David W. Pittman. Upon his selection to the Senior Executive Service in January 2005, Dr. David W. Pittman became the Director of the Geotechnical and Structures Laboratory at the US Army Engineer Research and Development Center in Vicksburg, Mississippi. Dr. Pittman leads a team of about 500 researchers and support staff in developing technologies primarily within the realm of geotechnical and structural engineering and the geosciences, addressing both civil works and military engineering challenges for the warfighter and the nation. For example, GSL researchers develop innovative technologies in force protection, force projection, maneuver support, and civil works infrastructure, and provide operational support and technology transfer to soldiers and civilians around the world. Dr. Pittman also leads ERDC's Military Engineering Business Area, which focuses on warfighter support in force protection, force projection, and maneuver support. Dr. Pittman conducted research on roller compacted concrete pavement design and construction, completing a Master's degree and a PhD on these topics. He has published numerous reports and technical papers on the subject. He serves as the current Chairman of ACI Committee 325, Concrete Pavements, and is a member of ACI Committee 327, Roller-Compacted Concrete Pavements. He contributed to the latest state-of-the-art "Guide for Roller Compacted Pavements" published by the National Concrete Pavement Technology Center in June 2010.

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U.S. Army Corps of Engineers

The Use of Roller-Compacted Concrete (RCC) Pavements in the United States: Past, Present, and Future

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Geotechnical and Structures Laboratory
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ACI 327 Session on RCC Pavements, Dallas, TX 19 March 2012

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Topics

- Background
- RCC Materials and Construction
- RCC Advantages and Limitations
- RCC Applications and Trends
- Summary and Questions

Background

What is RCC Pavement?

Zero slump portland cement concrete…

…placed and compacted like asphalt concrete…

…and cured to form portland cement concrete pavement.


RCC Materials
and Construction
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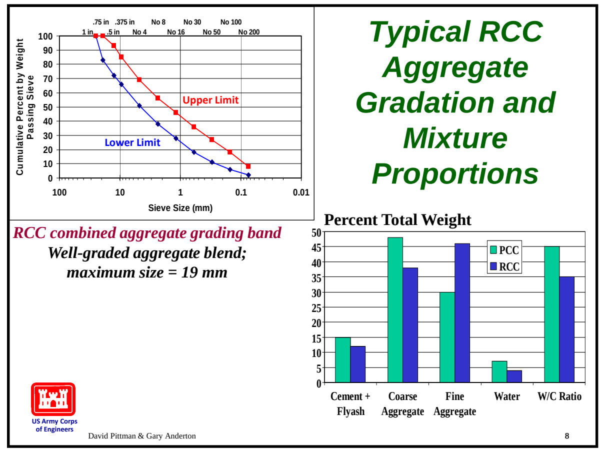
Typical RCC
Aggregate
Gradation and
Mixture
Proportions
Cumulative Percent by Weight Passing Sieve
Upper Limit
Lower Limit
Sieve Size (mm)
RCC combined aggregate grading band
Well-graded aggregate blend;
maximum size = 19 mm
Percent Total Weight
PCC
RCC
Cement + Flyash
Coarse Aggregate
Fine Aggregate
Water
W/C Ratio
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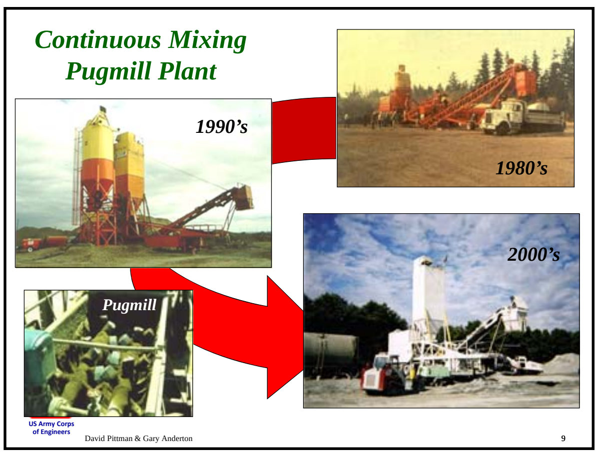
Continuous Mixing
Pugmill Plant
1990's
1980's
2000's
Pugmill
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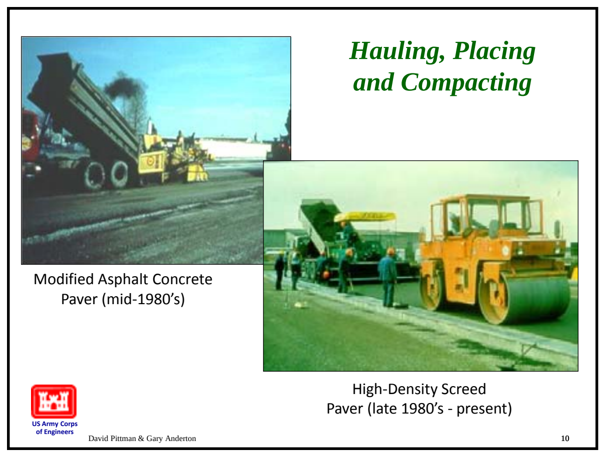
Hauling, Placing
and Compacting
Modified Asphalt Concrete
Paver (mid-1980's)
High-Density Screed
Paver (late 1980's - present)
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Moisture Control
and Curing
Water Spray Truck
Moist Curing
Curing Compound
Photo courtesy of John Hawkins, USACE
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Quality Control
and Assurance
Extracting cores from test section
Checking density with nuclear gauge
Photo courtesy of John Hawkins, USACE
Fabricating cylinders
Measuring smoothness with straightedge
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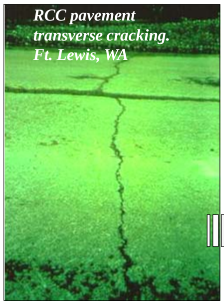

