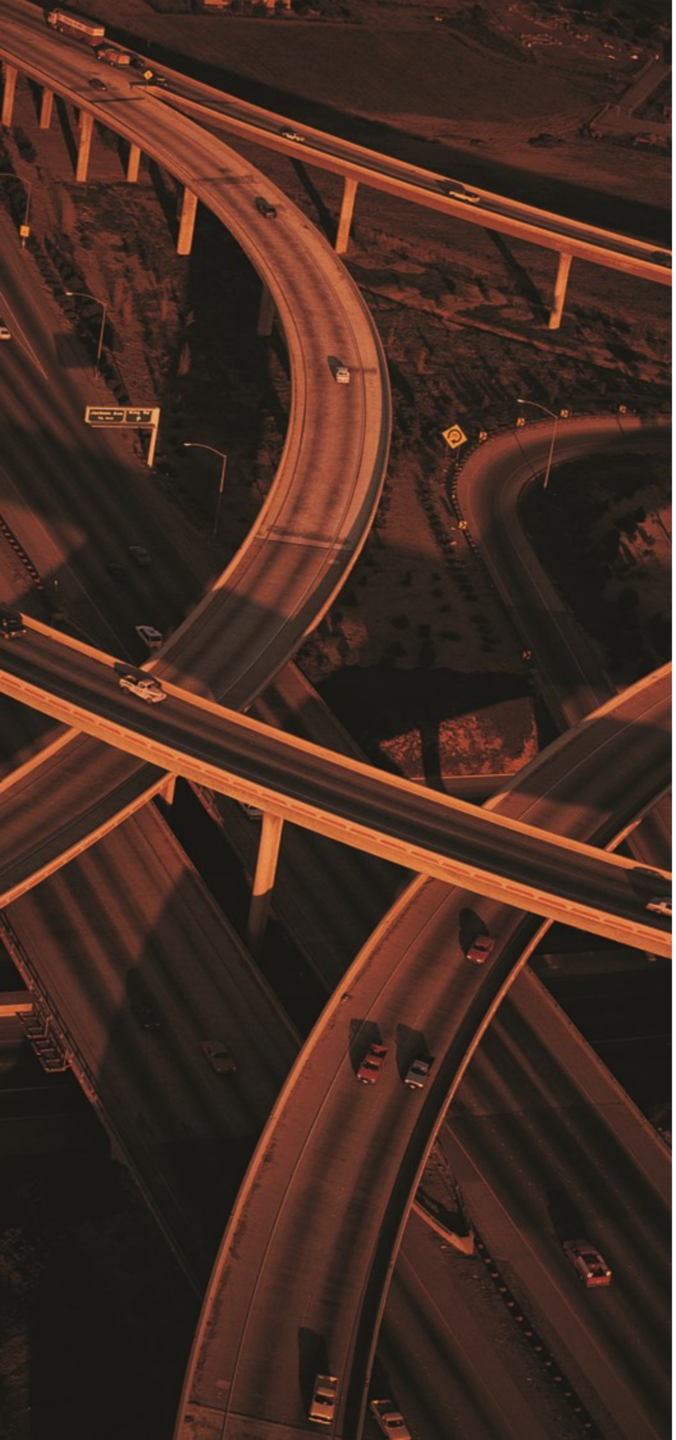


RUTGERS

Center for Advanced Infrastructure and Transportation

A U.S. Department of Transportation University Transportation Center

# Evaluating the Impact of Activated Carbon on the Engineering Properties of Cement-Stabilized Contaminated Dredged Sediment

