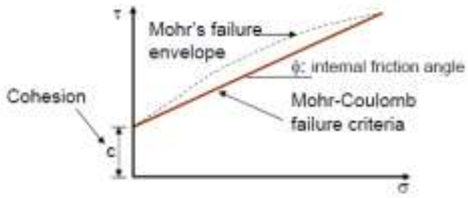
Concept of rupture for materials

1) Failure under combined σ and τ.
2) Any stress state that combined effect reaches the failure plane.

Mohr-Coulomb failure criteria:
τf = c + σ tanφ
In terms of effective parameters:
τf = c' + σ' tanφ'



Cap model

This is a form of soil constitutive model of the plasticity type based on the concept of Continuum mechanics and important state expressed in terms of three-dimensional stress state. As the basis for the improvement of a cap model for partially saturated soils serves the changed cap model presented.

Primary assumptions are the additive decomposition of the overall strain tensor **e** into an elastic component.
ee and a plastic Component **e**p,

e=**e**e + **e**p……………………………… (1)

And, determination of the stress tensor from the elastic strains by the formula of Hooke's law.

r=**C**: **e**e =**C**: *(***e** *–* **e**p*)…………… (2)*

C denoting the elasticity tensor.

*f*1*(***r***)* =_**s**_ *− Fe (I*1*)……………… (3)*

With,

*Fe (I*1*)* =_ + _*I*1…………………………… (4)

And the strain hardening cap as

*f*2*(***r***,* _*)* = *Fc* (_**s**_*, I*1*,* _*) − Fe (*_*)…… (5)*

CONVENTIONAL DESIGN THEORIES OF SHEET PILES

Several theories are existence for determination of pressure distribution used for the layout of the cantilever sheet pile. The maximum prominent of these theories and modelling consists the Coulomb and Rankine theories each made of equations developed with fundamental answer for the cantilever sheet pile.

Coulomb Theory.

Coulomb principle first studied the problem of lateral earth pressures on retaining structures. He restriction equilibrium concept, which considers the failing soil block as a free body so one can order to determine the limiting horizontal earth pressure. The horizontal restricting horizontal pressures at failure in extension or compression are used to determine the K_a and K_p respectively. Since the trouble is indeterminate a number of capability failure surfaces need be analyzed to determine the critical failure surface.

$$K_a = \frac{\cos^2(\phi-\theta)}{\cos^2\theta\cos(\delta+\theta)\left(1+\sqrt{\frac{\sin(\delta+\phi)\sin(\phi-\beta)}{\cos(\delta+\theta)\cos(\beta-\theta)}}\right)^2}$$

$$K_p = \frac{\cos^2(\phi+\theta)}{\cos^2\theta\cos(\delta-\theta)\left(1-\sqrt{\frac{\sin(\delta+\phi)\sin(\phi+\beta)}{\cos(\delta-\theta)\cos(\beta-\theta)}}\right)^2}$$

As opposed to evaluating the above equations or the use commercial of software applications for this, books of tables for the maximum commonplace cases can be used.

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Rankine theory.

Rankine principle is a stress field solutions are that predicts active and passive earth pressure. Its assume that the soil is cohesion less, the wall is frictionless, the soil-wall interface is vertical, the failure surface on which the soil moves is planar, and the ensuing force is angled parallel to the backfill surface. The equations for lively active and passive lateral earth pressure coefficients are given following.

$$K_a = \cos\beta \frac{\cos\beta - \left(\cos^2\beta - \cos^2\phi\right)^{1/2}}{\cos\beta + \left(\cos^2\beta - \cos^2\phi\right)^{1/2}}$$

$$K_p = \cos\beta \frac{\cos\beta + \left(\cos^2\beta - \cos^2\phi\right)^{1/2}}{\cos\beta - \left(\cos^2\beta - \cos^2\phi\right)^{1/2}}$$

For the case where β is 0, the above equations simplify to

$$K_a = \tan^2\left(45 - \frac{\phi}{2}\right) = \frac{1 - \sin(\phi)}{1 + \sin(\phi)}$$

