Job Report Cold Recycling

WR 2500: Foamed bitumen rehabilitation near Los Baños, California / USA

Wirtgen Cold Recycling:

In situ foamed bitumen rehabilitation
San Luis & Delta – Mendota Water Authority
Canal Road, Los Baños District, California

Mike Marshall, August 2000

1. Brief description

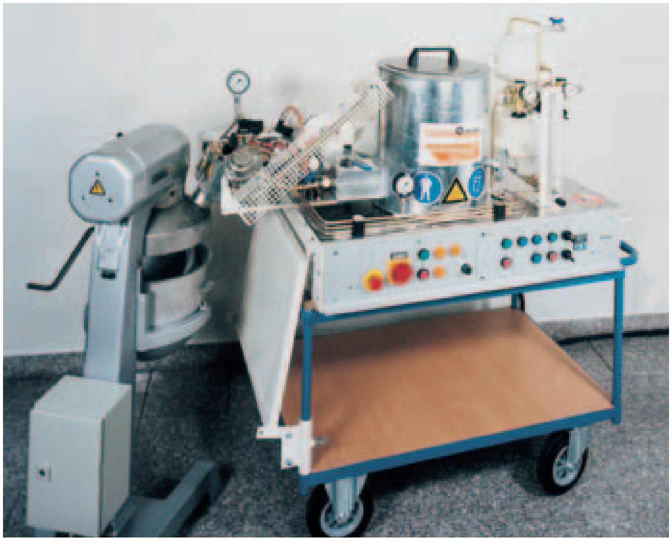
1.1 Background

Following a Wirtgen / A. A. Loudon seminar on Foamed Bitumen Technology, the San Luis & Delta – Mendota Water Authority approached Wirtgen to discuss the viability of this rehabilitation process to solve the problem of their highly distressed canal roads.

Initial investigation of the site showed poor surface shape, severely distressed surfacing with wide longitudinal cracks. The proposed solution was to recycle the existing pavement with the Wirtgen WR 2500 using foamed bitumen as the binding agent.

1.2 Investigation & mix design

After initial inspection of the road it was agreed to carry out a detailed laboratory investigation and mix design, consisting of grading analysis, moisture / density relationship tests and optimum binding agent (bitumen) determination.



Wirtgen WLB 10, foamed bitumen laboratory unit was used to determine optimum mix design

The mix design was determined as:

3 %	Foamed bitumen (AC5) @ 350 degrees F
1.5 %	Cement
1.5 %	Water
4”	Recycling depth

A detailed report of the inspection & mix design can be found on page 9 – 11.

2. Trial section

The section of Canal Road designated for the foam bitumen recycling trial started at Creek Road (Los Banos District) and extended 0.93 miles North. The width of the road to be recycled was generally 14 ft, except for the junction with Creek Road where a wider turn in area was to be created, 26 ft entrance tapering to 14 ft road width.

3. In situ rehabilitation

3.1 Pre-pulverise & shape

As the road was severely distressed and out of shape it was necessary to pre-pulverise the entire section. This operation allows the road to be put into a more uniform shape prior to the recycling operation.

Grader and compactor pre-shape road after pulverisation.

3.2 Cement spreading

Cement (1.5 % by mass) spread onto pulverised and pre-shaped road surface prior to foam bitumen recycling.

3.3 Recycle road with foamed bitumen

The recycling train consists of:

- Bitumen (oil) tanker, AC5 @ 350 deg F
- Wirtgen WR 2500 recycler
- Water cart
- Compactors, steel and pneumatic

The steel drum compactor follows immediately after the water cart to even out the tyre prints of the train, avoiding uneven localized compaction strips.

Road material after recycling with foamed bitumen (view between rear of WR 2500 and front of water cart).

3.4 Grading

Following initial compaction with the steel drum compactor, the grader is used to cut the road to the required levels. The foam bitumen recycled material flows easily off the grader blade.

3.5 Compaction

Required compaction achieved with 12 ton steel drum compactor. Surface finish compaction by means of multi tyred pneumatic compactor.

To ensure a close knit surface finish, it is essential to liberally water the recycled surface when compacting with the pneumatic tyred compactor.

3.6 Surface finish

An excellent surface finish can be achieved, providing a smooth running surface.

