Recycled PET Carpet (RPC) materials in California Civil Engineering Applications

PRESENTED BY:

Joaquin Wright, GHD Inc.

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California Carpet Stewardship Program

An initiative of CARE: Carpet America Recovery Effort

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Todays Topics

Phase I, Feasibility of using RPC in Civil Engineering Materials

Phase II, Potential RPC application pilot studies

Phase III, Outreach and RPC users in California

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Phase I, Investigate feasibility of RPC material (completed)

Feasibility of Recycled Polyethylene Terephthalate (PET) Carpet in Civil Engineering Applications

GHD Inc. & Humboldt State University(HSU) Environmental Resource Engineering(ERE) Department, Fall 2016

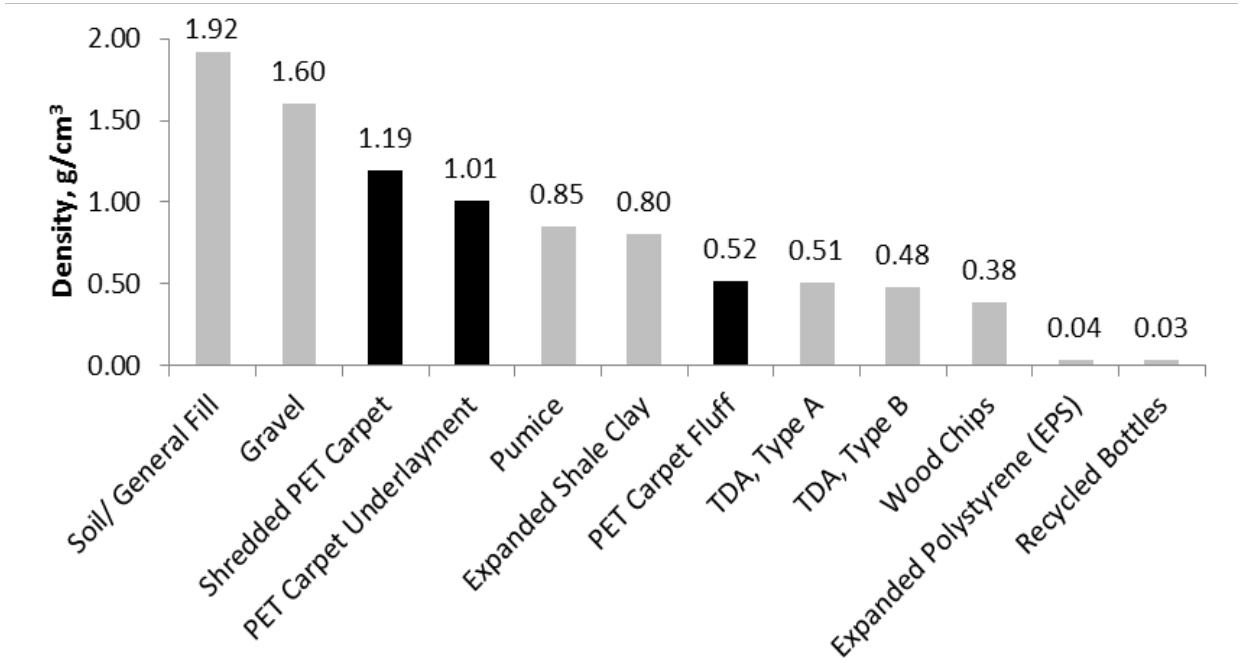
Physical properties of RPC

- Density and water holding capacity
- Compressibility, porosity and hydraulic conductivity
- Hazard Material assessment
- Water Quality
- Leachate analysis