**Robert Miskewitz**
(rmiskewitz@envsci.rutgers.edu)

**Lauren Iacobucci**
(lauren.iacobucci@rutgers.edu)

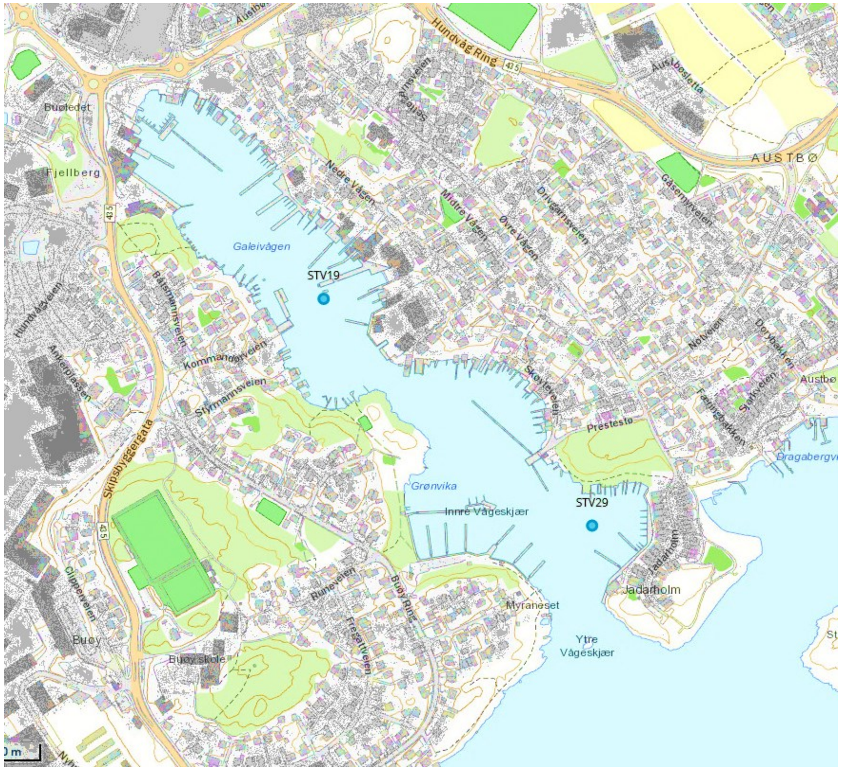
# Background

- Solidification/stabilization (SS) of dredged sediment for beneficial reuse
- Challenges:
  - Contaminant mobility
  - Highly organic sediment → reduced strength
- Potential solution:
  - Portland cement (PC) +
  - Powdered activated carbon (AC)

# Material - Overview

NY/NJ Harbor – United States

Stavanger Harbor – Norway

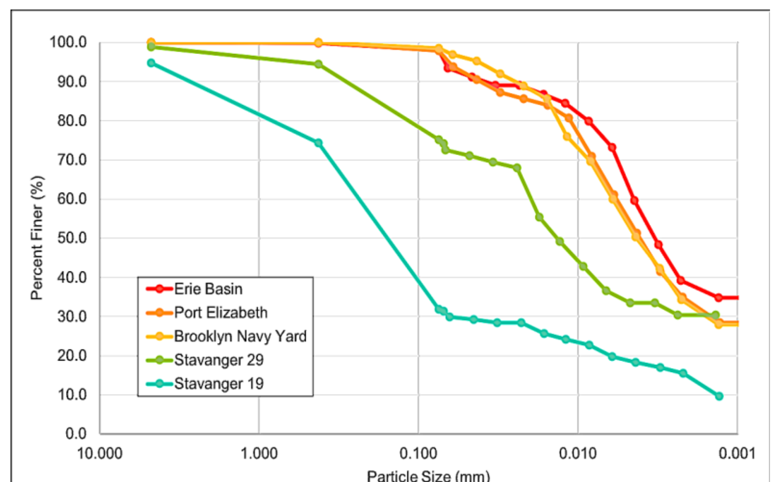
# Material - Physical Properties

## Physical Properties of the Sediment

| | | Erie Basin | Brooklyn Navy Yard | Port Elizabeth | Stavanger 19 | Stavanger 29 |
|---|---|---|---|---|---|---|
| Specific gravity | $G_s$ | 2.67 | 2.62 | 2.68 | 2.69 | 2.46 |
| **Natural water content** | **$w_n$ (%)** | **187** | **237** | **213** | **326** | **160** |
| Natural organic content | OM (%) | 9.5 | 9.2 | 8.9 | 20.3 | 8.0 |
| Grain size distribution | Gravel (%) | 0.0 | 0.0 | 0.0 | 5.2 | 1.2 |
| | Sand (%) | 2.0 | 1.5 | 2.2 | 62.9 | 23.7 |
| | Silt and Clay (%) | 98.0 | 98.5 | 97.8 | 31.8 | 75.1 |
| Bulk density | $\rho_m$ (g/cm$^3$) | 1.27 | 1.24 | 1.24 | 1.32 | 1.19 |

## Stavanger 19 Sediment

## Particle Size Distribution



# Experimental Method

Experimental Mix Designs (Dry Mixing Ratios)

| Mixture ID | Portland Cement, PC (% wet wt. of sediment) | Activated Carbon, AC (% wet wt. of sediment) |
|---|---|---|
| Raw material | 0.0 | 0.0 |
| 0%PC + 1%AC | 0.0 | 1.0 |
| 0%PC + 3%AC | 0.0 | 3.0 |
| 4% PC* | 4.0 | 0.0 |
| 8% PC | 8.0 | 0.0 |
| 8%PC + 1%AC | 8.0 | 1.0 |
| 8%PC + 3%AC | 8.0 | 3.0 |
| 12% PC* | 12.0 | 0.0 |

* Mixes created for Stavanger Harbor sediment (Stavanger 19 and Stavanger 29) only

- Dry mixes due to high natural moisture content
- Quikrete Type I/II cement + powdered activated carbon
- Cured for 28 days @ 20°C