Natural cracks formed at 10 to 30+ m intervals

Cracks and Contraction Joints

Sawing joints at 10 to 15 m intervals

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RCC Advantages and Limitations

Advantages and Limitations

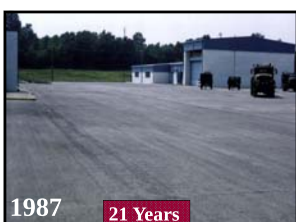
Advantages

- Low construction cost
  - Rapid placement, high production
  - No reinforcing steel, dowels, forms
  - Less equipment, labor
- Ease of construction
  - Uses existing construction methods
- High strength
  - Low w/c, high density
- Early loading
  - Inherent stability of fresh, stiff concrete

Limitations

- Smoothness
  - Most applications limited to low-speed traffic
- Surface texture
  - Coarser than PCC
  - Similar to AC
- "Uncontrolled" cracking
  - Used to save costs
  - Most use sawed joints now
- Surface raveling
  - When poor curing, finishing practices used
- Freeze-thaw durability
  - Poor lab, excellent field performance

RCC Applications and Trends



21 Years Later!

Military Application

Ft. Campbell, Kentucky

- *Motor Pool (military tanks, heavy trucks)*
- *Built in 1987*
- *$16.50/sq m ($13.84/sq yd)*
- *30% savings over conventional concrete*
- *57,000 sq m (sq yds), 190 mm (7.5 in) thick*
- *Cracks at 15 to 56 m (50 to 180 ft) spacing*
- *60 freeze-thaw cycles/year; little/no damage*
- *Designed for 20 years' traffic*

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Military Application

Ft. Carson, Colorado

- *Motor Pools, Tank Trails (military tanks, heavy trucks)*
- *Built in 2008*
- *170,000 sq m (203K sq yds), 250 mm (10 in) thick*
- *Longitudinal cracks observed one year after placement*

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Paving RCC Shoulder, I-285, Atlanta, Georgia

Photo from www.agpeltz.com


Completed RCC Shoulder, I-285, Atlanta, Georgia

Public Sector Application

I-285 Shoulder Replacement, Atlanta, GA

- Shoulder replacement
- First use on U.S. Interstate Highway
- October 2004 – Sept 2005
- $45/sq m ($38/sq yd)
- 28 km (17 miles) long, 3 to 4 m (10 to 13 ft) wide
- 150 to 200 mm (6 to 8 in) thick
- Joint spacing matched main-line paving joints
- Designed for 20 years' traffic

