TRACC PROJECT: ROAD TECHNIQUES ADAPTED TO CLIMATE CHANGE

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ABSTRACT

Increasing concerns regarding climate change confronts us with the need to discuss the practices used in the maintenance of the road network, as well as to propose improvements in research & development of more innovative techniques, applicable in the territory of SUDOE.

The TRACC (Techniques routieres adaptées au changement climatique) project aims to ensure the promotion and development of road techniques adapted to climate change. This involves several steps:

1. Evaluation of existing TRACC techniques.
2. Looking deeply into innovative TRACC techniques.
3. Socio-economic and environmental studies.
4. Field trials using environmentally friendly road techniques.
5. Development of a guide aimed primarily at the institutions that make projects and at the ones to which the work is awarded.
6. Spreading of the guide produced in the project.

This project involves institutions from three countries (Spain, France & Portugal). For the completion of this project, a aid form FEDER (Fondo europeo de desarrollo regional) has been awarded for the 75% of the project cost (2.208.873 €)

The implementation of this project could mean a breakthrough in the development of cold and warm techniques, both using bitumen emulsion as a binder and, therefore, environmentally friendly. Other techniques that allow waste recovery and reduction in processing and placing temperatures could be promoted in the project.

On the other hand, it is important to develop a final document (guide) collecting the experience with these techniques in three countries with similar climate (SUDOE).

This guide may be used as a reference document for designers to develop alternative solutions, especially in the maintenance of road pavements with TRACC techniques.

Keywords: TRACC, SUDOE, warm techniques, bitumen emulsions, environmental friendly, guide

1. INTRODUCTION

Worldwide, the construction industry has an important role in the economies of countries, either by the financial values or by the resources of manpower, materials and equipment involved. Furthermore, in all economic models, the development of economy depends on the existence of modern infrastructure in the regions / countries, attracting investments and supporting local entrepreneurs. However, this industry is also connoting environmental impacts of built infrastructure, and the employed techniques.

In December 2008, the European Commission adopted a climate-energy package published as "20-20-20 targets", EC (2010), in which countries commit to 2020: (i) reduce the emission of 20% greenhouse gases, compared to those of the 1990; (ii) 20% reduction in energy consumption through an increase in energetic efficiency and (iii) increase the use of renewable energy to 20% of total energy production.

In the construction of roads, most of the current paving techniques involve the use of materials from loan local involved in industrial units with hydraulic and / or bituminous binders at high temperatures, and transport to the construction site. These techniques consume many natural and non-renewable resources, and energy. The acquisition of new technical skills and new knowledge will enable the construction industry in different considered areas to adapt the mode of intervention to the new context of climate change. Failing this, not changing construction techniques, this is an industry whose existence could be questioned if it does not show ability to carry out projects that consume less energy and natural resources.

The aim of the study, developed under the European project TRACC and described in this paper, is to understand, analyze, compare and develop different sustainable techniques of roads employed in France, Spain and Portugal. The techniques are dependent on local practices, on nearby available materials and on equipment or technical skills of the companies.

This paper presents the selection and evaluation of each country techniques that were considered as potentially environmentally friendly. The techniques were evaluated according to the following criteria: construction conditions, resources preservation, energy consumption, technical characteristics, social impacts and economic cost. Existing techniques evaluation was based on each country experience while for new techniques some work trials have been carried out in Spain and France.

2. TRACC PROJECT

The "TRACC -Techniques of Roads Adapted to the Climate Change-" is a European project, funded by the Territorial Cooperation Programme for the European Southwest Space (SUDOE) and whose priority is to develop technologic research and type-pilot projects with high potential for transferability of their results. The project aims to ensure the promotion and development of road techniques adapted to the climate change. It comprises an evaluation phase of the friendliest environment and employed in Europe existing techniques, an analysis of innovative techniques, a socio-economic and environmental study and development of support guidance, which facilitates decision for managers of road networks.

The project is led by LRPC - Laboratoire Régional des Ponts et Chaussées de Toulouse (France) and includes partners from other countries SUDOE Space (France, Spain and Portugal). The other project partners TRACC are as follows:
• SinesTecnopolo (Portugal);
• ATEB - Technical Asociation of bituminous emulsions (Spain)
• Junta de Castilla y Leon – Roads conservation and exploitation (Spain)
• SPRIR Midi Pyrénées (France)
• CG31 - Haute-Garonne Counsel General (France)

The project partners are connected to different areas related to the road industry: (i) control, research and technical training laboratories, (ii) public entities responsible for management of roads, (iii) representatives of companies related to road construction.

