

# RTSA SA CHAPTER NEWSLETTER

June 2011 Edition



**NEXT MEETING: Flood Damage to Tarcoola to Alice Springs Line'**

**Next meeting –Thursday 7<sup>th</sup> July 2011**

**Peter Jaehne, Tom Hampton Genesee and Wyoming FreightLink**

**'Flood Damage to Tarcoola to Alice Springs Line'**

In early January 2010 the Alice Springs – Darwin Railway suffered a washout north of Illoquara and was closed for about a week while repairs were effected. The weather system which triggered this event also caused significant damage along the rail corridor between Alice Springs and Tennant Creek.

This presentation looks at the reasons for the damage and lessons learned.



Peter Jaehne was Manager Rail Infrastructure with FreightLink for almost 7 years and involved with the maintenance and management of the Tarcoola – Darwin railway from mid-2001. Peter is a Civil Engineer and has been in the rail industry for almost 30years.'

Tom Hampton currently holds the position of National Track Manager with Genesee & Wyoming Australia, having overall responsibility for the company's track assets, including the Tarcoola to Darwin railway. Tom is a professional civil engineer with over ten years experience in the construction and maintenance of freight and passenger railways.

## TECHNICAL PRESENTATION

### VENUE:

Engineers Australia  
Sir Robert Chapman  
Theatre  
Level 11  
108 King William St  
Adelaide

### DATE:

Thursday 7<sup>th</sup> July 2011

### TIME:

5.30pm

Light Refreshments will  
be provided.

**The Railway Technical Society of Australasia (RTSA)**

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ENGINEERS  
AUSTRALIA  
RTSA



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## CONTENTS

<b>Editorial</b>	3
<b>Chairman's Chatter</b>	4
<b>Meet the team</b>	5
<b>Coming Events</b>	6
<b>Letters to the Editor</b>	6
<b>News - Heavy Rail</b>	7
<b>News - Light Rail</b>	8
<b>Mark Drechsler's presentation</b>	10

## CHAPTER MEETINGS 2011

### Thursday 4<sup>th</sup> August 2011

Randall Barry and Simon Mitchell.  
PTS  
PTS Railcar Fleet

### Thursday 1<sup>st</sup> September 2011

George Erdos, ATSB  
Near miss at Cootamundra

### Thursday 6<sup>th</sup> October 2011

PTS and Bombardier speakers TBA  
New PTS railcar depot at Dry Creek – (Site Visit)

### Publisher

This newsletter is a publication of the South Australian Chapter of the Railway Technical Society of Australasia. Opinions expressed within are not necessarily those of the Chapter, Society or Editor.

### Contributions

Contributions, including news, opinions, or letters to the Editor, are always welcome. Send material by e-mail to [saeditor@rtsa.com.au](mailto:saeditor@rtsa.com.au)

### Continuing Professional Development

Engineers Australia members are reminded that attendance at RTSA technical meetings contributes towards CPD requirements. Each RTSA technical meeting generally has a value of 1 CPD point.

### RTSA Website

The RTSA website [www.rtsa.com.au](http://www.rtsa.com.au) has details of RTSA activities, including future meetings and reports from past meetings, for all Chapters. Membership information for potential new members and an application form may be found at [www.rtsa.com.au](http://www.rtsa.com.au).

### Chapter Contacts

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Newsletter Editor - Russell Fuller	Ph: 7129 8283

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## EDITORIAL

I would remind all our members that we welcome correspondence of all kinds; news, points of interest, activities that members may be interested in or our member's thoughts and views on recent rail related engineering events.

The presentation given by Mark Drechsler at the Joint meeting with PWI on the 2<sup>nd</sup> June 2011 is provided at the end of this newsletter for those who may have missed it. I have reduced the slides to four per page to reduce the page numbers this month.

It is my intention that any future presentations of this nature will be made available on the RTSA website under the SA chapter 'tab'. I am advised that this will have to wait until the website has been updated and site access is secured by member log in – watch this space.

This month's chatter from Daniel is a thought-provoking discussion on the moral and ethical responsibilities, perceived or otherwise, held by engineers.

Daniel's approach is clearly based on the modern engineer, as history has demonstrated that "the human factor" has not necessarily been at the forefront of engineer's minds during the days of pioneering and colonisation.

Daniel's topic is also timely, as the UK government has announced that the rail vehicles contract in the Thameslink project has gone to a German company and the vehicles will be built and tested in Germany. This will be to the detriment of the sole remaining UK based manufacturer.

Some three thousand direct jobs and an estimated six thousand supply jobs will be put in jeopardy and all this following a previous statement from the UK government that it wants UK manufacturing to lead the country out of the current economic problems. So much for the humanitarian consideration of the UK rail industry workers.

All news articles are taken from  
<http://www.rail.co>

**Russell Fuller - Newsletter Editor.**

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## CHATTER FROM THE CHAIR

### Engineering humanitarianism or human rights?

Engineers Australia theme for 2011 is 'Humanitarian Engineering'. Humanitarianism can broadly be defined as limiting inequality-based suffering, and EA want to recognise engineering's role in bettering quality of life – ie in reducing this kind of suffering.

Compassion is one of our noblest qualities, but individual humanitarianism can be vexed. Well may One Engineer say that their underpaid, overworked, not-for-profit position embodies 'enough' humanitarian engineering! Engineer Two might subject their family to a lifetime under canvas while they volunteer for causes. Engineer Three may lobby for middle ground instead, without defining 'middle'. And which sources of inhumane suffering should these Engineers try to address: inequalities of opportunity, or inequalities of outcome? And by how much?

