



Use of Shredded Tires in Landfill Construction

THIS POLICY DOES NOT HAVE THE FORCE OF LAW

Applicable Rules

MSW: OAC 3745-27-08

ISW: OAC 3745-29-08

RSW: OAC 3745-30-07

Tires: OAC 3745-27-60

OAC 3745-27-78

C&DD: OAC 3745-400-07

DMWM Cross-Reference internal operating procedure:

#155 Protection of the Composite Liner - Materials and Thickness

#158 Freeze/Thaw Protection During Construction of Recompacted Soil Liners and Recompacted Soil Barrier Layers

#648 Class I and Class II Scrap Tire Storage Facilities

Policy Statement

The use of shredded tires in landfill construction and as landfill components is a beneficial use if the shredded tires meet the engineering and performance requirements of rule and the shredded tires are used in an amount and in a manner that is not disposal. The maximum thickness of a layer of shredded tires as it is deployed is four feet. If a thicker layer is to be used, the owner or operator will need to demonstrate that a thicker layer is necessary to meet engineering requirements.

This document also presents recommended design considerations and construction practices when shredded tires are used.

Applicability

This document applies to the construction of municipal (MSW), industrial (ISW), residual (RSW) solid waste landfills, scrap tire monofills, and construction and demolition debris (C&DD) facilities.

Definitions

The definitions used in this document are based on the definitions used in ASTM D 6270-98 Standard Practice for Use of Scrap Tires in Civil Engineering Applications.

“Bead wire” means a high tensile steel wire surrounded by rubber, which forms the bead of a tire that provides a firm contact to the rim. The “bead” is the anchoring part of the tire which is shaped to fit the rim and is constructed of bead wire wrapped by the plies.

“Rough shred” means a piece of a shredded tire that is larger than 2 inches by 2 inches by 2 inches, but smaller than 30 inches by 2 inches by 4 inches.

“Shredded tire” means a size reduced scrap tire where the reduction in size was accomplished by a mechanical processing device, commonly referred to as a shredder.

“Tire chip” means a piece of scrap tire that has a basic geometrical shape and is generally between 0.5 inches and 2 inches in size and has most of the wire removed. This is also referred to as tire derived chip in OAC 3745-27-01.

¹ Note: This document was originally published on the date noted above. DMWM re-issued the document to make it consistent with current formatting and publication standards after evaluating the content and determining it is still relevant and appropriate. No substantive changes were made to the document.

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“Tire shred” means a piece of scrap tire that has a basic geometrical shape and is generally between 2 inches and 12 inches in size.

Detailed Discussion

OAC 3745-27-78 states:

- (E) Authorized beneficial uses of shredded scrap tires. The following uses of shredded scrap tires are authorized by rule:
- (1) For civil engineering applications in a solid waste landfill, as specified in the approved landfill permit to install or alteration or other authorizing documents.
 - (2) For civil engineering applications in a construction and demolition debris landfill, as specified in the approved license, license modification, or other authorizing documents.

POSSIBLE USES. Tire chips, tire shreds, and rough shreds may be a substitute for granular materials in landfill construction. Ohio EPA views this substitution of scrap tire material for natural materials to be one means of managing scrap tires. Two of the advantages cited to using shredded tires are their comparative light weight and high hydraulic permeability (even under loads of up to 17,000 psf, permeability of 1×10^{-2} cm/sec and greater has been established^{1,2,3,4}). Shredded tires have been used to protect the recompacted soil liner from desiccation, freeze/thaw cycles, wet/dry cycles, and intrusion of objects; as the leachate collection drainage layer or to enhance a granular or geosynthetic drainage layer; as the gas collection material in gas venting/extraction systems; for or around underdrains; and in sumps/trenches as a means for dispersing leachate to be recirculated. This document will not address all of these uses specifically, nor is this list all inclusive. However, the general considerations presented can be used when considering these and other applications.

The construction and demolition debris (C&DD) rules directly address appropriate landfill construction applications for shredded tires. Solid waste landfill rules address the use of alternate materials, but not shredded tires specifically.

ENVIRONMENTAL CONCERNS. The major environmental concerns with the use of shredded tires as construction material at landfills are that preconstruction stockpiles of tires do not catch fire, that stockpiles are not abandoned, and that the materials are compatible. Material compatibility concerns include damage to the flexible membrane liner (FML) of a solid waste landfill by bead wires in the shredded tires under the shifting weight of construction equipment and later under the stresses created by disposed waste, erosion damage from the movement of the relatively high velocity leachate flow across recompacted or in situ soils, and the protrusion of shredded tires into the recompacted or in situ soil. When shredded tires are used as drainage material, material compatibility concerns also include clogging of the drainage layer.