# Experimental Method

Homogenization of sediment prior to mixing

Filled molds, sealed and ready for curing

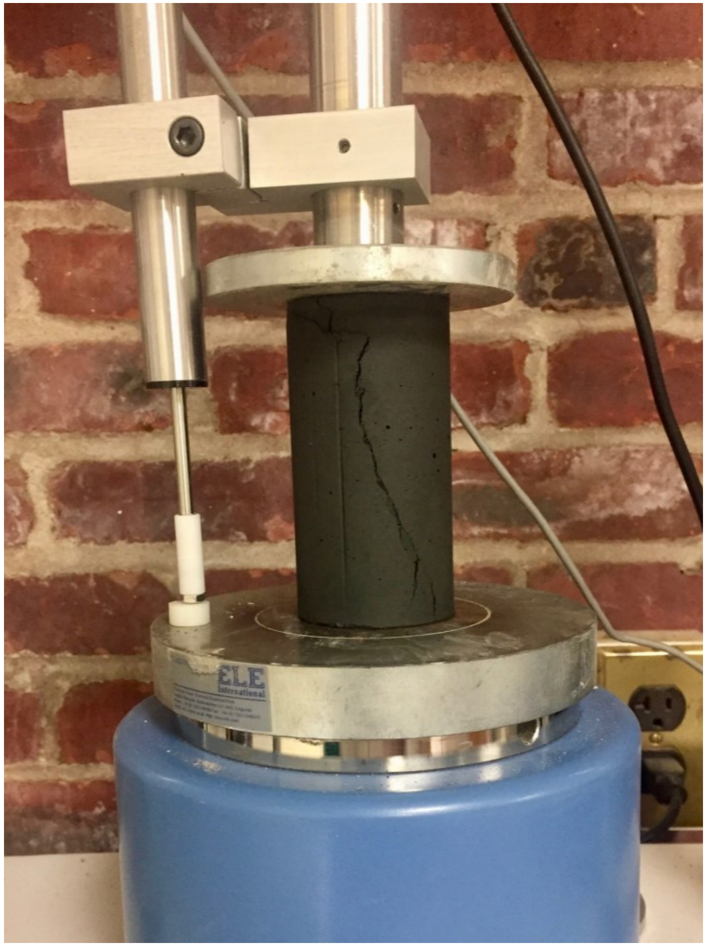
Thermocure II water bath curing box

# Experimental Method

- Triplicate samples tested for **unconfined compressive (UC) strength** after 28 days

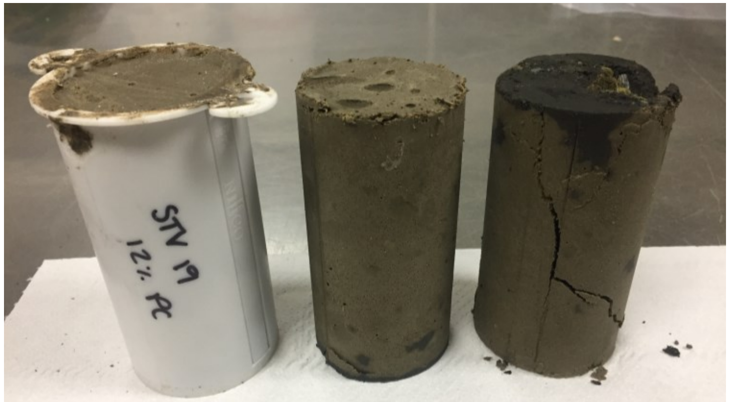
- Duplicate samples from broken cores extracted for PAHs via the **Synthetic Precipitation Leaching Procedure (SPLP)**