Addressing inequality of *opportunity* means everyone gets a chance to put in more effort for commensurate reward. Sounds 'fair enough'.

Addressing *any* inequality of *outcome* sometimes seems considered a matter of human rights. The thinking appears that manufacturing an averaged outcome appropriately redistributes good fortune - even if at the expense, dispossession or suppression of others, and of their own human rights. This paradox seems considered morally and ethically debatable, but if all involved have had equal opportunity this resembles a double standard – not in keeping with to the principle of impartial consistency valued by Engineers.

Addressing *gross* inequality of *outcome* is a different matter: an admirable expression of

empathy, common humanity and a pseudo-globalisation of the safety nets provided by affluent social democracies. This responds to basic needs like sanitation (EA cite 2.6 billion lack it, globally), accessing electricity (a quarter of the world's population can't), and having adequate access to water (1.1 billion people don't). Engineers can offer to build solutions to these issues, but with caution: requisite funding can ironically produce broader issues. Zambian-born economist Dambisa Moyo suggests aid is "killing Africa": fostering corruption, creating a dependence culture and perpetuating poor governance - growing poverty despite growing aid. Engineers can challenge this sort of systemic illness with objective problem-solving.

So matters of inequality seem to require a nuanced, balanced and mature response. In navigating this you may like to comment on EA's current draft Reconciliation Action Plan, aiming to "assist in achieving Indigenous equality", or attend the upcoming 15th International Conference for Women Engineers and Scientists. This is the first event of its kind in the Southern hemisphere; its agenda includes topics on "gender policy and ... commitment to equality in the workplace".

'Smart' humanitarianism may be a practical avenue for individual action. SA Chair of Young Engineers Dr Cristian Birzer is a volunteer tutor for the Australian Refugee Association - helping this part of the community to be the best they can be. Education fosters more-equal opportunity, producing the best chance of a less-unequal outcome: very much in the spirit of 'fair-go' Australian Engineering.

**Daniel Martucci – Chair, RTSA SA Chapter**

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## MEET THE TEAM

As there have recently been a number of changes to the Committee of this chapter, it seems like a good opportunity to acquaint / re-acquaint our members with their committee.

This month's new committee member's 'pen portrait' is'

### **Doug Gillot**      **Committee Member**



Doug is a Fellow of Engineers Australia and is a past President of Engineers Australia SA Division and National Vice President Engineering Practice.

He gained a Mechanical Engineering degree at RMIT in 1988 and later was awarded a Master's degree in science and business administration.

Doug has spent 20 years in the Australian Army where he served until 1996. On leaving the army, Doug moved into defence manufacturing.

Doug has set up an engineering consultancy business providing engineering management and maintenance management systems and supporting complex procurement.

Doug also regularly delivers training in the Middle East.

Doug is a keen conservationist with a particular interest in the reclamation of native bushlands and wetlands, his other interests are cycling, agriculture and rogaining (Editor Note: long distance, cross-country navigation).

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## COMING EVENTS

### Advance Notification of next year's RTSA Awards

Please note that nominations for the 2012 Railway Engineering Student Thesis Award and the Wheel-Rail Interface Award are now being taken.

For both awards, the closing date is Friday 24th November 2011.

Both awards attract prizes of:  
\$4000;  
Plaque and;  
One year free membership of the RTSA.

Full details can be found in the March newsletter.

**ICWES15**  
**Leadership, Innovation, Sustainability**  
The 15<sup>th</sup> International Conference of Women Engineers and Scientists  
Details can be found at [www.icwes15.org](http://www.icwes15.org)

19<sup>th</sup> – 22<sup>nd</sup> July 2011  
Adelaide Convention Centre  
Adelaide  
South Australia

## LETTERS TO THE EDITOR

There has not been any correspondence for the chapter this month.

If you have a comment or observation you would like to raise or even a relevant anecdote, the SA Editor would be pleased to hear from you at [saeditor@rtsa.com.au](mailto:saeditor@rtsa.com.au)

# RTSA SA CHAPTER NEWSLETTER

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## NEWS - HEAVY RAIL GERMANY

### Deutsche Bahn orders 56 regional trains from Alstom.



*Since the launch of the first trains in 2000, Alstom has sold nearly 600 multiple units to both public and private operators in Germany, the Netherlands and Denmark. Photo: Chris S.*

German operator DB Regio AG has placed a €325 million order with Alstom to supply 56 Coradia Lint regional trains.

The trains are slated to go into service in December 2013 on largely non-electrified lines in Greater Cologne and in the Eifel region, the Cologne diesel network. The Cologne/Bonn region is one of the biggest agglomerations in Germany. Using these 56 new Coradia Lint trains, DB will achieve around 7.2 million train kilometres per year. Currently 65,000 commuters are using the DB trains daily.

The Coradia Lint trains made up of are two and three car diesel multiple units which will be designed and manufactured at Alstom's site in Salzgitter.

To meet the requirements of regional and suburban operation, the trains will be characterised by high acceleration and high seating capacity.

The new vehicles with 180 seats (Lint 54) and 300 seats (Lint 81) can run up to a maximum speed of 140 km/h. Movable steps will facilitate the boarding and disembarkation of passengers, especially at different platform heights.

