LEED for Neighborhood Development

Guideline for Concrete Pipe and Boxes

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Content

Introduction

The purpose of this guideline is to help applicants for a LEED certified project achieve LEED points with reinforced concrete pipe and boxes.

The U.S. Green Building Council (USGBC), the Congress for the New Urbanism (CNU), and the Natural Resources Defense Council (NRDC)—three organizations that represent some of the U.S.A's leaders among progressive design professionals, builders, developers, and the environmental community—have come together to develop a national set of standards for neighborhood location and design based on the combined principles of smart growth, new urbanism, and green building. The goal of this partnership is to establish these standards for assessing and rewarding environmentally superior development practices within the rating framework of the LEED® (Leadership in Energy and Environmental Design) Green Building Rating System™.

Unlike other LEED products that focus primarily on green building practices, with relatively few credits regarding site selection and design, LEED for Neighborhood Development places emphasis on the design and construction elements that bring buildings together into a neighborhood, and relate the neighborhood to its larger region and landscape. The work of the committee is guided by sources such as the Smart Growth Network's ten principles of smart growth, the Charter of the New Urbanism, and other LEED rating systems. LEED for Neighborhood Development creates a label, as well as guidelines for design and decision-making, to serve as an incentive for better location, design, and construction of new residential, commercial, and mixed use developments.

The existing LEED for New Construction Rating System has a proven track record of encouraging builders to utilize green building practices, such as increasing energy and water efficiency and improving indoor air quality in buildings. It is the hope of the partnership that LEED for Neighborhood Development will have a similarly positive effect in encouraging developers to revitalize existing urban areas, reduce land consumption, reduce automobile dependence, promote pedestrian activity, improve air quality, decrease polluted stormwater runoff, and build more livable, sustainable, communities for people of all income levels. Source: Pilot Version, LEED for Neighborhood Development Rating System.

LEED for Neighborhood Development's principal aim is to improve land-use patterns, neighborhood design, and technology. In terms of eligibility for the pilot program, there is no minimum or maximum for project size and no strict definition for what would comprise a neighborhood. The only requirement is that projects must be able to meet all prerequisites and anticipate that the minimum number of points through credits to achieve certification can be earned.

Concrete pipe and boxes are extremely durable and should be the products of choice for a sustainable drainage infrastructure. Reinforced concrete pipe (RCP) has a proven record of accomplishment for over a century of providing a strong and durable structure for sewers and culverts, and is produced from one of the most versatile green building materials (concrete) available today.

A "sustainable" or "green" building is defined as a structure that is developed, designed, built, renovated, operated, reused or redeveloped in a resource efficient manner. LEED is the effort to create and provide a national standard for what constitutes a green building and sustainable building practices. It is important to note that the LEED system does not certify products to be used in LEED projects; rather the system sets forth a design and construction process in which a product can help the project achieve LEED points, if the product has specific qualities that are considered sustainable or green.

Project Checklist for Concrete Pipe – LEED ND

Due to the versatility of reinforced concrete pipe, it can be used in a multitude of applications in the LEED process (such as stormwater control), and as a building material to achieve the intent of the LEED credit. As a material, concrete will receive LEED credits in the Materials and Resources section of LEED for New Construction, but the RCP will be used as a building material in other LEED categories. In other words by using more RCP throughout the project, RCP can help the project gain LEED points under the Materials and Resource credit. While RCP and other materials can both be used in stormwater applications, RCP should be the sustainable choice due to its durability and reduced bedding requirements.

The purpose of the rating system is to accumulate enough project points to reach a level of certification set forth by the LEED program and thus provide a classification for rating the sustainability of the project. The LEED certification process provides third-party certification that a project meets the building and performance standards set forth by LEED. The project must submit an application and provide documentation throughout the project to receive credit for possible LEED credits. Some of the LEED categories have prerequisites that must be achieved to qualify for LEED certification. The points available for each LEED category vary and a project checklist is used to allocate points for specific design and building elements of a project, such as the types of construction materials used, or the efficiency achieved.

The LEED sustainability classification considers the entire project, including the vertical and horizontal infrastructure, footprints of structures, impervious surface area, resource conservation, and energy conservation. There are four LEED-ND certification levels based on points accumulated.

Certified 40-49 points
Silver 50-59 points
Gold 60-79 points
Platinum 80-106 points

Total - 106 Points

The key to getting LEED points is to design for energy efficiency, minimize the project waste streams, and use renewable materials all together to create a green project. One of the best green materials that can be used in numerous applications on a project to receive LEED points is reinforced concrete and one of the key products made with reinforced concrete is reinforced concrete pipe. Although easily overlooked, RCP can help a project secure valuable LEED points and RCP has a proven record of being a durable and sustainable drainage product. The following checklist highlights the credits in green that might be possible by incorporating reinforced concrete pipe and/or boxes into the project design. Each of the highlighted sections is detailed following the checklist and in some instances cross over into calculations used in LEED for New Construction when LEED NC is cross-referenced in LEED ND. On any project, the use of reinforced concrete pipe and boxes should not be overlooked for their use in constructing infrastructure or components of buildings. Even though the structures built from precast concrete pipe and boxes may not contribute to LEED points, they should not detract from the rating system, if the owner is looking for infrastructure that is sustainable for the design life of the project.