Recently, the New University of Lisbon began collaboration in the development of the project as a technical partner of the member SinesTecnopolo.

The development work was divided into the following groups of tasks:

• GT1: coordination & gestion
• GT2: current techniques

• GT 3: innovative techniques
• GT4: socio-economic impacts
• GT 5: Guide to decision support

The total project cost is expected to be € 2,208,873, 75% funded by FEDER program.

3. ROAD TECHNIQUES ADAPTED TO THE CLIMATE CHANGE

In this paper, the developed work in working groups 2 and 3 is described: This work will provide–from a scientific and technical point of view- a support guide to facilitate the decision for managers' use of road infrastructure.
In Section 3.1 the chosen techniques in each country are described; in section 3.2, the used evaluation methodologies and in section 3.3, the evaluation results.

3.1 Selection

The work began in 2009 with the selection of techniques considered "environmentally sutainable" as currently used and the innovative, experimental passages used in occasional work. The most promising techniques are already used more often are listed in Table 1. Table 2 indicates the considered innovative techniques that were used in experimental sections or construction / rehabilitation of some road sections, but still there is no experience of application

Table 1.- Technical working group selected in GT2

France	***Spain***	***Portugal***
-Grave-emulsion -Recycled cold mix asphalt in situ with emulsion -Recycled cold mix asphalt in situ with cement -Surface-coatings; -Asphalt-Lamas -Recycled hot mix asphalt 100% of RAP	-Grave-emulsion -Recycled cold mix asphalt in situ with emulsion -Recycled cold mix asphalt in situ with cement -Surface-coatings; -Asphalt-Lamas -Recycled hot mix asphalt 100% of RAP -Porous asphalt	-Recycled cold mix asphalt in situ with emulsion -Recycled cold mix asphalt in situ with cement -Recycled hot mix asphalt (low incorporation of RAP) -Thick mix asphalt of rubber modified bitumen -Porous asphalt of rubber modified bitumen

Table 2.- Technical working group selected in GT3-1

France	***Spain***	***Portugal***
-Grave-emulsion with 100% RAP -Cold mix asphalt -Recycled cold mix asphalt in situ mixted	-Recycled cold mix asphalt in plant with 100% RAP -Warm mix asphalt -Recycled hot mix asphalt (up to 50% RAP) -Half warm mix asphalt porous -Mix asphalt of rubber modified	-Warm mix asphalt -Recycled half warm mix asphalt -Recycled cold mix asphalt in situ with bitumen mousse -Recycled hot mix asphalt (incorporating high RAP)

From the comparison of the techniques listed in previous tables, it can be concluded that most of the techniques called "environmentally sustainable" are used in the construction industry of the three countries. There is the experience of the use of rubber modified bitumen in Portugal, using a tire residue obtained at the end of life, and in Spain and France a mixture type grave-emulsion, produced in cold central, and recycling of bituminous mixtures with high incorporation of reclaimed asphalt pavement (RAP).

3.2 Evaluation

The evaluation of the techniques was performed in two ways: (i) the collection of written information and personal experience of the technicians on the road, either during construction or during the period of life, (ii) performance of some experimental work most promising innovative techniques.

In Table 3 are shown some techniques used in the event of experimental work in three countries in 2009 and 2010.
Table 4 indicates the experimental techniques used in roads made until now within the European project TRACC. The evaluation of innovative techniques resulted from information from all parts of experimental work and cases identified.

