Bituminous emulsions

REVETEMENT SUPERFICIEL COMBINE (French Cape Seal)

Sabine LEBECQ[1], Claude GIORGI[2], Christophe PRIEZ[3]
[1]EUROVIA, [2]EIFFAGE Infrastructures, [3]COLAS NORD EST

Abstract

In a context of economic crisis and constrained budgets,France has been questioning maintenance techniques to optimize costs and performance.Maintaining the road heritage is a major challenge that keeps the comfort and safety qualities of the pavement for the user,facilitate economic exchanges and preserve the infrastructures from the usual climatic conditions. However,the degradation of part of the road network under the effect of traffic and weather often comes from a lack of impermeability.The technique of surface dressing is the most used surface maintenance technique,but its efficiency in terms of cost/durability ratio does not always offer the optimum sought by the customers and is sometimes badly accepted by the users because of the chip loss and its rolling noise. The technique of microsurfacing which has little defect of rejection, is also widespread.These two techniques sometimes find their limits in terms of sustainability on highly degraded or heterogeneous roads, as well as on high traffic. This is one of the reasons why “combined layers”(RSC,Revêtements Superficiels Combinés,in French)have appeared in France in different forms.Inspired from the Capeseal technique that first appeared in South Africa in the 1950s,this technique consists in carrying out a surface treatment to improve the impermeability of the roadway.It combines an opened monolayer surface dressing made from bitumen emulsion,and a microsurfacing layer, both specifically studied.This technique has the dual advantage of protecting the tired or damaged pavements at a lower cost and to give them back their service qualities, thereby extending their service life. Rapidly,the technique has been accepted all over the country as one of the most cost effective maintenance technique available. The IDRRIM organization,wrote a technical note to introduce, promote and give the best practices for the application of this technique.This article will summarize this note and illustrate the use of these “combined layers” on a few typical jobsites.

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In a context of economic crisis and constrained budgets, France has been questioning maintenance techniques to optimize costs and performance. Maintaining the road heritage is a major challenge that keeps the comfort and safety qualities of the pavement for the user, facilitate economic exchanges and preserve the infrastructures from the usual climatic conditions. However, the degradation of part of the road network under the effect of traffic and weather often comes from a lack of impermeability. The technique of surface dressing is the most used surface maintenance technique, but its efficiency in terms of cost / durability ratio does not always offer the optimum sought by the customers and is sometimes badly accepted by the users because of the chip loss and its rolling noise. The technique of microsurfacing which has little defect of rejection, is also widespread. These two techniques sometimes find their limits in terms of sustainability on highly degraded or heterogeneous roads, as well as on high traffic. This is one of the reasons why “combined layers coatings” (RSC, Revêtements Superficiels Combinés, in French) have appeared in France in different forms. Inspired from the Cape-seal technique that first appeared in South Africa in the 1950s, this technique consists in carrying out a surface treatment to improve the impermeability of the roadway. It combines an opened monolayer surface dressing made from bitumen emulsion, and a microsurfacing layer, both specifically studied (designed). This technique has the dual advantage of protecting the tired or damaged pavements at a lower cost and to give them back their service qualities, thereby extending their service life. Rapidly, the technique has been accepted all over the country as one of the most cost-effective maintenance technique available. The IDRRIM organization, wrote a technical note [1] to introduce, promote and give the best practices for the application of this technique. This article will summarize this note and illustrate the use of these “combined layer coatings” on a few typical jobsites.