For mobility-impaired passengers, the trains will be equipped with two wheelchair spaces and one WC for disabled as well as a ramp for bridging the gap between the train and the platform edge.

After a tender process, the mass transit associations 'Nahverkehr Rheinland' (NVR) and 'Nahverkehr Westfalen-Lippe' (NWL) and the rail-bound passenger traffic association 'Schienenpersonenverkehr Rheinlandpfalz-Nord' (SPNV-Nord) commissioned DB Regio Rheinland GmbH to operate the passenger service on the mass transit lines and to expand the rail transportation service.

"With this investment we are continuing consequently the upgrading of our train fleet. We are empowering our company for a sustainable future. This will be to the benefit of the German railway system and mostly of our customers," explained Dr. Rüdiger Grube, CEO of Deutsche Bahn.

This article can be found at <http://www.rail.co/2011/06/22/deutsche-bahn-orders-56-regional-trains-from-alstom/>

# RTSA SA CHAPTER NEWSLETTER

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NEWS - LIGHT RAIL AUSTRALIA



## PPP GoldLinQ to deliver the new Light Rail Transit system for the Gold Coast



*Bombardier Transportation will design and supply the system-wide E&M elements including 14 distinctive, modern 45 m long FLEXITY 2 Light Rail Vehicles (LRVs).*

Bombardier Transportation (BTA) announced on the 8<sup>th</sup> June 2011 in Berlin that the GoldLinQ consortium, of which is it a member, has been awarded a contract by the Queensland Government to design, build, finance, operate and maintain the first stage of the Gold Coast Rapid Transit light rail public transportation system in an 18-year Public Private Partnership.

The Gold Coast Rapid Transit system will deliver a world-class public transport service for the city. Patronage numbers are expected to grow to 50,000 per day and GoldLinQ has in-built capacity to cater for up to 75,000 passengers per day. 16 stations are planned for the 13 km light rail corridor which will serve the new Gold Coast University Hospital, Griffith University and the fast growing commercial, retail and recreational centres of Southport, Surfers Paradise and Broadbeach.

Passenger services are scheduled to start in 2014, and as this new transit mode is adopted by residents and visitors to the area, GoldLinQ is well placed to meet future demands on the service.

BTA will design and supply 14 modern 45m long Flexity 2 Light Rail Vehicles and other system-wide elements including, signalling and control systems, communication systems, electrification. In addition, BTA will provide vehicle maintenance for a period of 15 years.

BTA's Dan Osborne said that Bombardier's latest generation of FLEXITY 2 Light Rail Vehicles will support the lifestyle and mobility needs of the people and communities across the region, providing a safe, accessible, sustainable transport option, and offering the public a real alternative to car travel."

More than 1,700 FLEXITY trams are already in revenue service and overall, BTA has more than 3,500 trams and LRVs operating or on order in cities across Europe, Australia and North America. The Gold Coast Rapid Transit system is Bombardier's first order for the longer, 7-module FLEXITY 2 tram version. In another first for Bombardier Transportation, the luggage racks for the new trams have been designed to accommodate surfboards to support the Gold Coast's most popular sport in this city, which is known by many as the ultimate surfers' paradise.

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## NEWS - LIGHT RAIL AUSTRALIA

### Sydney's \$180 million light rail plan



*Sydney Council has announced a \$180 million investment to run light rail down the city's spine and clear cars out for good.*

Draft budget plans reveal the council will make its single biggest investment in a decade to give George St to the people and run trams down the city heart.

Its bold plan is to pedestrianise up to 1km of George St from Bathurst St, near Town Hall, to Hunter St, near Wynyard Station.

Lord Mayor Clover Moore yesterday promised the changes would make it easier for motorists who had to drive through the city. "Many international cities have pedestrianised roads in their city centre and these cities continue to thrive - we only have to look at New York's Broadway, London's new West End and our own Pitt St Mall to see evidence of how it works well," Ms Moore said.

"George St will flourish if we remove the traffic congestion currently choking it. We want to open up a network of vibrant lanes and small plazas that encourage shops, bars and other small businesses to thrive."

"Light rail is the solution to the gridlock in the city," Ms Moore said. "Our investment is dependent on the State Government building light rail down George St, which all our research shows is the optimal route into the city centre."

The council's investment will be spent on street scaping, signs, laneways, landscaping and traffic management works to redirect vehicles around George St.

"This is about making it easier for people who need to drive to be able to do so," she said.

"While we are looking at pedestrianising a part of George St if light rail is introduced, other easier routes will be found for motorists and buses." Ms Moore said bold changes were urgently needed to stop the gridlock gripping Sydney, which costs \$3.5 billion a year.

"Congestion is crippling our city and it's not going to get any better unless we radically rethink the way our city works and how people move around," she said. "Congestion costs are expected to more than double to \$7.8 billion by 2020 if we do nothing."

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Mark Drechsler - Geotechnical studies and track formation design for the Adelaide Rail Revitalisation Project

Here is Mark Drechsler's presentation from the joint meeting with the Permanent Way Institute

The presentation is four slides to a sheet to reduce the numbers of pages.

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## Geotechnical studies and track formation design for the Adelaide Rail Revitalisation Project

**Mark Drechsler BSc(Hons) MBA**

Technical Executive – Geotechnical  
Parsons Brinckerhoff Australia, Adelaide

**PWI/RTSA meeting**  
2 June 2011, Adelaide



## Presentation



- Project outline
- Investigation program
- Subgrade and ballast results
- Data presentation
- Mechanistic design of track formations
- Quality Control and track formation testing methods
- Challenging DTEI specifications
- Track formation design philosophy
- Project summary



## DTEI Rail Revitalisation project Adelaide SA



Core component of \$2 billion public transport investment.