Smart Location & Linkage 30 Possible Points

Prereq 1 Smart Location Required
Prereq 2 Proximity to Water and Wastewater Infrastructure Required
Prereq 3 Imperiled Species and Ecological Communities Required
Prereq 4 Wetland and Water Body Conservation Required
Prereq 5 Agricultural Land Conservation Required
Prereq 6 Floodplain Avoidance Required

Credit 1 Brownfield Redevelopment (2 points) **RCP/Boxes**
Credit 2 High Priority Brownfields Redevelopment 1
Credit 3 Preferred Locations 2-10
Credit 4 Reduced Automobile Dependence 1-8
Credit 5 Bicycle Network 1
Credit 6 Housing and Jobs Proximity 3
Credit 7 School Proximity 1
Credit 8 Steep Slope Protection (1 point) **RCP/Boxes**
Credit 9 Site Design for Habitat or Wetlands Conservation 1
Credit 10 Restoration of Habitat or Wetlands 1
Credit 11 Conservation Management of Habitat or Wetlands (1 point) **RCP/Boxes**

Neighborhood Pattern & Design 39 Possible Points

Prereq 1 Open Community Required
Prereq 2 Compact Development Required
Credit 1 Compact Development (1 to 7 points) **RCP/Boxes**
Credit 2 Diversity of Uses 1-4
Credit 3 Diversity of Housing Types (1 to 3 points) **RCP/Boxes**
Credit 4 Affordable Rental Housing 1-2
Credit 5 Affordable For-Sale Housing 1-2
Credit 6 Reduced Parking Footprint 2
Credit 7 Walkable Streets 4-8
Credit 8 Street Network 1-2
Credit 9 Transit Facilities 1
Credit 10 Transportation Demand Management 2
Credit 11 Access to Surrounding Vicinity 1
Credit 12 Access to Public Spaces 1
Credit 13 Access to Active Public Spaces (1 point) **RCP/Boxes**
Credit 14 Universal Accessibility 1
Credit 15 Community Outreach and Involvement 1
Credit 16 Local Food Production (1 point) **RCP/Boxes**

Green Construction & Technology 31 Possible Points

Prereq 1 Construction Activity Pollution Prevention Required
Credit 1 Certified Green Buildings (1 to 3 points) **RCP/Boxes**
Credit 2 Energy Efficiency in Buildings (1 to 3 points) **RCP/Boxes**
Credit 3 Reduced Water Use (1 to 3 points) **RCP/Boxes**
Credit 4 Building Reuse and Adaptive Reuse 1-2
Credit 5 Reuse of Historic Buildings 1
Credit 6 Minimize Site Disturbance through Site Design 1
Credit 7 Minimize Site Disturbance During Construction (1point) **RCP/Boxes**
Credit 8 Contaminant Reduction in Brownfields Remediation 1
Credit 9 Stormwater Management (1 to 5 points) **RCP/Boxes**
Credit 10 Heat Island Reduction 1
Credit 11 Solar Orientation 1

Credit 12 On-Site Energy Generation 1
Credit 13 On-Site Renewable Energy Sources (1 point) **RCP/Boxes**
Credit 14 District Heating and Cooling (1 point) **RCP/Boxes**
Credit 15 Infrastructure Energy Efficiency 1
Credit 16 Wastewater Management (1 point) **RCP/Boxes**
Credit 17 Recycled Content in Infrastructure (1 point) **RCP/Boxes**
Credit 19 Comprehensive Waste Management 1
Credit 20 Light Pollution Reduction 1

Innovation & Design Process 6 Possible Points

Credit 1 Innovation and Exemplary Performance (1to 5 points) **RCP/Boxes**
Credit 2 LEED Accredited Professional 1

Potential LEED Credit Considerations Using Reinforced Concrete Pipe and/or Boxes

Smart Location & Linkage 30 Possible Points

Credit 1 Brownfields Redevelopment (2 points) RCP/Boxes

Intent

Encourage the reuse of land by developing sites where development is complicated by environmental contamination, reducing pressure on undeveloped land.

Concrete Solution

Reinforced concrete pipe and boxes have been used successfully in brownfield development in deep buries or in an environment of contaminated soils. Concrete mixes and service life of precast concrete products ensure low maintenance of a sewer and minimal disturbance of soils for the design life of a project. Concrete pipe installations located within brownfields has been tested for continued performance and left in the installed condition for the redevelopment of the site. Reinforced concrete pipe and boxes are a compatible infrastructure material for the redevelopment of brownfield sites.

Credit 8 Steep Slope Protection (1point) RCP/Boxes

Intent

Minimize erosion to protect habitat and reduce stress on natural water systems by preserving steep slopes in a natural, vegetated state.

