

# Deep Lift Insitu Recycling Construction Phase<sup>1</sup>

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## 1 INTRODUCTION

Recent developments in stabilising equipment have allowed for insitu mixing of pavement materials and binder to the full depth required for heavily bound pavements. This is usually in the order of 350 to 370 mm. The Bega District Office has, to June 1994, completed 71 km of deep lift Insitu work. It is planned to complete another 45 km of insitu stabilisation in the 1994/95 financial year.

The Bega District Office area has been affected by the ever decreasing availability of reasonably priced DGB 20 material suitable for overlays. One of the real advantages has been the ability to use inexpensive natural gravels which contrary to DGB 20 supplies, are readily available. Hence, shape correction work is able to be completed for relatively small costs of between \$3.00 to \$6.00/m<sup>2</sup>.

These natural gravels are also invariably suited to the slow setting additives that Bega District continues to use. These additives allow for adequate mixing, compaction and trimming time so as to produce average roughness counts of 36 counts per kilometre. Well below the specified value of 50 counts per kilometre.

These results are attributable not only to the use of slow setting additives but also the implementation and improvement of Quality Systems and Quality Assurance procedures. In conjunction with Wollongong Zone Office, a Quality Assurance specification has been developed which includes a locally modified version of Part R253.

Bega and Cooma Works Depots have developed and are using Project Quality Plans. These have been developed in accordance with Australian Standard AS3902 and the Wollongong Zone Quality Manual.

## 2 PRE-PLANNING REQUIRED

### 2.1 Survey work

Prior to insitu work commencing, a survey of the existing road formation is required. This is done at 20 metre intervals with the centreline and both edge lines being surveyed. At the same time, the location and depths of all culverts are recorded to determine whether there is sufficient cover over the culverts. The location and depth of all Public Utilities are also determined.

### 2.2 Road Design

The Road Design Officers are given the survey information and via PAVEMOSS produce a set of new levels which allow for shape correction of the road and suitable cover over culverts and any identified rock bars. In general, traffic lane widths of 3.5m and shoulders of between 0.5m to 1.2m have been specified in the design stage.

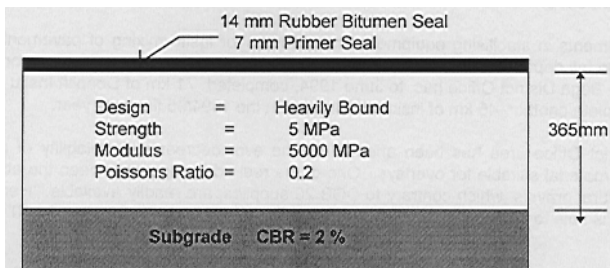
### 2.3 Existing Asphalt Patches

An inspection of the road pavement is required to determine whether there are asphaltic concrete patches - anything greater than 100 millimetres in depth will cause the RS500 to slow down and introduce wet spots. It is advised that prior to work commencing these patches be removed and replaced with suitable gravel - compatible with the additive proposed to be used.

### 2.4 Pavement Design.

The pavement design adopted for the deep lift insitu stabilisation work is shown in Figure 1.

<sup>1</sup> From **Workshop on Pavement Recycling Technology** RTA Technology Development Branch, Canberra, October 1994.



**Figure 1** Pavement design for deep lift insitu stabilisation.

### 2.5 Source of Water Supply

During the insitu stabilisation process, the mixer will require up to 5 water tanker loads each day, that is, 75,000 Litres depending on the moisture required in the pavement, so it is necessary to determine the location and quality of the water source for each job to be undertaken.

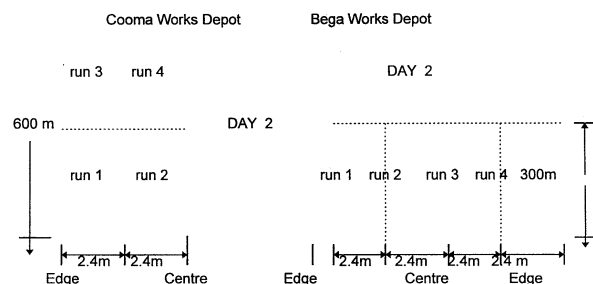
## 3 SPREADING OPERATION.