General Considerations

Although the uses of shredded tires in landfill construction are various, there are some basic design considerations and common construction practices. This policy presents these considerations and practices; however, not all of the following are pertinent for every use of shredded tires.

BENEFICIAL USE VS. DISPOSAL. When authorized to be used as construction material in a landfill in accordance with OAC 3745-27-78(E), shredded tires are not considered disposed solid waste and, therefore, are exempt from solid waste disposal fees. However, this determination will take into consideration whether the amount of shredded tires used is appropriate for the application, or if the use of shredded tires is actually disposal. Generally, the maximum thickness of a layer of shredded tires as it is deployed is four feet. To demonstrate if a thicker layer is necessary to meet engineering requirements, DMWM may require the owner or operator to provide calculations showing that the thickness of the shredded tire drainage layer will compress to the equivalent thickness of granular material (i.e. one foot) under the weight of the waste or debris while continuing to comply with the other drainage layer requirements for maximum permeability and maximum head.

BEAD WIRE AND PROTECTION OF THE FLEXIBLE MEMBRANE LINER (FML). Shredded tires with bead wires pose a risk to the integrity of the FML due to punctures that may occur. DMWM has identified that there are at least three acceptable options when deploying shredded tires within 10 inches of an FML:

- Option 1: When using tires debeaded prior to shredding, place a geotextile between the shredded tires and the FML.
(debead)
- A geotextile with a minimum average roll value (MARV) mass per unit area (weight) of at least 8 oz/yd² is likely to be sufficient when used with tires debeaded prior to shredding.

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- Option 2: (sand) When using shredded tires containing bead wire, place a layer of sand or other appropriate material between the shredded tires and the FML.
- In the past, Ohio EPA has deemed a ten inch thick sand layer as sufficient. A thinner layer may be used if the owner or operator can show that the FML will not be damaged during installation of such a thin layer.
- Option 3: (geotextile or geocomposite) When using shredded tires containing bead wire, place a puncture resistant geotextile or geocomposite. Selection of this option entails excavation of test pits.
- In the past, Ohio EPA has deemed geotextiles with a minimum average roll value (MARV) mass per unit area (weight) of at least 16 oz/yd² and a puncture resistance of at least 283 lbs and 341 lbs (as determined by ASTM D 4833) to be sufficient.

SPECIFICATIONS AND QUALITY. Although shredded tires generally have a much higher permeability than the granular materials typically used as a drainage material, it is important the shredded tires not contain dirt clods, loose wires, or be coated with fines. The owner or operator needs to take care to keep any shredded tire stockpiles clean, and not to dig up any underlying soil when removing shredded tires from the bottom or edge of the stockpile. To remove loose wires, DMWM recommends the use of a magnet during shredding and screening. The magnet can also be used to remove those tire shreds or tire chips which are mostly bead wire. Fines in the shredded tires have caused sumps to fill quickly with fines and require more frequent leachate pump and sump maintenance. In practice, it has been found that more than one percent fines in the drainage medium causes problems with keeping sumps clear. Ohio EPA recommends that prior to placement of shredded tires from tire dump site clean-ups, or from the bottom of stock piles, the fines and dirt be removed by screening and/or washing.

MATERIALS TESTING. All the required material testing for a component also applies to shredded tires, with additional specifications a possibility. Note: Shredded tires are not considered granular material; they are a synthetic material or an alternative material when used as a leachate collection system drainage material.

As with any material used on the interior side slopes of a landfill, the material needs to be assessed for internal and interface shear strength.

The shredded tires should be constantly inspected visually to confirm the size, the absence of bead wire if the shredded tires were to have been debeaded, and the absence of dirt clods, loose wires, and a coating of fines.

LAYER THICKNESS. Tire shreds and chips have consistently been shown in the laboratory to lose from 60 to 65 percent of the loose thickness when incrementally loaded to 16,000 or 17,000 psf of normal compressive stress. The maximum thickness of shredded tires, when they are deployed, is generally four feet. However, if the depth weight of the waste will exceed 14,000 psf, DMWM may require the owner or operator to provide calculations and lab test results. The thickness of the shredded tires will need to be shown to compress to the equivalent thickness of the originally specified or required layer under the weight of the waste and continue to comply with the other drainage layer requirements for maximum permeability and maximum head.

