Using Recycled Industrial Materials in Buildings

Greening the built environment.

This information sheet discusses the use of recycled industrial materials in buildings as an alternative to virgin materials and building products. Industrial materials are the byproducts of industrial processes. Each year in the United States, industries produce over half a billion tons of residuals that are potentially usable materials, such as coal combustion products (CCPs), construction and demolition (C&D) materials, spent foundry sand, used tires, and slags. Many of these materials have chemical and physical properties that make them valuable resources when recycled or beneficially reused, but they are often disposed of as waste. The U.S. Environmental Protection Agency (EPA) is committed to increasing the recycling of industrial materials as part of its ***Resource Conservation Challenge***, a national effort to conserve energy and other resources and reduce greenhouse gas emissions by managing materials more efficiently. Industrial materials recycling (IMR) helps accomplish these goals by conserving natural resources and decreasing energy use and greenhouse gas emissions.

www.epa.gov/industrialmaterials

An Overview:

Why Use Industrial Materials in Buildings?

Environmental Benefits

Since many industrial materials are used to replace non-renewable virgin materials that must be mined and processed for use, IMR conserves natural resources and reduces the energy use and pollution associated with these activities. For example, substituting coal fly ash (an industrial material) for portland cement in concrete saves the energy and greenhouse gas emissions associated with producing cement. The beneficial use of industrial materials results in less material being sent to disposal facilities, which saves landfill space and further reduces greenhouse gas emissions and other pollutants.

Economic Benefits

Industrial materials are often less expensive than virgin materials, so they make good economic sense for builders and project owners. Further, reusing or recycling C&D materials onsite can reduce material hauling and disposal costs. These savings, applied to the total project cost, make it possible to do more work with the same budget. In addition, C&D recyclers will often charge less to accept recyclable materials that have already been separated from non-recyclable materials—a practice that can be encouraged at the building site by using separate containers for various materials.

Performance Benefits

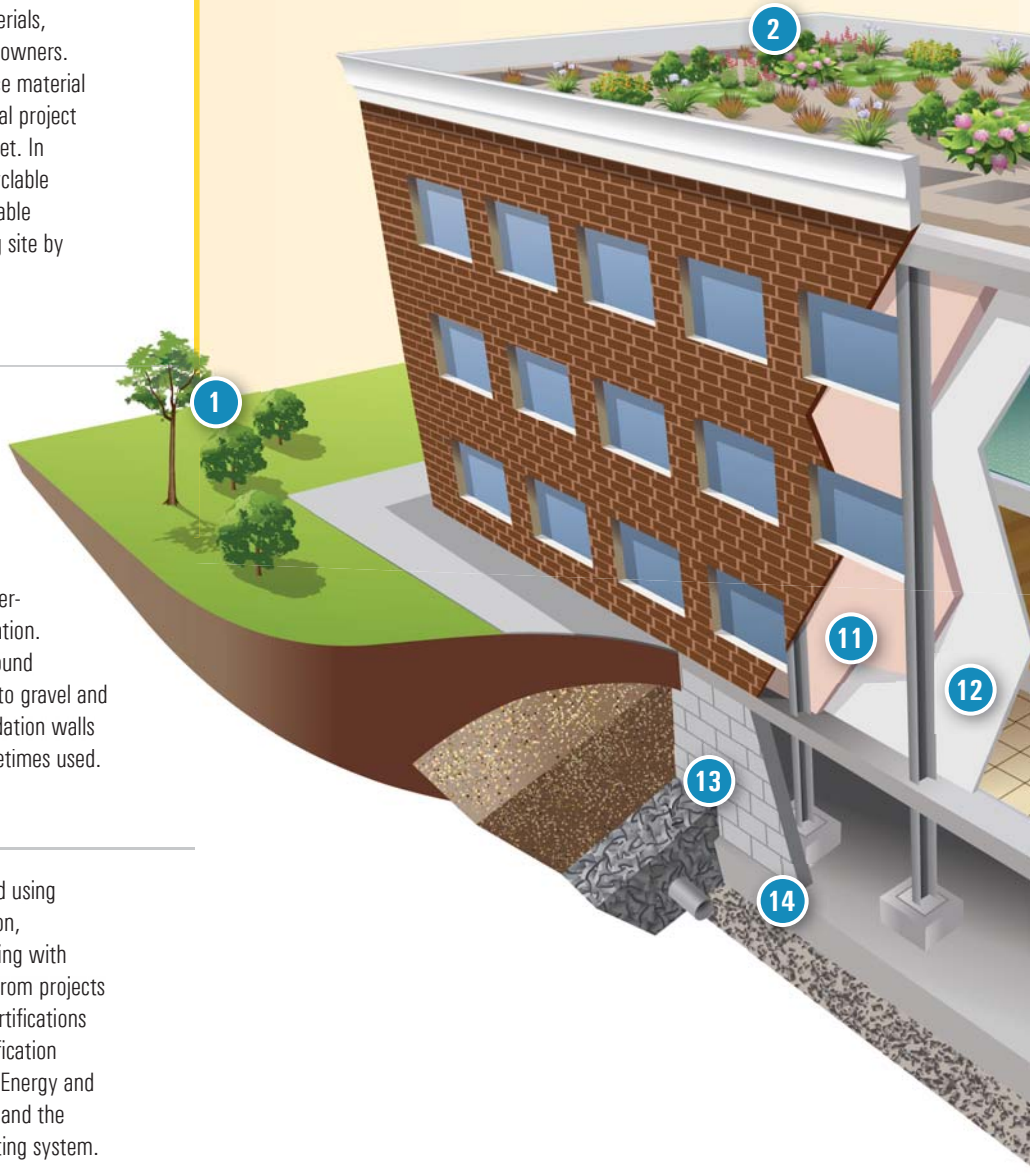
Some industrial materials, such as fly ash and slag cement used as supplementary cementitious material in concrete, offer significant performance benefits over virgin materials. Other industrial materials, such as foundry sand, perform just as well as—and in some cases better than—virgin materials in building applications. Coal bottom ash used as bedding material for green roofs is lighter-weight than alternatives, an important quality in this application. Tire shreds can not only provide more effective drainage around building foundations due to a greater gap structure relative to gravel and dirt alternatives, but also put less pressure on building foundation walls compared to the denser and heavier materials that are sometimes used.

