

RESTORATION OF SURFACE PROPERTIES OF CONCRETE PAVEMENTS: OVERVIEW OF PRACTICES AND ASSESSMENT IN FRANCE

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The highway pavement production chain has for many decades favored the durability of structures and comfort, seeking to achieve "maximum flatness" of pavements. Other objectives are also being increasingly stressed, such as minimizing disturbances to the environment, gradual investments along with better oriented maintenance policies or improved user safety. The traditional priorities assigned to objectives by agencies has been upset as a result of the many players and functions involved, the urban thoroughfare being the extreme case: many projects emphasize esthetic considerations and urbanistic designs in which are integrated the thoroughfares, "reservoir" pavement functions consisting of porous materials which cut off stormwater and reduce the number of improvements required, or the "noise absorption" pavement function consisting of other types of porous materials are experimentation and research approaches which testify to the value of an overall view of the design of highway facilities in which cement concrete techniques can offer interesting advantages and potentialities.

Highway safety is also a major issue, and priority is increasingly being given to this by agencies. Regulatory policies have shown their limits in this area, and actions focused on the behavior of motorists and the perception of surroundings, as important and as highly productive as they may be within the framework of development operations integrating this aspect fully, are difficult to apply generally in order to progress at the rate desired by the community. Actions on highway facilities still constitute one of the basic levers of a highway safety policy. In particular, it is necessary to promote any action aimed at improving skid-resistance by making the surface more uniform over the different routes and more compatible with skid-resistance requirements.

This is the essence of the new circular on the skid resistance of new wearing courses under preparation in France. Although, strictly speaking, it is applicable to new pavements, the circular offers a good framework for orientations and objectives in the future for the restoration of pavements using powerful mechanical processes. The adopted procedure is the following:

- 1 - Immediate publication of a provisional circular setting forth a policy for better meeting skid-resistance requirements in the choice and design of wearing courses, with recommendations stressing the qualitative aspects more than the quantitative aspects. The objective is primarily "instructional" and is aimed at initiating a change in relation to former documents which have become obsolete, while awaiting the publication of a permanent circular. Even if the thresholds set on the national level still need to be refined, there is a consensus regarding the need to achieve better awareness from everyone involved (agencies, contractors, managers, etc.) so that skid-resistance properties are truly taken into account in quality specifications and decisions.

- 2 - Initiation of a short-term research plan for the use of all data available in road data banks and mainly in the French data bank covering the national highway network, so as to detail the acceptability limits for skid resistance.

- 3 - Publication of complete and final circular within no later than two years.

The immediate application of the circular requires the following in practice as concerns pavement skid-resistance properties:

- 1 - Confirmation of complementary functions of microtexture and macrotexture.
- 2 - Offering a range of techniques making it possible to obtain the required macrotexture under normal construction conditions.

A/ - Functions of microtexture and macrotexture

Microtexture characterizes the presence of short wavelength irregularities (fraction of a mm) with sharp edges capable of piercing the water film. It determines the general skid-resistance level and depends on the ability of aggregates:

- to offer sharp edges and to maintain them as long as possible;
- to resist fragmentation;
- to offer good resistance to polishing, especially under intense traffic.

Satisfactory objectives are achieved in these areas using aggregates complying strictly with the conditions summarized in Table 1 (SETRA/LCPC Directive of April 1984 on specifications relative to aggregates; NFP 18 301 standard).

TRAFFIC CLASSES	T3	T3	T2	T1	T0	T0
TRAFFIC THRESHOLDS	50	150	300	750	2000	
HARDNESS OF CHIPPINGS						
. Los Angeles coefficient (4)	40			25		
. Micro-deval coefficient in presence of water (MDW) (4)	35			20		
AGGREGATE POLISHING RESISTANCE						
. Accelerated polishing coefficient (APC) (2)			0.45		0.50	
FRIABILITY OF SANDS						
. Sand friability coefficient	40		20(3)			

**Table 1 : THRESHOLDS OF SPECIFICATIONS
GUARANTEEING CORRECT AND DURABLE
MICROTEXTURE ON PAVEMENT CONCRETE**

- (1) Average daily truck traffic (TT - MDY) on most heavily trafficked lane. Trucks are all vehicles with a useful load greater than or equal to 5 metric tons (legal axle: 130 kN).
- (2) Applies to concrete pavements not covered with a wearing course or chippings.
- (3) The sand brittleness coefficient may be raised to 40 if the concrete pavement is covered with a surface dressing.
- (4) These three coefficients may be compensated within the limit of 5 units between the LA, MDW and 100 APC coefficients.

