Where the rubber meets the road

by Todd Dickson, P.E.

Scrap tires take to the road with great potential as civil engineering construction material.

As elsewhere, the demand to recycle and reuse consumer waste products is ever increasing in the state of New York. State organizations, such as the Department of Environmental Conservation and the Department of Economic Development, have the responsibility of dealing with and meeting this demand as expeditiously as possible. The ongoing challenge is to strike a balance between the communal good and economic reality.

In an effort to respond to these demands and to experiment with and develop new construction materials, the New York State Department of Transportation, Region 9-Binghamton has developed a prototype embankment section that utilizes shredded scrap tires. The scrap tires serve as embankment fill on a construction project of a seven-mile section of Route 17 between Five Mile Point and Occorum, just south of Binghamton.

The Scrap Tire Management Council (Washington) reports that in 1998, civil engineering projects used 20 million scrap tires. Shredded tires have been used in place of conventional materials such as aggregate, clean fill and rock. In addition to lightweight road embankment fill, scrap tires are useful for backfill, frost insulation and aggregate in landfills and septic systems. Benefits of shredded tires as a construction material include:

- less weight than conventional materials, putting less pressure on walls and abutments and causing less settlement of the subsurface soils
- good insulation characteristics
- drainage of water, very permeable
- long-term durability.

Where best to test

The prototype embankment section, designed by DOT’s Main Office Geotechnical Engineering Bureau, is part of a larger embankment section that was constructed in the fall of 1999 for a Route 17 offramp. The prototype section measures approximately 650 feet in length. The siting of the prototype embankment section was chosen based on four characteristics.

First, engineers wanted the prototype embankment located away from structures and strictly within a fill section to avoid adversely affecting existing or newly constructed structures.

Second, the location had to be able to provide fill heights that allowed five feet of cover. The fill depth was necessary to seal the area to avoid exposing tire shreds to air or water and to avoid differential icing due to insulation effects.

Third, the prototype embankment had to be sited above the water table in order to promote drainage of the tire shred layer.

Finally, as a pilot project, DOT required that the site be off the main line. By sit-
ing the project on an offramp and out of the main flow of traffic, engineers could access the embankment without greatly disrupting traffic in the unlikely event that remedial work was necessary.

**Making a shredded tire sandwich**

To begin constructing the embankment, the general contractor, Green Island Construction Co. (Glenmont, New York), placed a layer of nonwoven geotextile on the natural ground. The geotextile was used as a separator between the native soil and the shredded tires. This barrier was important in order to prohibit dirt (which potentially could hold water) and other contaminants from moving up into the tire shreds.

Once the geotextile layer was in position, tire shreds were placed on top in one-foot lifts and compacted using eight passes of a smooth steel wheel roller with a minimum weight of 10 tons and a maximum speed of 6.5 feet per second. In compliance with guidelines approved by the Federal Highway Administration (Washington), the tire shred layer was limited to a maximum height of 10 feet and was constructed to recommended specifications in order to avoid any internal heating problems.

The tire shreds were covered completely with five feet of regular embankment fill on the top and three feet of regular embankment fill on the side slopes. Then, to begin compression of the shredded tire layer, the contractor surcharged the embankment with an additional four to eight feet of fill (see Figure 1). The contract required a waiting period of at most two months to allow settling of the tire shreds before the contractor could remove the surcharge and pave the exit ramp. When completed, this offramp is expected to have a life expectancy of 50 years.

**The meat of the project**

Although site preparation wasn’t started until August 1999, tire shredding began the previous May. Cycletech (Hudson, New York), which was hired as a supplier by Green Island Construction, provided 2,640 tons of tire shreds, representing approximately...
270,000 scrap tires (see sidebar).

All tires were obtained from New York State scrap tire stockpiles. In fact, Green Island Construction took advantage of a monetary incentive program jointly developed by the New York State Department of Transportation, Economic Development and Environmental Conservation. In exchange for clearing and cleaning scrap tire stockpiles, Green Island Construction received additional compensation beyond the contract amount for the shredded tire material.