Green Building

Green, or sustainable, building is the practice of creating and using healthier and more resource-efficient methods of construction, renovation, operation, maintenance, and demolition. Designing with industrial materials and recycling C&D materials generated from projects leads to more sustainable buildings. Most green building certifications give points for these practices; two of the best-known certification systems are the U.S. Green Building Council's Leadership in Energy and Environmental Design (LEED)® green building rating system and the Green Building Initiative's Green Globes ™ green building rating system.

Building Applications for Industrial Materials

This diagram illustrates a variety of common building applications for industrial materials. Note that the availability of specific industrial materials can vary regionally. The websites in the "Resources for More Information" section of this document may provide information on identifying suppliers of industrial materials in your region as well as local C&D materials recyclers.



1 2 Green Roofs & Landscaping

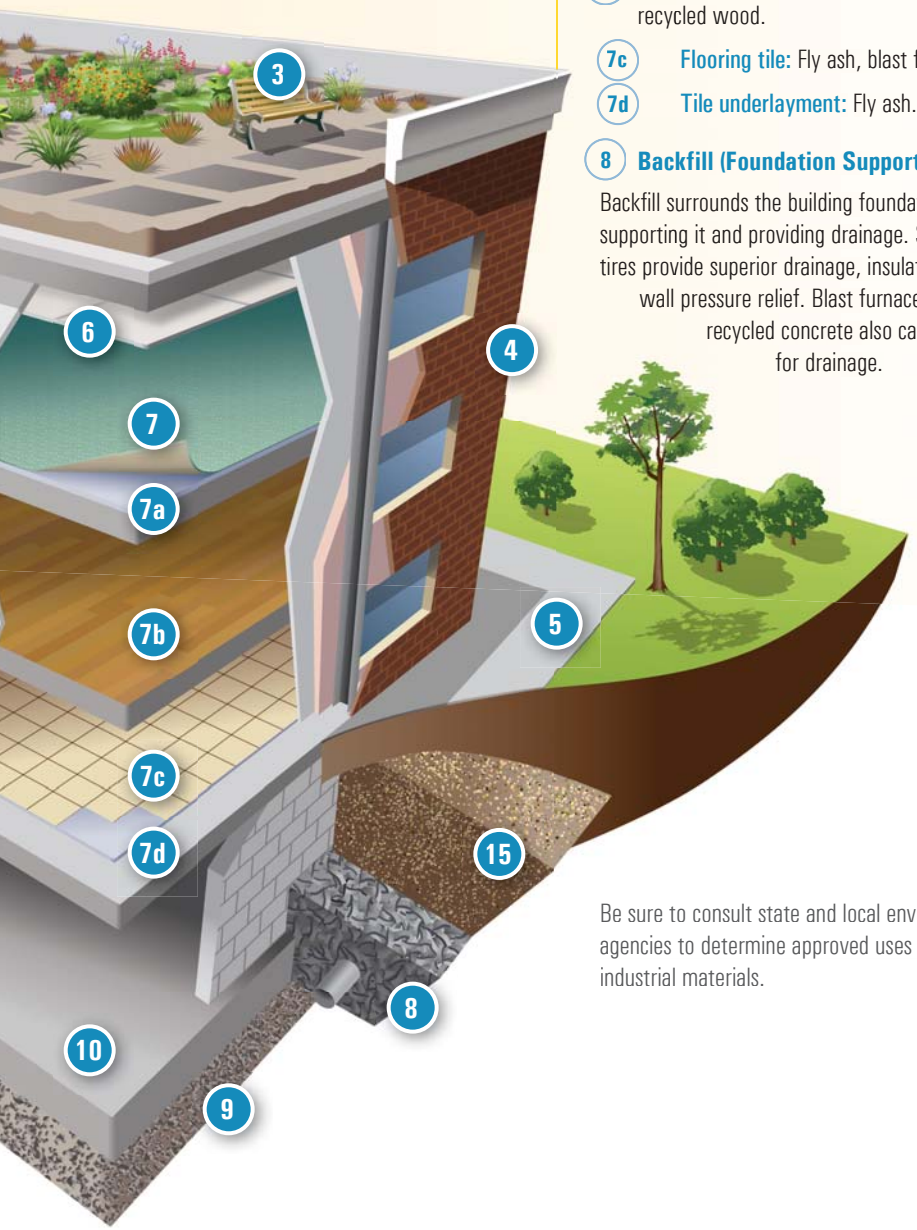
Green roofs are roofs covered with plants; they reduce storm runoff and provide insulation. Scrap tires can be used to make rubber tile for walkways. Bottom ash can be used as bedding material. Clean wood, recycled gypsum wallboard, and cardboard can be ground and used as soil amendments in both green roofs and landscaping applications.

3 Landscape Furniture

Benches can be made with plastic lumber containing fly ash or with recycled C&D wood.

4 Building Facing Material

Manufactured stone, which is concrete mixed with aggregates, is commonly used as building facing material. Fly ash can be used in the production of manufactured stone.



5 Sidewalks

Industrial materials can be used to make concrete sidewalks, and used tires can be recycled to create rubberized sidewalks. Asphalt concrete sidewalks can be made with recycled asphalt pavement and recycled asphalt shingles.

