

Final Project Portfolio:

Rural Renaissance

Client: Lithic
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Abstract

Lithic Industries requires a new method for repaving roads using Reclaimed Asphalt Pavement (RAP) in combination with polymer, T Pro 500. The current methods of road paving used in industry produce a significant source of waste and/or an abundant source of RAW Materials, which is an issue in American road systems and other parts of the world. Lithics Industries tasked the Rural Renaissance team with the following two primary tasks. One, focus on utilizing RAP material to provide all necessary raw materials to repave worn and deteriorated asphalt roads. Second, provide a cost-effective system for rural dirt or engineered aggregate roads that currently require annual maintenance and are a source of particulate release and, during certain seasons and conditions, dangerous to traverse. To find a solution for Lithic Industries, Rural Renaissance strictly followed TxDOT and AASHTO standards for road repaving and construction. The team designed a mixture formula using research and tools provided to them. Seven different mixtures were tested to determine which performed best to meet the project goals, requirements, and specifications.

Introduction

The current methods of road repaving and construction yield high costs, waste, and construction time. Lithic Industries is currently looking for a solution to repave roads throughout the world that minimizes waste, construction time, and cost while using reclaimed asphalt pavement materials in combination with the polymer T-Pro 500. Lithics Industries is continuing to take action to find a solution to this problem in order to create a more cost-effective and environmentally friendly method of road construction and repaving.

Problem Statement

Lithic is asking Rural Renaissance to create a design for a road surface utilizing reclaimed asphalt pavement and T-Pro 500 that minimizes waste, cost, and construction time and meets AASHTO and TxDOT standards for the road surface.

Stakeholders

The benefits of a revised solution would benefit a variety of parties. These benefits would be either direct or indirect benefits as repairing the roads would enhance the appearance, safety, and public perceptions of cities where this repaving system would take place. On the other hand, ease of construction would cut down the time spent paving and cleaning up during and after construction.

Stakeholders would include (but are not limited to):

- Cities where roads are repaved
- Politicians of cities
 - Initiatives to repair roads while saving money would be achieved
- Construction crews
- Drivers on Roads
- Lithics Industries

Requirements and Specifications

The requirements and specifications for this project have been made by Rural Renaissance based on information from meetings with Lithic and research done by the team. The following requirements and specifications must be approved by Lithic and signed at the bottom of this document. The requirements and specifications are as follows:

1. The project must be completed by May 2023.
2. The team must design an asphalt system using T Pro™ Polyler and Reclaimed Asphalt Pavement (RAP).
3. RAP must adhere to the guidelines in the TxDOT Standards Specifications for Construction and Maintenance of Highways, Streets, and Bridges in Item 292, Section 2.2.
4. Design should maintain roadworthy conditions for a minimum of one year.

5. Design must be cost-effective in comparison to current average roadway designs.
6. Design must be environmentally benign.
7. Design must meet standards for road design found in the TxDOT Standards Specifications for Construction and Maintenance of Highways, Streets, and Bridges in Item 300, Section 2.4.
8. Design should minimize the use of raw construction materials.
9. Design must be resistant to abrasion.
10. Design must follow AASHTO standards for compressive strength and other physical properties.
11. The following testing methods shall be used: ASTM D-1557 Modified Proctor and ASTM-136 Sieve Analysis for fine grain aggregates.
12. Design must meet test standards four in Item 341, Section 4.1 of the TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges.
13. The depth of the asphalt required should be minimized from TxDOT standards.
14. The team must provide complete and reliable systems and data to validate the design.
15. Road construction time must be reduced.
16. Design should lower the carbon footprint of the current road construction procedures.
17. Design, construction, and formulation shall not violate EPA laws and regulations.
18. The team must report accurate quantitative and qualitative testing.

Service Environment

The service environment will include testing sites of the road surface, and the environment will primarily consist of the road where the pavement is laid. Due to the outdoor nature of locations of roads, all weather conditions are possible.

