softsand® Case Study

Elastomeric Construction Coatings

Typical upper level parking deck with waterproof, traffic bearing membrane applied to protect lower parking levels.

Elastomeric deck coatings (CSI Division 7), which are found in construction applications around the world, serve a dual purpose. The first is to waterproof and the second is to provide a traffic bearing surface. Whereas the first requirement can be effectively met with any number of low cost roofing materials, the second one effectively limits the selection to higher performing compounds. A variety of flexible urethane, epoxy and acrylic formulations, applied in multi-layer coatings, are typically used to meet these dual requirements. For example, an aromatic urethane base coat serves as the waterproofing layer and is then protected by a top coat of a more durable, weather resistant aliphatic urethane. Manufacturers spent significant R&D resources to develop the coatings and application techniques to satisfy these dual requirements, and detailed technical specifications and test results were published for them.

Non-Skid Coatings are Composites

> ***A coating with particles is actually a composite***

Along with the requirement to bear traffic comes yet a third requirement — non-skid. In contrast to the rigorous effort that went into the formulation of the coatings, this third requirement was handled almost as an afterthought. Many manufacturers allowed the contractors to pick whatever was available to them locally: beach sand, river sand, aluminum oxide, black beauty, colored quartz, ground walnuts, ground tires, ground tennis balls, etc. The coating manufacturers typically designed around this variability by specifying that the aggregate could not be used in their base coat or their top wear coat (unless it was a light duty traffic requirement). This meant that the aggregate had to be isolated in its own middle coat between their carefully formulated and tested base and top coats.

Failure Analysis

The manufacturers realized that they had a less than optimal composite structure. Isolating the aggregate in its own layer was a workaround at best. After experiencing a number of coating failures and warranty claims on high traffic surfaces, one innovative manufacturer decided to take a closer look at this composite structure. They sent a technical team out to inspect these problematic installations and were surprised by what they learned. Rarely did the base coat fail on its own. When it did, it was due to the failure of the topcoat to protect it. Failures of the topcoat in turn at first appeared to be due to excessive wear - too much traffic for the coating to handle. But on further analysis, the topcoats were failing not because the urethane couldn't take the punishment, but because the urethane "composite" couldn't.

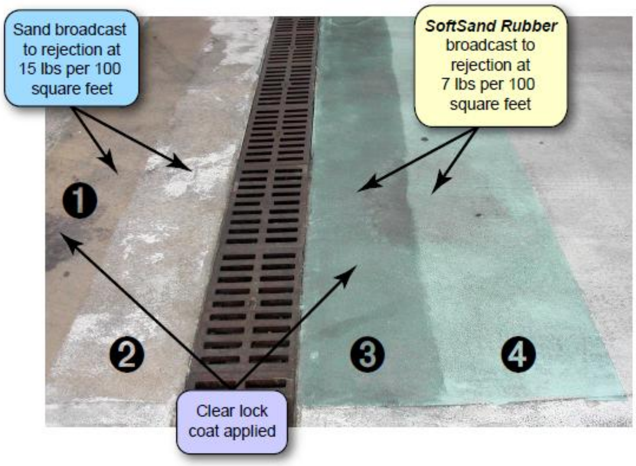
One of the first observations made by the team was the presence of some loose aggregate on the deck and even more in the gutters and drains. It became clear that once the topcoat wore to a point where the aggregate was exposed, the particles were being ejected from the coating by traffic. Adding insult to injury, these abrasive particles once free were then grinding away against the coating under traffic causing accelerated wear. Compounding this insult, the holes left by the particles exposed the base coat to all the elements it needed protection from. As one savvy deck hand put it, "we literally sow the seeds of our own destruction when we broadcast these particles."

With Sand:
After years of vehicular traffic, sand particles are torn from the coating leaving black holes. A loose grain of sand was placed on the dime. White dots are SoftSand rubber granules still embedded in the coating.

With SoftSand:
Even spinning tires fail to dislodge the white SoftSand granules used in this coating.

Elastomeric Particles for Elastomeric Coatings

The failure analysis made it clear that hard aggregates in elastomeric coatings made for a weakened composite structure. Isolating the aggregate in a mid coat was sufficient for lighter duty traffic conditions but the inherent design flaw could not stand up to heavier traffic loads. Once the manufacturer resolved that this was a composite failure issue, they began looking beyond the available list of aggregates for an elastomeric particle that would enhance rather than detract from their well formulated urethane coatings.



Inspection Results:

1. Heavily worn; exposed concrete; sand mostly ejected; lock coat helped retain some sand.
2. Heavily worn; exposed concrete; sand mostly ejected; loose sand on deck.
3. Worn but still intact; clear lock coat retained ground-in dirt.
4. Worn but still intact; no exposed concrete; SoftSand granules worn but overall appearance is that of a green rubber sheet. Some fading to a lighter shade of green noticed.

They tried elastomeric particles from scrap sources. Rubber from ground car tires was quickly dismissed for several reasons - tire rubber compositions vary not only between manufacturers but also from one part of the tire to another (tread, bead, sidewall, shoulder etc.). This made it difficult to characterize the surface that their urethanes had to bond to. Tires also contain numerous chemicals designed to protect the tire from the elements (oxidation, UV degradation, ozonolysis) and these chemicals often interfere with the interfacial adhesion between the urethane coating and the tire particle. They can also migrate and cause yellowing of the coating over time. Finally, the appearance of black dots as the topcoat wears was determined to be cosmetically unacceptable. Ground rubber roofing, although derived from a different polymer than tires, is designed for weathering not wear, and was dismissed for many of the same reasons as ground tire rubber.

