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Best Practice Project Management when there are so many Geosynthetic solutions for a project.

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Abstract

Best practice Project Management of Geotechnical projects benefits from a broad knowledge of cross disciplinary methods of assessment. The product and its performance, relies equally from each contribution, whether from the Engineer, the Engineering geologist, the Materials laboratory, the Manufacturer, the Contractor and the Owner. Each discipline/stakeholder have their own way or methods of accurately defining the proposed objective and the project success is dependent on the interpolation and understanding clearly, the ramifications of a poor respect for the contribution from environmental elements. The current increase of geosynthetic choices allows the practitioner a wide range, from which to consider any solution. The extensiveness of options raises the risk for incorrect choices or combinations thereof.
The Project Manager has the arduous task to facilitate the contribution from each in the group and ensure that when the environmental characteristics fluctuate, the results and performance, although now more difficult to predict, culminates in a satisfactory design and execution. Mechanically stabilized walls and slopes are projects that require a serious approach to approving which geosynthetics to use in the design. Historical performance has excellent value in the base choices of materials to use, but with careful consideration and management the innovative materials can develop and open new boundaries.

Keywords: *Ramifications, assessment, interpolation, MSEW, environmental, cross disciplinary.*

1 Introduction

MSE (Mechanically Stabilized Earth) walls have gained wide acceptance within the public and private sectors, becoming the standard of practice for filled walls. The evolution of MSEW has been gaining traction as they are less expensive to construct and easier to design and build. This evolution has sparked a boom in a wide variety of proprietary systems with various combinations of facing types and connection methods for different reinforcements. Failures in these structures are reported to be as high as 5% (Berg 2010). Most of these failures are either from improper design or poor installation.

Geosynthetics provide the backbone for MSEW projects and with many new innovations in technology, Geosynthetics have evolved in all different shapes, textures, strengths and sizes. Each supplier having their own types of testing methods, project managers and designers of MSEW have the arduous task of sifting through this information to find a solution that is fit for purpose. Manufacturing times, Aggressiveness to fluctuations in environment, ease of installation, construction requirements and specifications go a long way in determining the type of geosynthetic used in material selection.

An MSEW relies on the contributions of multiple stakeholders which can include a project engineer, geotechnical engineer, wall vendor, wall designer, contractor, subcontractor, surveyor, architect, inspector, and owner. This can lead to confusion as well as a shirking of responsibilities which in turn leads to performance issues.

Many of these stakeholders have their own way or methods of defining the proposed objectives at times without a systematic approach to effective project management elements. These elements can assist in the project success by eliminating multitude of choices at the disposal of the project team.

For these reasons, the use of a few elements of project management considered “best practice” (J.N, 2000) are necessary for successful project management implementation on geosynthetic projects.

A proper evaluation of the proposed use, materials specification, and installation procedures is important to achieve good construction practices. Geosynthetic stabilization of soils involves four basic functions of reinforcement, separation, filtration and drainage. The relative importance of each function is governed by the site conditions, especially soil type and groundwater drainage, and the construction application. In many cases, two or more basic functions are required of the geosynthetic in a particular application (for example, separation and filtration).

2 Factors influencing the selection of Geosynthetics

While there are many reasons to choose Geosynthetics over traditional solutions, there is an inherent need for membrane-like materials as geotechnical structures are built with granular materials; the integrity of layers of granular soils can be disrupted by erosion, settlements and earthquakes while a geotextile layer remains continuous. Besides, geotextile are bi-dimensional and its flexibility is well-suited to geotechnical structures subjected to different movements. Geotextiles are also useful, either as interface between layers or as a liner or a protection at the surface of the mass geotechnical structures. More over, the stakeholders involved, the site conditions, material properties and the basic function required play an integral role in selection of the type and their use in the design of geotechnical structures.
Furthermore, geotextiles have been successful because manufacturers have aggressively developed and supported their use with convincing case studies which has helped to market them and because contractors, consultants and owners have elected to use them because of this confidence.

2.1 Stakeholders

a) **Owners**: Owners are satisfied the industry and market trend of using geosynthetics as combination of low cost and more stable requirements allow room for innovation in design. For owners, by adopting geotextile products or solutions, maintenance work can be reduced which in turn save costs.

b) **Consultants**: With the greater emphasis now placed on "value engineering", Consultants are required to produce economical designs to remain competitive. Consultants find that geotextile products may increase the reliability of a structure because the quality control of their placement is relatively easy, their installation is not weather dependent, their properties are more uniform than soil particles and they mitigate soil defects by bridging weak spots and separate layers which tends to mix. Geotextiles has thus opened the door for new possibilities in design.

c) **Contractors**: The ease of installation of geotextiles compared to granular fill reduces construction time. Using geotextiles in road construction is recommended more often because geotextile is less weather dependent, and trucks are less likely to get overwhelmed when a geotextile is used. Geotextile can also reduce the amount of earthwork as geotextile drains and filters are far less bulky than granular fill. The cost of earthwork is reduced if geotextile reinforcement allows the use of lower quality fill materials, which are less expensive. Besides earthwork, transportation costs can be reduced by replacing granular fills with geotextile. It will improve the environmental impact since there is less noise and dust associated with transportation of construction materials.

d) **Material Suppliers**: Often the role of the manufacturers/supplier's knowledge/skill has contributed to the Technical and Engineering needed by the consultants, owners, and contractors in many ways, including when required to Professional liability signing off on global stability of the structure, checking and advising on quality assurance and providing support.

