

Use of Road Fabrics in Resurfacing and Reconstruction

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INTRODUCTION

During the past several years, there has been some discussion about the effectiveness of fabric membrane interlayes in resurfacing and reconstruction of highways and streets. I would like to share with you our experiences with fabric membranes in St. Joseph County over the past nine years. Our contractors have placed about 1,000,000 sq ft of geotextile fabrics in resurfacing and reconstruction projects since 1976.

If anyone thinks that I am here to tell them that fabric membranes are going to stop pavements from cracking, we're both at the wrong presentation. As we all know, not even reinforcing steel will stop pavements from cracking. When pavements cool, they must shrink; and when they shrink, they must pull apart someplace. Therefore, some kind of uniform lateral cracking of both PCC and HAC pavements is a part of their nature.

The most important function that we believe fabric membrane interlayers perform under a pavement surface is to waterproof the existing pavement and subgrade under itself. That is the key to its success and that is the end result which we have been looking for in St. Joseph County from fabric membrane interlayers.

The accepted reference in the highway industry for construction fabrics is geotextiles; therefore, that is one of the labels, along with paving fabrics, filter fabrics and fabric membrane, that will be used during this presentation.

GEOTEXTILES AND PAVING FABRICS

Types: Woven, Non-Woven

In St. Joseph County, we have chosen to use non-woven fabric because it is less susceptible to unraveling than the woven type when punctured or torn under the heavy stresses of construction and service.

PRIMARY USES: FILTRATION, STABILIZATION, ASPHALT MEMBRANE INTERLAYER

St. Joseph County has used fabrics for all three of these purposes and a discussion of each use follows:

Drywells and Trench Drains—1970 Thru 1985

About 15 years ago we decided to attack the problem of drywell backfill settling or collapsing around the top within the first year after its construction. Investigation indicated that the fines (sand, silt, etc.) were washing back through the filter stone and into the body of the drywell. To prevent this backwash, we began wrapping the body of the drywell with 15 lb felt prior to the installation of the filter stone. This system worked relatively well, but we were concerned about the impermeability of the asphaltic felt. When we became aware of filter fabrics about ten years ago, St. Joseph County wrote into their specifications that all drywells placed as part of new construction or resurfacing must be wrapped with a filter fabric. The contractors now wrap the filter fabric around the drywell sections and tie it on with twine before they leave the plant so that their installation time is not lengthened. In the past ten years since this procedure has been implemented, we have not lost a single drywell of some 150 placed since then.

Another standard application which I have used is to line a trench with filter fabric before placing filter stone and perforated pipe into the trench. I have used this application to tie drywells together when I needed more storage or percolation surface area. Again, the idea is to keep the fine soils outside of the percolation trench or trench drain from contaminating the filter stone or, worse, collapsing the ground above.

Area Stabilization

Another use of geotextiles is bridging over poor soils which cannot economically be removed either because they are too deep or because the road is to be temporary. In this case, the fabric is laid over the poor soil and a light weight or standard weight gravel is placed on top of it to receive some kind of pavement and loading. The fabric prevents the unstable soil particles from pumping up through the gravel and rendering the roadway useless. Some railroads have been using geotextiles to prevent mud from pumping through their ballast. Laying down a mat over poor soils has been used by engineers for hundreds of years as witnessed by the many corduroy log roads we still find in our excavations today.

Elm Road Bridge—1979

This bridge, located in the middle of several square miles of peat lands, was replaced in 1979 because the roadway portion of the structure was too narrow for current standards and the timber piling had been rotted away because the ditch was lowered and the piling exposed. Additionally, the approaches to this bridge were located over peat which our soil borings indicated was 27 ft deep. The south approach had sunk more than 2 ft in the 40 years since the bridge had been constructed. What was happening was that the road had been filled over the years

by gravel and asphalt placed to build it back up as the road sunk. This dense material was surcharging the organic soils and its load, along with the standard organic breakdown of the peat, was causing the pavement to sink at a rate of more than $\frac{1}{2}$ in. per year.

We removed the existing bridge and replaced it with a prestressed concrete box beam bridge supported on steel encased concrete piling. Since the peat was 27 ft down and the water in the ditch was only 10 ft down, complete excavation of the peat was out of the question. After conferring with our soils consultant, we decided to unload the poor soils and try to bridge them with light weight fill over a fabric mat. Our contractor removed approximately 2 ft of gravel and asphalt (3500 lb cu yd) which had been built up over the years as the roadway settled. The peat was then leveled and covered with a non-woven fabric (10 oz/sq yd). A 2 in x 4 in graded blast furnace slag (1800 lb/cu yd) was then placed about 20 to 22 in. deep and was choked off with a #53 blast furnace slag (2000 lb/cu yd). The new asphalt pavement was then placed over this light weight aggregate.