Note : Test procedure used to meet requirements.

French Standard NF P 18-573 October 1978 "LOS ANGELES TEST"

The purpose of this standard is to define the procedure for measuring the shock fragmentation strength of elements of an aggregate sample. The test consists in measuring the quantity of elements smaller than 1.6 mm produced by subjecting the material to the impact of standard balls in the Los Angeles machine.

French Standard NF P 18-572 October 1988 "MICRO DEVAL WEAR TEST"

The purpose of this standard is to define the procedure for measuring the wear resistance of an aggregate sample. The test consists in measuring the wear produced in a rotating cylinder under well-defined conditions, by friction between the aggregates and an abrasive load. For certain rocks, this wear resistance is not the same in the dry and in the wet.

French Standard NF P 18-575 December 1979 "MEASUREMENT OF ACCELERATED POLISHING COEFFICIENT OF GRAVELS"

The purpose of the test is to provide a relative measurement characterizing the ability of road gravels to polish under the effect of traffic. It includes two successive parts :

- specimens of gravels are first subjected to polishing action in a special machine (wear wheel with water and abrasives) ;
- the state of polish reached by each specimen is then measured using a standard pendulum.

French Standard NF P 18-576 October 1978 "MEASUREMENT OF FRIABILITY COEFFICIENT OF SANDS"

The purpose of this standard is to define the procedure for determining the fragmentation strength of sands. Only the elements of the sand larger than 2 mm are checked. The test consists in measuring the particle size changes produced in a rotating cylinder under well-defined conditions by fragmentation under a load in the presence of water.

Macrotexture characterizes the presence of roughness with wavelengths of the order of the centimeter. It allows the removal of water in the tire contact area and determines the loss of skid resistance with increasing vehicle speed. Macrotexture depends on the mix design, on pavement manufacturing and placement conditions, as well as on any surface treatment provided.

The property characterizing macrotexture is the texture depth with the sand patch test (HS). Detail technical specifications accompanying the provisional circular favors for the measurement of this value by means of the Mini Texture Meter (Figure 1). In the event of questionable results in relation to the specifications of the agency, use is made of the braking

force coefficient (BFC) (Figure 2).



Figure 1 : Mini Texture Meter for measurements.

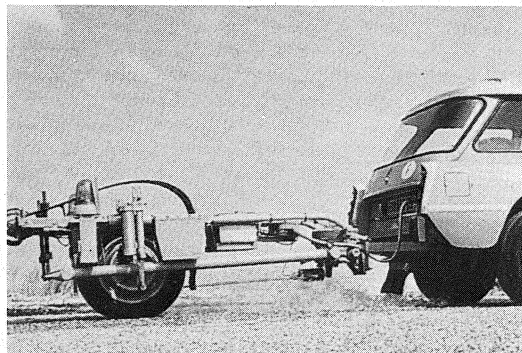


Figure 2 : LCPC skid trailer recommended for assessment measurements.

B/ Choice of surface treatment techniques

Table 2 provides skid resistance data relative to cement concrete pavements.

Table 2 : Extract from circular on the skid resistance of new wearing courses of the French national highway and freeway network. Suitability of cement concrete pavements and surface dressings with respect to the skid resistance criterion.