1 STATE OF THE ART

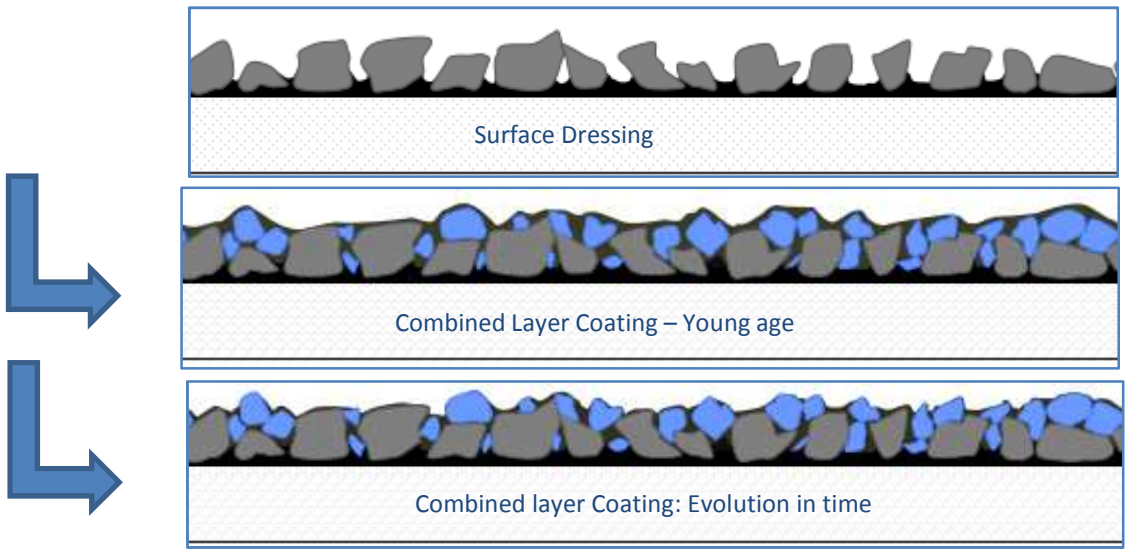

Figure 1: Principle

The first achievements in combined layers coatings date back from the 1950s. This technique, known as Cape seal, was invented in South Africa (in Cape Town, hence its name). It was composed, for the original structure, of a superficial single layered surface dressing (typically 10/14 or 14/20 mm) covered weeks later by a bituminous slurry. To date, the technique is spreading around the world, with changes in the formulation of both layers especially in France since 2010.

It is also found under the name "Sealed Pavement” in Northern Europe.
The Cape-seal is used when pavement damage is too important to be treated with microsurfacing or surface dressing alone. It restores imperviousness to the surface of the road while restoring the adherence of the wearing course.
In general, this technique is composed of the following elements: A first layer of a single, 6/10 or 10/14 mm, chip seal with an open mesh (coverage capacity below 80%) to ensure good distribution of the microsurfacing between the aggregates (sealing action). • A second layer consisting of a microsurfacing. In some cases, there may be a size gap between the surface dressing (SD) and the microsurfacing layers to allow better sealing of the first layer.

Photo 1 *Surface dressing*

Photo 2 *Microsurfacing laydown*

This combined layer coating thus produced makes it possible to obtain a waterproofing of the pavement, to avoid the phenomenon of rejection and to guarantee macrotexture over time. Indeed, the initial macrotexture of the microsurfacing layer can be relayed, after wear of it, by the emerging macrotexture of gravel heads of the surface dressing layer.

Field of application:

As for other surface coatings, combined layer pavements are only recommended for surface problems, namely to:

- Restore grip.
- Waterproof the surface.
- Stop the evolution of ravelling.
- Restore homogeneity of texture to facilitate maintenance and restore comfort of use,
- Extend the life of the roadway.

2 REALIZATION STEPS

As with any superficial technique, it is recommended to follow the following steps:

- Support survey: homogeneity, deflection level (especially for medium and high traffic roads), cracking, localization.
- Surface coating design.
- Possibly preparation of the support.
- Production.
- One-year performance evaluation.

2.1 Design

The choice of constituents is made according to the standards in force listed below:

- Chippings of the Surface Dressing comply with the specifications of standard NF EN 12271.
- Chippings and sands of the microsurfacing comply with the specifications of standard NF EN 12273.
- Bitumen emulsions for SD and microsurfacing meet the requirements of standard NF EN 13808.

To date, the techniques used since 2010 by companies, include the following specificities:

- Pure bitumen emulsions or modified emulsions (fluxed bitumen is not recommended for SD).
- Addition if necessary, of fiberglass in the surface dressing layer.
- Addition if necessary, of fibres (glass, cellulose or synthetic) in the microsurfacing layer.

Depending on the companies, different adaptations in design may exist.

The design parameters are established based on the elements of the support survey which is mandatory as for Surface Dressing and microsurfacing techniques.

For example, the table below gives the residual binder content of a combined layer pavement compared to a dual layer SD or dual layer microsurfacing (without compensation applied). The high surfacic rate of binder partly explains the great interest of this technique for waterproofing on cracked supports.

Technique	Comparison*	
	Structure and dosage of the different techniques	**Residual binder content (kg/m²)**
Combined layer coating 6/10 – 0/6	SD 1,6 kg/m² of a 69% binder emulsion and 15 kg/m² of micro	**2,2 kg/m²**
Dual layer SD 6/10 – 2/4	SD 1,0 kg/m² of a 69% binder emulsion for the first layer and 1,30 kg/m² of emulsion for the second layer	1,6 kg/m²
Dual layer micro 0/4 – 0/6	9 kg/m² of a 0/4 micro, followed by 12 kg/m² of a 0/6 micro. 21 kg/m² of materials containing 12% of a 60% binder emulsion	1,5 kg/m²

Table 1 – Examples of different surface treatment designs

***: These values are given as an indication; they will have to be adapted according to the traffic and the state of the support.**

In the field of low traffic waiting techniques, specific designs can be proposed to adapt to certain supports having particular characteristics (high deflections and large cracks).
Rolling noise performance and user discomfort of combined layer coatings are like microsurfacing techniques. They can therefore be recommended in urban and peri-urban high traffic without constraint to the user after return to service.

