Geo Grid and Steel Netting for Road Slip Slope Protection Efficiency and Effectiveness Assessment: Department of Public Works and Highways, Aurora District, Philippines

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Abstract: - This purpose of the was to assess the efficiency and effectiveness of the Geo Grid and Steel Netting for Road Slip Slope Protection among the projects of the Department of Public Works and Highways, Aurora District, Philippines. Variables to be presented were; (i) Program Evaluation Review Technique (PERT); (ii) Critical Path Method (CPM); (iii) Core Boring Test; and (iv) Scope, Schedule, Budget, Satisfaction (team, customer) and quality. The current study utilized the quantitative research design through various assessment of the geogrid and steel netting among the projects of the DPWH-Aurora with regards to the road slip slope protection. This study was participated by forty project implementers among the forty selected projects on slope protection. The findings revealed that the PERT, CPM, Core Boring and Project Management were found to be outstanding. Slope safety has always been a top priority throughout highway building and operation. The use of highway slope ecological protection technologies could swiftly restore the region's ecological balance, general landscape, and biodiversity.

Key Words: — *Geogrid, Steel Netting Road Slip, Slope Protection.*

I. INTRODUCTION

Slope protection and stability that is properly planned must have two components: a vegetational-biological component and a mechanical-structural component. Both components must be integrated prior to road building for optimal effect. Vegetative coverings that are well-designed and planted can help to reduce surface erosion and shallow mass collapses. On shallow soils on steep slopes, live plant root systems serve as a binder for individual soil particles or aggregates. They increase slope stability in three ways: (1) they bond unstable soil mantles to stable subsoils or substrata, (2) they provide a cover of laterally strong fine root systems close to the surface, and (3) they provide localized centers of reinforcement near individual trees where embedded stems act as a buttress pile or arch-abutment on a slope.

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Traditional retaining walls, either gravity or cantilever, or a reinforced earth structure might make up the structural-mechanical component. When there is a risk of deep-seated slope movement or large lateral earth stresses, structural-mechanical stabilizing solutions are required. A simplified flow chart depicts the best approach combination for maintaining or achieving a stable, erosion-free slope. The effect of water and the significance of efficient drainage are implicit in any discussion of slope stability. Plant transpiration, in addition to mechanical controls, can provide a sort of "biological" drainage through vegetation. During their active growing season, root systems can successfully dewater soil mantles, yet the periods when sloe failure and erosion are most likely do not coincide with peak transpiration.

However, this is far more difficult to consider in the slip roads otherwise known as slip lanes. Landslides pose a severe threat to road maintenance. It depicts the various types of slope risks that regularly occur on highways. Shallow slope collapses that occur within roadside cut slopes and the slopes above are by far the most common. These causes partial or complete road closures, causing traffic congestion for several hours at a time.

When there are several landslides and/or limited earth-moving equipment available to clear them, this disruption can extend for days. The majority of the geotechnical tests were focused on earth movements beneath the road. Stream erosion and scour below culvert outlets, seepage of road runoff into slopes, and headward regression of landslide and erosion scars were the main sources of these issues. A site investigation was conducted at each of these locations, which included topographic mapping, engineering geology mapping, and ground investigations. Trial pits can be used to explore shallower slope failures, including the use of a dynamic cone penetrometer to test retaining wall founding conditions.

At deeper sites, drill holes were used to complement trial pits. Regardless of the slip road slope protection treatments that can be applied, the Department of Public Works and Highways has typically designed numerous possibilities to build a castigating effort for these types of works that do not require reworks.

The purpose of this study was to compare the strength characteristics of geogrid and steel netting in the slip road slope protection. Also, an attempt has been made to partially replaced treatment in slope protection, which is a by-product of the geogrid and steel netting. The rising cost of river sand, which is utilized as fine aggregate in concrete, has driven up construction costs dramatically in recent decades. Foundry sand, which is obtained from foundry industries, is classified as a waste material with the ability to be recycled in concrete, and it has been proposed for use in this study as a partial replacement for sand. Using the above materials, various mix proportions were created, and panels were created to determine the best percentage based on the compressive and tensile strength of cube and cylinder specimens. Panels were cast with two layers of steel mesh and geogrid mesh. The strength parameters of the panels were compared, and the failure patterns of the panels were investigated. The strength of geogrid panels was found to be comparable to that of ferrocement panels, with geogrid panels outperforming ferrocement panels in terms of corrosion resistance and flexibility.