Locations in consideration include:

- Testing stations
- The roads in America
- The roads of the 3rd world countries

The environment itself consists of

- All weather conditions
- All times of day
- All elevations

Users and Operators

The users and operators will encompass drivers as well as the construction crews making the roads. With the wide variety of drivers and cars on the road, it must be a safe place for drivers to drive.

Users will include:

- Drivers on the road
- Construction workers who are building the road
- Maintenance Crews

Research

Properties and usage of T-PRO® 500

T-PRO® 500 is a commercially available non-hazardous latex copolymer dispersion designed for soil stabilization and dust suppression for a variety of soil types. It has been found that the addition of T-PRO® 500 has significantly increased the strength and durability of polymer-modified mortars (Hadi et al., 2019). Table 1 in Appendix A the chemical properties of the polymer as a binder (Hadi et al., 2019).

From different tests that have been done on the polymer, the compressive strength of the outcome depends on how long it took the specimen to cure. However, increasing the concentrations higher than needed decreases the unified compressive strength due to the higher water content of the polymer, which might have led to a decrease in the maximum dry density and strength of the mixture (Hadi et al., 2019).

According to TERRATECH, the polymer cures rapidly for minimal traffic interruption in road stabilization and repair projects. The polymer solids are applied in a solution, and as the water evaporates during curing, the polymer molecules coalesce and form strong bonds between solid and aggregate particles.

Reclaimed Asphalt Pavement:

Reclaimed asphalt pavement (RAP) is used all throughout the world in road repaving. It is collected through milling roads. It is used for its cost-effectiveness, how environmentally friendly it is, and its physical properties. The usage of 40% RAP can save 34% in monetary savings (Al-Ghurabi, & Al-Humeidawi, 2021), so a higher

percentage of RAP could save even more. RAP is used in hot mixed asphalt (HMA), which consists of an aggregate and a binder. The four most effective uses of RAP in HMA were found to be, Use the coarser particles (Al-Ghurabi, & Al-Humeidawi, 2021), A one hundred percent RAP aggregate HMA is possible (Tao & Mallick, 2009), Polymer is an excellent binder for RAP-based HMA (Osamah et al., 2021), and Fifty percent RAP is the most effective amount of RAP in a mixture (Osamah et al., 2021). The reason for using the coarser particles is that they have better physical properties than finer particles. One hundred percent of the aggregate being RAP is possible but still needs more testing to know the long-term effects. The polymer has been tested as a binder which works great. Fifty percent of the aggregate being RAP is the best amount for HMA.

Federal and State Standards for Road Construction

Standards and regulations for road construction can be found at national, state, and municipal levels. At a federal level, there is the Federal Highway Administration (FHWA) which is a division of the U.S. Department of Transportation. At a state level in Texas, there is the Texas Department of Transportation (TxDOT), and at a municipal level, standards and regulations are designated by the county or city. Other agencies and commissions also play an important role in implementing standards and regulations. A primary federal agency that acts as a liaison between the FHWA and TxDOT is the American Association of Highway and Transportation Officials (AASHTO). The principal role of AASHTO is to educate the public and important decision-makers on the importance that transportation plays in creating safety on the roads, improving the quality of life, and a stronger economy. The following are ways in which AASHTO

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targets its goals: setting standards for design and installation, providing resources and guidance, and developing outreach materials (FHWA Highway Safety Programs, 1).

Environmental Impact

Taking care of the environment is a large concern in any aspect of life, and with it comes a responsibility to prevent problems from occurring. In the process of road construction and repaving, the main areas of the environment impacted are air, water, and land through the use of fuel consumption and emissions. Sustainable approaches to help solve these problems can be simple yet effective such as reducing idle time of equipment or using alternative fuels (FHA 2022). In the case of road repaving and using the RAP, this is a way to help reduce the overall impact on the environment. According to a study on road pavement at the Queensland University of Technology, if there was the use of RAP in the process of repaving, then it could lead to upwards of a 20% reduction in global warming potential (Newman, 2012).

