

# Beneficial Use of Industrial Materials and Recycling in Indiana DOT Projects

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## KEY PLAYERS

### **Indiana Department of Transportation (InDOT)**

The Indiana Department of Transportation (InDOT) has completed several demonstration projects beneficially using coal combustion products, foundry sand, shredded scrap tires and crushed glass. Case studies of some of those projects are presented here. InDOT has helped to promote the use of industrial byproducts in highway construction by performing these projects, by evaluating material performance, and by creating special provisions to address the use of certain materials.

InDOT has several special provisions that address the use of non-hazardous industrial materials, e.g.:

- InDOT Special Provision 203-R-360 “Embankments Construction of Coal-Combustion By-Products”
- InDOT Special Provision “Embankments Construction Using High-Volume Fly Ash (HVFA)”
- InDOT Special Provision 200-R-401 “Recycled Foundry Sand”
- InDOT Special Provision “Embankment Construction Using Tire Shreds –Granular (TSG) Mix”
- InDOT Special Provision 211-R-415 “Crushed Glass as Bedding Material”

### **Indiana Department of Environmental Management (IDEM)**

Beneficial use is managed by IDEM through a combination of rules and programs. Indiana Statute ([IC 13-19-3](#)) governs the use of coal combustion products ([IC 13-19-3-3](#)), foundry sand ([IC 13-19-3-7](#)) and iron and steel mill slag ([IC 13-19-3-8](#)). Other uses of byproducts are evaluated under Indiana’s Solid Waste Rules ([329 IAC 10-3-1](#)) on a case-by-case basis. Finally, land application uses are addressed under the State’s Water Rules ([327 IAC 6.1](#)). While there is no regulatory definition of “legitimate use,” IDEM evaluates the merits of a proposed beneficial use project by considering whether the material performs as an effective substitute for another material, meets product/material specifications, and is supported by valid research. IDEM also considers the physical and chemical characteristics of a material and its proposed use in engineering or project plans.

## **CASE STUDY #1: Use of Bottom Ash in an Embankment by InDOT**

Location *U.S. 12 in Lake County, Indiana*

Project Background *A 290 ft long embankment widening, located about 5 miles from Nipsco, was selected in 1994.*

### 1. Contact Information

InDOT: Athar Khan ([atkhan@indot.state.in.us](mailto:atkhan@indot.state.in.us)) and Nayyar Siddiki ([nsiddiki@indot.state.in.us](mailto:nsiddiki@indot.state.in.us))

IDEM: Tracy Barnes ([tbarnes@idem.IN.gov](mailto:tbarnes@idem.IN.gov), 317/308-3110)

Generator: *Nipsco*

Consultant: *GAI*

### 2. Material Used

- a. Specific type: *Bottom Ash*
- b. Amount used: *5000 yd<sup>3</sup>*
- c. Amount of virgin material that the recycled material replaced: *5000 yd<sup>3</sup>*

### 3. How the material was used/Application

- a. Application: *Bottom ash was used to widen an embankment*
- b. Type of project: *InDOT initiated the demonstration project as part of its overall policy to conduct field testing of materials. This was InDOT's first demonstration project involving bottom ash for embankment widening.*
- c. Related standards and specs used:  
*InDOT Special Provision 203-R-360 "Embankments Constructed of Coal Combustion By-Products"*
- d. Special technical considerations/adjustments  
*Adjustment to moisture content by nuclear. Moisture content should be well below the optimum moisture content for compaction.*
- e. Performance issues/Environmental Monitoring  
*Good embankment material. No pavement distress based on visual observation. Materials were incorporated into the embankment as delivered. Foundation soils were granular. No environmental monitoring was done; IDEM exempted InDOT from monitoring.*

### 4. Savings and Benefits

- a. Short or Long term performance benefits  
*Due to granular nature of bottom ash, settlement of bottom ash was achieved during construction and no settlement was observed.*
- b. Economic benefits  
*Not evaluated, as this was the first demonstration project*
- c. Landfill Space Savings: *5,000 yd<sup>3</sup>*

### 5. Follow-up to assess recycled material performance or environmental impacts

*Currently, InDOT does not plan to return to the demonstration site to evaluate performance.*

### 6. Photos or other documentation

*See "InDOT BU Case Study Documentation.pdf"*

## **CASE STUDY #2: Use of a Mixture of Bottom Ash and Fly Ash in an Embankment by InDOT**

Location *56<sup>th</sup> Street over I-465 in Indianapolis, Indiana*

Project Background *A 1300 ft. long widening of 56<sup>th</sup> Street at I-465 was constructed in 1995.*

