Strategies for Reducing the Environmental Impacts of Construction

“Improving Erosion and Sedimentation Control Practices on Construction Projects”

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16 November 2015
ABSTRACT

There are numerous potential impacts associated with constructing our built environment; one in particular is fresh on contractor’s minds around the country and that is the erosion and sedimentation of our waterways. In this essay, I explain why this issue has become such a pivotal discussion within construction and green building efforts, what strategies have recently become available for addressing these issues, and how their implementation will affect a project’s overall budget and schedule. The strategies I have chosen to discuss are silt fence tieback systems, polyacrylamide (PAM) flocculants, and unmanned aerial vehicle inspections.
In the United States, 250% more firms reported high levels of green construction in their portfolios in 2012 compared to 2009; they expect this figure to rise an additional 33% by 2015. Globally, green construction comprises 38% of building activity, doubling from 2008 to 2012, which has led many firms to report that by 2015 the majority of their work will be green projects (Fien and Winfree 2014). However, the construction industry is still often considered one of the primary sources of environmental pollution in the world. Pressures from the general public and new government regulations are requiring construction professionals, especially project managers, to consider the environmental impacts of their projects more now than ever before. These rising expectations for sustainable design are forcing construction companies to continue looking for new and innovative strategies in order to stay competitive in this global market.

**The Erosion and Sedimentation of Waterways**

On a complex project, there are dozens of different ways the environment can be impacted, directly and indirectly. In most cases it is the responsibility of the project manager to take these environmental impacts into consideration and employ the best strategies available to minimize their affects, while working within the means of his or her schedule and budget. As a result, it is crucial that a project manager be able to accurately anticipate where their project will have the most trouble meeting environmental standards.

Every year, construction sites discharge approximately 80 million tons of sediment into their storm water runoff, which on a unit area basis, is approximately 1,000 times more sediment than any other typical urban land use (Zech and Clement 2012). This substantial amount of sediment-laden runoff is primarily due to erosion through
excavation and other vegetation clearing activities, such as grading and filling. The potential environmental impacts of sedimentation are equally substantial, which according to the United States Environmental Protection Agency (USEPA) includes: reduction of important or sensitive underwater habitat, decrease in fishery reserves, loss of recreational spaces, human health dangers, increases in erosion, and rising *turbidity levels*.

In 2008, the USEPA proposed more stringent effluent limitation guidelines, mandating construction sites to reduce initial turbidity levels to 280 NTU. Although, these new guidelines are still under review, they have generated considerable momentum within the construction industry to test and install better practices for controlling erosion and sedimentation from construction sites (Zech and Clement 2012). Consequently, a clear need exists for project managers and other construction professionals to begin searching out and applying new Best Management Practices (BMPs) that sufficiently address these growing concerns.

I propose implementing three strategies for erosion and sediment control that have currently become available within the construction industry: silt fence tieback systems, polyacrylamide (PAM) flocculants, and unmanned aerial vehicle inspections.

1. **Silt Fence Tieback Systems**

   The silt fence is one of the most common BMPs used on construction sites for the abatement of sediment and other debris into the waterways by way of storm water runoff. They are typically installed around the perimeter of a site, where they act as a barrier for runoff which allows sediment to settle out of suspension by slowly filtering the water.
Yet, if you have spent any time out on a construction site, you know just how frustrating and prone to failure these devices can be.

Some problems are due to improper installation and poor management, however Zech et al. (2007) argue that most failures are due to "improperly designed silt fence installations." The traditional linear design system has proven susceptible to strenuous flow along the fence which leads to substantial sedimentation, scouring at the downslope end of the system, and erosion along the toe of the fence at many upslope locations (Zech et al. 2007). Growing up working for my father’s commercial landscaping company, I am well aware of these issues. If we had a hard rain the night before, I could count on finding a section of silt fence blown out the next day because too much runoff had found a low spot and overwhelmed the fence.

