The LEED rating system

Erin Mack Ashley, Ph.D.
Director of Codes and Sustainability, NRMCA

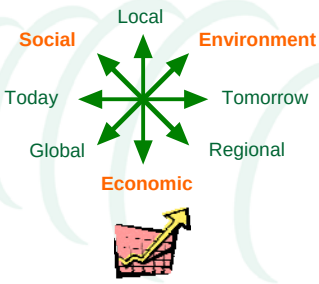
NRMCA

What is Sustainable Development?

"development that meets the needs of the present without compromising the ability of future generations to meet their own needs"

World Commission on Environment and Development's (the Brundtland Commission) report, *Our Common Future,* (Oxford University Press, 1987)

Triple Bottom Line



Green Building

- Focuses on the built environment
- Minimize environmental impact of buildings and their surrounding landscape
- A subset of sustainable development

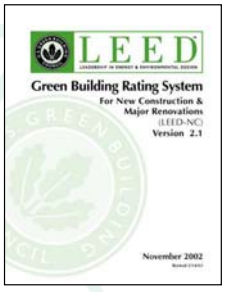
Major "Green" Market Driver

United States Green Building Council

Mission *to promote the design and construction of buildings that are environmentally responsible, profitable, and healthy places to live and work.*

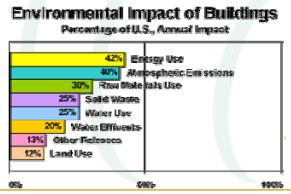
LEED

- LEED – Leadership in Energy and Environmentally Design
- Green Building Rating System
- Covers whole buildings and their exteriors, not individual parts of buildings



Environmental Impact of Buildings

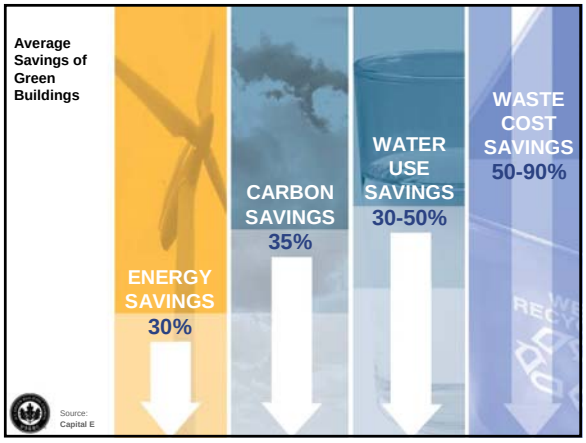
- Buildings accounted for 39.4 percent of total U.S. energy consumption in 2002.
- Buildings in the United States contribute 38.1 percent of the nation's total carbon dioxide emissions, including 20.6 percent from the residential sector and 17.5 percent from the commercial sector.



Concrete vs. Asphalt

- Life cycle analysis on concrete and asphalt roadways
- Compared embodied energy and global warming potential for construction and maintenance over a 50-year life cycle
- For a high volume highway
  - Asphalt pavement required 3 times more energy than concrete pavement
  - Asphalt generated global warming potential of 738 t/km of CO_2 equivalents compared to 674 t/km for concrete

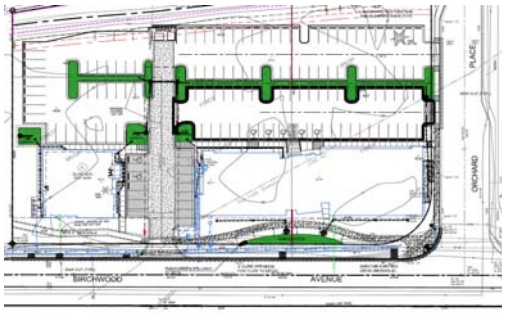
A Life Cycle Perspective on Concrete and Asphalt Roadways: Embodied Primary Energy And Global Warming Potential, Athena Institute, Ottawa, Ontario, 2006.



LEED NC (New Construction)

Buildings are certified, not materials, products, companies, or individuals

LEED NC

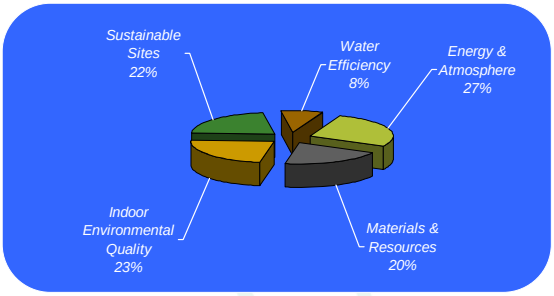


Park Tower Plaza, Bellingham, WA

LEED Certification

Certification Levels	*Points Required*
Certified	26-32 Points
Silver	33-38 Points
Gold	39-51 Points
Platinum	52-69 Points

LEED® Categories



Stormwater Management

Sustainable Sites Credit 6.1

- Limit disruption and pollution of natural water flows by managing stormwater runoff
  - Option 1: If existing imperviousness is less than 50% then maintain existing discharge rate
  - Option 2: If existing imperviousness is more than 50% then decrease discharge rate by 25%

Stormwater Management

- Promote natural infiltration
- Minimize impervious surfaces
  - Green roofs
  - Pervious pavements

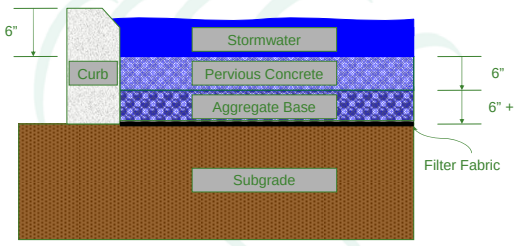
Stormwater Management

- Pervious Concrete
  - 15-30% voids
  - Rainwater percolates through the slab
  - Minimizes runoff to surrounding streams and lakes
  - Functions like retention basins
  - Recharges groundwater supplies

Water Efficient Landscaping

- Limit the use of potable water for landscape irrigation
  - Potable water for irrigation must be reduced by 50%
- The gravel sub-base under pervious concrete can be used to store stormwater for irrigation,

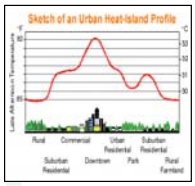
Pervious Pavement Profile



Heat Island Effect (non-roof)

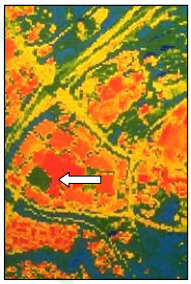
Sustainable Sites Credit 7.1

- Reduce heat islands
- Option 1: Provide any combination of the following for 50% of the site hardscape
  - Shade (w/in 5 years of occupancy)
  - Paving materials with a Solar Reflectance Index (SRI) of at least 29
  - Open grid paving system for 50% of parking area
- Option 2: Place a minimum of 50% of parking spaces under cover where roof has an SRI of at least 29

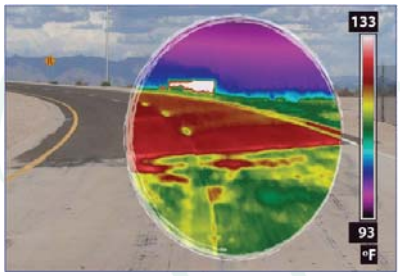


Heat Island Effect

- Shade constructed surfaces with landscape
- Use green roofs
- Specify high-albedo materials (reflectance greater than 0.3)
  - Concrete reflectance: 0.35 - 0.8
  - Asphalt reflectance: 0.05 – 0.15
- Use underground or covered parking



Heat Island Effect (Green Highways)



Light Pollution Reduction

Sustainable Sites Credit 8

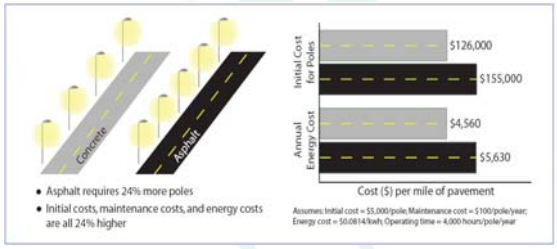
- Reduce impact on night sky
- Interior Lighting: Angle of maximum candela shall not exit out through windows
  - OR – All non emergency lighting shall be automatically controlled to turn off during non-business hours
- Exterior Lighting: In addition to interior lighting requirements, only light areas required for safety and comfort.

Reduced Light Pollution

- 30% fewer fixtures can produce the same level of lighting on concrete compared to asphalt

Source: Road Surface's Reflectance Influences Lighting Design" RP269.01P, R. E. Stark, Portland Cement Association, April 1986.