Table 3 – Selected techniques in workgroup GT3-2

France	*Spain*	*Portugal*
– Mixed surface dressing – Surface dressing: RAP lower than 10% – High-modulus surface dressing RAP: higher than 10% – Surface dressing using vegetal fluxed bitumens* – In situ foamed bitume surface dressing	– Warm-mix asphalt – High-modulus warm-mix asphalt (high RAP) – Rubber–asphalt surfacing	– Warm-mix asphalt – Warm-mix recycled asphalt

***** bitumen with a type of bio-flux derived exclusively from plant based (vegetal)

Table 4 – Selected techniques in workgroup GT3-3

Technique	*Place*	*Description*
In situ recycling with bitumen emulsion using the old asphalt recycled pavement	RD 125 Luchon – FRANCE	Task 1: Recycling a base layer recycled in 2001 with rejuvenating oil and thicknes 8 cm Task 2: 4 cm surface course recycling (asphalt concrete) and 4 cm base layer recycling Task 3: 8 cm recycling: mastic asphalt in surface layer (2 cm) before recycling, 4 cm asphalt concret and 2 cm recycled base layer Task 4: 8 cm recycling: asphalt concret in surface layer (4 cm) before recycling, and 4 cm asphalt concret actual surface course
In situ recycling with very aged bitumen emulsion	RD 20 Vendine – FRANCE	In situ recycling of a pavement with a very aged bitumen (TR&B > 77ºC), thickness 7cm, two different bitumen emulsions
Cold-mix asphalt 100% RAP	RD 23 Lamasquere – FRANCE	Cold-mix asphalt 100% RAP (4 different granulometries and emulsions)
Recycled semi-warm-mix asphalt 100% RAP	CL 600 Tudela – Puente Duero - ESPAÑA	Asphalt concrete from mixing plant: 95ºC, 100% RAP and emulsión (7 cm)

In order to make a difference between all these thecniques, there has been made an evaluation of each one**,** basing on numerous elementary criteria related to the environmental impacts and technical characteristics. They were defined 4 general categories (environmental, technician, social approval, economics), and subdivided in elementary criteria.

In table 5, are indicated all the criteria considered in evaluation. For each of the criteria is conferred a punctuation between 0 and 4 as we see**:**

- 0 – unadvisable technique
- 1 – indifferent technique
- 2 – appropriate performance technique
- 3 – good performance technique
- 4 – excellent performance technique

Table 5 – Criteria for evaluating the technical road

General Category	Criteria elemental	
environmental	Preservation of resources	– aggregates – binder – water – recovery of waste
	Energy Saving	– Raw materials production - Mixes production - Raw materials transport - Mixes transport - Paving
technical	– Structural behavior - Reinforcement of adherence - Cracking - Take off layers - Permeability - Oozing - Permanent deformation - Longitudinal regularity - Breakdown - Audible noise - Ruin	
Social Acceptance	- Noise reduction - Conditions of use - Working conditions - Environmental impacts	
Economic	- Direct costs - Damage due to traffic - Operating and maintenance costs - Durability - Level of recycling	

3.3. Evaluation results

Tables 6, 7 and 8 presents the classification of road construction techniques, respectively, French, Spanish and Portuguese. The value presented in each category is the result of the score for each criterion.

In the category of environmental assessment techniques are better for cold in situ recycling with emulsion, foam bitumen or cement. With a slightly lower valuation arise recycling hot and temperate. In contrast, with the worst environmental assessment techniques, although still relatively high values, are surface coatings and blends with bitumen modified with rubber. The high values founded in this category are due to the selection of techniques have been made based on environmental criteria.

In the category of behavior in service, technical, techniques that are considered to pose better behavior are involved in in situ cold recycling. In Spain and Portugal it is considered that the recycling hot or lower temperatures (temperate and semi-temperate) also have a good behavior. In contrast, the techniques with behavior weaker are surface coatings and bituminous cold mixes.

In the category of social acceptance, there are differences in the assessment in each country. In France stand out positively in situ recycling techniques and cold all mixes produced at lower temperatures (temperate and semi-temperate), with assessments within a smaller range of other criteria. In Spain are highlighted surface coatings. In Portugal, using mixtures of bitumen modified with rubber to best get the best result, but with considerably less than the maximum score assigned in Spain and France (0.45 to 0.65 and 0.75). The rating assigned is weaker in France and Spain to the cold asphalt, while in Portugal all other evaluation techniques have only slightly lower than the highest rated.

In the economic category are two groups of techniques rated, sludge asphalt and surface coatings, and recycling techniques in situ cold. The techniques are more costly to severe grave-emulsion in France, the cold asphalt mixes in Spain and rubber modified bitumen mixes, due to the cost of initial investment, in Portugal.