Rail Revitalisation will transform the metropolitan passenger rail network by delivering a number of rail initiatives, including:

- gauge convertible concrete re-sleeping
- ballast, track formation and drainage upgrades
- electrification of the Noarlunga, Tonsley, Outer Harbor, Grange and Gawler lines
- interchange and station upgrades.



## Setting the foundation for Adelaide's Rail Revitalisation project



- Unique opportunity to upgrade and electrify the metropolitan rail network.
- Geotechnical and environmental investigations along the Gawler, Outer Harbor, Tonsley, Noarlunga and Grange lines, a total of over 100 km of rail network.



## Setting the foundation for Adelaide's rail revitalisation project



- Fieldwork began in June 2009 and the main field program was completed in December 2009.
- Safety – an absolute priority to the Rail Commissioner.
- Very important project requirements:
  - high quality fieldwork and reports
  - detailed scheduling for community liaison and field work program
  - integration of geotechnical and environmental programs
    - track formation design
    - contaminated material re-use
  - presentation of data to design engineers/client/contractors
  - client-focused team meeting changing and challenging program requirements.



## Project team safety and scheduling



- Night works – midnight to 5 am to avoid train traffic.
- Rostering – one geotech and one environment staff member working 10 nights on then two nights off.
- Scheduling was detailed and updated every day, with back-up staff and contractors on call.
- Reporting program concurrent with fieldwork, network divided into sections.



## Scope of works



- Walkover survey during the day to assess drainage, underground services and access issues.
- 700 test pit excavations through the ballast into the natural subgrade at about 100 m spacing over the network.
- 100 boreholes into the subgrade to 3 m depth at 1 km spacing to provide deeper soil profile information and soil suction data.
- Track protectors at all times
- Extensive laboratory testing of ballast, subballast and natural subgrade materials for geotechnical and environmental parameters.



## What subgrade conditions did we find?

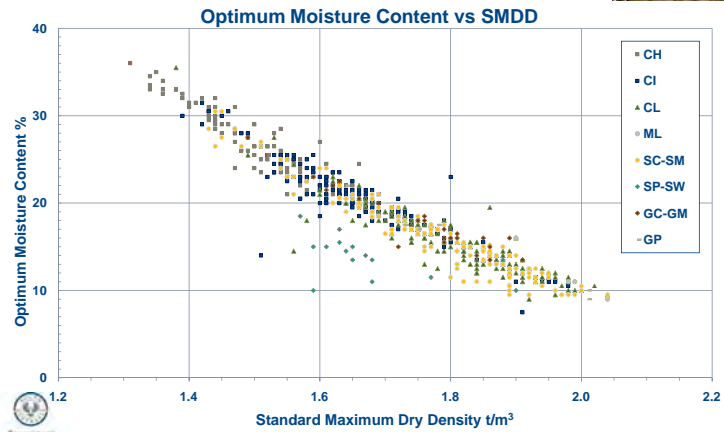


90% of natural subgrade in clayey soils.

Unified Soil Classification	Percentage of samples
CI, intermediate plasticity Clays	26%
CL, low plasticity Clays	26%
SC, clayey Sands	23%
CH, high plasticity Clays	15%
GC, clayey Gravels	4%
SP/SW, Sands	2%
GP, Gravels	1%
ML, Silts	1%
SM, silty Sands	1%
GM, silty Gravels	<1%



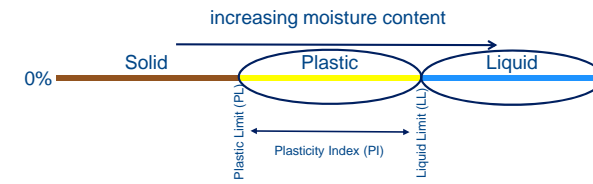
## What subgrade conditions did we find?



