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Value Engineered Heavy Duty RCC Pavements

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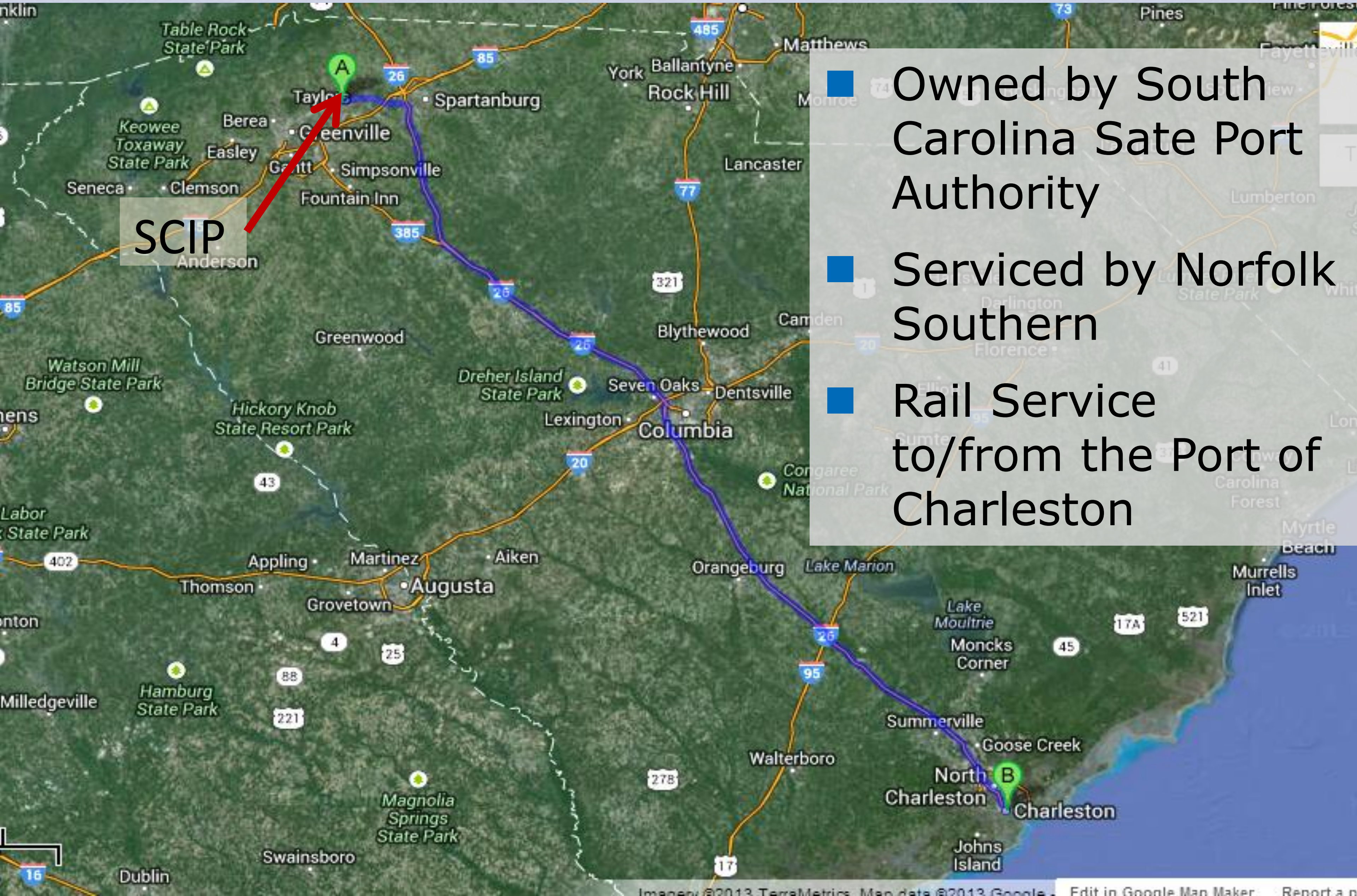
Groundbreaking Solutions