6 Ceiling Tile

Ceiling tile can contain flue gas desulfurization (FGD) gypsum (a material resulting from burning coal to produce electricity), fly ash, recycled gypsum wallboard, or air-cooled blast furnace slag.

7 Flooring

Industrial materials can be used in various flooring applications.

7a **Carpet backing:** Used tires, fly ash, or recycled carpet.

7b **Wood flooring:** Salvaged lumber or recycled wood.

7c **Flooring tile:** Fly ash, blast furnace slag.

7d **Tile underlayment:** Fly ash.

8 Backfill (Foundation Support)

Backfill surrounds the building foundation, supporting it and providing drainage. Scrap tires provide superior drainage, insulation, and wall pressure relief. Blast furnace slag and recycled concrete also can be used for drainage.

Be sure to consult state and local environmental agencies to determine approved uses of industrial materials.

9 Foundation Structural Fill

Structural fill is an engineered fill that is constructed in layers and compacted to a desired density. Coal fly ash, bottom ash, slag, and spent foundry sand can all be used as structural fill. Concrete can be crushed and used onsite as structural fill.

10 Poured Concrete Foundation

Concrete, which is composed of cement, aggregate, and water, is used in a wide array of building applications. Industrial materials can be recycled in cement and concrete in many ways. Here are a few examples:

- Fly ash and ground granulated blast furnace slag can be used as partial cement replacements. Using these materials can produce stronger, longer-lasting concrete.
- Portland cement itself can be made with fly ash, FGD gypsum, foundry sand, recycled gypsum wallboard, blast furnace, and steel slag.
- Concrete aggregates can include bottom ash, foundry sand, crushed concrete, and blast furnace slag.