I believe an feasible solution rests in the silt fence tieback system, or “J-hook,” design, which uses upward sloping hooks in the fence at intermittent points where the sediment-laden runoff can form smaller detention basins that allows much more time for settling. Studies show a significant reduction in sedimentation rates of the conventional linear design (75%) when compared to the tieback design system (90%) (Zech et al. 2007). On construction projects, particularly when large volumes of site work are involved, the true value of this system resides in its ability to minimize the chances of failure modes that come with traditional silt fence systems. The tieback design system, although it may seem quite simple, could in fact significantly reduce the amount of rework and management.
2. Polyacrylamide (PAM) Flocculants

For decades, chemical compounds called polymers have seen increased usage in a range of industries, particularly within water and sewage treatment, where they have proven exceptionally effective in facilitating solid-liquid separations during processing and the clarification of various types of effluents. Their effectiveness lies in their ability to enhance coagulation and/or flocculation of fine particles, allowing for more rapid settling in downstream detention practices (Toronto and Region Conservation Authority 2010). In recent years, anionic polyacrylamide (PAM), one of the more common polymer flocculants on the market, has garnered a lot of attention within the construction industry due to its low toxicity rate, coupled with its unique ability to bind soil particles together to form an erosion-resistant surface and reduce sedimentation caused by turbid construction runoff.

Proactively regulating this runoff prior to being discharged into local waterways has been a common challenge for construction managers. While controls that reduce sedimentation through technologies such as sediment basins and check dams have shown to be effective in eliminating a majority of suspended sediment, the amounts left in construction effluent remain above the threshold for USEPA standards and for protection of freshwater ecosystems (Toronto and Region Conservation Authority 2010). Thus, PAM-based treatment systems may provide a desirable alternative when project managers need additional help improving sediment removal.

In 2012, the Auburn University Highway Research Center published an extensive report on the use and application of anionic polyacrylamide (PAM). In their report they present the results of intermediate-scale experiments conducted to evaluate the
performance of different PAM application methods (Zech and Clement 2012). Their conclusions confirm that PAM could in fact be a valuable tool for project managers, yet they acknowledge that PAM-products should be used in conjunction with other best management practices, such as sediment basins, control trenches, and silt fences, until further research warrants otherwise (Zech and Clement 2012).

3. Unmanned Arial Vehicle (UAV) Inspections

When most people envision drones, or Unmanned Arial Vehicles (UAV), they probably imagine futuristic, high-tech military machinery used for dangerous reconnaissance missions over enemy territory. In reality, UAV technology in the past few years has made significant advances, to the point that any “regular joe” can purchase and operate a small drone for recreational use for a few hundred dollars. This past semester, one of my professors who has done extensive research on UAVs through Auburn University, said that “the commercial application of this technology [speaking about the construction industry] isn’t something happening 5 or 10 years from now, contractors across the country are trying to find ways to use drones on their projects as we speak.”

With that said, the Federal Aviation Administration (FAA) has implemented strict regulations governing drones for commercial use that have made authorization a difficult and lengthy process. Contractors who wish to use UAVs on their projects must obtain a FAA 333-exemption grant, which includes aircraft registration, hiring a licensed, “qualified” pilot, and attaining operational approval. Although frustrated, many construction managers remain undeterred in their implementation of this technology. Just this last year, a project manager with Brassfield & Gorrie, LLC, applied for and received a grant from the FAA through Auburn University to study drone usage in construction in
conjunction with the multimillion-dollar Grandview Medical Center project in Birmingham, AL (Tomberlin 2014).

Now, what many are beginning to see is an incredible opportunity to use this technology to monitor erosion and sediment control best management practices. In their report, Using Unmanned Aerial Vehicles (UAVs) to Conduct Site Inspections of Erosion and Sediment Control Practices and Track Project Progression, Perez et al. (2014) identify two specific applications: construction site storm water inspections and tracking progress progression.

On large or complex projects, erosion and storm water inspections can quickly become a slow and inefficient task. The USEPA require formal site inspections be performed on a weekly basis or within 24 hours of the occurrence of a storm event producing 0.25 in. (0.64 cm) of rainfall or greater (Perez et al. 2014). Exploiting UAVs for this purpose provides the potential for greatly accelerating this process for quality control personnel, who in the past have had to inspect the site on-foot. They can identify and document areas throughout the site with inadequate or failing erosion control devices that warrant immediate attention by quickly generating a unique aboveground perspective. Also, UAV inspections could potentially be used to locate storm water runoff routes and determine areas of the construction site that will be most susceptible to erosion and sedimentation.