Concrete Solution

Reinforced concrete pipe has been used successfully for drop structures of approximately 30 metres to preserve the integrity of slopes and vegetation in environmentally sensitive areas. Concrete pipe has been microtunnelled at the base of steep slopes to avoid disturbance of the slopes and vegetation. The long service life of concrete pipe and boxes ensures that the slopes and vegetation would not have to be disturbed for maintenance or replacement for at least 100 years.

Credit 11 Conservation Management of Habitat or Wetlands (1 point) RCP/Boxes

Intent

Conserve native wildlife habitat, wetlands and water bodies.

Concrete Solution

Concrete pipe and boxes have been used successfully to conserve habitat, wetlands and water bodies with the casting of internal baffles or dissipaters to reduce the energy of flowing water before it discharges into receiving lakes and streams. Such systems have been used for storm sewers, intermittent streams and creeks enclosed in culverts for road crossings. Precast concrete culverts can be three sided leaving the natural ecosystems of the stream intact and accommodating aquifer recharge, or cast with artificial bases to facilitate the movement of aquatic life through the culverts so that migration and spawning characteristics of an ecosystem can be maintained. Speedy installation of precast concrete pipe and box sewers and culverts reduces the impact on habitat during construction and ensures long service life with little maintenance to disturb habitat, wetlands and water bodies for periods of 100 years and more. Precast boxes have been used successfully for constructing aquatic habitat in harbors while providing structures for piers and groynes to manage currents.

Neighborhood Pattern & Design 39 Possible Points

Credit 1 Compact Development (1-7 points) RCP/Boxes

Intent
Conserve land. Promote community livability, transportation efficiency, and walkability.

Concrete Solution
When development is intensified or made compact, sewer services and others must have a service life that at least matches the design life of the project. Concrete pipe and box sewers and culverts ensure 100 years or more of service life. Sewers, watermains and utilities can be enclosed in precast concrete galleries with maintenance access entry points so that the residential, commercial, industrial or institutional development on the surface need not be disturbed for the maintenance or expansion of buried services and utilities. With long-term buried concrete service systems, transportation in compact developments need not be disturbed or disrupted by sewer replacements, and the movement of pedestrians remains safe and undisturbed for the design life of the project.

Concrete pipe can be used for geothermal systems used to heat and cool multiple housing/employment/commercial/institutional structures and reduce energy costs. Earth tube technology is proven and in use for unique structures.

Credit 3 Diversity of Housing Types (1-3 points) RCP/Boxes

Intent
To enable citizens from a wide range of economic levels and age groups to live within a community.

Concrete Solution
Concrete pipe can be used for geothermal systems used to heat and cool multiple housing/employment/commercial/institutional structures and reduce energy costs. Earth tube technology is proven and in use for unique structures. Concrete pipe and box sewers can be used to service any housing type and can be designed with a service life to match the design life of the project with minimal maintenance. The least cost (life cycle cost) of a long-term concrete sewer will be far cheaper than systems made with corrugated metal and thermoplastic materials currently on the market.

Credit 13 Access to Active Public Spaces (1point) RCP/Boxes

Intent
To provide a variety of open spaces close to work and home to encourage walking, physical activity and time spent outdoors.

Concrete Solution
Precast concrete boxes and pipe are used for walkways under railways and roads to link places of work with residential neighborhoods, to link neighborhoods with recreational areas and to maintain pedestrian and bicycle pathway linkages under major arterial roads. Developable sites need not be separated by transportation facilities when concrete pipe and boxes can be used for safe tunnels and passageways.

Credit 16 Local Food Production (1point) RCP/Boxes

Intent
Promote community-based and local food production to minimize the environmental impacts from transporting food long distances and increase direct access to fresh foods.

Concrete Solution
Precast concrete pipe and boxes can be used for the construction of cisterns and storm water retention and detention systems so that gray water from rainfall and snowmelt can be used for local irrigation of urban food lands and gardens during periods of low precipitation, or in arid regions. The use of underground structures made of precast concrete would reduce the use of treated municipal potable water for irrigation and could reduce the cost of local food production. In developments in arid regions, storm water can be channeled to local food lands in concrete pipes to reduce evaporation before the water is used in food production. Buried storm water detention systems made of precast concrete pipe and boxes can be constructed in compact urban areas where long service life of construction material and structures must match the design life of the developments to ensure low maintenance and little disruption of transportation and residential use due to reconstruction. Food lands can be planted over precast concrete structures without fear of damaging the structures by agricultural practices designed to have regard for the buried structures.

Green Construction & Technology 31 Possible Points

Credit 1 Certified Green Buildings (1-3 points) RCP/Boxes

Intent
Encourage the design and construction of buildings to utilize green building practices.

Requirements
Option 1 – For projects with 5 or fewer habitable buildings
Design, construct, or retrofit one building as part of the project to be certified under one of the following LEED building rating systems: **LEED for New Construction**, LEED for Existing Buildings, LEED for Homes, LEED for Core & Shell, LEED for Schools, or any Application Guides of these rating systems (1point). Additional points (no more than 3 total) may be earned for each additional certified building that is part of the project;
or
Option 2 – For projects with 6 or more habitable buildings
Design, construct, or retrofit a percentage of the square footage of buildings that are part of the project to be certified under one of the LEED building rating programs listed above.