## What subgrade conditions did we find?



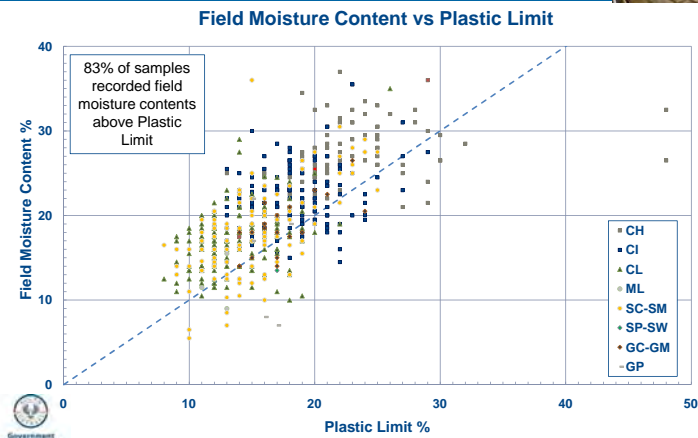
### Atterberg Limits in Clays



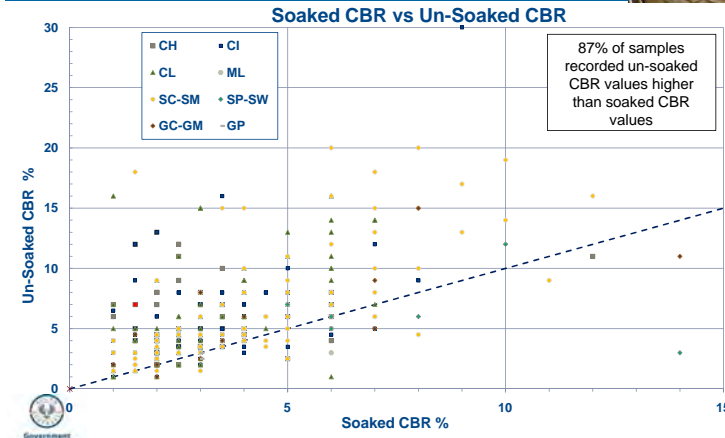
83% of field moistures higher than plastic limit of subgrade  
 1% of field moistures higher than liquid limit of subgrade  
 68% of field moistures were higher than optimum moisture contents



## What subgrade conditions did we find?



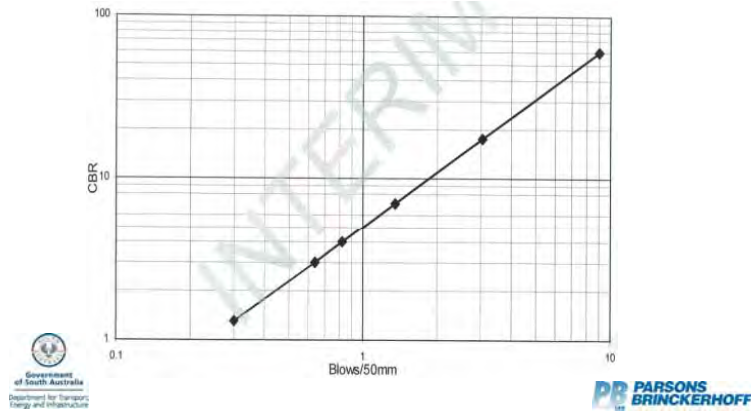
## What subgrade conditions did we find?



## What subgrade conditions did we find?



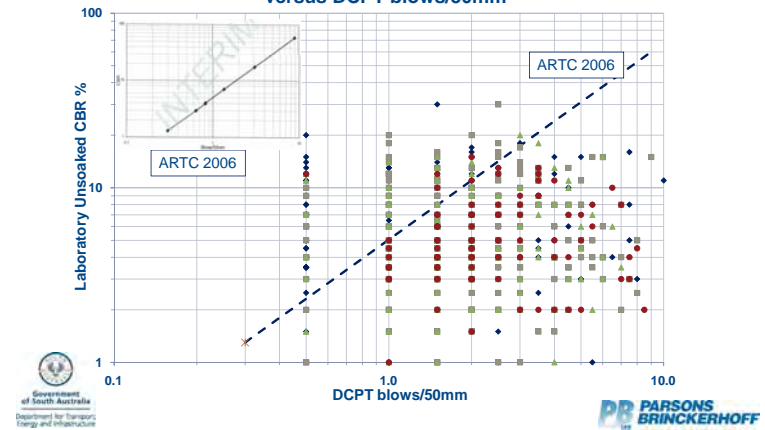
ARTC 2006 Dynamic Cone Penetrometer  
Insitu CBR Determination



## What subgrade conditions did we find?



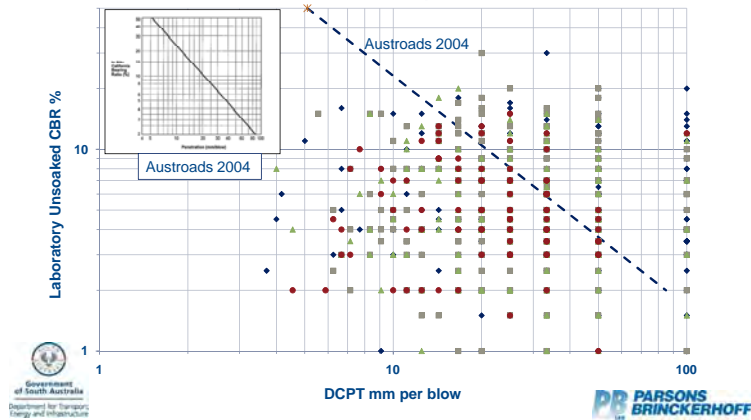
Laboratory Unsoaked CBR %  
versus DCPT blows/50mm



## What subgrade conditions did we find?



Laboratory Unsoaked CBR %  
versus DCPT mm per blow



## What subgrade conditions did we find?



89% of unsoaked CBR results higher than soaked CBR results.

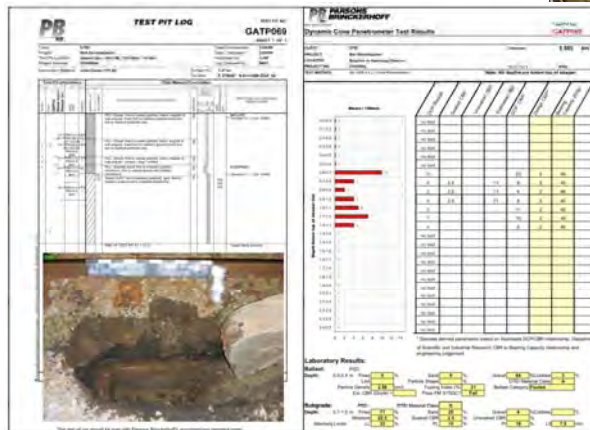
	Soaked CBR %	Unsoaked CBR %	Insitu DCPT CBR %
Average	4.1	6.3	10.2
Min	0.5	1	0
Max	35	30	75
Count	616	313	1814

DETI and ARTC track formation specifications.