High on DEC's list were smaller stockpiles around the state that could be remediated completely. Before beginning cleanup, both Green Island Construction and Cycletech met with DEC to determine and document the pre-removal condition of each stockpile. Green Island Construction then commenced cleanup of the site, and Cycletech began shredding the tires. Upon completion, DEC verified removal of the stockpile, and DOT then paid the incentive payment. From this prototype embankment project alone, DOT expects six stockpiles to be eliminated.

DED provided a $500,000 fund for the
When incorporating scrap tire shreds as a construction material within civil engineering applications, changes to normal operating procedures may be necessary. Not only did the New York State Department of Transportation (Albany) need to re-tool its specifications for embankment fill, but the shredded tire supplier needed to re-fit its operations to meet these new requirements.

Cycletech, Inc. (Hudson, New York) supplied 2,640 tons of tire shreds, representing approximately 270,000 scrap tires, for the prototype embankment on Route 17 in Binghamton. Founded in 1993, the company operates on 29 acres of land with a 32,000-square-foot processing building and a 54,000-square-foot storage building.

With 12 employees, Cycletech handles 100 tons of scrap tires per day, or the equivalent of 2.5 million tire units annually. According to Cycletech founder Dave Guido, the bulk of its feedstock comes from two sources. Half are retrieved from scrap tire stockpile remediation, as was the case in the DOT embankment project. Cycletech removes and processes tires for recycling while subcontracting actual site cleanup. For example, together with W.M. Biers Co. (Albany), Cycletech undertook the cleanup of a tire processing site at the Port of Rensselaer, New York that had been abandoned for over 10 years. This project produced more than 5,500 tons of material, and the companies left the site with grass planted 10 weeks after starting.

Tire jockeys are another major source of scrap tires. Haulers collect tires from retail outlets, cull out good used tires for resale and deliver the scrap to Cycletech. Local municipalities also can deliver scrap tires for a tipping fee of $50 to $200 per ton, depending upon the type and quality of materials.

In many ways, tire shredding at Cycle-tech is similar to that at other companies (for example, see “Installation Focus” featuring Global Tire Recycling on page 26 of this issue). Trucks dump tires onto an indoor tipping floor. Skidders separate out both truck tires and tires with rims. While still on the floor, employees use fire hoses to rinse off any dirt and to add water as a lubricant. Each tire is placed manually on a conveyor and inspected to prevent any foreign materials from entering the Eidol 72-42 shredder. A disc classifier separates the shreds by size.

DOT’s embankment specifications called for shreds between 1½ and 12 inches. To meet this size restriction, Cycletech refitted its production line to include conveyors that recirculate oversize product back to the shredder. Guido says Cycletech not only added $10,000 worth of new conveyor equipment, but tore apart and rearranged the existing line.

Shreds meeting the specification drop to a conveyor, while too large of pieces are recirculated to the shredder to be recut. Feedstock continues to recirculate until it conforms to the size specification. Guido reports return rates ranging from 10 percent with new blades to 50 percent as the blades dull.

Final product is conveyed first to a scale and then to outdoor inventory piles, which normally are cleared within two weeks. Although final shreds pose less of a fire hazard and vector problem than whole tires, storage piles conform to New York State Department of Environmental Conservation (Albany) regulations. (According to Guido, DEC limits piles to 50 feet wide, 200 feet long and 20 feet high, with 50-foot
Equipment modifications weren’t the only changes Cycletech has faced in the business of shredding tires. Three years after opening, the operation had exceeded its permitted storage amounts (see other sidebar for more information on New York State’s scrap tire program). With an investment in the business of over $6 million, Cycletech quickly resolved the matter with the state. The company cleaned up its site and installed numerous safety systems before again accepting tires for processing.

Most of these safety systems are geared toward firefighting. For example, the grade of the site is pitched so that in case of fire, water drains into a collection basin fitted with retention mechanisms to remove oil or other contaminants. Additional measures include direct hookup to the town’s water main, a piping system to provide water from a nearby lake, and a large pile of sand that can be moved to smother a fire.