Concrete Solution
Precast concrete pipe has been used successfully as earth tubes in institutional buildings, butterfly conservatories, and greenhouses of botanical gardens. Earth tubes work on the principles of geothermal heating, ventilating, and air conditioning in all seasons of the year. Earth tubes can be used to ventilate single structures or multiple building developments.

The use of concrete pipe and boxes for sewers and galleries ensures that the service life of the infrastructure will match the design life of the green buildings to maximize energy and maintenance cost efficiencies.

In LEED for New Construction, under LEED MR Credit 3 – Material Reuse, MR Credit 3 is a Credit for Materials Reuse and the intent for the LEED-NC points is:

> "Reuse building materials and products in order to reduce demand for virgin materials and to reduce waste, thereby reducing impacts associated with the extraction and processing of virgin resources."

Under MR Credit 3 Materials Reuse salvaged or reused reinforced concrete pipe could be reused on the project. The credit requirements for MR Credit 3 are:

- Use of salvaged, refurbished or reused materials such that the sum of these materials constitutes at least 5% (value 1 LEED-NC point) or 10% (value an additional LEED-NC point for a total of 2), based on cost, of the total value of materials on the project.[1]
- Mechanical, electrical and plumbing components and specialty items such as elevators and equipment shall not be included in this calculation. Only include materials permanently installed in the project. Furniture may be included, providing it is included consistently in MR Credits 3-7.

For RCP to help the project obtain LEED-NC points under this Credit the RCP used on the project must be salvaged or reused from another site. The cost of the reused material will be either the actual cost paid for the reused or salvaged material or the replacement value if the material came from on-site. Under this credit LEED allows that if the actual cost paid for the reused or salvaged material is below the cost of an equivalent new item, the higher value of the new material can be used in the calculations. Also if the cost to reclaim an item found on site is less than the cost of an equivalent new item, the higher cost of the new item should be used in the calculations. The salvaged material that is used from both on-site and off-site can be applied to Regional Materials Credit (MR Credit 5) if they comply with that credit's requirements.

In LEED for New Construction, under LEED MR Credit 4 – Recycled Content MR Credit 4 is a Credit for Recycled Content and the intent for the LEED-NC points is:

> "Increase demand for building products that incorporate recycled content materials, thereby reducing impacts resulting from extraction and processing of virgin materials."

Under MR Credit 4 Recycled Content, if the RCP used on the project contains more that 10% recycled content it will help the project obtain LEED-NC points under MR Credit 4. The credit requirements for MR Credit 4 are:

- Use of materials with recycled content such that the sum of post-consumer recycled content plus one-half of the pre-consumer content constitutes at least 10% (value 1 LEED-NC point) or 20% (value an additional LEED-NC point for a total of 2), based on cost, of the total value of the materials in the project.[2]
- The recycled content value of a material assembly shall be determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value.
- Mechanical, electrical and plumbing components and specialty items such as elevators shall not be included in this calculation. Only include materials permanently installed in the project. Furniture may be included, providing it is included consistently in MR Credits 3-7.
- Recycled content shall be defined in accordance with the International Organization of Standards document, ISO 14021 – Environmental labels and declarations – Self-declared environmental claims (Type II environmental labeling.)

Post-consumer material is defined by the USGBC as the waste material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product, which can no longer be used for its intended purpose.

[1] It is possible for the project to receive an additional point under the Innovation Design section for exemplary performance when a project documents that the value of salvaged or reused materials used on the project is equal to at least 15% of the total materials costs.

[2] It is possible for the project to receive an additional point under the Innovation Design section for exemplary performance when a project documents that the next incremental step is has been meet for recycled content and the total recycled content on the project has reached 30% or greater.

Pre-consumer material is defined by the USGBC as the material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it. **Note: USGBC has determined that fly ash should be considered a Pre-Consumer Recycled Content material.**

The recycled content value of the project uses the following two equations. Note that only half of the pre-consumer recycled material counts towards the recycled content value. The Recycled Content Value is calculated by taking the percentage of the post-consumer recycled content multiplied by the material cost plus half of the value of the pre-consumer recycled content multiplied by the material cost.

$$\text{Recycled Content Value (\$)} = (\%\,\text{post-consumer recycled content} \times \text{material cost}) + \frac{(\%\,\text{pre-consumer recycled content} \times \text{material cost})}{2}$$

The percent recycled content is calculated by taking the total recycled content value and diving it by the total materials cost.

$$\text{Percent Recycled Content} = \frac{\text{Total Recycled Content Value (\$)}}{\text{Total Materials Cost (\$)}}$$

Supplementary Cementitious Materials

When considering supplementary cementitious materials (SCMs) MR Credit 4 allows the recycled content value of concrete to be calculated by the mass of the cementitious materials only, rather than on the entire concrete mix. For example, if the SCM used is fly ash and 150 pounds is used per cubic yard of concrete, the fly ash would only represent 5% of the material if yard of concrete was 3,000 pounds. LEED allows the design team to calculate the recycled material based on the fraction of cementitious materials only. The value of the cementitious materials will be needed.