11 Insulation

Air-cooled blast furnace slag can be used to produce mineral or rock wool insulation (also known as slag wool insulation).

12 Drywall/Wallboard

FGD gypsum and recycled gypsum wall board can be used to manufacture drywall.

13 Mortars, Grouts, Stucco

Mortars, grouts, and stucco contain aggregate (sand), binder, and water. Fly ash, foundry sand, silica fume, and slag cement can all be used as partial cement replacements.

14 Masonry Blocks

Masonry blocks are made from cement and aggregate. Slag cement, fly ash, or silica fume can substitute partially for cement. Bottom ash, blast furnace slag, and recycled concrete aggregate can substitute for newly mined materials.

15 Base Material

Spent foundry sand can be used in place of natural soil as base material for the building site. In cold weather climates, this strategy can extend the construction season because foundry sands do not freeze as readily as most soils. Recycled concrete is also commonly used as base material.

Case Study

EPA Potomac Yards Buildings Maximize the Use of Recyclable Materials

The EPA buildings at One and Two Potomac Yard, located in Arlington, Virginia, are prime examples of how buildings can be constructed with resource management in mind. The buildings are U.S. Green Building Council LEED® Gold certified and contain, on average, 27% recycled content (as per LEED® calculations). Environmentally preferable products used in the buildings include slag concrete aggregate, fly ash, certified hardwood and softwood building products, recycled-content ceiling panels, carpet tile, and gypsum wallboard. Portions of the below-grade, poured-in-place concrete structure used 35% recycled-content concrete. This concrete contained approximately 670,000 pounds of slag for aggregate. Further, fly ash was used in concrete masonry unit blocks.

Prior to construction, the project team developed a C&D materials management plan. This included tracking the amount of C&D materials diverted from landfill disposal once construction commenced. The major groups of recycled materials were wood; steel; concrete, asphalt, and concrete masonry units; cardboard and paper; and drywall. An estimated 71% (about 2,000 tons) of the C&D materials generated during the construction of One and Two Potomac Yard was diverted from landfills. The majority of these materials were separated in material-specific dumpsters at the jobsite, which were then taken to C&D recyclers.

The project won several awards for its green design, including the 2007 White House Closing the Circle Award, a 2007 award for best environmentally responsible building from the Northern Virginia Chapter of the National Association of Industrial and Office Properties, a 2005 Green ABBIE Award from the Arlington Economic Development Commission and Arlington Chamber of Commerce, and the U.S. General Services Administration (GSA) Lease Project of the Year Award (2004).

Did You Know?

The American Society for Testing Materials (ASTM) has studied and evaluated the benefits of using industrial materials in civil engineering applications. ASTM C 150, ASTM C 311, ASTM C 595, ASTM C 618, and ASTM C 989 are standard specifications for using fly ash and ground granulated blast furnace slag in cement and concrete in buildings. ASTM D6270-98 provides design guidelines for using scrap tires in civil engineering applications. Be sure to contact your state and local environmental agencies for more information about approved uses of industrial materials. See the ASTM website at: www.astm.org

Resources for More Information

EPA's Industrial Materials Recycling Homepage: Provides an overview of industrial materials, their benefits, and opportunities for reuse and recycling: www.epa.gov/industrialmaterials

EPA's Comprehensive Procurement Guidelines (CPG): Offers information about construction, landscaping, and other products containing recycled content. Though designed for procuring agencies using federal funds, these guidelines are also useful for the private sector: www.epa.gov/cpg

Construction Industry Compliance Assistance (CICA) Center: Contains a C&D materials State Resource Locator, where you can find state environmental agency Web sites: www.cicacenter.org

Industrial Resources Council (IRC): The IRC is composed of industry trade associations representing coal combustion products, foundry sands, iron and steel slag, wood and pulp materials, rubber materials, and C&D materials. This Web site contains information about industrial materials and their applications: www.industrialresourcescouncil.org

The University of North Dakota's "Buyer's Guide for Coal Ash-containing Products": Provides links to suppliers of building materials containing coal combustion products: www.undeerc.org/carrc/BuyersGuide

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