A thinner layer may be approved if the owner or operator provides calculations or test results showing that the thickness of the shredded tire layer will not compress to less than the equivalent thickness of the original specified or required layer under the weight of the waste, debris, or overburden. If the thickness of the deployed layer of shredded tires is less than 30 inches, and the shredded tires contain bead wire, and they are being deployed above the FML using the puncture resistant geotextile option, then an increased frequency of test pit investigations may be required as discussed in the section on "Test Pits."

DEPLOYMENT OF SHREDDED TIRES. Deployment of shredded tires above a geotextile within ten inches of an FML necessitates special construction practices as discussed below. If the shredded tires are not being deployed within ten inches of an FML, there are no special considerations with respect to lift thickness or vehicle weight.

Debeaded shredded tires placed above an 8-oz/yd² geotextile should be deployed using equipment with a low gross weight and low ground pressure (< 5 psi). Equipment travel during deployment of shredded tires must be carefully controlled to eliminate quick starts and stops, sharp turns, and any activity that may result in dragging of the shredded tires across the geotextile protection layer. Test pads, discussed below, can be used to determine the level of damage expected to the FML, if any, for any given combination of geotextile, shredded tires, equipment, and deployment procedures.

Deployment of shredded tires with bead wire above a puncture resistant geotextile should also use equipment with a low gross weight and low ground pressure (< 5 psi). In addition, Ohio EPA has observed that maintaining thicker layers of tire shreds between the geotextile and the deployment equipment reduces the potential for damage to the FML by the bead

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wire. So, to provide the least risk of damage to the FML, DMWM recommends the entire thickness of the shredded tire layer be deployed as one lift. If a layer less than 30 inches thick is deployed, an increased frequency of test pits, as discussed in the section on "Test Pits," may be required.

Equipment travel during deployment of shredded tires must be carefully controlled to eliminate quick starts and stops, sharp turns, and any activity that may result in dragging of the shredded tires across the geotextile protection layer. Test pads can be used to evaluate the risk of damage to the FML, if any, for any given combination of geotextile, shredded tires, equipment, and deployment procedures.

Shredded tires deployed against the interior side slope should be pushed uphill in amounts and in a manner that will minimize stress on the liner material interfaces. Once shredded tires have been deployed on a side slope, no equipment should travel on the slope.

Additionally, Ohio EPA has received reports that the geotextiles, often used as the filter layer above or surrounding a drainage layer, cannot be deployed across rough shreds. The geotextile snags and then tears when the first lift of waste is placed. DMWM has not observed any difficulties with deploying geotextiles over tire chips.

For information about storing scrap tires, see document #648 *Class I and Class II Scrap Tire Storage Facilities*.

TEST PADS. Deployment of the shredded tires must be carried out cautiously so as not to risk the integrity of the FML due to punctures. To evaluate the risk of damage to the FML before actual placement of shredded tires in the phase, Ohio EPA suggests that a test pad be constructed to test the combination of FML, geotextile, shredded tires, deployment procedures, and equipment. The use of a test pad is especially useful for the first time use of shredded tires by a contractor, or when using new combinations of materials, equipment, and deployment methods. Test pads are sized so that normal operating speeds of deployment equipment can be reached. Dimensions two to three times the equipment's width and length have been sufficient.

Test pads have shown that some larger-sized tire shreds were not able to be placed with the chosen construction equipment. Test pads have also revealed the type and extent of damage to be expected, if any, during deployment of shredded tires using a specific geotextile, equipment and deployment methods. The FML and geotextile can be analyzed to determine if the FML has been adequately protected.

To inspect for damage, all the shredded tires can be removed from the test pad, or very large test pits (e.g. 100 ft²) can be excavated. Assessment of FML punctures and gouging can be carried out by sight (magnifying glass), touch, probing (wire or blade type feeler gauges), spark testing, and vacuum testing. Further risk to the FML can be assessed by examining the geotextile for puncturing. This can be carried out by looking for bead wire poking through the geotextile, light box testing, or observing scratches that are characteristic of damage to the FML caused by bead wire. In addition, quality assurance/quality control procedures can be adapted to the specific combination of geotextile, shredded tires, equipment, and deployment methods being used to minimize damage to the FML.