Reduced Light Pollution (Green Highways)



Regional Materials

Materials & Resources Credit 5.1 and 5.2

- Increase demand for materials within region
- Based on value (cost) of materials
- Worth 1 point for 10% manufactured regionally within a radius of 500 miles
- Worth 2 points if 20% of regionally manufactured materials are also extracted, harvested, and recovered with 500 miles

Regional Materials

- Concrete
  - manufactured within 500 miles
  - often extracted within 500 miles

Recycled Content

Materials & Resources Credit 4.1 and 4.2

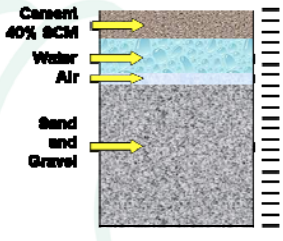
- Increase demand for recycled products
- Post-consumer + ½ post-industrial
- Based on value (cost) of materials

Recycled Content

- Identify material suppliers that use recycled material
  - Fly Ash
  - Slag
  - Silica Fume
  - SCMs are considered post-industrial

Innovation in Design

- Reduction of CO_2 by 40%
- Increase use of SCMs such as fly ash and slag



Benefits of LEED Certification

- Minimizes environmental impact
- Projects a positive image
- Energy cost savings
- Increased labor productivity
- Tax credits in some cities and states
- Higher rents for green buildings

Pervious Concrete Pavement
LEED Example Project – City Recreation Center

- 75,000 SF community center on 10.5 acres
- No curbs
- No catch basins
- 100,000 SF of pervious concrete pavement
- Raingardens
- Infiltration of roof water
- Pool-water re-use for toilet flushing

Firstenburg Community Center, City of Vancouver, WA

Pervious Concrete Pavement
LEED Example Project – City Recreation Center

Firstenburg Community Center, City of Vancouver, WA

Summary

- U.S. Green Building Council (USGB)
  - Developer and administrator of the LEED® Green Building Rating System
- LEED® - A leading-edge system for designing, constructing, operating and certifying the world's greenest buildings.
- LEED® - Categories:
  - Sustainable site planning
  - Safeguarding water and water efficiency
  - Energy efficiency and renewable energy
  - Conservation of materials and resources
  - Indoor environmental quality
- **CONCRETE** - Is a major contributor to earning points necessary for LEED® Certification.

Additional Information

www.nrmca.org
www.rmc-foundation.org
www.ecco.org
www.usgbc.org

NRMCA

Questions?

NRMCA

Chincoteague Project Overview

Long Life Aspects

Henri Sinson, PE
Virginia Concrete Conference
March 6, 2008

HARDESTY & HANOVER, LLP
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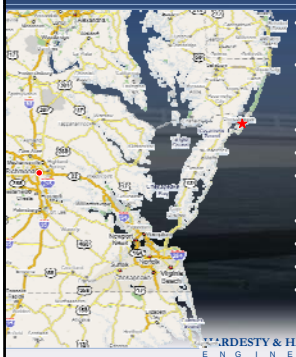
Presentation Goals

- Project Overview
  - Site Conditions
  - Scope
  - Alignment
  - Constructability
- Bascule Span Highlights
- Approach Substructure
  - Satisfied Aesthetic Requirements
  - Satisfied Subsurface Conditions
  - Details for Long Life
- Approach Superstructure
  - Satisfied Aesthetic Requirements
  - Details for Long Life
  - Innovation for Efficiency
  - Innovation for Long Life

Project Overview



- Bridge on Rte 175 Over Black Narrows and Lewis Creek Channel
- Accomack County and Town of Chincoteague, Virginia

- 4035'-0" low level bridge
- 123'-6" single leaf bascule span
- 729'-0" low level connector bridge

- Owner: VDOT
- Designer: Hardesty & Hanover, LLP
- Contractor: American Bridge
- Contractor Bid: $68.7 million

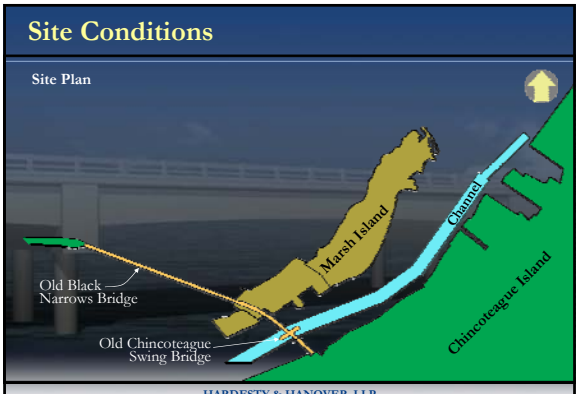
Site Conditions

Town of Chincoteague & Marsh Island

Old Chincoteague Bridge

Site Conditions

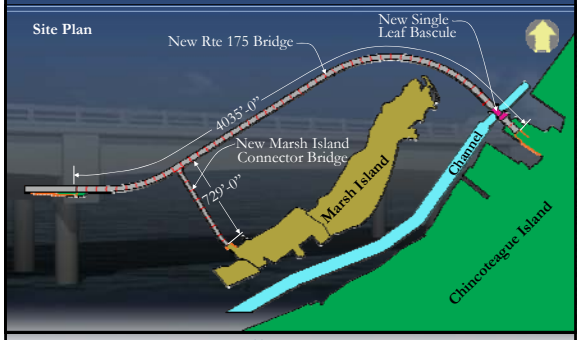
Site Plan



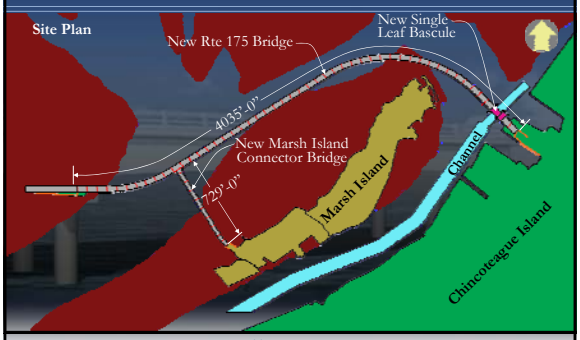
Scope

Site Plan

Alignment



Constructability



Bascule Span

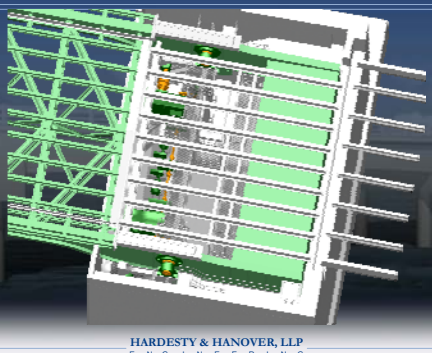
- 92'-0" Span Length
- Closed Pit Pier
- 5" Half filled grating
- 1662 Kip Leaf
- 26" Trunnion Diameter
- Gear Driven
- 75 HP, 900 RPM Primary

Bascule Span

Bascule Span

Bascule Pier

Bascule Pier Deck Removed



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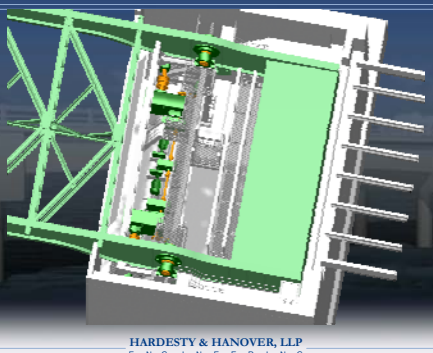
Bascule Pier Stringers Removed



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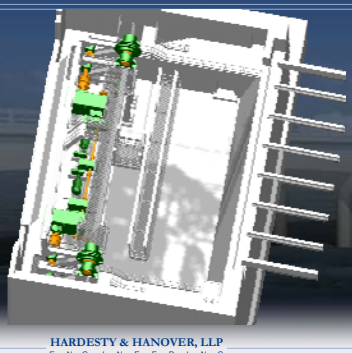
Bascule Span Removed



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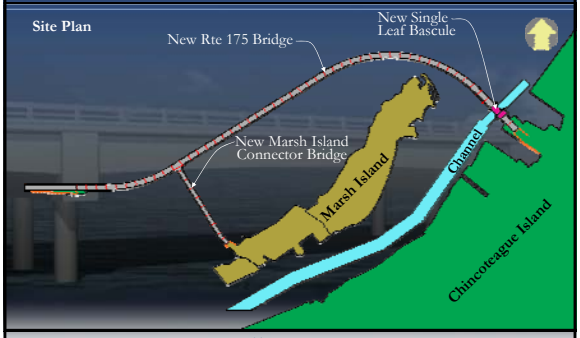
Approach Substructure



