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Cold in place recycling machinery

European project SustainEuroRoad

Cold in-place recycling jobsite of the RD 1089 in France

Among the tools implemented by the European Union (EU) to encourage Member States to adopt a proactive policy of sustainable development, the Green Public Procurement (GPP) is a mechanism reflecting the inclusion of environmental criteria into public procurement contracts. Although based on voluntary commitment, this instrument can play a key role in the Union's efforts towards a more sustainable economy. Nevertheless, in order to succeed, the project must rely on clear, quantifiable and verifiable environmental criteria for the products, services and works that it intends to regulate.

It is precisely in the area of road construction and maintenance work that the SustainEuroRoad environmental software (voir en can contribute to the GPP. At the tender phase, SustainEuroRoad will offer a comparison between the various technical solutions from the environmental standpoint. This comparison will be based on quantifiable indicators, such as energy consumption, emissions of greenhouse gases (GHG) or preservation of natural resources.

The current challenge is to ensure that the emission factors of the Member States are consistent. By proposing uniform environmental data all across Europe, the SustainEuroRoad software falls precisely within this approach. This will promote fair judgments, will foster the Single Market economy and will enable selecting and developing roadwork techniques that provide equal performance but are more environmentally friendly.

To ensure successful completion of the SustainEuroRoad project, environmental performance reviews of European worksites have been carried out using different techniques. The worksite presented in this paper uses cold in-place recycling with bitumen emulsion on road RD 1089 and is a good example of a circular economy, illustrating potential uses of tools such as SustainEuroRoad to:

- Promote road work techniques adapted to climate change;
- Undertake more environmentally-friendly public procurement contracts.

The RD 1089 worksite

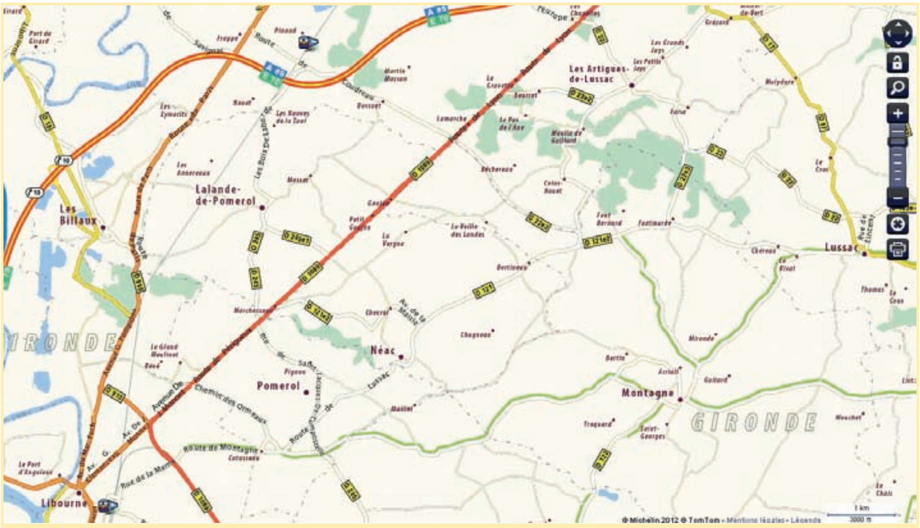
The French example presented below describes the cold in-place recycling with bitumen emulsion technique applied on a section of Departmental Road (RD) 1089, formerly National Road (RN) 89 (Bordeaux – Lyon) in the Gironde Department, linking the Dordogne border in the north to highway A89 at Bordeaux.

Adopted technical solution

The Gironde Department has undertaken road maintenance over a 10-km section of this route in the north of Libourne. Previous pavement work had been carried out in 1993, which justified the presence of fatigue, essentially expressed as cracking.

A first section of 5 km was handled in 2014, and the work continued for the remainder of the section in 2015.

The technical solution adopted during both years was cold in-place recycling with bitumen emulsion on 8 to 10 cm of the road (**graph 1**) followed by a 5-cm cover of warm-asphalt concrete (BBSG) with a 30% content of reclaimed asphalt pavement (RAP).



Graph 1
Road map of the RD 1089

Michelin

Photo 1
Cold in place recycling

USIRF

Photo 2
Final part: Application of the cold asphalt concrete

USIRF

SustainEuroRoad Project

The SustainEuroRoad European project proposes creating, validating and implementing a software application to assess and mitigate the implications of road construction or maintenance work on the environment in Europe.