### 1. Contact Information

InDOT: Athar Khan ([atkhan@indot.state.in.us](mailto:atkhan@indot.state.in.us)) and Nayyar Siddiki ([nsiddiki@indot.state.in.us](mailto:nsiddiki@indot.state.in.us))

IDEM: Tracy Barnes ([tbarnes@idem.IN.gov](mailto:tbarnes@idem.IN.gov) 317/308-3110)

Generator: Indianapolis Power & Light Co. (IPL)

Consultants: Purdue and InDOT

### 2. Material Used

- a. Specific type: *Co-mingled coal ash*
- b. Amount used: *10,000 yd<sup>3</sup>*
- c. Amount of virgin material that the recycled material replaced: *10,000 yd<sup>3</sup>*

### 3. How the Material was Used

- a. Application: *Co-mingled coal ash was used to widen an embankment.*
- b. Type of project : *InDOT initiated the demonstration project as part of its overall policy to conduct field testing of materials.*
- c. Related standards and specs used:  
*InDOT Special Provision 203-R-360 "Embankments Constructed of Coal Combustion By-Products"*
- d. Special technical considerations/adjustments  
*Moisture and dusting need to be controlled. Six roller passes were recommended for 95% compaction. InDOT does not permit stockpiling at a project site and requires cover on the truck while hauling material.*
- e. Performance issues/Environmental Monitoring  
*Good embankment material. Based on visual observation, no distress on pavement or slope failure was observed. Groundwater was monitored for four years.*

### 4. Savings and Benefits

- a. Short or Long term performance benefits:  
*Settlement was minimized with a restriction of 40% of #200 sieve and settlement was completed during construction. On recent observation, embankment and side slopes are doing well.*
- b. Economic benefits:  
*Not evaluated, as this was a demonstration project and coal ash was donated by Indianapolis Power & Light Co.*
- c. Landfill Space Savings: *10,000 yd<sup>3</sup>*

### 5. Follow-up to assess recycled material performance or environmental impacts

*Currently, InDOT does not plan to return to the demonstration site to evaluate performance.*

### 6. Photos or other documentation

*See "InDOT BU Case Study Documentation.pdf"*

## **CASE STUDY #3: Use of a Mixture of Fly Ash and Bottom Ash in an Embankment by InDOT**

Location *U.S. 50 in Gibson County, Indiana*

Project Background *New road construction on U.S. 50 in Gibson County, Indiana*

### 1. Contact Information

InDOT: *Athar Khan (317) 610-7251 ext 219, [AtKhan@INDOT.state.in.us](mailto:AtKhan@INDOT.state.in.us) and Nayyar Siddiki (317) 610-7251 ext 228, [NSiddiki@INDOT.state.in.us](mailto:NSiddiki@INDOT.state.in.us)*

IDEM: *Tracy Barnes ([tbarnes@idem.IN.gov](mailto:tbarnes@idem.IN.gov) 317/308-3110)*

Generator: *Cinergy*

Consultant: *InDOT and GAI*

### 2. Material Used

- a. Specific type: *Comingled coal ash*
- b. Source: *Gibson Power Plant*
- c. Amount used: *45,000 yd<sup>3</sup>*
- d. Amount of virgin material that the recycled material replaced: *45,000 yd<sup>3</sup>*

### 3. How the material was used

- a. Application: *Co-mingled ash was used as borrow materials to construct an embankment*
- b. Type of project: *InDOT initiated the demonstration project as part of its overall policy to conduct field testing of materials*
- c. Related standards and specs used:  
*InDOT Special Provision 203-R-360 “Embankments Constructed of Coal Combustion By-Products”*
- d. Special technical considerations/adjustments  
*Moisture and dust need to be controlled. Dust was addressed by spraying with lime water. Six roller passes were recommended for 95% Compaction. InDOT does not permit stockpiling at a project site and requires a covered truck while being transported to the project site.*
- e. Performance issues/Environmental Monitoring  
*Good embankment material. Embankment and slope are stable. Groundwater was monitored for two years.*

### 4. Savings and Benefits

- a. Short or Long term performance benefits:  
*Embankment and slope are stable and no distress was noted*
- b. Was byproduct economically competitive with virgin materials?  
*Not evaluated, as this was a demonstration project and coal ash was donated by Cinergy.*
- c. Landfill Space Savings: *45,000 yd<sup>3</sup>*

### 5. Follow-up to assess recycled material performance or environmental impacts

*Currently, InDOT does not plan to return to the demonstration site to evaluate performance.*

