



## Review

## A literature review on cold recycling technology of asphalt pavement

Feipeng Xiao<sup>a,\*</sup>, Shenglei Yao<sup>a</sup>, Jingang Wang<sup>a,\*</sup>, Xinghai Li<sup>b</sup>, Serji Amirkhanian<sup>a</sup><sup>a</sup> Key Laboratory of Road and Traffic Engineering of Ministry of Education, Tongji University, Shanghai 201804, China<sup>b</sup> Beijing Key Laboratory of Highway Engineering Materials and Testing & Authentication Technology, Beijing Road Engineering Quality Supervision Station, Beijing 100076, China

## HIGHLIGHTS

- Cold recycling technology has obvious advantages but needs further investigation in details.
- CIR method eliminates distresses, saves cost and energy and reduces project period.
- Bitumen and cementitious stabilization agents are two main categories used in the construction.
- Empirical and analytical designs are two major cold pavement design methods.
- A series of laboratory and field test technologies are indispensable to characterize the material properties.

## ARTICLE INFO

## Article history:

Received 23 December 2017

Received in revised form 31 May 2018

Accepted 1 June 2018

## Keywords:

Cold recycling technology

Cold in-place recycling (CIR)

Cold central plant recycling (CCPR)

Full-depth reclamation (FDR)

Construction and design technology

Test technology

Pavement performance

## ABSTRACT

Due to the advantages of less raw materials and fossil fuel consumption, lower carbon footprint, and the capability of pavement performance improvement, the recycling technology of asphalt is developed and applied for road rehabilitation and construction in the western countries over the past two decades. However, some technical problems still need to be concerned about, for instance, the techniques in recycling process and the optimization of mix design. In order to promote the application of cold mixing technology in practice widely, and better follow up the research progress of cold recycling technology, this paper reviewed and discussed the classification of cold recycling, the scope of application, raw materials, mix design procedure and construction technology, test method, pavement performance.

© 2018 Elsevier Ltd. All rights reserved.

## Contents

|                                                         |     |
|---------------------------------------------------------|-----|
| 1. Introduction                                         | 580 |
| 2. Classification of cold recycling                     | 582 |
| 2.1. Cold in-place recycling (CIR)                      | 582 |
| 2.2. Cold central plant recycling (CCPR)                | 583 |
| 2.3. Full-depth reclamation (FDR)                       | 583 |
| 2.4. Summary                                            | 583 |
| 3. Scope of application of cold recycling               | 583 |
| 3.1. Application areas                                  | 583 |
| 3.1.1. America                                          | 583 |
| 3.1.2. Canada                                           | 584 |
| 3.1.3. European countries                               | 584 |
| 3.1.4. Asia countries                                   | 584 |
| 3.2. Application of structure position                  | 584 |
| 3.3. Application for different levels of traffic volume | 585 |
| 3.4. Summary                                            | 586 |

\* Corresponding authors.

E-mail addresses: [fp Xiao@tongji.edu.cn](mailto:fp Xiao@tongji.edu.cn) (F. Xiao), [jg wang@tongji.edu.cn](mailto:jg wang@tongji.edu.cn) (J. Wang).

|        |                                           |     |
|--------|-------------------------------------------|-----|
| 4.     | Raw materials                             | 586 |
| 4.1.   | RAP materials                             | 586 |
| 4.1.1. | Field moisture content of RAP             | 586 |
| 4.1.2. | Asphalt binder condition in RAP           | 586 |
| 4.1.3. | RAP content                               | 586 |
| 4.1.4. | RAP source                                | 586 |
| 4.1.5. | Gradation of aggregate in RAP             | 586 |
| 4.2.   | Stabilization agents                      | 587 |
| 4.2.1. | Bituminous stabilization agents           | 587 |
| 4.2.2. | Cementitious stabilization agents         | 588 |
| 4.2.3. | Other additives                           | 590 |
| 4.3.   | Summary                                   | 590 |
| 5.     | Design and construction technology        | 591 |
| 5.1.   | Design process                            | 591 |
| 5.1.1. | Pavement design approaches                | 591 |
| 5.1.2. | Laboratory mix design                     | 592 |
| 5.2.   | Construction process                      | 594 |
| 5.3.   | Construction quality control              | 594 |
| 6.     | Test technologies                         | 596 |
| 6.1.   | Laboratory test technologies              | 596 |
| 6.1.1. | Marshall test                             | 596 |
| 6.1.2. | Indirect tensile testing                  | 596 |
| 6.1.3. | Cantabro testing                          | 596 |
| 6.1.4. | Bending beam rheometer testing            | 596 |
| 6.1.5. | Asphalt pavement analyzer related testing | 596 |
| 6.1.6. | Resilient modulus testing                 | 596 |
| 6.1.7. | Creep compliance testing                  | 596 |
| 6.1.8. | Ct & dip                                  | 596 |
| 6.1.9. | SEM test                                  | 597 |
| 6.2.   | Field test technology                     | 597 |
| 6.2.1. | Sampling technology                       | 597 |
| 6.2.2. | GPR                                       | 597 |
| 6.2.3. | FOS                                       | 597 |
| 6.2.4. | FWD                                       | 598 |
| 6.2.5. | NNDG &PSPA                                | 598 |
| 6.2.6. | ARAN                                      | 598 |
| 6.2.7. | NAT                                       | 598 |
| 6.3.   | Summary                                   | 598 |
| 7.     | Pavement performances                     | 598 |
| 7.1.   | Permanent deformation                     | 600 |
| 7.2.   | Raveling mechanism                        | 600 |
| 7.3.   | Low temperature performance               | 601 |
| 7.4.   | Fracture characteristics                  | 601 |
| 7.5.   | Fatigue behavior                          | 601 |
| 7.6.   | Performance prediction                    | 601 |
| 7.7.   | Summary                                   | 601 |
| 8.     | Conclusions                               | 601 |
|        | Conflict of interest                      | 602 |
|        | References                                | 602 |

## 1. Introduction

As we all know, the development of road industry have made many achievements, especially in the highway engineering. However, due to the low level of technical process, lack of good quality materials, the unreasonable pavement design method, and the bad construction quality control and so forth, the early built asphalt pavement was damaged seriously and different types of distress occurred such as rutting, cracking, moisture damage, corrugations & shoving, pothole, raveling, bleeding etc. Therefore, it is of significance to construct sustainable asphalt pavement because of the globally ever-increasing expansion of road transportation systems [1–4].

Moreover, with the rapid development of modern industry, the huge consumption of traditional energy resources, especially petroleum, leads to the severe energy crisis and environmental issues. Above all, seeking alternative pavement materials and initiative

construction technology to maintain an efficient, safe and cost effective pavement system has become an urgent task for government departments, academic community as well as construction contractors.

In recent years, due to the obvious rehabilitating existing pavements advantages, great attention have been paid on recycling technology [5,6]. Generally speaking, recycling technology has the virtue of consuming less raw materials and fossil fuel, lower pollutant emissions, and improving the pavements performance [7–11]. From a historical point of view, recycling techniques have developed rapidly in the countries including the United States, Canada, France, Germany, Spain and Australia. In Spain, for instance, the recycling of asphalt pavement has been used over a decade. Moreover, it has been used worldwide because of its potential to alleviate the serious pollution issues, prolong the life cycle of pavement and save the construction cost [12–14].

Download English Version:

<https://daneshyari.com/en/article/6712400>

Download Persian Version:

<https://daneshyari.com/article/6712400>

[Daneshyari.com](https://daneshyari.com)