Below are two examples of reinforced concrete pipe design mixes and the calculations that would be done to determine the recycled amounts applicable to obtain LEED credits under MR Credit 4.

Concrete Pipe Batch Design Cementitious Materials Examples:

Example 1: Small Diameter Dry Cast Pipe: Vibration System

Based on a cubic yard of concrete

- Type I/II Cement: 745 lbs (cost $113.21 / ton)
- Grand Blast Furnace Slag: 230 lbs (cost $96.60 / ton)
- Type F Fly Ash: 250 lbs (cost $16.00 / ton)

Example 2: Large Diameter Dry Cast Pipe: Packerhead System

Based on a cubic yard of concrete

- Type I/II Cement: 388 lbs (cost $113.21 / ton)
- Grand Blast Furnace Slag: 185 lbs (cost $96.60 / ton)
- Type F Fly Ash: 42 lbs (cost $16.00 / ton)

Example 3: 5000 PSI Wet Cast Pipe and Boxes

Based on a cubic yard of concrete

- Type I/II Cement: 394 lbs (cost $113.21 / ton)

- Grand Blast Furnace Slag: 170 lbs (cost $96.60 / ton)
- Type F Fly Ash: 0 lbs (cost $16.00 / ton)

Table of Example Results: Supplementary Cementitious Materials Calculation[3]

Mix	Mass of Portland cement (lbs)	Mass of recycled SCMs (lbs)	Mass of total cementitious materials (lbs)	SCMs as a percentage of total cementitious materials (%)	Dollar value of all cementitious materials	Recycled content value per yard [(SCM/2)x$ value]
Ex. 1	745 lbs	480 lbs	1225 lbs	39.2%	$55.28	$10.83
Ex. 2	388 lbs	227 lbs	615 lbs	36.9%	$30.68	$5.66
Ex. 3	394 lbs	170 lbs	564 lbs	30.1%	$30.00	$4.52

Once the value of the recycled cementitious content is calculated per cubic yard the amount of recycled content of the amount of reinforce concrete pipe can be calculated for the project. The reinforcement contained in the pipe should also be calculated as a recycled content value, and listed as a line item for the reinforced concrete pipe on the project. The project data and calculations will be submitted by the project LEED coordinator and is required to document the process using a submittal template. The data that will be required to track recycled content must include a description of the material, the manufacturer of the material, the product cost, the pre-consumer and/or post-consumer recycled content percentage, and the source of the recycled content data.

In LEED for New Construction, under LEED MR Credit 5 – Regional Materials MR Credit 5 is a credit for use of regional materials in the project and the intent for the LEED-NC points is:

> "Increase demand for building materials and products that are extracted and manufactured within the region, thereby supporting the use of indigenous resources and reducing the environmental impacts resulting from transportation."

Under MR Credit 5 Regional Materials, RCP that is produced with regional materials will help the project obtain LEED-NC points under MR Credit 5. The credit requirements for MR Credit 5 are:

- Use building materials or products that have been extracted, harvested or recovered, as well as manufactured, within 500 miles of the project site for a minimum of 10% (value 1 LEED-NC point), based on cost of the total materials value.
- If only a fraction of a product or material has been extracted/harvested/recovered and manufactured locally, then only that percentage (by weight) can contribute to the regional value.
- Includes only materials that are permanently installed in the project. Mechanical, electrical and plumbing components and specialty items (elevators and equipment) are not included in the calculation.

Regionally Manufactured Materials are defined by the USGBC as materials that are assembled as a finished product within a 500-mile radius of the project site. For MR Credit 5, assembly does not include on-site assembly, erection or installation of finished components, as in structural steel, miscellaneous iron or system furniture.

[3] The recycled content value is calculated using the SCM percentage divided by two due to the fact that USGBC has determined that fly ash should be considered a Pre-Consumer Recycled Content material.

Regionally Extracted Materials are defined by the USGBC as materials having their source as a raw material from within a 500-mile radius of the project site.

To calculate the percent of local materials:

$$\text{Percent Local Materials} = \frac{\text{Total Cost of Local Materials (\$)}}{\text{Total Materials Cost (\$)}}$$

Reinforced concrete pipe can be made of several recycled materials that allow the project to claim LEED-NC certification points under the Materials and Resources section for materials with recycled content.

Durability

LEED Canada's Materials and Resources Credit 8 Durable Building (LEED Canada-NC 1.0) requires building designers to develop a Building Durability Plan to ensure that the predicted service life of the building and its components exceeds the design service life. The credit draws from CSA S478 (R2001) Guideline on Durability in Buildings to establish requirements and minimum benchmarks to achieve the single point available for this credit.

In satisfying the requirements for this credit, the designer is asked to establish a Design Service Life from Table 2 in the Guideline. Except for temporary buildings and parking structures, Table 2 requires that all buildings be designed for a service life in the range of 50-99 years.