### 6. Photos or other documentation.

*See “InDOT BU Case Study Documentation.pdf”*

## **CASE STUDY #4: Use of Foundry Sand in an Embankment by InDOT**

Location: *New road construction at S.R. 206 in Butler, Indiana*

Project Background: *A 374 ft. long, 280 ft. wide and 30 ft. high roadway section was constructed with foundry sand in 1996.*

### 1. Contact Information

InDOT: Athar Khan ([atkhan@indot.state.in.us](mailto:atkhan@indot.state.in.us)) and Nayyar Siddiki ([nsiddiki@indot.state.in.us](mailto:nsiddiki@indot.state.in.us))

IDEM: Tracy Barnes ([tbarnes@idem.IN.gov](mailto:tbarnes@idem.IN.gov)) 317/308-3110

Generator: Auburn Foundry

Consultants: Purdue University and InDOT

### 2. Material Used

- a. Specific type: *Foundry Sand*
- b. Source: *Auburn Foundry*
- c. Amount used: *45,000 yd<sup>3</sup>*
- d. Amount of virgin material that the recycled material replaced: *45,000 yd<sup>3</sup>*

### 3. How the material was used?

- a. Application: *Foundry sand was used as borrow material to construct an embankment*
- b. Type of Project: *InDOT, Purdue University and industry (INCMA) initiated the demonstration project as part of InDOT's overall policy to conduct field testing of materials*
- c. Related standards and specs used:  
*InDOT Special Provision 200-R-401 "Recycled Foundry Sand"*
- d. Special technical considerations/adjustments  
*Roller passes-6 No and Moisture Range between 12 to 15% for achieving adequate compaction. Must be careful with big metal pieces that may damage tires. Also, dusting is an issue. InDOT does not allow stockpiling at the project. The material was incorporated upon delivery.*
- e. Performance issues/Environmental monitoring  
*Good product. Small internal deformation was observed during construction. Split spoon test of greater than 20 ft was observed in post-construction evaluation. Extensive monitoring was done for two years by Purdue University*

### 4. Savings and Benefits

- a. Short or Long term performance benefits: *No settlement or slope failure observed.*
- b. Economic benefits?  
*Foundry sand was donated by Auburn Foundry, however INDOT saved on the purchase of virgin materials and Auburn foundry regained 1.5 years of life of its monofill*
- c. Landfill Space Savings: *45,000 yd<sup>3</sup>*

### 5. Follow-up to assess recycled material performance or environmental impacts

*Currently, InDOT does not plan to return to the demonstration site to evaluate performance.*

### 6. Photos or other documentation.

*See "InDOT BU Case Study Documentation.pdf"*

## **CASE STUDY #5: Use of Shredded Tires in an Embankment by InDOT**

Location *U.S. 31, 0.4 miles South of S.R. 4 in Lakeville, St. Joseph County, Indiana (2001).*  
Project Background *A 70 ft long, 100 ft wide and 10 ft high embankment was selected to construct with tire chips and granular mixture. The project was close to the source.*

### 1. Contact Information

InDOT: Athar Khan ([atkhan@indot.state.in.us](mailto:atkhan@indot.state.in.us)) and Nayyar Siddiki ([nsiddiki@indot.state.in.us](mailto:nsiddiki@indot.state.in.us))  
IDEM: Tracy Barnes ([tbarnes@idem.IN.gov](mailto:tbarnes@idem.IN.gov) 317/308-3110)  
Generator: Dillon Tires  
Contractor: Reith Riley  
Consultant: Purdue

### 2. Material Used

- a. Specific type: *Shredded tires (2"x2" chips) and granular soils*
- b. Amount used: *1000 yd<sup>3</sup>*
- c. Amount of virgin material that the recycled material replaced: *1000 yd<sup>3</sup>*

### 3. How the material was used

- a. Application: *Tire chips and granular mix were used to construct an embankment,*
- b. Type of project: *InDOT initiated the demonstration project as part of its overall policy to conduct field testing of materials*
- c. Related standards and specs used:  
*InDOT Special Provision "Embankment Construction Using Tire Shreds-Granular (TSG) Mix"*
- d. Special technical considerations/adjustments  
*InDOT increased the tire chip size (2" to 8") and tire chip portion ( from 50% to 60% in the mix) for future projects. Stockpiling of mixture was allowed. However, tire chips were mixed with sand upon delivery and mixture was incorporated as soon as possible. Used 6 to 8 passes of vibratory roller on 12 in thick lift of tire chips and granular mix*
- e. Performance issues/Environmental Monitoring  
*No settlement to date. Monitored geotechnical instrumentation and ground water for one year.*

