State of art of surface adherence considerations in Argentina

Authors:

Marta Pagola
Researcher, IMAE Road Laboratory, National University of Rosario, Argentina
Berutti and Riobamba, 2000 Rosario, Argentina, pagola@fceia.unr.edu.ar

Oscar Giovanon
Director and Researcher, IMAE Road Laboratory, National University of Rosario, Argentina

ABSTRACT

In Argentina pavement auscultation has begun in 1960, when the National Road Administration created a special Department. In that time two Mu Meter equipments were bought and network surveyors have begun.

Since then surface adherence consideration has changed. Nowadays two characteristic parameters of surface are analyzed: texture and friction, and IFI concept have been introduced. Moreover, polished stone resistance of aggregates has begun to study, and quarries are being analyzed in systematic way working together with National Road Administration.

Part of this evolution was because of Road Concession implementation, in 1990, when new surface layer materials were introduced from foreign countries, especially from Europe, considering improvements to user's security.

In agreement with surface materials evolution, new equipments were incorporated in National Road Administration and in private companies, Grip tester and Scrim Tex.

Finally, research results have been used to modify Specifications, introducing IFI concept.

In the paper, the evolution and some results obtained with new considerations are shown.

1. INTRODUCTION

Road surface adherence is one characteristic parameter of surface that has influence on driver security; it is related with stopping distance and control of vehicle during travels. In general, drivers feel when the adherence is reduced or it is no present, situations that happen when the road surface is wet or with ice, and there is the possibility of slipping.

The surface of road and specially the aggregates that are inside surface layer must have certain characteristics to give security conditions to road users:

- Break the water film that covers the road surface during rain, giving a real contact between wheels and road surface.
- Give the possibility that water that is under wheel drains.
- Maintain secure conditions for users all the time.

The first of these conditions depends, fundamentally, on aggregates surface conditions, at the beginning and during service conditions under traffic. This characteristic is related with irregularities present on aggregates surface and it is called microtexture.

The second condition depends on surface texture; it is related with aggregates gradation and with works realized over it, like grooving on cement concrete.

As a conclusion of previous considerations, it is evidently that the use of aggregates composed with mix of minerals, polish resistant, open gradation, the size of aggregates, etc, are factors that have an important influence on surface texture, and therefore on surface adherence, an finally on security given to users.

In a secure users driving are involve different factors: the driver, the surrounding, the vehicle conditions and the road surface. In general, road surface adherence is enough when surface is dry; and it decreases in an important way during rain because there is a water film between wheels and surface.

To use the adherence capacity that road surface can give, other aspects related with road have to be fulfilled, like:

- Good geometric design (radius of curve, transversal and longitudinal slopes)
- Draining system that take out the water from the surface very quickly
- Correct shoulder level that does not interrupt water draining

2. SURFACE LAYER MATHERIAL

Traditionally in Argentina, hot mix asphalt was used to build road surfaces, with low texture and designed from structural point of view to resist traffic load and to preserve the structure from water.

Since 18 years ago, maintenance and reconstruction of many kilometers of roads have changed from public administration to private companies. From that moment, the adherence consideration has begun, and many kilometers have been covered with new special surfaces types, like SMA, porous and thin layers.

3. EQUIPMENTS

In Argentina, road auscultation has begun in decade of 1960 and had a similar evolution that has happened in the world, but slowly. Since then, private and from National Road Administration professionals have had constant participation in international congresses and courses to complete their formation and to maintain actualized with new developments and researches.

Studies and activities relates with road surface adherence have taken more importance since the beginning of road concessions, when new surface types have begun to use to fulfil new exigencies originated from traffic increment.

The first equipments were Mu Meter, in use for the National Administration since 1980 to survey friction coefficient in periodic measurements on national network. The TRRL Pendulum was in general used in researches. In the last time, other devices were incorporated to routine surveys, like Griptester and Scrim Tex.

Following there is a description of different equipments in use, and working conditions adopted.

3.1. SKID RESISTANCE

In Argentine, there is more than one type of equipment to measure skid resistance. These devices are very different in design and working conditions and therefore the results obtained cannot be compared. Because of that, when IFI index was defined the equipments were calibrated and their results compared using this index.

3.1.1. Mu Meter

The first equipments were Mu Meter, in use for the National Administration since 1980. They were used to measure friction coefficient in national network routine surveys. The original equipments had mechanical acquisition and data recording on paper; and the watering of surface were done in a previous way from another vehicle. Nowadays, the equipments were modified and have electronic data acquisition on PC and self watering system.

The Mu Meter is a small trailer that measures CFT (transversal friction coefficient), this equipment is appropriated to be used in airport, but in Argentine it is used to survey roads and airports. The two measurement wheels have 15º between them. Working conditions adopted for road measurements are speed 60 Km/h and water depth 1 mm. Two devices of this type are in use and were calibrated respect to IFI.

The Argentina Air Force has various Mu Meter equipments and they are used to measure airport conditions.


Figure 1. Mu Meter equipments

3.1.2. TRRL Pendulum

Other equipment in use is a TRRL Pendulum. Fundamentally, it is used in section studies, because his operation is slow. It measures CFL or CFT, depending on its position over the surface. The measurement is realized on wet surface, and the slider speed is approximately 10 Km/h. In Argentina there are various equipments of this type in use in private and public organizations.

Figure 2. TRRL Pendulum

3.1.3. Griptester

The Griptester is a light trailer with three wheels, where the central back wheel measure friction coefficient. It measures CFL (longitudinal friction coefficient); the friction wheel is blocked and has 14 % of slippery resistance. Working conditions adopted for road measurements are speed 65 Km/h and 0.25 mm of water depth. It is in use in a private road concession.

Figure 3. Griptester equipment

3.1.4. Scrim Tex

The Scrim Tex was acquired by the National Road Administration in year 1999 to WDM Ld. of England. Because of administrative and custom problems it was stopped during various years, but nowadays it is working properly and doing measurements on national road network.

In the same vehicle there is a water tank and the measurement system. The water tank has 5000 litre of capacity, giving the possibility to survey long distances. The equipment has one wheel mounted on each side of vehicle to measure friction coefficient. Wheels have 20º of deviation and measure CFT. Working conditions adopted for road measurements are speed 50 Km/h and 0.50 mm of water depth.

Figure 4. Scrim Tex

3.2. TEXTURE

With respect to surface texture, the generalized methodology in use in Argentine is volumetric, using sand or glasses beans.

Figure 5. Sand patch equipment

Scrim Tex equipment has two laser sensors to measure texture, located at both sides of vehicle and it reports one result each 10 metes of road. It has three ways of signal processing: MPD Lin, MPD Curve, and RMSTD.

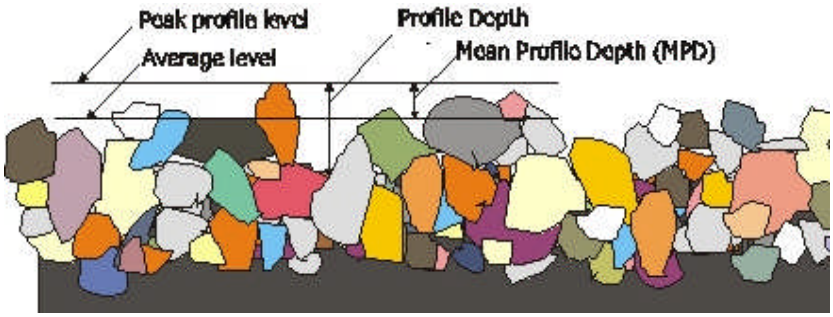

Figure 6. Texture parameters

MPD analysis was adopted in ASTM Standard E 1845 “Standard Practice for Calculating Pavement Macrotexture Mean Profile Depth”, and the RMSTD is the traditional parameter used in England to express texture results. In Argentina, MPD Lin unit was adopted.

Results of texture obtained with laser MPD and sand patch are different. Using measurements realized in road sections the relationship between them was analyzed. The equation obtained is:

ETD = 0.55 MPD Lin – 0.06 where: ETD and MPD are in [mm]

This relationship is different from one indicates in ASTM 1845, but the same situation has been reported previously by another authors.

3.3. CALIBRATION RESPECT TO IFI

In the world and in Argentina too there are many different devices to measure skid resistance and texture of road surfaces, all of them works on their own units and they are non comparable. Because of that, during 1992 an international experiment was carried out to compare and harmonize these methods, under supervision of the PIARC Technical Committee for Surface Characteristics.