LEED –ND projects may reference this LEED system and in so doing may benefit from the documented durability of reinforced concrete pipe that has a record of accomplishment surpassing 100 years.

Credit 2 Energy Efficiency in Buildings (1-3 points) RCP/Boxes

Intent

Encourage the design and construction of energy efficient buildings to reduce air, water, and land pollution and environmental impacts from energy production and consumption.

Concrete Solution

Precast concrete pipe has been used successfully as earth tubes in institutional buildings, butterfly conservatories, and greenhouses of botanical gardens. Earth tubes work on the principles of geothermal heating, ventilating, and air conditioning in all seasons of the year. Earth tubes can be used to ventilate single structures or multiple building developments.

The use of concrete pipe and boxes for sewers and galleries ensures that the service life of the infrastructure will match the design life of the green buildings to maximize energy and maintenance cost efficiencies.

Credit 3 Reduced Water Use (1-3 points) RCP/Boxes

Intent

Minimize water use in buildings and for landscape irrigation to reduce the impact to natural water resources and reduce the burden on municipal water supply and wastewater systems.

Concrete Solution

Precast concrete pipe and boxes can be used for the construction of cisterns and storm water retention and detention systems so that gray water from rainfall and snowmelt can be used for local irrigation of gardens during periods of low precipitation, or in arid regions. The use of underground structures made

of precast concrete would reduce the use of treated municipal potable water for irrigation and could reduce the demand for treated water for uses that do not require treated water like washing driveways, windows and cars.

Credit 7 Minimize Site Disturbance During Construction (1 point) RCP/Boxes

Intent
Conserve existing natural areas and protect trees to provide habitat and promote biodiversity.

Concrete Solution
Sites can be serviced with precast concrete pipe by microtunnelling through environmentally sensitive areas and not disturbing vegetation or habitat. Construction of infrastructure by microtunnelling can be done quickly with small construction footprints for access and exit sites. Trench width can be minimized with concrete pipe. Construction of the pipeline is completed once for the design life of projects and maintenance is minimal.

Backfill requirements should also be considered when designing a project to achieve LEED credits. One advantage that RCP has over competitive products is that RCP can be installed with the native material used for backfill rather than transporting additional backfill material to the site, and transportation/importing material has to be considered under LEED.

Credit 9 Stormwater Management (1-5 points) RCP/Boxes

Intent
Reduce adverse impacts on water resources by mimicking the natural hydrology of the region on the project site, including groundwater recharge. Reduce pollutant loadings from stormwater discharges, reduce peak flow rates to minimize stream channel erosion, and maintain or restore chemical, physical, and biological integrity of downstream waterways.

Concrete Solution
Precast concrete pipe and boxes are commonly used for underground storage of runoff that can be used for irrigation or part of a retention system of treated storm water and snow melt connected to oil sediment separators using precast concrete pipe, manhole and box components. Concrete detention and retention systems are used to reduce pollutant loadings in surface water bodies and to help restore local hydraulic regimes to pre urban development. Specially designed concrete pipe and boxes with internal baffles can reduce the energy of stormwater flow for discharge into streams, rivers and lakes with reduced or no erosion near the outfall. Concrete pipe producers have manufactured perforated concrete pipe and three-sided boxes to help recharge aquifers with stormwater channeled from urban areas with impervious streetscapes and parking areas.

Credit 13 On-Site Renewable Energy Sources (1 point) RCP/Boxes

Intent
Encourage on-site renewable energy self-supply in order to reduce environmental and economic impacts associated with fossil fuel energy use.

Concrete Solution
Precast concrete pipe has been used successfully as earth tubes in institutional buildings, butterfly conservatories, and greenhouses of botanical gardens. Earth tubes work on the principles of geothermal heating, ventilating, and air conditioning in all seasons of the year. Earth tubes can be used to ventilate single structures or multiple building developments. Geothermal heating is far removed from the use of fossil fuels and concrete pipe with its own thermal mass helps regulate the temperature of air.

Precast concrete pipe can be used for water intakes and delivery systems for water used in heating and cooling office and industrial buildings. There have been applications of concrete pipe for industrial steam systems (automotive) and conduction of moist air in butterfly conservatories. Water heated by solar energy can be stored in buried tanks and cisterns made of precast concrete pipe and boxes for residential, commercial, and industrial use. The quantity of fossil fuels used for heating and cooling can be reduced by using concrete pipe and boxes for service infrastructure.

Once a concrete pipe system is installed with its service life matching design life of a project, there will be minimal energy requirements for maintenance over a period of 100 years or more.

Credit 14 District Heating and Cooling (1 point) RCP/Boxes

Intent
Reduce air, water, and land pollution resulting from energy consumption in buildings by employing energy efficient district technologies.

