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A REVIEW ON PARAMETRIC STUDY OF MULTI TIERED REINFORCED FLY ASH WALL

Pallavi N. Gharade[1], Dr. A.P. Dange [2]
[1](Civil engineering, Government College of Engineering Amravati, India)
[2](Civil engineering, Government College of Engineering Amravati, India)
Pallavigharade1999@gmail.com

Abstract: *The demands for construction of taller retaining wall are increasing with the rapid development of urban infrastructure and growing restriction of space. However, with the increase in height, the cost of the retaining wall constructed using conventional methods increases rapidly. The multi-tiered wall is an earth-retaining structure in which offsets are provided at certain heights. As the wall height increases, stresses on the wall increases, causing an increase in the project cost and difficulty in construction. Provision of offset at specific heights in high walls provides a new platform which makes construction more manageable and reduces the stresses. The provision of offset increases the stability of the wall.*

This study presents a comprehensive analysis of multi-tiered reinforced retaining walls constructed using fly ash, a byproduct of coal combustion, as a sustainable alternative material. The investigation focuses on the structural performance and stability of these innovative retaining systems, which offer promising solutions for sustainable infrastructure development. External stability, internal stability, and deformation characteristics are scrutinized to assess the structural integrity and long-term performance of the retaining system. The analysis considers the incorporation of geosynthetics reinforcement characteristics, to enhance the overall stability and load-bearing capacity of the retaining walls. By optimizing the reinforcement configurations and material properties, the study aims to maximize the structural efficiency and resilience of the multi-tiered retaining system. Through comprehensive sensitivity analyses, critical design parameters are identified, aiding in the development of robust design guidelines and recommendations for practical implementation. The findings of this study contribute to the advancement of sustainable infrastructure practices by demonstrating the feasibility and effectiveness of multitiered reinforced fly ash retaining walls. By leveraging innovative analysis techniques, engineers and designers can optimize the design and construction of retaining structures, fostering resilient and environmentally conscious infrastructure development.

Key Word: *Fly ash, Multi-tiered Wall, Geosynthetics, Reinforced earth, offset*

1. Introduction

Reinforced earth retaining walls are generally built to hold back soil mass. Retaining walls are structures that are constructed to retain such materials which are unable to stand vertically by themselves. They are also provided to maintain the grounds at two different levels. A retaining wall is a geotechnical structure constructed to counteract the lateral earth pressure when a change in ground elevation is needed. Geosynthetic-Reinforced Soil (GRS) walls are now widely used in civil engineering practice. In some cases, GRS walls are designed and constructed in tier configurations rather than utilizing them as single walls due to wall stability, construction constraints, space requirements for drainage along the height of the wall, and aesthetics. The wall design with tier configuration is more complicated than a single wall since the upper and lower tiers mutually interact over wall deformation and reinforcement loads. Fly ash can be utilized in many ways in the field of civil engineering applications, roads, railways and dam embankments. Fly ashes have been used in low lying areas as structural fill for developing residential sites and for mine filling. Embankments for roads and highway bridges were constructed using the fly ash to generate from coal fired power plants. Fly ash has also been used as backfill materials behind the retaining walls. Reinforced soil is the technique where tensile elements are placed in the soil to improve stability and control deformation. In this technique, the reinforcements must intersect potential failure surfaces in the soil mass. Strains in the soil mass generate strains in the reinforcements, which in turn, generate tensile forces in the reinforcements. These tensile forces act to restrict soil movements and thus impart additional shear strength.

1.1 Reinforced Earth Retaining Wall

The use of reinforced earth is a recent development in the design and construction of foundations and earth-retaining structures. Reinforced earth is a construction material made from soil that has been strengthened by tensile elements such as metal rods or strips, nonbiodegradable fabrics (geotextiles), geogrids, and the like. The fundamental idea of reinforcing soil is not new, in fact, it goes back several centuries. (There is little difference in reinforcing soil or reinforcing concrete-both materials use reinforcement to carry the tension stresses developed by the applied loads. Bond stresses resist pullout in concrete and soil uses friction stresses developed based on the angle of friction & between soil and reinforcement. The principle of reinforced earth is not new as straw, bamboo rods and similar alternative materials have long been used to reinforce mud bricks and mud walls of primitive houses. Following are the three basic components involved in reinforced earth. Figure 1.1 shows the basic components of reinforced earth wall.