The general objectives of PIARC experiment were:

- Develop relationships between skid resistance measurements and texture measurements using various devices on various road surfaces
- Quantify relationships between the results recorded by the various devices
- Analyze repeatability and reproducibility
- Develop a new international scale of friction values, to be used for all of devices

The most important result has been to obtain an international scale, the IFI. This parameter is calculated from two surface measurements: friction resistance and texture. As is said in PIARC Report, the IFI should be used in every situation related with skid resistance, like: accidents, road management, runway surveys, etc. However, the most important aspect is that from now, the experiences of different administrations can be interchanged.

3.3.1. IFI application methodology

To perform calibration respect to IFI of equipments in Argentina, the following methodology was used, proposed in the International Experiment final report:

- Selection of road sections covering a wide range of friction and texture

- Measure sections with devices that have worked in the experiment and obtain the IFI using the constants defined in that opportunity. (In the present analysis were used the TRRL Pendulum and volumetric method)
- Measure sections with all new equipments
- Determinate the specific constants for new equipments

3.3.2. Calibration constants obtained

Were selected 27 sections on in service roads and they were measured with equipments, more than five times. All surveys in each section were made during the same day, to minimize seasonal variations. There were a variety of mix surfaces: 7 conventional asphalt concrete, 6 aging asphalt concrete, 5 thin asphalt layers, 1 porous mix, 4 SMA and 4 cement concrete.

The measurements taken as reference were: friction with TRRL Pendulum and texture with volumetric method using sand.

Following the methodology described the equipments were calibrated. The constants obtained for equipments are:

IFI CONSTANTS					
Friction	**Texture**	**a**	**b**	**A**	**B**
TRRL Pendulum	Sand patch	-11.5981	113.63	0.07784	0.00709
Scrim Tex	Laser MPD Lin	-16.4452	60.63	0.0738	0.00664
Mu Meter 2	Sand patch	-11.5981	113.63	0.0867	0.00708
Mu Meter 1	Sand patch	-11.5981	113.63	0.0818	0.00808
Griptester	Sand patch	-11.5981	113.63	0.0751	0.00663

Figure 7. Calibration constants obtained for friction equipments

4. MIX DESIGN SPECIFICATION

As was said previously, the most material for road surface layer is hot asphalt concrete, with low texture and designed from structural point of view to resist traffic load and to preserve the structure from water.

In the last years, new technologies applied in road design and constructions have improved comfort and security of users. Related with aggregates, they use materials with high polished stone value.

The polishing stone test is widely used to study this aggregate resistance. In the year 1998 the equipment was bought by the University and the research has began. Working together with National Road Administration a group of quarries were analyzed, first looking for one which aggregate could be used as control stone and after that to characterize commercial materials.

To select a control stone the standard NLT 174 from Spain was adopted because in this moment European standards were no ready to use. An inter laboratory study was performed with the Laboratory of Spanish Ministry of Fomentation in Torremolinos, because this laboratory has a wide experience in PSV test.

In road construction in Argentina the most usual aggregates are granite. This is because the biggest part of road network is located in areas where the aggregates are of this type. Argentina is an extended country and transportation distances are very long, then they have strong incidence in road construction costs.

In the study quarries of different materials like granite and basalt where considered, but finally a commercial granite quarry was selected. The macroscopic analysis of granite shows a material of dark grey and red colours, with medium size grains, integrated with quartz and feldspar. In average it has 35% quartz and 40% feldspar.

The PSV value of this material is very low, 40, but it is representative of granites in use in Argentina.

