



Foundry Sand and Other Solid Waste as Structural Fill

Office of Land Quality, Solid Waste Program

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Description:

Indiana and the Indiana Department of Environmental Management (IDEM) lead the nation in working with industry to reuse foundry sand and other solid wastes. Indiana statute allows for specific reuse of type III foundry sand without having to get a permit from IDEM (IC 13-19-3-7). Indiana's Solid Waste Rule (329 IAC 10-3-1) allows for other uses of spent foundry sand and other solid waste when the reuse is determined to be "legitimate."

Foundries and the metal casting industry generate spent foundry sand as part of their process. These facilities purchase new, virgin sand to make casting molds and reuse the sand several times within the foundry. Eventually, the foundry sand is unsuitable for production. The spent sand can be utilized in non-foundry applications. Reusing the sand saves energy, reduces the need to mine virgin materials, reduces landfill disposal and reduces the cost for producers and consumers of foundry sand. Industry statistics indicate that less than 30 percent of spent foundry sand is reused or recycled. The industry estimates ten million tons of spent foundry sand are generated annually (American Foundry Society).

IDEM has also issued commissioner approvals for other solid wastes in structural fill applications. Examples of wastes include painted concrete, contaminated soil, mixed foundry wastes, and street sweepings. Companies interested in using other solid waste must demonstrate that the use is a legitimate use. Demonstrating the use of type III foundry sand (or other solid waste that meets "legitimate use" criteria) as structural fill depends on several factors. Planning and construction standards for the use of foundry sand and other solid waste is comparable to construction standards when using soil or virgin sand as fill material. The proper planning and application of the material at the construction site separates the use as legitimate structural fill from waste disposal and open dumping.

At a minimum, structural fill projects should meet the definition in 329 IAC 10-2-183 which states structural fill is "...material that is placed in lifts and compacted to a specified density as determined by a construction quality assurance/construction quality control (CQA/CQC) plan or by the design specifications".

Factors for Demonstrating Legitimate Use:

Projects may have unique conditions. Factors applicable to a project will depend on the size, scope, location and materials. Standard construction procedures are acceptable unless the fill material has unique properties. The following factors are appropriate for most structural fill project plans:

- The site should be prepared for type III foundry sand or other solid waste placement in the same way it is prepared for similar soil or virgin sand fill materials. Clear, grub and retain the topsoil for final cover where the fill may remain exposed.
- Use the material to support a specific structure. The design specifications should include the foundation requirements for the specific structure. IC 13-19-3-7 lists several categories such as roads, parking lots, floor slabs, etc.
- Place the structural fill in an area with a stable foundation. Consider factors such as the geological formation and hydrology of the site.
- Account for unique properties and potential variability of the structural fill material. To establish a material's properties, you may need to run the following tests: grain size, Atterberg limits, moisture/density curve, moisture content, and friction angle.
- Design calculations such as slope stability analysis, erosion calculations, stormwater drainage ditch sizing and pipe crushing calculations must be performed as applicable.
- Follow normal precautions for draining the site to prevent seeps, pools or springs from contacting the fill material.
- Adjust the water content of the fill material to prevent dusting and enhance compaction.
- Spread fill material using standard construction equipment, such as dozers.
- Determine optimal compaction for the lift thickness, the weight and speed of the compaction equipment, and the number of passes. Lifts may be adjusted based on site and fill conditions but are usually 6 to 12 inches thick. Test pads are an appropriate method to determine the best construction methods to accomplish the required compaction rate.

- As with any fill material, controlling its moisture is an important consideration in compaction. Be sure to compare placed and compacted fill material moisture content and density to the desired water content and maximum dry density specified by the design.
- Sediment and erosion control techniques commonly used for other earthwork operations should be adequate to prevent wind and water erosion of the surface of the fill material.
- The completed project, not including the structure being constructed (e.g., asphalt parking lot, building, etc.), should be covered with clay type soil and vegetation. The thickness of the cover will depend on the proposed use and site conditions but should, under normal conditions, not be less than 12 inches. No solid waste or foundry sand should remain exposed. Any erosion that exposes the fill must be repaired.

The Structural Fill Construction Standards Checklist is included as an attachment to this fact sheet to assist you in addressing the factors above.

Environmental Impacts:

- Following the basic engineering and construction practices outlined above will help ensure that the use of foundry sand or other solid waste qualifies as structural fill.
- For structural fill using type III foundry sand in accordance with IC 13-19-3-7, an IDEM approval or permit is not required for individual projects as long as the foundry has a current Type III waste classification.
- Avoid impacts to the environment such as run-off of waste material by following the basic engineering and construction practices and recommendations outlined in this fact sheet and the Structural Fill Construction Standards Checklist.
- The structural fill guidelines outlined in this fact sheet are not intended to impact existing guidelines for foundry sand or other solid waste uses such as daily cover, protective landfill leachate cover, capped embankments, land application, soil amendment, and raw material incorporated into another product.