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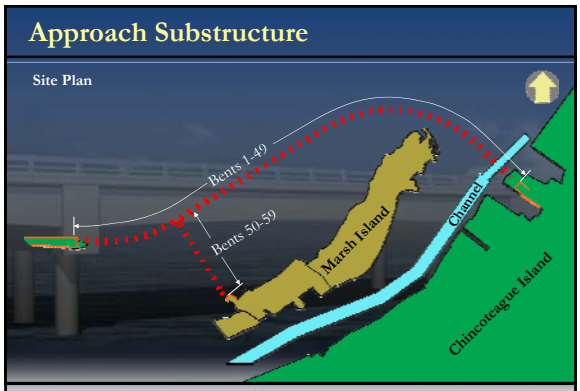

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Substructure Aesthetics

Typical Trestle Bent

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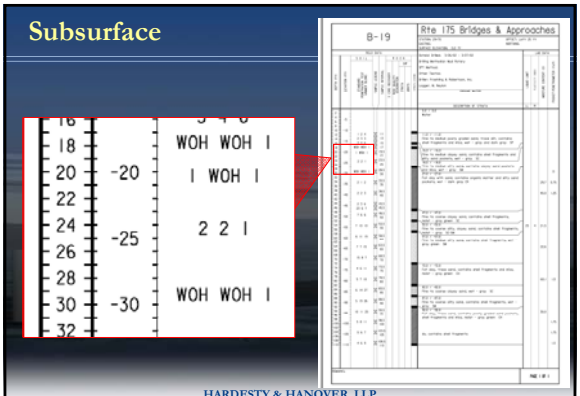
Substructure Aesthetics

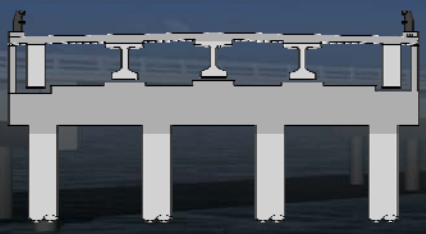
Cylinder Pile Bent

Subsurface



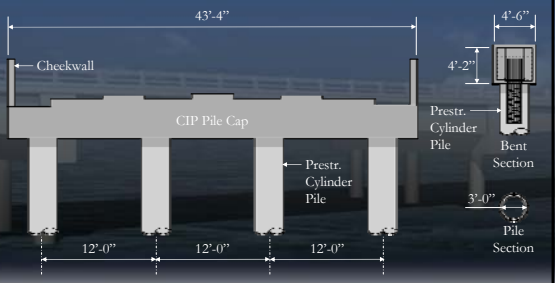
Substructure Details

Bent Elevation



Substructure Details

Bent Elevation



Approach Substructure

Approach Substructure

Photo Courtesy of Jacobs Engineering Group Inc.

Approach Superstructure

"Baseline" Bridge Elevation

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Superstructure Aesthetics

Addition of Cheekwalls

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Superstructure Aesthetics

Addition of Arched Fascia Beams

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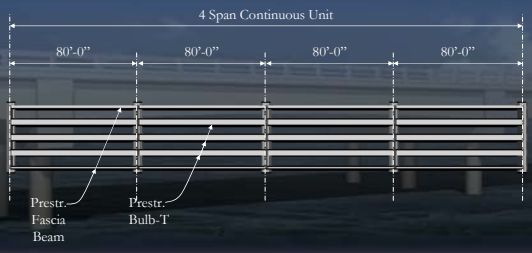
Superstructure Details

Framing Plan



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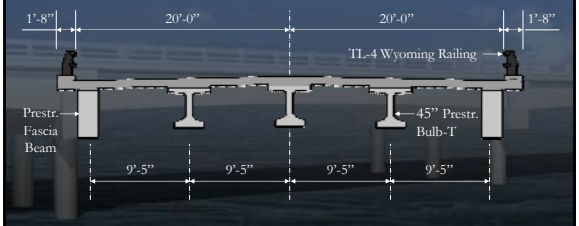
Superstructure Details

Cross Section



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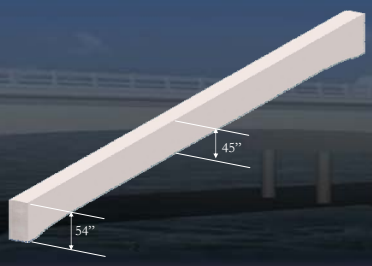
Innovation for Efficiency

Arched Prestressed Fascia Beam



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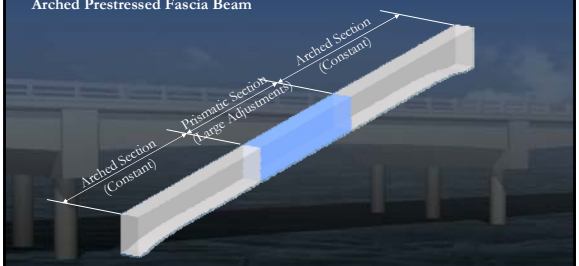

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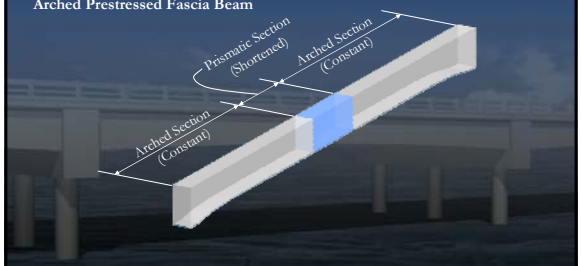

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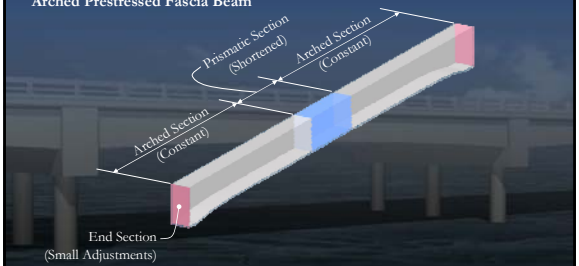

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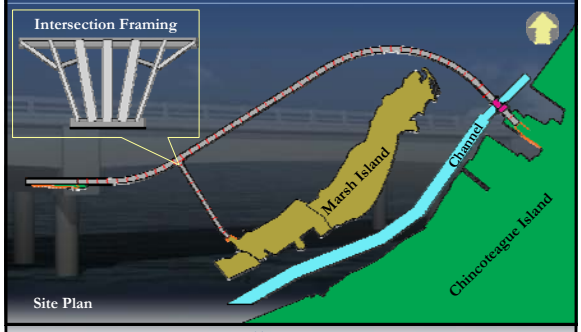
Innovation for Long Life



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Innovation for Long Life

Intersection Framing

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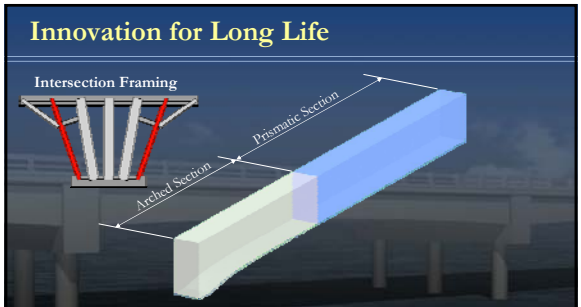
Intersection Framing



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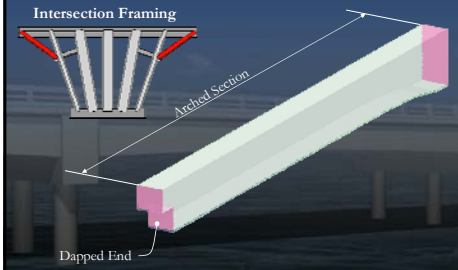

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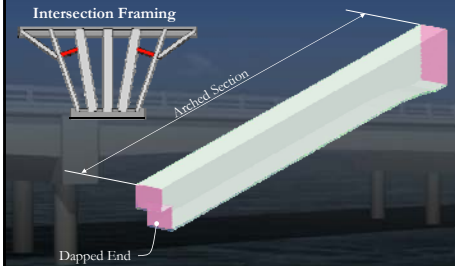

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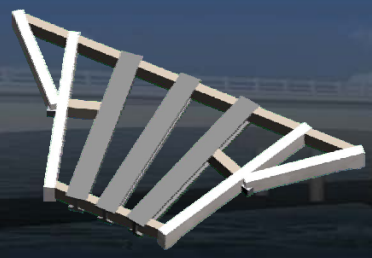

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Innovation for Long Life

Intersection Framing

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Innovation for Long Life

Intersection Framing

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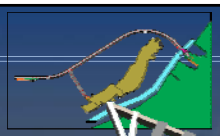
Chincoteague Project

