Dipartimento DIIES

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https://scholar.google.com/citations?user=mulQMbgAAAAJ&hl=en

http://www.unirc.it/scheda_persona.php?id=668

http://www.unirc.it/ricerca/laboratori.php?lab=41

Sommario

Notizie biografiche (Short biography)

NOTIZIE BIOGRAFICHE.

Nato il 6 luglio 1963 a Reggio Calabria, dopo il diploma di scuola media inferiore (Spanò Bolani – *Reggio Calabria*, ottimo/ottimo) e superiore (Alessandro Volta - *Reggio Calabria*, 60/60), ha conseguito la laurea in Ingegneria Civile presso l'Università di *Pisa* (110/110) ed il dottorato di ricerca presso l'Università di *Palermo* (Dipartimento DIIV).
Prestato il servizio militare e conclusa la prima esperienza industriale, ha iniziato a lavorare presso l'Università *Mediterranea*:

- Ricercatore (2000-2002);
- Professore associato (2002-);
- Abilitato Professore ordinario (tornata concorsuale 2012).

Direttore del Laboratorio di Prove sui Materiali Stradali, Ferroviari ed Aeroportuali, ha ricoperto/ricopre diversi incarichi alla *Mediterranea*, in ambito internazionale e nazionale.

Tesi (Laurea/Master/Bachelor/Ph.D. Theses): >100

Corsi: http://www.unirc.it/scheda_persona.php?id=668

Progetti di Ricerca/ aree principali di ricerca (scientifica o/e industriale) e le principali tematiche didattiche includono la sicurezza stradale, ferroviaria ed aeroportuale, i materiali stradali, ferroviari ed aeroportuali, i cantieri ed i numerosi aspetti relazionati a tali domini di ricerca (cfr sito: http://www.ing.unirc.it/scheda_persona.php?id=668):
• Proprietà superficiali delle pavimentazioni e geometria dei tracciati stradali;
• Manutenzione delle pavimentazioni stradali;
• Sicurezza e geometria delle infrastrutture di trasporto;
• Sicurezza intrinseca delle infrastrutture;
• Problemi inerenti all'esercizio delle infrastrutture di trasporto;
• Ottimizzazione progettuale delle Infrastrutture di trasporto, inclusa la cantieristica;
• Gestione delle emergenze infrastrutturali e mitigazione dei rischi nei trasporti Hazmat;
• Riciclo;
• Rischi ambientali;
• Inquinamento acustico ed atmosferico da traffico veicolare;
• Materiali stradali, ferroviari ed aeroportuali;
• Modelli costitutivi del conglomerato bituminoso;
• Conglomerati bituminosi speciali;
• Grandezze fondamentali ed empiriche per la stima dell'apporto meccanico dei sottofondi;
• Riciclo a caldo ed a freddo dei conglomerati bituminosi;
• Approccio volumetrico al progetto delle miscele bituminose;
• Impiego di materiali innovativi e/o di risulta nel solido stradale, ferroviario od aeroportuale;
• Grandezze e strumentazioni innovative per l'analisi delle proprietà funzionali del piano di via;
• Approcci meccanicistici al dimensionamento sovrastrutturale;
• Analisi agli elementi finiti e validazioni sperimentali.

SHORT BIOGRAPHY.

Filippo Giammaria Praticò earned his Laurea Degree in Civil Engineering from Pisa University and his Ph.D. from Palermo University.
After a period in industry, *Filippo* joined the *Mediterranea* University of Reggio Calabria and became Associate Professor in 2002, habilitated as full professor in the 2012 call, serving as Deputy of the Master School, Deputy of the DIMET Department, Director of the Road Laboratory.
He is Member of a number of international committees.

Theses (Laurea/Master/Bachelor/Ph.D. Theses): >100

Courses:
http://www.unirc.it/scheda_persona.php?id=668

Main Areas of expertise/Research Projects:
Civil Engineering;
Transportation and Geotechnical Engineering;
Life cycle cost analysis and Infrastructure Asset management;
Construction and infrastructure management;
Sustainability and environmental impact of construction projects;
Road, Railways and Airport Materials quality;
Marginal and recycled materials;
Road, Railways and Airport safety and geometrics;
Road and airport surface properties;
Road, Railways and Airport workzones;
Road, Railways and Airport crises management;
Application of navigation and positioning systems to transport by air, by sea, by road, by rail; environmental issues.

Esempi di Ricerche con colleghi della Università Mediterranea (Research At The Mediterranea)

Corriere F., Lo Bosco D., Praticò F.G., Scopelliti F.,Un modello matematico per l'analisi sistemica delle prove di laboratorio; la ricerca del legame fra il coefficiente di gelività di una terra ed altri indicatori di qualità del materiale, Convegno SIIV, I materiali nella sovrastruttura stradale, Ancona, 14-16 Ottobre 1996.