When we gave our soils consultant the weight removed per square yard over the peat, he indicated that the pavement should not settle for ten years (because we had reduced the surcharge by about half) and then it would begin to settle at about half the rate that it had before because the organics in the peat would again begin to break down with age. During the past six years of service, there has been some settlement at the outside edge of the shoulder at the bridge (this resulted because the encasement backfill was peat and the slopes were 2:1 or steeper), but the driving lanes have not settled an iota in an area which was settling at a rate of more than $\frac{1}{2}$ in. per year prior to this action.

Asphalt Membrane Interlayer

Most of our experience in St. Joseph County has been in the area of asphalt membrane interlayers in resurfacing and widening projects. Figure 1 is a picture of a core sample which shows what the fabric membrane interlayer is suppose to do. The lower portion is the existing pavement, including its crack, which was overlaid. The upper portion is the new HAC overlay, and the pen point is at the location of the asphalt impregnated fabric membrane layer. As stated earlier, I don't think that anything is going to stop our pavements from cracking either through contraction or reflection of underlying pavement cracks, but this membrane layer will retard reflective cracking simply because it is a somewhat lubricative layer (i.e. it will relieve some of the friction bond between pavements as the lower pavement moves horizontally).

The key, though, in our minds is the ability of this asphalt impregnated membrane to waterproof the pavement and subgrade beneath it. It is something like roofing the road before resurfacing it. In dealing

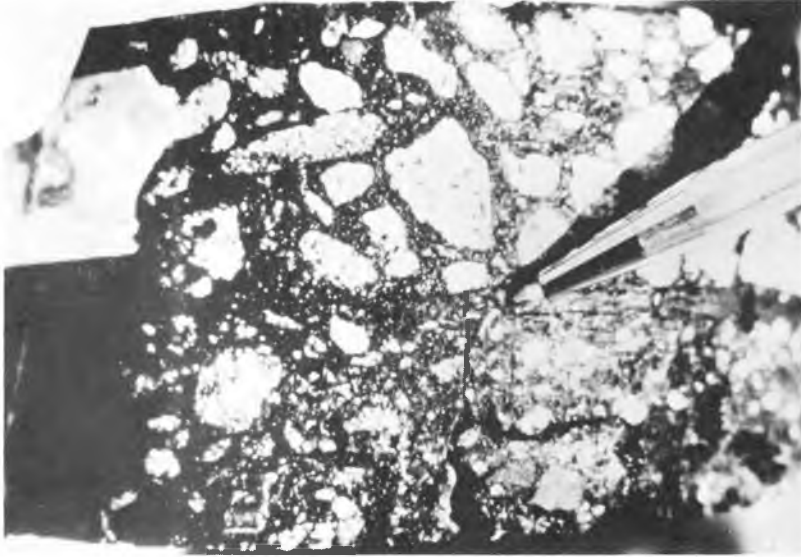


Figure 1.

with local roads, we have found water to be the greatest single enemy to contend with. Not only does water soften our subgrades (causing many of us to consider passing frost laws to protect our roads), but it is the agent which, through freezing and thawing, literally destroys the integrity of our road surfaces. The more water that we can prevent from entering pavement cracks and poorly drained subgrades, the longer we can expect the pavement to last. We spend hundreds of thousands of dollars each year to clean and seal cracks in our pavements for this same reason.

Although keeping water from entering cracks from the surface of the pavement may not be as important in the case of a well drained subgrade (such as on the interstate system or along major highways), all of us want to prevent as much of the accompanying sand or grit from entering these cracks; because once it has penetrated deeply into the cracks, this sand and grit is difficult—if not impossible—to remove. For those of us on the county, city or state levels who have pavements with poor subgrades which swell, soften, or otherwise become unstable; keeping water and grit from entering the pavement cracks and subgrades is critical to the survival of our roads.

COMPONENTS OF ASPHALT MEMBRANE INTERLAYER: NON-WOVEN FABRIC, ASPHALT CEMENT

As I stated earlier, we have chosen to use non-woven polypropylene fabric membrane in our projects, because of its resistance to unraveling. We have also used only AC-20 for our applications; this will be discussed further in the following section.

