CETRA 2014

3rd International Conference on Road and Rail Infrastructure
28–30 April 2014, Split, Croatia

Road and Rail Infrastructure III

Stjepan Lakušić – EDITOR

Organizer
University of Zagreb
Faculty of Civil Engineering
Department of Transportation

CETRA 2014
3rd International Conference on Road and Rail Infrastructure
28–30 April 2014, Split, Croatia

TITLE
Road and Rail Infrastructure III, Proceedings of the Conference CETRA 2014

EDITED BY
Stjepan Lakušić

ISSN
1848-9850

PUBLISHED BY
Department of Transportation
Faculty of Civil Engineering
University of Zagreb
Kačićeva 26, 10000 Zagreb, Croatia

DESIGN, LAYOUT & COVER PAGE
minimum d.o.o.
Marko Uremović · Matej Korlaet

PRINTED IN ZAGREB, CROATIA BY
"Tiskara Zelina", April 2014

COPIES
400

Zagreb, April 2014.

Proceedings of the
3rd International Conference on Road and Rail Infrastructures – CETRA 2014
28–30 April 2014, Split, Croatia

Road and Rail Infrastructure III

EDITOR
Stjepan Lakušić
Department of Transportation
Faculty of Civil Engineering
University of Zagreb
Zagreb, Croatia

CETRA 2014
3rd International Conference on Road and Rail Infrastructure
28–30 April 2014, Split, Croatia

ORGANISATION

CHAIRMEN

Prof. Stjepan Lakušić, University of Zagreb, Faculty of Civil Engineering
Prof. Željko Korlaet, University of Zagreb, Faculty of Civil Engineering

ORGANIZING COMMITTEE

Prof. Stjepan Lakušić
Prof. Željko Korlaet
Prof. Vesna Dragčević
Prof. Tatjana Rukavina
Assist. Prof. Ivica Stančerić
dr. Maja Ahac
Ivo Haladin
dr. Saša Ahac
Josipa Domitrović
Tamara Džambas

All members of CETRA 2014 Conference Organizing Committee are professors and assistants of the Department of Transportation, Faculty of Civil Engineering at University of Zagreb.

INTERNATIONAL ACADEMIC SCIENTIFIC COMMITTEE

Prof. Vesna Dragčević, University of Zagreb
Prof. Isfendiyar Egeli, Izmir Institute of Technology
Prof. Rudolf Eger, RheinMain University
Prof. Ešref Gačanin, Univeristy of Sarajevo
Prof. Nenad Gucunski, Rutgers University
Prof. Libor Izvolt, University of Zilina
Prof. Lajos Kisgyörgy, Budapest University of Technology and Economics
Prof. Željko Korlaet, University of Zagreb
Prof. Zoran Krakutovski, University of Skopje
Prof. Stjepan Lakušić, University of Zagreb
Prof. Dirk Lauwers, Ghent University
Prof. Zili Li, Delft University of Technology
Prof. Janusz Madejski, Silesian University of Technology
Prof. Goran Mladenović, University of Belgrade
Prof. Otto Plašek, Brno University of Technology
Prof. Vassilios A. Profillidis, Democritus University of Thrace
Prof. Carmen Racanel, Technical University of Civil Engineering Bucharest
Prof. Tatjana Rukavina, University of Zagreb
Prof. Andreas Schoebel, Vienna University of Technology
Prof. Mirjana Tomičić-Torlaković, University of Belgrade
Prof. Audrius Vaitkus, Vilnius Gediminas Technical University
Prof. Nencho Nenov, University of Transport in Sofia
Prof. Marijan Žura, University of Ljubljana

CETRA 2014 28–30 April 2014, Split, Croatia
3rd International Conference on Road and Rail Infrastructure

EXAMPLES OF REUSE OF MATERIALS OF DECONSTRUCTION FOR THE CONSTITUTION OF A ROAD STRUCTURE – RECYVIA® PROCESS

Jean-Etienne Urbain, Eric Layerle
Eurovia, France

Abstract

Maintenance of the existing road network is a critical point for every stake older. The main issues are very often: a) economical solution in order to aloud a good service level on the whole network with structural decrease of dotation budgets and b) environmental friendly solution in order to preserve the materials and the environment. With the background of these 2 main issues, recycling solutions are excellent solutions : economical aspect (it is cheaper to re-use instead of milling/evacuation/renew operation) and environmental aspects (less transport, less energy consumption, less fumes emission for cold solutions, smaller global carbon footprint ...). Of course, deep analyses have to be undertaken on the road condition (structural and surface conditions) as well as on the materials themselves (relevant analyses in Laboratory). Road conditions measurements will permit a good pavement design corresponding to the traffic and lifetime data for the reinforcement or maintenance works.
On the second hand, the analyses on the materials of the existing layers will define the possible ways of recycling. Indeed, the type of recycling (cement, bituminous emulsion, bituminous foam, association of hydraulic and bituminous binders...) and the re-use conditions will be defined from the results of the Laboratory analyses (grading, fine content, binder content, ageing, residual mechanical performances...). The aim of the paper is to explain how the best solution is found (definition of the technic and design of the whole reinforcement or maintenance structure) from the measurements done on the existing road.