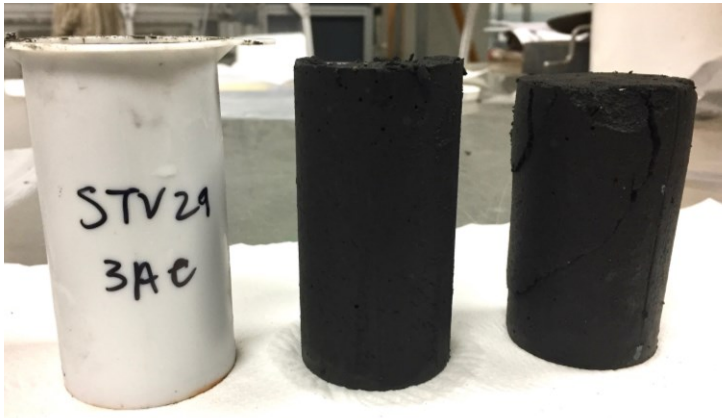
# Geotechnical Results - UC Strength




Sample undergoing UC testing on ELE device

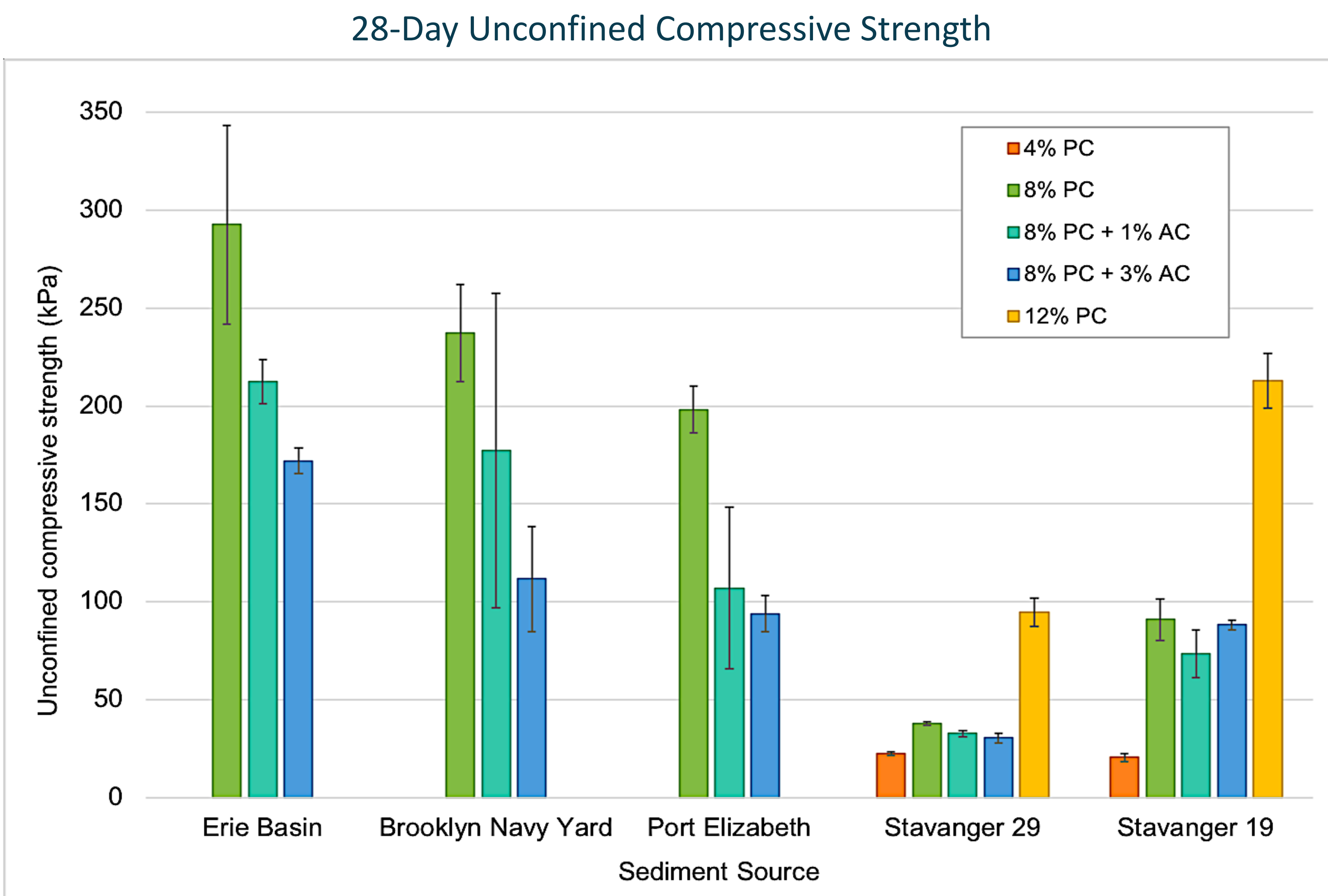
STV 19 and STV 29 samples during UC tests



