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نموذج مختبري للركائز اللوحية المعرضة للحمل الدوري في التربة الرملية

رسالة مقدمة الى قسم الهندسة المدنية جامعة ديالى وهي جزء من
متطلبات نيل درجة الماجستير في علوم الهندسة المدنية

من قبل

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(بكالوريوس هندسة مدنية/ 2017)

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College of Engineering

Laboratory Model for Sheet Pile Subjected to Cyclic Load in Sandy Soil

A Thesis Submitted to Civil Engineering Department College of Engineering, University of Diyala in Partial Fulfillment of the Requirements for Master Degree in Civil Engineering / Soil and Foundation Engineering.

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Abstract

One of the most significant technologies for usage in civil engineering projects is sheet pile walls. Applying sheet pile walls with anchors limits sides excavation to a depth of more than six meters. The effects of a lateral displacement sheet anchored pile wall on sandy soil under a 10% Cyclic Load Ratio (CLR) and for 100 cycle's number were investigated experimentally in this study.

This study examined the effects of different parameters on cantilever and anchored sheet pile wall stability under periodic load. The parameters which are studied: the ratio of spacing between anchored to free height of sheet pile wall (S/H= 1/3, 2/3, and 1), ratio of anchored length to free head of sheet pile wall (L/H= 1, 4/3, and 5/3), distance of strip footing from sheet pile wall (D/H= 1, 1/2, and 1/4) and inclination rods angle (Θ= 0^o, 10^o, 15^o, 25^o, and 30^o) under influence of two–way cyclic lateral load at 0.2 Hz frequency. Lateral displacement of sheet pile wall as well as the total settlement of strip footing and tilting are recorded during the test. When used the wale for sheet pile decreased the lateral displacement of a sheet pile to (66%, 20%, and 9%) as compared to values of lateral displacement without using wale for (D/H= 1, 1/2, and 1/4) respectively. The horizontal angle of anchors (Θ= 0^o) supplied the reduction 89% in lateral displacement of the anchored sheet pile wall as compared the value of lateral displacement of cantilever sheet pile for length of anchored rod (L/H= 5/3) with spacing between two anchored rods to free height of sheet pile wall (S/H= 1/3) for distance (D/H= 1/2), but the angle (Θ= 30^o) of length of anchored rod to free height of sheet pile wall (L/H= 5/3) reduce the lateral displacement about 98% as compared to cantilever sheet pile wall's lateral displacement. The angles of anchors (Θ= 10^o, 15^o, and 25^o) with the length anchored rod to free height of sheet pile wall (L/H=4/3) with spacing between two anchored rods (S/H= 1/3) and distance from strip

footing to free height of sheet pile wall (D/H= 1/2) provided reduction in lateral displacement of the anchored sheet pile wall (92.81%, 94.91%, and 96.79%) respectively. The total settlement of strip footing for distance from strip footing to free height of sheet pile wall (D/H= 1/4) is exceeded the allowable settlement, but for distance from strip footing to free height of sheet pile wall (D/H= 1, and 1/2) is not exceeded the allowable settlement for all inclination angle rods. The tilting of strip footing for distance from strip footing to free height of sheet pile wall (D/H= 1) is not exceeded the tilting limit, but for distance from strip footing to free height of sheet pile wall (D/H= 1/2, and 1/4) is exceeded the tilting limit. The safe distance for total settlement of strip footing to free height of sheet pile wall is (D/H= 1, and 1/2). But the safe distance for tilting of strip footing to free height of sheet pile wall should be more than (D/H > 1/2).

CHAPTER ONE
INTRODUCTION

CHAPTER ONE

1.1 Introduction

A sheet pile wall is one kind of retaining wall. It protects deep vertical ground cuts, waterfront structures, bridge abutments, and cofferdams.

In geotechnical engineering, sheet pile walls are preferable to retaining walls. Sheet pile walls are the ideal solution in cases when land acquisition is a problem. Sheet pile walls can fail flexural and rotation in stratified soil. Providing enough penetration depth can help to prevent the rotational failure. The in-front foundation soil produces a passive force that opposes the driving or active force from the backfill soil. The flexural failure is prevented by one or more anchors positioned at a certain location on the sheet pile. Often used as either temporary or permanent earth support structures, steel sheet pile walls are used for quay walls, breakwaters, cofferdams, bridge abutments, underground constructions, trenches, and flood protection in a variety of engineering applications. Most sheet pile walls need extra support at the top, which can be given by attaching the wall's top to a dead anchor or by bracing within excavations with struts and wales (ArcelorMittal, 2021).