The spreading of the additive in the Bega District is carried out by bulk spreaders with a minimum capacity of 16 T of stabiliment and equipped with calibrated load cells. The minimum requirement for the spreader is necessary to minimise refill times and to cater for bulking of lower density additives. Now that the lime spreaders are being equipped with calibrated load cells, the ability for the operator to adjust drop rates on the run has improved the spreading operation. The operator is able to constantly monitor the drop rate as he knows the amount of product that is required to be placed over 20 metres and so checks at every survey peg that the tonnage is correct (refer to Figure 2).

The amount of additive incorporated into the existing pavement material in the Bega District has been generally 5% by weight, which has meant that the total spread rate required is around 37 kg/m<sup>2</sup>, assuming an existing pavement density of 2.0 T/m<sup>3</sup>. Due to operational problems of spreading and mixing this quantity of additive in one step, the additive is spread in two passes by the spreader.

Prior to spreading the additive, the edges of the stabilising run are marked with paint, from the surveyors pegs which are offset at a known distance from the centreline, to guide the spreader.

The additive is spread over runs 1 and 2 initially at approximately half the total spread rate, that is, 19 kg/m<sup>2</sup> and is sprayed with water from a water cart with a side spray to "wet" the product and inhibit its movement due to wind, plant movements and during the mixing process. Once the additive is dry mixed with the stabiliser, a single pass of a padfoot or smooth drum roller is then used to flatten the surface for the spreader to drive over. The remaining additive (18 kg /m<sup>2</sup>) is then spread over runs 1 and 2 (refer to Figure 2). The spread rate is then checked, run by run, from the spreaders load cell readings and tray tests to confirm that the actual spread rate is within 10% from the nominated spread rate. The stabiliser and the water cart then mixes the remaining additive down to the full depth specified. The same spreading procedure is followed for runs 3 and 4.



**Figure 2** Diagrams of typical spreading and mixing operation.

[Note: 1. Daily Outputs of 2,800m<sup>2</sup> are currently being achieved. 2. 110 Tonnes of additive are required each day. (5 tankers of 22T).]

The spreading and watering of the additive creates a dust cloud which requires the traffic to be stopped temporarily for safety reasons. These include the problem of the traffic being baulked by the cloud and the dust entering vehicles and causing potential claims for respiratory problems or the fact that the dust has settled in or on the vehicle causing claims for cleaning of vehicles.

The different additives used by Bega and Cooma to date are listed in Table 1.

**Table 1** Additives Used In Bega/Cooma.

Blend	Ratios	Binder constituents
Triple Blend	30 / 50 / 20	Slag / Lime / Flyash
Blend	50 / 50	Slag / Lime
Blend	60 / 40	Slag / Lime
Blend	85 / 15	Slag / Lime
Triple Blend	45 / 45 / 10	Slag / Lime / Calcium Chloride

The 85/15 additive has been found to be the most easily loaded and more accurately spread due to the density of the additive. However, in a normal production day of around 110 tonne of product, the extra delays due to loading/spreading may only total 1 hour. In order of manageability the additives rank as follows:

85/15	Slag / Lime
60/40	Slag / Lime
50/50	Slag / Lime
30/50/20	Slag / Lime / Flyash
45/45/10	Slag / Lime / Calcium Chloride

The use of hydrated lime in Bega has meant that the claims for damage due to lime on vehicles can be deflected on the grounds that the lime is alkaline and causes no damage to paint work nor does it cause rusting and all that is suggested is that people hose their vehicle. In the twenty months that Bega has been using this technique, we have been able to contain claims to around five in this period and all of these have been for minor problems only.

Bega Works Depot has also trialed the use of a blend of 45/45/10 lime/slag/calcium chloride where it was found that organic matter in the pavement was slowing/inhibiting the setting of the mix. This trial had difficulties in that it was found that the bulk pressurised tankers used to transport the additive was not appropriate for this blend. Also unloading into the spreader and then trying to spread the material was equally as difficult.