Table 6– Evaluation for roads techniques in France

Road Techniques	*Criteria*			
	Enviromental	*Technical*	*Social Acceptance*	*Economic*
FRANCE				
Situ recycling with bitumen emulsion	1,38	0,61	0,7	0,32
GE structure without recycled	0,83	0,51	0,5	0,24
GE structure with recycled	0,87	0,51	0,55	0,12
GE reprofiling without recycled	0,83	0,37	0,5	0,16
GE reprofiling with recycled	1,02	0,37	0,55	0,16
GE 100% recycled	1,14	0,46	0,7	0,2
BB 10% : BBUM	0,99	0,24	0,45	0,4
BB 10% : BBTM	0,99	0,25	0,45	0,32
BB 10% : BBM	0,87	0,33	0,45	0,28
BB 10% : BBSG	0,88	0,49	0,45	0,28
BB 10% : BBME	0,85	0,49	0,45	0,24
BB 10% : GB	0,88	0,49	0,45	0,08
BB 10% : EME	0,85	0,49	0,45	0,16
Mono-layer Coated Cold Cast	0,97	0,24	0,6	0,44
Double- Layer Coated Cold Cast	0,97	0,24	0,6	0,44
Surface coatings MONO	0,97	0,17	0,6	0,44
Surface coatings MDG	0,97	0,17	0,6	0,44
Surface coatings BICOUCHE	0,81	0,18	0,6	0,44
Surface coatings MPG	0,97	0,15	0,6	0,44
Surface coatings BPG	0,97	0,2	0,6	0,44
Retreatment with hidraulic binders	1,02	0,58	0,6	0,32
Situ recicling mixt	1,03	0,6	0,6	0,32
Cold asphalt concrete	0,86	0,38	0,65	0,32
Mixed cold R coating thin layer	0,96	0,35	0,4	0,28
Mixed cold R coated thickly	0,91	0,51	0,4	0,28
Mixed cold coated structured	0,91	0,49	0,45	0,36
Warm mixture <10% recycled GB	0,95	0,49	0,7	0,24
Warm mixture <10% recycled EME	0,95	0,49	0,7	0,2
Warm mixture <10% recycled BBME	0,95	0,49	0,7	0,28
Warm mixture <10% recycled BBSG	0,95	0,49	0,75	0,32
Warm mixture <10% recycled BBTM	0,97	0,25	0,75	0,24
Warm mixture >10% recycled GB	1,02	0,49	0,75	0,16
Warm mixture >10% recycled EME	1,02	0,49	0,75	0,2
Warm mixture >10% recycled BBME	1,02	0,49	0,75	0,28
Warm mixture >10% recycled BBSG	1,02	0,49	0,75	0,32
Half warm mixture <10% recycled GB	0,94	0,49	0,7	0,24
Half warm mixture <10% recycled EME	0,94	0,49	0,7	0,2
Half warm mixture <10% recycled BBME	0,94	0,49	0,7	0,28
Half warm mixture <10% recycled BBSG	0,94	0,49	0,75	0,32
Half warm mixture <10% recycled BBTM	0,94	0,25	0,75	0,24
Half warm mixture >10% recycled GB	1,01	0,49	0,75	0,16
Half warm mixture >10% recycled EME	1,01	0,49	0,75	0,2
Half warm mixture >10% recycled BBME	1,01	0,49	0,75	0,28
Half warm mixture >10% recycled BBSG	1,01	0,49	0,75	0,32
BB vegetable bindersBBM	0,98	0,31	0,7	0,2
BB vegetable binders BBTM	0,98	0,25	0,7	0,24
Reprocessing foamed bitumen	1,30	0,61	0,7	0,32
GB high tax of agregate	1,02	0,49	0,65	0,12
EME high tax of agregate	1,02	0,49	0,65	0,2
BBME high tax of agregate	1,02	0,49	0,65	0,28
BBSG high tax of agregate	1,02	0,49	0,65	0,32