PREPARATION AND APPLICATION PROCEDURES

Some of the major manufacturers of fabric membrane interlayer products offer installation procedures. Listed and discussed below are the procedures from one of the manufacturers:

1. Clean and Fill Cracks
2. Place AC at 0.25 gal/sq yd
3. Place Fabric over AC
4. Place HAC Pavement Over Fabric

Clean and Fill Cracks

The process of cleaning and filling cracks is a costly and labor intensive one. I must confess to never having cleaned and filled cracks under an asphalt membrane interlayer. If the cracks were too severe, we would scratch the rough surface with 100 to 200 lb/sq yd of HAC Binder before laying the asphalt liquid and fabric.

Place AC at 0.25 gal/sq yd

To those of us who are not familiar with this type of application, this sounds like an incredibly high application rate. This is true, and without the fabric to soak up the excess asphalt, the asphalt overlay will probably slip right off of the roadway. This heavy application of asphalt cement will be drawn into the fabric when the heat of the asphalt overlay reheats and reliquifies it. The end result will be an asphalt impregnated membrane with enough flexibility to maintain its waterproofing integrity as pavement cracks expand and contract above and below it.

In virtually all of the applications of fabric membrane that I have placed, only AC-20 has been used. Asphalt emulsion offers some serious, but not insurmountable, problems. The most serious problem is that because of the amount of water in the emulsified asphalt, the surface application rate has to be raised to 0.33 to 0.35 gal/sq yd to maintain a 0.25 gal/sq yd residual for the fabric. This application of AE sometimes is difficult to keep from running off of the pavement. Also, this rate of application takes a relatively long time to break, even under the best of conditions. If you must use AE, then you must wait for all of the water to evaporate before placing the fabric or the application will not work correctly.

Place Fabric Over AC

We have laid fabric both by hand and by mechanical laydown equipment, and both the county engineering staff and the contractors have decided that the mechanized laydown is in everyone's best interest.

Place HAC Over Fabric

The binder or surface coarse is then placed right over the fabric membrane in pretty much the same fashion that a standard overlay is placed.

Some caution must be taken to assure that the trucks do not pick up too much tack on their wheels and stick to and pull up the fabric. When the truck wheels begin to stick to the fabric, a shovel full of asphalt cast in the wheel path usually is sufficient to break the bond.

LOCAL ROAD AND STREET PROJECTS

Dogwood Road—General

Figure 2 shows a section of concrete pavement which has been covered with chip & seal in the last year. The wallet was placed at this crack



Figure 2.

to show the magnitude of the displacement that had to be dealt with along this length of roadway. The concrete was placed about 50 years ago directly on top of very poorly drained clay soils.

Dogwood Road: Jackson Road to Dragoon Trail—1971

This section of Dogwood was paved without the fabric membrane interlayer. Figure 3 is a picture taken a week ago which shows the lateral and transverse crack patterns which have reflected through the 200 lb/sq yd binder and the 650 lb/sq yd widening each side of it. This pavement was widened about 4 ft on the left side of the picture and 2 ft on the right. Before this section of road was chip and sealed two years ago, it was bumpy and loaded with potholes. Also, the widening cracks on both sides had reflected through for almost the entire length.

Dogwood Road: Roosevelt Road to Jackson Road—1977

Because of the poor soils under the entire length of Dogwood Road,



Figure 3.

my predecessor decided to try the fabric membrane interlayer system to retard reflective cracking from the severely displaced and randomly broken concrete slabs. The pavement was widened 2 ft on each side with 650 lb/sq yd of HAC Base. The daily reports then indicate that the AC and fabric were then laid directly on top of the broken concrete. Then 275 lb/sq yd of HAC Base Wedge and Level was placed over the in-

terlayer and 110 lb/sq yd of HAC Surface, #11 was placed over the HAC Base.

The results, as shown in Figure 4, were interesting and somewhat impressive. The cracks from the severely displaced slabs began to reflect



Figure 4.

through during the following year. I don't think that anyone expected that these severe cracks could be prevented from reflecting through. But, the impressive result was that hardly any (less than 2%) of the widening cracks had reflected through to the surface even after several years. This was the most impressive result of this use of fabric membrane interlayer, because it had been our experience that widening cracks almost always reflected through within the first year to two years.

Dogwood Road: Madison Road to Roosevelt Road—1979:

Because we were impressed with some of the results of the earlier section laid with fabric membrane interlayer, we constructed the next section with the membrane interlayer also. The procedure was improved on this section of roadway by adding a scratch coarse of #9 binder at an average of 100 lb/sq yd to level and rebuild the crown. The asphalt cement and fabric membrane was then placed over this leveling coarse. The membrane was then overlaid with 250 lb/sq yd of HAC Base and 100 lb/sq yd of HAC Surface. This section had held up quite well considering the instability of the concrete slabs prior to resurfacing. Again, as shown in Figure 5, less than 2% of the edge widening cracks have come through in the eight years since reconstruction.