Lo Bosco D. Praticò F.G., L'analisi del sistema "variabili-unità di osservazione" nello studio di ottimizzazione progettuale per un'infrastruttura di trasporto, Reggio Calabria, 24.10.1995, Atti della Facoltà di Ingegneria dell'Università degli studi di Cagliari, Ottobre 1996.

Bevilacqua A., Praticò F.G., Una metodologia di ottimizzazione per l'analisi del rischio nell'esercizio di un'infrastruttura stradale – Caratterizzazione di una specifica tecnica statistica multivariata, Giornata di studio sul tema: La sicurezza intrinseca delle infrastrutture stradali, Roma, 20/21.02.97.

Lo Bosco D., Praticò F.G., L'analyse du système "variables – unités d'observation" dans l'étude d'optimisation de project pour une infrastructure de transport, Seminarberichte aus dem Fachbereich Mathematik, herausgegeben von den Dozenten der Mathematik, FerUniversitat, Gesamthochsule in Hagen, Band 57, 1997, ISSN: 0944-5838. Memoria accolta anche nelle Mémoires de l'Académie Des Sciences Inscriptions te Belles-Lettres de Tolouse.

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Corriere F, Lo Bosco D., Praticò F.G., The Project optimisation of an infrastructure of transportation: the research of the least dimension of the representation space of the synthetic indicators, Seminarberichte aus dem Fachbereich Mathematik, herausgegeben von den Dozenten der Mathematik, FerUniversitat, Gesamthochsule in Hagen, Band 58, 1997, ISSN: 0944-5838

Lo Bosco D., Praticò F.G., Studio dell'influenza della forma degli elementi lapidei sui risultati delle analisi granulometriche mediante l'utilizzo della geometria stocastica, Quarry and Construction, Giugno 1998.

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Lo Bosco D., Praticò F.G., Una metodologia di approccio al problema della ottimizzazione della relazione infrastruttura-ambiente: un modello matematico per la valutazione del Traffic Noise Index, Atti Convegno Nazionale SIIV, Catania, 2000.

Lo Bosco D., Leonardi G., Praticò F.G., Le criticità del sistema viario nazionale – analisi e proposte per il riequilibrio funzionale dell'offerta di mobilità, Regione Calabria, Franco Angeli Editore, 2002. Franco Angeli 2000.977- ISBN: 8846433904

Lo Bosco D. e Praticò F.G., The shape analysis of the aggregates for the optimization of the mixtures quality for road constructions: a mathematical model of stochastic-multivaried type and its experimental validation (L'analisi di forma degli aggregati per l'ottimizzazione della qualità delle miscele per usi stradali: un modello matematico di tipo stocastico-multivariato e sua validazione sperimentale), Convegno di Geometria stocastica, Corpi convessi & Applicazioni ingegneristiche, Tropea, Settembre 2001.

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terotecnologici, Convegno Internazionale SIIV Parma, 2002.

Lo Bosco D., Praticò F.G. Soprano V., L'ottimizzazione globale del trinomio "infrastruttura ferroviaria – veicolo – ambiente": modelli per l'analisi delle vibrazioni in esercizio, Rivista RFI argomenti, n.2/2004,pp. 106-125, ISSN 1973-4220, 2004

Moraci Nicola, Praticò Filippo Giammaria, Montanelli Filippo, Improving Flexible Pavement Performance by Geosynthetics: Experimental Investigations by the Means of Full Scale Trials, Proceeding of the 3rd Asian Regional Conference on Geosynthetics, Seoul, Korea, June 21~23, 2004, ISBN 89-952189-4-0 93530.

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Barrile V., Cotroneo F., Praticò F.G., Processi Di Aggiornamento In Automatico Dei Rilievi Delle Pertinenze Stradali E Delle Difettosità Superficiali: Proposta Di Una Metodica Innovativa Ad Alto Rendimento, Convegno Nazionale Siiv Cosenza, Settembre 2006, PP. 295-344. (ISBN 88-7458-050-9).

Praticò F.G. Leonardi G., Scopelliti F, Giunta M., Assessing Road Safety Levels In A Road Network On The Basis Of Unlocalised Accident Data, 4th International SIIV Congress, Advances in Transport Infrastructures and Stakeholders Expectations, Palermo, Italy, 12th – 14th September, 2007, pp. 10. ISBN 13 978-88-8207-260-5.

