ROAD PAVEMENTS FORUM

Continuously Reinforced Concrete Pavement – Labour Based
N3 Package K: Ashburton to Murray Rd Bridge

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SANRAL
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Reg.No.1998/009584/30
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The BIG Picture

Meets NDP goal of maximising job creation.

Labour-enhanced construction of the CRCP rather than mechanical paving was an ideal opportunity to:

- Meet SANRAL's transformation framework and policy in terms of the transformation of the South African construction and engineering sectors
- Maximise on training and skilling of locals - can be employed on other concrete-related works after completion of this project;
- Increase the flow of revenue earned by the labour directly into the local economy of the project target area;

How is it possible ?

Labour-enhanced construction of concrete pavements is not a new phenomenon and is highly dependent on:

- The right tools being provided;
- The proper training and motivation of labour;
- Efficient and timeous procurement of Materials to site;
- Avoiding stoppages or bottlenecks;
- A competent supervision team – full understanding of roles and responsibilities.

Quality of workmanship can be as good as plant-intensive methods.

Requires strong, able bodied persons and so certain categories of previously disadvantaged persons may have to be excluded from these activities.

Scope

5km between Ashburton Interchange and Murray Road Brudge

4-5 lanes - in each carriageway

260mm thick CRCP layer overlain by 100mm concrete interlayer

57000 m^3 of CRCP

Investigation and planning for labour based concrete pavement and composite pavement trials

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Contractors CRCP Management Team

Quality Plan - Part D1000: the Contractor has the following CRCP quality management team in place:

- An experienced Labour-enhanced Concrete Pavement Construction Manager;
- An experienced Labour-enhanced Concrete Pavement Procurement Officer; and – with the LIC NQF 5 certificate
- Experienced Concrete Pavement Construction Supervisors

The CRCP concrete layer is one of several activities through which the Contractor aims to achieve their target of 10% Local Labour on the project.

Task breakdown for Labour-based concrete pavement and composite pavement trials

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Breakdown of Labour Based Activities

- Steel Fixing - carried out in the same way irrespective of concrete construction method
- Setting of Shutters
- Concrete placing & spreading - Care needed accessing the area to be tipped, to avoid segregation and to prevent damaging the reinforcing.
- Vibration – use of hand pokers
- Screeding and Finishing – use of vibrating beams
- Curing
- Removing shutters - Care needed not to damage edges
- Cleaning

Labour breakdown - Concreting

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Programmed Activity

200m^3 per day per team. Two teams for full production.

48 staff per team

- 1 Labour is responsible for keeping the substrate wet continually and mist spray to create humid environment before curing application.
- 1 Labour is responsible for the concrete discharge from the concrete truck
- 8 Labourers are responsible for concrete spreading
- 2 Labourers are responsible for poker vibrator
- 2 Labourers are responsible for moving the poker vibrator drive unit
- 4 Labourers are responsible for the 2 x vibrating screed beams
- 3 Labourers are responsible for the bull float
- 2 Labourers are responsible for the straight edge
- 2 Labours are responsible for edge finishing
- 1 Labour is a team leader
- 1 Labour is a nominated SHE Rep
- 3 Labourers are responsible for curing compound application and cleaning

Labour breakdown - Formwork and Steel

- 4 Labourers are responsible for erecting the formwork and shutter oil application; stripping and cleaning of shutter
- 8 Labourers are responsible for steel fixing.
- 4 Labourers are responsible for arranging the steel.
- 2 Labourers are responsible for cleaning and removing the binding wire off cuts using magnets; air blower to remove dust; and final cleaning using pressure washer to clean substrate surface.

Resourcing to Maximise Productivity with Quality

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- 400m^3 production targeted per day using two teams.
- 96 Local Labour sourced from Project Area
- 28 experienced labour sourced from Package J – bull float finishing; edge finishing; vibrating beam; poker vibrators; concrete placing estimator; curing compound application.
- Concrete Specialist (Bryan Perrie) brought in for practical training in reinforcement and concrete spreading, compacting and finishing during the paving trials.
- Additionally SAQA classroom training undertaken.

Training

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Skills Training

SAQA ID

- 65409 Carpentry
- 24133 Roadworks
- 49016 Construction: Concreting
- 65709 Construction: Steelwork

- 80 Labourers trained
- Cost of training: R2 514 666

Planning for Labour Based Concrete Pavement

Prior to commencing with the CRCP Works, the Contractor had to submit a Quality Plan, for approval by the Engineer, detailing methodology, checks and hold points relating to the CRCP construction process.