3. 7 Surface sealing

The recycled road must finally be sealed, this can be achieved by a number of options:

- Chipseal
- Asphalt overlay
- Slurry seal
- Sand seal

Sealing of the recycled road maybe delayed up to several days if necessary, meanwhile it is possible to run traffic on the recycled material without any problem. It was decided to seal the Canal Road with a single chipseal, 3 days after the recycling process was completed. This delay in sealing was to accommodate the SLDMWA sealing program, the road was open to traffic at all times between completing the recycling and sealing.

Final chipseal at junction with Creek Road, turn in area created during recycling process, 26 ft entrance, tapering to 14 ft road width.

4. Detailed inspection & mix design report

A. A. Loudon & Partners Report

"San Luis & Delta – Mendota Water Authority, Rehabilitation of the Canal Road Flanking Road North of Creek Road"

1. Introduction

The Delta – Mendota Water Authority recognised the use of foamed bitumen stabilisation for the rehabilitation of their existing road network as a viable option and approached Wirtgen/Loudon for assistance in setting up a trial section to demonstrate the capabilities of the WR 2500 to the Authority officials.

2. Background history

The canal was constructed during the 1950's by excavating the in-situ clayey material from the base of the canal and placing it as levees on either side. Subsequently various material types were used to construct flanking roads along-side the canal. These flanking roads are used mainly by the Delta – Mendota Water Authority as service roads and therefore carry very little traffic. These roads are also open to the local farming community whose contribution to the traffic volume is mainly in the form of light vehicles with occasional heavy vehicle during the harvest period.

3. Available information

No historical traffic counts or as-built materials data are available.

4. Traffic

As mentioned no traffic information is available but with the knowledge that this section of road is lightly trafficked, an assumption of 50,000 ESALs was made for design purposes.

5. Scope of investigation

The section of road designated for recycling started at Creek Road and extended approximately 0.93 miles north. The section was pre-marked at 100 feet intervals in order to reference the positions of the distress, test pits and dynamic cone penetrometer probings.
A visual inspection was carried out during July 2000.

Three test pits were excavated along the section of road under investigation.

Dynamic cone penetrometer (DCP) probings were carried out at each test pit location and at other positions along the section of road under investigation.

6. Visual inspection

The visual inspection was carried out by walking and recording the distress evident along the section of road under investigation.

The surfaced road width was generally 14 feet wide, with a chip seal surface. A 400 feet section just north of the gate on the Creek Road side was patched with cold mixed asphalt. This section was previously excavated after heavy storms to allow the water from the left side of the road to enter the canal.

The road is characterised mainly by cracks to the surfacing and chip loss in some areas. Edge break is evident along the chip seal section. Isolated rutting and deformation, caused by water ingress through the cracked seal and consolidation of the underlying layers, was also noted.

The section patched with cold mix showed signs of rutting, crocodile cracking and severe bleeding within the left outer wheel path. The section north of the siphon also showed wide cracks characteristic of desiccation of the underlying clay layers or movement of the embankment slope adjacent to the canal. Inspection of the embankment slope showed no signs of movement.

The unsurfaced portion of the road formation and the slopes showed evidence of large boulders within the embankment and possibly the pavement layers.

7. Test pit findings

Three test pits were excavated to a depth of 1 m by means of a TLB in order to determine the pavement profile. Representative samples were taken in order to determine the quality of the in situ materials and to carry out mix designs to determine the optimum foamed bitumen content.

The first test pit excavated at 165 feet north of Creek Road showed a composite seal surface of 20 mm. The base layer comprised 200 mm of moist sandy river gravel of medium dense compaction and a plasticity index of 6. The sub base also consisted of river gravel. This layer was well compacted and close to optimum moisture content. The subgrade consisted of moist silty sands, which showed a medium dense compaction. This material was found to be slightly plastic. The second test pit was excavated at 1045 feet north of Creek Road.

This portion of the road was excavated during a period of heavy rains to allow passage to water trapped on the left side of the embankment. All the excavated material was placed into a single stockpile, which was used to reinstate the excavated section. This section was characterised by a cold mix asphalt surfacing varying in thickness, from 25 mm to 50 mm. The asphalt was rich in bitumen and possibly due to a heavy application of tack some parts of this section were rutted with bleeding. Crocodile cracks were evident in the wheel paths. The asphalt was fairly soft and poorly compacted. The underlying material was a mixture of silty sands, river gravel and boulders.

The third test pit was excavated 4670 feet north of Creek Road in an area showing severe longitudinal cracks at the canal side edge. This section also had a chip seal surfacing showing extensive crocodile cracking.