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Praticò F.G., Dattola V., Moro A., Ammendola R., Mavilia L., A Theoretical and experimental investigation on Cold Recycling, 4th International Conference – Modern Technologies In Highway Engineering - Poznan, September 3-4, 2009, Isbn: 978-83-929466-0-1 - ISBN: 978-83-61352-36-5, pages 165-174.

Praticò F.G., Vaiana R., Giunta M., Role Of Pavements Surface Properties In The Management Of The Road Safety For Ordinary And Hazmat Transport, 4th International Conference On Modern Technologies In Highway Engineering Poznan, Poland, September, 3-4, 2009. , Isbn: 978-83-929466-0-1 - Isbn: 978-83-61352-36-5, Pages 175-186.

Praticò F.G., Giunta M., Operational and safety effects of two-lane roads alignment 4th International symposium on highway geometric design, June 2-5, 2010, Valencia, Spain. ISBN 978-84-8363-556-8

Praticò F.G., Giunta M., D'Agostino P., Road base stabilization: performance improvement and pavement life cycle consequences, ICTI-ISMARTI Second International Conference on Transport Infrastructures, São Paulo, Brazil, 4-6 August 2010, ISBN: 978-972-8692-57-5.

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Praticò, F.G., Giunta M., (2016) Assessing the sustainability of design and maintenance strategies for rail track by means of life cycle cost analysis, COMPRAIL, 15th International Conference on Railway Engineering Design and Operation, 19 - 21 July 2016, Madrid, Spain, WIT Transactions on The Built Environment, Volume 162, Pages 12, Page Range 251 – 262, 2016.

Selezione di prodotti di ricerca (A selection of papers)

Introduction

At an international level there are numerous definitions of the term "texture", as well as numerous classes of sub-categories, according to the dimensional range considered (micro, macro, mega roughness) [1, 2, 4, 7, 9].

All the definitions accept that the interface between the upper layer of the surfacing (whether a bituminous mix or concrete) and the atmosphere can be described in terms of its deviation from a Euclidian plane (a surface in $\Re^3$, a profile in $\Re^2$, fractal dimension, etc.). Furthermore, the "pavement-vehicle" system is based on the use of this boundary surface to transmit tangential tyre-pavement contact forces, whose work (provided by a chemical energy source) moves people and goods.

Measurement, analysis and monitoring of the ;characteristics of the texture T (Fig. 1, [15]) are therefore of fundamental importance.

In particular, T affects the following:

➢ interference mechanisms between light waves and the plane of the pavement;
➢ the control of the kinematics and steering of the vehicle (macroscopic adherence parameters);
➢ associated interactions between the pavement and liquid/pneumatic substances (drainage, splashing, etc.);
➢ the production of mechanical stresses (deformations and vibrations, etc) within the pavement material, the solid bodies in contact with it (vehicles and structures) and the atmosphere (rolling noise inside and outside the vehicle);
➢ the performance of the system, in particular energy loss as a result of rolling resistance, fuel consumption, wear on tyres etc., and gas emissions.

These actions interfere directly with the general requirements which apply to transport systems, such as:

➢ application of appropriate safety standards with regard to adherence, mechanical integrity, reflection of light and vibratory and acoustic comfort;
➢ reduction of environmental nuisances (vibrations, noise and exhaust gases);
➢ control of consumption (tyres, fuel) and supply (level of service provided to users, journey time, etc.).

The activities and strategies that are intended to ensure that these characteristics are durably maintained require measurement instruments and analysis and computational methods that allow informed, targeted and efficient maintenance management in order to guarantee the permanence of surface parameters.

