Sustainability, Resilience, and Concrete Pipe

ACPA May Webinar
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PRIMARY ELEMENTS OF DESIGN

FUNCTIONAL

COST-EFFECTIVE

AESTHETIC

SUSTAINABLE

RESILIENT

“new kids on the block”
Why are we here?

[our] FUTURE

[your] MATTERS

[their]
Objectives of today’s webinar

1a. Define sustainability

2. Relate sustainability and resilience to each other

1b. Define resilience

3. Explore environmental, economic, and social sustainability

Sustainable Actions

4. Discuss resilience and risk assessment

Resilient Actions
THINK ABOUT IT:

What comes to mind when you hear the word “SUSTAINABILITY”?
Meeting our own needs without compromising the ability of future generations to meet needs of their own

-International Institute for Sustainable Design
Infrastructure and Sustainability

Providing **social functionality** and engagement to communities, being mindful of short-term and long-term **environmental implications** and ensuring that the infrastructure is constructed and maintained in an **economically viable** manner.
THINK ABOUT IT:

What comes to mind when you hear the word “RESILIENCE”? 
Resilience

“the ability of a system to resist, limit impacts, and rapidly return to service after a disruptive event.”
Resilient Infrastructure

Transportation

Housing

Power

Water/sewer systems

Public systems having the ability to effectively resist and readily adapt to conditions above and beyond typical design conditions.
POLL:

How do sustainability and resilience relate to each other?
Sustainability vs. Resilience
Sustainability  Resilience
Resilience and Sustainability

• Less waste, limited impact on environment
• Significant long-term cost savings
• Reduced concern associated with loss of critical infrastructure functions

“Many LEED certified buildings in Superstorm Sandy were designed to have a low impact on the environment... but not for the environment to have a low impact on them” (U.S. Resiliency Council, 2016)
Environmental Sustainability
“Environmental sustainability is about acting in a way that ensures future generations have the natural resources available to live an equal, if not better, way of life as current generations.”

- United Nations (UN) World Commission on Environment and Development
1. Life Cycle Analysis of drainage piping systems
Data extracted from BSRIA Inventory of Carbon and Energy (ICE)
UK Study

Source: carbonclear
control your carbon impact.

HDPE and concrete pipe cradle-to-site comparison (DN2100 pipe)

35% difference
Sustainable Features of Concrete Pipe

- **Lowest material emissions per unit weight**: Less than 1/10th the emissions of plastic
- **Recapturing of CO2 over service life**: ~50% of cement emissions are recaptured
- **Shortest average transport distance**: Hundreds of miles less than flexible pipes (avg.)
- **Less emissions from mining & transport of imported fill**: 55% less required imported fill
- **Highest expected design life**: 25-75 yrs higher than alternate materials
- **Lower freshwater demand than HDPE & PP per foot**: 20-30% less water used (cradle-to-gate)
POLL:

Have you ever made a material selection based on environmentally sustainable criteria?
1. LCA of drainage piping systems
2. Re-use capabilities at end of service life
RE-USE
Economic Sustainability
“... practices that support long-term economic growth without negatively impacting social, environmental, and cultural aspects of the community.”

- University of Mary Washington, Office of Sustainability
1. Life-Cycle Cost Analysis (LCCA)
POLL:
Does your agency incorporate some type of Life Cycle Cost Analysis (LCCA) for determining culvert material/type?
Life Cycle Cost Analysis of Drainage Systems

COST PER YEAR =

INITIAL CONSTRUCTION
- Pipe Material
- Installation Materials/Methods
- Pre/Post Installation Inspection

MAINTENANCE
- Inspection Frequency
- Cleaning
- Historical data

SERVICE LIFE
- Product History
- Local Experience
- Residual Value
Sustainable Actions

1. Life-Cycle Cost Analysis (LCCA)

2. Use of local resources/businesses

“Buying local is touted as the best way to be environmentally friendly while supporting local communities at the same time. By purchasing food and other goods that are produced locally, consumers help stimulate their regional economy, help create and retain valuable jobs, support families and strengthen community and culture.”
Local Resources/Businesses
highest initial value

load-tested prior to shipment

lowest installation costs

longest expected service life

stimulates local economy

residual value after use
Social Sustainability
“Social sustainability combines design of the physical realm with design of the social world – infrastructure to support social and cultural life, social amenities, systems for citizen engagement and space for people and places to evolve.”

- Diversity for Social Impact
1. Community Interaction

2. System Safety/Reliability
Resilience
Resilience Measurement Index: An Indicator of Critical Infrastructure Resilience
Threats to Drainage Infrastructure

**Natural**
- Flooding
- Severe Rain
- Tropical Cyclone
- Wildfire
- Extreme Temperatures
- Winter storms

**Unnatural**
- Litter/Debris
- Vehicle Accidents
- Poor Installation
- Other
**Billion-Dollar Disasters**

**BY THE NUMBERS (1980–2020)**

- **1980**
  - The year NOAA started tracking billion-dollar disasters

- **22**
  - Number of U.S. billion-dollar disasters in 2020—the most on record

- **285**
  - Number of billion-dollar disasters in the U.S. since 1980

- **7**
  - Number of billion-dollar tropical cyclones that struck the U.S. in 2020

- **50**
  - Number of states that have had at least one billion-dollar disaster

- **119**
  - Number of billion-dollar events from 2010-2019

- **7.0**
  - Average number of billion-dollar disasters per year since 1980

- **$1.875 Trillion**
  - Total cost of the 285 billion-dollar disasters

- **15.1**
  - Average number of billion-dollar disasters per year since 2015

- **124**
  - Number of billion-dollar disasters that have impacted Texas since 1980—the most of any state

For more info: [www.ncdc.noaa.gov/billions/](http://www.ncdc.noaa.gov/billions/)
TOTAL COST OF BILLION $ DISASTERS

- Drought: +16%
- Flooding: +3%
- Freeze: +6x
- Severe Storm: 6x
- Tropical Cyclone: 6x
- Wildfire: +9x
- Winter Storm: +16%
Vulnerabilities of Drainage Infrastructure

- Slope stability/erosion
- Buoyancy
- Flammability
- Infiltration
- Poor installations
Consequences to Drainage Infrastructure

- Flotation
- Washout
- Structural Failure
- Road Collapse
- Consequent Flooding
Resilient Actions

1. Design overland flow path
2. Inlet protection/Headwalls
3. Post installation Inspection
4. Flammability Considerations
5. Flotation resistance
Resilience of RCP

- Inherently non-flammable
- Weight reduces risk of floatation
- Primary structure is pipe itself, resistant to installation issues or loss of support material
- Proven performance: 100-yr service life
- Rigid, high-tolerance joints ensure dependable seal
Evaluate economic viability over life-cycle + true cost of ownership

Consider full environmental implications of products in use

Build to connect communities, keep consistent standards

Incentivize systems that can stand up to the threats of today and tomorrow
Concrete offers lowest environmental impact
Re-use of RCP sections limits waste

Investment in long-term value
Local plants support local economy

Provides safe, dependable infrastructure
Flame-proof

Heavy, flotation resistance
Manufactured primary structure
Thank you!