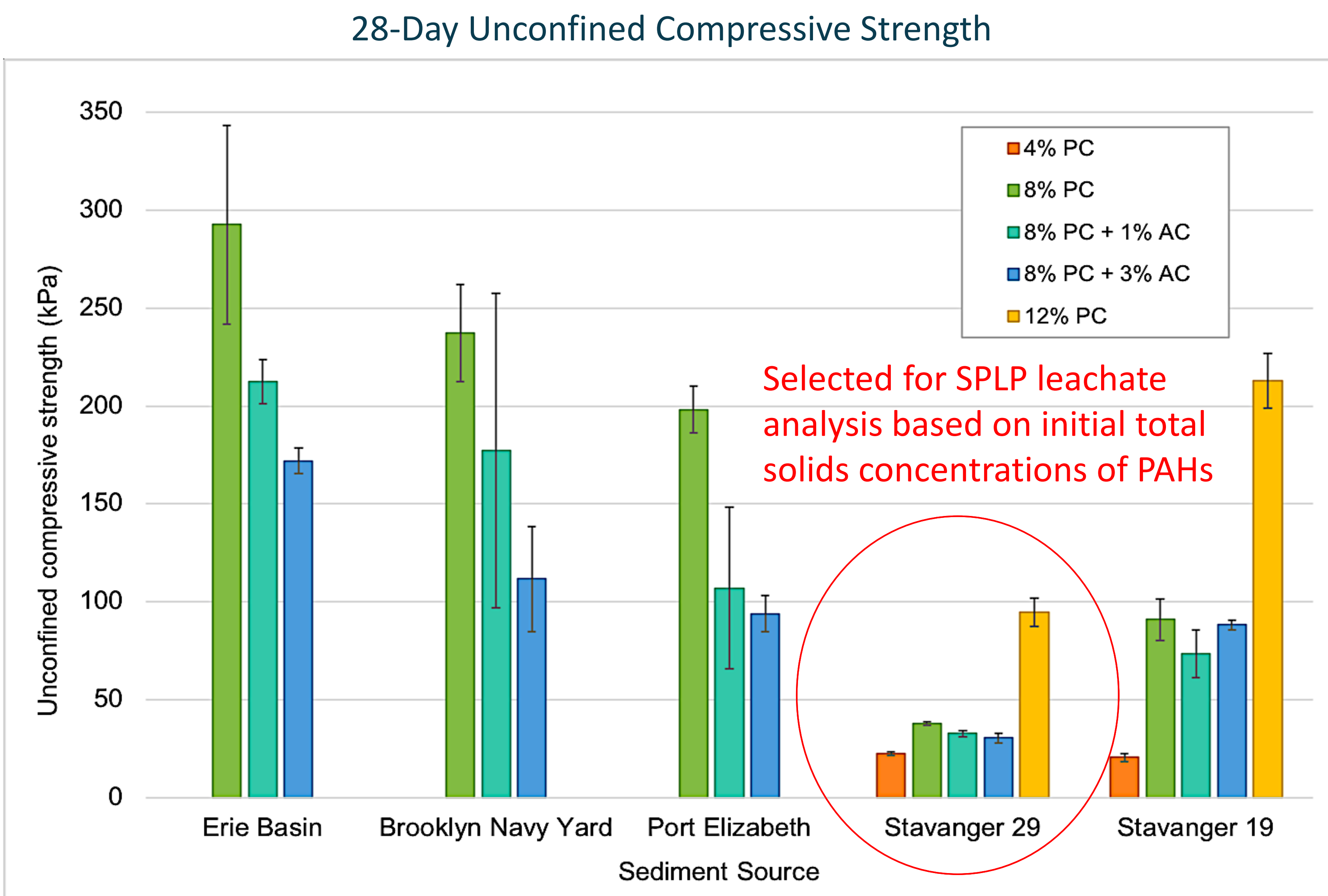




Left: sample still inside mold
Center: sample removed from mold but untested
Right: broken sample after testing