Economic Factors

The recent Texas population boom has led to a growing need for rural infrastructure improvements. While Texas has been transitioning towards a largely urban state (as in, most of the population is made up of urban residents), there are still many roads & highways throughout Texas that remain primarily rural. Maintaining and converting these roads to be more urban-oriented requires massive amounts of both time and money. Four state highways that require attention are US 59, US 281, US 69 / US 175, and US 87 / 83 (Begley, 2022).

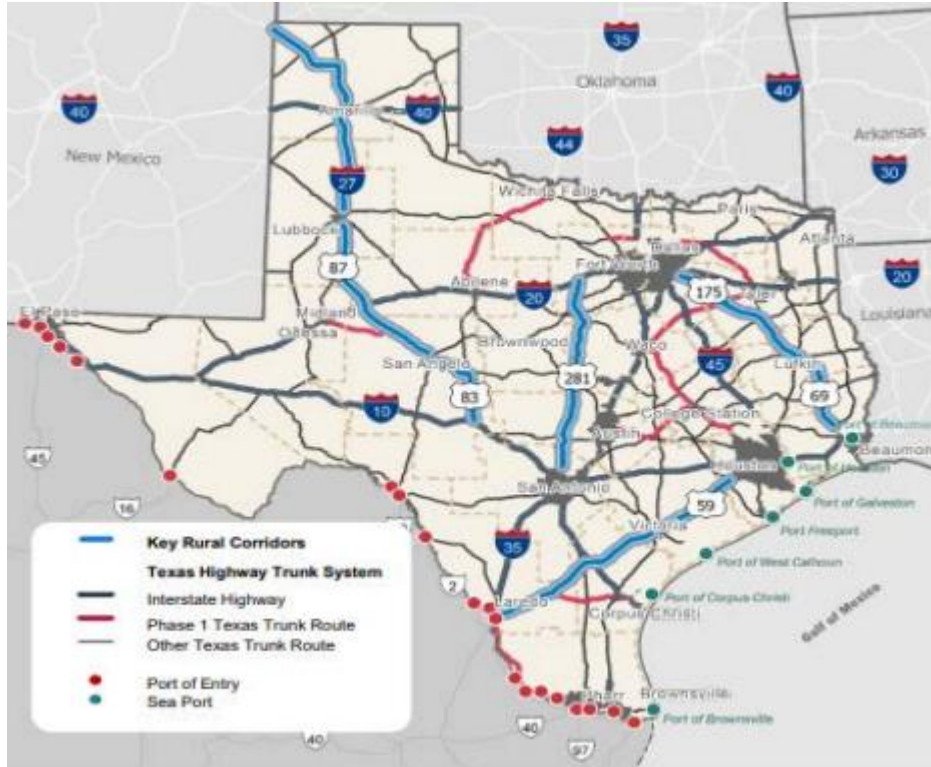


Figure 1: Texas Rural and Statewide Highway Network

An increase in people driving on these roads means more wear and tear, with repairs following shortly after. To eliminate a large amount of time and costs, TPro-500 can allow for these roads to be repaved using RAP rather than tearing away the previous pavement and starting anew. Recycling the pavement lowers the production cost and also allows for a more efficient pour rate. This drastically reduces two of the main issues associated with infrastructure adaptation.

Pavement Process

According to Andrew Kim of Alpha Paving Industries LLC, there is a six-step process in road pavement: design, planning, clearing, grading, foundation, and courses

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(Kim, 2020). The first step is to design the road. This step consists of determining the maximum loads the road can bear, so the contractor will have to take into account the location to assume what types of vehicles will be driving over the asphalt. Another part of the design is to take soil samples of the ground that will be paved over to use the data from the samples to formulate the best possible outcome for the life span of the road. Once the design is finalized, a plan of execution will be made, which includes all the working pieces to get the pavement poured. For example, traffic control would have to be considered to ensure fluid motion in traffic if construction is near other roads or to determine when the best time is to load and unload materials and equipment for optimum efficiency. The third step is clearing, which can be different depending on where the road is being made. If it is a new area, there will need to be heavy machinery to remove trees and bushes, and if it is an already existing road, it will need to be demolished and cleaned up. Once the site is clean, step four is grading which is a fancy word for leveling. The surface must be level while also having a slope to provide drainage and prevent flooding. When the slope is correct, step five is to lay the foundation which consists of a finely crushed asphalt mixture that will be best suited for the soil on the site. The foundation is the part of the road that sets a precedent for the rest of the road because if the foundation is poor, then the rest of the road will not last long and will have severe damage done to it (Kim 2020). Once all these steps have been carried out, it is time to pour layers of asphalt known as courses. The number of courses can be different depending on the road being made, but it eventually reaches the final course, and then the road is finished.