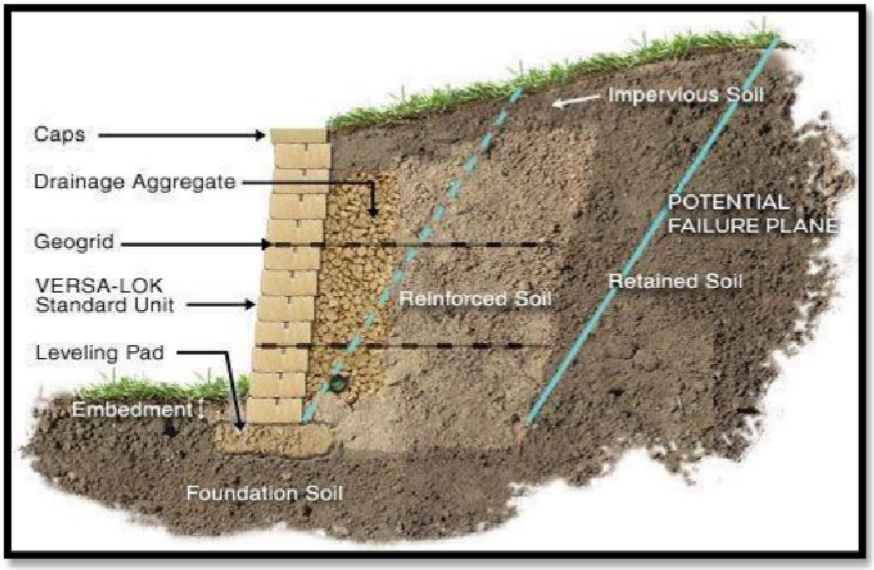


Figure 1.1 Reinforced Earth Retaining Wall

1.2 Multi-Tiered Reinforced Wall

The multi-tiered wall is an earth-retaining structure in which offsets are provided at certain heights. As the wall height increases, stresses on the wall increases, causing an increase in the project cost and difficulty in construction. To take advantage of both the aesthetics and the economics of MSE walls while considering high heights, multitiered walls are often used. In such walls, an offset between adjacent tiers is used. If the offset is large enough, the tensile stress in the reinforcement in lower tiers is reduced. Provision of offset at specific heights in high walls provides a new platform which makes construction cost more manageable and reduces the stresses. Previous studies on multi-tiered walls have established that the provision of offset increases the stability of the wall. In reinforced soil walls, if the wall divided into several sections (here called tiers) it can be called multi-tiered reinforced soil retaining walls (MRSRW). These walls are considered to be a good solution especially if the wall's height need to increase. Figure.1.2

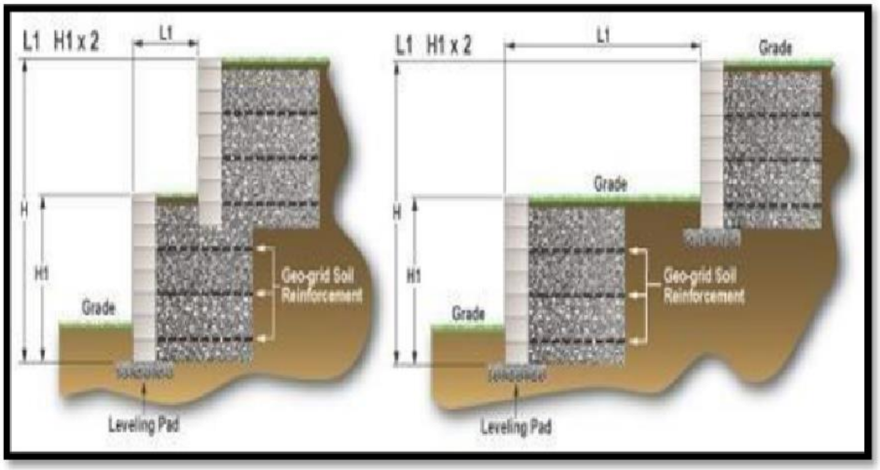


Figure 1.2 Multi-Tiered Retaining Wall .