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Saturn Plant, Tennessee


RCC Entrance Road, Saturn Plant

Private Sector Application

Saturn Plant, Tennessee

- Roads, parking areas, loading docks
- Built in 1989
- $10.76/sq m ($9/sq yd)
- 540,000 sq m (134 acres)
- 125, 150, 250 mm (5, 6, 10 in) thick
- Some areas used AC, PCC overlays for smoothness, appearance
- Led to many other automobile applications in 1990's, 2000's

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RCC Pavements, Honda Plant, Alabama


RCC placement & compaction, Honda Plant

Photos from www.agpeltz.com

Private Sector Application

Honda Plant, Lincoln, Alabama

- Roads, parking areas, loading docks
- Built in 2000-2006
- Estimated 30% savings over AC
- Total over 917,000 sq m (226 acres)
- 125 to 180 mm (5 to 7 in) thick
- Served as staging areas during vertical construction
- Zero to low maintenance to date

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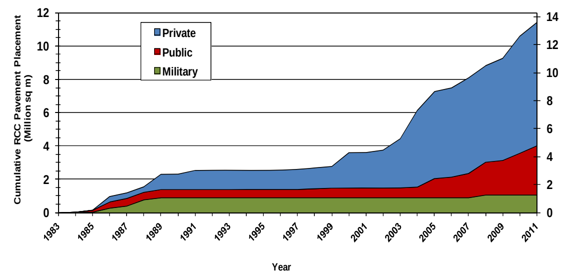

Roller-Compacted Concrete (RCC) pavement production in the United States, 1983-2011

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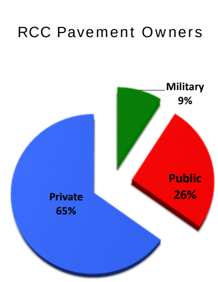

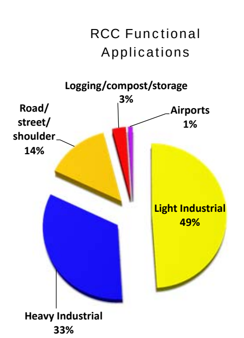

Proportion of owners and functions of RCC pavements in the United States, by surface area, 1983-2011

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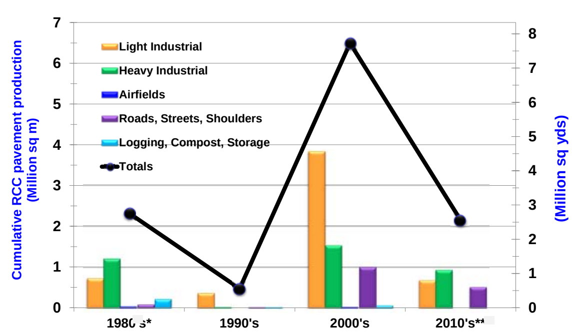

RCC placement per decade, by function, 1983 – 2011

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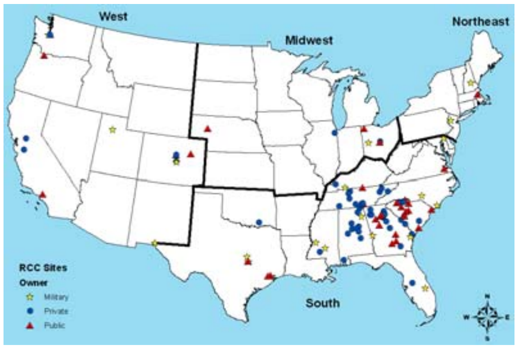
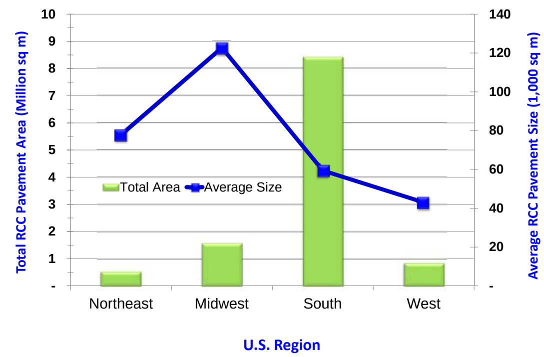