Original Proposed Design

The team will design a mixed asphalt pavement consisting of reclaimed asphalt pavement (RAP) and T Pro 500 polymer, and the mix will also consist of virgin aggregate mixed with the RAP. Before testing begins, an optimum mixture will be determined. This will be determined with help from the spreadsheet in the project plan summary. To determine the optimum mixture, the team will test different percentages of RAP to aggregate and T Pro 500. The aggregates are clay, limestone, and roadbase. As of right now, oily sand or asphalt sand could be an option, but only if the other ones fail testing, as the sand is not as available. The original mixtures will be forty, fifty, and sixty percent of each aggregate and sixty, fifty, and forty percent RAP. Fifty percent was found to be the optimal amount through research, which can be seen above because fifty percent is optimal. That is where the team will start while also testing plus and minus ten percent. Once the optimum mixture is determined, the team will acquire the materials and create samples from the mixture, then begin physical testing. The physical testing will be done at a minimum of three times for each percentage of each material. Creating a total of twenty-seven tests. These tests will allow us to determine what mixture best meets the requirements set by TxDOT and AASHTO.

Performance Estimates

In order for the project to be successful, RAP must adhere to the guidelines in the TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges in item 292, section 2.2, and the design shall pass the freeze-thaw

test, sieve analysis test, and modified proctor compaction. Moreover, pass or fail requirements will be dictated by AASHTO and TxDOT requirements. Design must meet or exceed standards for road design found in the TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges in item 300, section 2.4. Furthermore, the Design must meet test standards found in item 341, section 4.1 of the TxDOT Standard Specifications for Construction and Maintenance of Highways, Streets, and Bridges.

Financial Considerations

The project was not given a budget to adhere to but rather has had opportunities to receive material from our client as well as other sources. Our client, Lithic, has provided testing tools and materials, which include brick molds, limestone, and T-Pro 500. The group has also acquired materials from Strain JH & Sons Inc, a paving contracting company located in Tye, Texas, and also provided commercial grade road base and RAP millings at no cost. The group will also acquire clay samples from eHT here in Abilene. There will also be a soft contingency fund set to be \$200, which was used for molds, standards, and buckets.

Changes from CDR

There were some changes that occurred from the time of our group's CDR to the final testing stages of the project. Many of these changes came from discussions with the clients on how the group could better execute what was required. The first change that can be seen is that any mixes that involved the road base and clay that was going to be used were removed due to the low amount of fines that could have been extracted from them in a sieve test. The second change, relating to the previous change, is that the only mixes used in this used were RAP and limestone. Because of this, the group was tasked to look at samples only composed of 50%/50% limestone and RAP, respectively, as well as samples composed of 100% RAP. The next major change was the number of tests produced by the group. After looking at the tests proposed in the CDR, there was a realization that most were out of date, and through further communication with the clients, most of the remaining tests were removed as well. From this, there were only three tests used, and they were the sieve test, the proctor test, and the compressive strength test.

Testing Plans

Sieve test

The sieve analysis test determines the gradation in order to determine compliance with design, production control requirements, and verification specifications. Gradation refers to the distribution of aggregate particles by size within a given sample.

