Sustainability within Asphalt and Concrete Paving Systems

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The construction industry is continually determining ways to make the building process more streamlined, cost efficient and, more recently, sustainable. As the commercial construction industry becomes more structured, industry leaders are looking for new ways to make installation of materials and cleanup more environmentally friendly. Construction is responsible for a large portion of the overall harm toward the environment. Although the commercial sector has made great strides toward this effort in the last fifty years with programs such as LEED, there is still much to be taken into consideration. The goal of this research is to analyze the current trends in increased sustainable practices, with a central focus on concrete and asphalt paving practices. This paper will focus on the means and methods of concrete and asphalt installation and production and examine the evolution of sustainable practices within the sector. This paper will also investigate the full-depth reclamation project completed by Dryco, Inc. at 6700 Stevenson Blvd. in Fremont, California. The project outlines the benefits of sustainable practices within the paving industry, as well as displayed the potential cost savings throughout the process.

Key Words: Sustainability, Full-Depth Reclamation, Cost Savings, Environment

Introduction

Concrete is one of the most widely used materials in construction. With five billion cubic yards being produced annually, it doubles the amount of all other building materials used in the industry, including wood, steel, plastic, and aluminum (EcoSmart). Similarly, concrete’s cousin, asphalt, is also used frequently throughout public and private projects. Across the United States, there are roughly 3,600 asphalt production plants that produce 450 million tons a year, on average. Of the miles of roads that stretch throughout the United States, about 94% of the surfaces are paved with asphalt (NAPA, 2019). However useful these materials may be, they continue to be a major factor in the unsustainable practices in the building process.
However, the industry is steadily improving. Although these processes continue to create large emission factors, the concrete and asphalt sectors have made fantastic strides in the effort to create sustainable and productive methods to reduce the carbon footprint. Manufacturing shortcomings are currently being addressed, while the means and methods of installation are consistently being examined with the goal of saving costs and the planet.

**Sustainability in the Construction Industry**

The construction industry has one of the largest environmental impacts on the planet. The industry alone consumes/exhibits: (GoConstruct, 2020)

- 25-40% of all total energy
- 30% of raw materials
- 30-40% of global greenhouse gas emissions
- 30-40% of solid waste

For some time now, the idea of sustainability within the construction industry as a whole has been increasingly important due to the major influence it has. Multiple nations have introduced programs across the world with the goal of reducing energy consumption and waste. The most widely used is LEED, or Leadership in Energy and Environmental Design. The U.S. Green Building Council (USGBC) began implementing the program to existing structures in 2000, and it has continued to be a major component for incentivizing sustainable construction. Certification has helped make construction more environmentally friendly, while reducing construction costs.

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**Figure 1** – Study of Green Buildings compared to Conventional Buildings in 2014  
*Source – USGBC 2021*

**Sustainability in Concrete and Asphalt**
Concrete-Manufacturing

Because concrete is the most commonly used material in construction, there is a large focus on improving its sustainable properties in both its manufacturing and installation processes. Currently, the manufacturing of cement accounts for 1.25% of United States Carbon Dioxide emissions (Shaped by Concrete). Portland Cement has made significant strides in reducing emissions during the cement manufacturing process and has set goals to achieve carbon neutrality by the year 2050 (Newsroom, 2020). Many may not be aware that the cement-making procedure exhausts a great number of resources. It requires persistent mining of limestone and other minerals, followed by the application of extreme heat. Recently, the cement industry has taken the proper measures to decrease its carbon footprint in the cement-manufacturing process. For instance, the PCA, or Portland Cement Association, has made efforts to transition their exhausted mines back into the natural world, creating new habitats and allowing plant life to make up for the destroyed land. They have also begun to use nonrenewable waste to power the kilns that heat up the ingredients for cement, which eliminates the need for fossil fuels.