Outline of Presentation

- A Case Study – South Carolina Inland Port
  - Project Background
  - Challenges
  - Value Engineered Solution
  - Base Layer
  - RCC Surface
  - Test Section
  - Construction Photos

South Carolina Inland Port
Greer, SC

SC Inland Port - Background



- Owned by South Carolina Sate Port Authority
- Serviced by Norfolk Southern
- Rail Service to/from the Port of Charleston

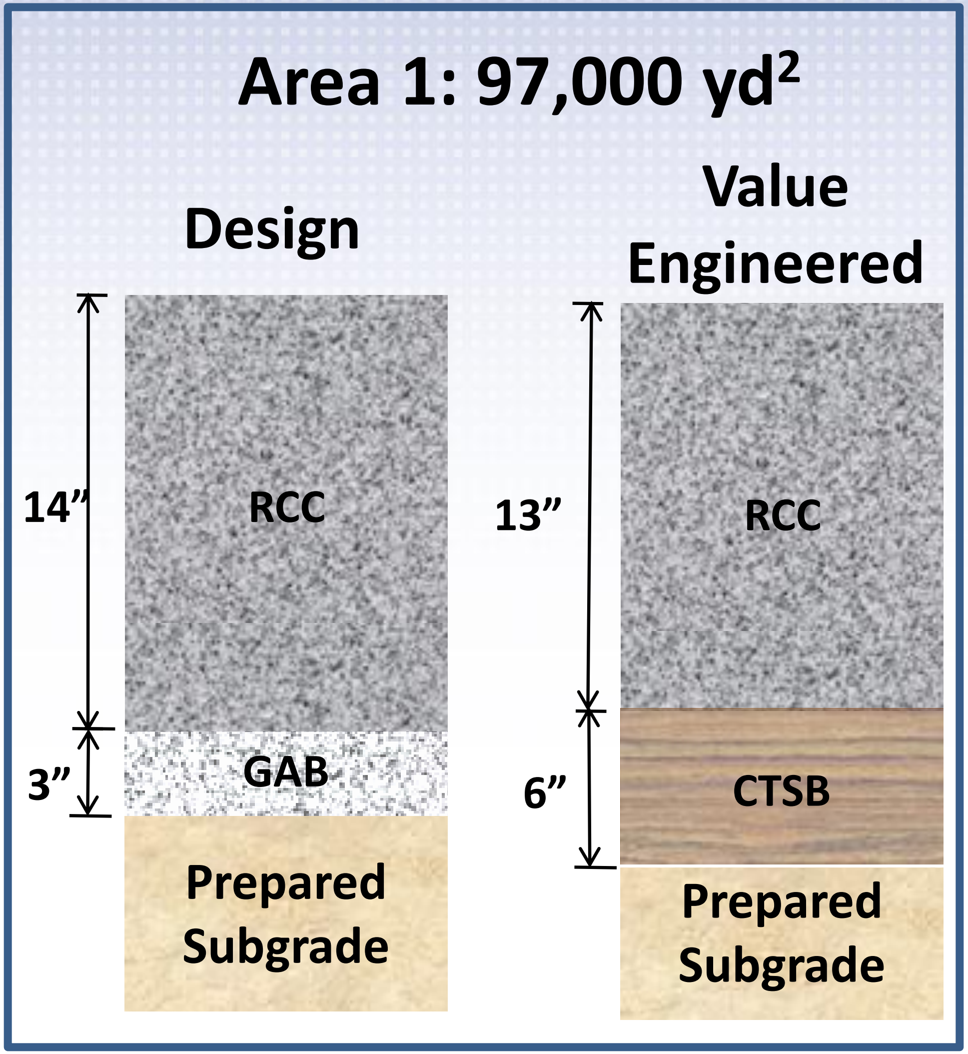
SC Inland Port - Background

- Paving Areas
  - Constructed July to December 2013
  - 3,000 ft. by 600 ft. container yard
  - Access Road
  - About one half (Area 1) heavy duty and one half (Area 2) medium duty

