# Oxford Street, Epping – Pavement rehabilitation using foamed bitumen stabilisation

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**Summary**

Insitu stabilisation is a proven process for rehabilitation of old, failed road pavements. Typically, the process offers a low cost, fast and environmentally friendly solution in comparison to other options.

Foamed bitumen stabilisation offers additional benefits in certain cases to traditional cementitious stabilisation, by producing a "low order asphalt" with flexible pavement characteristics as well as increased strength. These are of particular value where existing pavements are thin.

Follow up testing and visual inspections at this site (Oxford Street, Epping in Sydney, NSW) demonstrate the potential value of utilising foamed bitumen stabilisation which, in this case, has successfully bridged poor subgrade conditions in a busy street, despite experiencing compaction difficulties, a common occurrence at such sites.

## 1 INTRODUCTION

The foamed bitumen stabilisation process has rapidly gained acceptance among road managers in recent years. The process creates a "low order asphalt", with similar flexible pavement characteristics to asphalt. In effect, it creates asphalt using the existing pavement materials instead of graded aggregates.

The reasons for utilising foamed bitumen stabilisation may be many and varied, but the greatest benefits are generally gained in cases where the existing pavement is too thin to rectify with cementitious stabilisation. Alternatively, it is a cheaper option in cases where asphalt might be desired but is prohibitive for budgetary reasons.

While technical information regarding the process is now widely available, performance data from the more recently completed projects that have been carried out with the latest generation technology (around 1997 onwards, in Australia) is limited. Follow-up core sampling at one site has provided a real case insight into the process and has allowed us to make a more informed assessment of the performance of this process.

## 2 SITE

Oxford Street, Epping is within the upper north shore shire of Hornsby, in northern Sydney, New South Wales (see Figures 1 and 2). The street is near a railway station and is thus quite busy, with traffic consisting of mostly light vehicles. Measured traffic volumes at this site were not available.

The section stabilised is between Surrey Street and Chester Street. The site was around 1800$m^2$ in size, stabilised with 3.5% bitumen and 2% hydrated lime to 175 mm depth.

**Figure 1** A view of Oxford Street after project has been completed.

**Figure 2** A view of Oxford Street near the roundabout.

## 3 PRE-CONSTRUCTION TESTING & INVESTIGATION

Pre-construction investigation works were carried out by geotechnical consultants. A summary of the findings are detailed in Table 1.

**Table 1** Existing pavement depth and subgrade strength at site prior to stabilisation.

| Borehole No | Pavement Depth (inc AC) | Subgrade CBR Value |
|---|---|---|
| 1 | 90mm | 10% |
| 2 | 290mm | 2-5% |
| 3 | 180mm | 5-7% |
| 4 | 370mm | 6-10% |
| NOTE - Boreholes 1 & 2 where located outside the area stabilised. | | |

From the above information, it was assessed that there was as low as 180mm of pavement in some locations, and that areas of poor subgrade were likely to be encountered during construction.

## 4 DESIGN, INCLUDING FOAMED BITUMEN STABILISATION MIX DESIGN

A sample of the pavement basecourse material was tested for suitability for foamed bitumen stabilisation. Appendix 1 shows details, including indicating that a mix design of 3.5 % foamed bitumen and 2% hydrated lime would yield resilient modulus values of 1,762 MPa for a wet (soaked) sample and 2,982 MPa for a dry sample. The generally accepted criterion is that the soaked sample needs to exceed 1,500 MPa. Also, the ratio of wet to dry modulus values should also be considered.

The decision regarding design depth in this case was determined by the available pavement thickness. Whilst more investigation and detailed design work could have been carried out (for instance, accurate traffic loading data was not available), the design was assessed and considered acceptable on the basis of estimated design values. Intuitively, it is also reasonable to assume that a stabilised pavement of similar thickness to the unbound original would offer an acceptable pavement life.

A nominal 30 mm thick AC wearing surface completed the design.

## 5 CONSTRUCTION

Stabilisation works were carried out in October 1998. The process was carried out in two stages. Firstly, a road profiler was used to premill and remove excess material in order to achieve final levels (to match existing kerb and gutter). Utilising a specialist profiler, materials were blended to depth at the same time as removal of surplus material, resulting in most of the original surfacing material being retained within the pavement. Secondly, the foamed bitumen stabilisation process was carried out. Council undertook final AC surfacing works.