However, in the section where we were able to spread some of the additive, the UCS results have proven to show far greater strength gain than the rest of the pavement. Because of this, further trials will be undertaken with the product being transported in pallets with plastic liners and

unloaded into the spreader by fork lift or by dissolving the calcium chloride into the water in the water cart and adding it to the mix as part of the wet mix with the RS500. This will occur sometime in the future and will need to be looked at for cost effectiveness.

#### 4 MIXING OPERATION

The RS500 stabiliser carries out in the mixing in two passes due to the need to spread 37 kg/m<sup>2</sup> of additive in two passes and to obtain adequate mixing. The mixer makes two passes for each run;

- The first mixer pass is carried out at a depth of between 260 to 300 mm. The first mixer pass is a dry mix carried out by the RS500 alone. It mixes 19 kg/m<sup>2</sup> of additive into the pavement material in a dry state, without the addition of water.
- The second mixer pass is a wet mix where the water cart is connected to the RS500 and the water is sprayed onto the mixture in the mixing chamber via nozzles in the mixing chamber. The second mixer pass is carried out at a full depth of 390 mm in which the remaining 18 kg/m<sup>2</sup> is mixed into the pavement. This depth takes into account the bulking factor of the decomposed natural gravel.
- A third dry mixing pass at full depth may be required in some materials. This is especially the case in materials with high clay contents as this final pass allows better moisture distribution and therefore prevents "wet spots" from occurring.

The mixer drum is 2.4 metres wide and an overlap of approximately 100 mm is required to ensure that there is no unstabilised material between the runs. This is assured in the field by marking the edge of the runs, after each spread of additive, from the surveyors pegs every 20 metres. The total mixed width, allowing for overlaps, is 9.3 metres.

The depth of stabilisation is determined by digging a hole after each full depth mixer pass and using a stringline to determine the depth to the bottom of the hole. At the end of the day following compaction, a stringline is used at the same recorded location to determine the depth to the top of the compacted stabilised layer. The depth of the stabilised layer is

the difference between the two readings prior to trimming. Following final trimming, the stringline is used to determine the depth to the top of the finished surface, which will determine the thickness of the trimmed layer. The actual thickness of the trimmed layer should be within the allowable range of 355 mm to 405 mm.

It is essential that the moisture content behind the mixer for the second pass be continually monitored by digging a hole and feeling the mix because if it proves to be too wet, then you need to remix as this is the only option to remove wet areas. Due to the depth of material it is nearly impossible to remove the moisture from the bottom of the layer without remixing. Generally, to achieve compactions required, the field moisture have been in the range of 2 - 3% below field optimum moisture.

The process of monitoring the moisture must be done at regular intervals on every run as existing pavement materials may vary significantly in any one pass. This may be due to gravel patches in the pavement or different sub-grade materials being present under the pavement.

The use of slow setting additives has allowed the stabilised pavement to be remixed within 48 hours without any additional additive due to rain damage, lack of compaction or wet areas. At present, if reworking is to be carried out after 48 hours an additional 1% additive is added prior to remixing.

The spreading and mixing process is summarised as follows:

- Spread 19 kg/m<sup>2</sup> additive over first two runs
- Dry mix these first two runs to a depth of 260-300 mm
- Roll flat with a smooth or padfoot drum roller
- Spread remainder of additive 18 kg/m<sup>2</sup> over first two runs again
- Wet mix these two runs to a depth of 390 mm.
- Dry mix again (only if moisture is a problem)
- Begin compaction of the first two runs together.
- Repeat process for runs three and four.

## 5 JOINTS

There are two arrangements for joints:

7.0 m pavement: 3 by 2.4 metre stabilising runs. This results in joints in the centre of the lanes. The full width of the pavement is stabilised in

any one day thereby eliminating cold longitudinal joints

9.3 m pavement: 4 by 2.4 metre stabilising runs. Either one lane or both lanes are stabilised per day. If half the road is stabilised each day, a longitudinal joint will be positioned on the centreline.

The initial compaction does not commence until adjacent stabilisation runs have been mixed to full depth.

