

## **Insitu Stabilisation in Local Government**

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This note conveys my recollections of 35 years in local government engineering on the use of insitu stabilisation for the recycling of existing pavements. Stabilisation over the years has had its ups and downs, mainly due to its use inappropriately. The lack of understanding of variation in the process has largely contributed to the inappropriate use.

My first association with insitu stabilisation was in the early 60s in western Queensland where 4% cement was used to stabilise a local loam to provide a basecourse for the highway. The alternative of ridge gravel was in short supply and had to be hauled large distances, so if an anticipated basecourse could be developed using stabilised plentiful local materials, it would provide large savings. Unfortunately, the experiment was considered a failure as the basecourse failed in fatigue at an early age.

After three years in the west I next became associated with stabilisation when I joined Ipswich City Council. Here black-soil lime-stabilisation to provide a working platform was developed. Ipswich City Council had its own stabilising machine which was a multi-pass 'Rotomobile'. Cement stabilisation of a design-graded basecourse for heavy-duty pavements was developed as an insitu roller-compacted concrete. Cement contents of up to 8% were used. The method adopted was to layer loose river gravel, river sand and loam by grader on the prepared subgrade. Cement was spread by hand from spotted bags. Generally, the single-pass P&H stabiliser was used to mix in place. Finishing was by grader to pegged finished levels. The product was a lean concrete (15 MPa). The pavement did suffer from uncontrolled shrinkage and cracking as no sawcutting was carried out to provide adequate contraction or expansion joints.

After Ipswich, I joined the Brisbane City Council for 29 years. When I first joined Brisbane City Council they were trying out two different processes which were similar to stabilisation. Both were off-site plant mixes. One was a lean concrete used as roller-compacted concrete, the other a plant-mixed stabilised natural granitic clayey sand. The roller-compacted concrete was laid on a prepared subgrade, contraction joints were pre-formed using a rolled-in cutter which penetrated about 40 mm. This type of pavement performed well when placed on a strong subgrade that allowed reasonable compaction of the lean concrete. However, where it was placed on a soft subgrade, the bottom layer was at best cement-coated stones. Fatigue failure occurred in these instances. Much of this type of pavement is still performing well with an asphalt surface. Cavendish Road was not resurfaced for 30 years, it was constructed with 300 mm of roller-compacted concrete with a 75-mm asphaltic concrete wearing surface.

The stabilised 'deco', ie decomposed granite, to my knowledge was not used as a full pavement construction but for maintenance of pavements. The performance of this material was similar to the lean concrete.

Insitu stabilisation was not regularly practiced until 1981, although many of the local streets were constructed with the granitic sand and similar inferior basecourse materials. The basecourse materials of this type are particularly susceptible to moisture, causing loss of strength. Cement stabilisation has always been a viable method of upgrading inferior basecourse materials to provide a suitable pavement material.

A small number of trials on insitu stabilisation was carried out between 1967 and 1977 involving different equipment. This showed that the technique was suitable; however, because the method was costed on a one-off basis, it could not compete with the conventional replacement method of reconstruction. All these trials are still performing well; however, the cement content of 6% has caused slab contraction cracking at about 6- to 8-m intervals.

With the development of the Pavement Management System in 1977, by 1979/80 there was sufficient data to show that stabilisation would be a viable method of reconstruction for a considerable number of local roads that had over 20% of pavement failure. This led to a pilot programme of 60 000 m<sup>2</sup> of stabilisation in 1981. This was carried out using special-purpose equipment, eg mechanical cement spreading and the Raygo Stabilizer. The equipment was hired but the work was carried out by day labour. This is still the preferred method of stabilisation adopted by the Council as it considerably reduces the contractor's risk of the unknown, like water services within 300 mm of the surface. The Council, with its local knowledge and its ability to locate and lower services if necessary well before the work is carried out, reduces the incidence of down time due to the breakages of services.

The original 60 000 m<sup>2</sup> adopted 4% cement content by weight at 150 mm thick. Extensive testing was carried out during the trial which showed: compaction 92% modified; unconfined compressive strength of 1.5 to 4.5 MPa.