Shreds Fluff Fabric

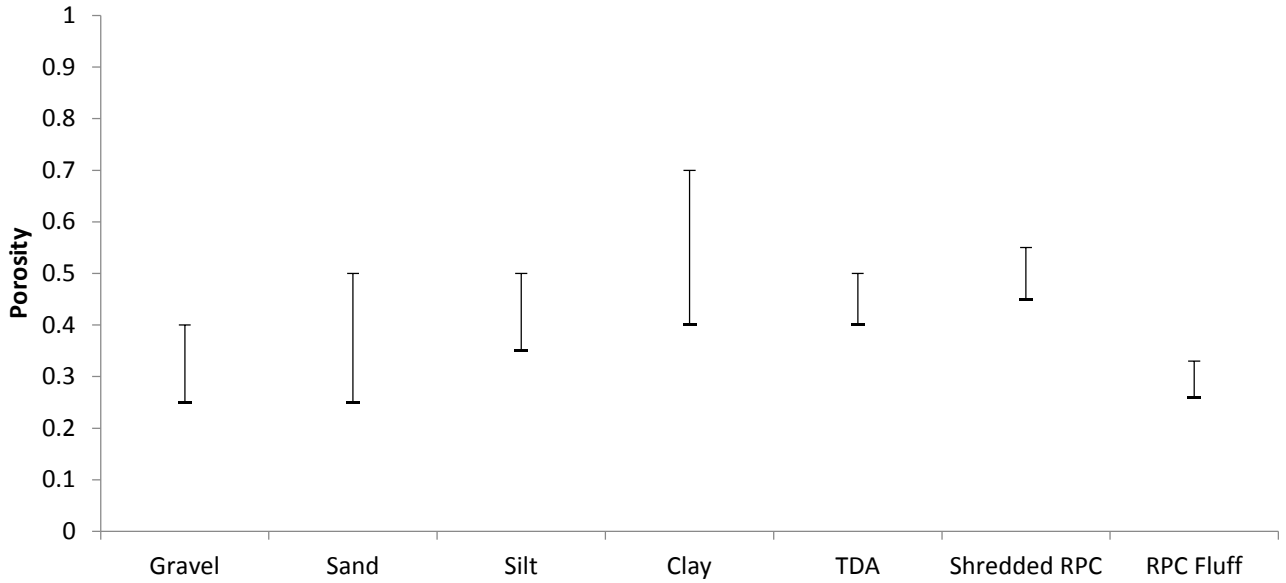
Phase I, Investigate feasibility of RPC material

Density of RPC Compared to other Civil Engineering Fill Materials



Phase I, Investigate feasibility of RPC material

Range of Porosity Values for RPC Compared with Soil and Gravel



Phase I, Investigate feasibility of RPC material

Physical properties of RPC

Hydraulic Conductivities of RPC Compared with Soil and Gravel [1]

Hydraulic Conductivity Range, ft/day		
	Lower Limit	Upper Limit
Gravel	90	14,000
Clean Sand	0.9	900
TDA	138	439
Shredded RPC and RPC Fluff	7.0	265
Silty Sand	0.09	9.00

Phase I, Investigate feasibility of RPC material

Water Quality

Sample Type	Soak Duration	No. of Samples	Assumed Contents
Carpet – 1	1 month	3	Shredded carpet (Face fiber, backing, and underlayment combined)
Carpet – 2	2 months	2	
Rinsed carpet	1 month after 2 month soak and rinse	1	
Underlayment	1 month	2	Underlayment
Face fiber	1 month	2	Face fiber

- ✓ Method detection limits (MDLs) are the current minimum detection available.
- ✓ 22 of the 115 constituents examined were determined to have concentrations above the MDL.
- ✓ The detected constituents were primarily metals
- ✓ No volatile or semi-volatile compounds found above the MDL.
- ✓ 7 constituents were within 80% of the existing regulatory limits examined,
- ✓ only antimony exceeded the CA maximum contaminant level (MCL).

Phase I, Investigate feasibility of RPC material

Water Quality Summary

- The presence of antimony was expected because it is a catalyst used in the synthesis to derive PET for plastic bottles, which is then recycled into PET face fiber and then carpet underlayment.

