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Measures to prevent retaining wall distress and failures, a review in light with previous available work.

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Abstract

Retaining walls are structures designed and constructed to withstand the lateral earth pressure of the soil or to hold the material of the soil. Retaining walls are permanent, relatively rigid masonry or concrete structures that support a mass of soil. By replacing the steep sides of the walls with the gentle natural slopes of the earth, it can be used on highways, road cuts, in and around buildings, and even in underground structures. Lateral earth pressure can also be due to earth pressure, water pressure, sand, and other granular material behind the retaining wall structure. The retaining wall is a stabilizing structure designed to hold down the ground. There are many reasons to build these structures. For example, prevention of erosion, aesthetic purposes, stabilization of sloping courtyards, etc. Retaining walls are commonly used to stabilize and correct slopes, level locations, and elevation differences between properties.

This is probably the most common reason hometowns choose to build retaining walls on their property. Retaining walls, if properly constructed, can provide the ground support needed to raise some slopes to a sufficient level for recreational or practical purposes. The stepped retaining wall can also turn an ordinary garden into a layered paradise of plants and flowers. Retaining walls often fail today. It causes disasters in human life, property and financial loss. Damage to retaining walls can endanger property and people. However, many retaining walls fail due to poor construction, poor drainage, and poor quality of materials used during construction. This study provides an overview of the causes of retaining wall breakage. The study also includes cases of heavy rains in June 2019 damaging retaining walls in Pune Maharashtra. The main reason for the failure was the infiltration of water into the backfill, causing death and property damage.

Introduction

Various measures to prevent retaining wall distress and failures shall be taken for safety and stability. There are various structural, design, and detailed reasons that affect the safety and stability of retaining walls. On the other hand, there are appropriate measures and procedures to reduce retaining wall problems and prevent retaining wall failures. The next section describes techniques used to reduce or eliminate retaining wall instability and stress. Keep in mind that these measures do not apply to walls that are almost completely worn.

Review on Litertaure

1. Case study of retaining wall breakage due to poor structure and design aspects. (From Hanifi Binici, huseyin Temiz Vol 6, No. 1, 2010): This study shows various causes of retaining wall breakage. B. Poor drainage characteristics, poor concrete quality, poor design despite the requirements of implementation standards. The condition of the drainage plays a major role in the successful damage of the retaining wall. When water collects behind the wall, the horizontal force increases significantly. Improperly placed or blocked or improperly sized drain holes can also cause wall damage. Without proper drainage, hydrostatic pressure will be created behind the wall. Saturated soil is considerably heavier than dry soil, so retaining walls are vulnerable to breakage unless the retaining wall is designed to bear such loads.

2. Evaluation of Retaining Wall Destruction Cases (Mu`azu Mohammed ABDULLAHI Issue 14, June 2009): They have soil slip, surrounding soil slip, tipping, forward slip, construction failure, hydraulic pressure; I investigated the cause of the lateral soil pressure. Earth pressure is not an inherent property of soil or rock, but it does apply to the materials that the support structure must support, the loads that the soil behind the structure must support, the groundwater conditions, and the support structure. Soil mechanics theory deals with earth pressure on retaining walls, but unfortunately, engineers who use the theory are not always aware of the

importance of the assumptions made in the development. Therefore, the spread of retaining walls involves many and partial failures. This is because build-based rules and expressions only meet a limited set of conditions.

3. Kyoto case study (E.C. Shin, S.D. Cho and KW Lee Osaka 2011): Consider the case of Korean reinforced soil retaining wall. Damage to reinforced soil walls in hills most often occurs due to extreme rainfall, and cracks in curtain walls are insufficient unconstrained compressive strength of curtain wall, imperfections between curtain walls and reinforcement elements. It is caused by proper connection and different subsidence. In the lower soil, improper treatment of subsoil by applying water pressure. The authors found that the infiltration of groundwater into the corners caused wall stability problems. Therefore, proper drainage system design and proper soil treatment are important factors in maintaining the stability of the reinforced mud wall.

4. Case research of 18 failed Concrete Retaining Block partitions in South Africa are considered (By Loren Agostini, Chapter 4, and December 2016): In this observe the 18 case observe of concrete keeping partitions in South Africa are considered. The 15 partitions had a Berea Red formation (Sand stone formation). Material as backfill, 2 partitions had residual granite and one had different formations. The bad placement and mistaken compaction of backfill triggered failure of keeping partitions. The failure came about due pinnacle slope which had a slope much less than 4^{o} to the horizontal. The fundamental failure of wall happens because of water and instability issues, outside and inner issues. By survey the primary purpose of failure had been through backfill material, bad compaction, bad drainage, water ingress, mistaken reinforcement, wrong design, overstressing of reinforcement. The maximum failure came about because of setting of drainage within side the backfill. Due to no concrete basis wall fails.