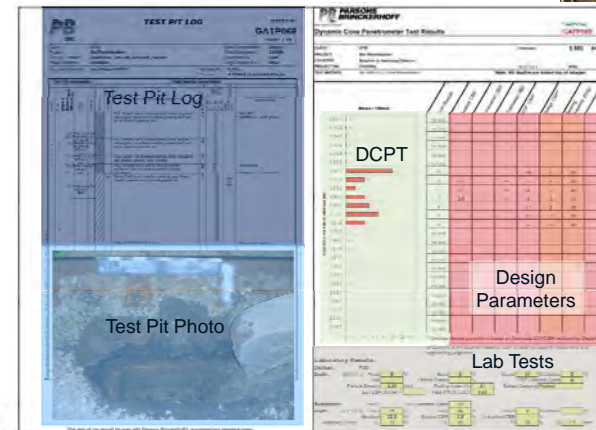
Soaked CBR Range	Track formation configuration	Soaked CBR tests
<1%	1300 mm structural fill plus 200 mm capping	5%
1% – 3%	1000 mm structural fill plus 200 mm capping	46%
≥3% – 8%	500 mm structural fill plus 200 mm capping	43%
≥ 8%	200 mm capping only	6%



## Unique geotechnical data presentation



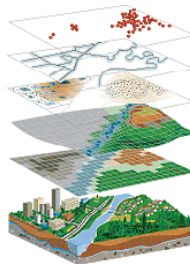
## Unique geotechnical data presentation



## GIS database



- Comprehensive GIS database provided spatial support to both field and office project team members.
- Intuitive web page style navigation menu:
  - mapping interface to both spatial and project data electronic reports
  - electronic reports.
- The database was packaged and supplied to DTEI on a stand-alone DVD.



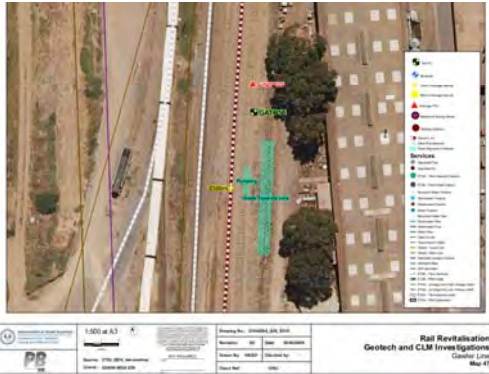
## GIS database



Valuable information source to supplement tendering information, design, construction and ongoing asset management.



## GIS database



Display of information:

- test locations
- visual inspections
- photographs
- services.

And hyperlinks to:

- logs
- photographs
- reports
- design parameters
- track conditions.

Basis of Rail Asset Management System



## Access database

Compilation of all data collected from the project and DTEI. Enables searches and queries for complex analysis.



## ECI Tracksure Soaked vs unsoaked CBR's

Current DTEI specifications based on conservative prescriptive track formation design criteria using ranges of 4 day soaked CBR values.

CBR range	Track formation configuration cut or fill embankments
<1%	1300 mm structural fill and 200 mm capping
1% – 3%	1000 mm structural fill and 200 mm capping
≥3% – 8%	500 mm structural fill and 200 mm capping
≥ 8%	200 mm capping only

Geotechnical investigations during winter determined unsoaked CBR values to be the most appropriate design parameter and DTEI specifications were challenged.

CBR range	Track formation configuration	Soaked CBR	Unsoaked CBR
<1%	1300 mm structural fill	5%	0%
1% – 3%	1000 mm structural fill	46%	20%
≥3% – 8%	500 mm structural fill	43%	60%
≥ 8%	200 mm capping only	6%	20%



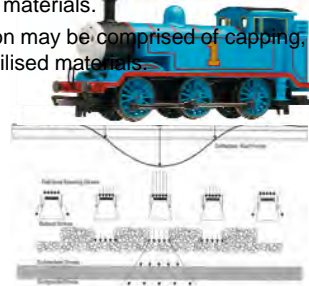
## ECI Tracksure Mechanistic design of track formation

DTEI specifications also allows for the mechanistic design of track formation by geotechnical specialists.

Eisenmann Formula used to calculate the stresses of train loads at the base of the sleeper.

Boussinesq Formula used to calculate the distribution of these loads into the underlying track formation layers, including ballast, subballast and subgrade materials.

Track formation may be comprised of capping, structural fill, retained ballast or stabilised materials.