Concrete Solution
Precast concrete pipe can be used for water intakes and delivery systems for water used in heating and cooling office and industrial buildings. There have been applications of concrete pipe for industrial steam systems (automotive) and conduction of moist air in butterfly conservatories. Water heated by solar energy can be stored in buried tanks and cisterns made of precast concrete pipe and boxes for residential, commercial, and industrial use. The quantity of fossil fuels used for heating and cooling can be reduced by using concrete pipe and boxes for service infrastructure.

Precast concrete pipe has been used successfully as earth tubes in institutional buildings, butterfly conservatories, and greenhouses of botanical gardens. Earth tubes work on the principles of geothermal heating, ventilating, and air conditioning in all seasons of the year.

Credit 16 Wastewater Management (1 point) RCP/Boxes

Intent
Reduce pollution from wastewater and encourage water reuse.

Concrete Solution
Precast concrete pipe and boxes with gaskets are used for major trunk and lateral sanitary sewers throughout the United States and Canada. Concrete pipe and box infrastructure is proven technology to reduce pollution from wastewater and eliminate disease such as cholera. Its service life is proven to exceed 100 years with minimal maintenance.

Precast concrete pipe and boxes are commonly used for underground storage of runoff that can be used for irrigation or part of a retention system of treated storm water and snow melt connected to oil sediment separators using precast concrete pipe, manhole, and box components. Concrete detention and retention systems are used to reduce pollutant loadings in surface water bodies and to help restore local hydraulic regimes to pre urban development. Specially designed concrete pipe and boxes with internal baffles can reduce the energy of stormwater flow for discharge into streams, rivers, and lakes with reduced or no erosion near the outfall. Concrete pipe producers have manufactured perforated concrete pipe and three-sided boxes to help recharge aquifers with storm water channeled from urban areas with impervious streetscapes and parking areas.

Precast concrete pipe and boxes can be used for the construction of cisterns and storm water retentions and detention systems so that gray water from rainfall and snowmelt can be used for local irrigation of gardens during periods of low precipitation, or in arid regions. The use of underground

structures made of precast concrete would reduce the use of treated municipal potable water for irrigation and could reduce the demand for treated water for uses that do not require treated water like washing driveways, windows and cars.

Credit 17 Recycled Content in Infrastructure (1 point) RCP/Boxes

Intent
Use recycled materials to reduce the environmental impact of extraction and processing of virgin materials.

Concrete Solution
Reinforcing steel used in reinforced concrete pipe and boxes is made with more than 90% of recycled scrap. Industrial byproducts like fly ash and slag are used to reduce the amount of cement in concrete pipe and boxes. Concrete pipe gaskets can be manufactured from recycled rubber. When concrete sewers have reached the end of their design life, they can be excavated and the pipe reused for other sewers. If they can't be reused, concrete pipe can be crushed and used as granular material for road beds required for the development of compact neighborhoods.

In LEED for New Construction, under LEED MR Credit 4 – Recycled Content MR Credit 4 is a Credit for Recycled Content and the intent for the LEED-NC points is:

> "Increase demand for building products that incorporate recycled content materials, thereby reducing impacts resulting from extraction and processing of virgin materials."

Under MR Credit 4 Recycled Content, if the RCP used on the project contains more that 10% recycled content it will help the project obtain LEED-NC points under MR Credit 4. The credit requirements for MR Credit 4 are:

- Use of materials with recycled content such that the sum of post-consumer recycled content plus one-half of the pre-consumer content constitutes at least 10% (value 1 LEED-NC point) or 20% (value an additional LEED-NC point for a total of 2), based on cost, of the total value of the materials in the project.[4]
- The recycled content value of a material assembly shall be determined by weight. The recycled fraction of the assembly is then multiplied by the cost of assembly to determine the recycled content value.
- Mechanical, electrical and plumbing components and specialty items such as elevators shall not be included in this calculation. Only include materials permanently installed in the project. Furniture may be included, providing it is included consistently in MR Credits 3-7.
- Recycled content shall be defined in accordance with the International Organization of Standards document, ISO 14021 – Environmental labels and declarations – Self-declared environmental claims (Type II environmental labeling.)

Post-consumer material is defined by the USGBC as the waste material generated by households or by commercial, industrial and institutional facilities in their role as end-users of the product, which can no longer be used for its intended purpose.

Pre-consumer material is defined by the USGBC as the material diverted from the waste stream during the manufacturing process. Excluded is reutilization of materials such as rework, regrind or scrap generated in a process and capable of being reclaimed within the same process that generated it. **Note:**

[4] It is possible for the project to receive an additional point under the Innovation Design section for exemplary performance when a project documents that the next incremental step is has been meet for recycled content and the total recycled content on the project has reached 30% or greater.

USGBC has determined that fly ash should be considered a Pre-Consumer Recycled Content material.