At the time of construction, SPA records show that there was some movement and cracking in the completed pavement (post stabilisation, trimming and compaction, before application of surfacing). This was attributed to the poor subgrade detected during pavement investigation works above.

Compaction testing indicated some low compaction levels at the bottom of the stabilised layer. One reading was as low as 97.5% standard compaction. Given the indication of poor subgrade, these are not unexpected results for compaction, reflecting the difficulty in compacting any pavement against a soft underlying material.

No action was taken in regards to these movements at this time. As is often observed in such cases, the stabilised pavement "tightened up" over the coming hours and days, bridging the subgrade without failing to the extent of requiring rectification, such as digging out to greater depth and backfilling with suitable material. There was no ongoing problem and final surfacing was applied to the pavement.

## 6 SITE INVESTIGATION AND CORING

In March 2003, as part of an AustStab initiated investigation program, this site was revisited for removal of core samples. Six samples were removed from the pavement by a dry coring process. Three cores were removed from within the wheel path areas of pavement, and a further three cores from between wheel paths.

When the samples were extracted, the bottoms of the cores were difficult to remove/obtain. Material at this depth showed a tendency to crumble and fall apart. This further indicates the lack of compaction achieved at the bottom of the stabilised pavement layer. The possible influence of the dry coring process, however, which created vibrations at the bottom of the core cannot be ruled out from influencing this.

The pavement appeared to be in good condition in March 2003 at the time of coring. The site was found to be in a similar condition when inspected again in early 2004, over five years after rehabilitation works were carried out.

## 7 TESTING OF CORES

Results of testing of core samples is presented in Appendix 3.

Resilient modulus results further indicate low compaction at the bottom of the stabilised layer through the lower strengths recorded here.

Resilient modulus values also indicate that strengths achieved at the top of the pavement layer were well in excess of those determined in the laboratory pre-construction. They not only exceeded the more conservative wet sample strengths, but well exceeded the dry sample strengths also. This indicates a significant strength gain that continues with time in the field.

## 8 CONCLUSIONS

Results of investigation works and visual assessment indicate that the application of a pavement solution based on foamed bitumen stabilisation of the existing basecourse has proven highly successful in bridging a poor subgrade with a relatively thin pavement layer.

Testing of cores extracted indicate that, due to poor subgrade conditions, an ideal level of compaction was not achieved, leading to lower strengths achieved at the bottom of the pavement.

This, however, merely serves to underline how effective foamed bitumen stabilisation has been at this site in still being able to withstand the traffic loading applied, and the corresponding stresses induced due to the poor subgrade.

Additionally, other alternatives are unlikely to have brought the same benefits. Although arguable due to the lack of sufficient design details, cementitious stabilisation, while being cheaper, may not have been successful at this site due to being too thin and rigid. Conventional granular reconstruction would have been far more costly and taken much longer to carry out while losing the significant environmental benefits of stabilisation processes.

Should the subgrade at this site have been even poorer, preventing any method of basecourse stabilisation being successful, an approach that may have been possible at this site, again subject to a complete formal design, is lime stabilisation of the soft subgrade material, either with or without stabilisation of the basecourse. This option would also still be cheaper than conventional granular reconstruction.

# MOBIL OIL AUSTRALIA

FAXED 28/09/98

**R & D Bitumen Laboratory** **MIX DESIGN REPORT**

44-76 Simcock Avenue SPOTSWOOD VIC-3015

REPORT NO. RP 98/ 0144 CUSTOMER: Stabilised Pavement of Australia

DATE: 28/09/98 Lab sample no: 98/0205

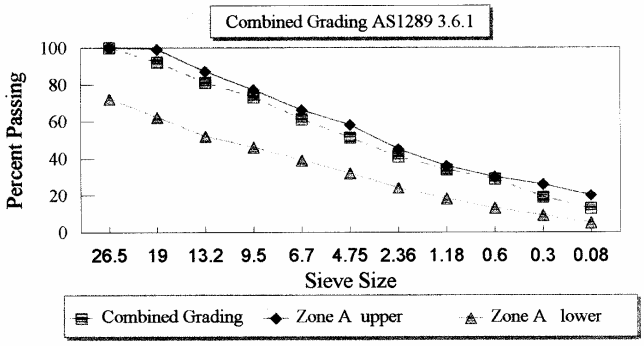
**SAMPLE MATERIALS:** **SPA 101 & 102 ( sampled by customer)**