Keywords: recycling, economy, environment, sustainability, technical solution

1 Introduction

Eurovia has developed since the 90's a range of processes that can be used in the capping layer or road base layer course which responds to the problems of the renewal of the roads of several clients under the form of simple, efficient and economical processes.
The RECYVIA® [1] range unites products and processes that consist in in-situ treatment (up to 32cm thick by pass of treatment) or a plant of aggregates, road asphalt pavement coming from planing or crushing, crushed concrete from civil engineer bridges. These materials are treated with a hydraulic binder, an emulsion or a foam bitumen. This mixture has the sufficient mechanical performances in order to ensure a veritable structural contribution and to present an excellent behavior under high traffic. The thickness of the surface layer is to be adapted to the solicitations of the road.
The most of the recycled materials can be inserted in the Recyvia® composition, under reserve of a previous study in laboratory and that one reaches a rate of 50 to 100% of recycled materials in the mixture. The paper presents the genesis of this product, its technical and environmental characteristics and describes some real laying examples.

2 Overview

Within the Eurovia Group, the cold retreatment has been developed by the Canadian subsidiary DJL since the 90ies with the RECYFLEX®: recycled coarse gravel based on crushed concrete, road asphalt pavement coming from planing or crushing and sometimes new aggregates. The materials are treated cold in a plant with the help of emulsion of bitumen combined with a hydraulic binder. The processes of cold road retreatments are part of this evolution. They allow:

- the natural resources preservation: up to 100% of recycled materials;
- the reduction of polluted emissions: use of cold processes reduces importantly the emission of CO2. For a warm mix one needs 10 to 14 liters of fuel per ton, less than one liter is necessary for the production of a ton of asphalt concrete with emulsion;
- the improvement of the environment of the jobsite: reduction of the inconvenience for the users thanks to a short delay of the jobsite, reduction of fumes and reduction of heavy traffic linked to the jobsite.

Another important key benefit of these techniques is, of course, their lower costs. The reuse of materials as well as the cold production allows effectively a considerable saving compared to conventional processes of road refurbishment.
Like every process, the cold treatment presents certain limits. Especially, they are not adapted in case of a presence of an important number of buried networks, it is necessary to carry out studies and test to qualify the support, which can increase the costs of the works.

3 Technical characteristics

In 2009, Eurovia united its processes of cold retreatment for road base layer courses under the range of RECYVIA®. With the integrated binder, the materials have sufficient mechanical performances in order to ensure a veritable structural contribution in order to guarantee the requested sustainability of the roads:

- one can privilege an emulsion or a foam bitumen for the roads the structural capacity of which is high. The presence of a hydraulic binder is aimed at obtaining good characteristics at a young age of the retreated material during the phase of maturation of the cold bituminous treatment;
- the unique contribution of the hydraulic binder allows an important structural reinforcement of the road and improves the mechanical properties of the material.

Recyvia® is mainly used for refurbishment of existing roads; this is its proper definition. However one can plan in the case of new roads by using recycled materials coming from other road or civil engineering jobsites. A complete mix design study, taking into account the characteristics of the used materials, is carried out. This study concerns especially the following points:

- complete characterization of the materials to be recycled (grading, cleanliness, density, penetration and residual ring and ball temperature of the binder);
- index on characteristics Proctor on the mixture;
- tests of mix design relative to the mixture in order to determine the dosing of the binder;
- mechanical characteristics of the mixture.

The previous study of the Recyvia® jobsite is compulsory in order to adapt the mix design to materials of the former structure. Note that the most of the recycled materials from the road can be inserted in the composition of Recyvia®. Binder and additives are adjusted in quality and quantity in order to reach the calculated performances.The Recyvia® in-situ process calls for a specific workshop of retreatment consisting of the most performing available equipment on the market, as the final setting is ensured with a grader (see Fig. 1). The laying of Recyvia® in a plant is carried out in a tradional way with the grader or paver according to its composition (see Fig. 2 and 3). In both cases, the compaction is ensured by a design workshop regarding the materials to be compacted and its thickness.

Figure 1 In-situ Treatment train Recyvia®, Route 202 in LACOLLE (Quebec)

Figure 2 Plant for production of Recyvia® in the bypass of Troyes (France)

Figure 3 Laying of Recyvia® in the bypass of Troyes (France)

4 Some jobsite examples

4.1 Bypass of Troyes

The jobsite of the bypass North of Troye (10 – France) was carried out in summer / autumn 2010 [2]. The road pavement structure was:

· Surface course: 2,5 cm VTAC / Binder course: 10 cm SCAC / geotextile / 20 cm RECYVIA® with pre-cracking Olivia / 19 cm RECYVIA®.