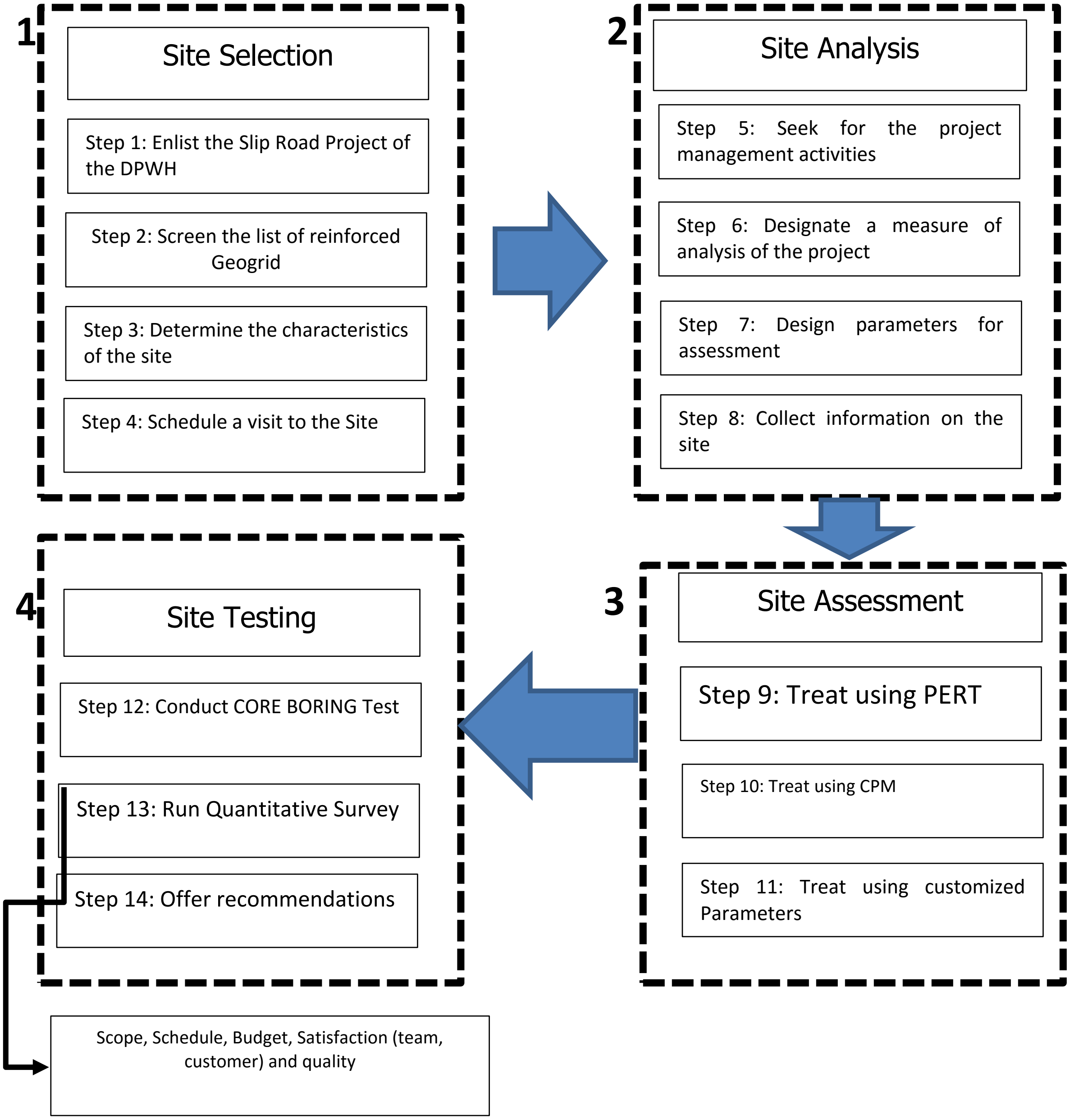
In this study, the proponents would like to assess the effectiveness and efficiencies of the Geo Grid and Steel Netting for Road Slip Slope Protection among the currently-built slope protection under the supervision and maintenance of the Department of Public Works and Highways in the district of Aurora. Treatment characterization and subsequent determination of treatment strength parameters play an important role in determining slope stability. Because the treatment properties are difficult to anticipate for a big volume, geotechnical engineering is always governed by substantial uncertainties. Because each design and project employ its own methods for evaluating and interpreting therapy, there is no standardized way for evaluating treatment parameters. Uncertainties are widespread in geotechnical engineering; thus, most projects require qualitative and quantitative risk management. The assessment of shear strength is critical in slope stability since it has a significant impact on the stability. This research will look into several approaches for estimating the characteristic value of Geo Grid and Steel Netting as slip road slope protection solutions.