					Cement concrete	
					Grooved	bared Chippings
OBSERVATIONS OF TECHNIQUES						
Site	Speed (km/h)	Type of Roads	Type of facility	Configuration		
URBAN	60	Transit roads			1	1
	110	High speed roads		Entire route	2	1-2
				Singular zones	3	
RURAL	90	Two-way roads	Easy (normal skid resistance requirements)	Entire route	2	
				Singular zones	3	
			Difficult (high skid resistance requirements)			
	>110	Divided Freeway and express highways at 110 km/h	Easy route	Entire route	2	2
				Singular zones	3	
			Difficult route			2

Legend :

- ☐ Suitable for skid resistance viewpoint
Possible utilization reserves
- ☒ Suitable if certain design precautions are taken
- ☒ Not recommended in general

Footnotes

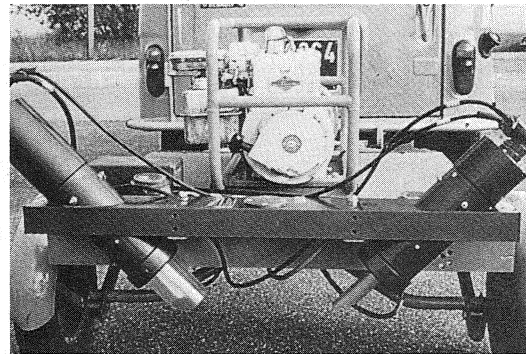
- (1) Suitable from the skid resistance viewpoint, with one reservation: disturbance to the environment from external rolling noise. For this reason, in urban areas, the choice of a small particle size (maximum aggregate size of 10 mm) is recommended. In addition, this technique is poorly suited to the treatment of singular zones (intersections, traffic lights, etc.) in urban areas.
- (2) Suitable from the skid resistance viewpoint, but this type of technique can cause a disturbance on long lengths because of rolling noise inside the vehicle.
- (3) Risk of fairly fast deterioration of skid resistance under heavy traffic; deep grooving is to be recommended.

This set of rules constitutes a framework for further consideration, requiring adaptation for the assessment of pavement quality in service and of skid-resistance restoration techniques. There are in fact:

- a variety of pavement surveying and evaluation systems, and preference should be given to those offering high output;
- methods for route analysis making it possible to integrate skid-resistance properties suitably in project priorities;
- specific restoration techniques, for which application areas are becoming increasingly clear as a result of over 10 years experience in certain cases.

PAVEMENT EVALUATION SYSTEMS

Pavement surveying devices used operationally in France for the evaluation of the highway network include the SCRIM (sideways force coefficient routine investigation machine) and the Rugolaser (continuous measurement of surface roughness and equivalent sand patch depth)(Figures 3 and 4).

**Figure 3: SCRIM****Figure 4: RUGOLASER**

The SCRIM was already described in earlier Purdue conferences; we shall consequently confine ourselves to some details on the Rugolaser.

The Rugolaser measures the roughness of the pavement using a laser-beam contactless sensor. The measuring instrument consists of a laser-beam emitter and a photodiode array (Figure 5).

This assembly is fixed 27 cm from the ground and the measurement range is ± 3.5 cm in relation to a neutral point of the pavement. The measurement acquisition-computation cycle is renewed every 25 cm. Every 40 cycles, i.e. every 10 meters, the system calculates the average value and the standard deviation of the "estimated roughness".

The measurement is carried out continuously under traffic at a speed of up to 100 km/h. Data is in most cases retrieved in the form of listings and histograms (Figure 6) giving directly the values of the sand patch depth owing to the excellent correlation between these values and the Rugolaser values.

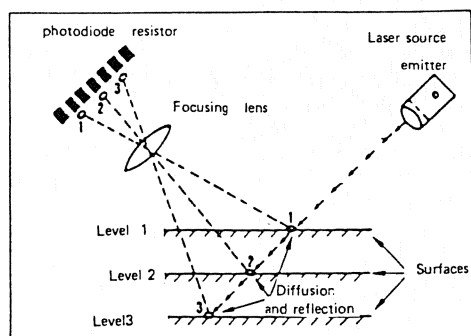


Figure 5 : Schematic diagram of Rugolaser sensor-receiver.

