

Insitu Stabilisation: Construction Issues: Getting it right the first time

by Nev Crase

Acting Manager, Road Rehabilitation, Construction and Maintenance Services (CAMS)
Brisbane City Council

1 Introduction and Aim

The purpose of this paper is to provide information on current construction processes and issues that have evolved through around 30 years experience by Brisbane City Council using Insitu Stabilisation as a significant part of its road rehabilitation “tool kit”.

2 Background

Brisbane City Council first trialed Insitu cement stabilisation at Strong Avenue Graceville around 30 years ago. Based on the success of this trial, a number of streets were stabilised in the 1970's. During this period Insitu stabilisation was viewed as a low cost alternative to full reconstruction of local roads that was worth gambling with. Added cement contents fell over this period from 8% down to 4% as confidence grew based on extensive evaluation and testing.

Annual programs of Insitu cement stabilisation were commenced by Brisbane City Council in 1981. These early programs ranged in size from 90,000 to 160,000 m² per year of local roads, 4% cement stabilised to a target depth of 150 mm using hired cement spreaders and stabilisation equipment and Council labour and plant for ripping (a separate process at that time) and stabilisation. Insitu lime stabilisation was first used extensively (and successfully) in 1983 to stabilise clay subbases, during construction of the Boondall Entertainment centre road and pavement system. Later programs progressively included work on higher class roads (up to 250 mm stabilised thickness) with variable treatment success.

Extensive research and pavement studies of stabilised streets commencing from about 5 years ago highlighted the major problem with Insitu stabilisation as variability of the thickness of the treated pavement layer. In many cases the average target thickness was being under achieved by up to 30% and large standard deviation values were occurring as a result of process variability. In 1993 new procedures were developed utilising latest technology “one pass” stabilisation equipment (RS-500 stabiliser) to ensure that 90% of the stabilised pavement met or exceeded the design thickness.

Current stabilisation annual programs in excess of 100 000 m² utilise this procedure to deliver a quality assured low cost effective rehabilitation treatment where applicable on Brisbane's road network.

Brisbane City Council has recently restructured and separated purchaser and provider functions. Construction and Maintenance Services (CAMS is the Council's provider unit currently in transition to be formally a Business Unit by 1 July 1998 which carries out the construction work for the Council purchaser. CAMS proposes to rename itself to City Works during the transition. City

Works will continue to develop strong partnerships with Councils purchaser and other industry expect companies to ensure that it maintains and enhances it's expertise and strong market production in the area of Insitu stabilisation and will expand it's offering of this service external of Council.

3 Construction issues for effective Insitu stabilisation

Once the pavement rehabilitation design process has identified Insitu stabilisation as the most appropriate whole of life cost effective treatment for a pavement and funding is available the construction process can commence.

The Insitu stabilisation construction process needs to be considered under 3 main phases:

1. Planning and Preparatory Work phase
2. Stabilisation phase
3. Post Stabilisation phase

I will now discuss each of these phases in more detail including appropriate and relevant issues during each phase.

3.1 Planning and Preparatory Work Phase

Insitu stabilisation is a fast and effective treatment for road pavements. The process itself is logistically complex and delays in the process are expensive. It is therefore vital that effective planning is carried out well in advance of site stabilisation to ensure the program of work proceeds effectively. The following issues need to be addressed and planned for:

- Services
- Preparatory work
- Stabilisation program
- Resourcing and costs

3.1.1 Services

Prior to the stabilisation phase it is essential that relevant service authorities (particularly gas and water) are notified to provide an opportunity for them to carry out service upgrades or other planned installation works to minimise the need to "dig up" the stabilised pavement after completion. Examples include installation of plastic liners on gas services, and replacing lead water services with copper pipe. Additionally, Brisbane City Council experience is that it is worthwhile to mark services (depth and location) on the roadway prior to stabilisation. This provides the opportunity to either arrange lowering of services within the affected pavement depth or to reduce stabilisation depth at the service during the work. Not only does this save money for service alterations but it also reduces the amount and cost of consequent failures and additional follow-up work during stabilisation. Manholes (and in particular buried manholes) have the potential to cause substantial damage to stabilisation equipment and the resultant delays and repairs are usually very expensive.

3.1.2 Preparatory work

This primarily includes the replacement of any concrete kerb and channel which would either not survive the stabilisation process or is at a stage in its life cycle whereby it would fail early in the new pavement life cycle. Any other work required in the street such as minor drainage work also needs to be programmed and completed prior to stabilisation. For CKC it is important that the preparatory work is completed sufficiently in advance of the stabilisation to allow the CKC to reach sufficient strength to avoid damage by stabilisation (ideally at least four weeks prior). Brisbane City Council experience indicates that side drains are only required in cases where the pavement is so weak from water ingress that it is unable to support construction traffic nor provide sufficient “anvil” for compaction.