The recycled content value of the project uses the following two equations. Note that only half of the pre-consumer recycled material counts towards the recycled content value. The Recycled Content Value is calculated by taking the percentage of the post-consumer recycled content multiplied by the material cost plus half of the value of the pre-consumer recycled content multiplied by the material cost.

$$\text{Recycled Content Value (\$)} = (\%\,\text{post-consumer recycled content} \times \text{material cost}) + \frac{(\%\,\text{pre-consumer recycled content} \times \text{material cost})}{2}$$

The percent recycled content is calculated by taking the total recycled content value and diving it by the total materials cost.

$$\text{Percent Recycled Content} = \frac{\text{Total Recycled Content Value (\$)}}{\text{Total Materials Cost (\$)}}$$

Supplementary Cementitious Materials

When considering supplementary cementitious materials (SCMs) MR Credit 4 allows the recycled content value of concrete to be calculated by the mass of the cementitious materials only, rather than on the entire concrete mix. For example, if the SCM used is fly ash and 150 pounds is used per cubic yard of concrete, the fly ash would only represent 5% of the material if yard of concrete was 3,000 pounds. LEED allows the design team to calculate the recycled material based on the fraction of cementitious materials only. The value of the cementitious materials will be needed.

Below are two examples of reinforced concrete pipe design mixes and the calculations that would be done to determine the recycled amounts applicable to obtain LEED credits under MR Credit 4.

Concrete Pipe Batch Design Cementitious Materials Examples:

Example 1: Small Diameter Dry Cast Pipe: Vibration System

Based on a cubic yard of concrete

- Type I/II Cement: 745 lbs (cost $113.21 / ton)
- Grand Blast Furnace Slag: 230 lbs (cost $96.60 / ton)
- Type F Fly Ash: 250 lbs (cost $16.00 / ton)

Example 2: Large Diameter Dry Cast Pipe: Packerhead System

Based on a cubic yard of concrete

- Type I/II Cement: 388 lbs (cost $113.21 / ton)
- Grand Blast Furnace Slag: 185 lbs (cost $96.60 / ton)
- Type F Fly Ash: 42 lbs (cost $16.00 / ton)

Example 3: 5000 PSI Wet Cast Pipe and Boxes

Based on a cubic yard of concrete

- Type I/II Cement: 394 lbs (cost $113.21 / ton)
- Grand Blast Furnace Slag: 170 lbs (cost $96.60 / ton)
- Type F Fly Ash: 0 lbs (cost $16.00 / ton)

Table of Example Results: Supplementary Cementitious Materials Calculation[5]

Mix	Mass of Portland cement (lbs)	Mass of recycled SCMs (lbs)	Mass of total cementitious materials (lbs)	SCMs as a percentage of total cementitious materials (%)	Dollar value of all cementitious materials	Recycled content value per yard [(SCM/2)x$ value]
Ex. 1	745 lbs	480 lbs	1225 lbs	39.2%	$55.28	$10.83
Ex. 2	388 lbs	227 lbs	615 lbs	36.9%	$30.68	$5.66
Ex. 3	394 lbs	170 lbs	564 lbs	30.1%	$30.00	$4.52

Once the value of the recycled cementitious content is calculated per cubic yard the amount of recycled content of the amount of reinforce concrete pipe can be calculated for the project. The reinforcement contained in the pipe should also be calculated as a recycled content value, and listed as a line item for the reinforced concrete pipe on the project. The project data and calculations will be submitted by the project LEED coordinator and is required to document the process using a submittal template. The data that will be required to track recycled content must include a description of the material, the manufacturer of the material, the product cost, the pre-consumer and/or post-consumer recycled content percentage, and the source of the recycled content data.

Innovation & Design Process 6 Possible Points

Credit 1 Innovation and Exemplary Performance (1 to 5 points) RCP/Boxes

Intent

To provide projects the opportunity to be awarded points for exceptional performance above the requirements set by the LEED for Neighborhood Development Rating System and/or innovative performance in green building, smart growth, or new urbanist categories not specifically addressed by the LEED for Neighborhood Development Rating System.

Concrete Solution

Concrete pipe in North America has a long history of dependability and performance. Quality of product and performance standards have taken a giant leap forward, making concrete a preferred material for many traditional sanitary and storm sewer applications. Precast reinforced concrete pipe and boxes have created niche markets where never before envisioned. Such markets include concrete pipe for ventilation tubing; buried utility galleries; groynes for current control and fish habitat; interlocking boxes for marine walls and small dams; standard boxes and pipe for animal and pedestrian crossings of rail lines and highways; tunnel systems for railways and raw material conveyances; storm water storage and retention chambers; small bridge structures; jacking and tunneling applications; and, marine outfalls. New applications are limited only by the imagination of infrastructure designers.

[5] The recycled content value is calculated using the SCM percentage divided by two due to the fact that USGBC has determined that fly ash should be considered a Pre-Consumer Recycled Content material.

Conclusion

Each project has different needs and design requirements, but RCP can be used in numerous applications throughout a project to provide a sustainable material that is designed to last. By reviewing the points available for each project RCP can contribute to LEED points, so that the more RCP is used on a project the more RCP can contribute to LEED credits.

Reference

Pilot Version: LEED for Neighborhood Development Rating System Updated June 2007, Developed through a partnership of the Congress for New Urbanism, Natural Resources Defense Council and the U.S. Green Building Council.

ACTB

Canadian Concrete Pipe Association

American **Concrete Pipe** Association