1.3 Fly Ash

Fly ash is the finely divided residue that results from the combustion of pulverized coal and is transported from the combustion chamber by exhaust gases. Following Figure1.13 shows the fly ash. Fly ash should consist the following characteristics.

- Fly Ash should be non-hazardous with regard to ignitability, corrosivity, reactivity and toxicity.
- It should possess high potential for improvability of its properties, such as workability, performance in conjunction with additives.
- Compatible with other construction materials and consistent in its properties.
- Economically feasible, it should have the characteristics of low unit cost and high quality resulting in savings on construction cost, usable as produced without costly processing, enough and easily available, easy to handle and store and possessing long term stability in performance.

Figure 1.3 Fly Ash

1.4 Soil Reinforcement

Soil reinforcement is a mechanical means of stabilizing weak soils that involves the use of fibrous materials as [illegible] and geonet) natural or synthetic randomly distributed fibers. Different functions perform by the soil reinforcement are as follows.

- Separation: The geo-synthetic, placed between two dissimilar materials, maintains the integrity and functionality of the two materials.
- Filtration: The geo-synthetic allows liquid flow across its plane, while retaining fine particles on its upstream side.
- Reinforcement: The geo-synthetic develops tensile forces intended to maintain or
- improve the stability of the soil geo-synthetic composite.
- Stiffening: The geo-synthetic develops tensile forces intended to control the deformations in the soil & geosynthetic composite.
- Drainage: The geo-synthetic allows liquid to flow within the plane of its structure.

Figure 1.4 shows the different functions perform by geosynthetics

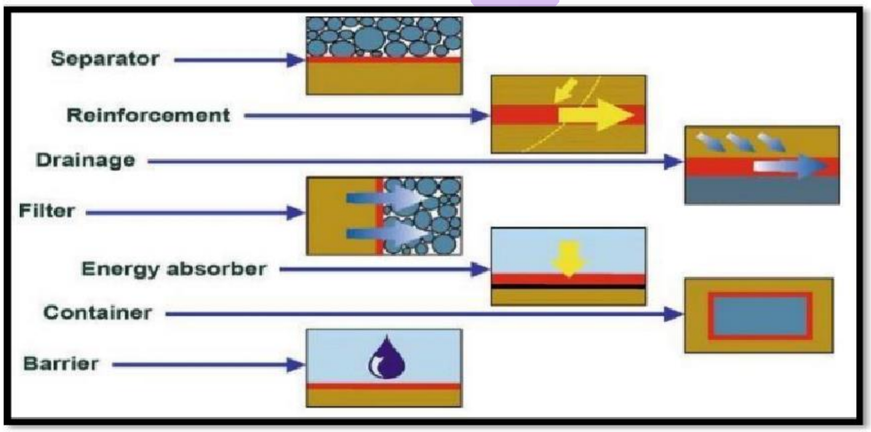


Figure 1.4: Different Functions Of Geosynthetics

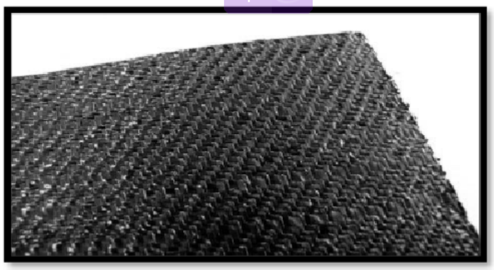
1.4.1 Geogrid

Geogrids represent a rapidly growing segment within geosynthetics. Rather than being a woven, nonwoven or knitted textile fabric. Geogrids are polymers formed into a very open, grid like configuration, i.e., they have large apertures between individual ribs in the transverse and longitudinal directions. Stretched in one, two or three directions for improved physical properties. Made on weaving or knitting machinery by standard textile manufacturing methods. By laser or ultrasonically bonding rods or straps together. There are many specific application areas however, geogrids function almost exclusively as reinforcement materials. The following Figure 1.5 shows the configuration of geogrid.