Specific points to consider are factors that can produce bleeding phenomena such as:
• Rutting sections
• Slow speed of vehicles
• Channelized traffic (trucks, buses, etc.)
• Indentable support.
In these cases, it is necessary to adjust the formulation parameters (choice of binder, dosage, etc.)

2.2 Preparatory works

The preparatory works and the preparation of the support do not differ from other surface treatment techniques.
The preparatory works are to be carried out preferentially in the previous year.
Prior to swiping, before applying the dual layer coating, an elimination of the thermoplastic resins (marking on the ground and slowing band) is to be expected.

2.3 Application

2.3.1 Surface Dressing

The objective of the surface dressing layer is to obtain an open granular mesh (limited to 80% of the covering capacity of the aggregates) in order to guarantee the imbrication of the microsurfacing within the granular matrix of the initial surface dressing layer.
The surface dressing layer must be compacted before the end of the cohesion built up of the emulsion to stabilize the mosaic.
The circulation of vehicles on the surface coating is strongly discouraged (very sensitive to chip loss).
The cohesion of the binder of the surface dressing must be enough to support the microsurfacing machines. Modified binders are strongly encouraged.

2.3.2 Microsurfacing

The application of the microsurfacing layer is preferably carried out on the same day as the surface dressing layer.
In certain configurations of construction sites and climatic situations, it can be deferred for one or more days. In this case, the site must be closed to traffic as long as the surface dressing layer is not covered.

The application is necessarily followed by compaction as soon as the beginning of the increase in cohesion built up is observed.
This operation makes it possible to embed the microsurfacing in the surface dressing.

The reopening to traffic be done quickly behind compaction. It is generally done between half an hour and one hour after the end of the implementation, depending on weather conditions and traffic characteristics.

3 EVALUATION OF THE PERFORMANCES

The evaluation of the performances is done at one year (11 to 13 months), on the basis of the visual evaluation of the defects of the microsurfacing layer according to the standard NF EN 12274-8.

4 EXAMPLE 1: JOBSITE ON THE « MONT-VENTOUX », RD 974

4.1 History of Mont Ventoux road and climatology

The departmental road 974 (RD 974) which links Malaucène to the summit of Mont-Ventoux was formerly a national road (RN 574), thus classified by a decree of July 21, 1932 and inaugurated by Edouard Daladier, at that time Minister of Public Works. This nationalization of the roads then made it possible to rehabilitate the road network so that it meets the expectations of its users.

Today, this maintenance mission is the responsibility of the departmental council of Vaucluse on this road with remarkable specificities (Figure 1):

It is first of all one of the access routes to Mont Ventoux, whose lunar aspect attracts every year many tourists. The attraction of the “Giant of Provence” is such that it has been borrowed 15 times by the Tour de France (including 9 times as finish stage), with famous winners, but also major failures. It must be said that the runners have to fight against several particularly hostile elements: the slope, with sections reaching 10% over 21 km (southern slope since Sault), very often the heat, that no shade comes attenuate, and finally the heavy wind (mistral).
The climatology of this road is also atypical, with temperatures that can be hot in the summer but strongly negative in winter at the summit and violent snowfalls that require the passage of the snowplough

Submitted to extreme rough conditions, the pavement of the RD 974 must, however, ensure both the surface seal and the level of comfort and safety necessary for its use.

4.2 Jobsite overview

The section of the RD 974 to be maintained represents 30 000 m², until the access to the ski resort of Mont Serein, at 1400 m altitude. The pavement was degraded mainly by surface cracking related to the aging of the pavement. These cracks were bridged, but the mesh became important and it became necessary to apply a general treatment. It was proposed an original solution with the double interest of being both economical and to perfectly meet the needs of the departmental council: sealing the road and ensuring a sufficient level of adherence.
The use of combined layers coatings has become quite natural in this context: remember that this technique was invented in the 1950s in Cape Province, South Africa. It was a process used in hard-to-access areas for hot techniques and still required longer service times than traditional cold techniques. This type of coating has since been widely used in the country and has been the subject of official technical recommendations on highways by the South African authorities since the mid-1990s [2]. The development of this technique then continued in the United States from 1977 and in Australia in particular. In 1998, the University of Austin, TX, wrote a technical summary of the evaluation of some 20 Capeseal sites in Texas between 1992 and 1997 on all types of traffic and environment [3]. In Australia, the technique has evolved to adapt to heavy truck traffic, using in particular, modified emulsions and aggregates of size 19.5mm [4].

4.3 Design applied

For the RD 974 construction site, the choice was made of a first application of a latex modified emulsion, dosed at 1.7 kg /m² and a 6/10mm sand-lime gravel at the rate of 6-7 l / m² for the surface dressing to get around 75-80% coverage. The microsurfacing layer was designed using a 0/6mm basalt aggregate with a specific modified emulsion, dosed at 18 kg / (Photo 4).
In a context of steep turns generating significant shear forces, the emulsions used were formulated to have a maximum cohesion greater than 1,2 J / cm^2 (according to the pendulum test, standard EN 13588) on the recovered binder.

Photo 3: Aspect of the Surface dressing layer

Photo 4: Aspect of the 0/6 microsurfacing layer

4. 4 Application

The construction was carried out under traffic, using 3 strips over the width of the roadway. A tire compactor set up the mosaic of surface dressing layer, which must remain opened. The microsurfacing layer was spread about 2 hours after the first layer. Reopening to traffic came about 30 minutes after the end of the implementation, with the expected result in terms of surface appearance and grip.

Photo 5: The construction site does not prevent cyclists from competing against Mont Ventoux.

5 EXAMPLE 2: JOBSITE ON THE A23 MOTORWAY

The use of combined layer coatings has also been validated on motorways, as it happens on the A23 highway, in the North of France between Lille and Valenciennes. The jobsite took place in 2013 and after 6 years in still looks as good as new. The average daily traffic was greater than 2000 trucks per day, it was a semi-rigid structure covered with a 14 cm thick bituminous product and a wearing course dating from 2004, consisting of a thick 0/10mm bituminous mix designed with a multigrade binder, for a total thickness of 7 cm.
The roadway had a state of generalized thermal cracking with locally an aggravation of the surface degradations (departure of materials). The structural integrity of the pavement was good.

Photo 6: Visual aspect of the damaged pavement before the jobsite

The challenge for the Network Manager (DIR Nord) was to preserve the structural state of its pavement with light and economical techniques allowing it to curb the kinetics of degradation while guaranteeing an acceptable level of use for the user in terms of operating constraints, adherence and traffic noise.

Photo 7: Laying down of the microsurfacing on the opened surface dressing layer

For 6 years, the pavement was observed by performing visual surveys, macrotexture measurements, CFL and CFT measurements as well as noise emission measurements.
So far, the assessment is extremely positive with no structural degradation, a surface coating that has retained all its integrity and no cracking over the area covered by the dual combined layer pavement.

Photo 8: After 6 years of service

6 EXAMPLE 3: OPERATIONS OF MAINTENANCE ON RN 2

This operation led by DIR Nord aims to deploy, over several years, a sustainable maintenance solution, making it possible to maintain the use of its network, to ensure comfort and safety for users while limiting the increase in disorders. The use of Combined Layers Coatings was therefore a natural choice to meet these objectives.

In 2016, 33,000m² were applied on the RN 2 between Urcel and Chavignon. Applied under heavy traffic (6,400 vehicles day and 15% heavy trucks), the dosages have been adapted: 1.75 kg/m² of emulsion + 5-6 l/m² 6/10 for the surface dressing and 18 kg/m² for microsurfacing.

The support, a very thin asphalt mix (BBTM) dating from 2006, mainly shows cracks and localized tearing areas. Localized repairs and crack bridging were required in the most degraded areas before Combined Layers Coating was carried out. Three other sections on RN2, RD59 (10 000m², DIR Est) and RD910 (60 000 m², CD 57) were completed in 2017. The first 2-year surveys show satisfactory behaviour on this level of traffic.

Photo 9: RN 2 After 2 years of service

7 CONCLUSIONS

Those three different jobsites on very different environments and configurations shows the flexibility and performance of this technique, offering a new tool in the available portfolio of solutions available for the surface treatment of damaged pavements.
More generally, since its reintroduction in France, back to years 2010-2011, the monitoring of the first sites makes it possible to highlight the potential of these combined layer coatings which present a technical and economic interest for all the road networks. Different benefits can be listed below:

These combined layer complexes combine the advantages of Surface Dressings and Microsurfacing by minimizing their disadvantages

Extending the application area to low-traffic degraded pavements helps preserve the structure and postpone more costly interventions. Combined layer pavements are an additional technique for the network manager in his maintenance choices.

Grip and noise characteristics provide a satisfactory level of use.

For standby techniques, under low traffic (< (less than T3), good behaviour on cracked pavements are observed,

Beyond specific designs, this technique, like its two components, requires not only technical skills but also expertise in its application.

One of the most sensitive points of the realization is the mastery of the sequencing between the workshops of application of the superficial surface dressing and that of the cold microsurfacing layer. Indeed, the circulation of vehicles on the first layer is strongly discouraged, on the other hand the rise in cohesion of the binder of the surface dressing layer must be enough to receive the installation workshop of the microsurfacing layer. The deadline must be as short as possible but sufficient.

The application of microsurfacing layer is preferably carried out on the same day as the first surface dressing layer. In certain cases of construction sites and climatic situations, it can be delayed.

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