Specific Applications

USE AT A C&DD FACILITY

As stated in OAC 3745-27-78(E) of the "Beneficial Use of Scrap Tires" rule, the mechanism to authorize shredded tires as a construction material in a C&DD facility is the license. The use of shredded tires is to be included in the design plan as part of the license application. The owner or operator and the licensing authority, when it is the local health department, should be aware that if thicknesses in excess of what is recommended in this document are proposed, the engineering justification needs to be reviewed by Ohio EPA DMWM to confirm that the shredded tires are being used appropriately and the use is not disguised solid waste disposal. Disposal of solid waste in a C&DD facility is prohibited.

USE IN THE LEACHATE COLLECTION SYSTEM. Although there are many applications for using shredded tires in the construction of a landfill, for C&DD facilities the most likely application is as the drainage medium of the leachate collection system. A comment following OAC 3745-400-07(F)(5)(c)(iv) allows the drainage medium to consist of shredded tires, but the permeability must be no less than 1×10^{-3} cm/sec and the drainage layer must be at least one foot thick.

USE AT A SANITARY LANDFILL FACILITY

As stated in OAC 3745-27-78(E) of the Beneficial Use of Scrap Tires rule, the mechanism to authorize shredded tires as a construction material in a solid waste landfill is the landfill's approved permit to install (PTI) or an approved alteration to that PTI.

Such PTI applications or alteration requests should include appropriate design drawings, calculations that show the shredded tires will function to meet design requirements, and a QA/QC plan. The QA/QC plan should contain the testing

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requirements, material specifications, equipment specifications, and deployment procedures that will be used for shredded tires. When shredded tires with the bead wires are being placed within ten inches of the FML, the QA/QC plan should also contain test pit inspection procedures, FML testing requirements, test pit closure procedures, and a contingency plan that includes progressive assessment of the FML should a puncture or significant damage be found in any test pit.

This section will address using shredded tires in the leachate management system, as intrusion protection layer, as the cap system drainage layer, and as a freeze/thaw protection layer. A separate section addresses the QA/QC plan.

LEACHATE COLLECTION SYSTEM DRAINAGE LAYER. As with any material used for the drainage layer, the shredded tires must comply with the material and testing specifications contained in the rules. This includes requirements for permeability, slope stability, limits on the amount of fines, and material testing prior to use in construction. Because shredded tires are considered an alternate material, the test methods normally used for granular materials may not be suitable. Other quality control testing needs to be approved by Ohio EPA prior to use.

Due to the compressible nature of shredded tires, the permeability testing should be run under normal compressive loads at least equivalent to the loads that will be created by the maximum height of waste in the phase. Any alternative thickness thinner or thicker than 30 to 48 inches may need calculations and lab test results showing that the compressed thickness of the shredded tires meet the specification of one foot thickness under the weight of the waste.

A filter layer is required by rule to be placed above the leachate collection system drainage layer to minimize the clogging of the drainage layer and perforations in the leachate collection system pipes.

For use at MSW facilities, Subtitle D requires that the level of leachate on the liner be limited to one foot. However, in order to take advantage of the free draining nature of the shredded tires, DMWM recommends for all facilities that the switch to turn on the leachate pump in the sump be set at the same elevation as the top of the sump, rather than at one foot above the liner.

Shredded tires with bead wires pose a risk to the integrity of the FML due to punctures and gouges that may occur. The section under "General Considerations," DMWM presents three options for using shredded tires as the leachate collection system drainage layer which should not risk the integrity of the FML.

LEACHATE COLLECTION SYSTEM PIPE BEDDING. The structural integrity of plastic leachate collection piping usually depends on an incompressible pipe bedding material such as stone, gravel, or coarse sand. Shredded tires are not recommended for leachate collection pipe bedding due to the compressible nature of shredded tires, thus resulting in a higher risk of the pipe crushing or deflecting under the weight of the waste. To date, there are no cases where shredded tires have been authorized in Ohio as pipe bedding for leachate collection piping. In order to obtain such authorization, a demonstration of the adequacy of shredded tires to protect leachate collection pipes from deflecting and crushing under the expected design load experienced by the pipes would need to be completed and the design approved by Ohio EPA.

INTRUSION PROTECTION LAYER. Twenty-four inches of shredded tires have been shown to provide adequate protection of the FML from intrusion of objects during waste filling. Such a layer of shredded tires has been accepted by Ohio EPA for protection from intrusion when a geosynthetic drainage net is used as the leachate collection layer. See document #155 *Protection of the Composite Liner - Materials and Thickness* for more information about intrusion protection.