Figure 5.

Beech Road: Kern Road to Dragoon Trail

Compare Figure 5 (Dogwood Rd. with fabric membrane—1979) to Figure 6 (Beech Rd.: Kern Rd. to Dragoon Tr. with no fabric membrane—1979) which is of a road paved with almost the identical



Figure 6.

asphalt section and within four miles of the Dogwood Road projects. Basically, the only difference was that no fabric membrane was used on the Beech Road project. Virtually 100% of the widening cracks had reflected through this no fabric overlay within the first two years along with the accompanying pothole problems. Potholes are almost nonexistent on the fabric membrane sections of Dogwood Road; even in the sections older than this section of Beech Road.

Edison Road: Pear Road to Pine Road—1984

Probably the most effective test section placed to date in St. Joseph County was placed after I left the county. This section of Edison Road was widened and overlaid originally in 1970. Within two years of its reconstruction, the widening crack had reflected through for the entire length. In 1984, the county paved half of the project length with full width fabric membrane and the other half with no fabric membrane at all. Figure 7 is a picture of the section with fabric membrane. A wheel



Figure 7.

survey indicated that less than 5% of the widening cracks had reflected through the membraned length since resurfacing. For Figure 8, the camera was turned 180 degrees from Figure 7 and moved to the edge to show the section which had no fabric membrane placed. A wheel survey indicated that about 60% of the widening cracks had reflected through this identical asphalt section with no fabric in less than eight months.



Figure 8.

ASPHALT PENETRATED FABRIC MEMBRANE AS BRIDGE DECK WATERPROOFING

The final use that we have found for fabric membrane interlayers is to waterproof our bridgedecks. St. Joseph County has used fabric membrane on about a half dozen bridges ranging in size from 35 to 450 ft long. All of the bridges with fabric membrane show dramatically less water penetration than those without fabric membrane.

Washington Street Over Baugo Creek—1973

Elm Road Bridge at Madison Road—1977

For instance compare Figure 9 (Washington St Bridge with concrete deck and no membrane) with Figure 10 (Elm Road bridge with asphalt deck and fabric membrane). Both were inspected and photographed shortly after a rain. The water can be seen coming through every joint of the bridge with no membrane, while the vast majority of beam interfaces with the membrane above were dry as in Figure 10.

Auten Road Bridge over the St. Joseph River—1976

This bridge's deck was beginning to deteriorate and water penetration was threatening to do even further damage. The county rebuilt all of the joints of each span and included a 1 in overlay dam at each joint. Then the deck was repaired in the usual fashion and overlaid with a fabric membrane interlayer and HAC Surface at 110 lb/sq yd. The end product still developed cracks (Figure 11) as would be expected with a



Figure 9.

steel structure which oscillates under heavy loads. Again, the key to the success of the fabric membrane is that, even though the top of the asphalt bridge deck is cracked, the membrane is not broken as indicated when inspecting under the structure after a rain. All of the old cracks which were leaking prior to the redecking still were marked with efflorescence



Figure 10.



Figure 11.

from when they used to leak (see Figure 12). But over 95% of these cracks showed no sign of water immediately following a long period of saturation. Figure 13 shows what it looked like under the sidewalk of the same bridge at the same time as Figure 12 was photographed.

Figures 12 and 13 are dramatic proof that the fabric membrane interlayer consisting of AC and non-woven fabric is doing exactly what we in St. Joseph County wanted it to do. It is effectively waterproofing the pavement (or, as in this case, the bridgedeck) beneath itself.

SUMMARY AND CONCLUSIONS

As a result of my experience with the maintenance and construction of county highways and city streets, I am convinced that the worst enemy we as highway engineers face is water penetrating our pavement cracks and poorly drained subgrades. In our vascillating climate, the freezing and thawing of this water is literally destroying our roads beneath us.

How many times have you noticed a difference in the ride on one of your own city's streets after a quick thaw and freeze cycle? There may have been times when you thought something was wrong with your car, because the bumps at each joint were so bad. You are sensitive to the way roads ride, and you hadn't noticed it this bad just a day earlier. If water expands only 10% when frozen, how deep must the water be in these cracks if they have risen just 1 in since yesterday? More importantly, how much irreparable damage has been done to the asphalt pavement adjacent to each joint?



Figure 12.

We are convinced that asphalt impregnated fabric membrane interlayers can help tremendously in keeping water out of pavement cracks, pavement subgrades, and bridge decks.



Figure 13.

I think that geotextiles are fast becoming a regular part of our road and bridge construction industry nationally, and I think that they have proven their worth to us in St. Joseph County.