Funded at 50% by the European LIFE + fund, the project has a budget of 1.3 million euros over the 2015-2017 period to develop the software, coordinate efforts, perform life cycle analysis (LCA) studies and validate environmental data. This budget does not include the funding of demonstrator worksites on which the environmental assessments are conducted.

http://sustainableroads.eu and http://sustaineuroroad.eu

Since this road had been reinforced during the 1970-1980 period, the Department was confident it had sufficient thickness of bituminous materials to implement this technique after taking preliminary bore samples.

Technologies with low GHG emissions, low energy consumption and, above all, low consumption of natural aggregates such as cold in-place recycling with bituminous emulsion, have deliberately been given priority for this site, in light of the 2009 commitment of the Gironde Department to the Agenda 21 program and the strong emphasis it places on these criteria in its tenders.

In addition, mindful of the morning and evening peak traffic, the selected technical solution allowed performing the cold in-place recycling work at night and with a minimum raise in the road profile.

Description of the worksite

- **Length: 5 km**
- **Width: 7 m**
- **Traffic: 12,000 vehicles per day (7% heavy trucks)**
- **8 to 10 cm of cold in-place recycling with bituminen emulsion**
- **5 cm of foam warm-AC (BBSG) with a 30% RAP content.**
- **Cold in-place recycling device: Recyclovia® with a Wirtgen 2500**
- **Asphalt plants: Enrobés de Gironde**

Worksite started on May 4, 2015 and included 10 days of cold in-place recycling with bitumen emulsion carried out at night during weeks 19, 20, 21 and 22. A curing period of 3 weeks of the cold in-place recycling technique material had to be observed before applying the wearing course during weeks 24, 25 and 26. The main objective was ensuring that the final road commissioning occured before the first weekend of July at the start of the holiday season, to avoid disrupting the heavy traffic of this region.

Ex-ante(upstream) SEVE study

In addition to collecting raw measurement data for the environmental assessment, the objective was also to compare the upstream study produced by the SEVE software to a retroactive project survey based on the materials follow-up report. The cold in-place recycling data available in the SEVE software will be refined as necessary and added to the SustainEuroRoad database, which is an "offspring" of SEVE.

The SEVE assessment presented below has been carried out in the frame of Recyclovia® in-place recycling worksite. The relevant section is located between PR 15 + 500 to PR 19 + 500. The traffic is 12,000 vehicles per day, 7% of which are heavy trucks.

The cold in-place recycling technique is compared to a basic solution consisting of a road milling stage to a depth of 8cm and application of gravel bitumen (GB) in the same thickness of 8 cm. Since the two techniques are not equivalent in terms of structural design, the cold in-place recycling solution is implemented with a thickness of 10 cm.

This environmental assessment does not include the wearing course, which is identical in both cases: foam warm-asphalt concrete (BBSG) with a 30% RAP content.

The basic solution

Tables 1, 2 and 3 show all the data used to calculate the environmental costs involved in a conventional technical solution (here, milling 8cm and application of 8cm of Gravel Bitumen) including production of raw materials, manufacturing process and subsequent application of materials at the site, serving as basis for tender specifications.

Devices	Quantity	Duration
Semi-Truck 24t	10	15 days
Sweeper	1	15 days
Milling machine 2m	1	15 days
Outgoing materials	**Quantity**	**Transportation**
RAP	6 750t	Semi-truck 24t – 45km

SEVE

Table 1
Road milling phase on 8cm

Alternative solution

Tables 4 and 5 show all the data enabling to calculate the environmental costs involved in the production of raw materials, manufacturing process and subsequent application of the materials at the site for the proposed in-place recycling solution.