Cycletech’s first project was to build an access road to its facility using tire shreds as a base. The road is 1,200 feet long and uses a rubber base 20 feet thick. The rubber base was covered with four feet of burden material and capped with two feet of shale for the traffic course.

Engineering applications — such as this roadbed, the DOT embankment and landfill cover for the city of Hudson — are the largest end markets for Cycletech. By April, however, the company also will produce crumb rubber for use on playgrounds and equestrian tracks, as well as in injection molding applications.

— Timothy Krause
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cleanup of scrap tire stockpiles based on a cost estimate for shredding ($100 per ton at 100 tires per ton) and transporting the shreds ($2.50 per mile for a 20-ton truck). An agreement between DOT and DED transferred funds to DOT so that payments to the contractor could be made directly.

During the summer of 1999, Cycletech acquired tires from these stockpiles and other scrap tire sources and shredded them at its facility before transporting them to the site during construction of the prototype embankment in October and November.

For this project, DOT had to develop new specifications for the contractor that addressed shredded scrap tires as a construction material. In general, tires were to be reduced to a size between 1/4 and 12 inches, with at least one sidewall cut.

Other specifications included:
- free from contaminants, such as grease, mud, gasoline, snow or ice
- no metal protruding more than two inches from any shred

Tire shreds need both an engineering application and economic feasibility to be a choice construction material. Tire shreds to better understand settlement characteristics. The shreds were expected to compress 10 percent of the total tire shred height. In reality, compression of the tire shred section ranged from 8 to 14 percent of the total tire shred height. Maximum compression was 15.5 inches.

Thermistors have been installed within the tire shreds to measure temperatures. Engineers look for spikes or gradual rises in temperature of the shreds as indicators of potential internal heating problems. To date, embankment temperatures have remained steady, conforming to the ambient temperature of roughly 40° to 50° F.

Water quality also is monitored as part of the prototype study. Two sampling collection points have been installed, one underneath the tire shred layer and one just outside. In addition, a groundwater observation well was established uphill of the embankment. Any water migrating through the embankment can be retrieved and tested for quality. Engineers will be monitoring for metals, such as lead and manganese.
that might be caused by the exposed metal in the shredded tires.

Pay dirt or pay tire?
This prototype embankment has allowed DOT to gain experience in working with shredded tires as a construction material — from issuing effective specifications to evaluating its performance, both in the construction process as well as in the long-term lifecycle of the road.

The largest single challenge to using tire shreds in civil engineering applications, however, remains cost. Typical embankment material (dirt, rock, etc.) can be fairly inexpensive, costing in the range of $2 to $4 per ton. Shredded tires for this project cost approximately $30 per ton. In addition, the general contractor probably would have used cut material from other portions of the project for the fill used in the construction of this particular embankment. If not for the sake of the prototype project, tire shreds would not have been used here. In another situation, however, where a civil engineering use is evident and the cost is comparable to another material, tire shreds may be the best product for the job.

For example, tire shreds may be a primary choice of construction material if a project requires lightweight fill. Tire shreds weigh only 45 pounds per cubic foot, about one-third the weight of soil. Comparable lightweight materials, such as expanded polystyrene-type products, can be very expensive, and this is where tire shreds can compete on an open market level. Tire shreds also can be effective in thin roadbed applications where they can help both to promote drainage and prevent frost heaving through their insulating properties.

The bottom line for DOT is that the product must have both an engineering application and be economically feasible.

Prototype embankment is a learning curve
Participants in this project all agree the project was successful. Engineers concluded the new specification worked well and the contractors had no real problem working with the material, which performed its intended function within the embankment.

Currently, New York has between 19 million and 38 million stockpiled scrap tires. Fifteen million to 20 million more tires are added each year. Although DOT alone cannot remedy this situation, it is doing its part by developing an initiative to use up to one million scrap tires per year from New York stockpiles in its engineering applications. With encouraging results from this prototype embankment, and with the success of similar projects around the state and the country, tire shreds will continue to see expanded use throughout the state of New York.

Currently, New York State stockpiles more than 20 million scrap tires each year.