Note: regarding the structural contribution, in this case, Recyvia® is nearly equivalent to a cement bound aggregate class T3 [3]. The road base course and the base layer are carried out with Recyvia® process characterized for this jobsite by a high percentage of recycled coarse gravel. A laboratory study allowed to determine the formula as follows:

· Contribution of fillerized sand 10 %
· Recycled coarse gravel 86,5 %
· Hydraulic binder 3,5 %

Samples were made in order to obtain the mechanical characteristics of the materials at 60 and 360 days. The tensile resistance [4] R_t and the elasticity modulus [5] E are measured. An estimation of the performances at 360 days was carried out according to the ratios:

· $R_{t60}/R_{t360} = 0.65$;
· $E_{60}/E_{360} = 0\ .70$, (EN 14227-5 page 4).

Table 1 provides the obtained values at 60 days and those estimated at 360 days.

Table 1 Measuring results on RECYVIA for the bypass North of Troye jobsite

	3.5% ROC SC	
	R_t [MPa]	E_t [MPa]
60 days	0.995	25572
360 days (estimation)	1.658	36531
Class after 360 days (est.)	T3	

The process of anti-reflective cracking is implemented for the inherent transversal cracking on hydraulic bound materials. It consists of a pre-cracking according to the Olivia® process and the geogrid Rotaflex 816 SL waterproofed with a bitumen emulsion dosed at 1.5 kg/m². The binder course, with semi-coarse asphaltic concrete, is produced "warm" according to the Evotherm® process and with the incorporation of 15% reclaimed asphalt pavement.

4.2 Other jobsites

A number of jobsites was carried out within the Eurovia group; while declining locally the Recyvia®. One can note for example:

- Vancouver (Canada): Recyvia® in-situ: 32,000 m²
  - Works on 2x2 lanes of an urban boulevard, with heavy traffic and bus stops, emergency lanes and road widening in crossroads.
  - Retreatment of the foam bitumen (+ 1% of cement Portland) on a thickness of 20cm

- Martin County – Florida (USA): Recyvia® in-situ: 116,000 m²:
  - Reconstruction of the CR 609 SW Allapattah Road, on a length of 17 km. Jobsite carried out within 60 days (see Fig. 4).

Figure 4 Martin County jobsite in Florida : before, during and after

5 Environmental interests

A base solution of the road structure can be compared to an alternative solution equivalent using Recyvia® in order to better take up the environmental contribution. The proposed example is the one of the Troyes bypass, in this case, Recyvia® is a treatment in a hydraulic binder plant that contains 86.5% of recycled materials. Its use, combined with the incorporation of RAP and the use of the Evotherm® MA3 process in order to produce semi-coarse asphaltic concrete that builds the binder course allows to obtain an environmental report more than positive compared to the base solution. Some points are particularly remarkable.

5.1 Transport

The retreatment of road materials in general and more particularly the in-situ retreatment, allows to reduce importantly the transport for the jobsite, as this transport represents more than 25% of the consumed energy and the production of greenhouse gas for a traditional road jobsite. Note that in the case of a retreatment in a treatment plant, the production tool, compact and mobile, is easily adapted at every type of jobsites: this flexibility allows its installation next to the works, reducing so the transport. In our example, this reduction is 35% and reaches 81% regarding the local road transport.

5.2 Energy savings

The cold retreatment allows important savings on the fossil energy consumption (fuel or gas) because of the absence of reheating of the aggregates components. 22% of the direct fuel consumption and 17% of the energetic resource consumption are saved.

5.3 Emission of greenhouse gas

In absence of the heating of the recycled aggregates components, the Recyvia® process does not emit in the atmosphere the greenhouse gas coming from the residual bitumen of the reclaimed asphalt pavement and allows in our example to reduce by 19%.

6 Conclusions

Studies are currently in progress in order to better know the behavior of Recyvia® depending on the type of the used binder, on the incorporated dosings and on type of the base materials. They will allow then to optimize the Recyvia® characteristics and to carry out a cartography of possible users of this process in the different entities of Eurovia all over the world.
Since the beginnings of this process in the 90ies in Canada, this process was applied by certain companies of the Eurovia group regarding the regulations and technical habits of every country. The feedbacks of the jobsites already carried out show that the process can respond to every type of traffic, from communal roads to highways with very high traffic while reducing the user's inconvenience (limits of the jobsite traffic by using the in-situ materials ...).
Taking into account the environmental preoccupation more and more strong, the wish to reduce the greenhouse gas and to limit the consumption of non-renewable materials, this process should be generalized by the clients within the scope of heavy refurbishment works (road refurbishment of the slow lane with high traffic, taxiways) but also the creation of new roads by using the materials of deconstruction of civil engineering (crushed concrete, sleepers ...). The use of the eco comparators in the judgment of the offers should also allow to highlight the undeniable environmental characteristics of the Recyvia® process.

References

[1] Recyvia is a trade mark belonging to Eurovia

[2] Article in "Route Actualités" 07/08/2010

[3] According to standard NF EN 14227-1

[4] According to standard NFEN 13286-42

[5] According to standard NFEN 13286-43