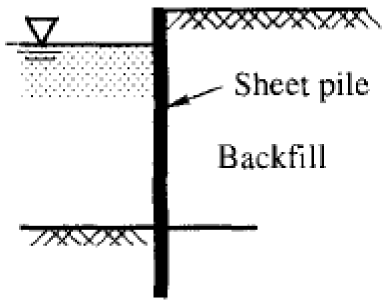
$$K_p = \tan^2\left(45 + \frac{\phi}{2}\right) = \frac{1 + \sin(\phi)}{1 - \sin(\phi)}$$

SHEET PILE WALLS AND DESIGN METHODS

Sheet pile wall may be classified into four types. The design methods are described as following.

Cantilever sheet piling.

Sheet piles are driven into the sufficient depth into the ground to end up fixed as a vertical cantilever in resisting the lateral earth pressure.it subjected to large lateral deflection and is readily affected by scour or erosion in front of wall as shown in Figure.



(Source:-http://www.fec.unicamp.br/~persio/ic523/Chapter%2020.pdf)

Fig 3: - Net pressure for cantilever wall.

Anchored wall

An anchored sheet piling derives its support against the lateral earth pressure by embedment in the ground surface. And by the use of tie rods near the top of piling. This type is suitable for moderated to the high walls. For walls higher than about 35ft. two or three tiers of rods may be necessary in order to reduce the required pile penetration and the flexural stresses. This is shown in Figure.

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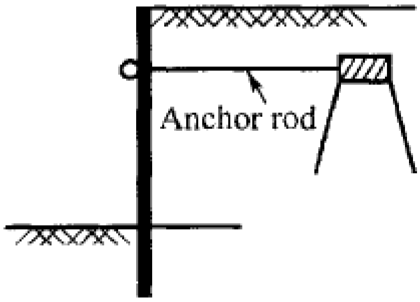
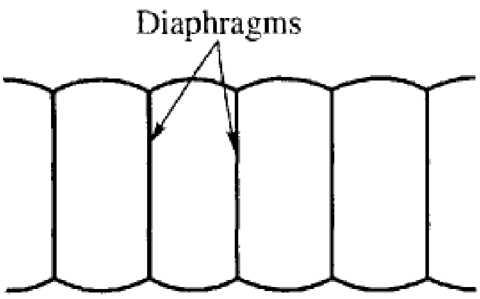


(Source:-http://www.fec.unicamp.br/~persio/ic523/Chapter%2020.pdf)
Fig 4: - Net pressure distribution in anchored walls.

Sheet piling with relieving platform.
A relieving platforms are a pile supported deck constructed for the purpose of supporting of the earth fill and other structure or super structure loads, thus relieving the lateral pressure from the sheet pile. This is mainly used in railway tracks or the crane runways are close to the sheet piling.

Cellular cofferdams.
Sheet pile is driven into the form of cells which are filled with granular material and becomes self-stabilizing retaining structures.



(Source:-http://www.fec.unicamp.br/~persio/ic523/Chapter%2020.pdf)
Fig 5:-Cellular cofferdam.

CONCLUSIONS
A cantilever sheet pile consist of a sequence of sheet piles pushed facet with the aid of facet into the ground therefore forming a continuous vertical wall for the cause of the maintaining an earth financial institution.
The following conclusions may be taken.

- A cantilever sheet pile wall acts like a retaining wall but unlike the RCC or masonry rigid retaining walls, it is low in weight and flexible.
- Disadvantages of cantilever sheet pile having heavy and bulky, requiring heavier equipment during handling and driving.
- The authentic behavior and significance of deformation for the cantilever sheet pile and pressure distribution etc. is the dependent on version and design technique chosen and a majority of these in trendy make contributions to the overall performance of each the soil and cantilever sheet pile wall.
- A cantilever sheet pile wall derives its stability entirely for the lateral pressure of soil resist into which it is driven and requires sufficient embedment in soil.it is economical only for the moderate heights of earthfill to be retained for which the depth of embedment required is too large.

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