3.1.3 Stabilisation program

To effectively program Insitu Stabilisation and minimise total costs, detailed assessments of the following need to be carried out:

- exact areas of streets - site measurement
- road cross falls and shape of roadway - including bulking allowance caused by cement addition.
- traffic conditions and constraints
- any special customer (resident and business) requests
- preparatory work requests

3.1.4 Resourcing and costs

Brisbane City Council has found that the most cost effective way to carry out Insitu stabilisation is to utilise a mixture of contract and our own Day Labour resources.

We normally contract out supply of specialised stabilisation equipment including stabilizer, cement spreader and water truck (with operators and foremen) and include in this contract the supply of cement, lime or other additive. Cement is normally a double-blend (70/30 Portland/ Fly ash), however trial programs using triple-blend (60/30/10 Portland/ Blast furnace slag/ Fly ash) indicate reduction in long term shrinkage and increase working time are worth further exploration.

Over many programs, Council has developed an experienced and effective team of Engineers, Supervisors, Foremen, Workers and Operators. A core group has been developed and retained and new personnel are trained during each program to ensure continuity. The core group comprises an Engineer or Supervisor, a Foreman and two or three Labourers an experienced Grader and roller operator.

Prior to commencing the Insitu stabilisation phase a vital part of the planning phase is to get the team together (including the contract Foreman from the Stabilisation company) to discuss the program, clarify responsibilities and establish performance targets. The two Foremen and the Engineer and Supervisor should site inspect all streets in the program.

Using equipment like the RS500 appropriate daily production targets of around 7000m² (one large street), 5500m² (two or more reasonably sized streets) and 3500m² (several small streets) are achievable.

4% Cement Stabilisation of a residential street pavement to a target depth of 150mm would indicatively cost \$12/m (roughly one-third the cost of full reconstruction) broken down as follows:

Hired Stabilisation Equipment -	\$1.20
Cement -	\$2.00
Council Team -	\$1.20
Testing -	\$0.60
Holding Seal -	\$2.20
Failures Removal -	\$0.60
25mm AC Overlay -	\$5.80
Total -	\$13.50

3.2 Stabilisation Phase

In addition to a basic good organisation of plant material and manpower, successful Insitu Stabilisation construction work is dependent on a good control of the following major aspects:

- customer management
- cement (or other binder) spread rate
- moisture content
- compaction
- treated layer thickness consistency
- trimming
- soft spot management
- curing and sealing

3.2.1 Customer Management

It is important that affected customers (Councillors, businesses and street residents) understand how Insitu stabilisation will impact on them during the work progress. Brisbane City Council manage this process by providing informational letters to residents before works commence, and by keeping the local Councillor fully informed.

3.2.2 Cement (or other binder) spread rate

By accurately measuring the pavement area to be treated during Phase 1 (Planning and Preparatory Work) an accurate estimate of binder required for the street provides the highest level of control of spread rate. At the detail level it is essential that the spread rate is checked regularly during each run spread by the spreader. This is performed by weighing the binder deposited into 1m² trays laid in the path of the spreader. This allows for spread rate adjustments to be regularly made and if necessary a corrector run can be made.

The binder should only be applied to the part of the road being treated progressively in each run. Traffic on the freshly laid binder should be eliminated where possible to maintain consistency in binder application.

3.2.3 Moisture content

During construction, the most effective method to control the moisture content is regular “squeeze testing”. This is the age-old method of picking up a handful of freshly mixed loose material from behind the stabilizer, squeezing it into a ball and then trying to break it cleanly. Optimal construction results occur when the material is slightly below optimum moisture content (OMC). This can be judged fairly accurately when breaking the ball in that it breaks easily with a tendency to fray out at the edges.

If sections of the newly treated pavement are too wet, it is best to remix these areas (with obviously no more water being added).

3.2.4 Compaction

Many of the local streets stabilised by Brisbane City Council have their pavements on poor, clayey subgrade. Generally they would have Benkleman Beam representative rebounds of around 3mm or more. For these reasons, compaction in excess of around 90% Modified AASHO is usually not possible through the lack of an effective “anvil”. For a design thickness of 150mm our target layer thickness is 185mm (which is based on a linear regression analysis of depth testing on stabilised streets). Ideally 8 passes (or at least 6 passes) of a SP56 or similar roller will achieve adequate compaction and provide adequate strength (approximately 3MPa or greater UCS).

From a construction viewpoint the most critical compaction issue is to achieve at least 6 passes of the roller as close behind the stabilizer as practical. Use of a 2-3 tonne vibratory roller to compact beside the CKC and leave about 25mm at the lip for future AC surfacing has proved effective.

3.2.5 Layer thickness consistency

Consistent achievement of the design thickness (without excessive over thickness and resulting strength loss) is extremely important in producing the design life of stabilisation treated pavements. It is only in the last few programs that we have developed a quality control process that guarantees that the treated thickness achieves target.