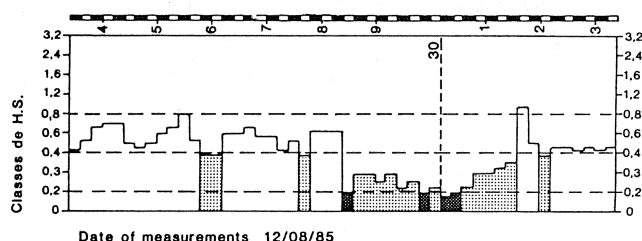


Figure 6 : Example of Rugolaser diagram with patch test depth given continuously.

In practice, the device is most often coupled with the SCRIM (installed on the SCRIM truck). It is then possible to obtain diagrams giving the two values (sideways force coefficient and patch depth) simultaneously (Figure 7).

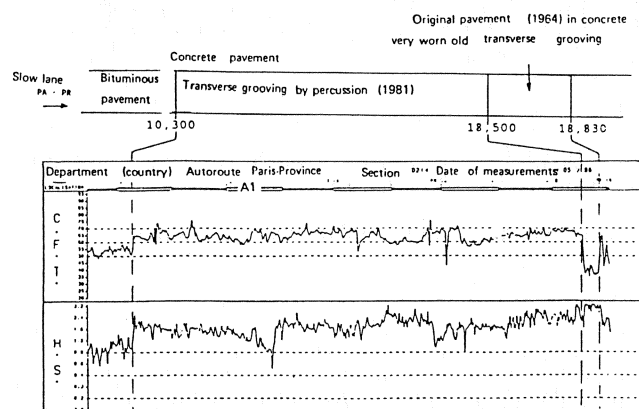


Figure 7 : Diagram of measurements carried out continuously and simultaneously with the SCRIM (sideways force coefficient SFC) and with the Rugolaser (sand patch height HS).

This diagram shows that the skid-resistance level is globally very satisfactory on this concrete pavement: SFC between 0.60 and 0.70 at 60 km/h, HS greater than 1.2 mm. It also shows the value of juxtaposing the two indicators (SFC and HS) in the zone between km 18.500 and 18.830. In fact, in this area, transverse grooving is very worn and simply measuring the sand patch depth yields a good value whereas the SFC shows a significant drop in skid resistance, detrimental to suitable skid-resistance uniformity.

In the left-hand part it is also observed that the examined concrete pavement offers higher performance than the adjacent bituminous section which was repaved with the use of new bituminous materials in a thickness of 2 m.

Special case of transverse grooving with diamond blade

In the case of grooving techniques using sawing, it is useful to determine the depth of the grooves and to follow possible variations with time. Contactless sensors can render great service in this area, by analogy with what took place with the measurement of the sand depth. This criterion is beginning to go into operational use on jobsites whenever it is possible to substitute the manual method for measuring the sand patch of jobsite equipment such as the Mini Texture Meter, or high output systems such as the Rugolaser.

ROUTE ANALYSIS METHODS

Methods employed by French concrete-paved freeway officials are based upon a common principle in which application methods leave considerable allowance for the specific nature of each type of network (concessionary or nonconcessionary freeway network, radial networks of urban areas or intercity freeway networks). Among the common aspects, the following may be noted:

- 1 - Safety based upon surface properties forms a significant part of the three basic criteria upon which is grounded the pavement monitoring system: structural deteriorations, evenness, comfort and safety (slab faulting) and skid resistance determined by the transverse force coefficient, cross-checked with the braking force coefficient.
- 2 - On these very heavily trafficked networks, systematic data are collected mainly by high-output devices capable of operating under traffic (longitudinal profile analyzer in its various forms, comfort, safety, structure and SCRIM). The devices carry out surveys every 4 years approximately on pavements exhibiting no particular problems. However, as soon as an indicator shows pavement conditions approaching a critical threshold or fast deterioration, the surveying intervals are reduced to 2 years. High-output devices are used primarily as alert indicators. More detailed investigations are carried out on doubtful sections.
- 3 - Pavement monitoring has an effect only on pavements whose structure, history and traffic are known. Most highway agencies make substantial investments on investigations when the pavement goes into service (zero points), making it possible to better determine the deterioration patterns which play an important role in the preparation of decisions.
- 4 - The analysis carried out by agencies is based to a great extent on:
 - schematic overall representations (general diagrams supplemented by specific diagrams). A multi-criterion analysis is already carried out at this level
 - quality indices which in certain cases are also used in a multi-criterion synthesis leading to a classification of priorities.