# Geotechnical Results - UC Strength

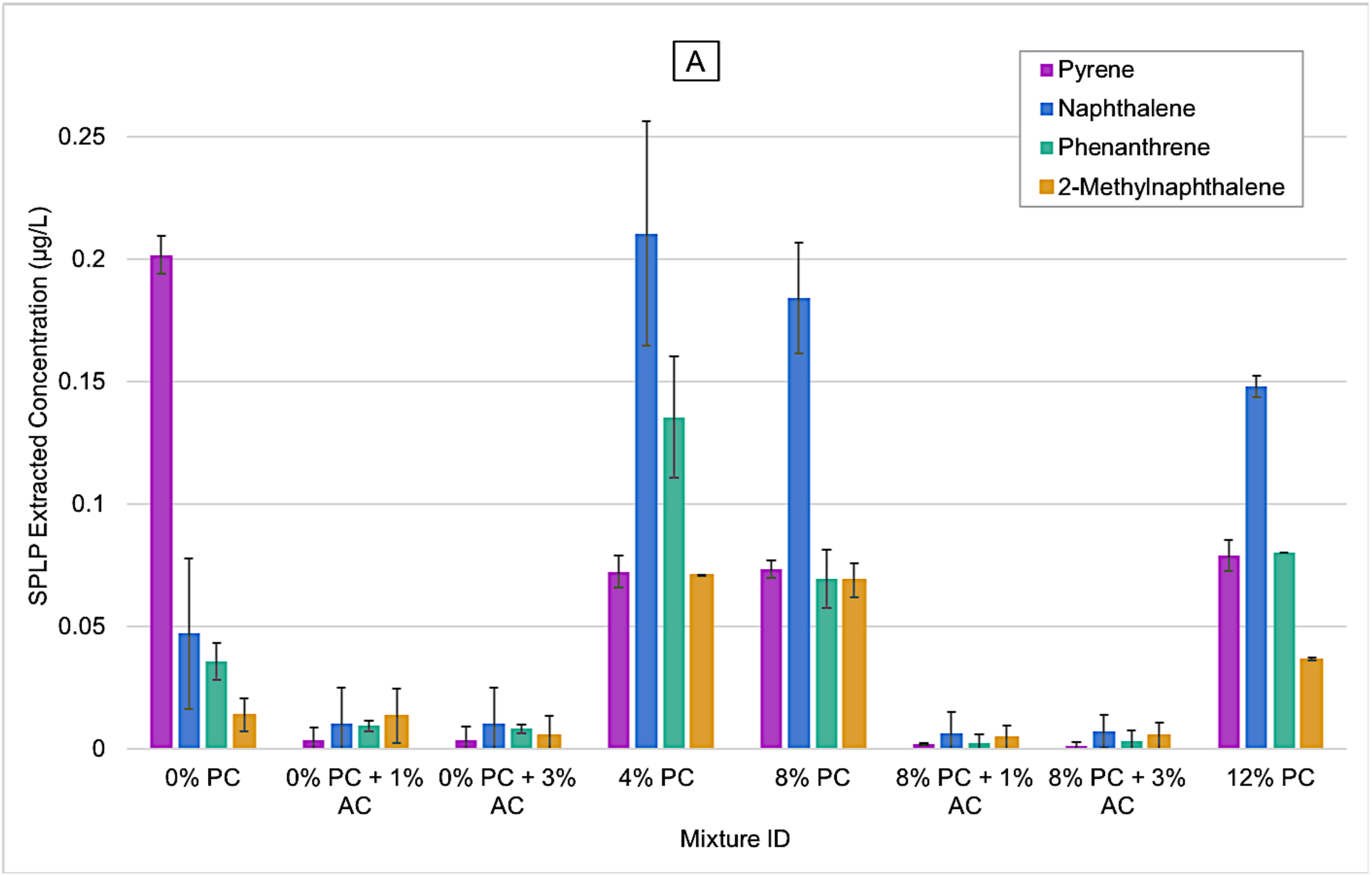


# Geotechnical Results - UC Strength



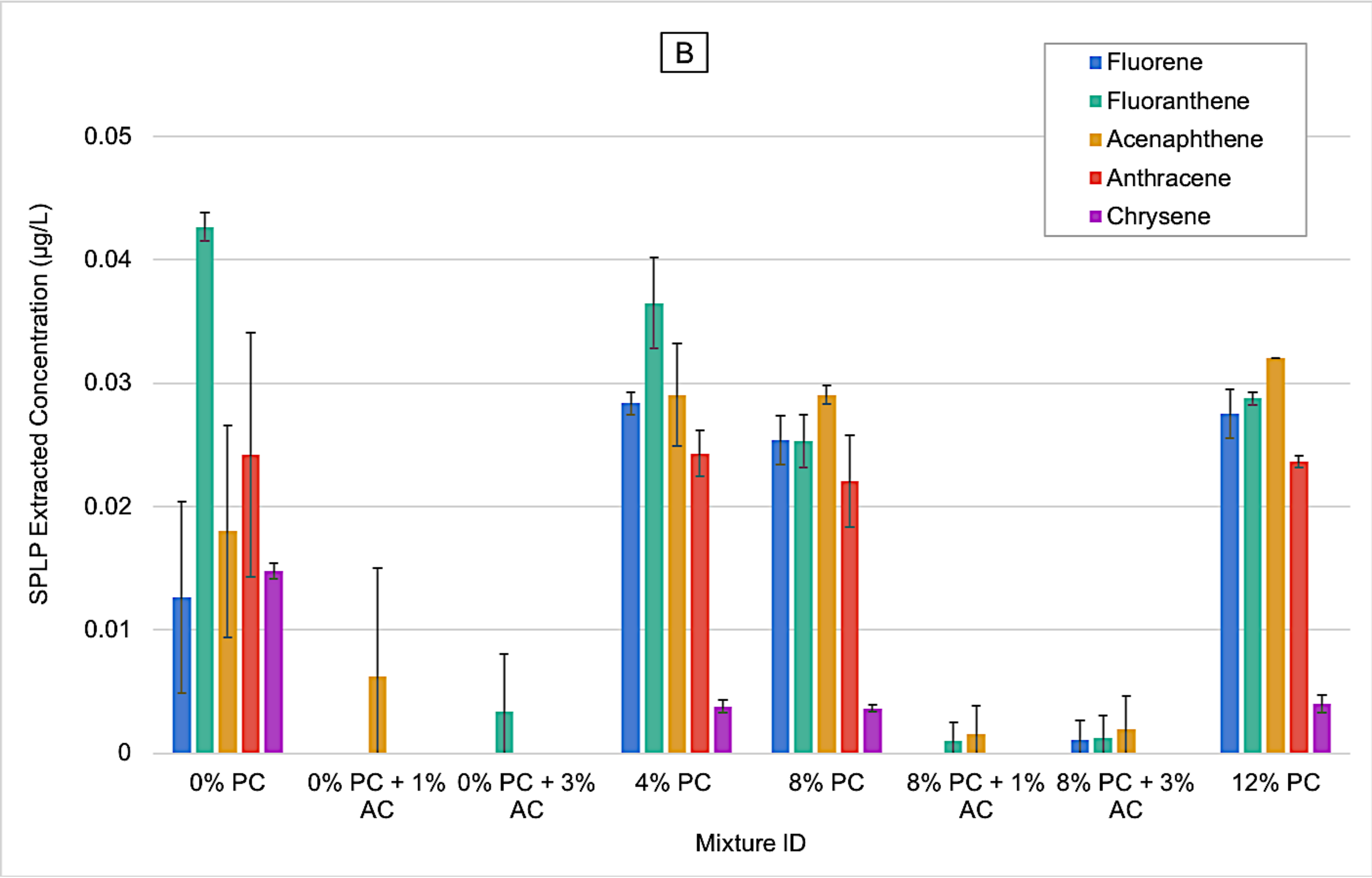
# Environmental Results - SPLP

Leachate Concentrations of Polycyclic Aromatic Hydrocarbons (PAHs)