![Figure 2 – Simplified Sustainability Efforts in Cement Making](source: PCA)

Concrete – Installation and Use in the Building Process

As expressed, concrete is one of the most heavily used materials on Earth, and in most cases requires significant effort to install and demolish for construction processes. Although it is difficult to obtain specific statistic about the environmental impact that concrete in the building process affects, it does make a large contribution to the typical issues that surround delivery and installation for construction projects. Massive amounts of potable water are used to mix the aggregates together during the transport cycle. This coincides with routine vehicle and equipment emissions that result from concrete pouring and installation. In addition, concrete construction degrades the landscape over time if left unattended. Fortunately, many emerging projects are implementing newer methods to reduce harmful environmental effects and healthier material life cycles. One of these methods involves the introduction of electro-conductive concrete, which has the electrical properties of many two-
dimensional materials such as typical wall systems. This can be used to cool or heat a building, improving the energy efficiency of buildings, which can make up for the construction process. Another innovative long-term improvement involves the “Design for Disassembly” approach, which allows for less of an environmental impact during demolition, as planned during design. “For example, elements such as columns, walls, beams, and slabs can be disassembled without material loss or pollution to be reused in extending existing buildings or in the production of new ones” (GCCA 2021).

**Asphalt – Manufacturing**

Asphalt production currently trumps concrete in terms of a beneficial environmental impact. Asphalt manufacturing uses perhaps the cleanest methods in comparison to all construction materials, with an emphasis on concrete. Greenhouse gas emissions are almost nonexistent throughout the production process. In the Asphalt Pavement Alliance’s words, “Asphalt pavements require less energy to produce, and their production generates less material waste than other paving materials, and its production emits fewer greenhouse gases than concrete pavement. In fact, the asphalt binder used to make asphalt pavements is a byproduct of fossil fuels that were never burned and used as energy, such as diesel fuel or gasoline. Thus, the inherent CO2 is never released into the atmosphere” (APA 2022). Furthermore, according to the EPA, “99.6 percent of the carbon in asphalt binder is stored instead of contributing to greenhouse gases. Not only are asphalt pavements a very effective means of sequestering carbon, the production of liquid asphalt from the heaviest fraction of a barrel of oil is much less energy intensive than trying to convert it to a fuel for energy use” (APA 2022).

**Asphalt – Installation and Use in the Building Process**

Asphalt has several properties that make it one of the most sustainable and practical building materials in the world. First and most importantly, the asphalt industry is America’s leading recycler, reclaiming about 65 million tons of material every year, and later reuses about 99% of the amount collected (APAI). Overall wear and tear can be fixed easily with a top layer removal and replacement. Another process, called rubblization, in which the worn-out pavement is fractured and therefore acts as a base for the new layer. This process indirectly saves fuel, materials, and costs. Certain porous asphalts can also help replace impermeable surfaces, which can turn runoff into infiltration, improving a site (APAI).
**Figure 3 – Normal vs. Porous Asphalt Pavement**  
*Source: Civilogistix 2017*

**Literature Review**

The sources used for the purpose of this research include information provided by paving and concrete experts such as the National Asphalt Pavement Association and EcoSmart Concrete. These organizations have been reporting statistics about concrete and asphalt for several years, making them very credible. Sustainability information is displayed through outlets such as the LEED organization, which is a national program that is used by the entire construction industry to determine the degree of environmental impact in buildings. These and other sources allowed access to crucially useful information regarding the pavement industry and sustainable practices.

**Methodology**

The methodology that I have chosen for this case study mainly revolves around quantitative data obtained for a project completed by Dryco Construction, Inc. Also included is qualitative data acquired through interviews with several current veteran employees. This particular study focuses on one of their recent Full Depth Rehabilitation Projects.

The goal for this case study was to:

- Analyze the benefits of using these sustainable methods
- Determine the differences in cost between this project and others like it
- Figure out if this procedure is worth it
- Encourage the construction companies to implement these sustainable practices into their respective scopes of work

**Case Study**

Dryco Construction, Inc. is a medium-sized concrete and asphalt subcontractor based out of the San Francisco Bay Area in California. They also focus on fencing and other similar hardscape work. Established in 1985, Dryco was founded by Daren R. Young, who began working as a laborer for his father and later started the company, mostly paving driveways in the high-end communities of the Bay Area. Dryco has grown to be a very successful company with influence that extends throughout the Bay Area, Sacramento, and the Central Valley regions. With the increased emphasis on sustainability in the construction demographic over the years, Dryco followed suit and has implemented multiple sustainable practices to help conserve materials, extend a project’s life cycle, and aid in decreasing the damage to the environment.