As seen in plate (1.1), this is commonly constructed using steel sheet piles to create a secondary anchor wall at a specific distance behind the main wall. About one-third of all installed steel sheet piles globally are found in port facilities and shoreline constructions, where the second option is typically used. It has been demonstrated that using Anchored Steel Sheet Pile walls (ASSP) to build new ports and enlarge existing ones is a prompt and economical solution. Materials such as steel, wood, or reinforced concrete are all suitable for sheet piles. Steel sheets are the most widely used form for walls because of their many benefits over other materials, such as their durability to high temperatures.

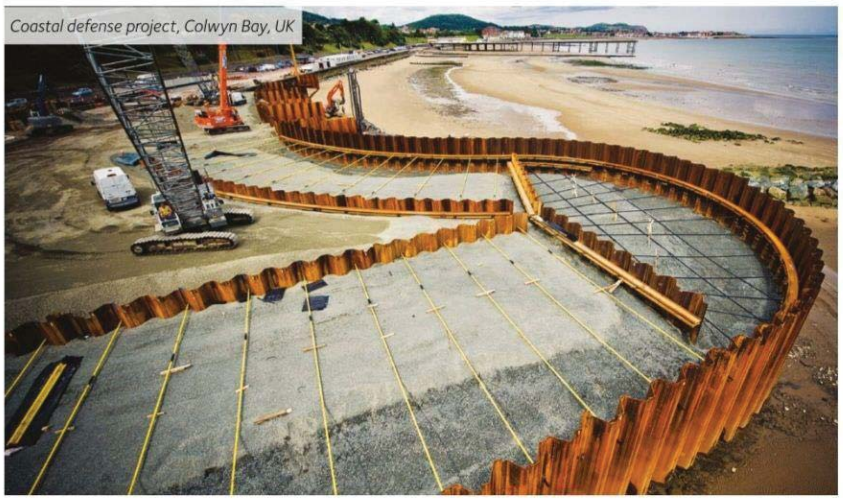

Figure (1.1): Anchored sheet pile walls employed in a coastal defence project, Colwyn Bay, UK, after ArcelorMittal (2021).

1.2 Anchored Sheet Pile Wall

It becomes more cost-effective to tie the wall near the top to anchor plates, anchor walls, or anchor piles when the backfill material behind a cantilever sheet pile wall is higher than roughly 6 meters (**Craige, 2004**). Call this kind of building an anchored bulkhead or an anchored sheet pile wall. In addition to lowering the weight and cross section area of the sheet piles needed for construction, anchors also minimize the depth of penetration that sheet piles require. Nonetheless, careful design is required for the tie rods and anchors. When designing anchored sheet pile walls, there are two main approaches:

(a) free earth support method and (b) fixed earth supported method The expected sheet pile deflection for each of the two methods is depicted in Figure (1.2).

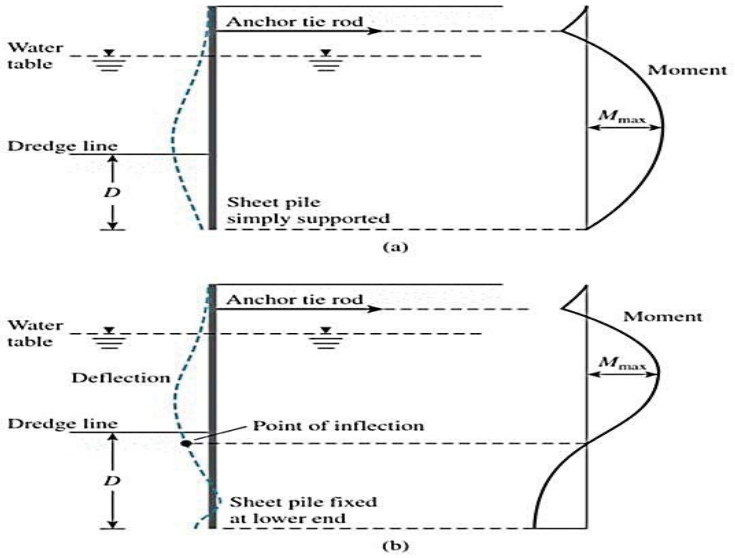

Figure (1.2): Nature of variation of deflection and moment for anchored sheet piles (Das, 2018): a) free earth support method, b) fixed earth support method.

The following are the common anchor types utilized in sheet pile walls :

1- Anchor plates and beams (deadman)
2- Tie backs
3- Vertical anchor piles
4- Anchor beams supported by batter (compression and tension) piles

Typically, cast concrete blocks are used to create beams and anchor plates (figure 1.3a). Tie-rods hold the anchors fast to the sheet pile. To make it easier to attach the tie rod to the wall, a wale is positioned at either the front or back face of the sheet pile. The tie rod is often painted or covered in asphaltic materials to prevent corrosion. When building tiebacks, bars or cables—typically made of high-strength, pre-stressed steel tendons—are inserted into predrilled holes Figure (1.3b) and filled with concrete grout. An anchor beam with batter piles and a vertical anchor pile are depicted in Figures (1.3c) and (1.3d).