- Project Overview
- Bascule Span Highlights
- Met Aesthetic Requirements
- Satisfied Challenging Site Conditions
- Innovation for Efficiency
- Innovation for Long Life



HARDESTY & HANOVER, LLP
ENGINEERING
Virginia Concrete Conference, Chincoteague Project Overview

DEPLOYABLE CONCRETE TECHNOLOGIES FOR PAVEMENTS

By
Angel L Correa
FHWA Resource Center, Atlanta

PRESENTED AT THE
" VIRGINIA CONCRETE PAVEMENT CONFERENCE"

Richmond, VA
March 6, 2008

Notice

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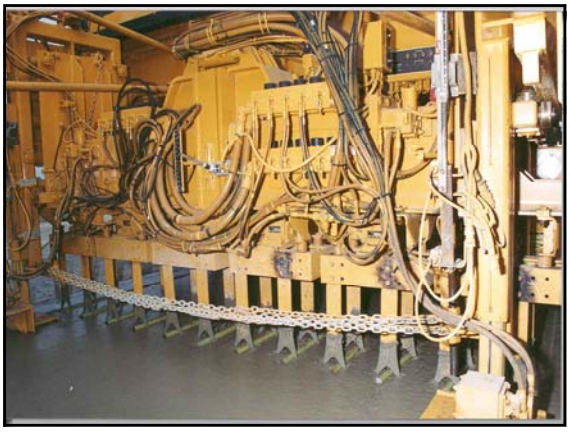
- The US Government does not endorse products or manufacturers.
- Trade or manufacturers' names may appear in this presentation only because they are considered essential to the object of this presentation.

DISCUSSION TOPICS

- **EQUIPMENT AND CONSTRUCTION**
- QUALITY CONTROL
- DESIGN
- SOFTWARE
- WIDE PCCP SLABS

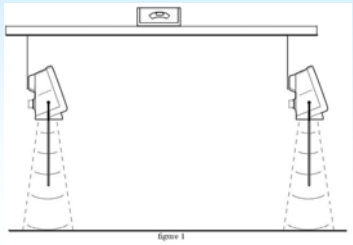
DOWEL BAR INSERTER



GSI

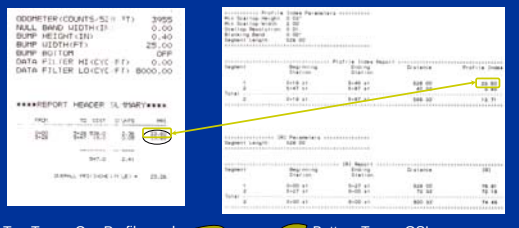
GOMACO Smoothness Indicator
"Revolution in Profiling"

GSI
GOMACO Smoothness Indicator



GSI taking readings behind a Paver

PI Comparison (GSI & Cox)



Top Trace: Cox Profilograph

Bottom Trace: GSI

STRINGLESS PAVING

Goals:

A. Control of slipform paving train without stringline
   1. X- Y - Z axis control
   2. Meet smoothness criteria
B. Control of as many as 4 companion machines
   1. Placer Spreader (s), Texture / Cure machine (s)
   2. Redundancy with back-up in case of failure

TEREX Roadbuilding Group

Control System

Laser kept within 500 ft of paver
(1000 ft range)

Control System

Note GPS
Receiver No 1

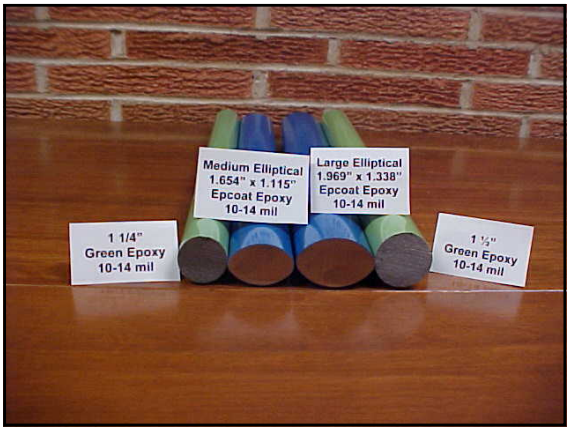
Laser Receiver (Tracking)
Mounted on paver

Control System

Left to Right
Computer
Sensor I/O's
Monitor
Foreground - Keyboard

Elliptical Dowels

American Highway Technology



Why Consider Elliptical Shapes

Reduce Bearing Stress

Engineer Dowel Spacing

Reduce Cost

Dowel Bar Test Results

Dowel Bar Type & Average Concrete Bearing Stress

Dowel Bar Description	Concrete Bearing Stress	
1.25 inch round steel	2,048 psi	(1.23 sq in)
1.5 inch round steel	1,568 psi	(1.77 sq in)
Large elliptical steel	1,147 psi	(2.08 sq in)
Medium elliptical steel	1,611 psi	(1.43 sq in)

DISCUSSION TOPICS

- EQUIPMENT AND CONSTRUCTION
- **QUALITY CONTROL**
- DESIGN
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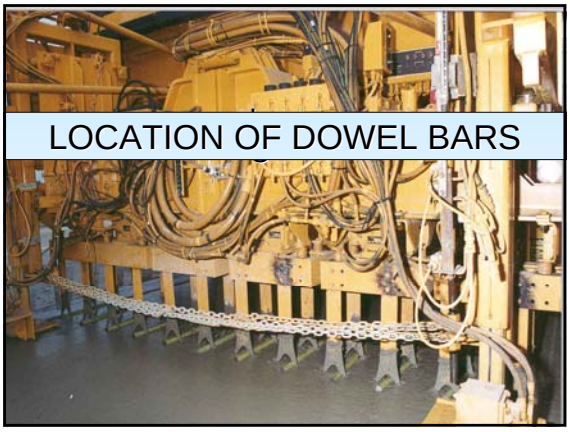
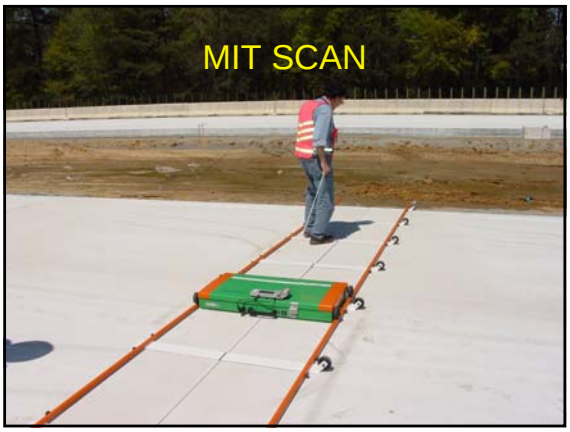
- WIDE PCCP SLABS





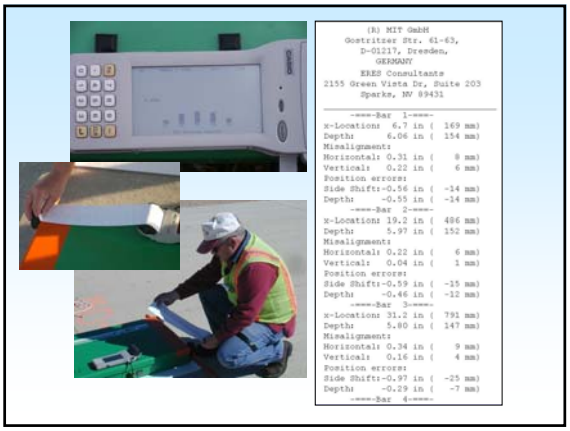
MIT-Scan

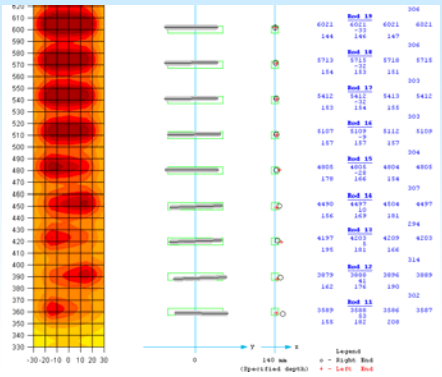
Developed by Magnetic Imaging Tools, GmbH

Based on the principles of pulse induction

Advantages

- Works on fresh or hardened concrete
- Real-time, automated data analysis
- Very accurate
- Reliable
- Efficient (1-2 min per joint)





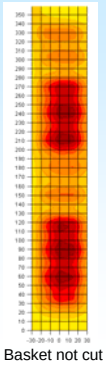
Dowels placed in baskets

The current software does not analyze dowels placed in baskets that are uncut

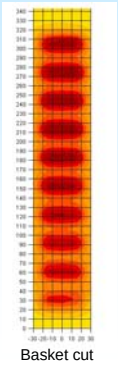
Good quantitative results can be obtained if the basket is cut

- Approximate results with general calibration
- More accurate results with calibration to specific basket type
- For accurately placed bars (placed within typical placement tolerance) the error is less than +/- 5 mm.