The underlying layer comprised a dense crushed gravel 200 mm thick. The longitudinal cracks extended through this base layer but not into the underlying subbase. The material below the base comprised of silty sand and river gravel with boulders to the full depth of the test pit. This layer was not well compacted and became less dense with depth.

8. Dynamic cone penetrometer (DCP) probings

Eleven DCP probes were attempted of which nine failed to penetrate to the required depth of 800 mm. The reason for this refusal to penetrate has to be the large quantity of boulders found in the pavement layers. Depth of refusals ranged from just below the chip seal surface to 365 mm.

The two DCP probes that penetrated through the pavement layers show the following,

At test pit 1

20 – 450 mm	Elastic modulus of approximately 250 MPa, which generally indicates good quality gravel
450 – 600 mm	Elastic modulus of approximately 150 MPa indicating a medium quality gravel
600 mm +	Elastic modulus of approximately 90 indicating a soil with an in situ CBR value of 10

At test pit 2

250 – 300 mm	Elastic modulus of approximately 150 MPa indicating a medium quality gravel
300 mm +	Elastic modulus of approximately 90 indicating a soil with an in situ CBR value of 10

9. Mechanistic analyses

Mechanistic analyses carried out show that a 100 mm thick layer foamed bitumen stabilised material will carry the design traffic of 50,000 ESALs on the weakest pavement support determined from the DCP probes. The more sound areas will be able to carry additional traffic. The 100 mm thick foamed bitumen stabilised layer would also provide a more durable pavement.

10. Summary of findings

The section of road under investigation is showing signs of distress predominantly in the form of cracks and associated failures related mainly to the ingress of water into the pavement layers. The chip seal has aged considerably and in its present oxidised state can be expected to crack further, thereby accelerating the failure of the present pavement.

The test pit excavations show the upper pavement layers to consist of varying proportions of a silty sand/river gravel blend whose quality ranges from medium to good, depending on the river gravel content. A large proportion of boulders were found within the pavement layers. The larger boulders definitely contribute to differential settlement within the pavement.

The DCP probings were unsuccessful due to the high volume of boulders present in the pavement layer. The two probes that penetrated to the required depth of 800 mm showed the in situ strength of the subgrade materials to be adequate.

In order to provide durability, the minimum thickness required is 100 mm and mechanistic analyses show that this thickness of foamed bitumen stabilised material, together with the underlying in situ pavement layers would have a structural capacity in excess of 50,000 ESALs.

11. Mix designs

Samples representing 100 mm of the in situ material were treated with foamed bitumen at the following percentages,

Test pit 1 2.5% foamed bitumen
3.0% foamed bitumen

Test pit 2 2.0% foamed bitumen

The lower percentage of foamed bitumen was added to the material from test pit 2 because of the cold mixed asphalt found within this section. The bitumen used to carry out these mix designs was AC-5 obtained from Paramount Petroleum, which had a penetration value of 152.

The three samples were foamed bitumen stabilised and briquettes were prepared using the Marshall method of compaction. The briquettes were cured and tested for indirect tensile strengths under soaked and unsoaked conditions, all in accordance with the mix design procedures described in Appendix 2 of the Wirtgen Cold Recycling Manual.

A summary of the results of the indirect tensile tests can be found in the Table 1 below.

Property	Test pit 1		Test pit 2
	2.5 %	3.0 %	2.0 %
ITS – unsoaked (kPa)	323	336	435
ITS – soaked (kPa)	28	141	9
Retained ITS (%)	9	42	2

Table 1 : Summary of Indirect Tensile Strengths

The results show the stabilised material has adequate strength in an unsoaked state but lacks strength under soaked conditions at foamed bitumen contents less than 3 %.

From the results above the optimum percentage of foamed bitumen required would be 3% and the addition of 1.5 % cement is recommended in order to assist with better dispersion of the foamed bitumen, thereby improving the retained strength of the saturated stabilised material.

12. Recommendations

The road under investigation is showing signs of distress and requires immediate attention in places. Instead of ongoing maintenance it was proposed that the upper pavement layer is recycled with a foamed bitumen stabilising agent. In order to improve the durability of the upper pavement it is recommended that the top 100 mm of the in situ pavement be foamed bitumen stabilised using 3 % foamed bitumen together with 1.5 % cement.

This rehabilitation measure would increase the structural capacity of the pavement to approximately 50,000 ESALs, which would convert to a pavement life in excess of 10 years at the present traffic volumes.

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