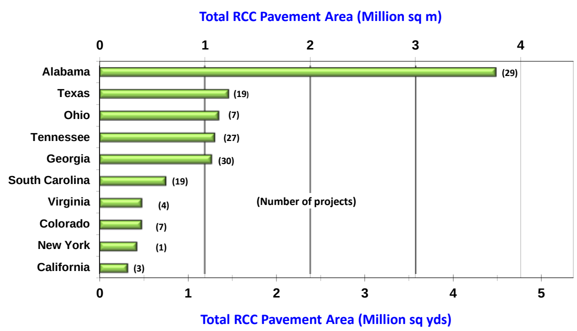
Locations of RCC pavement projects in the United States.

25



Total RCC pavement area, and average RCC pavement size, per region

26



Top ten states for RCC pavement usage

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Pave-ment Size	Light Industrial	Heavy Industrial	Airfields	Roads, Streets, Shoulders	Logging, Compost, Storage	All RCC Pavements
	sq yd	sq yd	sq yd	sq yd	sq yd	sq yd
AVG	102K	91K	24K	53K	35K	82K
MAX	1 M	420 K	41K	675K	169K	1 M
MIN	50	470	15K	500	3.3K	50
MED	24K	55K	21K	15K	21K	29K
Total	6.7M	4.4M	98K	2M	385K	13.6M
# of Projects	66	49	4	37	11	167

Analysis of RCC pavement size, by function

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	Light industrial	Heavy industrial	Airfields	Roads, streets, shoulders	Logging, compost, storage	All RCC pavements
Pavement Thickness	Inches	Inches	Inches	Inches	Inches	Inches
AVG	7	12	9	8	9	9
MAX	10	20	14	12	15	20
MIN	4	4	6	4	5	4
MED	7	12	8	8	8	8
Number of Projects	89	62	4	45	15	215

Analysis of RCC pavement thickness, by function

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	Unit Cost of RCC Pavement		
Pavement Cost	$/sq m	$/sq yd	Cost Savings
AVG	$27.51	$32.74	27%
MAX	$75.00	$89.29	58%
MIN	$ 8.00	$ 9.52	9%
MED	$19.20	$22.85	22%
Number of Projects	38	38	21

Cost data for RCC pavements

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Summary

- RCC is an excellent, low cost paving alternative in the United States
  - Used for over 30 years
  - Over 13.5M sq yds in military, public, private applications
- Demand for low-cost, durable, heavy-duty paving alternatives is growing
  - U.S. infrastructure condition is declining
  - Investment in public, private infrastructure is growing
    - Over 60% of RCC paving has occurred in last 7 years
- RCC should provide a viable paving alternative for years to come

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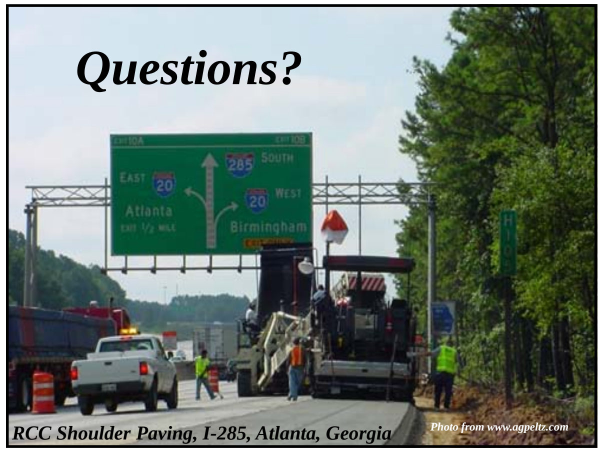

RCC Shoulder Paving, I-285, Atlanta, Georgia