This procedure involves carrying out the following steps.

1. Survey the road surface prior to stabilisation - 10 m spacings longitudinally and 2 metre spacing across the road.
2. Establish control charts for use by the stabilisation foreman. The original surface level is set out in the control chart,.

3. During stabilisation and directly after the stabilizer has passed, remove the loose treated material down to fresh subbase, take and record level on the control chart as “base of stabilised layer.”
4. The foreman assesses the likelihood that the target thickness will be achieved and takes corrective action on the cutting depth settings on the stabiliser if needed.
5. Near the end of the final trim process the surface is resurveyed and the control chart used to calculate if the target depth has been achieved. If the depth is insufficient, retrimming of the pavement to add material or, if need be, remixing of shallow areas is carried out.

3.2.6 Final trimming

This is a very critical part of the construction process and it is essential to have an experienced and effective grader operator. Inevitably, bulking of the old pavement occurs and the profile of the final trim must provide a safe and suitable profile for asphalt overlay. On a 7m wide road pavement a combination of trimming edges for a 25mm overlay and bulking from added cement generally would raise the crown around 80mm. This effect is magnified if the old pavement has a “rounded up” profile. In extreme cases two options are available to solve this problem (which should have been foreseen and designed for in the first phase). These are either:

- a) trim off and cart away the excess treated material (adjusting initially for increased spread rate of binder).
- b) remove subbase material by cutting the pavement with the stabilising machine, windrow the pavement material aside and cut and remove subbase material. Once removed the pavement material can be respread and stabilised conventionally.

Although more expensive in the long term, option b) above, is preferred for lowest whole of life cost if significant material needs to be removed to correct cross fall (say greater than 10 tonnes/100m²).

3.2.7 Soft spot management

Although modern Insitu stabilisation has progressed a long way over the last thirty years, there is still a degree of “art” involved in the process. Most of this “art” involves dealing with soft and potential failure areas in the newly treated pavement. Some examples of the actions that can be taken to reduce failures and the cost of stabilisation include:

1. remixing with or without added binder the soft areas and increasing the depth if necessary to bridge soft areas of subbase.
2. barricading to prevent traffic use of those areas of the pavement which are soft, providing time for these areas to cure and gain strength.
3. spreading bagged lime and remixing soft clayey areas.

4. ripping soft areas and blade mixing added surplus treated material from other areas.
5. soaking the surface (with a hand held hose if necessary) to wash cement fines into movement cracks to seal them.
6. restabilise bad sections a few days later as an add-on to the program

It should be remembered that any actions taken to reduce future failures at this stage are much cheaper than coming back to the street later to treat failures at, say, \$30/m².

3.2.8 Curing and sealing

To achieve the maximum design strength of the pavement, it is important to adequately cure the treated pavement (particularly for cement stabilisation). Our practice has evolved to put on a holding seal as soon as practical after stabilisation. Until this is applied a water cart is used to regularly flood the surface (around three times a day).

Soft pavements, as mentioned in 3.2.7., can be damaged by the water cart as well as the bitumen sprayer and aggregate trucks in the sealing process. Again, to reduce the damage, lightly loaded vehicles can be used where necessary for sealing and watering. After the seal, deformed soft areas can be “laid flat” with a light roller to give them every chance of coming good as they cure and gain strength.

4 Post stabilisation phase

This phase commences immediately after stabilisation and continues through to the end of the maintenance period. For cement stabilisation, which forms the great majority of Council Insitu stabilisation, final surfacing is not put on until Benkleman Beam testing either identifies weak areas for failure treatment or confirms that the work has been successful.

In the month after stabilisation and prior to testing the key construction issue is to carry out the minimum work necessary to maintain the treated streets in a safe trafficable condition. Past experience has shown that attempts to remove failures during this strength gaining period result in increased work and costs compared to waiting until the pavement has gained at least 28 days strength.

Final surfacing (usually 25mm asphalt overlay) is then applied and the completed street is monitored until the end of the maintenance period.

Throughout this phase, as for earlier phases, I cannot overstress the importance of keeping customers (clients, residents, Councillors etc.) informed of progress.

5 Future insitu stabilisation challenges

Apart from continually improving processes and utilising latest technology and materials, the most significant challenge for cement stabilisation, in my view, is to develop a methodology of incorporating wet cement paste into the mixing chamber and eliminate the environmental impact associated with spreading dry cement powder on roads.

6 Conclusion

Insitu stabilisation is a low cost effective method for treating sub strength pavements and subgrades. Brisbane City Council and CAMS (to be - City Works) are jointly proud of our achievements and progress in this field over many years which has certainly saved Brisbane ratepayers a lot of money. Over the last few years we believe that we can finally claim to have achieved a construction process that “gets it right the first time”.

If anyone would like further information please feel free to call myself on 07 34031030, Bruce Hansen on 07 34030836 or City Works generally on 07 34037121.

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