Extending the Useful Life of Your Tipping Floor

Owners have more choices than ever to protect their floors from excessive wear. Protective toppings have proven to be a wise investment in maintaining the uptime and longevity of your facility and reducing unnecessary extra expenditures on floor repairs or replacement.

By Bruce Clark, P.E.

The tipping floor at a typical transfer station handling municipal solid waste (MSW) is constantly under attack from the waste itself. The same thing can be said of tipping floors at waste-to-energy plants and mixed material recovery facilities (MRFs). MSW typically creates a leachate that can become strongly acidic in a short period of time. Acidity can be measured by pH, with a mild acid having a pH of around 3. Many foods are acidic; fruits can have a pH of less than 3. Some energy drinks and cola sodas are a pH of 2.5. Portland cement concrete will not stand up long to a solution with a pH lower than 3.0.

Acids react with the calcium hydroxide of the hydrated Portland cement, which is the "paste" holding everything together in concrete. In most cases, the chemical reaction forms water-soluble calcium compounds, which are then leached away by aqueous solutions (ACI 201 1992). On a new concrete floor this degradation process starts slowly. This is known as a chemical degradation. Then, as the hard and abrasive materials in the waste (glass, ceramic, brick, plastic) are pushed across the floor by the wheel loader, the repetitive pounding and scraping motion, the weight of the bucket and often the entire machine's weight, help these materials to gouge the concrete. This is known as mechanical degradation.

Together, the two degradation processes rapidly accelerate the erosion of the floor. The cement breaks down and is weakened, and is further destroyed by the abrasive action. The floor surface is literally worn away—up to approximately ¾" annually is not uncommon. Within about three years, the wear can be so significant that the top bars of the reinforcing steel mat are exposed, usually correlated to a loss of at least 2" to 2-1/2" of concrete (see Figure 1).

Adding to the erosion problem, you now have the steel bars that are directly exposed to acidic leachate. This accelerates corrosion of the bars and leads to loss of metal. For slab-on-grade floors (i.e. floors completely supported by a soil pad) this usually does not introduce a structural concern. However, if the slab is unsupported, this continued deterioration could weaken the slab to the point of imminent failure. The exposed bars also are a safety hazard to the wheel loader and most operators cut the exposed bars and remove them. If that was not bad enough, the loss of cement and aggregate creates "bird baths"—

Figure 1: Exposed reinforcing bars signal repair is necessary. Photo courtesy of SCS Engineers.

Figure 2:
Start of repairs – grinding existing concrete.

Figure 3: Pouring a topping with hard mineral aggregate.

multiple low points in the floor where the most erosion has occurred. The bird baths act to contain the leachate and abrasives, subjecting the concrete to even faster wear and loss.

Floor Repair Options and Costs

Compressive strength is the most important factor controlling the abrasion resistance of concrete, with abrasion resistance increasing with increase in compressive strength. The service life of some concrete, such as tipping floors subjected to abrasion by steel or hard rubber wheels, may be greatly increased by the use of specially hard or tough aggregate.

Fortunately, the concrete products industry has responded with several potential options for repairing existing floors, and providing enhanced protection for new floors during installation. The most commonly used products are designed to be installed as a protective surface of varying thickness on top of the base concrete slab. These include:

- Product containing steel slag or a very hard natural mineral that supplement standard aggregate and act to absorb the shock of pounding and provide better abrasion resistance. These are typically part of a mix using a high compressive strength (i.e. > 7,000 psi) concrete.
- Product composed of a two-part self-hardening epoxy. This is used by itself, not in a concrete mix. The longevity of the topping is usually determined by the quality and solids content (expressed as a percent) of the epoxy.
- A high-strength concrete mix containing either stainless steel or plastic reinforcing fiber. The fibers, up to 3 inches long, substitute for regular steel mesh or reinforcing bars.

Not to leave anyone out, but there is at least one transfer station operator that swears by the use of asphalt for their protective floor topping. They acknowledge that it will wear away in about a year, and

Table 1: Common floor toppings.

Concrete Floor Topping Product Type	Advantage	Potential Concerns
A (hard mineral aggregate)	Provides significant extended life (6-8+ years)	Relatively expensive Requires a separate binding glue to substrate Requires at least 7-10 days before put in service
A (iron slag aggregate)	Provides significant extended life (6-8+ years)	Floor turns dark color as slag rusts Relatively expensive Requires a separate binding glue to substrate Requires at least 7-10 days before put in service
B	Fast curing allows floors to be returned to service within 2 to 3 days	High costs typically limits use to relatively small, thin (usually 1/4" to 3/8") patches Requires separate primer coat
C	Least expensive of products Mixes and installs like regular concrete	Typically does not provide significant extended life—must be reapplied every one to two years

Table courtesy of SCS Engineers.