**Project Data**

The project data that I received involves information regarding an asphalt and concrete paving job for Insurance Auto Auctions, located at 6700 Stevenson Blvd. in Fremont, California. For this project the company used Full Depth Rehabilitation to replace the surface of a parking lot. Additional project information is as follows:
• Projected Cost – $297,995
• Projected Material
  o 36,640 SF of concrete
  o 7,600 SF of 3” asphalt
• Projected Timeline – 3 months
• Project Scope – Asphalt and Concrete removal and replacement, with cement lime treatment of soil to account for full depth rehabilitation

**Full-Depth Rehabilitation**

Full Depth Rehabilitation is a technique used in the process of replacing failed or failing asphalt and concrete pavement. It is also known as pulverization or lime treatment for short. The process involves the removing of the current distressed layer of existing asphalt, blending it with the existing stone base, and creating a recycled, usable base for the new asphalt (11). Normally when asphalt fails, the procedure is to remove and replace the existing compromised asphalt layer along with the base layer, which is usually base rock or compacted soil. The removed base layer is then transported off-site to a dump site, while some of the removed asphalt is taken to a nearby production plant where it is processed to be reused. Full-depth reclamation allows the project team to work around many of these costly steps and minimize waste, which is more beneficial to the surrounding environment. There are many things to consider when choosing this process over the typical remove and replace procedure, which are as follows:

**Benefits of Full-Depth Reclamation**

• Cost savings upwards of 50%
• High potential to shorten a project’s overall schedule due to less demanding scope of work
• Existing base rock and asphalt is 100% recycled, creating increased sustainability
• Reduces carbon footprint of a project by eliminating trucking and equipment use, which therefore reduces emissions and fuel consumption (Brazer 2017)
• Jobs such as commercial parking lots don’t have to be entirely shut down, allowing the customer to continue operations

**Things to Consider Regarding Full-Depth Reclamation**

• The process involves raising the grades of the area. Things like curbs, buildings, or other existing features may limit the ability to do this
• Must be an existing sufficient material depth to support new asphalt
• Soil type and density must be taken into consideration as well

**Results and Discussion**

Overall, Dryco, Inc used this method to minimize costs and accelerate overall schedule. Although the project management team did not actively intend to consider environmental factors when choosing this method, they inadvertently implemented sustainable construction practices. They were able to eliminate excess trucking, which reduced emissions and minimized fuel consumption. They were also able to recycle almost all the material, which decreased production output from the local plants. It may have been a small amount; however, every bit counts in the race toward environmentally
conscious construction practices. Hopefully, methods like these will become more common in the pavement industry.

Conclusions and Future Considerations

The asphalt and concrete paving industry has made fantastic strides in the sustainability effort. Processes such as the full-depth reclamation technique mentioned above have saved countless amounts of material, equipment usage, time, and costs. The Dryco case study only scratches the surface of what is possible with concrete and asphalt. After conducting this research, the author as though the main problem lies within production of material. As mentioned previously, concrete is the most widely used material in construction, which means it is one of the most widely produced materials as well. These production processes contribute to a large percentage of CO2 emissions across the globe. The same goes for asphalt production. I believe the next step in the race toward environmental harmony is to attack the problem at its source, that is at the production stage. If we as an industry can figure out how to make the production process more sustainable, then we will be one step further to full sustainability from one of the most common materials in the world. This will in turn make a significant dent in the emission level. Fifty years ago, the commercial construction industry was not even close to considering techniques such as these, and now we have achieved monumental accomplishments in the area. Imagine what the industry will be capable of in another fifty years.
References