Figure 8 is an illustration of such an analysis. The number of criteria takes into account the degradation (degraded slabs and deterioration classes), evenness (short, medium and long wavelengths) and slab faulting. It will be noted that, in varying degrees, each of these components involves questions relative to both the safety and the durability of structures.

In addition, skid-resistance properties properly so-called (measurements of SFC, BFC, HS and longitudinal faulting between slabs) act as independent alert criteria since they are not integrated within the notation system which establishes priorities on the basis of the highest "value added" (focus on points in which the cumulative number of defects is greatest).

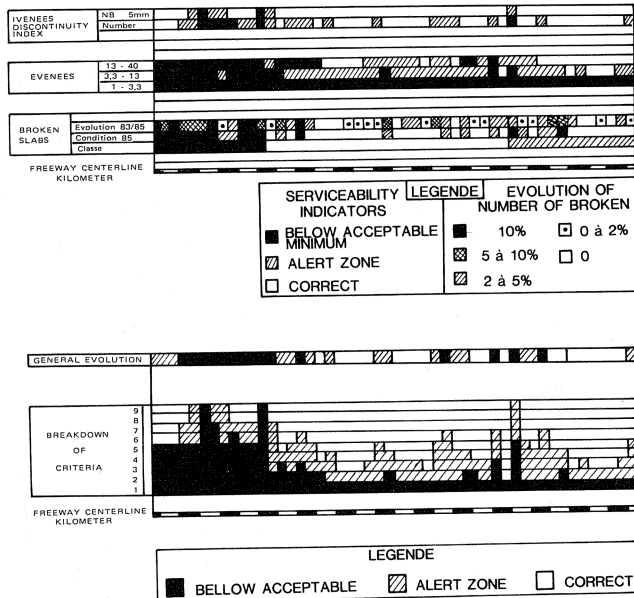


Figure 8 : SAPRR/A6 - TOURNUS/MACON Nord - PARIS/LYONS direction - Synthesis of pavement condition indicators - Grouping of criteria

When an agency wishes to apply a very strict policy with respect to safety, it examines each "skid resistance" criterion independently and programs the emergency work as soon as an inadmissible threshold is reached, and maintains the alert when a doubtful value is revealed. An example of guidelines used in this case is illustrated in Table 3 in which class C corresponds to emergency intervention and class B initiates a first alert.

INDICATOR	CLASS A	CLASS B	CLASS C
LONGITUDINAL FAULTING	7 mm	7 to 12 mm	12 mm
BRAKING FORCE COEFFICIENT (120 km/h)	0.22	0.17 to 0.22	0.17
MACROROUGHNESS - SAND PATCH DEPTH	1.2 mm	0.8 to 1.2 mm	0.8 mm
SIDEWAYS FORCE COEFFICIENT (100 km/h)	0.55	0.45 to 0.55	0.45

Table 3: Example of guidelines for surface properties

5- The range of tests calls for their prioritization. SFC measurements are readily used for monitoring highway networks owing to their high output possibilities. HS measurements are used for acceptance testing on projects owing to their convenience (simple and available devices). On the other hand, within the freeway network context with its specific geometries, the BFC constitutes the final arbiter on which assessments are made for decisions.

6- As shown in the above-mentioned multi-criterion example, the

examination of pavement roughness properties must never be associated from an overall analysis of the structure. Structural quality determines to a great extent whether use is to be made of certain surface restoration techniques which will be described below.