SC Inland Port – Site Conditions

- Variable soils
  - Sandy SILT in fill area
  - Silty SAND in cut areas
- 0.5% grade

Design and Value Engineered Sections

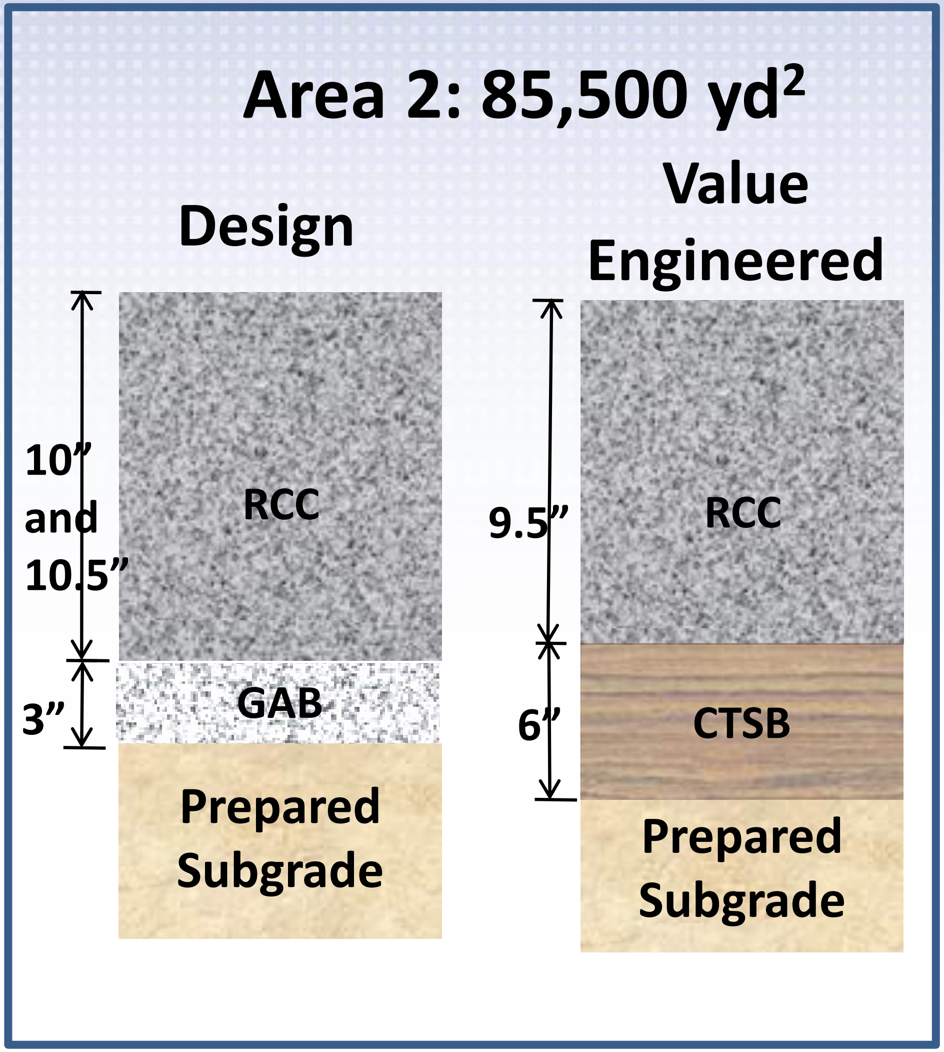


- Heavy-Duty Section
  - Constructability challenges considering 3” GAB, expected rain frequency, geologic conditions, and 0.5% grade
  - Value engineered solution offered better structural support at no additional cost, and reduced downtime after rain events