Development of SoftSand Rubber

Clearly the table was set for the development of a rubber compound that would enhance rather than detract from the performance of an elastomeric urethane coating. The field conditions were known. The relative short-comings of the other non-skid additives were also known. This information was fed to an experienced rubber chemist who proposed several compounds (a given rubber formula will have over a dozen components). From these, SoftSand Rubber was chosen as the best overall compound to serve as the elastomeric particle in their elastomeric coatings.

Commercial Introduction of SoftSand Rubber

Field trials with SoftSand Rubber began shortly thereafter. Within the first six months of application, promising signs were already being noticed - no loose granules on the deck or in the gutters and no pop-outs in heavy traffic areas for starters. After a few years, it became clear that SoftSand rubber was performing as designed. An additional benefit to this system was also noticed - using SoftSand Rubber particles made the coating feel a lot softer, which was especially appreciated with bare feet. The decision was made to quietly introduce SoftSand rubber particles as a more comfortable alternative to sand for pedestrian and light duty traffic applications.

Head to Head Competition with Sand

Experienced contractors quickly recognized the benefits of this new, elastomeric system for non-skid coatings and wanted to use it on more demanding applications such as ramps and turn areas. Since these areas comprise a small percentage of the total deck, it was felt that SoftSand particles could be used in these limited areas despite its higher material cost. Sand would still be used on the other areas to reduce cost. Fortunately, the field trials of SoftSand rubber were continuing to perform well, giving the coating company confidence that they could allow this. They amended their warranty policy to include heavy duty traffic areas with SoftSand Rubber.

Paradigm Shift

Years of using hard sand to create a weakened, urethane composite coating created a mindset that viewed the base coat as the "money" or waterproofing layer protected by what amounted to an ablative topcoat. Hard sand particles encapsulated in the urethane top coat (never allowed in the base coat) would eventually pop-out and begin to act as an abrasive medium on the coating. The solution was essentially more sand which required more urethane. This mindset is evident in the "broadcast to excess" method, where sand particles were broadcast into the applied coating (mid coat) until it was no longer visible. Excess particles were then removed after the coating cured. For heavy duty applications, this process would be repeated before the application of a final topcoat. Sand broadcast rates as high as 50 lbs per 100 square feet were common.

SoftSand rubber particles created a paradigm shift in this industry. Initially, they were used as a direct replacement for hard sand. They were mixed into the coating and rolled out or broadcast in the same method as sand. Once the superior performance of the elastomeric composite structure was recognized, it quickly became clear that this mindset could change. The assumption that a SoftSand system was more expensive would change with it.

Performance and Cost Optimization

First, the broadcast rates for SoftSand were dramatically reduced. Realizing that the coating and particle were now reinforcing each other and wearing as one, the rates were significantly reduced compared to sand. The concept of a "controlled broadcast" was introduced with targets in the range of 5 to 10 lbs per 100 square feet, down almost a factor of 10 when compared to sand.

This made SoftSand more economical and for some applications, such as patios and balconies on high rises, it was considered a savings to use SoftSand rubber over sand simply due to the weight savings. Later, when it became clear that a single mid coat with SoftSand particles would outperform a double mid-coat with sand for heavy duty applications, it became clear that SoftSand particles represented a savings over sand. The savings were realized on both materials — one less mid-coat, and labor — one less coating layer to install. The improved performance of the deck coating was an additional source of savings realized through reduced complaints, recoats and warranty claims.

Since then, other refinements have taken place. Confident in the performance of the elastomeric composite, the manufacturer began to look at other optimizations. The concept emerged that broadcasting rubber particles is akin to broadcasting the mid coat — this composite is formed by a liquid elastomer (coating) and a solid elastomer (particle). The ratio between these two was varied with interesting results. Along the way, it was discovered that reducing the thickness of the mid-coat to a few mils virtually eliminated particle stacking, which was visible in cross sections of the cured coating. This in turn meant that even fewer particles were required to create an evenly textured surface. Controlled broadcast rates in the range of 1-3 lbs per 100 square feet were tested with these thinner midcoats. This represented a dramatic shift in approach from the use of traditional sand particles. Efforts were also begun to test other paradigms, including the prohibition against putting the aggregate directly into the base coat.

About SoftSand Rubber

SoftSand particles are rubber granules that offer a softer alternative to sand and other hard materials when used in non-skid applications. SoftSand rubber particles will help provide a comfortable, skid resistant surface, and will work in most urethane, epoxy, and acrylic coatings. SoftSand rubber particles can also be blended together, and used with paints to provide truly unique, functional and decorative coatings.

SoftSand rubber particles can be used in the same manner as sand and other commonly available skid resistant additives. These rubber particles are an excellent alternative to traditional sand as they do not contain free crystalline silica. They also weighs less than sand so they won't settle as quickly when pre-mixed with paints. The particles can be either mixed directly into the paint, or they can be sprinkled onto the wet paint, after it has been applied.