RESTORATION TECHNIQUES

The techniques described below and the teachings that their application to heavily trafficked pavements make it possible to derive for France are applied today almost exclusively on old pavements, or those having already handled significant traffic for some time (at least 5 years). For new pavements, unlike the situation existing when substantial investments were initially made for restoration techniques, present methods make it possible to settle the problem directly and very effectively (differentiated surface layers - cf. article by Verhée -, chemical etching, chippings, deep grooving, and so forth). Nevertheless, almost 15 years' experience with old pavements has proven very useful for the many kilometers of existing pavements, especially as these often correspond to strategic routes, and for the future of new pavements constructed in recent years.

Three approaches are used in France: surface dressings, sawn grooving and, more recently, surface peening.

Surface dressings

Subject to very strict precautions and recourse to experienced contracting firms, this technique has been undeniably effective in its application area after 15 years of perspective.

The typical mix design for freeway applications is a single layer of bitumen with two layers of chippings (1.5 kg/m² of elastmer-bitumen binder, 13 kg/m² of chippings of 10/14 mm of excellent hardness, for very high traffic levels, up to Los Angeles 10) and polishing resistance (APC 0.50) and 7 kg/m² of chips of 4/6 mm with the same characteristics). Two surface dressing layers with modified bitumen emulsion have sometimes also been placed. Several million m² have been applied, even if the underlying surface was formerly grooved. To date, several hundreds of kilometers of concrete truck lanes have received their third wearing course using this mix design.

The service lives of these pavements are determined firstly by the function of the lane (truck lane) and secondly by the structural condition of the pavement (Table 4).

STRUCTURAL CONDITION TYPE OF LANE	GOOD	FAIR
HEAVY	7 years	4 to 5 years
LIGHT	12 to 15 years	8 years

Table 4 : Service life of surface restorations using surface dressings on a concrete pavement freeway handling To traffic (2,000 to 4,000 trucks per day on most heavily trafficked lane).

In every case, the service life of these dressings varies with the amount of scabbing at concrete slab joints, occurring earlier if the structure is doubtful (slab deflection), or scabbing due to accidents even if they are smaller in number, or even to heterogeneities due to the patching of fractured slabs.

Skid-resistance properties always remain excellent, even at the end of the pavement's service life. Measurements conducted on such surface dressings after 10 years yield average BFC values of 0.40 at 120 km/h (see class A in Table 3). The service life figures given in Table 4 are to be managed with the other structural requirements of the pavements.

In particular, on truck lanes, joints are repaired on the average every 5 years or, most often, one year before the surface dressing. The photographs in Figures 9 to 10 illustrate the characteristic appearance of the pavement in the middle of its service life and at the end of its service life.



Figure 9 :

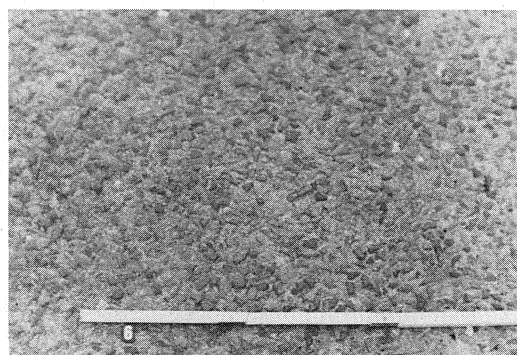


Figure 10 :

General appearance of surface dressing and texture on a section having a sound structure after 4 years (traffic of 350 trucks per day on truck lane).

For the traffic range considered -- up to 4,000 trucks per day on the most heavily trafficked lane -- this technique is very efficient for pavements in good structural condition, and can be optimized in conjunction with structural maintenance treatments in the case of structures in poor or deteriorating condition. The "connector-dressing" combination constitutes a package which is altogether suited to pavements handling heavy but not exceptional traffic, and for the rural network.

Grooving

Grooving techniques, like surface dressings, have been under investigation in France for the past 15 years or so. The definition of a policy has however been marked more by external events (user pressure groups) or by the appearance of innovative equipment.