Brown - Grey coloured, granular material with some asphaltic material, some low quality aggr and coarse to fine non - plastic sand. Containing approximately 16.0% macadam above size 26.:

**MIX DESIGN: Combined Sample + 2% Lime + 3.5% Foam bitumen.**

**Plasticity Index(%) = 0**
**AS 1289 3.3.1**

| Sieve Size | % Passing |
|---|---|
| 26.5 mm | 100 |
| 19.0 mm | 92 |
| 13.2 mm | 81 |
| 9.50 mm | 73 |
| 6.70 mm | 61 |
| 4.75 mm | 51 |
| 2.36 mm | 41 |
| 1.18 mm | 34 |
| 600 µm | 29 |
| 300 µm | 19 |
| 150 µm | 14.2 |
| 75 µm | 12.6 |




| | |
|---|---|
| **BINDER CONTENT AND TYPE** (Including foamant and anti-strip) | **3.5 % C170(including 1.1% bitumen additives)** |
| **OPTIMUM MOISTURE CONTENT AS 1289 5.2.1** (With above binder content) | **7%** |
| **COMPACTION AS 2891 .2.2 No. OF GYRATORY CYCLES** | 85 |
| **CONDITIONING TIME - DRY** | 3 days @ 60°C in an oven |
| **- Wet** | One hr in water under vacuum (-98kpa) at 25°C |
| **DENSITY - DRY (T/m)³ AS2891.9.3** | 2.00 |
| **(at OMC ) - WET (T/m³)** | 2.14 |
| **MODULUS (MPa) AS2891.13.1** | |
| - DRY | **2982** |
| - WET | **1762** |
| - RATIO (WET/DRY) | **0.59** |

Sample History : Air dried sample
Wet sieved AS 1289.3.6.1
Liquid Limit AS 1289.3.1.2
Plasticity Index AS 1289.3.3.1
Soil compaction and density test AS 1289.5.2.1
Compaction AS 2891.2.2
Resilient modulus AS 2891.13.1

Approved signatory R. Gao
R Gao

SPA98144.WK4 28/09/98

**APPENDIX 2 – Core samples**

## APPENDIX 3 – Laboratory report for tested core samples

**SPA Foamstab Cores - April 2003**

| Core Location | Core layer | Resilient modulus, MPa (25 deg C and 40 ms) | Moisture content % |
|---|---|---|---|
| 1 - Between Wheel Path (Centre) | 1 (Top) | 7,313 | 3.8 |
| Average | | 7,313 | 3.8 |
| 2 - Wheel Path (Centre) | 1 (Top)<br>*2 (Bottom) | 4,717<br>374 | 3.8 |
| Average | | 2,546 | 3.8 |
| 3 - Between Wheel Path (North) | 1 (Top)<br>2 (Bottom) | 3,117<br>1,353 | 4.0 |
| Average | | 2,235 | 4.0 |
| 4 - Wheel Path (North) | 1 (Top)<br>2 (Middle)<br>3 (Bottom) | 3,540<br>4,331<br>1,747 | 4.2 |
| Average | | 3,206 | 4.2 |
| 5 - Wheel Path (South)* | 1 (Top)<br>2 (Bottom) | 3,256<br>1,834 | 3.7 |
| Average | | 2,545 | 3.7 |
| 6 - Between Wheel Path (South) | 1 (Top)<br>2 (Bottom) | 4,304<br>1,632 | 4.2 |
| Average | | 2,968 | 4.2 |

**Core makeup:**

- 30 to 50 mm of Asphaltic Concrete (AC) on about 145 to 220 mm of Foamstab material
- The AC was removed and the Foamstab core was cut into two layers.

*Sample was cracked.

[END]