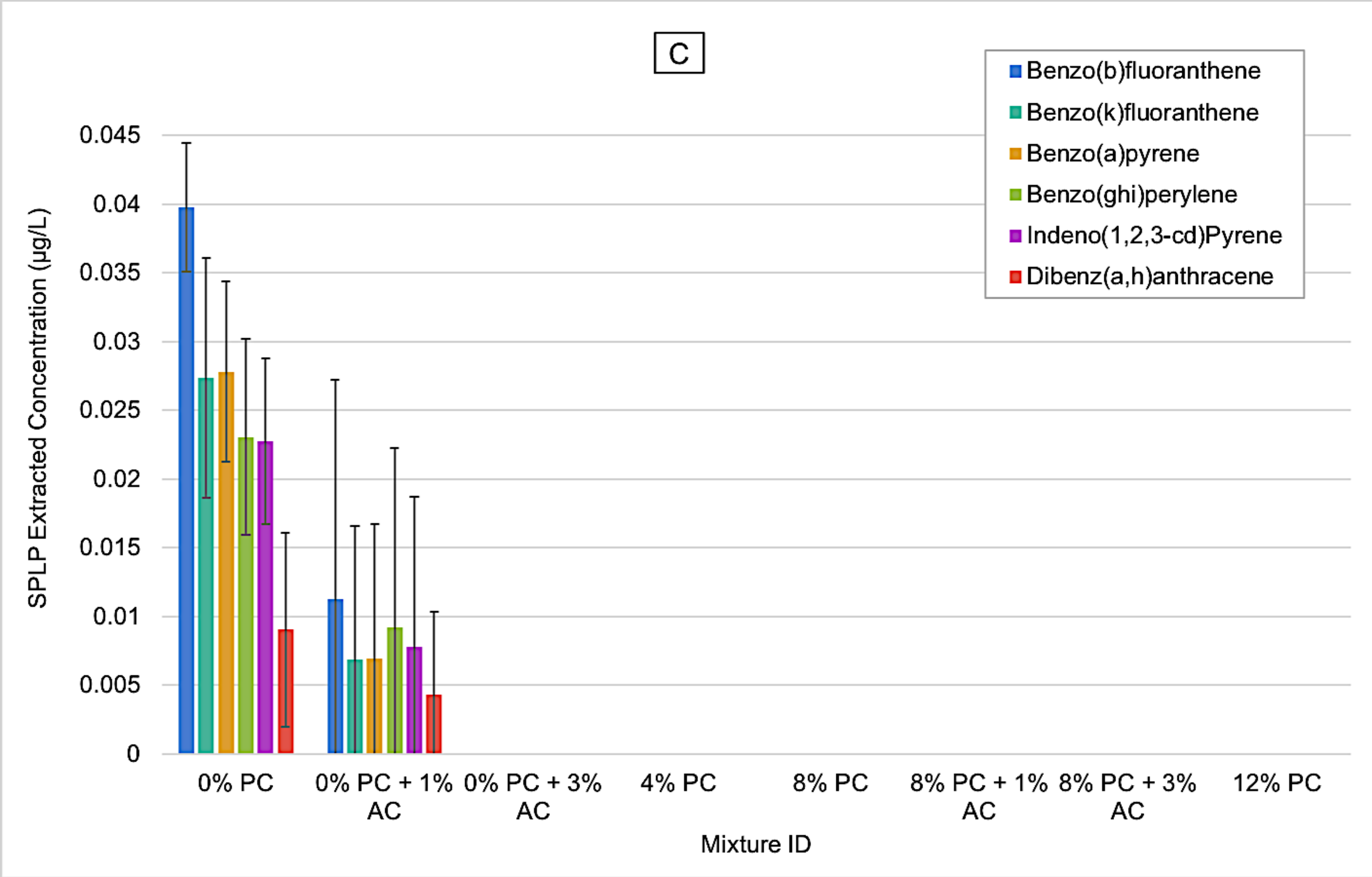
# Environmental Results - SPLP

Leachate Concentrations of Polycyclic Aromatic Hydrocarbons (PAHs)

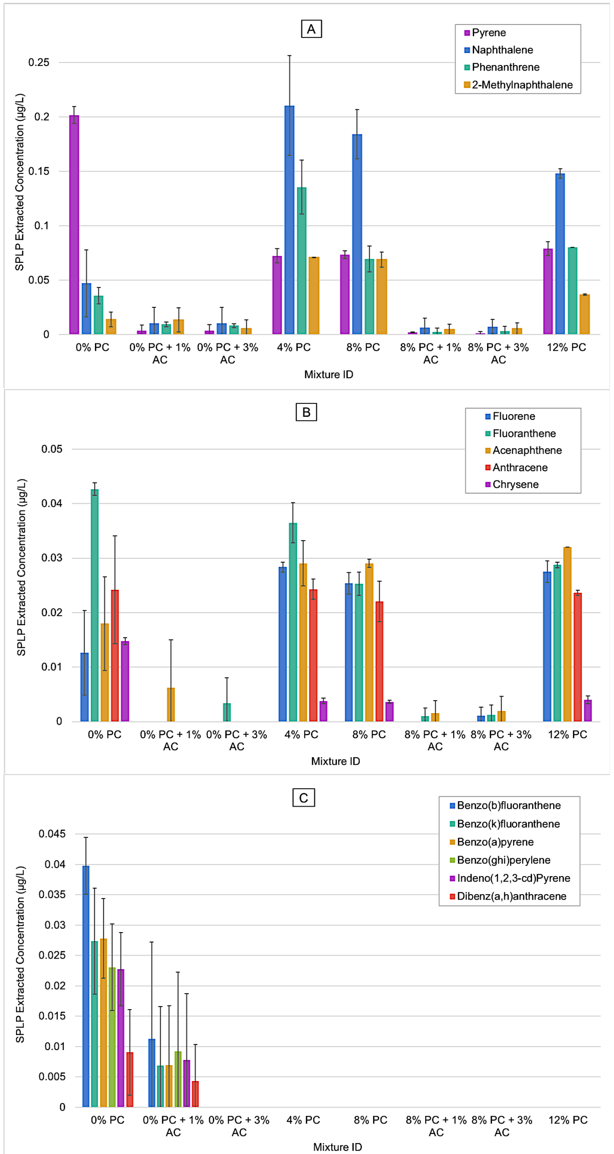


# Environmental Results - SPLP

Leachate Concentrations of Polycyclic Aromatic Hydrocarbons (PAHs)