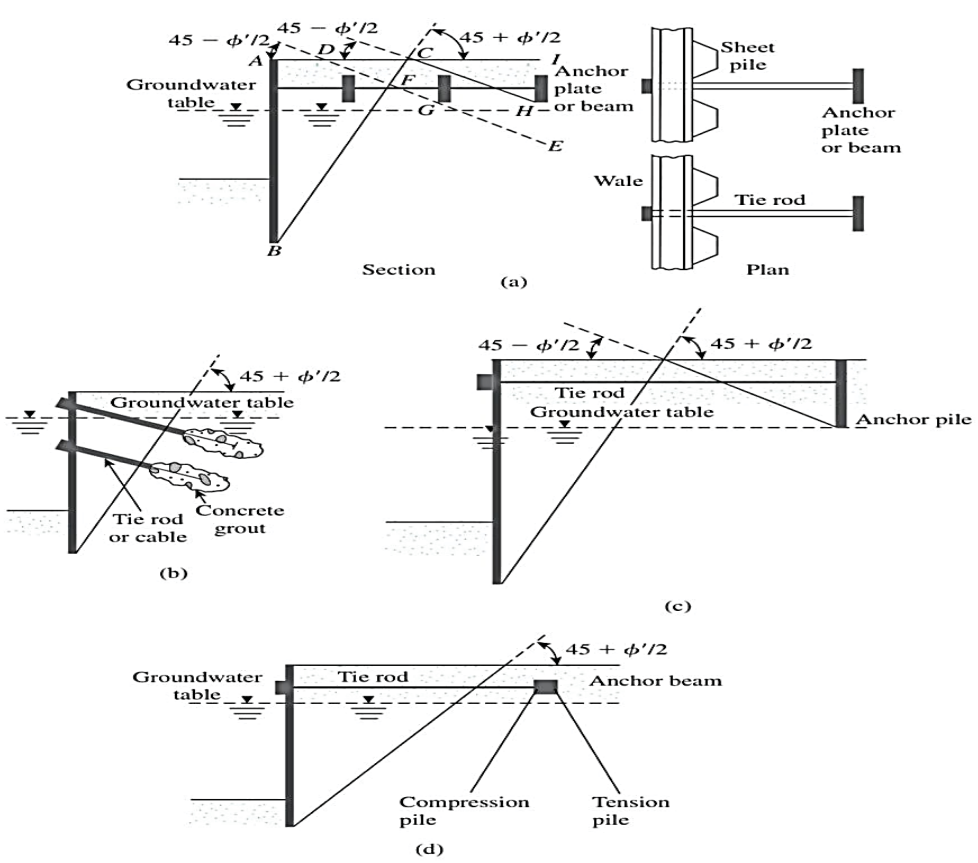

Figure (1.3): Various types of anchoring for sheet pile walls (Das, 2018) : (a) anchor plate or beam (b) tieback (c) vertical anchor pile (d) anchor beam with batter piles

1.3 Aims of the Study:

The aim of the study is to

1- Examine how anchored rod horizontal spacing affects the sheet pile wall's lateral displacement under lateral cyclic load.
2- Examine how the anchored rod spacing affects the strip footing surcharge's tilt and total settlement under lateral cyclic load.
3- Investigate the effect of anchored rod length embedded in sandy soil on lateral displacement of sheet pile wall also, on tilt and total settlement of strip footing (Surcharge load).

4- Evaluate the effect of angles inclination of anchored are connected to sheet pile on lateral displacement of sheet pile wall.
5- Evaluate the effect of angles inclination of anchored are connected to sheet pile on tilt and total settlement of strip footing (Surcharge load).
6- Investigate the effect of distance of strip footing (Surcharge load) from sheet pile wall on stability of sheet pile wall.

1.4 Layout of the Study

This study is divided into five chapters that comprise its major content:

Chapter One: It includes a brief introduction, general details regarding sheet piles, anchored sheet pile walls, and the study's aims.

Chapter Two: provides an overview of previous theoretical and laboratory research, along with an overview of cyclic loads and some field investigations to sheet pile walls and the anchors that are placed in them.

Chapter Three: contains information about the laboratory work, such as soil utilized, the anchored model and container, the installation technique for the anchored, and the device test used for the cyclic lateral load.

Chapter Four: This chapter includes a presentation and discussion of test findings for sheet pile walls subjected to lateral cyclic loads.

Chapter Five: provides the study's conclusions and its most significant recommendations for further research.