## 6 COMPACTION OPERATION

### 6.1 Compaction equipment

The following compaction plant is used by Bega and Cooma Works Depots to complete the deep lift works:

Bega Works Depot	Cooma Works Depot
Vibrating Padfoot roller (18 t)	Vibrating Padfoot roller (15 t)
RAM45 Compactor (22 t)	CAT825C compactor (35 t)
Smooth drum roller	Smooth drum roller
Rubber tyred roller (38 t)	Rubber tyred roller (20 t)

The RAM45 is a machine similar to a CAT825 Compactor but better suited for the Bega area because:

- The width of the machine is only 2.7m with an all up width of the blade of 3.2m. Due to the narrower formation widths of the Princes Highway a conventional CAT815 or CAT825 with a minimum width of 3.2m and greater will be unable to compact the whole lane without interfering with the traffic.
- The weight of the machine is only 22 tonne which is less than a CAT825 however, with a padfoot length of approximately 125mm this machine has proven itself capable of achieving the required density of the full 365mm depth.

The pad length of any of these rollers is important and must be in excess of 120 mm long. Also with

the vibrating 18 tonne rollers, it must be pointed out that there are a lot of the rollers around claiming to be this size are to be avoided. Invariably to boost the weight, extra weight is added to the rear of the machine where it is of no benefit. Only vibrating padfoots with a front drum module of approximately 12 tonne will be successful in compaction of depths greater than 300 mm.

The other problem is that some rollers will have a front module in this range but will not have the hydraulic power to make it vibrate satisfactorily. The Cougar which has proved to be at this stage the only vibrating padfoot roller capable of achieving compaction at the required depth, as it has a hydraulic motor of 70 HP which is double that on most large machines.

## 6.2 Compaction Process

Compaction of the stabilised pavement is carried out following the full depth mixing of the first two runs together. After about 4 to 6 passes, the grader shapes the stabilised material prior to the compactor and the padfoot completing the compaction process by "walking out" of the layer.

Final rolling is completed by a combination of vibrating smooth drum and/or medium/ large pneumatic tyred rollers. This is carried out after grading to eliminate padfoot marks.

## 6.3 Compaction Test Results

Compaction tests are carried out using a nuclear Density meter to determine insitu wet density on a random basis. A lot consists of a days work with a typical area of 2800 m<sup>2</sup>, which requires five (5) density locations to be tested. A characteristic value of Relative compaction, Q is then determined over a depth of 300 mm for the five test holes. Density results are also obtained for the top 150 mm (0-150mm) and the bottom 150mm (150-300mm).

Compaction results have varied depending upon the subgrade conditions and the material to be stabilised. Where the subgrade conditions have been able to adequately support compaction then the Q value of 100 has been achieved.

It is difficult to specify a Q value because of this. At the moment, a Q value, of 100 for the full depth (that is, 300mm) is being specified. Bega is evaluating this and considering changing this to a Q value of 98 on the 150-300 mm bottom and a Q of

100 on the 0-150 mm top. Laboratory trials are underway to determine the impact that this change will have on pavement life.

To monitor the setting up of the pavements a program of 3 monthly coring has been instigated whereby the actual results in the field are being compared with those assumed achievable in the laboratory (refer to Table 2). Tests completed by Bega has shown that lack of 100% compaction will effect the ultimate strength of the pavement and thereby effect the pavement life.

## 7 FINAL TRIMMING

The use of slow setting additives has allowed final trimming work to be carried out for up to 56 hours after start of mixing. The mixing process causes the material to "bulk up" by 30 to 60 mm depending on the type of material being mixed. On the same day as mixing, the job is trimmed to shape and left high in readiness for final trimming work.

The pavement is CUT only with all material being cut to waste to prevent laminations occurring in the pavement. This final trim work still leaves the pavement in the range of 0 to 50 mm high as per the specification. As part of the Quality Assurance procedures, the finished surface levels are checked every 20 m by stringing between the surveyors pegs. The surface quality is checked by carrying out ten 3m straight edge readings for every 200 m lane length.