II. Estimate At Completion And Earned Value Management

The widespread estimate at completion (EAC) presupposes a linear cumulative labor curve, which is rarely explained. This is an example of Koskela and Howell's (2002) criticisms of project management as a "limited" (i.e., linear) theory and a "implicit" theory (i.e., the linearity is rarely acknowledged).

We address these concerns by presenting a theory that starts with the explicit premise that activities are linked by sequential dependencies, as is the case in the standard project network diagram. With the addition of a few plausible assumptions, a practical relationship between the project's network topology and the labor rate profile develops, which becomes a fundamental project observable, as we use the term in the formal scientific sense. The labor rate is integrated into a typical S-shaped curve, resulting in a far more realistic project management model. We demonstrate how to characterize the S-curve labor profile's parameters in terms of cost and schedule. We test our theoretical model's predictions against a real-world project, and the consistency between theory and practice provides preliminary empirical validation of the theory and demonstrates that a theory of project management with immediate practical benefits may be developed. Finally, we look at some of the theory's ramifications.

Fig.1. Research Paradigm



Even though the critical path method (CPM) and earned value management (EVM) are said to have universal applicability, the definition of a project specifically incorporates the idea that each one is unique. As a result, there is an unsaid assumption that CPM and EVM have valid, global applicability due to the existence of some form of shared, underlying theory. In practice, EAC has proven to be dependable and effective. Why, then, should such a limited. (i.e., linear) theory operate so well when real-world labor curves are typically S-shaped? Furthermore, the difficulties of using EVM to schedule prediction are well-known, and various attempts have been made to address this problem. The earned schedule equations, for example, are empirical, and there are no linear models to support the earned schedule estimation formulae that we are aware of. As a result, one could argue that there isn't even a "implicit and narrow" theory for timetable estimate.

In addition, project control is reduced to a simple thermostat model that corrects deviations from predefined parameters. This necessitates a number of assumptions, including the existence of a performance standard that can be defined and measured, the existence of a causal relationship between management actions and project outcomes, and the ability of management actions to return the project to the desired state. There is no certainty that any individual action taken by a project manager will fix, or even affect, the observable in question without a theory that describes the explicit relationships between observables. As a result, a flaw in the thermostat model is that the causes of problems are unknown without an underlying theory. The scientific method should be used to create a more advanced model. We propose a rigorous theoretical underpinning for attempts to address these difficulties.

III. Methodology

This study sought to assess the efficiency and effectiveness of the Geo Grid and Steel Netting for Road Slip Slope Protection among the projects of the Department of Public Works and Highways, Aurora District, Philippines. More specifically, it answered the following questions:

1. How may the slip roads built by the Department of Public Works and Highways in the District of Aurora be described along:
    a. Program Evaluation Review Technique (PERT); and
    b. Critical Path Method (CPM)?
2. How may the geogrid and steel netting be assessed through its effectiveness and efficiencies in road slip slope protection along the:
    a. Core Boring Test; and
    b. Scope, Schedule, Budget, Satisfaction (team, customer) and quality?
3. What recommendations can be drawn from the findings of the study?