Dowels Placed in a Basket

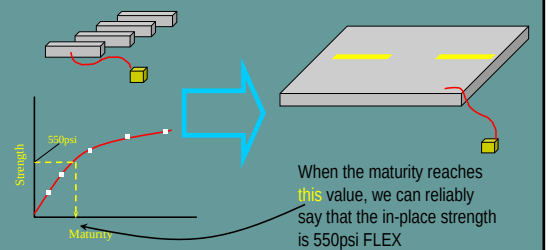


Basket not cut



Basket cut

Maturity Method



When the maturity reaches this value, we can reliably say that the in-place strength is 550psi FLEX

(ASTM C 1074)

Measuring Devices




Reestablishing Maturity Curve

Factors Affecting Maturity

- Cement
- Fly Ash
- Admixtures
- W/C ratio
- Mix type
- Aggregate gradation

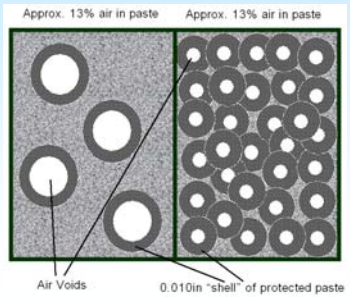
AASHTO Technology Implementation Group

Air Void Analyzer (AVA)

An apparatus that measures the air-void characteristics of fresh concrete

A 2002 Focus Technology

Spacing Factor



(Diagram per Hover)

Air Void Analyzer allows …

More control of air-void characteristics in ***fresh*** concrete

Quantify the air-void structure in the field

Rapid QC/QA testing, useful for concrete placed in extreme climates

AVA Equipment

Data Analysis Tools

Concrete Sampling Equipment & misc

AVA

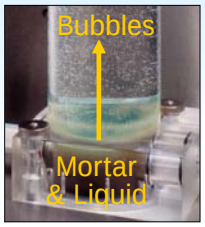
(Photo Courtesy of)

How the AVA works

A cement mortar sample is placed in the analysis liquid. They are stirred together.

The air bubbles contained in the mortar are released.

Large bubbles rise to the surface faster than small ones.



(Photo Courtesy of)

AVA Limitations

Equipment is sensitive to vibration. Testing needs to be performed in a quiet environment, like a permanent structure.

Small sample size

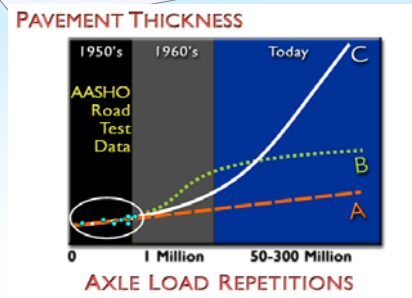
Air characteristics are calculated based on assumed volume fractions. Sample excludes aggregate larger than 6 mm (0.24 in).

DISCUSSION TOPICS

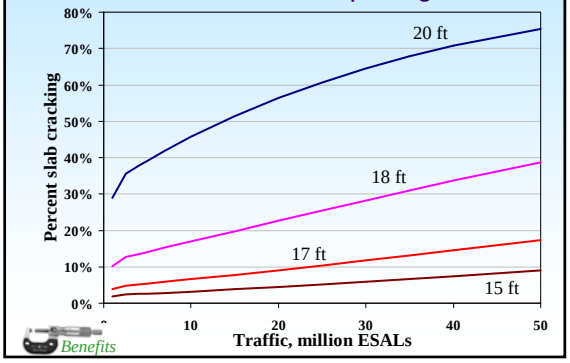
- EQUIPMENT AND CONSTRUCTION
- QUALITY CONTROL
- **DESIGN**
- SOFTWARE
- WIDE PCCP SLABS

WWW.TRB.ORG/MEPDG

Limitations: Huge Extrapolation

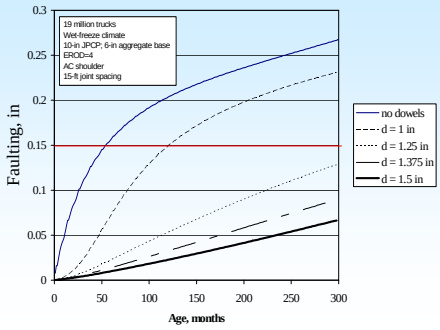


Effect of Joint Spacing



Benefits

Effect of Dowel Diameter on Faulting



DISCUSSION TOPICS

- EQUIPMENT AND CONSTRUCTION
- QUALITY CONTROL
- DESIGN
- **SOFTWARE**
- WIDE PCCP SLABS

HIPERPAV II

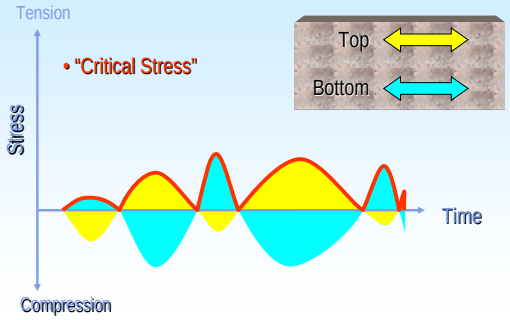
THE TRANSTEC GROUP

What is it?

- HIgh PERformance Concrete PAVing

  an integrated computer system that analyzes material, environmental, design, and construction variables

Critical Stress



What are typical uses?

Predict responses in cold and hot weather paving

Predict potential strength gain for tight closures and opening to traffic

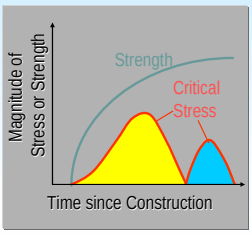
Determine effects of design parameters on stress development

- Joint spacing, thickness, base type

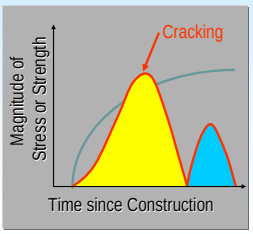
Determine optimal mix characteristics

Forensic studies – crack development

JCP Stress and Strength Development



Scenario #1
Cracking should not occur

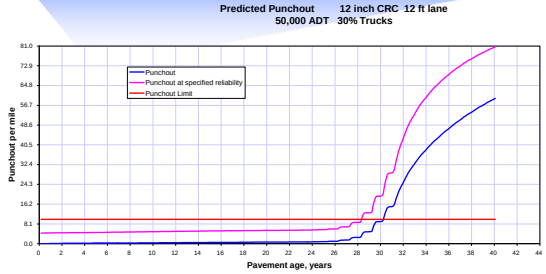


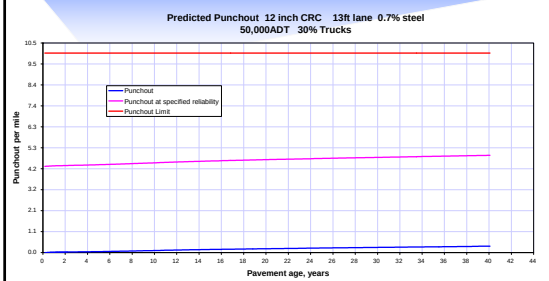
Scenario #2
Cracking may occur

DISCUSSION TOPICS

- EQUIPMENT AND CONSTRUCTION
- QUALITY CONTROL
- DESIGN
- SOFTWARE
- **WIDE PCCP SLABS**

WIDENED LANES





CRC WIDENED LANE

(50,000 ADT 30% TRUCKS 90% RELIABILITY)

THICKNESS	% STEEL	YRS TO FAILURE 12 FT WIDE	YRS TO FAILURE 13 FT WIDE	ESAL'S 12 FT WIDE	ESAL'S 13 FT WIDE
10	0.70	14.3	30.3	76 MILLION	191 MILLION
12	0.70	28.3	40+	175 MILLION	281+ MILLION
10	0.65	12.3	26.3	64 MILLION	159 MILLION
12	0.65	24.3	40+	145 MILLION	281+ MILLION

Thank You!