CAP SYSTEM DRAINAGE LAYER. The uses of shredded tires in the cap system are similar to those in the leachate collection system (i.e., as drainage layer material). See the section on "Leachate Management Systems" above for more detailed information.

FREEZE/THAW PROTECTION FOR THE SOIL LINER. Tire shreds have been shown to be effective as freeze/thaw protection.⁵ For more information about freeze/thaw protection, see document #158 *Freeze/Thaw Protection During Construction of Recompacted Soil Liners and Recompacted Soil Barrier Layers*.

Disposal fees do not have to be paid on the use of shredded tires as freeze/thaw protection as long as either of the following conditions is met:

- (1) The shredded tires are removed.
- (2) The shredded tires have been approved to remain in place for another purpose e.g. as drainage layer or intrusion protection layer.

Test Pits

When shredded tires are to be deployed within ten inches of an FML, Ohio EPA has required test pits to allow inspection of the FML to verify that no punctures or significant damage has occurred, i.e., a puncture or gouge in the FML (the FML has lost its integrity) or a puncture through the geotextile (the geotextile failed as a cushion layer). Procedures for test pit

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inspection, FML testing, and test pit closure, as well as a contingency plan that includes progressive assessment of the FML if a puncture or significant damage is found in any test pit, should be included in the QA/QC plan for the facility.

TEST PIT INSPECTION. Damage to FML caused by bead wire has been seen in test pits and test pads. Even if a test pad is constructed or lab testing conducted, factors such as equipment operator diligence, differences in materials from one manufacturer to another, and the variability and lack of standards in the quality of shredded tires, has lead Ohio EPA to rely on test pits to demonstrate that the FML has not been punctured or that significant damage has not occurred during tire shred deployment. Test pits large enough to expose at least nine square feet of FML are dug through the deployed tire shred drainage layer to expose the FML. Test pits are typically excavated at a minimum frequency of one per acre. Constructing test pits in areas that were subject to the highest stresses during deployment has been one method of locating test pits. If the deployed layer of shredded tires is less than 30 inches thick, or if the sand layer thickness or geotextile puncture resistance is less than that stated under the section on “General Considerations,” then an increased test pit frequency (e.g., two test pits per acre) is likely to be required.

Ohio EPA recommends that excavation of test pits begin as soon as an area of a phase has received the total authorized thickness of shredded tires, so that if concerns arise regarding any damage that is found, deployment practices or material specifications can be changed early during the deployment.

Test pit areas are restored in a manner that is protective of the FML by stitching or heat bonding overlapping patches of geotextile to the original geotextile and then replacing the shredded tires.

Construction certification reports should contain detailed information of test pit locations and the results of the inspection and testing of each test pit. Photographs of the exposed FML have also been valuable in showing the absence or presence and degree and extent of any damage or marring.

PUNCTURES AND SIGNIFICANT DAMAGE. During inspections of the test pits, assessment of FML punctures and gouging can be carried out by sight (magnifying glass), touch, probing (wire or blade type feeler gauges), spark testing, and vacuum testing. Assessment of geotextile puncturing can be carried out by looking for bead wire poking through the geotextile, light box testing, or observing scratches that are characteristic of damage to the FML caused by bead wire. If any punctures or gouges are present in the FML in the test pit, a contingency plan should be implemented to assess if any damage has occurred to more of the FML. The contingency plan should be part of the QA/QC plan.

CONTINGENCY PLAN TO INVESTIGATE PUNCTURES AND SIGNIFICANT DAMAGE. If any punctures or gouges are found, progressive assessment, including an increased frequency of test pits and other actions has been used to verify whether or not the puncture or significant damage observed is an anomaly or is characteristic of the shredded tire deployment. DMWM recommends that the test pit frequency be increased a minimum of one additional test pit per acre. If it can be demonstrated that the damage found is an anomaly, then the damage can be repaired, changes can be made to improve protection for the FML, if necessary, and deployment can continue along with the increased frequency of test pits. However, if it is determined that the punctures or damage are characteristic of the deployment, then it will be necessary to stop deployment of shredded tires and change the deployment parameters in such a way as to provide adequate protection to the FML. In addition to changing deployment parameters, repair or replacement of the FML that is under the already deployed shredded tires will be necessary.

References

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3. K.R. Reddi and R.E. Saichek, 1998, “Assessment of damage to geomembrane liners by shredded scrap tires” Geotechnical Testing Journal, Dec: 307-316.
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