2.2 Basic functions of the Geosynthetics and Site Conditions

Geosynthetic stabilization of soils involves four basic functions of reinforcement, separation, filtration and drainage. The relative importance of each function is governed by the site conditions, especially soil type and groundwater
drainage, and the construction application.

Reinforcement: A geotextile acts as a tensile member when it provides tensile strength to a soil with which it is interacting through interface shear strength, for instance the interlocking, friction, cohesion and adhesion.
Separation: prevention of mixing of different soils and rock used in the different construction materials
Filtration: the unimpeded flow of water through a geosynthetic, without allowing a significant amount of soil particles to flow through
Drainage: the gathering of water and move it through the geotextile towards an outlet.

The geosynthetics ability to accommodate poor construction conditions on site without losing its performance integrity.

2.3 Material Properties

In each application, the relevant contribution of the geosynthetic product to soil stabilization is governed by its material properties. These properties are used to quantify the strength, hydraulic characteristics and durability of the geosynthetic. They determine the benefit to be gained through improved reinforcement, separation, filtration and drainage of the soils. Material properties are the basis for product selection and, therefore, are referenced in standard specification documents.

Long Term Resistance
Geotextiles have been widely used in geotechnical engineering for several decades. Along with polymers such as polyester (PET) or polyethylene (PE), polypropylene (PP) is the polymer most used for these applications. When engineers began to

use these materials, the first investigations on the long-term performance for instance, UV resistance, chemical resistance, biological resistance etc. under practical environmental conditions started.

UV Resistance
Any polymer used for the manufacture of geotextile will degrade when exposed to the ultraviolet radiation of natural sunlight overtime. Therefore, it is essential to consider resistance of geotextile to the effects of sunlight when designing with geotextiles. Care is necessary when geotextile is to be installed in regions of the world where the UV radiation levels are high or when geotextile will remain exposed over a period of weeks or even months on large scale projects. It is wiser to protect the geotextile from degradation. This can be done by using stabilizers, to match the aging process with the long-term requirements of the application. High quality geotextile comes equipped with high performance stabilizers; therefore, the required lifetime of the geotextile is guaranteed. However, predictions based on laboratory testing is not possible to determine the degradation of geotextile caused by UV sunlight due to the considerable number of parameters influencing the product lifetime. For instance:
a) The degradation process within the polymer of the geotextile is extremely slow under ambient temperatures.
b) There is no proven correlation between laboratory tests and practical application, as these products have only been in use for 30 years. However, if a design lifetime of 120 years is required it requires the reliance on accelerated laboratory testing.
c) The comparison of products installed 30 years ago with currently manufactured ones is difficult since today's product, has a different structure and chemical composition because of constant ongoing product development.
d) The chemical reaction of oxidative process is very well known, but in practical applications other stress factors, such as installation damage, chemical attack and many variable factors, may be superimposed on it.

Chemical Resistance
Polypropylene is characterized by an excellent resistance to chemicals. It is proven during CE certification programme as several investigations were carried out in accordance with ISO 14030. For polypropylene geotextile, no strength loss was observed, even in acidic or alkaline conditions, in contrast to polyester products. The fiber surface of polyester yarns is particularly susceptible to degradation when exposed to alkaline condition (pH >10), external hydrolysis will take place. But even when it is exposed to acidic condition, the material is gradually degraded by internal hydrolysis. In this case, the polymer chains are split by the presence of water, thereby reducing the molecular weight. Finally, it will lead to a drastic reduction of mechanical properties. Therefore, it is essential to protect polyesters material by providing extra coating such as a PVC for a simple example.

Biological Resistance
Investigations according to EN ISO 12225 have shown that polypropylene geotextile are 100% resistant to micro-organisms. Currently, no organisms are known to be harmful to polypropylene. It is important to know the biological resistance of the material in long term applications, as the influence of the organisms cannot be estimated.

5 Best Practice

- **Defined Life Cycle**
  - Organizations need to map and define phases, deliverables, key milestones and sufficiency criteria for each group involved in the project. There are four phases to a project life cycle—Concept, Planning, Implementation and Closeout. Project management is used in all types of industry and business. Adopting four basic phases provides a collective understanding about projects that cross industry lines.