2008 Annual Virginia Concrete Conference
Count on Concrete for Long Life and Value
Sheraton Park South Hotel, Richmond, VA
March 6 - 7, 2008

César A. Constantino, Ph.D.
Director of Process & Quality
cconstantino@titanamerica.com

Current Admixture Technology

Contents

Background

Admixture

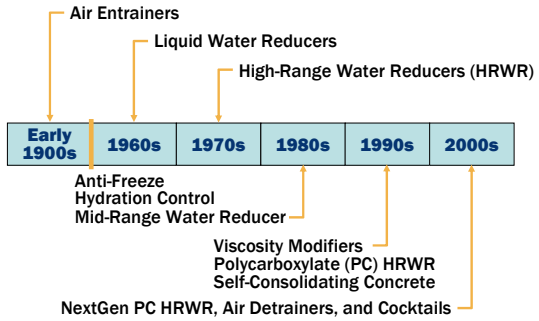
- ACI 116R-00 definition
  - A material **other than**
    - water,
    - aggregates,
    - hydraulic cement, and
    - fiber reinforcement,
  - used as an ingredient of a cementitious mixture to modify its freshly mixed, setting, or hardened properties and that is added to the batch before or during the mixing.

Fly Ash Particles

Scanning electron microscope (SEM) micrograph of fly ash particles. Although most fly ash spheres are solid, some spheres are hollow cenospheres (as shown)

Chemical Admixtures

- V.S. Ramachandran:
  - … important group of admixtures used in small amounts…
  - Water soluble or emulsified systems
  - Accelerators, retarders, water reducers, superplasticizers, etc.
  - Air entraining, pumping aids, coloring, alkali-aggregate expansion-reducing, and others…



Admixture-Related Innovations Timeline

TITAN AMERICA

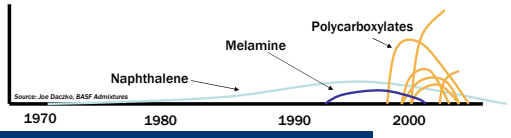
- Standard Specifications
  - Air Entraining Admixtures
  - Water-Reducing
  - Retarding
  - Accelerating
  - Water-Reducing and Retarding
  - Water-Reducing and Accelerating
  - High Range Water-Reducing
  - High Range Water-Reducing and Retarding
- Specifications for others?

Chemical Admixtures

TITAN AMERICA

Chemical Admixtures
HRWR (Super P)

- Comprised of four major groups
  - Sulfonated naphthalene-formaldehyde condensate (SNF)
  - Sulfonated melamine-formaldehyde condensate (SMF)
  - Modified lignosulfonate (MLS)
  - Polycarboxylates



HRWR (Super P)

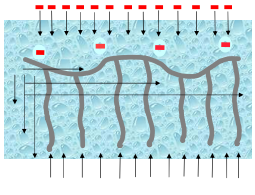
TITAN AMERICA

- Design molecules for specific performance and specific cement chemistries

Molecular attributes can be altered to affect performance (via synthetic chemistry)

- Density of side chain grafts
- Density of charge on backbone
- Molecular weight of side chain
- Molecular weight of backbone

Backbone and side chain chemistry are by design

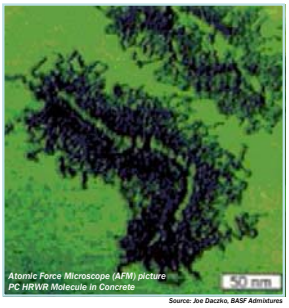


Source: Joe Daczko, BASF Admixtures

NextGen PC HRWR

TITAN AMERICA

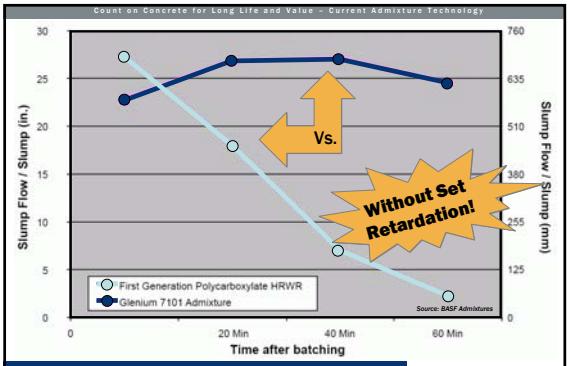
- Results of PC HRWR molecular design
  - Dispersion efficiency
    - Electrostatic repulsion
    - Steric repulsion
  - Slump retention
  - Control over setting time
  - Early-age strength



Source: Joe Daczko, BASF Admixtures

NextGen PC HRWR

TITAN AMERICA



NextGen PC HRWR

TITAN AMERICA

Viscosity Modifying Admixtures

- A material added to concrete that changes its viscosity and improves the stability of the mixture
  - Cellulose
  - PEG – Glycol derivative
  - Natural Gums (Welan, Diutan, Guar)

Source: BASF Admixtures

Increase in Viscosity

Viscosity Modifying Admixture

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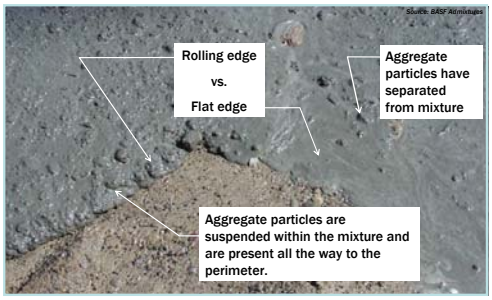


Viscosity Modifying Admixture

TITAN AMERICA

Pervious No VMA

Pervious VMA

- VMAs
  - Provide cushion to aggregate particles
  - Add more "body" or "cream" to concrete
  - Keep particles suspended, reduced segregation

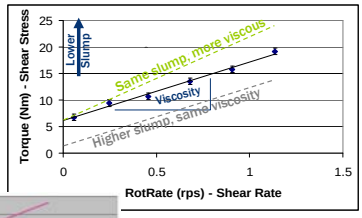
Viscosity Modifying Admixture

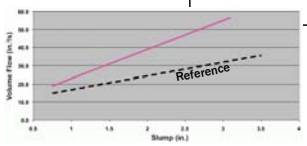
TITAN AMERICA

Rheology-Controlling Admixture

- **Rheology** http://www.wikipedia.com
  - The study of the deformation and flow of matter under the influence of an applied stress, which might be shear stress or extensional stress.
- **Rheometer**
  - An H-shaped impeller spins in a bucket of concrete
  - Data is converted to torque
  - Torque data is then collected for various impeller rotation rates

- The point at which the line intercepts the torque axis (y-intercept) correlates to slump.
- Higher intercept points correspond to **LOWER** slumps
- The slope of the line correlates to viscosity
- A greater slope signifies a higher viscosity





Admixture effect
- Lowers force required to initiate flow, without affecting the viscosity
- Improves response to vibration
- Lubrication effect
- Enhances consolidation

Air Detrainer Admixture

- Not recommended for use in air-entrained concrete…
- Reduces the air content of concrete mixtures
- Helps to maintain design strengths of concrete mixtures
- May reduce rejected load potential
- Other benefits?
  - Interior flatwork

Compatibility of Admixture Systems

- Combination of Water Reducer and HRWR
  - Low water content concrete, i.e. zero slump (initial water content is critical)
  - Add Type A (2.0 oz/cwt) to increase to 2 in slump
  - Add type F (9.0 oz/cwt) to increase to 11 in slump
  - Higher strengths, lower shrinkage
  - High slump retention
  - Good pumpability

Source: Richard Szecsy, Lattimore Materials Company, L.P.

- Combination of Mid-Range and Retarder
  - High temperatures, low humidity
  - Longer working time
  - Better control over set time
  - Typically 8.0 oz/cwt and 2.0 oz/cwt, respectively

Source: Richard Szecsy, Lattimore Materials Company, L.P.

- Combination of hydration stabilization admixture (HAS) and accelerator and HRWR
  - Job Constraints/Specifications
    - 3000 psi in 6 hrs, Type I/II cement
    - 2 yd^3 bucket placement, 8 yd^3 per truck
    - 45 min haul to job
    - No staging of trucks, tight jobsite
  - Admixture Sequencing
    - Type F added to truck
    - Type C added after Type F
    - Type B added after Type F and C

Source: Richard Szecsy, Lattimore Materials Company, L.P.