## ECI Tracksure Mechanistic design of track formation



**Mechanistic design** to determine track formation thickness of subballast and subgrade layers:

- 250 mm ballast layer
- 21 t axle loads
- 110 kph speed
- 2600 mm broad gauge convertible concrete sleepers at 670 mm spacing
- AS47 rail
- UCL = 1 (84.1%)
- TCF = 0.2 (good)



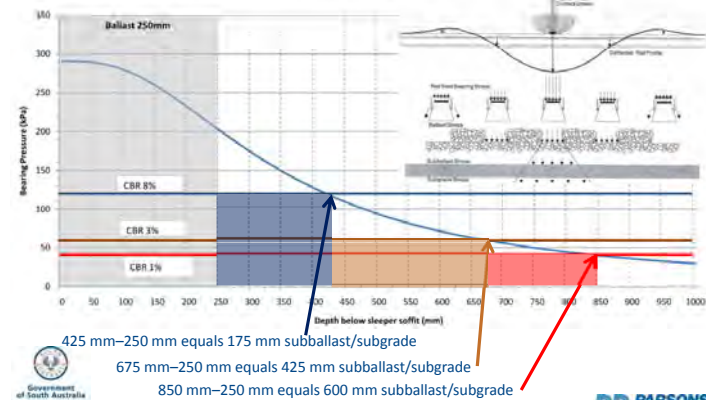
Subballast and subgrade fill layers may be comprised of capping, structural fill, retained ballast or stabilised materials



## ECI Tracksure Mechanistic design of track formation



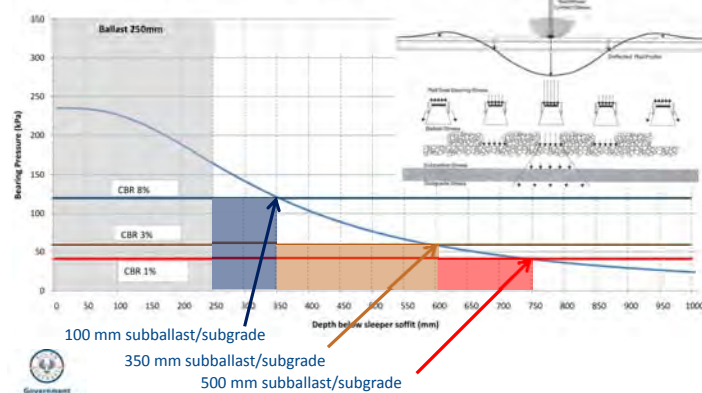
**21 t axle load scenario** Depth below concrete soffit vs bearing pressure (Boussinesq Method)



## ECI Tracksure Mechanistic design of track formation



**17 t axle load scenario** Depth below concrete soffit vs bearing pressure (Boussinesq Method)



## ECI Tracksure Mechanistic design of track formation



Comparison of current DTEI specifications to mechanistic design approach for determining track formation configuration

CBR Range	DTEI/ARTC Track formation configuration	Mechanistic design subballast and subgrade materials thickness	Potential benefits
<1%	1300 mm structural fill and 200 mm capping	900 mm	600 mm
1% – 3%	1000 mm structural fill and 200 mm capping	600 mm	600 mm
≥3% – 8%	500 mm structural fill and 200 mm capping	425 mm	275 mm
≥ 8%	200 mm capping only	175 mm	25 mm

Benefits of extensive testing and mechanistic design analysis on track formation:  
Soaked CBR 2% using DTEI specification requires 1200 mm subballast/subgrade  
Soaked CBR 2% using mechanistic design requires 600 mm subballast/subgrade  
Unsoaked CBR 4% using mechanistic design requires 425 mm subballast/subgrade.

**775 mm less subballast and subgrade materials required using unsoaked CBR values and mechanistic design – \$M benefits in rail upgrade program**

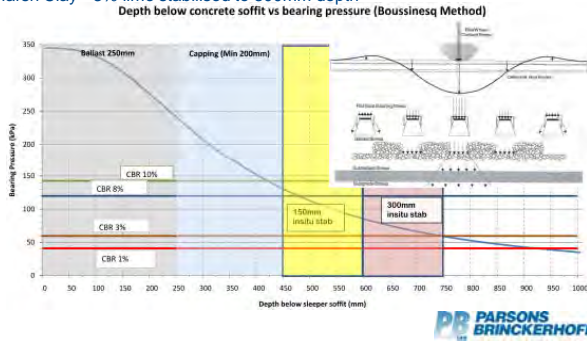


## Seaford Rail Extension Mechanistic design of track formation



Minimum of 250mm ballast layer and 200mm capping layer (CBR>50%)  
 21t axle loads, 130kph speed, 4 million gross tonnes annually, AS50 rail  
 Good track condition for 100 design life (Upper Confidence Limit of 97.7%)  
 Well drained and profiled to minimise moisture ingress into subgrade  
 Subgrade in Calcareous soils - 2% lime stabilised to 150mm depth  
 Subgrade in Hindmarsh Clay - 3% lime stabilised to 300mm depth

250 mm ballast  
 200mm capping  
 2600mm sleepers  
 AS50 rail  
 21 t axle loads  
 130 kph speed  
 UCL = 2 (97.7%)  
 TCF = 0.2 (good)



## Quality Control & Design Verification



- Reduced track formation thickness requires greater certainty by owners and designers in construction methods meeting design parameters.
- Current method 'Proof Rolling' – qualitative approach.
- Need quantitative test methods during construction to verify each layer meets design criteria.
- Research on international test methods for strength testing of fouled ballast as part of track formation upgrade program:
  - Humboldt GeoGauge
  - Lightweight falling weight deflectometer (LWFWD)
  - 20 kg Clegg Hammer



## Ballast Strength Testing Program



Light Weight Falling Weight Deflectometer (LWFWD) used in Europe to determine bearing resistance requirements (ZTVE-StB 94)