Recording the progress of a project has become an essential aspect of construction management. On nearly all construction projects today, someone is left with the toilsome responsibility of walking the site and taking daily progress photos. It is a very necessary process, having a visual record of the construction activities from start to finish, but it is
very time-consuming and is usually delegated down to interns or new-hires who don’t really know what to look for. With UAVs, detailed, aerial imagery can be used to document overall project progression, virtually eliminating the need for progress photos of site work like erosion abatement activities. According to Perez et al. (2014), this information can be compiled after each site visit and used to evaluate contractor progress, claims or disputes, and whether corrective actions have been taken to mitigate erosion and sediment control deficiencies identified during previous site inspections.

**Economic and Schedule Impacts**

Due to the nature of construction, any good project manager will always ask at least three questions before implementing a new strategy. How much will it cost? How long will it take? And what is the benefit? In lieu of this concern, I will explain possible impacts my proposed strategies can have on a project’s finances and schedule.

First, what is great about the silt fence tieback systems is that its implementation would create very little budget or schedule impact in the scope of a project. The only additional cost would consist of the price of the additional linear footage of fence needed to make the upward sloping hooks. Although, the time spent installing the additional fencing may take time, the potential cost-savings for rework on large projects could quickly make up for the lower production rates. However, one thing project managers would need to take into consideration with this design is the spacing between the hooks required to maximize the efficiency of this system. For some time there was debate on the appropriate distance, but recently Zech et al. (2012) have developed a formula for accurately spacing the hooks which would inevitably mean incurring some costs for training for labors and managers.
Polyacrylamide (PAM) flocculants could have a significant impact on the feasibility of a project, especially construction sites with complex topography or excessive amounts of erosion and storm water runoff. The new USEPA effluent limitation guidelines could potentially require contractors to install and manage multiple layers of erosion control devices for certain projects. PAM flocculants provide the capability to drastically reduce the number of these controls. The savings associated with fewer conventional erosion control devices could quickly overshadow the expense incurred with the application of PAM products. Established companies, such as Applied Polymer Systems, Inc., already have performance-tested products on the market and ready for shipping. Another great advantage that PAM flocculants offer is the versatility in which they can be applied. PAM-products are available in a variety of forms. For instance, they can be dispersed as dry-granules, sprayed as a liquid by on-site watering vehicles, or introduced through a hydro-seeding mixture to provide additional protection during seed establishment. These methods give contractors the flexibility to spend less time and money on traditional practices, which can involve constant maintenance and replacements.

Finally, the impact of unmanned aerial vehicles (UAVs) is difficult to measure at this time due to the infancy of its application in erosion and sediment control practices. Current restrictions by the FAA make it challenging and time-consuming attaining authorization for using drones on construction projects, but recently it has been announced that new UAV certification regulations have been released for public comment with hopes for an official release by Fall 2016. That said, the potential impact this technology could have on the economy and schedule of large and complex project is
quite extensive. Minus the cost of the equipment and training, thousands of dollars and hours of management could be saved with the proper application of these devices.

**My Educational Experience**

There are many experiences in my life that have prepared me for the construction industry, its environmental impacts, and the management of construction projects. However, my time spent as a student at Auburn University in the McWhorter School of Building Science is by far the most valuable. As part of one of my classes, I was given the opportunity to visit one of the nation’s leading erosion and sediment control testing facilities, which is staffed by the university and funded thousands of dollars every year in research grants by construction companies and government agencies looking to find innovative, new practices. Auburn University is the first institution in the country that is approved by the FAA to train UAV pilots for commercial use, which has allowed me to experience a lot of this state-of-the-art technology first-hand. In regards to identifying and planning for environmental impact management, I do not believe there is a better school in the country that could have better trained me for this industry.

**Conclusion**

There are numerous potential impacts associated with constructing our built environment, the erosion and sedimentation of waterways is just one of many. The development and implementation of strategies to minimize these impacts can no longer be passed off as wishful thinking. As a future construction project manager, I believe the construction industry has a responsibility to continue developing and employing Best Management Practices, such as the silt fence tieback system, PAM flocculants, and drone inspections, thus raising awareness and promoting a new age of green building.
BIBLIOGRAPHY