5. Field Study of keeping wall built with clay-stuffed soil luggage (By Sihong Liu, Kewei Fan SiyuanXu 2018):

This paper gives discipline observe of building keeping wall the usage of soil luggage which can be shaped through filling the excavated clayey soil into woven luggage (geosynthetics). It may be seemed as new form of Geosynthetic – strengthened earth keeping wall. The soil luggage built keeping wall has the benefits of weight mild and suitable adoption to basis deformation like geosynthetic strengthened earth keeping wall.

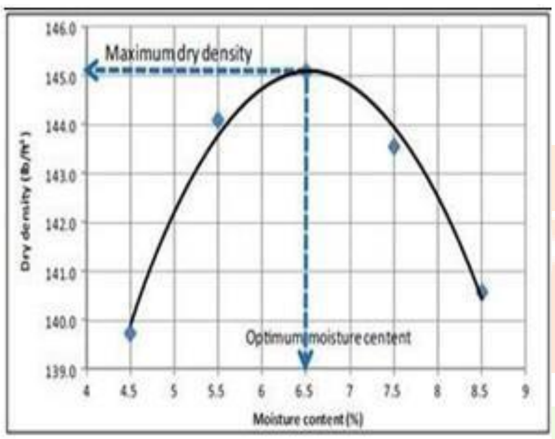
METHODOLOGY

By study of above literature research papers we found different causes through studies of soil testing and case studies such as; Test to be carried out

1. Compaction test:

The Proctor compaction test is a laboratory geotechnical testing method used to determine the soil compaction properties, specifically, to determine the optimal water content at which soil can reach its maximum dry density.

Graph.1. Moisture Content Vs Dry density



Causes of failure	Preventive measures
Poor Drainage	Redeem Surface drainage problems
Shallow Footing	Extend Footing
Lack of reinforcement /improper R/F placement	Tie backing Technique
Extra load on top	Wall push backing
Slope failure	30 degree slope excavation.
Saturated Backfill	Remove and replace backfill materials.
Design error	Tear down wall
Foundation Issues	Soldier beam
Saturated Backfill	Mechanical Stabilization
Poor water pressure	Add key
Lateral earth pressure	Lateral support-pilling wall, gravity wall, anchored wall

Table.3. Causes failure and Preventive measures

Optimum Moisture Content for different types of soil as per IS:-

Table.1.Standard Limits of OMC

Types of Soil	**OMC (%)**
Sand	6 to 10%
Sand silt of silty sand	8 to 12 %
Silt	12 to 16%
Clay	14 o 20 %

1. Bearing Capacity Test:

The in situ density of natural soil is needed for the determination of bearing capacity of soil, for the determination f pressure on underlying strata for the calculation of settlement and the design of underground structures.

Table.2.Standard Values of Penetration Test

Penetration of Plunger (MM)	**Standard Load (kg)**
2.5	1370
5.0	2055
7.5	2630
10.0	3180
12.5	3600

2. Atterberg Limit:

Atterberg limit are the basic measure of water contents of fine grained soil; its Shrinkage limit, Plastic limit, and liquid limit

• Shrinkage limit is commonly much less than the liquid limit andplastic limit.

• Plastic limit (PL) is the moisture content

• Where the thread breaks apart at a diameter of 3.2 mm.

• Liquid limit (LL) is the water content at which the behaviour ofclayey soil changes from plastic state to liquid state

Plasticity Index - (PI = LL - PL)

Soil Description based on:
(0) – Non plasticity
<7 - Slightly Plastic
7-17 – Medium Plastic
> 17 – Highly Plastic

Modes of Retaining Wall Failure

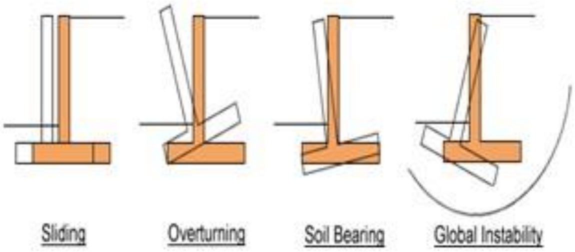


Image.1.Retaining wall stability failure modes

Measures to Prevent Retaining Wall Distress and Failures

Following are the methods to prevent failure and distress in retaining walls:

1. Redeem surface drainage problems
2. Reduce retaining wall height
3. Use tie backs
4. Extend the footing
5. Remove and replace backfill materials
6. Reinforce the front of the wall
7. Add a key
8. Use cantilevered soldier beams
9. Getting a building permit
10. Move forward it back to plump
11. 'Tear down that wall'
12. An out of the ordinary solution

Redeem Surface Drainage Problems

Replacing backfill materials or reaching to the drainage system at retaining wall base is uneconomical. Therefore, it is recommended to prevent accumulating water at the back face of the wall by re-grading backfill material surface or constructing small concrete culvert to divert water and direct it away from the backfill. Moreover, increasing number of weep holes might be another mitigation strategy, even though it can be objectionable aesthetically. Furthermore, in most cases, it is feasible to solve drainage issues by just closing active drainage systems.

Reduce retaining wall height

There are number of options that can be used in the case where reducing soil pressure is required for example decreasing retain earth height by re-grading backfill earth surface, and landscape changing or pressing down drainage culvert at the wall back face. These techniques may decline retained earth height to a satisfactory level depend on as-built capacity of the retaining wall.

Use tie backs

Tie backing retaining wall can be used as mitigation method for situations that stem wall overstressed extremely. A hole is drilled in the back of the wall and a back tie is attached that extends beyond the damaged surface of the backfill. It is necessary to recalculate the wall shear and moment due to the constraint change. This method is considered aesthetically unfavorable because back anchors will appear on the exposed side of the wall or the surface will be back-glued with concrete blocks.

Extend the base

Stretching your toes will significantly reduce your ground pressure. After the required extension is determined, the ground can be excavated, concrete poured and, if necessary, a deep foundation for the wrench. The connection between the new concrete and the existing concrete is made by drilling holes in the existing concrete and then placing epoxy dowels to withstand the calculated pull-out and, as a result, transfer shear forces and moments.

Remove and replace backfill material

This solution is used when the backfill soil is saturated and cannot be softened by the surface. Crushed stone is one of the alternatives to backfill soil and should ensure good drainage at the base of the wall.

Reinforce the front of the wall

To strengthen the front of the wall, the floor thickness is increased by adding concrete and taper to the extent that it does not need to be thickened. Since this method only improves the compressive strength, it is also necessary to deal with shear transfer at the interface. Interface thrust can be transmitted by fixing the knock pin.

Add key

Deepening the critical equipment in front of the existing foundation can solve the retaining wall slip problem and increase passive resistance.

Use cantilever

A girder is installed in a hole drilled in the landing of the foundation and fixed to the wall to transmit the load. Joists are spaced along the horizontal span of the wall by a specified distance. In addition, the distance between the wall and the support is controlled by the heel of the foot.

Get a building permit

There may be no apparent damage to the retaining wall, but vigilant building inspectors have discovered that they have not been granted the permits given when new construction or property additions were made. .. If retaining wall planning is available, the calculation should be validated with the signature of the engineer. One of the mitigation techniques described in this article is used to resolve congestion if the calculation cannot be justified. If you don't have a wall construction level, you need to determine how the retaining wall is constructed. This can be done by dimensioning the toes and heels of the foundation, probing and testing to specify bar spacing and position, and testing core samples to determine material strength. Recalculate the design to match the actual bearing capacity of the retaining wall and, as a result, verify the suitability of the retaining wall. This reveals how important it is to get a permit and may avoid future costs.

Push it back to plum

This method is not recommended, but it works fine if the wall slope is about 1 inch or 2 inches. The probability that this technique will work successfully depends on certain conditions. B. No backfill material is placed, retaining wall height, and the above modifications. Factors such as hitting a wall or using a mechanical compressor near the wall can cause the wall to bounce. There is some debate about this method, but it can be done properly with care. In most cases, you should remove a large amount of backfilling to avoid problems.

"Break the wall."

If the retaining wall is in a difficult condition and none of the above wall rehabilitation solutions seem feasible, it may be more economical to destroy and rebuild the wall. Using this option is highly recommended when new conditions arise. B. Need for higher walls, or preference for different building materials.

Exotic solution

There are exceptional field conditions that can be addressed in a particular economic way. In this case, the engineer can come up with a very clever and unique idea to solve the problem and prevent the demolition and reconstruction of the retaining wall.

Conclusion:

To avoid hydrostatic pressure, it is necessary to use good backfill material with good drainage properties. In order to construct high quality reinforced soil walls, it is necessary to take serious design and quality control of construction. After the cause was clarified, another method of backfilling or expanding the base could significantly improve the resistance to wall breakage.

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