Figure 1.5 Geogrid

1.4.2 Geotextile

Geotextiles are permeable fabrics which, when used in association with soil, have the ability to separate, filter, reinforce, protect, or drain. Typically made from polypropylene or polyester, geotextile fabrics come in two basic forms: woven (resembling mail bag sacking) and nonwoven. Figure 1.6 shows different types of geotextile (a) woven geotextile (b) nonwoven geotextile.



(a)

(b)

Figure 1.6 Different Types of Geotextiles

2. Literature Review

Ankita Kumar *et al* (2019) performed the parametric study on multi-tiered model fly ash wall. The various stages such as multi-tiered wall model of fly ash and reinforcement, experimental programmed which includes loading setup and procedure. A good quality fly ash and jute geotextile is used as per standards to build the wall model. Loading setup includes the loading frame and other measurement devices The relationship between different design parameters is carried out such as reinforcement length, reinforcement spacing, offset distance etc. The horizontal displacement of wall is reduced to greater percentage when there is inclusion of reinforcement as compared to unreinforced wall. The offset distance is increased When there is addition of reinforcement, settlement of wall is also reduced due to provision of reinforcement. The critical offset distance is also found out for unreinforced and reinforced wall.

K. Jagdish *et al* (2018) performed the numerical analysis of multi-tiered wall, the author has described the various failure pattern of multi-tiered wall by analyzing the internal and external stability. Poorly graded sand well graded gravel is use with inclusion of reinforcement for the wall modelling. Types of failure such as sliding overturning, bending and settlement. The distribution surcharge load is calculated for each separate tier by using geo5 modelling software Slope stability analysis of wall is carried out by bishops' method After it is concluded that the increase the resistance to pullout the reinforcement length should be minimum, overturning behavior of wall is dependent on its geometry and load intensity is dependent on the offset distance between the wall.

A Bhattacharjee *et al* (2015) performed the finite element numerical analysis of multi-tiered retaining wall by using the ANSYS software, comparison between the single and multi-tiered wall model is done with and without inclusions of reinforcement. The main objective of research was to study the different design parameters of multi-tiered wall and their major role for controlling the effect of different forces as compared to single tiered wall. The material use for the construction of model is concrete backfill soil as gravel material and geogrid reinforcement with suitable desired properties.it was observed from the study that the lateral displacement is maximum at offset junction or at the mid height of wall. The displacement decreased with increased in tier offset. The upper wall acts as a surcharge on lower tier which increases deformation at middle. The maximum lateral pressure acts at base of wall and decreases with increased in height. The addition of reinforcement holds the surrounding soil and transfer the stresses partially o facing and soil mass. The vertical stress is higher in unreinforced wall as compare to reinforced wall.

Abedi *et al* (2016) performed the experimental investigation on multi-tiered wall for the determination of lateral pressure and horizontal as well as vertical deflection. The design and geometry consideration of tiered wall taken into account as important to carried out the performance against different failure condition such as settlement lateral deformation etc. The materials used for making the model are poorly graded sandy soil as retained backfill concrete and geogrid reinforcement for filling. A small loading frame is used to apply the load It is concluded that when the tier width and the number of tiers get increased there is decreased in the horizontal deformation and settlement of wall. The number of reinforcement layers can provide best interaction between upper and lower tier to reduce the lateral deformation and increase the bearing capacity of wall.