GAB: Graded aggregate base

CTSB: Cement treated soil base

Design and Value Engineered Sections



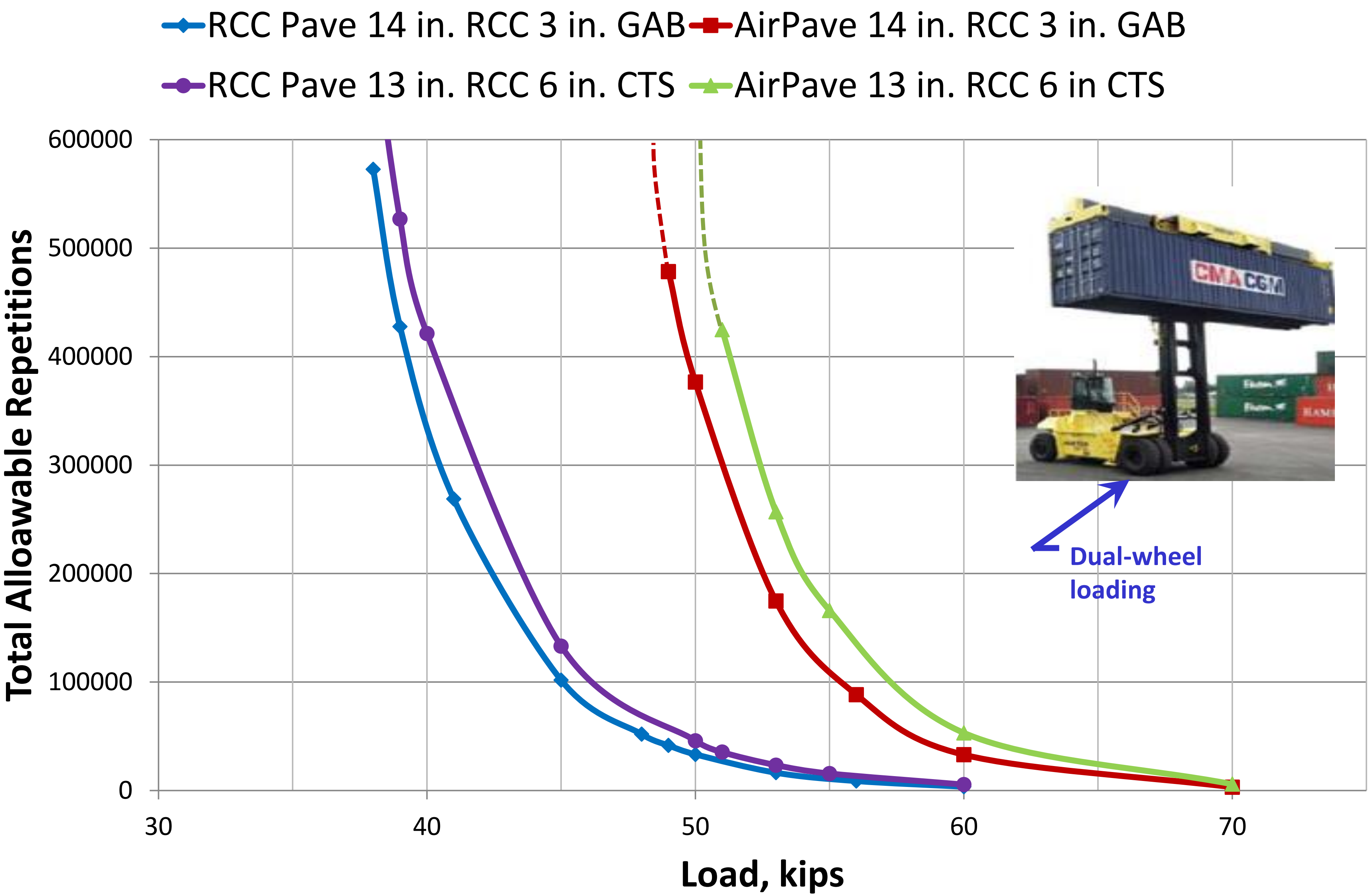
GAB: Graded aggregate base

CTSB: Cement treated soil base

SC Inland Port – Loads/Traffic

- Containers
  - Stacked 5 loaded
  - Stacked 7 empty
- Cranes
  - Eight tires each side
- Container Handler
  - Single axle, 4 tires