The current study utilized the quantitative research design through various assessment of the geogrid and steel netting among the projects of the DPWH-Aurora with regards to the road slip slope protection. The assessment was within four- part scenario. The first part is the scope of the PERT which engaged the selected projects into review how the project was dons. The second part was the CPM method of the project how it was controlled during its implementation. The third part was mathematical approach on testing the selected projects which were treated with core boring test. The last part was a descriptive assessment based on the response rating of the project managers on the scope, schedule, budget, satisfaction and quality of the works. This study was participated by forty project implementers among the forty selected projects on slope protection.

The ratings for the efficiency and effectiveness of the geogrid and steel netting of road slip slope protection could be determined with the following range scales:

Table.1. Range Interval

Description	Range Scale
Excellent	4.21-5.00
Outstanding	3.41-4.20
Satisfactory	2.61-3.40
Fair	1.81-2.60
Poor	1.00-1.80

IV. Results And Discussion

Results showed that project implementers of the road slip slope protection using geogrid and steel netting was fascinated with their works as it rated generally as outstanding with 3.50 average weighted mean. However, the PERT Method of their projects were satisfactory rated when it came to pessimistic time, most likely time and expected time as some of these projects were affected by the different influencing factors such as weather and the availability of the resources. More importantly, the optimistic time was quality in control as the most possible time was met during the project management in reinforcing the geogrid and steel netting to the road slip slope protection.

Optimistic time is a concept used in the PERT. It represents the shortest estimated time period within which a task is likely to be completed, and is used in project planning. PERT estimation technique will be a practical approach for estimating when the tasks on hand are filled with uncertainties, where the tasks may take up different estimates depending upon certain conditions. Actual estimate is dependent on certain variables.

Table.2. PERT Method

Item Statement	Rate	Descriptive Interpretation
Optimistic Time	4.03	Outstanding
Pessimistic Time	3.40	Satisfactory
Most Likely Time	3.23	Satisfactory
Expected Time	3.33	Satisfactory
Overall Mean	3.50	Outstanding

With regards to the Critical path Method, it as found out that it was rated outstandingly as the project implementers sought that their control over the projects were most likely attainable. However, tracking of the project progress had been rated satisfactorily as some points in time management, there were constraint whether the projected GANTT Chart can be measured with its attainability during the imposition of the project, likewise the solitary effects of some environmental elements like weather, holidays and some other forms.

Critical path analysis (CPA) is a project management technique that requires mapping out every key task that is necessary to complete a project. It includes identifying the amount of time necessary to finish each activity and the dependencies of each activity on any others. Critical path analysis identifies the sequence of crucial and interdependent steps that comprise a work plan from start to finish. It also identifies non-critical tasks. These may also be important, but if they hit an unexpected snag they will not hold up any other tasks and thus jeopardize the execution of the entire project. The project plan must be tracked through the course of a project to make sure every task is on track and no adjustments need to be made. The timeline in a CPA is often expressed as a Gantt chart, a type of bar chart that is designed to illustrate the key dependencies in a complex project.

Table.3. CPM Method

Item Statement	Rate	Descriptive Interpretation
Minimum time in which the project can be completed	3.93	Outstanding
Sequence of activities completed on time	3.63	Outstanding
Tasks can be delayed without delaying the project completion time	3.53	Outstanding
Early and Late Start of tasks	3.66	Outstanding
Tracking project progress	3.16	Satisfactory
Overall Mean	3.58	Outstanding

For the core boring test, it was generally rated as outstanding with 3.74 weighted mean despite the satisfactorily rating of the thickness which was the most needed analysis for the efficiency of the geogrid and steel netting. However, it can be said enough that road slip slope protection projects were close to excellence as its strengths, toughness, comprehensiveness and absorbability were all rated as outstanding.