Hold Points

• CRCP Construction Manager CV with **LIC** Certificate	• Approval of overtime by BCCEI and Department of Labour
• CRCP Procurement Officer CV with **LIC** Certificate	• Target Labour signed Contracts of Employment – Remuneration as per the gazetted labour rate – currently R54.06 per hour
• CRCP Supervisor CV with relevant experience	• Adherence to FIDIC Clause 4.4 for Subcontracted works
• Approved Method Statement	• Labour training by Concrete Specialist
• Approved Mix Deign	• Weather station positioned 1.0m above the pavement being constructed
• Approved Quality Plan	• Weather limitations (Cold weather - concrete falling below 5°C within 48 hours after casting, rainy weather, hot and windy)
• Approved Drawings	• Concrete temperature exceeding 32°C – cease paving operation
• Approved Targeted Labour Plan	• Acceptance and approval of the preceding layers
• Ergonomics Training and Fatigue Management Plan	• Reinforcement pre-pour inspection and approval
• Health and Safety Risk Assessment and Environmental Risk Assessment	• Approved curing compound – solvent-resin-based curing compound containing no water

Mix Optimization

Mix supplied by Afrisam Umlaas Plant

A 200m paving trial conducted on SBC temporary widening

A key factor was to determine the appropriate slump - somewhere between 75mm and 125mm – suitable for LIC.

A Slump of 110-125 exhibited excessive mastic at the surface; finishing takes longer.

The ideal Slump was 85mm-110mm – Labour (Slip form is around 30-50mm)

With the target slump set – any load falling outside of the specified range (75mm-125mm is rejected. 24 trucks out of 777 trucks rejected to date.

28 day Target Compressive Strength is 46Mpa; ensures 95% of results exceeds specified strength of 40Mpa

28 Day Flexural Strength of 4.4 Mpa (Checked one load per week)

Mix Optimization

Cement contains 80%-94% clinker and 6%-20% fly ash/limestone.
Spec allows for 20% maximum Extender.

Admixtures

- Chryso Omega 180 used as a water reducing plasticizer – 1% of cement content – max of 5% allowed.

Advantages:

- Improved consistence without increased water
- Improved cohesion with lower viscosity of the mix.
- Improved durability through reduced permeability.

Mix Optimization

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Curing Agents

- The Contractor is using a resin-emulsion curing compound that complies with water retention and light reflectance requirements of ASTM C309-19.

- Mist spray application to create a humid environment – to minimize evaporation and avoid rapid loss of surface moisture before curing

Supervision and Quality Control – Contractor

The **Contractor's** site supervision CRCP responsibilities:

- Pre-pour inspections, before issuing a request for inspection to the Engineer's team.
- The CRCP Construction Manager is responsible for planning the works.
- The Procurement Office communicates with the batch plant timeously.
- The CRCP supervisor is responsible for managing the team and to ensure the method statement is followed.
- The Tally Clerk is responsible for recording concrete batch - arrival, discharging and completion time.
- Temperature records for each delivery – mix temperature; min and max temp. for the day.
- Collection of batch slips to ensure the correct mix is delivered to site as per approved mix design.
- Control supplier ready mix trucks turnaround times to ensure there is no cold joints.
- Post pour inspection is done jointly by the Contractor's and Engineer's representative at the end of each day production.

Supervision and Quality Control - Engineer's site team

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The **Engineer's** site supervision CRCP monitoring responsibilities:

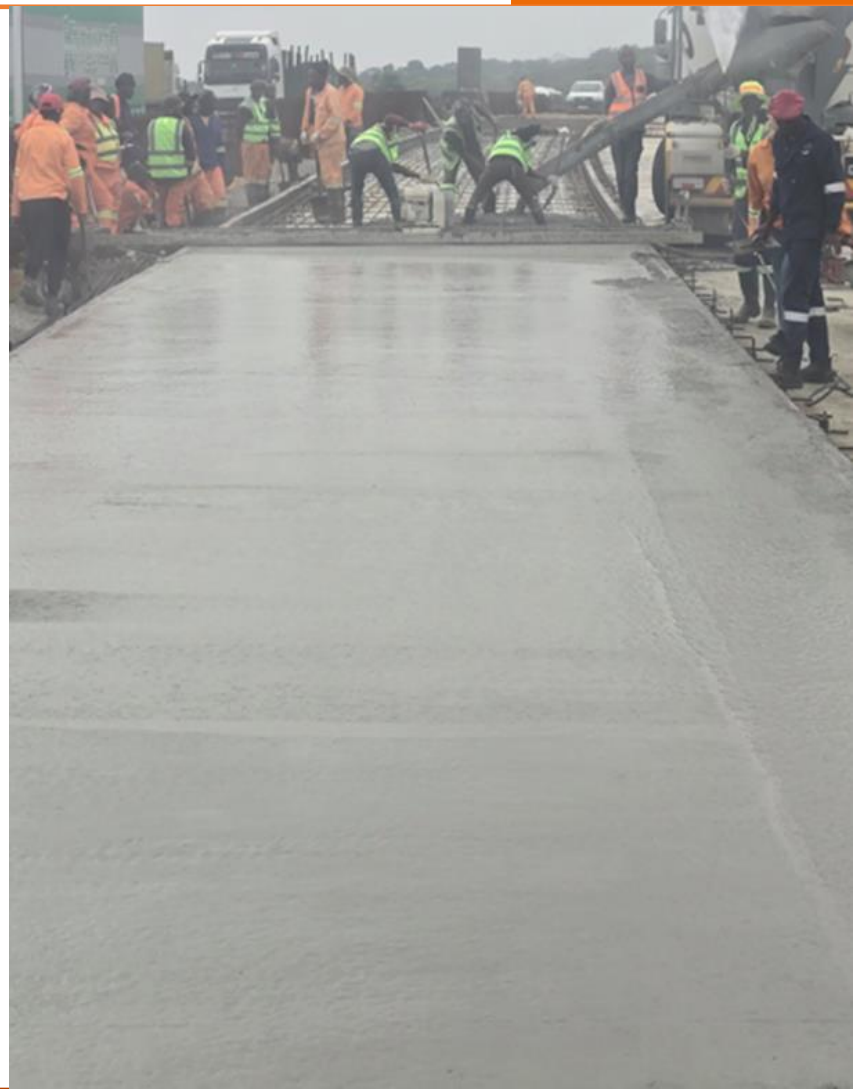
- Pre-pour inspection: reinforcement, cleanliness, wet subbase, shutter and shutter-oil
- Post-pour inspection: adequate application of curing compound, stop-end / slotted formwork, extra bars for construction joint after every two spaces
- Slump test by site laboratory to monitor consistence.
- Manufacturing of concrete cubes for compressive strength and beams for flexural strength.
- Temperature records for each delivery.
- Check batch-slips if correct mix was sent to site and mix constituents are within SANS 878 tolerances.
- Monitor ready mix trucks turnaround times to ensure there is no cold joints.
- Ensure that the Contractor keeps records e.g. truckload vs chainage; delivery notes
- Frequent sampling and testing of coarse and fine aggregates stockpiles and engage the supplier if changes are observed in quality of materials.