Table 7 – Evaluation for roads techniques in Spain

Road Techniques	*Criteria*			
	Enviromental	*Technical*	*Social Acceptance*	*Economic*
SPAIN				
Recycling "in situ" with bitumen emulsion	1,25	0,62	0,65	0,44
Cold recycling in factory	1,03	0,64	0,50	0,32
Grave-emulsion	0,82	0,58	0,55	0,36
BB 10% : BBTM	0,80	0,31	0,35	0,20
AC (Asphalt Concrete 16 : 4-5cm)	0,75	0,46	0,35	0,28
Slurry monolayer	1,09	0,14	0,55	0,40
Slurry bilayer	0,92	0,25	0,55	0,40
Surface treatment monolayer	0,99	0,13	0,55	0,40
Surface treatment monolayer doblue engravillado	0,99	0,17	0,55	0,40
Surface treatment bilayer	0,99	0,26	0,55	0,40
Surface treatment monolayer " pre-engravillado"	0,99	0,22	0,55	0,40
Surface treatment bilayer " pre-engravillado"	0,99	0,24	0,55	0,40
Surface treatment type trilayer	0,99	0,30	0,55	0,36
Treatment with hydraulic binder (Ground-cement y Gravel-cement)	0,81	0,39	0,50	0,36
Recycling "in situ" mixed (Bitumen emulsion + cement)	1,25	0,66	0,65	0,44
Cold mix asphalt	0,91	0,37	0,50	0,24
Semi-hot mix asphalt type AC < 10% RAP	0,78	0,46	0,40	0,32
Semi-hot mix asphalt type BBTM < 10% RAP	0,78	0,47	0,40	0,32
Temperate mix asphalt Abierta < 10% RAP	0,87	0,43	0,50	0,24
Temperate mix asphalt type AC < 10% RAP	0,87	0,47	0,50	0,28
Temperata recycling (100% RAP)	1,08	0,63	0,50	0,40
BBTM with modified bitumen with crumb rubber	0,93	0,32	0,35	0,20
BBTM with highly modified bitumen with crumb rubber	0,91	0,36	0,35	0,16
Hot recycling with high percentage of RAP	0,96	0,56	0,30	0,36
AC 32 base S, AC 22 y 32 base G (Upgradede bitumen with grumb rubber)	0,95	0,44	0,35	0,28
AC 22 bin D, AC 22 y 32 bin S (Upgradede bitumen with grumb rubber)	0,94	0,43	0,35	0,28
AC 16 y 22 surf D, AC 12 y 22 surf S (Upgradede bitumen with grumb rubber)	0,97	0,43	0,35	0,28

Table 8 – Evaluation for roads techniques in Portugal

Road Techniques	*Critérios*			
	Enviromental	*Technical*	*Social Acceptance*	*Economic*
PORTUGAL				
AC with ≤10% of RAP	0,85	0,52	0,35	0,32
AC between 10% and 25% of RAP	0,85	0,50	0,35	0,28
Recycling "in situ" with bitumen emulsion	1,25	0,62	0,35	0,44
Recycling "in situ" with cement	1,21	0,65	0,35	0,40
Hot mix asphalt with highly modified bitumen with crumb rubber - (MBA - BBA)	0,88	0,31	0,45	0,20
Hot mix open asphalt with highly modified bitumen with crumb rubber - (MBR - BBA)	0,88	0,38	0,45	0,20
Temperate mix asphalt	0,95	0,56	0,35	0,28
Semi-hot mix asphalt with 100% RAP	1,06	0,52	0,45	0,32
Recycling "in situ" with bitumen foam	1,22	0,62	0,35	0,44

AC between 25 and 50% de RAP	0,78	0,50	0,35	0,32

5. Conclusions

In the world opinion, the construction industry of roads is labeled with the destruction of the environment and the disproportionate consumption of natural ambitious goals to reduce energy consumption and emissions of greenhouse gase by 2020.

Taking it´s inspiration from these challenges, the project is in development cooperation and technological development TRACC trying to find the way environmentally safe technique to a large number of criteria, experince and information available locally and experimental pieces made for the project. The techinques that had the best overall performance, taking into account the envirinmental, techinical acceptance, economic and social, are cold recycling “in situ” with bitumen emulsion or bitumen emulsion with a little of cement.

The work is still under evaluation “ecological footprint” of each technique, which aims to determine the energy consumption and emissions in al phases of construction. In the end, we intend to create a software tool that helps decisons makers in the management of roads.

6. Agradecimentos

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7. Bibliography

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