For the purposes of this project, the sieve test was used to separate different sizes of soil samples by the percent passing each pan ranging from an opening of 4.75 mm being the largest to 0.075 mm being the smallest. The sieve test is conducted by placing a material in the stack of descending sieve sizes and then clamping it securely in the sieve shaker for 10 to 15 minutes to thoroughly distribute the materials. The materials in this project that were put through the sieve consisted of limestone and recycled asphalt pavement. The samples were created using the fines of each of these materials, which were any material that passed through the number 100 sieve with a 0.15 mm opening as well as RAP from numbers 4, 8, 16, and 100.

Mix Creation

The mixture was determined using the sieve analysis test. The two mixtures needed to be made with one main thing in focus: the number of fines in the mix. The minimum amount of fines that Lithic required was ten percent of the mix. The reason for this is the fines fill the cracks of the bigger particles and make it so that there is not as much if any, void space in the mix. The rest of the mix was up to the team. A substantial amount of bigger particle sizes was still wanted, however, as those provide more strength in the mix.

For the 50-50 mix of limestone and RAP, the limestone is what was used for the fines. The number of fines that were used for the mix was thirty percent, and twenty percent of the mix came from the 100 sieves of limestone. The RAP part of the mix was made up of the bigger particles. It was composed of thirty percent from the number 8

and a little bit of the number 50 sieves, and the remaining twenty percent came from the number 4 sieve.

The 100 percent RAP mix had a bit of a different mixture. There are a couple of different reasons for this; first, the RAP did not have as many fines present as the limestone, and the team also wanted to achieve a higher strength than the 50-50 mix achieved. Thus, the number of fines was reduced in this mix to ten percent. The remainder of the mix was composed of thirty percent of each of the following sieve sizes 100, 16, and 8.

Proctor test

The Proctor Compaction Test is a laboratory method of experimentally determining the optimal moisture content at which a given soil type will become the densest and achieve its maximum dry density.

For the case of this project, the proctor compaction test was performed on the 50/50 samples of limestone and RAP as well as on the 100% RAP samples. From this test, the optimum moisture contents were determined, which would be crucial in further testing. The test is conducted by having a compaction mold filled with the sample as well as a proctor rammer to compact the soil with further access to moisture containers and an oven. The soil preparation is the first step which begins with acquiring 3 kg of the soil passing through the #4 sieve. From here, weigh both the soil and the mold without the collar and then begin mixing the soil with water to reach the desired moisture content. Next, begin filling the mold in 3 even layers with 25 blows from the proctor rammer in between each layer. Once compacted, remove the collar and weigh

the sample, then take a portion from the sample to dry in the oven and determine the optimum moisture content from further calculations.

Sample Creation

The samples that were used in this project were 2" x 2" x 2."OMC calculator was used to determine the amount of water and polymer. The soil was determined from the particle sizes according to the sieve test as mentioned above in the mix creation. Their moisture content percentages were determined using the proctor test. These percentages were fifteen percent for the 50-50 mix and twelve percent for the RAP mix. We then varied off this by plus and minus one percent to see how the samples were affected. Then after we did the 50-50 mix, we found that one percent below optimum was best, so for the RAP mix, we did twelve percent and then the two percentages below optimum.

After having the required soil mixture, the next step was to add water and the polymer. We started with the polymer that was mixed with the soil, and then we added water. Water was added gradually to make sure that the mixture was consistent and that it was homogeneous.

The homogeneous mixture was added to the cubic molds. A third of the mold was filled at a time and then compacted enough before we could add any other layer. When the samples were compacted enough, we added them to the oven for three days which was heated to 130°F. After that, the samples were left to dry at room temperature for four days.

Compressive Strength Test

A compressive test was done in order to determine the amount of force that could be applied to the samples in compression before the samples could break. According to AASHTO 165 and 167, the minimum compressive strength for class A is 304 psi, which was what we were aiming for while doing the test. The test was done on three different categories of samples - dry, polymer coated, and soaked for 24 hours, and water soaked for 24 hours. The soaking for twenty-four hours of the samples was to simulate rain and flooding on the samples to see how they were affected by this.

For the test to be effective, the side of the samples, top, and bottom, were dipped into the capping compound that provided a flat surface that allowed the test to be smooth. For the wet samples to give accurate strength, the capping compound was added immediately after removing them from the water. The compression test was done 2 hours after putting the capping compound. The compression machine was set to break at 70%, and the ramp rate was 75 psi/s.

