Full Depth Reclamation Symposium

Greensboro, NC
Full Depth Reclamation with Cement Equipment and Process

Mark Stahl
Cold Recycling Handbook

- Investigation of Roadway
- Design Process
- Types of Recycling
  - In Place
  - In Plant
- Stabilization agents
  - Bitumen
  - Cement
The WIRTGEN Cold Recycling Manual

With the Cold Recycling Technology Manual, WIRTGEN provides a comprehensive compendium on everything to do with the economically efficient and environmentally friendly rehabilitation method. The manual describes the methods and options of cold recycling, methods for analyzing existing pavement structures, as well as procedures for selecting suitable binding agents. The authors have also included many suggestions for practical implementation.

Cold recycling clearly explained from A to Z with practical application examples. Includes the newest research results on the use of bitumen for cold recycling with 80 new illustrations of cold recycling technology.

Please click here to open the hands-on manual as PDF file:
4.2 Stabilising with cement

4.2.1 General

Cement is the most commonly used stabilising agent, its use worldwide far exceeds all other stabilising agents combined. The main reasons for this are cost and availability; cement is manufactured in most countries throughout the world and is relatively inexpensive. Another reason is its proven track record as a construction material. There is a plethora of standards, test methods and specifications available and cement stabilised layers have provided excellent service on thousands of kilometres of roads.

Cement stabilisation, however, requires a proper design approach. The primary function of cement addition is strength gain and the Unconfined Compressive Strength (UCS) has achieved global acceptance as the principal design criterion. However, several factors other than UCS need to be considered, such as the rate of strength gain, the Indirect Tensile Strength (ITS), cracking potential and durability issues. These are addressed in the following sections.

4.2.2 Factors affecting strength

The compressive and tensile strength achieved in a cement stabilised material is largely determined by the amount of cement that is added, the material type, the density of the compacted material and extent of curing. Strength generally increases in a linear relationship with cement content, but at different rates for different materials and cement type. Density plays a major role in determining the ultimate strength whilst ambient temperature directly affects the rate of strength gain; the higher the ambient temperature, the faster the rate of gain of strength.

Crystalline bonds start forming between particles as soon as cement comes into contact with water in the mixing process. Some of these bonds are destroyed when the material is compacted, thereby reducing the strength that can be achieved. In addition, such bonding has the effect of reducing the maximum density achievable. It is therefore important to expedite the placing and compaction operations and complete them as soon as possible after mixing, in order to achieve maximum density as well as obtaining the anticipated strengths from the compacted material.

This is particularly important where ambient temperatures exceed 40°C and where the material is prone to rapid strength gain (e.g. amorphous silica reaction). Under such conditions, an alternative stabilising agent to ordinary Portland cement should be investigated, such as blends of slag, cement and/or lime, with a slower rate of strength gain. It should also be noted that the finer the cement powder, the faster the rate of cementation.

4.2.3 Cracking of cement stabilised layers

All cement-treated materials, including concrete, are prone to cracking. The rate of gain of compressive and tensile strength in cement stabilised material is a function of time, as shown in the sketch. Tensile stresses develop within a cement-treated material as a result of shrinkage and/or traffic and, if these exceed the tensile strength at that time, cracks occur.

Strength/time relationship for cemented material:

Such cracks can be controlled and are not necessarily detrimental. However, it is important to recognise that cement treated material tends to crack for two very different reasons. The first is caused by shrinkage that is a function of the chemical reaction that takes place when cement hydrates in the presence of water and is therefore not traffic induced. The second is caused by the repeated loading of traffic over a period of time. Crack initiation and subsequent propagation are entirely different processes, warranting that they be considered separately.

Note:
- The strength of cemented material generally increases linearly with cement content
Recommended Construction Guidelines
For
Full Depth Reclamation (FDR)
Using Cementitious Stabilization
FDR102
01/27/2015

ARRA
Design = Construction Plan

- Design needs to be practical and obtainable in the field
- Design is the Benchmark
- Construction should mimic the design otherwise why have the design?
Execution Inconsistencies

- Cement not spread accurately
- Water application not precise
- Materials mixed inconsistently
- Surface finished poorly
Cement
Cement
Cement

Start/Stops

18” depth
Cement

Application Higher than Design:

- Shrinkage Cracks
- During hydration process
- More rigid than desired
- Results in extra maintenance sooner
- Cracks larger at surface
Cement