- Levels of antimony and other leachate constituents would be less in actual field installations where saturation times would be much less and water quantity amounts would be much higher then in a laboratory

Phase I, Investigate feasibility of RPC material

Recommendations

Based on laboratory results, background research of existing literature, and a review of industry-related products, GHD recommended conducting further research on the following civil engineering applications of RPC:

Septic systems/ infiltration

RPC's drainage properties combined with its high surface area may provide advantageous results for biomat formation in septic system and infiltration applications.

Lightweight fill applications

The density of RPC is lower than that of conventional fill materials like soil and gravel.

Road surface reinforcement applications

The RPC fabric density, surface area, and fiber strength may be suitable as a pavement reinforcing layer.

Erosion control products

RPC fabric density, surface area, and fiber durability suggest that RPC erosion control materials have great potential.

Erosion control products made with recycled carpet are already produced. Because these products have not gained widespread traction to-date, conducting future studies to determine the obstacles that are limiting the presence of recycled carpet erosion control products in the market may be beneficial.

Phase II, Pilot study uses of RPC material (in progress)

Phase II (currently in progress)

Based on the Phase I Feasibility investigation CARE developed further research on the following civil engineering applications of RPC:

Septic systems/ filtration

- ❑ RPC high surface area may provide advantageous results for biomat formation in septic system and infiltration applications.
- ❑ Septic system/ infiltration research at the City of Arcata Waste water treatment facility is showing some of the benefits that RPC fibers can provide to cleaning water.

Erosion control products

- ❑ RPC fabrics are currently being made for underlayment applications. The properties of these fabrics, high potential biomat surface area from fibers, density of fibers per square inch, and high durability of the RPC fibers, lend themselves to erosion control and water filtration applications.
- ❑ Research and pilot studies of fabric mats and rolled fabric wattles are ongoing at multiple sites northern California and are helping to show the many benefits of RPC materials in erosion and storm water control setting.

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Phase II, Pilot study septic system filtration with RPC material

Phase II

Septic systems/ infiltration

Septic system horizontal leach line pilot study

Phase II, Pilot study septic system filtration with RPC material

Summary of analysis for conventional wastewater parameters in wastewater samples.

Water Quality Constituent	Number of samples	% of samples where Influent > Effluent	Average (SD) Influent Concentration	Average (SD) Effluent Concentration	Avg Removal (%)
BOD (mg/l)	7	7	140 (37)	81 (34)	42
COD (mg/l)	7	7	217 (57)	139 (35)	36
TSS (mg/l)	7	7	102 (15)	44 (17)	57
Turbidity (NTU)	6	6	51.7 (16.5)	28.6 (11.3)	46
Oil & grease (mg/l)	7	5	3.53 (4.34)	3.20 (3.99)	20
Spec Cond (µm/cm)	6	1	655 (49)	672 (23)	-3

Comparison of average removal rates for selected water quality constituents for rock, TDA and shredded RPC media filters.

Constituent	Average Removal Rate (%)		
	Rock Aggregate*	TDA*	Shredded Carpet Media
Iron	8	-500	66
Manganese	8	-20	73
Zinc	20	-103	74
BOD	1	10	42
COD	1	11	36
TSS	14	8	57
Ammonia	19	12	28

Comparison of average removal rates for selected water quality constituents for slow sand and shredded RPC media filter.

Constituent	Average Removal Rate (%)	
	Slow Sand Filter*	Shredded RPC Media
BOD	37	42
COD	30	36
TSS	68	57
Ammonia-N	53	28