Benkelman Beam tests were carried out before and within three months of the completed work to ensure that the stabilisation had reduced the  $d_0$  to acceptable levels. The Benkelman Beam  $d_0$  criterion has been confirmed by separate studies.

The existing pavement materials – even within a street section – can be extremely variable, ranging from a quality crushed rock to clayey gravels. 4% of cement was adopted as it is the optimum amount that is required for most basecourse materials encountered. It was also noted that some blending was achieved during the mixing process.

Thus, the stabilisation technique had now been developed as a 'process' that was applicable as a reconstruction alternative for a large number of streets that met simple intervention standards. These included percent pavement failures, rebound deflection, thickness and type of basecourse material. Trial mixing of different proportions of cement for individual streets is not required.

It should be noted that local road pavements that provide an adequate response to loading (which is determined by deflection measurements at the most critical environmental conditions) should not require reconstruction as part of the life cycle. Shape correction and resurfacing at regular intervals only will be required.

The trial was completely successful as it provided data which showed:

- The stabilised pavement was equal to a reconstructed pavement in quality and uniformity.
- It cost less than 50% of the reconstruction alternative.
- It was customer-friendly as the work on the street could be completed in a day.
- It was susceptible to rain damage only for a very short period between the mixing and rolling, whereas conventional reconstruction was susceptible to rain damage for most of the reconstruction time.

The trial was so successful that since 1981 no local road total reconstruction by conventional means has been carried out. Selected reconstruction is still economical for streets with less than 15% pavement failures.

The original trial was surfaced with a bitumen seal. All stabilised pavements are now surfaced with asphaltic concrete as a customer service requirement. During the last 14 years the process has been continuously monitored and reviewed, extended and modified. Significant changes to the process in this period include:

- ❑ Use of slag blend cement to extend the trimming and rolling time. Strengths are not reduced.
- ❑ Development of a statistical quality control method to ensure that 90% of the pavement is stabilised to a depth greater than the design.
- ❑ Extend the process to 250 mm deep in one layer.
- ❑ Eliminate the pre-ripping cycle of the grader by use of the large purpose-built recyclers. These are capable of mixing the cement into the basecourse without loosening the existing pavement.
- ❑ The pavement thickness design for heavy trafficked roads can be carried out using CIRCLY with Queensland Transport fatigue design criteria.
- ❑ For local roads, a 150-mm stabilised basecourse is standard.

The stabilisation of local roads in Brisbane has been very successful. To date, no street has had to be reconstructed. From in-house studies carried out the expected life is at least 30 years. The first trial is now 29 years old. Problems were encountered in some of the heavy-traffic stabilised pavements which have been eliminated by using a statistical method of thickness control in the field. It was found that premature fatigue failure occurred where the thickness was less than designed.

Over three million square metres of local roads have been stabilised in Brisbane during the last 14 years. Because the standard of the road network has continually been improved, the number of streets that are now candidates for stabilisation is steadily reducing. However, it is apparent that stabilisation as a reconstruction method will continue. It is probable that when the existing stabilised streets reach the intervention standard that they will be re-stabilised, as the equipment is sufficiently robust to be able to remix the low-strength stabilised material.

Stabilisation has now come of age. It is the most economical method of reconstruction of local roads. It can also be a viable alternative for major roads reconstruction. In summary, I believe that when contemplating stabilisation you should consider the following:

- ❑ It is a process and as such there are large gains for an economy-of-scale approach.
- ❑ For local roads, 4% of blended cement provides an adequate pavement.
- ❑ For major roads, a stabilised pavement should be designed using linear elastic theory, eg CIRCLY.
- ❑ Process control of the thickness of stabilisation and cement spreading rates are critical to the performance of the pavement. Statistical quality control is recommended.

In conclusion, I believe that cement stabilisation is probably the most economical and friendly method of reconstructing local roads where the basecourse provides inadequate structural support, particularly when this is a result of moisture-sensitive materials.