Incoming Materials	Quantity	Transportation
GB 0/10 with 30% RAP	6,750t	Semi-truck 24t – 45km
Emulsion 65%	20t	Distributor for bituminous binder
Devices	**Duration / Quantity**	
Tack coat device: • Distributor for bituminous binder • Chip spreader	10 days • 1 unity • 1 unity	
Laying asphalt concrete device: • Paver (15 to 20t) • Vibrating tandem V1	10 days • 1 unity • 2 unities	
Sprayer	10 days	

SEVE

Table 2
GB3 0/10 with 30% RAP on 8cm

GB3 0/10 with 30% RAP			
Asphalt plant: Enrobés de Gironde	Localisation: Bassens		
Fuel for the plant: Natural Gaz			
Manufacturing temperature : 160°C			
Products	**%**	**% water**	**Transportation**
RAP MVA	30	2	Semi-truck 24t – 5km
Filler Carmeuse Saint-Porchaire	0.5	1	Semi-truck 24t – 5km
Natural Aggregates Mazières	66	1	Train – 206km
Pure bitumen 35/50	3.5	0	Tanker truck 24t – 250km

SEVE

Table 3
Asphalt concrete formula

Incoming Materials	Quantity	Transportation
CEM II	30t	Truck 14t – 200km
Emulsion 60%	250t	Tanker truck 24t – 80km
Devices	**Duration / Quantity**	
Cold in-place recycling device: • Cold in-lace recycling machinery • Vibrating tandem V1 • Distributor for bituminous binder • Sprayer	10 days • 1 unity • 2 unities • 1 unity • 1 unity	

SEVE

Table 4
Cold in-place recycling on 10cm

Incoming Materials	Quantity	Transportation
Aggregate from Thiviers	400t	Truck 14t – 130km
Emulsion 65%	20t	Tanker truck 24t – 80km
Devices	**Duration / Quantity**	
Seal coat device: • Distributor for bituminous binder • Chip spreader	10 days • 1 unity • 1 unity	

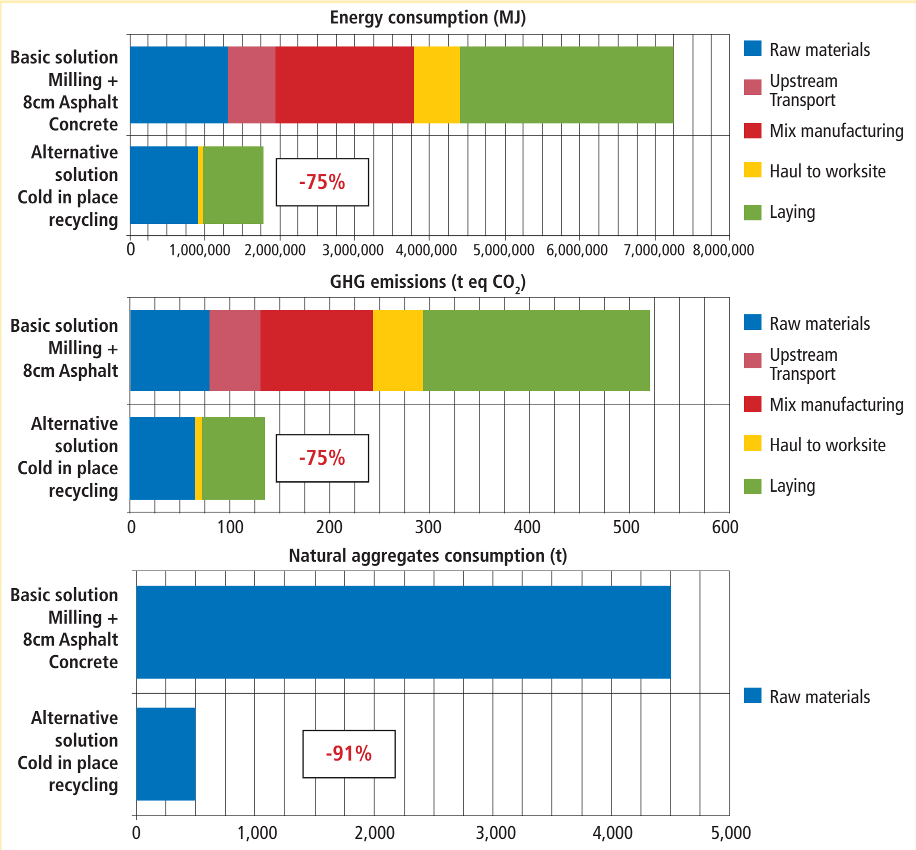
SEVE

Table 5
Seal coat

Comparison between the basic solution and cold in-place recycling

The charts in **graph 2** were taken from the SEVE final report and can be used to compare these two solutions. As can be clearly seen, for these 3 indicators, the cold in-place recycling technique offers a substantial improvement compared to the basic solution.