### 4. Savings and Benefits

- a. Short or Long term performance benefits:  
*Embankment construction was completed well ahead of schedule. Wet season did not affect construction. No settlement or slope stability problems.*
- b. Economic benefits: *not evaluated by InDOT*
- c. Landfill Space Savings: *1,000 yd<sup>3</sup>*

### 5. Follow-up to assess recycled material performance or environmental impacts

*Purdue is planning to perform a plate load test soon.*

### 6. Photos or other documentation.

*See "InDOT BU Case Study Documentation.pdf"*

## **CASE STUDY #6: Use of Crushed Glass as Backfill by InDOT**

Location *Bruceville, Indiana*

Project Background *Use of Crushed Glass as bedding and backfill material (2001)*

### 1. Contact Information

InDOT: Athar Khan ([atkhan@indot.state.in.us](mailto:atkhan@indot.state.in.us)) and Nayyar Siddiki ([nsiddiki@indot.state.in.us](mailto:nsiddiki@indot.state.in.us))

IDEM: Larry Haag

Generator & Contractor: *Solid Waste District and InDOT*

Consultants: *Purdue and InDOT*

### 2. Material Used

- a. Specific type: *Crushed Glass*
- b. Source: *Solid Waste District*
- c. Amount used: *about 20 yd<sup>3</sup>*
- d. Amount of virgin material that the recycled material replaced: *about 20 yd<sup>3</sup>*

### 3. How the material was used

- a. Application: *Crushed glass was used as bedding and backfill material around pipe.*
- b. Type of Project: *InDOT initiated the demonstration project as part of its overall policy to conduct field testing of materials.*
- c. Related standards and specs used:  
*InDOT Special Provision 211-R-415 "Crushed Glass as Bedding Material"*
- d. Special technical considerations/adjustments  
*None. InDOT utilized the research and experience of other states. Glass was incorporated as delivered.*
- e. Performance issues/Environmental monitoring  
*Glass bottles can be crushed into granular fill, which is quite comparable to natural aggregate. No settlement. No environmental monitoring.*

### 4. Savings and Benefits

- a. Short or Long term performance benefits: *Crushed aggregate performed as well as natural aggregate. Saving of natural aggregate*
- b. Economic benefit:  
*Local communities may use crushed glass in smaller projects in their community instead of sand filling.*
- c. Landfill Space Savings: *20 yd<sup>3</sup>*

### 5. Follow-up to assess recycled material performance or environmental impacts

*Currently, InDOT does not plan to return to the demonstration site to evaluate performance.*

### 6. Photos or other documentation.

*See "InDOT BU Case Study Documentation.pdf"*



## USEFUL LINKS

EPA's Resource Conservation Challenge

[www.epa.gov/rcc](http://www.epa.gov/rcc)

Indiana Department of Environmental Management Office of Land Quality

[www.in.gov/idem/programs/land/index.html](http://www.in.gov/idem/programs/land/index.html)

Statutes and Rules:

Indiana Code 13-19-3-3 Pertains to CCPs

[www.ais.org/legislative/ic/code/title13/ar19/ch3.html#IC13-19-3-3](http://www.ais.org/legislative/ic/code/title13/ar19/ch3.html#IC13-19-3-3)

Indiana Code 13-19-3-7 Pertains to Foundry Sand

[www.ais.org/legislative/ic/code/title13/ar19/ch3.html#IC13-19-3-7](http://www.ais.org/legislative/ic/code/title13/ar19/ch3.html#IC13-19-3-7)

Indiana Code 13-19-3-8 Pertains to Slag

[www.ais.org/legislative/ic/code/title13/ar19/ch3.html#IC13-19-3-8](http://www.ais.org/legislative/ic/code/title13/ar19/ch3.html#IC13-19-3-8)

329 IAC 10-9-4 Pertains to Foundry Sand Waste Classification

[www.in.gov/legislative/iac/T03290/A00100.PDF](http://www.in.gov/legislative/iac/T03290/A00100.PDF)

Case-by-Case Approvals are Covered under 329 IAC 10-3-1

[www.in.gov/legislative/iac/T03290/A00100.PDF](http://www.in.gov/legislative/iac/T03290/A00100.PDF)

Land Application is Covered under 327 IAC 6.1

[www.in.gov/legislative/iac/T03270/A00061.PDF](http://www.in.gov/legislative/iac/T03270/A00061.PDF)

Indiana DOT Construction Standards and Specifications

[www.in.gov/dot/div/contracts/standards/book/index.html](http://www.in.gov/dot/div/contracts/standards/book/index.html)

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