The roughness counts achieved in the Bega District to date lie in the range of 27 to 44 counts per kilometre, with an average roughness of 36 counts per kilometre, which is well within the specified limits of 50 counts per kilometre.

These results can be also attributed to:

- The use of slow setting binders
- Survey and design work prior to the job commencing with the aim of correcting with the aid of PAVEMOSS any noted areas where there are hollows in the pavement
- Attention to the shape correction work to ensure that the correction works are within specification
- The stringing of the works to verify that the finished surface levels are within tolerance

**Table 2** Compaction results for 1993/94 insitu stabilisation program statistics for q value of each lot.

Road	Location	Length	No of lots	Mean	Std Dev	Min	Max
SH1	Moruya	3.50	18	97.8	1.8	95	101
SH1	Bodalla	2.15	9	99.0	2.8	93	101
SH1	Victoria Creek	0.89	3	100.6	0.6	100	101
SH1	Sams Creek	2.29	8	98.5	1.1	97	100
SH1	Quaama	2.80	10	98.9	1.7	95	101
SH1	Greendale	7.70	18	102.1	1.6	100	105
SH1	Bega Lookout	1.20	6	101.0	1.4	99	103
SH1	Cooper's Gully	1.37	4	100.5	2.5	98	104
SH19	Michelago	3.74	18	101.9	2.0	99	104
SH19	Colinton	2.10	10	99.6	2.3	97	104
SH19	Ingelara	1.80	9	100.8	1.8	98	104
SH19	Kelly's Corner	5.00	5	98.8	1.8	97	101
SH19	Native Dog Creek	1.85	5	100.0	1.9	97	101
SH19	MacLaughlin's River	1.00	4	101.7	2.1	100	104

- Highly skilled and motivated grader operators who are trained and form part of the project team prior to work commencement
- A commitment from the entire work team to quality and pride in the finished works
- The development of local Quality Plans

## 8 CRACKING OF INSITU PAVEMENTS

Cracking of insitu pavements does occur. The Bega District Office carries out a 3 month, 6 month and 12 month crack surveillance program for all the completed insitu jobs. A Rocond survey is carried out where a typical 100m section every 1 km is chosen and the cracks are then drawn on a plan. It has been found that the majority of the cracks are transverse hairline cracks (rated as slight: 0.1 to < 1 mm width) and that these cracks occur at variable spacings generally range from 4 m to 12 m apart. The longitudinal cracking found has been along the centreline of the road.

The provision of a 15% scrap rubber bitumen seal has been effective to date in stopping cracks from reflecting through to the surface.

## 9 CONCLUSIONS

The pre-planning works will affect the finished quality of the works. There needs to be adequate survey, design and laboratory work completed prior to any insitu stabilisation work commencing.

While some concern still exists with the variability in the spreading operation it has been proven that compaction to the required depth can be achieved. If better confidence in the spreading operation could be found then further reductions in unit costs could be achieved by reduction in required additive. At the present stage the additive comprises up to one third the cost of the whole process and a 1% reduction from 5% to 4% by weight in the required additive would amount to significant reductions in additive cost and hence reduce further the overall costs of this process.

The continued use of slow setting binders in the Bega and Cooma areas allows sufficient time for mixing, compaction and trimming works. This is evident in the compaction and roughness results that have been presented.

On the evidence so far, Deep Lift Insitu Stabilisation is a cost effective treatment for the rehabilitation of flexible granular pavements. Typical unit rates including shape correction, insitu stabilisation and primer sealing of between \$16 and

\$22 per square metre are being achieved. These rates are dependent on the quantity of shape correction work required to be completed prior to the insitu stabilisation work commencing.

With the use of slow setting binders in the Bega and Cooma areas, a 14 mm rubber bitumen seal has proven sufficient as a second treatment to bridge any controlled cracking. Therefore, the need for geotextile seals and/or asphaltic concrete correction overlay works to control cracks and improve roughness has been eliminated.

In May/June 1994, an ALF trial was set up at Numeralla near Cooma to test the pavement life of various depths of deep lift insitu pavements constructed using 85/15 slag/lime additive. Some of the results from the ALF trial will be available in October 1994.

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