- **Stable Requirements and Scope**
  - It is important for the design team to stay current on project specifications. While it may be easy and tempting to "cut and paste" specifications from one project to another, doing so can be harmful to the project in several ways. Over-specifying products to the point it is hard to find a material that works, under-specifying products such that they may be inferior for the design intent and specifying installation practices that are out dated and compromise quality during installation.
  - The design team should use all resources available in determining the specifications and developing QA Plan. There are plenty of resources readily available to assist the design team in this function, such as manufacturer's websites which contain typical specifications, product installation manuals, technical data sheets, etc. that can be obtained on the internet and/or through a phone call. Likewise, many material suppliers employ engineers that usually are happy to assist in answering questions about designs.

- **Defined Team, Systems, and Roles**

There are plenty of variations in both the qualifications of individual contractors, from the design firm through to the construction teams. To achieve the best output possible, it is important to determine exactly what you are going to get for your investment. Regardless of which decision is made, key components of the team should be evaluated, and their roles defined

- **Design team**: It is important to properly vet the design team to ensure they can design and have facilities to conform to the needs of the owner. This may require investigating references, asking for samples of similar designs and specifications with comparable products on similar projects. It is important that the design team understands the geosynthetics with which they are working with and the construction process and takes appropriate steps within the design, specifications, and QA plan that mitigate the risks commonly associated with installations. It is also imperative that the design team understands the owner's expectations, and properly sets the project up for success using the project specifications and QA Plan.
- **Installation team**: Choosing a competent installer is one key to obtaining a good final product. Not only should the installation company be properly vetted by checking out references for projects of similar materials on similar projects, but the proposed individual crew members should also be properly vetted for experience. Not every installer, nor every crew working for one company, is created equal.

  Having a competent installer should result in minimizing the number quality issues and reducing the number of peripheral damages that occur during the installation process. A competent installer should also be able to adhere to an approved panel layout drawing.

  It is important that the installer provide a method statement for the project, prior to their mobilization on the project. This submittal will allow parties such as the design engineer, certifying engineer, owner, and QA team to evaluate the plan and determine potential ways to minimize repairs, as well as ensuring constructability of the project.
- **QA Team**: The QA team should be thought of as your insurance policy. The role of QA is particularly important as these field personnel are truly the "eyes and ears" of the project and their ability to not only recognize problems but bring them to the attention of appropriate parties before things spiral out-of-control is of the utmost importance.

  Like other subcontractors, the QA team needs to be properly vetted. QA personnel should be attentive to the project and work pro-actively with the installer in ensuring the goals of the owner are being achieved.
- **Material Supplier**: The material supplier works with all the team members in the organogram from design team at concept of the project, the QA team and installation team during construction. The material supplier's role needs to be properly defined at the initial stages of the project to allow proper engagement through the project as whole. Identifying a material partner with sufficient references and approved and understood testing methods are of utmost importance when committing to a project.

- **Quality Assurance**
  - Like the construction specifications, the QA Plan needs to remain current and practical, otherwise it limits the abilities of the QA team, potentially limits the abilities of the installer, and may do more harm than good. It is important to empower the QA team so they can properly perform their function, both in the field and behind the scenes in the office. While many QA Plan's do well at focusing on values and procedures of field-testing during installation, there are several shared areas that can use improvement. For instance, the QA Plan should force the QA team to competently evaluate material test results. As an example, a material may meet average tensile strength requirements, but on close examination could show that the average was carried by several high values outweighing some extremely low outliers, which could cause installation or long-term problems when the material is put under stress in the field. It is important that the results be evaluated with the operational functionality of the material in mind and not just a crosscheck of whether minimum and/or average values are obtained.

    The project specifications and QA Plan are good places to spell out the specific expectations of the construction team members, from education to relative experience on similar projects, to industry certifications.

- **Planned Commitments**
  - Plans must be based upon the process capability of the organization and not upon wishful thinking. It is common to see wishful project schedules built upon a "house of cards" where

sufficient resources are not available. Plans must be more than schedules in that they address elements of the project management process. Planned Commitments includes:

•Planning the project

•Scheduling the project

•Resource allocation and staffing

•Budgeting.

It is never too early to start planning. Planning needs to go on even when there is not enough information to do the formalized plan. Planning aims to reduce the unknowns and uncertainty and to increase the likelihood of the project succeeding. If there is not enough information to produce a plan, then the planning should focus on how to learn enough to plan the next stage.

- **Tracking and Variance Analysis**
  The ability to track performance and jot down continuously the improvement methods can prove vital for not only project success but for the success of future projects. Having a track record of variances and the causes of variances can provide the owners, design team, contractors with a powerful FAQ for future projects through shared input.
  Projects should be managed with an implementation and execution plan of effectively dealing with variations from plans and reported immediately. Regular meetings and progress reports can help resolve several installations, design and performance issues and queries. The question becomes what variances should be calculated to ensure that the performance of the project can be understood for the project manager to make corrective action decisions.

- **Work Authorization and Change Control**
  Late changes in projects are a major source of disruption that lead to schedule slippage, cost overruns, insertion of defects and rework. A formal system of change control and change management must be in place. Changes caused by scope creep must be resisted and change control is needed to prevent these problems.

  A critical challenge to project managers is to ensure that control is established over both the ways work is authorized and the way changes are approved. (J.N, 2000)

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