Digioa *et al* (1972) says that with drainage, the ash can be effectively and economically utilized as a fill material to construct stable embankment for land reclamation on which structure can be safely founded.

Leonard's *et al* (1972) reported that untreated pulverized coal ash with no cementing quantities was used successfully as a material for structural fill. Although, the ash was inherently variable, it could be compacted satisfactorily, if the moisture content was maintained below the optimum obtained from standard laboratory tests and if the percentage of fines (passing the No.200 sieve) was below 60%

Kumar *et al* (1999) gives the results of laboratory investigations conducted on silty sand and pond ash specimens reinforced with randomly distributed polyester fibers. The test results reveal that the inclusion of fibers in soils increases the peak compressive strength, CBR value, peak friction angle, and ductility of the specimens. It is concluded that the optimum fiber content for both silty sand and pond ash is approximately 0.3 to 0.4% of the dry unit weight.

Bera *et al*. (2007) presented the study on compaction characteristics of pond ash. Three different types of pond ash have been used in this study. The effects of different compaction controlling parameters, viz. Compaction energy, moisture content, layer thickness, mold area, tank size, and specific gravity on dry density of pond ash are highlighted herein. The maximum dry density and optimum moisture content of pond ash vary within the range of 8.40–12.25 kN/m^3 and 29–46%, respectively. In the present investigation, the degree of saturation at optimum moisture content of pond ash has been found to vary within the range of 63–89%. An empirical model has been developed to estimate dry density of pond ash, using multiple regression analyses, in terms of compaction energy, moisture content, and specific gravity. Linear empirical models have also been developed to estimate maximum dry density and optimum moisture content in the field at any compaction energy. These empirical models may be helpful for the practicing engineers in the field for planning the field compaction control and for preliminary estimation of maximum dry density and optimum moisture content of pond ash.

Bera *et al*. (2009) have studied the shear strength response of reinforced pond ash, a series of unconsolidated undrained (UU) triaxial test has been conducted on both unreinforced and reinforced pond ash. In the present investigation the effects of confining pressure (σ_3), number of geotextile layers (N), and types of Geotextiles in shear strength response of pond Department of Civil Engineering, 2013, NIT Rourkela Pond ash are studied. The results demonstrate that normal stress at failure (σ_{1f}) increases with increase in confining pressure. The rate of increase of normal stress at failure (σ_{1f}) is maximum for three layers of reinforcement, while the corresponding percentage increase in r_{1f} is around (103%), when the number of geotextile layers increases from two layers to three layers of reinforcement. With the increase in confining pressure the increment in normal stress at failure, Δr increases and attains a peak value at a certain confining pressure (threshold value) after that Δr becomes more or less constant. The threshold value of confining pressure depends on N, dry unit weight (γ_d) of pond ash, type of geotextile, and also type of pond ash.

Ghosh *et al*. (2010) presents the laboratory test results of a Class F Pond ash alone and stabilized with varying percentages of lime (4, 6, and 10%) and PG (0.5, and 1.0), to study the suitability of stabilized pond ash for road base and sub-base construction. Standard and modified Proctor compaction tests have been conducted to reveal the compaction characteristics of the stabilized pond ash. Bearing ratio tests have been conducted on specimens, compacted at maximum dry density and optimum moisture content obtained from standard Proctor compaction tests, cured for 7, 28, and 45 days. Both un-soaked and soaked bearing ratio tests have been conducted. This paper highlights the influence of lime content, PG content, and curing period on the bearing ratio of stabilized pond ash. The empirical model has been developed to estimate the bearing ratio for the stabilized mixes through multiple regression analysis. The linear empirical relationship has been presented herein to estimate soaked bearing ratio from un-soaked bearing ratio of stabilized pond ash. The experimental results indicate that pond ash-lime-PG mixes have potential for applications as road base and sub base materials.