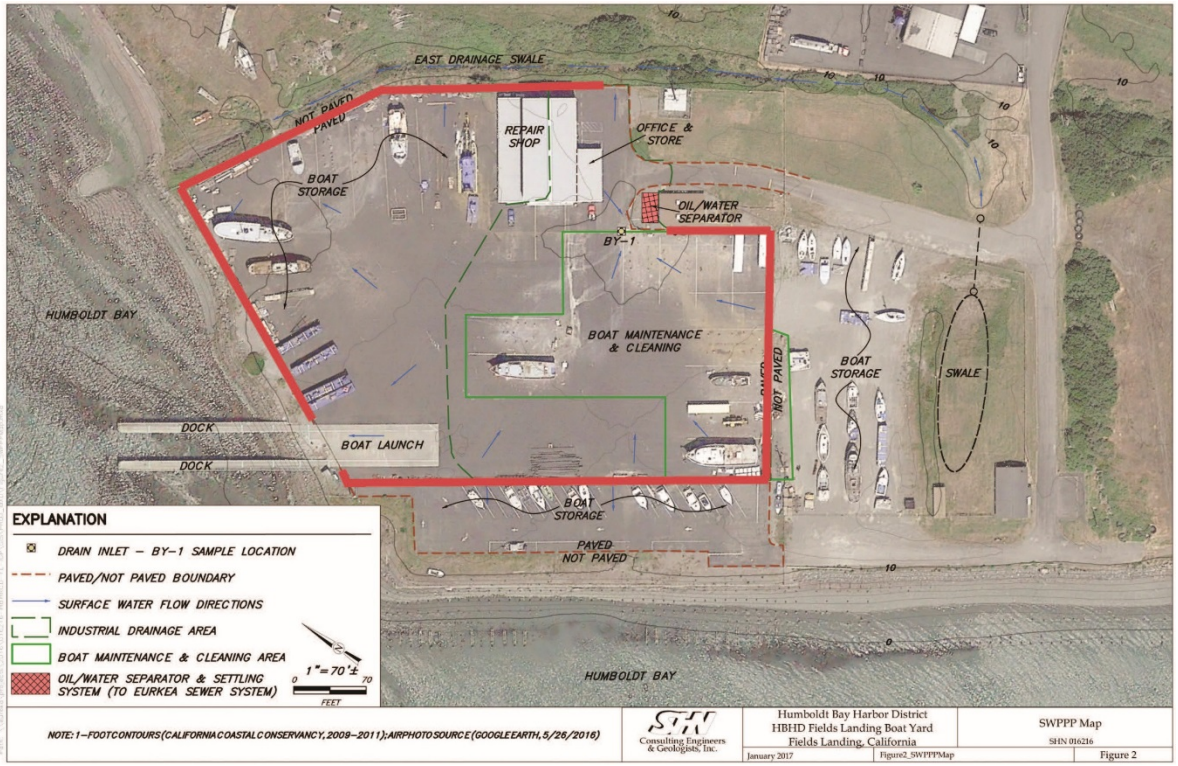
Phase II, Pilot study uses of RPC Fabric material

Phase II (currently in progress)

Erosion control products

RPC fabrics are currently being made for underlayment applications. The properties of these fabrics, high potential biomat surface area from fibers, density of fibers per area, and high durability of the RPC fibers, lend themselves to erosion control and water filtration applications. Research and pilot studies of fabric mats and rolled fabric wattles are ongoing at multiple sites northern California.

The RPC fabric, when used for water filtration, clearly reduces the quantity of TSS and heavy metals leaving the sites. This application alone has great potential in California where all industrial business sites are subject to restrictive storm water discharge regulations.



Phase III, Share RPC material benefits with potential California users

Phase III

Based on the known RPC material properties and the current Phase II pilot study investigations,

- ❑ Based on Phase I and Phase II studies, RPC material properties suggest these types of civil engineering applications have potential
  - ❑ Reinforcement fabric for road construction
  - ❑ Filtration media for industrial and waste water facilities
  - ❑ Erosion control products

- ❑ Outreach efforts to educate and incentivize potential California RPC users of currently available RPC products
  - ❑ Industrial waste water filtration market
  - ❑ Erosion control for industrial sites where stormwater control is necessary and often regulated
    - ❑ TSS, Metals, nitrate reduction

- ❑ Development of procurement incentives for potential RPC civil engineering product users
  - ❑ Civil engineers and industry managers are very conservative and trying something new requires
    - ❑ Product performance data
    - ❑ Environmental data
    - ❑ Incentives to overcome the “cost of change” inherent when trying different products and/or systems

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Questions?

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