Conclusions

Chemical Admixtures

- NextGen High-Range Water Reducers (Superplasticizers, aka Super P)
- Viscosity Modifying Admixtures
- Rheology-Controlling Admixtures
- Air Detrainer Admixture
- Compatibility of Admixture Systems

Thank You

cconstantino@titanamerica.com

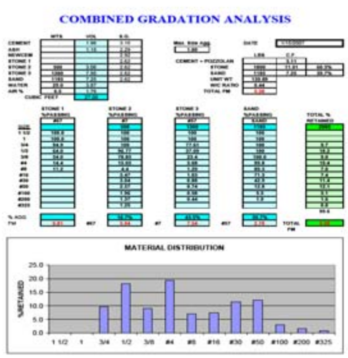
TITAN AMERICA

Route 5 – Chickahominy River Bridge

VDOT End Result Specification (ERS) Pilot Project

Date of Pour 3/8/2007
Mix ID 400

	Date Tested	Age (Days)	Unit Weight (grams)	Unit Weight (pcf)	Maximum Load (pounds)	Compressive Strength (psi)	Average	Remarks
ELKO	1	3/9/2007			17684	1400		
ELKO	1	3/9/2007			20724	1650	1525	
239	2	3/10/2007	3772.2	143.0	28166	2242		In the mold for 2 days
240	2	3/10/2007	3787.7	143.6	27826	2215	2229	In the mold for 2 days
241	4	3/12/2007	3823.9	145.0	35405	2819		
242	4	3/12/2007	3831.5	145.3	35320	2812	2815	
ELKO	4	3/12/2007			31149	2480		
ELKO	4	3/12/2007			35922	2860	2670	
243	7	3/16/2007	3815.2	144.7	37650	2998		
244	7	3/16/2007	3809.1	144.4	38720	3083	3040	
ELKO	7	1/7/1900			39313	3130		
ELKO	7	1/7/1900			40192	3200	3165	
245	21	3/29/2007	3832.4	145.3	51675	4114		Broken at 21 days for review
246	28	4/5/2007	3840.8	145.6	52015	4141		
247	28	4/5/2007	3808.4	144.4	54395	4331	4236	
ELKO	28	4/5/2007			62350	4962		
ELKO	28	4/5/2007			58820	4689		
ELKO	28	4/5/2007			59100	4703	4784	
248	28	4/5/2007	3832.0	145.3	58625	4600		Cured under water 1st 2 days (cap only)
249	28	4/5/2007	3830.0	145.2	55805	4461		Cured under water 1st 2 days (Cap and duct tape)
250	28	4/5/2007	3826.8	145.1	59430	4732	4581	Cured under water 1st 2 days (No cap)
251	56	5/3/2007		0.0		0		
ELKO	56	5/3/2007			0		0	
252	Permeability	4/5/2007						Sent to Boral (San Antonio)
253	Permeability	4/5/2007						Sent to Boral (San Antonio)

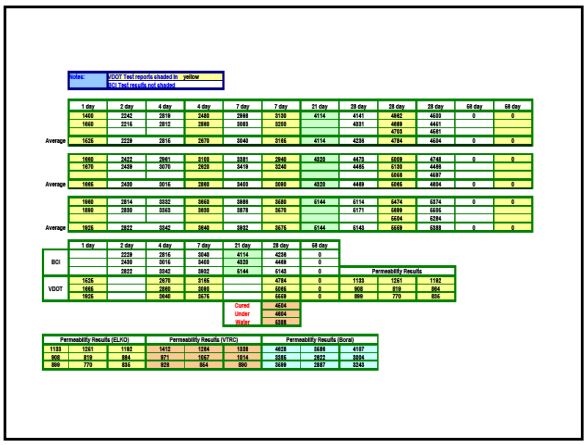


Date of Pour 3/8/2007
Mix ID 401

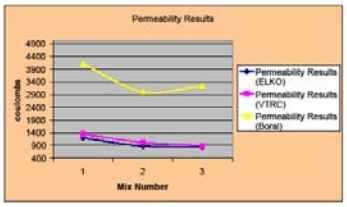
	Date Tested	Age (Days)	Unit Weight (grams)	Unit Weight (pcf)	Maximum Load (pounds)	Compressive Strength (psi)	Average	Remarks
ELKO	1	3/9/2007			20850	1660		
ELKO	1	3/9/2007			20975	1670	1665	
264	2	3/10/2007	3758.7	142.5	30415	2422		In the mold for 2 days
265	2	3/10/2007	3769.9	142.8	30635	2439	2430	In the mold for 2 days
266	4	3/12/2007	3755.6	142.4	37185	2961		
267	4	3/12/2007	3788.2	143.6	38555	3070	3016	
ELKO	4	3/12/2007			38936	3100		
ELKO	4	3/12/2007			32807	2620	2860	
268	7	3/16/2007	3787.5	143.6	42465	3381		
269	7	3/16/2007	3791.2	143.7	42945	3419	3400	
ELKO	7	1/7/1900			36928	2940		
ELKO	7	1/7/1900			40694	3240	3090	
260	21	3/29/2007	3781.3	143.4	54260	4320		Broken at 21 days for review
261	28	4/5/2007	3781.4	143.4	56180	4473		
262	28	4/5/2007	3798.4	144.0	56080	4465	4469	
ELKO	28	4/5/2007			62960	5009		
ELKO	28	4/5/2007			64480	5130		
ELKO	28	4/5/2007			63630	5066	5065	
263	28	4/5/2007	3814.8	144.6	59635	4748		Cured under water 1st 2 days (cap only)
264	28	4/5/2007	3802.2	144.2	56095	4466		Cured under water 1st 2 days (Cap and duct tape)
265	28	4/5/2007	3808.8	144.4	57735	4597	4604	Cured under water 1st 2 days (No cap)
266	56	5/3/2007		0.0		0		
ELKO	56	5/3/2007			0		0	
267	Permeability	4/5/2007						Sent to Boral (San Antonio)
268	Permeability	4/5/2007						Sent to Boral (San Antonio)

Date of Pour 3/8/2007
Mix ID 402

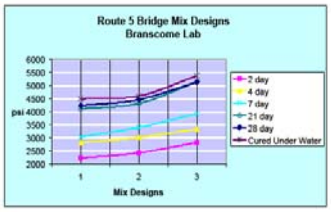
	Date Tested	Age (Days)	Unit Weight (grams)	Unit Weight (pcf)	Maximum Load (pounds)	Compressive Strength (psi)	Average	Remarks
ELKO	1	3/9/2007			24818	1960		
ELKO	1	3/9/2007			23738	1890	1925	
269	2	3/10/2007	3817.8	144.7	35345	2814		In the mold for 2 days
270	2	3/10/2007	3820.5	144.9	35545	2830	2822	In the mold for 2 days
271	4	3/12/2007	3845.5	145.8	41845	3332		
272	4	3/12/2007	3828.8	145.2	42110	3353	3342	
ELKO	4	3/12/2007			45844	3850		
ELKO	4	3/12/2007			45593	3830	3840	
273	7	3/16/2007	3827.7	145.1	50060	3986		
274	7	3/16/2007	3848.3	145.8	48705	3878	3932	
ELKO	7	1/7/1900			44995	3680		
ELKO	7	1/7/1900			44839	3670	3675	
275	21	3/29/2007	3885.8	148.6	64610	5144		Broken at 21 days for review
276	28	4/5/2007	3833.1	145.3	64235	5114		
277	28	4/5/2007	3862.6	146.4	64945	5171	5143	
ELKO	28	4/5/2007			68790	5474		
ELKO	28	4/5/2007			71620	5699		
ELKO	28	4/5/2007			69160	5504	5559	
278	28	4/5/2007	3848.4	145.8	67600	5374		Cured under water 1st 2 days (cap only)
279	28	4/5/2007	3847.1	145.9	69140	5505		Cured under water 1st 2 days (Cap and duct tape)
280	28	4/5/2007	3858.9	146.2	66385	5284	5388	Cured under water 1st 2 days (No cap)
281	56	5/3/2007		0.0		0		
ELKO	56	5/3/2007			0		0	
282	Permeability	4/5/2007						Sent to Boral (San Antonio)
283	Permeability	4/5/2007						Sent to Boral (San Antonio)



Route 5 – Chickahominy River Bridge



Route 5 – Chickahominy River Bridge

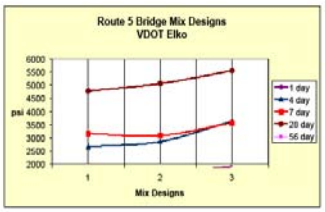


Route 5 – Chickahominy River Bridge

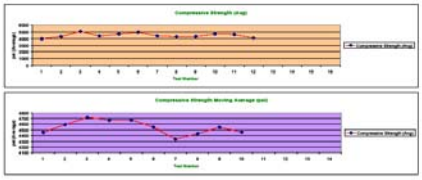
Contractors Results

Date	Location	Test Number	Truck No	Quantity	Slump.in	% Air	Temp.	Scale Wt Minus Pot Wt.	Pot Wt. lbf 0.09 Times	Unit Weight PCF	
					5" to 9"	4% - 9%	40 to 90			133.51 lowest	
10/26/2007	Bent 1B CAP	1	168	9	8.50	7.5	63	35.00	4	140.00	Accept
10/26/2007	Bent 1B CAP	2	142	9	8.00	6.0	60	35.60	4	142.40	Accept
10/26/2007	Bent 1B CAP	3	139	9	8.00	5.5	62	35.95	4	143.80	Accept
10/26/2007	Bent 1B CAP	4	159	9	8.50	6.0	62	34.95	4	139.80	Accept
10/26/2007	Bent 1B CAP	5	195	9	8.00	7.4	66	34.80	4	139.20	Accept
10/26/2007	Bent 1B CAP	6	168	9	7.50	6.8	65	35.05	4	140.20	Accept
10/26/2007	Bent 1B CAP	7	142	9	7.00	6.4	65	35.20	4	140.80	Accept
10/26/2007	Bent 1B CAP	8	139	9	8.00	6.5	69	35.05	4	140.20	Accept
10/26/2007	Bent 1B CAP	9	159	9	7.50	5.8	69	35.50	4	142.00	Accept
10/26/2007	Bent 1B CAP	10	195	9	7.50	6.4	69	35.60	4	142.40	Accept
10/26/2007	Bent 1B CAP	11	168	9	7.50	5.4	71	35.75	4	143.00	Accept
	Averages				7.82	6.34	65.55			141.25	
10/26/2007	Independent verification Cylinders 1D-1S A-B-C-D	4	159	9	8.50	6.0	62	35.00	4	140.00	Accept