Testing Data

Sieve test

Tables 1: RAP and Limestone sieve tests

RAP			
Sieve #	Weight (g)	% Retained	% Passing
Bottom	548.2	1.80%	0.00%
200	738.8	8.19%	1.80%
100	1021.2	18.34%	9.99%
16	982.5	24.23%	28.33%
8	1146.7	26.13%	52.57%
4	836.2	13.03%	78.70%
1/2 in	720.3	7.64%	91.73%
Total weight	6332.3	99.37%	
RAP weight	2634.8		

Limestone			
Sieve #	Weight (g)	% Retained	% Passing
Bottom	553.9	3.40%	0.00%
200	724.2	12.76%	3.40%
100	979.9	27.94%	16.16%
50	887	34.32%	44.10%
8	592.1	8.49%	78.43%
4	677.5	11.70%	86.92%
1/2 in	540.2	1.38%	98.61%
Total weight	5276.2	99.99%	
Limestone weight	1583.5		

As you can see in the tables above, the RAP had a smaller amount of fines than the limestone by five percent. While the other sieve sizes all had a good variety and were evenly

balanced on each of the other sizes, we wanted to use the size 4-100 sieves for both RAP and limestone.

Proctor test

Tables 2: RAP and 50-50 mix Proctor data

50-50 Mix	
Moisture %	Density (g/in ³)
16.25	28.71
	28.65
15	30.53
	30.38
13.75	27.95
	27.78

100% RAP	
Moisture %	Density (g/in ³)
13	28.08
	27.76
12	30.03
	30.15
11	29.63
	29.54

This test showed our optimum moisture content for the two mixes, which came out to be fifteen and twelve, as seen above. This was then used for what and how the samples were created, which is detailed in the sample creation section above.

Compressive Strength Test

Tables 3: RAP and 50-50 compressive strength test data

50-50 Mix	Average (psi)
15% Control	166.33
15% dry	454.67
15% polymer dipped	366.00
15% soaked and dried	335.33
15% soaked	271.00
14% Control	188.67
14% dry	432.33
14% polymer dipped	396.67
14% soaked then dried	370.00
14% soaked	250.00
13% Control	168.00
13% dry	442.00
13% polymer dipped	427.33
13% soaked and dried	390.33
13% soaked	233.50

100% RAP Mix	Average (psi)
12% Control	278.67
12% dry	388.67
12% polymer dipped	185.00
12% soaked	208.00
11% Control	329.67
11% Control Soaked	79.00
11% dry	412.00
11% polymer dipped	192.00
11% soaked	194.67
10% Control	283.67
10% dry	332.00
10% polymer dipped	73.33
10% soaked	149.33

100% RAP Mix 11% Moisture	Average (psi)
0.75% Dry	716.33
0.75% Soaked	288.00
0.75% polymer dippe	312.67
1.25% Dry	753.00
1.25% Soaked	311.33
1.25% polymer dippe	335.33

As you can see above, the best-performing samples were the RAP mix at eleven percent optimum moisture and 1.25% polymer percentage. The RAP mix at 0.75% polymer at eleven percent optimum moisture also performed very well. It just did not quite meet the minimum for the soaked samples.

Conclusion

The information presented in this report, coupled with the research found above, led the Rural Renaissance team to believe that the plan for the design met the requirements and specifications. Based on the team's research, the proposed design will meet the requirements and specifications as the usage of RAP and T Pro 500 are environmentally friendly, cost-effective, and meet all required tests based on similar mixtures previously used by others. RAP will also help lower material usage as it is reusing currently used materials.

The design that was found to be best was the one hundred percent RAP mix at eleven percent optimum moisture. The amount of polymer, however, depends on the cost and location of the road. The two options, 0.75 and 1.25%, are both viable in dry conditions, and when they are polymer dipped, they are viable in both dry and wet conditions. The only difference is in wet conditions with no polymer dip, and the 0.75% does not meet the requirements of compressive strength. So the selection mix would depend on the price and location of your road. Another option would be to optimize the polymer percentage, which we believe would be somewhere between 0.9 and 1%.