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Kumar *et al* (2012) Reinforced earth retaining wall is comparatively a new construction technique. Due to its simplicity, economy and faster pace of construction, several such retaining walls have been constructed all over the world and this technique has almost replaced the conventional reinforced concrete and gravity retaining walls. To reduce the congestion on National Highway-2 at the crossing of Kalinda Kunj near Sarita Vihar, New Delhi, a flyover was constructed along Badarpur-Ashram direction. The construction of approach road was carried out with reinforced retaining wall with friction polymeric ties (geosynthetic material) as reinforcement material. Instead of conventional earth, pond ash from the nearby Badarpur thermal power plant was used as backfill material. The paper discusses the properties of geosynthetic reinforcement; backfill material, design details and the methodology adopted for construction of reinforced approach embankments. Conclusions have been drawn about the suitability of geosynthetic material as a reinforcement and pond ash as a backfill material for the retaining wall.

S.Adhana *et al* (2011) perform parametric study on reinforced fly ash slope using different geosynthetics. The model tests were conducted in the laboratory without and with reinforcement in fly ash steep slopes on soft foundation to check the stability of steep slope. In this experiment fly ash is used as a filling material and two types of reinforcement were used: (a) Three dimensional circular geocell strip (diameter =5 cm and height=1cm) made from waste plastic bottles and (b) polyester geogrid strip (width = 4.5 cm and thickness = 0.3 mm). The properties of geocell and geogrid strip are determined. From the experiments, load and settlement have measured. From these data, load –settlement curves have reported. It has been observed from test results that load carrying capacity of geocell is more than that of geogrid strip. The deformation of geocell is slightly more than that of geogrid strip. A Finite Element Method (F.E.M.) was also evaluated using PLAXIS 8 version The failure pattern, deformations and factor of safety are reported based on analytical programmed.

Mohammad Al-Barqawi et al (2021) presented a review on Polymer geogrid for study of its Material, Design and Structure Relationships in which he introduces the properties of geogrid, test method to find out the properties, how to design the reinforcement for particular structure and failure of reinforcements are also described In this review, advances and current understanding of geogrid materials and their applications to date are presented. A critical analysis of the various geogrid systems, their physical and chemical characteristics are presented with an eye on how these properties impact the short- and long-term properties. The review investigates the approaches to mechanical behavior characterization and how computational methods have been more recently applied to advance our understanding of how these materials perform in the field. Finally, recent applications are presented for remote sensing subgrade conditions and incorporation of geogrids in composite materials.

2. Conclusions

From the above literature the following conclusions can be drawn

1. Numerical study on the behavior of multi-tiered reinforced fly ash wall.
2. Experimental study on dynamic behavior of multi-tiered fly ash wall with different geosynthetics reinforcements.
3. Parametric study on dynamic behavior of multi-tiered fly ash wall.
4. Effect of various geosynthetic reinforcement can be studied for different parameters.