Application lower than design:

Less strength for anticipated traffic

Structure will not bear traffic loads

Results in future base failures
Spreading Cement

ARRA Recommended Guidelines
Full-Depth Reclamation-FDR
FDR102

7.6 Cementitious Spreading

• Spread consistent, accurate and uniform in length and width
• Calibrated, automated meters
• Application Rate within 5% of mix design

• 5% Design
  • Range of 4.75%--5.25%
Streumaster Binding Agent Spreaders
Modern machinery for universal spreading applications

Mounted and Towed “C” series
Streumaster Binding Agent Spreaders
Modern machinery for universal spreading applications

Dust separation filter

Electronic Regulation

Volumetric Dosing

Weightronic
Streumaster SW “C” series – Onboard Electronic

The high-precision binding agent spreaders
Streumaster SW “C” series
The high-precision binding agent spreaders

3 x 2.67 ft

8 ft
Streumaster SW 16 TC

Consistent Application
New Dustless Technology

WR with S-Pack
New Dustless Technology
New Dustless Technology

Precise Accuracy
New Dustless Technology

Dust-free application
New Dustless Technology

WR with S-Pack—Normal fill
New Dustless Technology

WR with S-Pack—Continuous fill option
New Dustless Technology

WR with S-Pack
Continuous Fill Hook up
Consistent Inconsistencies

- Cement not spread accurately
- **Water application not precise**
- Materials mixed inconsistently
- Surface finished poorly
ARRA Recommended Construction Guidelines
Full-Depth Reclamation-FDR
FDR 102

6.3 Mixing

• Water shall be injected into the mixing drum during mixing and shall be metered and consistent.
• Water content will be monitored closely to ensure conformance within -1% to +2% of OMC from design.
• **Important to know in-situ material moisture**
  • Nuke gauge
  • Dry down
Water
Water
Water Injection

Working Direction →
Water Injection

16 injectors

Microprocessor-controlled

Precise accuracy

Input desired %

Ability to turn off individual nozzles
Moisture Checks
Consistent Inconsistencies

- Cement not spread accurately
- Water application not precise
- **Materials mixed inconsistently**
- Surface finished poorly
4.1 Gradation

- Ability to pulverize and mix to achieve 100% of reclaimed material mixture passes a 3” sieve; 95% passes a 2” sieve
- Control depth of scarification
  - Depth of design is achieved
  - Sub-base materials are not disturbed
Variable Volume Mixing Chamber

Smaller Volume at Shallow Depth
Variable Volume Mixing Chamber

Larger Volume at High Depth
MILLING AND MIXING ROTOR FOR THE WR 250

Cutting tool arrangement precisely tailored to the performance of the WR 250

Hard-wearing quick-change toolholder system

Cutting tool arrangement at a tool spacing LA = 30x2 mm

High, heavy-duty forged holder bases

Large number of cutting tools for high mix quality at high advance rates

Rotor especially suitable for tough cold recycling applications, such as pulverizing hard asphalt layers

Interchangeable edge ring segments open at the sides
Mixing of materials

Gradation in spec
Materials thoroughly mixed

Proper moisture content
Mixing of materials

Large gradation
Additive not mixed thoroughly

Low moisture level
Overlap Pass

Spreader half width

WR Injection System
Consistent Inconsistencies

- Cement not spread accurately
- Water application not precise
- Materials mixed inconsistently
- Surface finished poorly
Compact and Finish

- 15-20 ton pad foot compactor
- Vital for project success
- The greater the depth, the more critical
- Need growth curve--refusal
- Target >95% maximum lab density

- Complete within 2 hours of cement
- Do not over-work
- Remove loose wind row
Compaction

Double vibratory after blade
15 ton

Pneumatic 15-25 ton
Roll for smooth finish
Good Finish

Maintain moisture

Large material off the edge

Pad foot dimples bladed out

Slush roll completed with pneumatic
Finish

Materials not mixed uniformly
Poor Finish

- Material dried out during finish
- Pad foot dimples still present
- Did not slush roll with pneumatic
Poor Finish
Design = Construction Plan

• Design needs to be practical and obtainable in the field

• Design is the Benchmark

• Construction should mimic the design otherwise why have the design?

• Pre-Construction Meeting is important
  • QC/QA issues
  • Production logistics
Thank you for your Attention

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