Embankment Prediction Symposium, Newcastle

History along the Pacific Highway and Decision Making

Presenter:
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Pacific Highway Upgrade:
Outline of Presentation

- Overview of upgrade
- Soft Soil Treatment (RMS approach)
- Case Studies
  - Ballina Bypass
  - Kempsey Bypass
- Client Issues
Overview of Upgrade:
Role of highway corridor

Key link in the National Land Transport Network

Service growing population centre
Overview of Upgrade: Pipeline of projects

- 660 km of upgrade over a 25 years
- Governments investing $15 billion
- 2020 target opening date for full duplication
- Dedicated RMS Program Office  “One Team Driving a Better Highway”
- Pipeline of upgrading projects:
  - last 20 years
  - pipeline of learning

Pacific Highway Objectives

- Improve traffic safety
- Reduce travel times and freight costs
- Engage the community & consider their issues
- Support economic development
- Support ESD principles
- Provide a safe workplace
- Create public value
Overview of Upgrade:

Status of Upgrading

Outcomes to date:

- 70% dual carriageway, 18% under construction & 18% being readied for construction
- Fatalities have halved
- Journey times >1.5 hrs down from 8.5 to 9 hrs (1996)....2.5 hrs by 2020
Overview of Upgrade:
Major engineering & environmental challenges

Ground treatment measures
(Ballina bypass)

3.2 km Macleay River crossing
(Kempsey bypass)

Environmental issues
(Bulahdelah bypass)

Constrained urban corridor
(Banora Point)
Overview of Upgrade:
Getting the balance right
Soft Soil Treatments: Geographic setting

- European settlement
- Sediment history
- Sediment depths
Soft Soil Treatments:

Nature of the issue

- Highway crosses many floodplains
- Underlying soils:
  - Variable in nature
  - Each project faces unique challenges
  - Low strength fluvial & estuarine clays
  - Settle under the weight of highway embankments
Soft Soils Treatments: 
Decision making processes - Techniques

- Engage the right knowledge:
  - Public sector
  - Private Sector

- Collect the right data:
  - Early & timely
  - Entire delivery process
  - Assist decision-making

- Whole-of-life approach

- Reflect on performance

- Apply learnings in the early phases of future projects

### Soft soil treatment

- Preload
- Surcharge
- Surcharge & wick drains
- Dynamic Replacement
- Stone Columns
- Vacuum Consolidation
- Deep soil mixing
- Light weight fill
- Piling
- Bridges

### Cost

### Time for result

### Post construction settlement
Soft Soil Treatments: Decision making process - Outcomes

- Strong corporate knowledge
- Robust decision making on treating soft soils
- Thinking outside the normal way of doing things
- Much earlier decision – making in project’s lifecycle
- Whole-of-life decision making

Next steps (W2B):
- Digital information system to assist more rapid decision-making
Soft Soil Treatments:
Available techniques

• **Prior to 1990 – “low and slow”**
  - Preload / Surcharge

• **Post 1990**
  - Higher embankments for flood immunity
  - Accelerated timeframe

  - Vertical wick drainage

  - High strength geosynthetics

  - Light weight (Bottom Ash) materials
Soft Soil Treatments:
Available techniques (con’t)

• Late 1990’s …..increasing availability of engineering solutions (in Australia)

  Timber piles
  Controlled modulus columns
  Deep soil mixing
  Stone columns
  Dynamic compaction
  Vacuum consolidation
  Bridging
Soft Soil Treatments:
Types of treatments

Wick drain/preload treatment
Vacuum consolidation treatment
Bridging over soft soils
Deep soil mixing treatment
Preloading/surcharging treatment
Light weight fill treatment
Soft Soil Treatments
Variability in performance

Sources of variation from prediction
• Accuracy of modelling (focus of symposium)
• Variability in ground
• Variability in loading
Soft Soil Treatments: Variability in loading

- Vertical Road Geometry
  - $S \leq 50\text{mm}$
  - $\Delta \leq 0.3\% \text{ (PCP)}$
  - $\Delta \leq 0.5\% \text{ (Flexible)}$
  - $S \leq 100\text{mm} \text{ (PCP)}$
  - $S \leq 200\text{mm} \text{ (Flexible)}$

- Transitions
  - Flexible or rigid pavement
  - Controlled settlement
  - Flood levels
  - Road design
  - Construction programme

Figure 3 - Wong and Summerell (2012) Settlement and Differential Settlement Criteria for Highway Projects, AGS (Sydney Chapter) Symposium on Advances in Railway and Road Engineering
Soft Soil Treatments
Variability in ground

- Type location
- Boundaries
- Across site
Case Study:

Richmond R/ Emigrant Ck Crossing, Ballina Bypass
Case Study No.3:
The Ballina Bypass Story - Background

- 12 km bypass of Ballina & Tintenbar Hill
- Major congestion point during peak traffic periods
- Traffic accidents/ incidents on Tintenbar Hill
- Community pressure for an early bypass
- Located in Richmond River flood plain:
  - Flood immunity of 1 in 20 ARI
  - Very deep and variable soft soils (up to 30 metres)

- Delivered in stages:
  - 2006  Early works on critical soft soils
  - 2008  Main works via an alliance
  - Late 2011  Bypass opened to traffic
  - Mid 2012  Completed
Case Study No. 3: The Ballina Bypass Story - Process