Analyses using RCC Pave and AirPave



RCC Pave and AirPave Results for Container Handler, Dual Wheels

Maximum Allowable Load For Unlimited Repetitions, kips		
	RCC Pave	AirPave
Design Section	37	48
Value Engineered Section	38	50

About 30 % higher capacity using AirPave for this loading condition

SC Inland Port – Cement Treated Soil Base

- Cement content by dry weight of soil
  - 6 percent in cut area (Silty SAND soil)
  - 7 percent in fill area (Sandy SILT soil)
- Compressive Strength
  - Lab specimens (mix design): 400 psi minimum at 7 days
  - Field quality control: 300 psi minimum at 7 days, or CBR of 50 percent minimum as determined by the Kessler Dynamic Cone Penetrometer

SC Inland Port – CTS Base Construction

Why CTS base?

SC Inland Port – Benefits of CTS Base

- Added structural capacity
- Improved load transfer at RCC joints and cracks
- Reduced downtime after rain events
- Economical
- Sustainability attributes

SC Inland Port – RCC Mixture

- Requirements
  - Specified compressive strength: 5,000 psi at 28 days (ASTM C1435 cylinders)
  - Specified split-tensile strength: 400 psi at 28 days
  - Minimum cement content: 500 pcy
- Aggregates
  - Considered aggregates from 2 quarries
  - At the time of construction, closest quarry did not produced washed manufactured sand
  - Natural sand not available locally
  - Tested a series of trial mixes using aggregates from both quarries
  - Selected #67 and washed manufactured sand

SC Inland Port – RCC Mixture

- Trial Batches
  - Cement contents: 500 and 575 pcy, Type I/II
  - Aggregates
    - #67 from each quarry
    - Washed manufactured sand from the farthest quarry and unwashed manufactured sand from the quarry closer to the job site
    - Crushed aggregates from both sources are granitic gneiss
  - Target lab strength: 6,000 psi at 28 days
- Selected Mix
  - 500 pcy cement
  - Aggregates: 45% #67 and 55% washed screenings

RCC Combined Aggregate Gradation

Sieve Size	Percent Passing	
	Selected RCC Mix	Project Specification
1”	100	100
¾”	95	85-100
½”	79	70-95
3/8”	70	60-85
#4	57	40-70
#16	32	15-40
#100	4.4	5-20
#200	1.8	0-8