5. Both experimental and analytical study can be carried out for seepage analysis with different materials.

3. References

1. Dutta, S., and J. N. Mandal. 2015. "Model Studies on Geocell-Reinforced Fly Ash Bed Overlying Soft Clay." Journal of Materials in Civil Engineering 28 (2): 04015091-1-04015091-13. doi:10.1061/(ASCE) MT.1943-5533.0001356.
2. Dutta, S., and J. N. Mandal. 2016. "Numerical Analyses on Cellular Mattress – Reinforced Fly Ash Beds Overlying Soft Clay." International Journal of Geomechanics 17 (4): 4016095-1-4016095– 17. doi: 10.1061/(ASCE)GM.1943-5622.0000772
3. Ghosh, A., A. Ghosh, and A. K. Bera. 2005. "Bearing Capacity of Square Footing on Pond Ash Reinforced with Jute-Geotextile." Geotextiles and Geomembranes 23 (2): 144–173. doi: 10.1016/j.geotexmem.2004.07.002.
4. Ghosh, A., A. Ghosh, and A. K. Bera. 2005. "Bearing Capacity of Square Footing on Pond Ash Reinforced with Jute-Geotextile." Geotextiles and Geomembranes 23 (2): 144–173. doi: 10.1016/j.geotexmem.2004.07.002.
5. Hatami, K., R. J. Bathurst, and P. Pietro. 2001. "Static Response of Reinforced Soil Retaining Walls with Non-uniform Reinforcement." International Journal of Geomechanics 1 (4): 477–506. doi:10.1061/ (ASCE)1532-3641(2001)1:4(477).
6. IS 3812-1 (2033): Specification for Pulverized Fuel Ash, Part 1:
7. Kim, S. B., and C. Yoo. 2008. "Performance of a Two-Tier Geosynthetic Reinforced Segmental Retaining Wall under a Surcharge Load: Full-Scale Load Test and 3D Finite Element Analysis." Geotextiles and Geomembranes 26 (6): 460–472
8. Kim, B., M. Prezzi, and R. Salgado. 2008. "Geotechnical Properties of Fly and Bottom Ash Mixtures for Use in Highway Embankments." Journal of Geotechnical and Geoenvironmental Engineering. ASCE 131 (7): 914–924
9. Krieger, J., and B. R. Thamm. 1991. "Studies of Failure Mechanisms and Design Methods for Geotextile-Reinforced Soil Walls." Geotextiles and Geomembranes 10 (1): 53–63.
10. Kumar, A., and J. N. Mandal. 2017. "Effect of Reinforcement on Multi-tiered Fly Ash Wall." Procedia Engineering 189: 446–453.
11. Lal, B. R. R., and J. N. Mandal. 2013. "Study Of Cellular Reinforced Fly Ash under Triaxial Loading Conditions." International Journal Of Geotechnical Engineering 7 (1): 91-104. doi:10.1179/ 1938636212Z.0000000001.
12. Mohammad Al-Barqawi 2021,"Polymer Geogrids: A Review of Material, Design and Structure Relationships", 14, 4745
13. NCMA. 1997, "segmental retaining walls"
14. Prateek Malik, Sudipta k Mishra Volume-10 Issue-3, January 2021Geosynthetics Stabilizers and Fly Ash for Soil Subgrade Improvement – A State of the Art Review ISSN: 2278-3075, International Journal of Innovative Technology and Exploring Engineering (IJITEE)
15. Sawicki, A., and D. Leś niewska. 1986. "Failure Modes and Bearing Capacity of Reinforced Soil Retaining Walls." Geotextiles and Geomembranes 5: 29–44.

16. Wright, S. G. 2005. "Design Guidelines for Multi-Tiered MSE Walls." FHWA Report No. FHWA/TX-05/0-4485-2
17. Yoo, C., and H. S. Jung. 2004. "Measured Behavior of a Geosynthetic-Reinforced Segmental Retaining Wall in a Tiered Configuration." Geotextiles and Geomembranes 22: 359–376.

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P/V You have used the passive voice in this sentence. Depending upon what you wish to emphasize in the sentence, you may want to revise it using the active voice.

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Article Error You may need to use an article before this word. Consider using the article **the**.

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Proofread This part of the sentence contains a grammatical error or misspelled word that makes your meaning unclear.

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Prep. You may be using the wrong preposition.

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Proofread This part of the sentence contains a grammatical error or misspelled word that makes your meaning unclear.

Garbled Grammatical or spelling errors make the meaning of this sentence unclear. Proofread the sentence to correct the mistakes.

Article Error You may need to use an article before this word. Consider using the article **the**.

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Missing "," You may need to place a comma after this word.

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Missing "," You may need to place a comma after this word.

Run-on This sentence may be a run-on sentence. Proofread it to see if it contains too many independent clauses or contains independent clauses that have been combined without conjunctions or punctuation. Look at the "Writer's Handbook" for advice about correcting run-on sentences.

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Article Error You may need to remove this article.

Article Error You may need to use an article before this word.

S/V This subject and verb may not agree. Proofread the sentence to make sure the subject agrees with the verb.

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Missing "?" Remember to use a question mark at the end of a question.

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