IDEM's Role:

IDEM is responsible for protecting human health and the environment while providing for safe industrial, agricultural, commercial, and governmental operations vital to a prosperous economy.

IDEM's Office of Land Quality will evaluate legitimate use requests for solid waste unless the use is type III foundry sand excluded under IC 13-19-3-7.

- Structural fill projects may also be subject to regulations regarding stormwater, construction in a floodway, wetlands, or fugitive dust.
- Foundries must obtain a type III waste classification from IDEM prior to use of any foundry sand waste streams. IDEM is responsible for issuing Waste Classifications under 329 IAC 10-9-4. IDEM guidance for foundry waste classification can be found at www.idem.IN.gov/landquality/files/sw_resource_foundry_waste_guidelines.doc.
- IDEM is responsible for issuing written commissioner approvals for use of other solid waste in accordance with 329 IAC 10-3-1 (16).

Additional Information:

- More information on the use of foundry sand as structural fill and a link to IC 13-19-3-7 can be found at:
 - Obtaining a waste classification: www.idem.IN.gov/landquality/files/sw_resource_foundry_waste_guidelines.doc
 - Storage of type III Foundry Sand: www.idem.IN.gov/files/nrpd_waste-0027.pdf
 - Use of type III Foundry Sand: www.idem.IN.gov/files/nrpd_waste-0028.pdf
- For questions and concerns, call IDEM's Office of Land Quality at (317) 234-6923 or (800) 451-6027. Refer to the "Structural Fill Construction Standards Checklist," attached to this fact sheet, for items that should be addressed and/or performed in demonstrating a legitimate structural fill use project.

Structural Fill Construction Standards Checklist

(Attachment to IDEM's Foundry Sand as Structural Fill fact sheet)

Definition (329 IAC 10-183)

“Structural Fill” means soil material that is placed in lifts and compacted to a specified density as determined by the CQA/CQC document or by the design specifications.

A. Have you investigated the fill site for the following items?

1. **Stable foundation**
A sub-base that is not susceptible to natural or human-induced events such as caving, sudden subsidence, liquefaction.

Examples of poor sub-base include:

- karst terrain (sinkholes),
- mine spoils,
- underground mines,
- saturated soil,
- poorly drain soils, and
- Manmade fills.

2. **Geological formation and hydrology**
Does the site have any of the following?
- High water table,
 - Water bearing zones,
 - Rock outcropping,
 - Ravines,
 - Surface water runoff pattern, springs, natural streams and drainage ways

Placing fill over such features is not recommended. If considered, develop a site-specific investigation and design.

B. Have you addressed the following items when designing your structural fill project?

1. **Load bearing requirements**
What structure does the fill support? _____

2. **Structural fill material specifications**
These include:
- Grain size analysis,
 - Atterberg limits,
 - Moisture/density curve and moisture content, and
 - Friction angle.

3. **Site design calculations**
These include:
- slope stability analysis,
 - erosion calculations,
 - stormwater drainage ditch sizing, and
 - pipe crushing calculations (if applicable)

4. **Construction Quality Assurance/Construction Quality Control Plan CQA/CQC**

This plan should include:

- Delineation of the responsibilities for CQA/CQC management
- Description of the required level of experience and training for the contractor, crew and CQA/CQC inspector
- A description of field observations and calibration procedures for field testing equipment
- Description of sampling protocols, sample size, methods for determining sample locations and frequency of sampling
- Procedures for handling/blending of material used for structural fill
- Design compaction. Unless design specifications or material properties require site specific densities IDEM recommends 90% modified Proctor or 95% standard Proctor density. Construction of a test pad may be necessary to ensure proper compaction of the fill.
- Lift thickness. IDEM recommends 6" to 12" loose lifts.
- Confirmatory tests before placement of fill material to assure that fill material meets the design specification. IDEM recommended testing and frequencies are:

Moistures content: one test for every 5,000 cubic yards and minimum three tests per project.

Grain size: every one test for 5,000 cubic yards and minimum three tests per project.

Atterberg Limits (liquid limit and plasticity index): one test for every 5,000 cubic yards and minimum three tests per project.

Moisture-density curve: one test for every 5,000 cubic yards and minimum three tests per project.

- Compaction equipment specification and number of passes
- In-situ tests on each lift during the fill placement. IDEM recommended testing and frequencies are:
 - Nuclear density test:** five tests per acre per lift.
 - Moisture content:** five tests per acre per lift.
 - Moisture-density curve:** every 5,000 cubic yards.
- Inspection records of construction.

C. Tasks you should perform before and during your structural fill project:

- 1. Review of design and specification for the structural fill with the construction representative
- 2. Oversight/inspection of construction/fill activity
- 3. Documentation of conformance testing that the fill material meets specifications and corrective measures taken if the project specification has not been met.
- 4. Daily inspection of construction site on days construction is occurring and days of inclement weather conditions. Document any necessary corrective measures taken.

Exceptions/Comments: _____