The principle of grooves is to create drainage channels on the concrete surface to allow the removal of water under tires in the tire/pavement contact area.

In fact, there is a twofold effect:

- faster drying of pavement surface (preventive effect);
- easier expulsion of water under tires (instantaneous effect).

Grooving by percussion (breakup of concrete by impact) has, like hammering, not been used extensively owing to the aggressive aspect of the treatment and its harmful effects with regard to joints. On the other hand, such grooves have demonstrated very satisfactory performance even after several years of service (more than 10 years). They have been preferred over diamond-blade grooving, which was widely used in both the longitudinal and transverse modes. The following results have been obtained:

- 1 - For the first years, short sections corresponding to zones having a special geometry and environment (ramps, gutters, slope transition zones or zones in which high accident rates have been observed on wet pavements) have been treated. Good local results have been obtained, but this policy has shown the limits of the great heterogeneity of routes so that the objective of treating routes continuously was considered several years after.
- 2 - This evolution came up against the problem of equipment. Longitudinal grooving, the privileged method for complete routes, was forbidden in France owing to pressure from cycle users (tracking and wobbling caused by large spaced grooves (50 mm). It was not until 1984, when Société Gailledrat developed a transverse grooving machine suitable for large projects under traffic, that very satisfactory qualitative and quantitative results were obtained, for example in the surface restoration of fast and middle lanes on truck lane rehabilitation projects.
- 3 - Optimum efficiency of transverse grooving is obtained for a grooving area of about 12% of the total area. This percentage is predominant in relation to grooving methods (groove width, spacing of grooves). On the other hand, for longitudinal grooving, use must be made of fine grooves closer together rather than large grooves with larger spacing, which also limits the tracking experienced by cyclists.
- 4 - The flatness of the concrete surface and compliance with grooving depths are essential for obtaining good results with the required durability (7 to 10 years). The average depth of grooves making it possible to obtain the best compromise between durability and cost is of the order of 6 mm. This means that, under old pavements with poor evenness, the depth reached over 90% of the concrete surface is 4 mm.

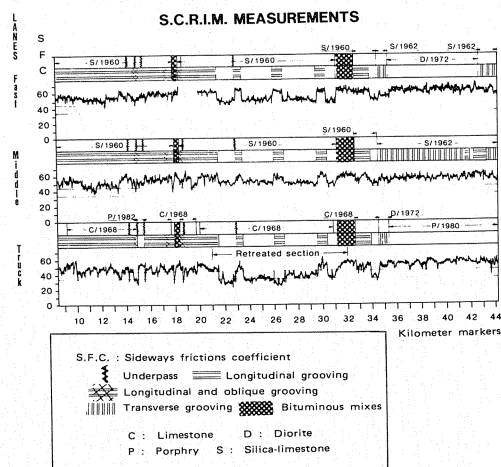


Figure 11 : Example of results obtained on a freeway after restoration of surface properties.

Comments on Figure 11:

- 1 - On the truck lanes of this freeway, there are sections exhibiting SFC values lower than 0.35 at 60 km/h, which are insufficient

and require priority intervention. These values correspond mostly to ungrooved limestone concrete.

- 2 - In the fast lanes, there are practically no values lower than 0.45. On silico-limestone concrete, one observes a significant gain afforded by longitudinal grooving (section from markers 22 to 31 with three small zones corresponding to increases in SFC of +0.10 on the grooved zones). Diorite concrete about 10 years old is particularly good.
- 3 - For the same type of pavement and surface treatment, the middle lanes exhibit SFC values higher than those found on truck lanes: +0.10 (analysis in both directions of traffic).

Peening

Although very old, this technique has been used operationally on a large scale on freeway projects under traffic only since a year ago, using American equipment adapted by Société Gailledrat (Figure 12). It is a technique with an application area complementing that of transverse grooving. Its main purpose is an increase in output.

The process uses steel balls which are projected on the pavement and recovered by suction and recycled after bouncing.