Figure 8. View of granite quarry

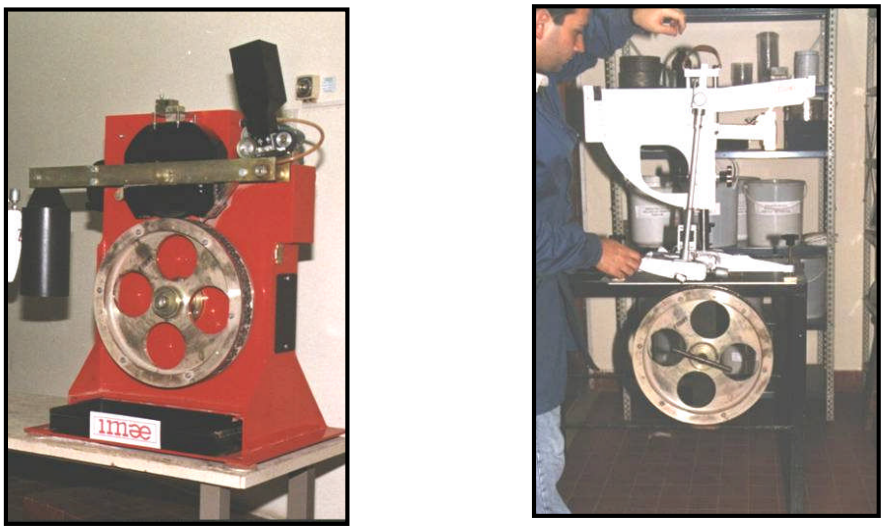

Figure 9. PSV Equipment, polishing and measuring

In year 2002 the Argentine National Institute for Normalization (IRAM) decided to incorporate PSV standard into its pack of standards. It was developed in base of UNE-EN- 1097-8 and the granite material analyzed was incorporated as local control stone. The Argentina Standard is IRAM 1543 “PSV Coefficient Determination”.

Since 1999 there exists an agreement between National Road Administration and IMAE Road Laboratory. The principal objective of work is to characterize stone quarries in Argentina. Three tests were adopted to analyze aggregates: Los Angeles, PSV and Micro Deval.

Nowadays the majority of commercial quarries were tested. In Figure 10 PSV results of some of them are shown. The next activity is to look for materials in the rest of the country, which is a difficult work because of country extension.

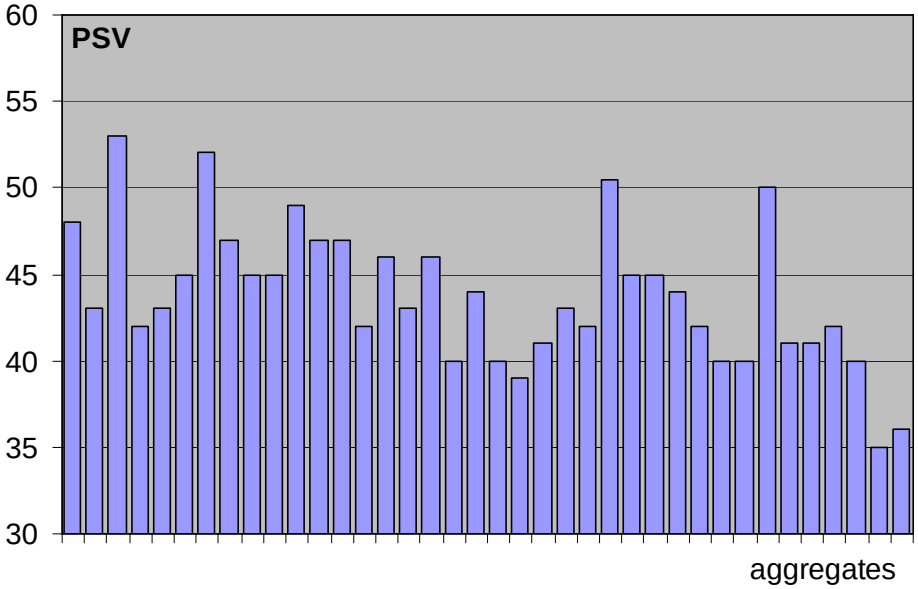

Figure 10. PSV results of some commercial quarries in Argentina

5. SPECIFICATIONS

In Argentina specifications of National Road Administration for new asphalt surfaces there are only exigencies for friction coefficient expressed in Mu Meter units, but they are old and now they are being modified. The new specifications are going to take in consideration open aggregate gradation to obtain high texture and PVS limit, depending on road quality and traffic volume.

Since Road Concession begun, in 1990, there were established limit values for in service roads. At the beginning the limits were only for friction coefficient and expressed in Mu Meter units. In agreement with them, the section average friction value had to be equal or higher than 40 (considering a range from 0 to 100).

Currently there are new specifications for road concession. They fix limits for texture and for F60 (IFI). For texture specifications: the average of kilometer has to be equal or higher than 0.3 mm, and no one value has to be lower than 0.2 mm. For F60 limits: the average of kilometer has to be equal or higher than 0.14, and no one value has to be lower than 0.12.

Related with limits in use in other countries these limits are very low, but they represent the reality of country.

6. FINAL COMMENTARIES

Adherence considerations in Argentina are changing. Not a long time ago they were very poor. Nowadays road user security is being considered and more exigent specifications are being developed, and there are better equipments in use for the National Road Administration.

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