# Environmental Results - SPLP




| Chemical compound | Max. Average Leachate Concentration (µg/L) | NJ Class II-A Ground Water Criterion (µg/L) |
|---|---|---|
| 2-Chloronaphthalene | 0.006 | 600 |
| 2-Methylnaphthalene | 0.07 | 30 |
| Acenaphthene | 0.03 | 400 |
| Acenaphthylene | 0.009 | - |
| Anthracene | 0.02 | 2,000 |
| Benz(a)anthracene | 0.004 | 0.05 |
| **Benzo(a)pyrene** | **0.007** | **0.005** |
| Benzo(b)fluoranthene | 0.01 | 0.05 |
| Benzo(ghi)perylene | 0.009 | - |
| Benzo(k)fluoranthene | 0.007 | 0.5 |
| Chrysene | 0.004 | 5 |
| **Dibenz(a,h)anthracene** | **0.004** | **0.005** |
| Fluoranthene | 0.04 | 300 |
| Fluorene | 0.03 | 300 |
| Indeno(1,2,3-cd)Pyrene | 0.008 | 0.05 |
| Naphthalene | 0.2 | 300 |
| Phenanthrene | 0.1 | - |
| Pyrene | 0.08 | 200 |

# Conclusions

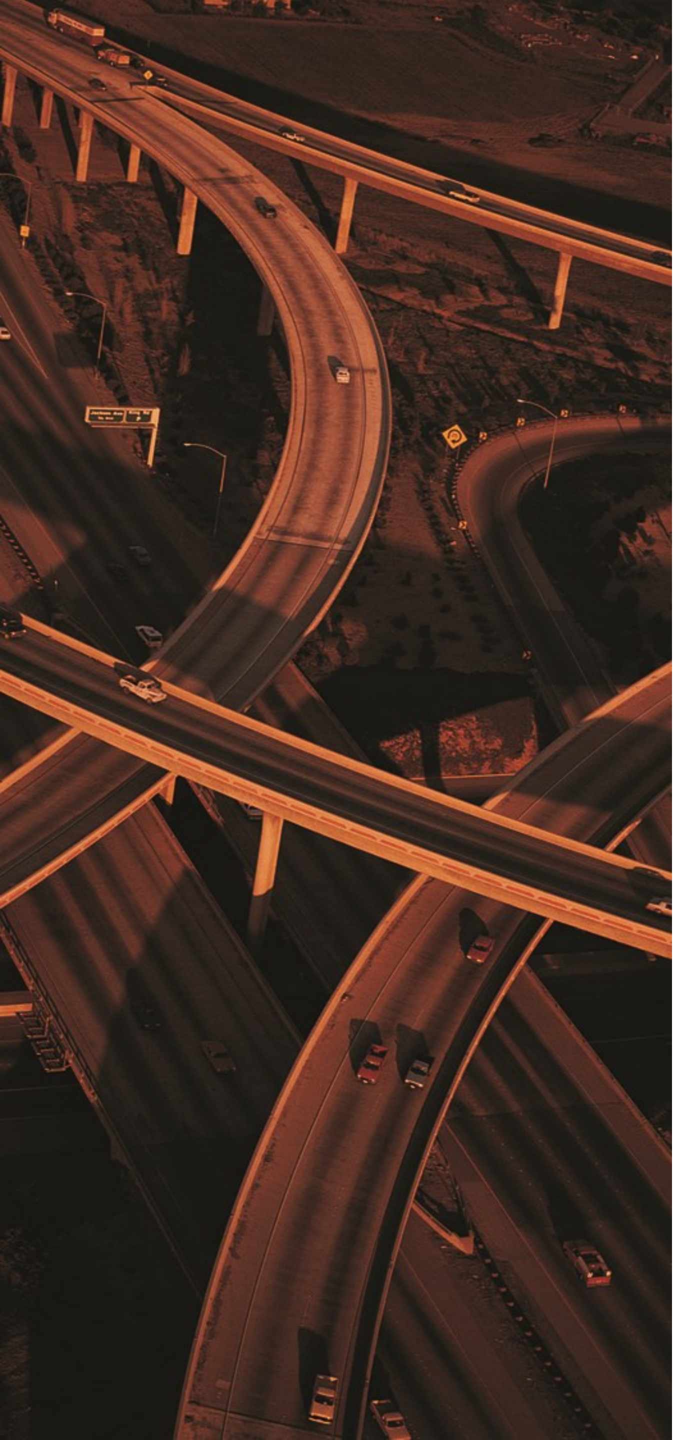
1. The addition of powdered activated carbon (PAC) produced 26% and 34% average decreases in the UC strength development of S/S sediment for doses of 1% and 3% PAC, respectively.

2. **PAC can reduce the mobility of contaminants in a Portland cement (PC) stabilized matrix.**

3. **Optimized mixtures of PC and PAC can be used to effectively treat unique sediment conditions via S/S.**

4. Samples containing 0% PC (three of the eight designed mixes) were unable to be tested for unconfined compressive strength due to their inability to hold shape outside of the plastic mold structure.

5. It is anticipated that the high water content of the Stavanger Harbor materials – especially that of STV29 – contributed to the low UCS values observed after 28 days.



RUTGERS

Center for Advanced Infrastructure and Transportation

A U.S. Department of Transportation University Transportation Center

# Questions?

**Robert Miskewitz**
(rmiskewitz@envsci.rutgers.edu)

**Lauren Iacobucci**
(lauren.iacobucci@rutgers.edu)