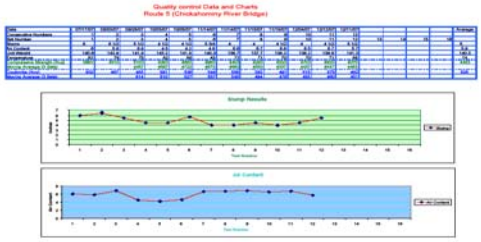
Route 5 – Chickahominy River Bridge



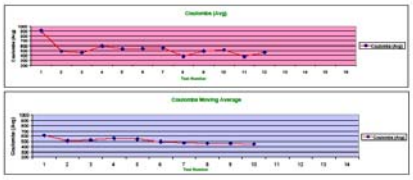
Route 5 – Chickahominy River Bridge



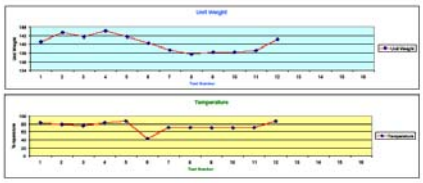
Route 5 – Chickahominy River Bridge



Route 5 – Chickahominy River Bridge



Route 5 – Chickahominy River Bridge



Questions or Comments

The End

VDOT END RESULT SPECIFICATION (ERS)

Celik Ozyildirim, Ph.D., P.E.
Research Council, VDOT

Virginia Concrete Conference, March 2008

Steps to Achieve Goal

- Educate VDOT/Industry on End Result Specification
- Incorporate pilot specification on projects
- Revise specification based on pilot projects
- Full implementation of specification

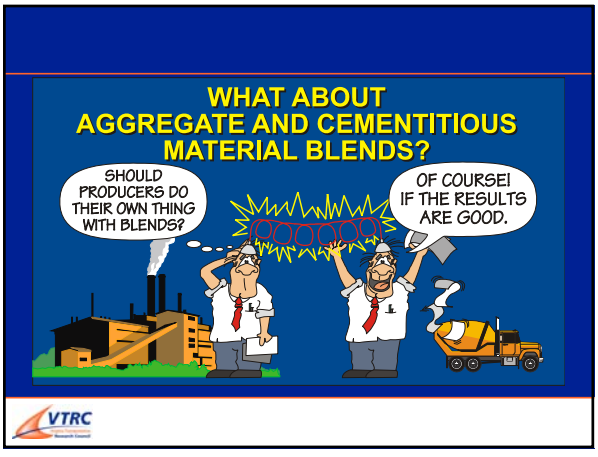
Goal

- To have long lasting concrete structures
- To ensure consistent uniform concrete prior to handling and placement
- Pay based on the quality of concrete

End Result Specifications (ERS)

- Contractor: Entirely responsible for supplying a product
- Agency: Responsible for accepting, rejecting, or applying a price adjustment

TRB Circular E-C074, Glossary of Highway Quality Assurance Terms.



Differences in Specifications

Item	Current	ERS
Mix Design	Prescriptive	Performance Measures
Testing	VDOT	Contractor and VDOT
Basis of Pay	Minimum	PWL

Pay Factor - by VDOT

Pay factor based on PWL
- Compressive strength
- Permeability

Pay as in the current spec
- Rideability
- Thickness (pavements)

ERS

Includes
1. QC Plan by the Contractor
   - Applicable to preconstruction and during construction
2. Mix design approval
3. Acceptance

First Pilot Projects

Salem:
Route 11 over the New River and Norfolk Southern Railroad tracks near Radford University

Culpeper:
Route 28 near Manassas

3. Acceptance

- Screening tests by the Contractor (slump, air content, unit weight, temperature)
- Pay factor tests by VDOT
- For structural, paving, and miscellaneous concrete
- Accepted on a lot-by-lot basis

Salem

Salem Mix Proportions

Material	Amount (lb/yd^3)
Cement Type I/II	318
Fly ash Class F	159
Slag	159
Fine aggregate	1101
Coarse aggregate	1755
w/cm	0.45

Proposed Projects

Each District will incorporate the ERS on two (preferred) of the following projects that will be advertised from 10/06 to 7/07

Salem Strength and Permeability

	Average (psi)	Std Dev
Strength	5016	305
Permeability	391	72

N=31

ERS PILOT PROJECTS

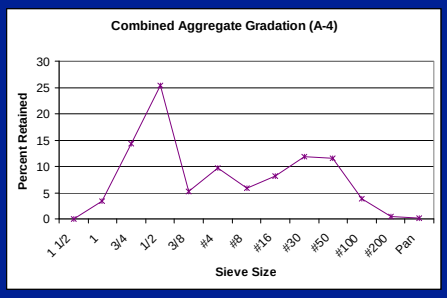
DISTRICT	PROJECT	STATUS
Bristol	PM07-084-186,C501	Ongoing
Culpeper	TBD	
Fredericksburg	Rte. 608 over Rte. 95 in Spotsylvania Co.	Ongoing
Fredericksburg	Rte. 3 over Piankatank River in Mathews Co.	On Hold
Fredericksburg	Rte. 624 over Cat Point Creek in Richmond	Ongoing
Hampton Roads	Rt. 175 – Chincoteague	Ongoing
Lynchburg	Rte. 734 over Cane Creek	Ongoing
Lynchburg	BR06-041-125, M400	Completed
Lynchburg	Carter Glass Bridge BR06-005-124, M400	Ongoing
Lynchburg	Rte. 652 over Graham Creek	Ongoing
Northern Virginia	Rt. 1 Bridge replacement at Neabsco Creek	Ongoing
Northern Virginia	I-95 – Fourth Lane	Ongoing
Richmond	Rt. 5 over Chickahominy	Ongoing
Salem	Rt. 723 Bridge over Nininger Creek 71610	Ongoing
Staunton	North Oak lane bridge replacement 60982	Completed
Staunton	Rte 340 Bridge	Ongoing

Culpeper

Rte 5 over Chickahominy

- Three trial batches with different cementitious material and w/cm
- Coarse aggregate does not meet #57; however, combined aggregate is considered.

Rte 5 over Chickahominy



Concerns

- Cost (trial batch, QC)?
- Bids?
- Available materials hinder innovation?
- Contractor (bonus?) producer (penalty?)

Thank You

VTRC
Virginia Transportation Research Council

2007 AWARD OF EXCELLENCE

VIRGINIA CHAPTER - AMERICAN CONCRETE INSTITUTE

Grantham Square Condominiums

- Owner: Grantham Square Associates, LLC
- Architect: Mayfield and Miller
- Engineer: The Spectra Group
- General Contractor: Covington Contracting, Inc.
- Finisher: Quality Enterprises
- Supplier: Titan America

Residential
Grantham Square Condominiums

Infrastructure
Pier 3

Residential
Grantham Square Condominiums

Pier 3

- Owner: Northrop Grumman Newport News
- Architect: CH2MHill/Lockwood Greene
- Engineer: Ch2MHill/Lockwood Greene
- Contractor: W. F. Magann Corporation
- Supplier: Branscome Concrete, Coastal Precast Systems

Commercial
Biotech 8 Office Building and Parking Garage

The Commonwealth Award

Biotech 8 Office Building and Parking Garage

Commercial
Biotech 8 Office Building and Parking Garage

Commercial
Biotech 8 Office Building and Parking Garage

- Owner: Biotech 8, LLC
- Architect: McKinney and Company
- Engineer: McKinney and Company
- General Contractor: Kjellstrom and Lee
- Supplier: TCS Materials, Ready Mixed Concrete, Tindall Precast