The first two indicators, energy (MJ) and greenhouse gases (t equivalent CO_2) point to a significant improvement of about –75% in favor of the cold in-place recycling technique, primarily accounting for the application phase, which in the base solution requires a higher number of construction vehicles, and the manufacturing phase, which is entirely conducted at cold temperatures and on site (without the use of asphalt plants).



Graph 2
Comparison between the basic (Milling + AC) and alternative (cold in-place recycling)

SEVE

The natural aggregates consumption indicator (t) is also better in the cold in-place recycling solution, indicating savings of ≥ 90% by reusing in place the constituent materials of existing pavement: at this site alone, savings of 4,000 tons of aggregates have so far been achieved.

Likewise, the use of this technique has also led to lower bitumen consumption, reflected in savings of about 90 tons for this site.

In addition to the energy savings, this solution significantly reduces the number of trucks sent out on the road (3,500 fewer trucks), which helps preserve the structural asset base of this route.

In general, the cold in-place recycling maintenance solution is characterized by savings on all environmental indicators present in a life cycle assessment, proving that is an environmental-efficient solution.

Advantages of the technique

From the technical standpoint, the investigation performed upstream of the operations on the ground is useful for selecting the best suited solution for the pavement condition.

In-place recycling can be used to re-homogenize the road base, eliminate interlayer detachments and handle cracking problems. Using a regenerating bitumen emulsion extends the service life of the pavement.

A single plant performs the milling operations, mixes the materials after adding water and bitumen emulsion, and reapplies the recycled product.

From the environmental standpoint, the cold in-place recycling technique offers the advantage of reusing the existing pavement; thus, the bitumen and aggregate are given a new lease on life with only very limited use of new non-renewable resources. This process is an excellent example of circular economy.

It also contributes to the preservation of the road asset base by reducing the number of trucks used in road works: the materials reused in place are not transported over the road network, reducing the traffic generated by the worksite and causing fewer disturbances to other road users.

This technique is the most economically and environmentally efficient alternative compared to conventional solutions.

Comparison of ex-ante SEVE analysis to SEVE ex-post analysis after completion of the worksite

Materials follow-up was implemented on site to compare the output indicators of the software based on the generic data in the SEVE database to the data measured on site and recorded in the software.

Tables 6 and 7 present the actual data corresponding to the worksite inflows and outflows of materials during site work.

Incoming Materials	Quantity	Transportation
CEM II	30t	Truck 14t – 366km instead of 200km
Emulsion 60%	240t instead of 250t	Semi-truck 24t – 87km instead of 80km
Devices	**Duration / Quantity**	**Consumption**
Cold in-place recycling device:	10 days	
• Cold in-place recycling machinery	• 1 unity	• Diesel fuel consumption reduced by 77% with the specific process
• Vibrating tandem V1	• 1 unity	• Same consumption
• Distributor for bituminous binder	• 1 unity	• Same consumption
• Sprayer	• 1 unity	• Same consumption

SEVE

Table 6
Cold in place recycling realized on 10cm

Incoming Materials	Quantity	Transportation
Aggregate from Thiviers	340t instead of 400t	Truck 14t – 130km
Emulsion 65%	20t	Tanker truck 24t – 87km instead of 80km
Devices	**Duration / Quantity**	
Seal coat device:	10 days	
• Distributor for bituminous binder	• 1 unity	
• Chip spreader	• 1 unity	