Fatigue and tiredness of workers

- Overall staff wellness is managed through BCCEI Conditions of Employment Collective Agreement
- Limited working hours – especially overtime related to production
- Adequate staffing – based on work study and progress
- Dedicated individuals for each activity.
- Timeous breaks – Lunch break, water breaks and hydration between the concrete trucks to mitigate heat exhaustion.
- PPE: work suit; safety boots; rubber boots; gloves; sun hats; rain suit for finishers.

Finishing

- Excess mastic exacerbate plastic shrinkage cracking
- A target slump of 100mm - avoids excess mastic on the surface
- Avoid over-vibration - segregation and surface laitance
- The CRCP will not be open to traffic – therefore tinning will not be done.
- Micro-milling to remove curing compound and create bonding texture.
- Curing compound is applied within 30 minutes of concrete placing to limit rapid loss of moisture through evaporation and mitigate plastic shrinkage.
- IRI is done after micro-milling; walking profilometer.



Lessons Learnt after the CRCP Trial Section Construction

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From Package J

- On site observations of work processes and quality control.
- Good control of finishing to attain riding quality
- Employment of CRCP Supervisor
- Employment of 28 experienced Labour

From CRCP Paving Trial

The purpose of the trial was for the Contractor to demonstrate that the equipment and processes to be used will enable the Contractor to construct the concrete layer in accordance with all the specified requirements.

- Construction tolerances as a whole and getting the subbase levels right
- Keeping the substrate continuously wet to avoid plastic shrinkage cracks
- Protection before curing, mist spray application to create a humid environment
- Ergonomics training – posture; lifting; bending.

CRCP Risks and Challenges

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- Achieving Construction tolerances for layer thickness and level
- Plastic shrinkage cracks caused by rapid loss of moisture will result in the CRCP layer rejection
- Cracks caused by expansion and contraction of longitudinal reinforcement will result in the CRCP layer rejection – use of anchor blocks at start; bottom/top of hills; end on anchor if delayed for a month
- Not achieving the daily production rate will delay the project end date
- Fatigue management – adequate staffing; water breaks between loads for hydration; labour rotation for lunch;
- Adverse weather conditions – Rainy; Heat; Cold

Cost of CRCP Works

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• Total **quantity of concrete** for the project:	**57 681 m^3**
• Two teams of 48 Labour each. **Productivity**:	**400m^3 per day**
• **Duration** of CRCP works:	**150 days**
• Total **Labour** (Concreting: 60, Reinforcement: 36):	**96 Labour**
• Current **Labour rate**/hour:	**R54.06**
• **Labour cost** for 150 days = 96*R54.06*9*150*1.05*1.05:	**R7 724 309**
• Cost of **concrete** - 57 681*R1660/m3:	**R95 750 460**
• Cost of **steel** - 4 950ton*R12 500/ton:	**R61 875 000**
• Cost of **formwork:**	**R2 000 000**
• Cost of **vibrating beams and pokers:**	**R302 000**
• Cost of **water** substrate and mist spray:	**R160 000**
• Cost of **curing compound -** 393 drums @ R7645/drum:	**R3 004 485**
• Cost of **training:**	**R2 514 666**
• **Total cost**:	**R173 330 920**
• **Labour %:**	**6%**

CRCP - Acknowledgements

- Martin Gardiner – Design team
- Riaan Joubert - RE
- Sbonelo Masikane - ARE
- Joel Khoza – SMT
- Sheun Vhudzijehna – Construction Manager
- Wang Qiang – Contractor’s Project Director
- Bryan Parrie – Concrete Specialist

End
Thank You