- Overall delivery strategy:
  - Enabling works
  - Alliance for main construction
- Engaged experts from private and public sector at various phases
- Whole-of-life decision making
- Providing best balance/ positive tension between:
  - Capital cost of construction
  - Timely opening to traffic
  - Settlement performance/ obligations post-opening:
    - 0 to 1 years  Alliance
    - 1 to 10 years  Project (RMS)
    - > 10 years  Assets (RMS)

Granular pavement under construction, Ballina Bypass (2011)
Case Study No. 3: The Ballina Bypass Story - Outcome

- For similar cost to base case, delivered:
  - bypass six months earlier
  - reduced overall construction period by 50% to 6-7 year timeframe
- Good community feedback on overall outcomes
- Whole-of-life decision making with accountabilities:
  - 0 to 1 years  Alliance
  - 1 to 10 years  Project (RMS)
  - > 10 years  Assets (RMS)
- Secured funding to complete Pimlico to Teven final stage:
  - Stage 1........complete
  - Stage 2........under construction
  - Stage 3........part of Woolgoolga to Ballina
Case Study No. 3: The Ballina Bypass Story - Learnings

- Convinced our funders to allocate & seek funding for early time critical works
- Value testing right through the entire delivery process
- Used a whole-of-life approach
- Engaged the right knowledge:
  - Public sector
  - Private sector
- Applied learnings to future projects & at a much earlier stage in a project’s lifecycle
## LES Pavement Strategy

<table>
<thead>
<tr>
<th>Year</th>
<th>Staged Pavement: Required Maintenance / Pavement Improvement Interventions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Construction</td>
<td>300mm chert pavement with spray seal wearing surface</td>
</tr>
<tr>
<td>0-1</td>
<td>Repair any initial defects and settlement</td>
</tr>
<tr>
<td></td>
<td>(Allow 0.25% surface area)</td>
</tr>
<tr>
<td>1</td>
<td>Apply Asphalt wearing surfacing</td>
</tr>
<tr>
<td>2 to 10</td>
<td>AC correction 10% (allowance)</td>
</tr>
<tr>
<td>8 to 10(^{#1})</td>
<td>100mm overlay (Chert or Asphalt)</td>
</tr>
<tr>
<td>30</td>
<td>Replace wearing surface including settlement correction (100mm) plus 1% heavy patching</td>
</tr>
<tr>
<td>40</td>
<td>Salvage</td>
</tr>
</tbody>
</table>

- **2011 / 2012**: 10m² patching 0.01% surface area
- **2012**: Correction with Overlay 3000m² correction 3% surface area
- **2015 YEAR 4**
- **2021 YEAR 10**
Location of LES

Figure 1 - Sketch Showing Design Settlement Zones Away from Structures
• Northbound (MC10)
• MC10 Chainage 126798 – 127188
• Max settlement to date – 310mm
- Northbound (MC10)
- MC10 Chainage 127358 – 127925
- Max settlement to date 120mm
Case Study:
Macleay R Crossing, Kempsey
Case Study No.4: The Macleay River Crossing Story – Background

- Preferred highway route to east of Kempsey:
  - 4.5 km crossing of Macleay River & floodplain:
    - 3 bridges / 2.2 km of opening
    - 2.3 km of embankment on deep & variable soft soils
    - ongoing community concerns about building an embankment in the floodplain
- Delivery phase was ‘fast tracked’:
  - $618 million from BAF
  - ‘start something’ by Dec 2009
  - must open by mid 2014
- Chosen delivery model:
  \[ \text{Alliance} + \text{D&C Contract} \]
  - Preliminary design & roadworks
  - Macleay R. bridges

Sample bridge length vs flood level impact (2004)
Case Study No. 4: The Macleay River Crossing Story – Decision Making Process

Requires ongoing performance accountabilities post opening

Alliance

D&C contractor

D&C Contract

Scope

Q (Project Control Group)

+ive tension

Legacy

Hard Ground Treatment

Soft Ground Treatment

Bridge Extension
Case Study No. 4: The Macleay River Crossing Story – Outcome

- Longer waterway opening & higher bridge
- Opened bypass 1.25 years earlier & within budget
- Very satisfied community & removed a perceived risk
Case Study No. 4: The Macleay River Crossing Story – Learnings

- Created environment to drive other innovations:
  - temporary levee to allow early access to floodplain
  - increased vibration & pressure limits in rock cuttings
  - bridge designed and built as a “manufacturing site”
- Created tension between public and private sector to drive better public value
- Strength of PCG to timely decisions
- Apply decision making process to other projects:
  - Nambucca River Crossing
  - Shark Ck Crossing
Clients issues

- Real

- Communicated ?????????
Client Issues (con’t)

- Risk appetite of client
  - Aggressive?
  - Conservative?

- Impacts Decision Making
  - $ Capex
  - Program
  - Time
  - Operational
  - Maintenance
  - Road User costs and benefits
CWhat are the issues faced by clients?  

Accuracy of predictions  
- Project stage  
- Communicated ????  
- Parameter selection  
- Risk profile / risk appetite of client
Client Issues

Performance requirements

Pavement Type

- Rigid – Residual Settlement < 100mm
- Flexible - Residual Settlement < 200mm ??

Total Residual Settlement which is defined as the total amount of settlement of the pavement, at any location on the pavement surface, that occurs in the period from the completion of pavement construction until the date which is the minimum Design Life of the pavement
More Information

RMS:
Pacific Highway Office
Ph. 1800 653 092 or Ph. 6640 1000