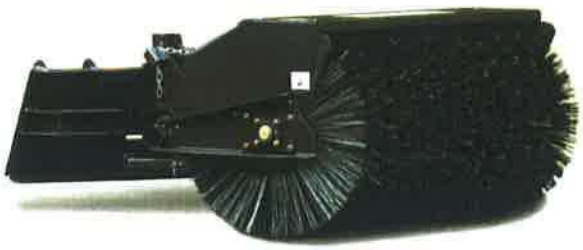

Figure 4:
Rotary broom attachment to skid-steer or loader.
Photo courtesy of Spartan Equipment.

Figure 5: Floor wear indicator. Photo courtesy of Cornerstone Construction, Orlando FL.

the downtime adds over time, but it is relatively inexpensive, and easy to re-apply, year after year. It is not everyone's cup of tea, but is one organization's solution to a problem.

A general summary of the advantages and potential concerns are provided in Table 1. Keep in mind that most all floor toppings will require that the base substrate be prepared to accept the topping and this will add to the cost. This usually involves high pressure washing and scarifying the substrate with traditional concrete grinding equipment to provide a good bond for the new materials (Figure 2).

The "A" products typically work best in a thickness from about 3/4" up to 2", or more in some special cases (**Figure 3, page 34**). The "B" products are installed thinner, typically ¼" to ½". Type "C" product is adaptable to a thickness up to 12".

Maintenance

Although every type of floor topping will eventually see wear, ongoing maintenance is the most important aspect for maximizing the life of the floor topping. I believe having a consistent and effective maintenance program can add at least a year of life before you have to start thinking seriously about re-topping.

The most important maintenance practice is washing the floor. Periodic washing of the floor with clean water and thoroughly removing the accumulated leachate and grit particles should be done consistently and at a frequency of no less than once per week for the best results. If the frequency between cleanings is too long, the level of effort and time required goes up considerably.

The wash down process should be conducted using the appropriate tools. These include a powered rotary brush that is either self-propelled or can fit a wheel loader and an adequate length of hose that can deliver a strong flow of water (Figure 4).

One operator told me they used an old mattress to swab the floor. That is not acceptable! Once the floor has been scrubbed, the rubber lip of the loader bucket can be used to push the water and residue off. Some operators opt to push the entire contents into a pile of waste that will go into the transfer trailer. Floor cleaning is a good time to also flush the floor drains clean and to inspect, and replace if needed, the rubber lip on the loader bucket.

Another good practice is to inspect the floor periodically for areas where the topping might have been chipped off. This can occur anywhere, but places where a transition is made, for example, where the topping meets steel floor plating and the area of the floor where the majority of waste is tipped and pushed, are two common locations. The damaged topping should be inspected and a repair made as soon as practical to ensure the underlying concrete damage is minimized. Consult a specialist that can advise on the repair material.

Keep in mind that the wear indicator devices installed with the topping will eventually start to show themselves in the heaviest use areas (Figure 5). Do not ignore them. Once the wear indicator shows, the floor has lost approximately ½" from the original surface. This is your call to start planning to restore the topping in that area. Ideally, this should be conducted within the next year; otherwise, you will run the risk of continuing to wear the floor away. The cost of the topping restoration goes up rapidly as the topping replacement thickness increases.

Many floors are constructed with two mats of steel reinforcing bars. The "top" mat is typically set 2-½" below the original surface, but in many cases, they can be inadvertently set more shallow and might only be 1-½" or 2" deep. If the erosion of the floor is allowed to get to the depth of the bar mat, then there may be extra costs for potentially removing and replacing reinforcing bars. Also, exposed bars can require grinding of the concrete for proper coverage of the topping around and under the bars and increases costs. This added preparation will prolong the time that your floor is out of service.

A Wise Investment

Owners have more choices than ever to protect their floors from excessive wear. Every transfer station floor handling MSW should have some type of protective topping. Protective toppings have proven to be a wise investment in maintaining the uptime and longevity of your facility and reducing unnecessary extra expenditures on floor repairs or replacement. | WA

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