The team also believes that the T Pro 500 polymer and different variations of RAP, whether in different locations or mixes of particle sizes, will find similar results and will be viable roads. The reason for this is because of how well the mix performed, almost doubling the minimum psi for a class A road. This would have to be confirmed in future tests before these roads were created.

Lessons Learned

Ethan

One important lesson that had been echoed throughout our various steps of the project was to ensure that our testing samples had minimal variation and were as consistently created as possible. This is something that we tried our best to maintain, but given our limited supplies, time, and experience, we ultimately had a few outliers that could have skewed our results (but thankfully did not). The best way to combat this in the future would be to have a dedicated material for compacting samples, ensuring that the limestone and RAP were pulled from the same stockpile for all samples in a batch.

Andrew

There were two main lessons that I learned throughout this project, one was learning how to effectively use the capping compound, and the other was learning the importance of pictures. The capping compound method was one that was hard at first and took many hours to complete. After many sessions of fine-tuning, we were able to work very efficiently and got the process down to a science. The other lesson I learned is the importance of documenting everything with pictures. There are many times in a project when you get wrapped up in the procedures and work that you do not stop and think about taking pictures to portray the work that was actually done. Pictures also are very helpful in the future to look back on the progress and work done to support claims and work.

Diane

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Working on this project opened my eyes to so many things; coming to work on a project that involves most of the knowledge in Civil engineering, which I did not have taught a lot in the construction field, like how we need multiple sieve numbers depending on the sizes of the particles needed. Moreover, I do to learn how that when you doing samples that requires fines, it is good to do the sieve analysis before the actual day of making the samples because it saves time.

Secondly, I learned that it is paramount to follow safety protocols, especially when using compounds that might have effects on the skin. For example, one day when we were doing the mixes, I did them without the gloves, and it did affected my hands. Thus, it reminded me of the importance of safety.

Maria

Many lessons were learned during the duration of this project. Two of the primary lessons learned was one having a surplus of samples created. During our testing, there were times samples were either ruined, or there were not enough to perform testing on. Due to the nature of the sample creation process, having extra samples is recommended for future groups.

The second lesson learned during this project was not having a consistent way to compact the samples into the molds. The team decided to compact the samples in the same manner and using the same technique, but the force applied during each compaction was not consistent. Future teams should aim at purchasing or creating a tool to make compacting the samples a measurable task.

Josiah

I learned a lot during this project and over this school year. The biggest area that I learned new things in was project management. I had never been a project manager on any project before this. So I learned a lot in that area, some of the things being managing other people and trying not to overstep and be too overbearing. I also learned how to better manage time. The biggest thing I would say I learned, however, in the project management aspect, would be coordination and communication, this was a crucial part of what I did, and it was very important to the outcome of our project, especially when it came to communicating with our client.

There were a couple of other smaller things that I learned during this time. The first being brings a shovel to the RAP stockpile. The first time we went to the RAP stockpile, we did not bring a shovel, and this made the process way harder. The second would be to make sure that the polymer-dipped samples are dried before they soak for twenty-four hours. I did not do this for the first 100% RAP samples, and this caused their strengths to be ruined as they failed to even reach 100 psi.

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Appendix A - TPro 500 data

Table 4: Chemical properties of T-PRO 500

Physical Form	Liquid
Color	White
Odor	Characteristics
Flash Point	Not applicable
Vapor Pressure	17 mm Hg @ 20°C
Solubility in Water	Miscible in all proportions
PH	6.0 - 9.0
Viscosity	< 500 cSt (estimated)
Total Solids	>50%
Minimum Film from Temperature	7 ° C (45°F)
Specific Gravity	0.95 – 1.10
Particle size	125 mm

Signatures of Endorsement

Team Members:

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Josiah Van Sant

Andrew Elliott

Faculty Coach:

Client:
