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**FIBROUS MICROSURFACING : PANORAMA OF APLICATIONS**

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**ABSTRACT:**

Since 1986, Eurovia Company has developed and has been using the first, gap graded micro-surfacing, which involves gap graded crushed aggregates mixed with polymer modified emulsion in conjunction with synthetic fibers fulfilling the needs to improve the skid resistance of slurries products and make it more durable over time.

Introducing fibers in the mix is was a real innovation. The advantages which it provides, in both the short and the long term have made it possible to open a wide range of use different micro surfacing application as:

1. High performance thin surfacing systems for motorways
2. Surface treatment for "black spot area"
3. Surface course with high amount of RAP
4. Crack inhibitor layer
5. Bond coat
6. Colored surfacing

The subject of this paper is to present an overview of more than 15-20 years of experience and assessment with the different application mentioned above of fibrous micro surfacing products.

**REMINDER**

Fibrous micro surfacing "Gripfibre" systems (patented) comprise a series of mixtures, principally consisting of a polymer-modified bituminous emulsions, graded coarse and fine aggregates and fibers.

## BINDER

The binder is a polymer modified asphalt cationic emulsion specially formulated to have controlled slow setting characteristics. The modification by EVA (ethylene vinyl acetate copolymer) improves four essential properties of the binder: cohesion, temperature susceptibility, rheological behavior and adhesion.

## AGGREGATES

The aggregates used are from crushed hard rock meeting the European specifications for asphalt concrete surface courses. They are gap-graded or continuous, usually from 0/6 to 0/10 mm.

## FIBERS

### A) TYPES OF FIBERS

Extra- fine synthetic fibers are used. They are relatively long (typically 4 mm by 1.6 decitex) and treated to facilitate dispersion in aqueous media.

Fiber content in the mix is only 0.1 to 0.2 % of the dry aggregate weight. However, because they are very fine and in a large number per unit area they induce a very dense fiber network.

### B) DOSING OF FIBERS

The few amount of fiber needed in the mix led to the development of a specific dosing device (patented) which distributes the fibers in both a reliable and accurate manner onto the aggregate conveyor (figure 1).

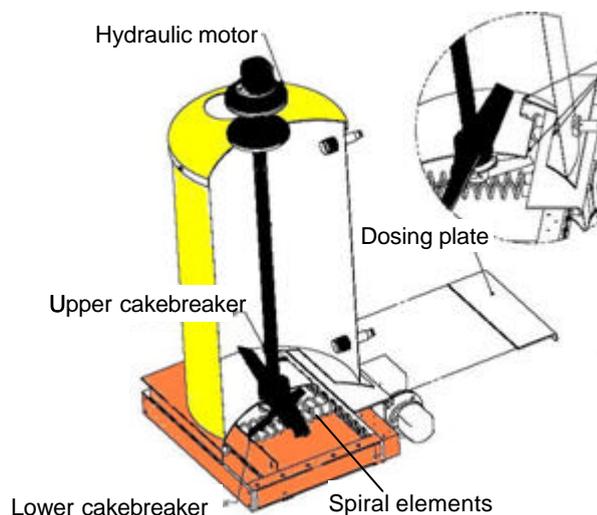


Figure 1

### C) EFFECT OF FIBERS ON THE MIX

The very dense fiber network modifies significantly the rheological behavior of the mix, giving short and long-term benefits. [1]

The addition of fibers greatly increases the apparent viscosity of the asphalt emulsion and leads to a thixotropic mixture. The apparent viscosity increases by a factor of ten.

The higher emulsion viscosity allows:

- very wide laying width until 3.85m without any risk of segregation when using gap-graded mixes 0/6 ,0/8 or 0/10.
- no loss of aggregates after opening to traffic. Fibers increase the shear strength of the mix even before the setting process has been completed ;
- laying touching longitudinal joints without overlapping as used in the case of normal slurry surfacing.
- very homogeneous macro texture.

After curing, the cold gap-graded asphalt concrete is reinforced by the fiber network which substantially increases the shear strength.

In addition the wear resistance of the fibrous mix in the presence of water is noticeably improved in comparison with the non fibrous mix [1].

## APPLICATION OF GRIPFIBRE SYSTEMS

### 1. High Performance Thin surfacing for Highways

Fibrous micro surfacing has been used on motorways since 1990 in France and 1994 in the United Kingdom. Their suitability has been proved on trial sections by fulfilling the requirements for durable skid resistance and texture depth on high speed trunk roads. The main advantages of thin layer include speed of application, which reduces traffic disruption, noise and spray reduction and relatively low cost.

The choice of aggregates types and size, the use of gap-graded grading, polymer modified emulsion and fibers provide the required performance in situations demanding relatively high skid resistance.

The excellent results of the durability of skid resistance are given by the following examples in different countries:

- Motorway A13 (France) between Rouen and Paris, highly trafficked with a significant movement of heavy lorries. The skid resistance is measured by the "Skid Resistance Trailer" built by the French Public Works Laboratories (figure 2).
- A46 Sedgeborrow Bypass of Evesham (United Kingdom) carriageway, where the skid resistance is measured by the Sideway-force Coefficient Routine Investigation Machine (SCRIM) ( figure 3).
- National Road 17 between Warsaw and Ryki (Poland), high speed trunk road. Skid resistance was measured by the IBDIM Trailer (figure 4).



- Conditions of measurement
- smooth - Tyre (PIARC)
  - 1 mm of water
  - locked Wheel
  - Speed 40 to 120 km/h

Standard NFP 98-220 -2

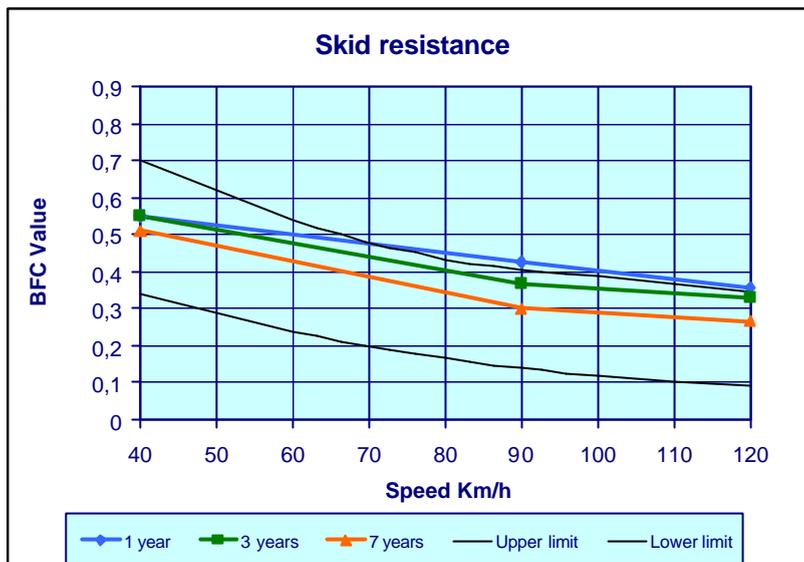
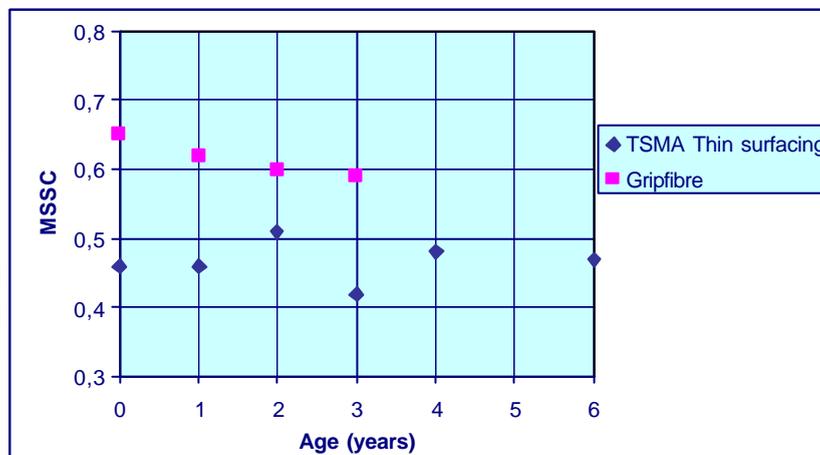


Figure 2 : Motorway A.13 (France)



Scrim measurements



MSSC = Mean Summer Scrim Coefficients  
 TSMA = Thin Stone Mastic Asphalt

Figure 3 : A46 Sedgeborrow (UK) : Average MSSC values

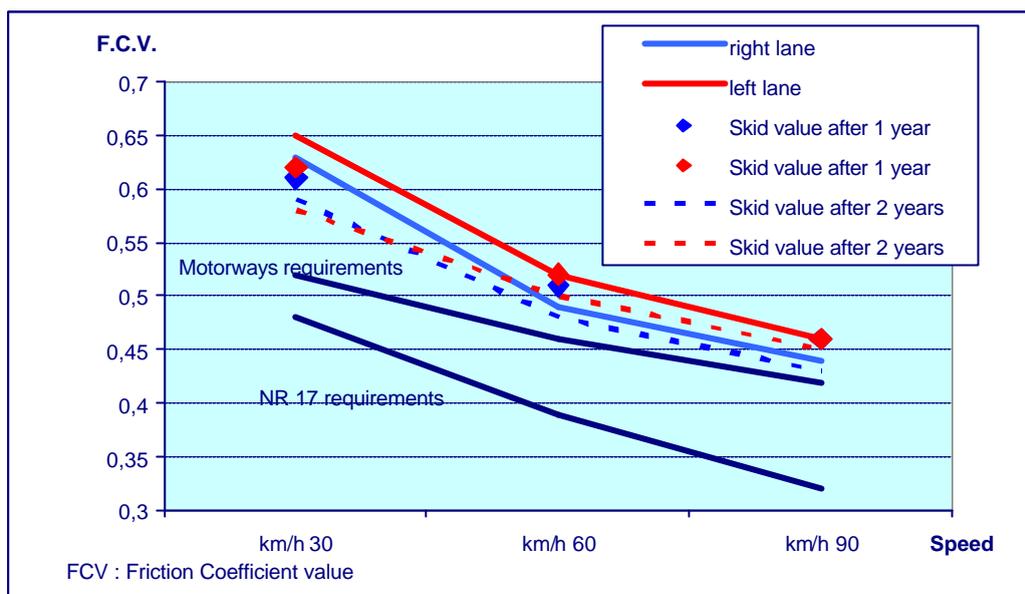


Figure 4 : Skid resistance measurements National Road 17 (Poland)

### Texture depth

After 3 years the texture depth measured by sand-patch on the Motorway A13 was 0.95 mm on the slow lane (wheel track) for 0.8 required and 7 years 0.75 mm. On fast lane values are 1.5mm (wheel track) after 3 years and 1.0 mm after 7 years.

The 18<sup>th</sup> month sand-patch texture depths at the A46 averaged 1.6 mm and are above the 1.5 mm initial limit (specified). The two years values averaged 1.3 mm, which is comfortably above the 1.0 mm limit for trafficked surfacing in the U.K.

Therefore, these values confirm that Gripfibre can provide and maintain the required texture for high speed trunk roads.

## 2. Surface treatment for Black Spot Areas

During the 5<sup>th</sup> ISSA World Congress held in Berlin in 2002, I have made a presentation on using Gripfibre system to treat effectively “black spot” areas [2]. Several examples has been presented, one of them was the National Road 152 between Blois and Tours in France.

Some 102 car accidents were reported over 5 years including 15 fatal accidents; 51 severe injuries and 107 light injuries. In order to decrease these figures, the Road Authority decided to make safety improvements in the “black spot” areas. Seven sections were repaired over a distance of 21 km between Blois and Tours. Gripfibre fibrous micro surfacing was chosen for the following reasons:

- its substantial capacity to improve the surface characteristics of the pavement
- it does not require preparatory work like milling or others
- rapid laying with less inconvenience for the user
- good technical-economic compromise. The durability of Gripfibre surface characteristics is eight years in average depending on traffic level and the chosen PSV of the aggregates.

The work was carried out in September 2000 and monitored over 5 years.

The latest accident figures given by the Road Authority shows the following:

- 69 accidents less which represent - 67%
- 10 fatal accidents less - 62%
- 30 severe injuries less - 59%
- 71 light injuries less - 66%

Analysis of the skid resistance measured by the "Skid Resistance Trailer" after 4 years shows that the surfacing has very satisfactory overall adherence, characterized by values at the top of the national range for all pavement (see figure 5).

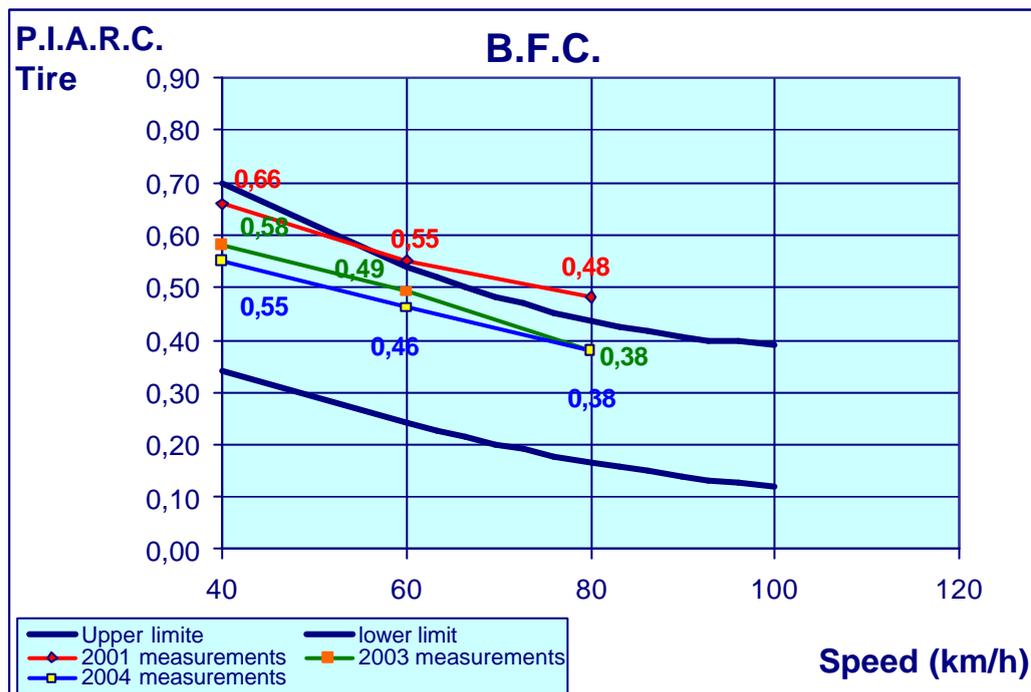


Figure 5

These performances are due to the polishing stone value of the aggregates and the maintained texture depth given by the use of gap graded formula with fibers which allows a good drainage capacity at the tire-pavement interface.

### 3. Surface course with high amount of RAP

Eurovia has developed an industrial procedure which leads to the production of aggregates by recycling old asphalt called reclaimed asphalt. This procedure was presented in the ISSA Annual Conference at Amelia Island in 2000 [3]. It leads to obtain an elaborated reclaimed asphalt aggregates and a mix design method adapted to meet the usual specifications.

The use of a high amount of reclaimed asphalt (80%) in the mix was one of the target and in order to avoid lumps during production, Eurovia developed a "cakebreaker" system fitted on the hopper of the machine to break the lumps and make easier the flow of the material (figure 6).

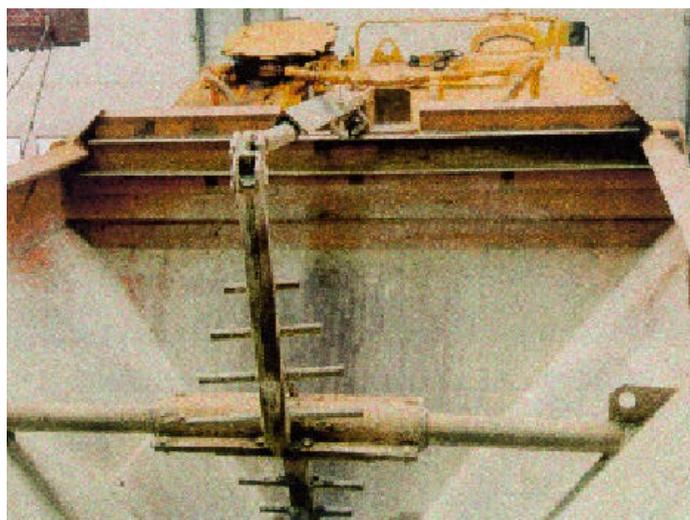


Figure 6

In September 2002 on National Road 11 near Poitiers a comparative Gripfibre job site have been conducted and monitored by the Road Authority. The National Road 11 is highly trafficked with a significant percentage of heavy lorries. It comprises two sections, the first one is a double layer of Gripfibre 0/4 and gap-graded 0/8 with 100% virgin materials( reference section), the second one is also a double layer of Gripfibre 0/4 and 0/8 mm on the top having 80% of RAP and 20% of new aggregates 4/6 mm.

The figure 7 shows the skid resistance values after 3 years for the two sections. The values are in the upper part of the envelop and are considered very well.

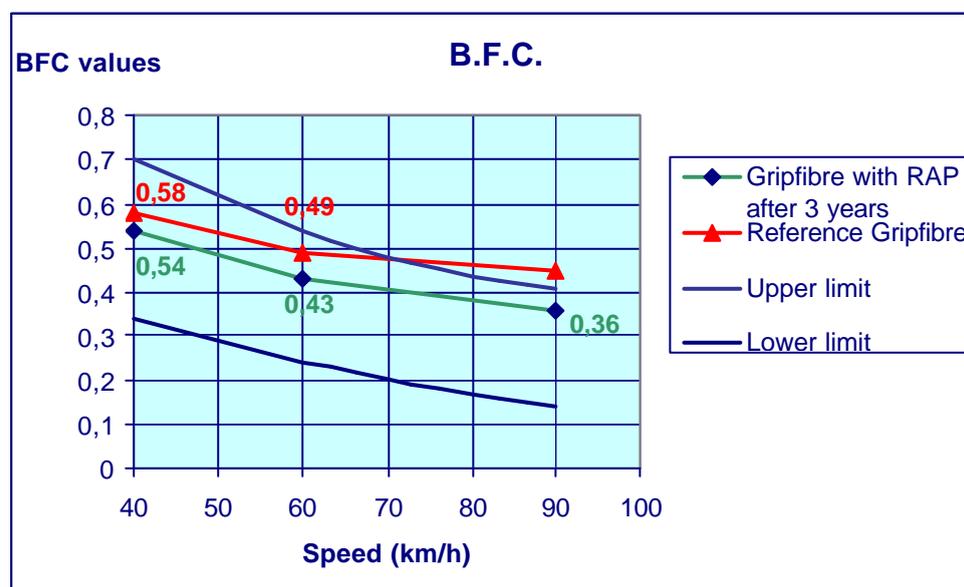


Figure 7

Values of Texture depth after 2 years are 0.81 mm measured on the wheel track for the Gripfibre with RAP and 1.01 for the reference Gripfibre. Despite this difference macro texture level is satisfactory for both sections. Visual assessment survey done have not pointed out any defects or degradation.

#### 4. Crack Inhibitor Layer

Gripfibre is a part of the "Flexiplast" System (patented) an inhibitor to reflective cracking.

The Flexiplast® System comprises:

- A highly modified reflective crack control membrane sprayed in situ
- A protection coat of "Gripfibre" fibrous micro surfacing , laid about 10 mm thick
- A surfacing of suitable thin surfacing, Rugovia M, 40 mm of hot asphalt concrete with polymer modified bitumen completes the System.

Flexiplast® was invented by Eurovia and believed to work on the basis that the movement in the support is decoupled from the overlay, Flexiplast gained an Avis Technique in 1994, the first material being laid in France was in 1990 and by 2004 over 3 million sq.m of the system had been used.

The Gripfibre protection coat is capable of horizontally slipping on the membrane and so reduces the horizontal tensile forces transmitted to the surfacing to a value it is capable of sustaining without cracking. The fibers in the Gripfibre provide additional resistance to transmitted tensile forces. In addition Gripfibre protects the membrane from traffic and temperature damage during construction of the surfacing.

The first installation of Flexiplast® took place in 1990 and by 2004 over 3 million sq.m of the system had been used.

Monitored sites show a variety of treated substrates including flexible, composite and rigid carriageways supporting heavy traffic. Monitoring sites took place up until 9 years after installation. The results are given in table below

Site	Age in years	Assessed by	Assessment techniques	Conclusions
RN 7	6	LCPC	Annual visual assessment	On composite pavements with 40mm overlay, no cracking after 4 years and after 6 years only 10% of cracks visible at surface
RN165	8	LRPC	Coring and FWD	No rupture of membrane present even at location of joints.
	9		Visual assessment for cracks and rutting	Cracks<6% Ruts<6mm

The graph below shows the evolution of the cracks with the Flexiplast for the RN 7 site compared to other systems. After 7 winters only 15% of cracks are visible at the surface (figure 8).

The system has demonstrated excellent performance over 9 years.

## CRACKS EVOLUTION

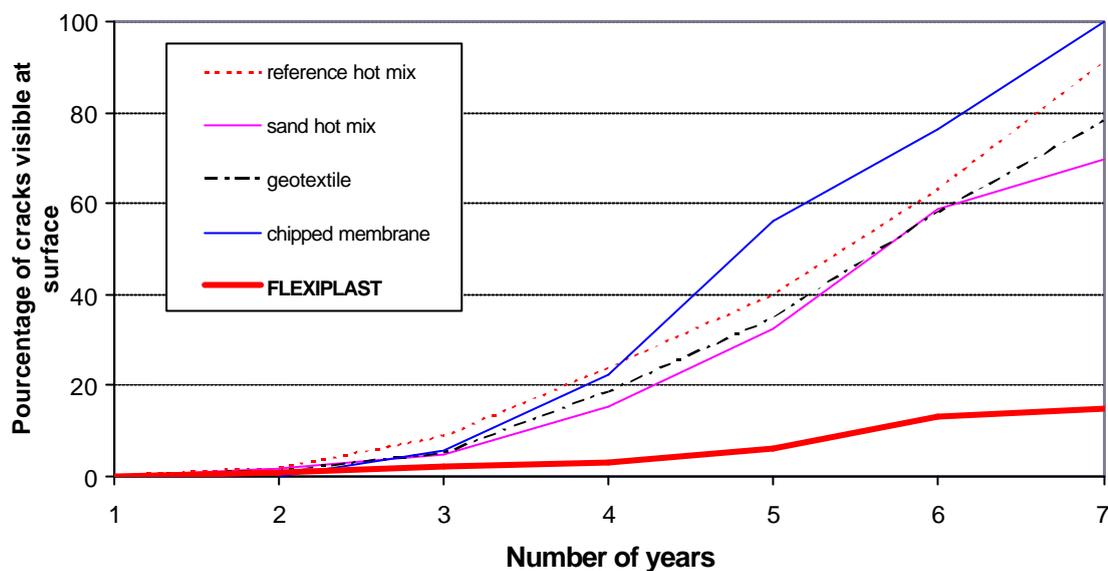


Figure 8

### 5. Bond coat

Thin, very thin and ultra thin hot surface course require more and more sophisticated bond coat system. The durability of such surfacing is considerably linked to the performance of the bond coat. Gripfibre slurry surfacing bond coat system presents the following advantages:

- ensure the perfect homogeneity of the bond layer due to the addition of fibers in the mix
- excellent bonding quality
- prevent pollution caused by the site trucks
- can be trafficked before placing the final surface course if the road must be re-opened to the traffic without any skidding problem.

The results carried out at the Eurovia Research Center on different bond systems over concrete support such as spraying bitumen emulsions modified or not can be summarized as follows (tests carried out with the Dynatest at various temperatures):

- For the tensile tests at 25° C, the resistance of the Gripfibre is 1.7 times higher than the best of the traditional bond coats realized with polymer bitumen emulsion. The bond coat tested is between a very thin layer of asphalt concrete and a binder course.
- Bond coats applied on asphalt concrete support and submitted to tensile stress at whatever temperature, it is the support which yields before the Gripfibre system contrary to the other bond systems tested.
- Lastly, the fibrous micro surfacing brings a sealing 10 times higher than that of the other tack coats.

To date more than 3 millions sq.m. of Gripfibre bond coat have been laid. The rate of application is about 5 kg/m<sup>2</sup> and the grading is 0/3 or 0/4mm.

It happens that the Motorway Authority can ask in the contract for a five years guarantee, concerning the bonding of the new surface course on its support, bonding is compulsory and measured by coring.

## 6. Other applications: colored surfacing

Colored micro-surfacing “Gripfibre” (red color, figure 9) have been used long time ago with normal bitumen emulsion. Recent progress has been made with regard to their composition, in particular their growth in cohesion over time and color durability.

New Gripfibre mix design use a semi-slow breaking cationic binders emulsion, with a synthetic binder of 70/100 pen, pigment in addition to fibers. Different color can be achieved and the choice of naturally colored aggregate participates largely to the final appearance (figure 10).



Figure 9



Figure 10

## CONCLUSION:

Gripfibre has a lower initial cost per square meter than thin surfacing hot mix, and lower whole life cost.

The technical objective of increasing the skid resistance of micro-surfacing to the level of thin and ultra thin hot mix on high- traffic roads was achieved by incorporating fibers allowing the use of gap-graded mix formula.

Gripfibre has high wear resistance, lasting skid resistance values and excellent surface uniformity making it ideal for surface treatment by using virgin aggregates or RAP.

Performance, thickness and acoustic comfort make Gripfibre valuable alternative to other techniques.

The use of fibers, the technological progress in terms of equipment and the experience acquired in the field enhanced the development of other applications beyond surface courses as:

- Fibrous micro surfacing bond coat providing an excellent bonding between the layers.
- Fibrous micro surfacing formulae Gripfibre as an essential part of the crack inhibitor system “Flexiplast” and has demonstrated excellent performance over 9 years

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