The impact of the balls has three main effects:

- 1 - Cleaning of surface (function originally desired for removing type marks on airport runways and the preparation of concrete surfaces and overlays).



Figure 12 : Peening plant re-treating the surface of freeway A6-Essonne; maximum application with 2.25 m; execution speed: 1 to 15 m/minute.

- 2 - The equipment removes the surface mortar around the aggregates (increase in macroroughness).
- 3 - It pigments the aggregates making up the pavement and improves microroughness.

Short-term results obtained on the first freeway projects handling very heavy traffic in the Paris area are altogether encouraging. On silex concrete, the sand patch depth increased from 0.4 to 1.5 mm and the braking force coefficient at 90 km/h increased from 0.11 to 0.43.

Conclusions on techniques for restoring skid-resistance properties

To deal with this recurrent question of the maintenance of surface properties as part of an increasingly emphasized safety policy, use is made in France of two techniques which have become perfectly mastered after 15 years of practice (surface dressings and transverse grooving by sawing), and a technique which is more recent in this area but the results of which are very promising and have to be confirmed. Sufficient perspective is available so that officials can work out a policy without stumbling over unrealistic methods or innovations. These techniques have been proven under traffic of 40,000 vehicles/day per direction on freeways in the case of surface dressings, with a maximum of three successive resurfacings, possibility of differentiating the treatments by lane as a function of the aggressiveness of loads (grooved truck lanes and fast lanes with surface dressings, etc.), maximum distance between traffic lane and a resurfacing, difficulty of completing two treatments successively by diamond-disk grooving, and so on.

These techniques are satisfactory, but if one wishes to achieve the level of performance required by users, in particular on very heavily trafficked facilities leading radially out of major urban centers, this range of techniques is liable to be insufficient in the short term. It is now necessary to integrate all the requirements with regard to user comfort in addition to safety, which is the basic function sought through these techniques. Among the questions that will decide on the choice of these techniques and perhaps on whether recourse will be had to innovative approaches, mention may be made of the following:

- 1 - Is there a traffic level beyond which it will no longer be possible, for objective and intuitive reasons, to differentiate the surface treatment of different lanes? Would it not also be necessary to define new thresholds as concerns project requirements so as to ensure the smallest amount of disturbance to users?
- 2 - The noise caused by the different surface treatments is a factor which will be given increasingly greater consideration, as regards both internal noise for vehicle occupants and external noise for the surrounding population. Optimization possibilities, pavement texture, rolling noise level at the tire/pavement contact, have not all been explored yet in this area. The exploration of the use of porous concrete in wearing courses also makes it necessary to go as far as possible in this respect.
- 3 - Against this background, the optimum management of pavement lanes from the threefold viewpoints of structural appearance, surface properties and environment becomes more complex. The use of management models is thus becoming increasingly necessary.

GENERAL CONCLUSIONS

As is often the case in highway engineering, goals are reached only by combining various actions which would individually have only a limited effect.

The restoral of surface properties on short sections which are found to be particularly accident prone in the wet, as well as over an entire facility are a piece of the puzzle contributing to highway safety in general. It was of interest to define in this regard a core of reliable approaches backed by 15 years of experience on the heavy traffic freeway network of France (surface dressings, transverse grooving and possibilities offered by peening).

The lessons to be drawn from this synthesis based upon an experimental approach should not conceal the need for pursuing experimentation and research into equipment and techniques which are innovative from two stand points:

- Improving outputs and costs through the effect of a broadened

market (1992 for the EEC). This also presupposes the need for pavement evaluation systems whose performance possibilities are in keeping with the high production outputs of projects.

Considering surface property constraints from the more global viewpoint of better pavement service levels, allowing better integration of behavioral and environmental aspects. In general, the pavement must perform more and more functions, in addition to its primary function which is to ensure smooth traffic flow under acceptable conditions of priority, comfort and safety and, for certain traffic configurations, also related to urban and peri-urban requirements. Some trends appear to show that exceptional quality service levels will exceed conventional concepts for which we are now well equipped with respect to pavement evaluation systems, methods and operational techniques.