SC Inland Port – Test Section Submittal

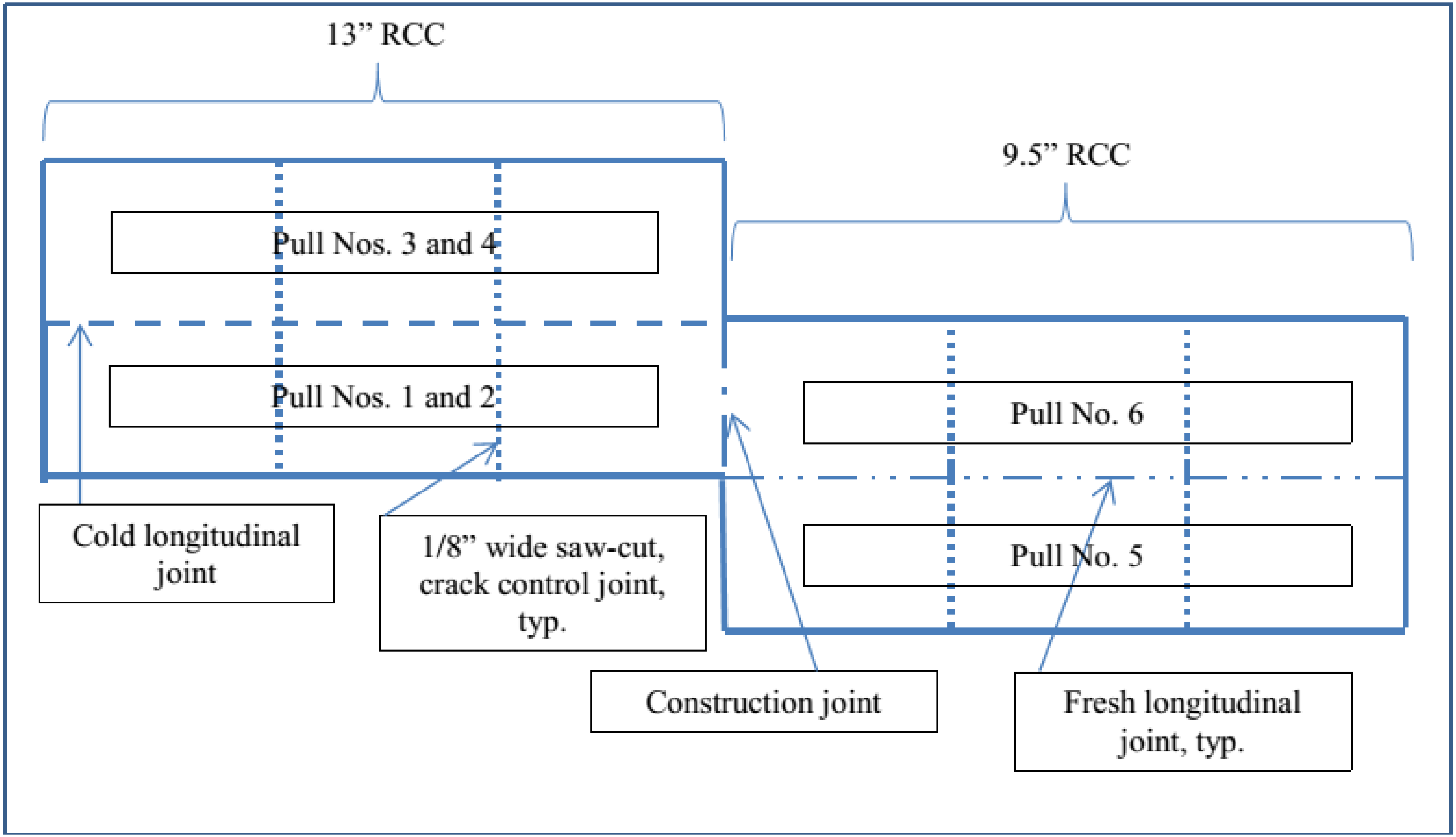


Figure 1. General layout of RCC test section (not to scale)

SC Inland Port – Test Section

- Testing of Test Section
  - Density of each lift
  - ASTM C1435 cylinders
  - Cores
    - Confirmed bond of both lifts
    - Met split tensile and compressive strengths
    - Determined density

SCIP RCC Mixing Plant

SCIP RCC Mixing Plant

SCIP RCC Placement

RCC Placement - Dual lifts when thickness > 10”

SCIP RCC Placement

RCC Placement –
1st lift”

SCIP RCC Placement

RCC Placement – 2nd lift”

Added Compaction at Longitudinal Joint


Dual-Lift Construction
VOLVO

Single lift


17
16
MAERSK
APL

Concluding Remarks

- Soil types and 0.5% grade were very challenging. Designers should consider 1% grade whenever possible.
- Using a cement-treated soil base instead of a thin unbound aggregate base was a game changer for this project built during the summer months when rain events are very frequent.
- Locally available manufactured granitic gneiss sands containing more than 6% fines may not be adequate for strength higher than 5,000 psi at 28 days

Concluding Remarks

- Analyses using different computer programs, field performance, and on-going research demonstrate the need for a unified design method that predicts the required thickness more accurately
- Results using RCC Pave appear to be too conservative, especially when designing for heavy loads for ports and intermodals
- Rapid strength gain of RCC allowed the owner to start assembling cranes and open the intermodal for operations quickly

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Questions?

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