In road construction, reinforcing wide soil slopes has always been a problematic problem. The deformation of expanding soil is strongly restricted by traditional inflexible structures, which can easily lead to structural failure under excessive stress. Instead, the slope may be harmed by higher deformation due to the flexible construction. When utilized alone, neither of them can accomplish the expected impact. The geogrid-steel tube expansive soil retaining wall is described in this work. It can reasonably coordinate the structure's stress and deformation, as well as support the expansive soil slope. For the reinforcement test, this paper employs a comparable material model in a big size. As a retaining wall filler, expansive soil is used. The wall's integrity and rigidity are improved by geogrids and longitudinal steel tubes. Under simulated rainfall circumstances, the new and traditional structures' reinforcement effects are compared. Furthermore, the reinforcement mechanism of a geogrid-steel tube expansive soil retaining wall is investigated by monitoring the retaining wall's horizontal displacement, earth pressure on the rear of the wall, and steel tube deformation. The results reveal that the deformation of a geogrid-steel tube retaining wall is substantially less and more evenly distributed than that of a standard geogrid retaining wall. The geogrid-steel tube retaining wall's bearing capacity has been greatly increased. The steel tubes, which are rooted in the foundation and pierce the wall longitudinally, efficiently improve the retaining wall's stress. The findings of this study can be used as a theoretical guide for choosing a reinforcement structure and designing a structural design for an expanding soil slope.

Table.4. Core Boing Test

Item Statement	Rate	Descriptive Interpretation
Strengths	3.46	Outstanding
Thickness	3.36	Satisfactory
Toughness	3.90	Outstanding
Comprehensiveness	4.16	Outstanding
Absorbability	3.80	Outstanding
Overall Mean	3.74	Outstanding

Lastly, the project implementers from the DPWH-Aurora rated the generality of the geogrid and steel netting and found out to be satisfactory. They knew for a fact that the budget and the quality of works were significantly related as the projects were budgeted and planned-well, there were doubts of depreciations which were subject to certain attainability of the success such as its scope, schedule and the satisfaction that the project that may dismay the team and the stakeholders.

It was claimed that because of the static stresses of self-gravity, as well as the dynamic load of train travel, the internal force and form of reinforced earth walls employed in high-speed railways alter. The study of the dynamic features of reinforced retaining walls is important for engineering applications and structural analysis since they are a type of flexible retaining structure. Recent breakthroughs in applying various research approaches to study the dynamic features of reinforced retaining walls are discussed. The study development of dynamic properties of reinforced retaining walls is presented through a series of experimental tests and numerical analysis. Various test methods are examined for their benefits, drawbacks, and application. Finally, based on prior research findings, laboratory model tests are described, and prospects for the development of dynamic features of reinforced retaining walls are given.

Table.5. Project Management Platform

Item Statement	Rate	Descriptive Interpretation
Scope	2.76	Satisfactory
Schedule	3.10	Satisfactory
Budget	3.83	Outstanding
Satisfaction	3.20	Satisfactory
Quality of the works	3.96	Outstanding
Overall Mean	3.37	Satisfactory

V. Conclusion

This study was delimited to the testing of the efficiencies and effectiveness of the geogrid and steel netting as those are used in slip road slope protection. There are many projects of the Department of Public Works and Highways-Aurora District which utilizes geogrid and steel netting in their processes. However, this research will only choose the projects in slip road slope protection all over the province. The fiscal year 2021 will only be covering the projects as reflected in the study. This will enlist the projects which are targeted for assessment for efficiencies and effectiveness. Moreover, there will be a descriptive survey among the project implementers of the targeted projects for Scope, Schedule, Budget, Satisfaction (team, customer) and Quality. These variables will be presented with descriptive analysis.

Slope safety has always been a top priority throughout highway building and operation. Ecological protection technology, which considers the roles of protection, ecology, and landscape, is commonly utilized in highway slopes. The major goal of ecological protection technology is to increase slope stability by combining supporting structures and plants, and vegetation restoration can help mitigate the detrimental effects of highway construction. The newest research progress in ecological protection technology was first evaluated in this study in order to identify the major construction method and types, which disclosed the ecological protection technology's protective mechanism. From the perspectives of air, water circulation, landscape, and biodiversity, the comprehensive benefits of ecological slope protection technology were examined. It has been discovered that highway slope ecological protection technology primarily forms the atmosphere-plant-soil system. Through the supporting structure and the anchoring action of plant roots, highway slope ecological protection technology improved the slope's stability. In addition, the regeneration of surface vegetation on the slope increased plant photosynthesis and transpiration, improving air quality along the highway. The use of highway slope ecological protection technologies could swiftly restore the region's ecological balance, general landscape, and biodiversity.

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