Type of route	Track Formation	Track Formation	Subgrade Types	Subgrade	Subgrade
	$E_{s1}$ N/mm <sup>2</sup>	Approx CBR		$E_{s2}$ N/mm <sup>2</sup>	Approx CBR
New line	45	30	GE, GI, GW, GU, SI, SW	35	20
City			All other soil groups	30	16
Railway			Soil stabilised with lime $\leq$ 48 hrs	35	20
			Soil stabilised with lime $\geq$ 48 hrs	40	25
			Cohesive soil improved with quick lime	35	20
Existing	35	20	GE, GI, GW, GU, SI, SW	25	12
Lines			All other soil groups	20	11
< 160 kph			Soil stabilised with lime $\leq$ 48 hrs	25	12
			Soil stabilised with lime $\geq$ 48 hrs	30	16
			Cohesive soil improved with quick lime	25	12



## Ballast Strength Testing Program



DTEI requested PB to identify the best method for insitu testing of the strength of fouled ballast under the new ballast. Several test methods trialled which may be able to verify track formation layer bearing capacities in the field.



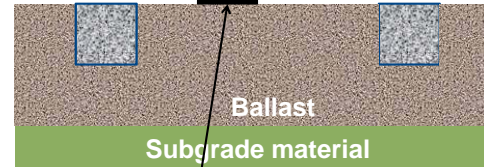
## Ballast Strength Testing Program



Lightweight Falling Weight Deflectometer (LWFWD) and Humboldt GeoGauge at five test sites



## Ballast Strength Testing Program

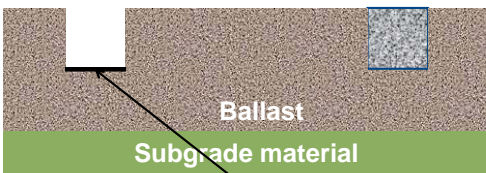


Lightweight Falling Weight Deflectometer (LWFWD) and Humboldt GeoGauge at five test sites

Test Site	Surface Crib between sleepers (kPa)
1	140-170
2	180-210
3	160-200
4	160-190
5	180-230



## Ballast Strength Testing Program

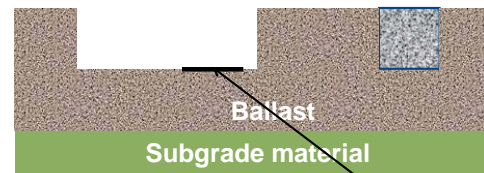


Lightweight Falling Weight Deflectometer (LWFWD) and Humboldt GeoGauge at five test sites

Test Site	Surface Crib between sleepers (kPa)	Sleeper Soffit (kPa)
1	140-170	180-220
2	180-210	200-230
3	160-200	170-210
4	160-190	160-240
5	180-230	210



## Ballast Strength Testing Program



Lightweight Falling Weight Deflectometer (LWFWD) and Humboldt GeoGauge at five test sites

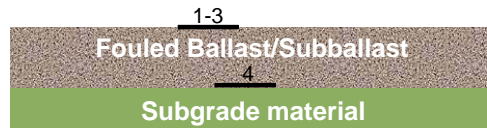
Test Site	Surface Crib between sleepers (kPa)	Sleeper Soffit (kPa)	Soffit level between Sleepers (kPa)
1	140-170	180-220	210-250
2	180-210	200-230	190-240
3	160-200	170-210	160-210
4	160-190	160-240	-
5	180-230	210	-



## Ballast Strength Testing Program



Also tested compaction of fouled ballast and subballast prior to placing new ballast



Generally prepared fouled ballast/subballast surface demonstrated lower strength than prior condition



Test Site	Base of sleeper (kPa)	Graded but not compacted (kPa)	2-3 passes CAT CS53E (kPa)	Many passes CAT CS53E (kPa)
1	180-230		170-180	
2	200-230		160-200	170-240
3	170-210	130-180	130-160	
4	160-240	70	70-100	



## Challenging DTEI specifications!!



- Subgrade CBR of 3, 500mm or 1000mm of structural fill?
- Subgrade CBR of 8, none or 500mm structural fill?
- Soaked, unsoaked or insitu CBR testing of subgrade?
- Should the capping material be less permeable?
- Structural and general fill properties reconciled against other DTEI material specifications - consistency
- Where is the quality control for subgrade, structural fill, capping and ballast material placement?
- Replace Activity Index with Weighted PI



## Track formation design philosophy



- Minimise moisture ingress into the subgrade
  - Drainage, capping, stabilisation and material selection
- Appropriate testing methods for subgrade conditions
  - Soaked versus unsoaked CBR or insitu CBR tests
- Insitu stabilisation of subgrade preferred over remove and replace
- Mechanistic design to optimise track formation
- Maximise ballast thickness
- Quality control included into construction requirements



**“A road with ballast, sleepers and rail on top”**



## Project summary



- Comprehensive geotechnical and environmental testing program over the whole rail network.
- Understanding of subgrade, ballast and drainage conditions.
- Use of extensive data to challenge conventional track formation design criteria and specifications:
  - soaked versus unsoaked CBRs
  - mechanistic design methods.
- Optimisation of the track formation that significantly reduces construction costs.
- Developing a Quality Control testing program to verify design parameters during construction.
- Challenging DTEI specifications to include all these benefits.

**Saving DTEI and taxpayers \$Ms**



## Acknowledgements



DTEI and TransAdelaide for permission to give this presentation:

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- TransAdelaide, Stephen Townsend.

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**Thank you**

