Using profiles to measure subsidence caused by longwall mining

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Overview

• Background
  – The Hume Highway
  – Longwall coal mining
• The issue
• Monitoring
• Profile evaluation
• Conclusions
Background - the Hume Highway

- Main thoroughfare between Melbourne & Sydney

- Length: 887 km
- 20 million tonnes of road freight annually
- > 39,000 vehicles per day
- 26% heavy vehicles
Bushrangers - Ned Kelly

“Such is life”
Background - longwall coal mining
Background - longwall coal mining
The issue – mining under highway
The issue - subsidence

- **Surface Zone**: Variable - mostly not detected due to presence of weathered surface layer or alluvial deposits. Surface effects only noted in areas with small depth of cover.

- **Constrained Zone**: Thickness varies depending on depth of cover.

- **Fractured Zone**: 21t - 33t depends on depth of cover and geological factors.

- **Caved Zone**: <10t (probably about 5t)

- **Goaf**: Coal Extracted - Thickness = t
## Predicted subsidence

<table>
<thead>
<tr>
<th>Stage of mining</th>
<th>Predicted subsidence (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>After longwall 702</td>
<td>&lt; 20</td>
</tr>
<tr>
<td>After longwall 703</td>
<td>703</td>
</tr>
<tr>
<td>After longwall 704</td>
<td>1076</td>
</tr>
</tbody>
</table>
Predicted impact

• A step or hump from compressive failure of the bound sandstone sub base
Solution - expansion slot

100mm AC (2 x 50mm LAYERS)
150 - 200mm SLAG PAVEMENT
300mm (NOMINAL) BOUND SANDSTONE UP TO 400mm DEEP

3 LAYERS AC14 HEAVY DUTY APPLICATION AR450 BINDER, PAFV > 48mm.

2 LAYERS AC14 HEAVY DUTY APPLICATION AR450 BINDER, PAFV > 48mm.

500mm WDE, 18mm THICK FIBROUS CEMENT SHEET.

MINOVA "CARBOFILL" OR APPROVED EQUIVALENT

50mm

450mm DEEP

CENTRELINE

TYPICAL CROSS SECTION OF PAVEMENT SLOTS

NOTE: PAVEMENT SLOT TO BE ANGLED 80° TO ROAD CENTRELINE ALIGNMENT.

NOTE: SLOT EXTENDS FOR FULL PAVEMENT WIDTH.
Expansion slots
Monitoring - meetings and reports

Small bumps in subsidence profile near Pegs E041 to E045.

Sustained irregularity at Pegs E065 and E066: High compressive strain with small bump.
Subsidence monitoring

- rod and level
- slot displacement
- visual surveys
- regular measurement of surface profile
Profiler analysis

• Aim: compare consecutive profiles and look for change
• Problem: long wavelength drift
Long wavelength drift

![Graph showing long wavelength drift](image)
Solution – high pass filter

![Graph showing elevation changes over distance](image-url)
Data collection

- Length: 2300 metres
- Fixed control points
9 step analysis methodology

1. Generate ERD files
2. Identify reference features in profiles
3. Adjust sample interval
4. Align profiles using auto-correlation function
5. Crop profiles (start and end)
6. High pass profiles
7. Flip profiles in counter direction
8. Interpolate sample interval to match
9. Subtract profile from original profile
2. Identify reference features
### 3. Adjust sample interval

<table>
<thead>
<tr>
<th>Date</th>
<th>Start (m)</th>
<th>End (m)</th>
<th>Length (m)</th>
<th>Difference (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8/06/2010</td>
<td>953.5429</td>
<td>2160.1797</td>
<td>1206.6368</td>
<td></td>
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<tr>
<td>22/10/2010</td>
<td>951.9143</td>
<td>2159.3450</td>
<td>1207.4307</td>
<td>0.79390</td>
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</tbody>
</table>
4. Profile alignment

<table>
<thead>
<tr>
<th>Maximum Correlation (%)</th>
<th>73.0</th>
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<tbody>
<tr>
<td>Relative Offset (m)</td>
<td>-1.0429</td>
</tr>
</tbody>
</table>

Correlation (%)
5&6. Crop and highpass filter profile

![Graph showing elevation changes over distance](image-url)
8. Interpolation
9. Differences
9. Differences
Identify slot location and size
Possible improvement to system

- Use of IMU to adjust long wave length drift
Conclusions

• Variations > 10 mm identified
• ProVal was essential to the process
• Better to know where the bump will develop rather than measuring it after the fact
• Technique could be improved by incorporating long wavelength profile measurement capability
The things you see.......
Thank you