SEVE

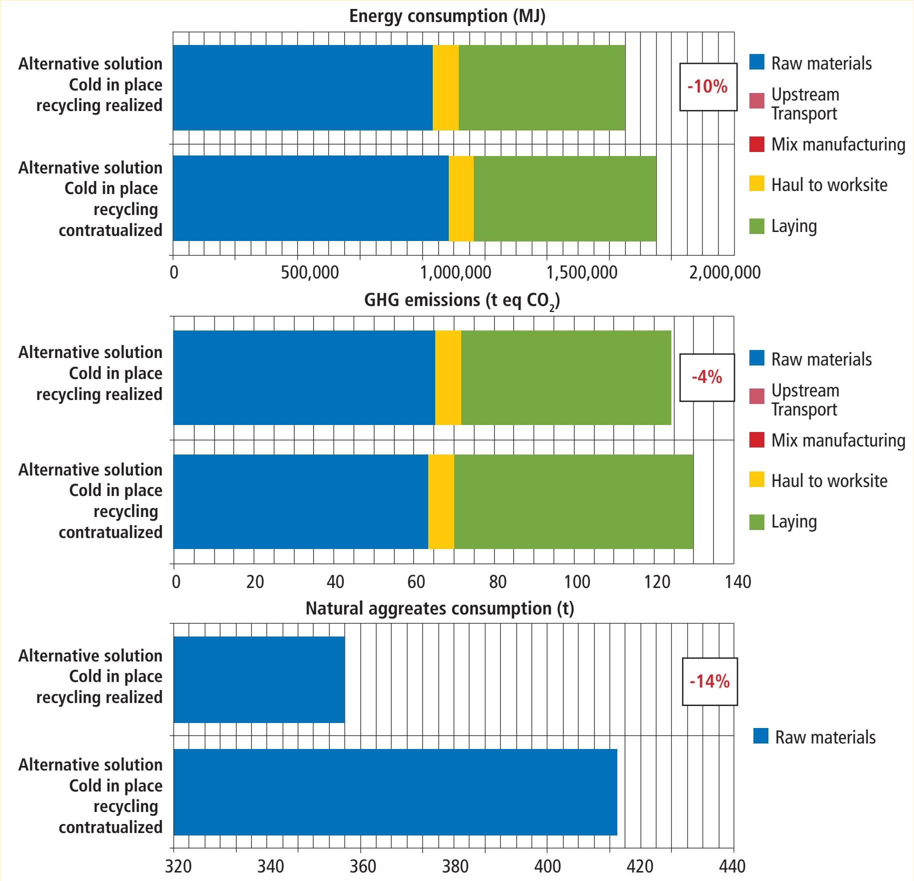
Table 7
Seal coat realized

The input data forecast in the SEVE preliminary assessment were fully confirmed by the data recorded on site during project implementation.

Additionally, the environmental assessment performed retrospectively using data collected on-site showed an improvement compared to the initial SEVE report, highlighting the benefits of the in-place recycling technique, particularly at the stage of implementation (**Graph 3**).

On the one hand, the LIFE + SustainEuroRoad demonstrator sites, such as the RD 1089 project validate the SEVE method and refine data related to materials, and on the other hand, they improve the thermal model of asphalt plants for application of hot-mix and warm-asphalt concrete.

Indeed, some measurements have been done during the application of the foam warm-AC (BBSG) with 30% RAP.



Graph 3
Comparison between ex-ante and ex-post Cold in place recycling solution on 3 indicators

Finally, we noted an improvement of the environmental assessment of the actual performed work versus the ex-ante SEVE project:

- Energy (MJ): - 10.29%
- GHG emissions (tons CO_2 equivalent): - 4.06%
- Consumed natural aggregate (t): - 14.35%

In fact, the SEVE program was developed based on generic and average data, so that using specific material data optimizes this technical solution, this optimization being clearly noted in the measurements performed on site.

Prospects

In France, local authorities, particularly at departmental level, together with the Ministry of Ecology and the road-building industry (in particular, the Union of French Road Industry Associations (USIRF)), have committed themselves in March 2009 to promote more sustainable road building and maintenance and improvement of environmental quality.

Designed as an industry-shared software application for selecting the optimum road-building or maintenance method in terms of environmental protection, SEVE software has been made available to the entire road-building community since 1st January 2012. In France, it has consistently expanded its scope both in terms of user base (currently more than 2,700 users) and application areas (urban works, earthwork, etc.) with excellent results.

In keeping with the GPP-associated mechanism, the USIRF and four of its partners (the European Road Federation - ERF, Colas Hungary, Eurovia and the Asociación española de fabricantes de mezclas asfálticas - ASEFMA), in association with the Gironde Departmental Council, have submitted to the European Commission in 2013 a plan to establish a software program inspired by SEVE and proposed to make it available to all European countries.

The next demonstration worksites are currently under planning or even under implementation in the project's partner countries (Hungary, Spain and Germany). They will enable compiling databases to determine the main emission factors, primarily GHG, applicable in each of the concerned countries.

At a later stage, the various national databases could serve to compile a European database, helping to develop a European software program as a generic tool that can be applied and used in any EU country.

In parallel, the project will also provide the operating procedure and detailed methodology to easily create a country-specific software tool for any country wishing to do so, based on the European software model.

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