In view of this and the strategic importance of rigorous structuring of analysis with regard to this topic which is widely dealt with in the scientific literature, it is worthwhile to construct and validate a common framework of reference for the analysis and codification of the logical structure of texture parameters and in order to catalogue them.
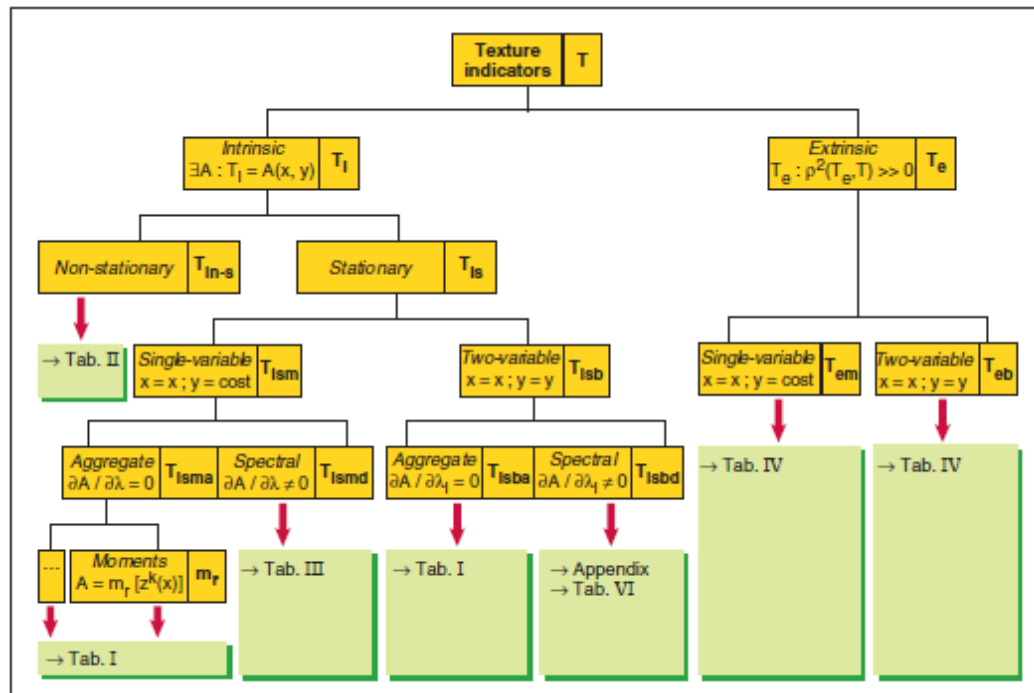

Fig. 2 - Coding of pavement surface texture indicators.

Abstract. This paper deals with Superpave Restricted Zone significance for bituminous mixtures added with Reclaimed Asphalt Pavement (RAP). The author designs and realizes a theoretical and experimental study in order to evaluate the synergism of aggregate gradation and RAP percentage in determining in-lab mechanical performance with regard to plastic deformation.

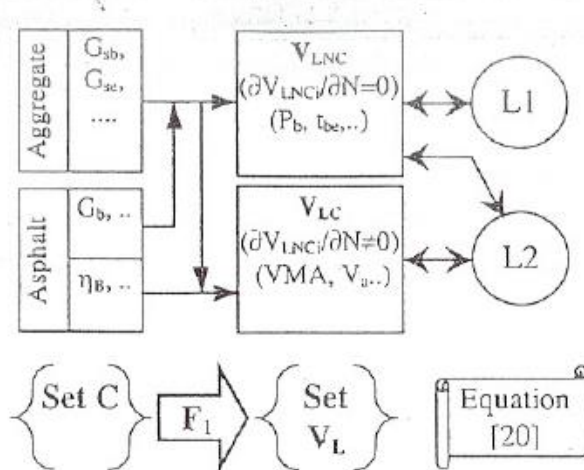**Keywords:** Reclaimed Asphalt Pavement, Gradation, Volumetrics, Rutting.

Figure 27. *Parameters affected (V_{LC}) or not (V_{LNC}) by compaction*
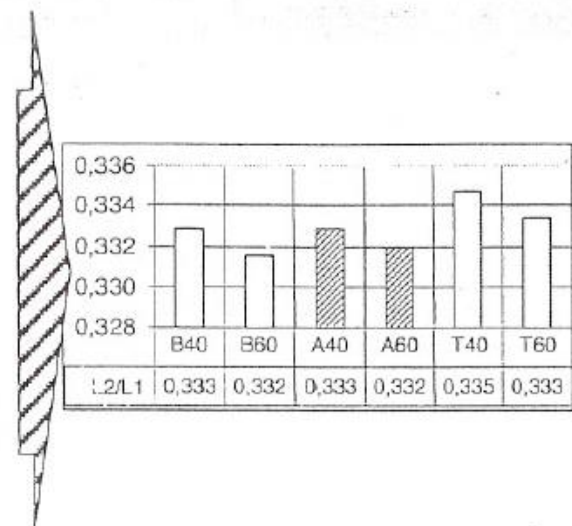
Figure 28. *Quantifying asphalt viscosity effect on HMA volumetrics*

Abstract. Timely completion and high performance are becoming key factors in modern road projects, so research is needed to have reliable contracts and acceptance criteria. The goal of this paper is confined to the formalization and validation of a unique model for the determination of pay adjustment on the basis of both quality (mechanical and surface performance of road pavements) and timeliness. Three main topics are addressed. The first is the estimation of pay adjustment (PA, negative or positive) when both structural and non-structural deficiencies/surplus in characteristics are detected (e.g. low drainability in porous asphalt concretes). The second is the estimation of PA based on the quality of all the layers of the pavement. The third is the estimation of PA for early or late completion of the work. The formalized model is applied to an experimental case history. Analyses and validation demonstrate that the proposed model can efficiently solve typical problems in contract administration, in which decisions based upon objective criteria are needed.

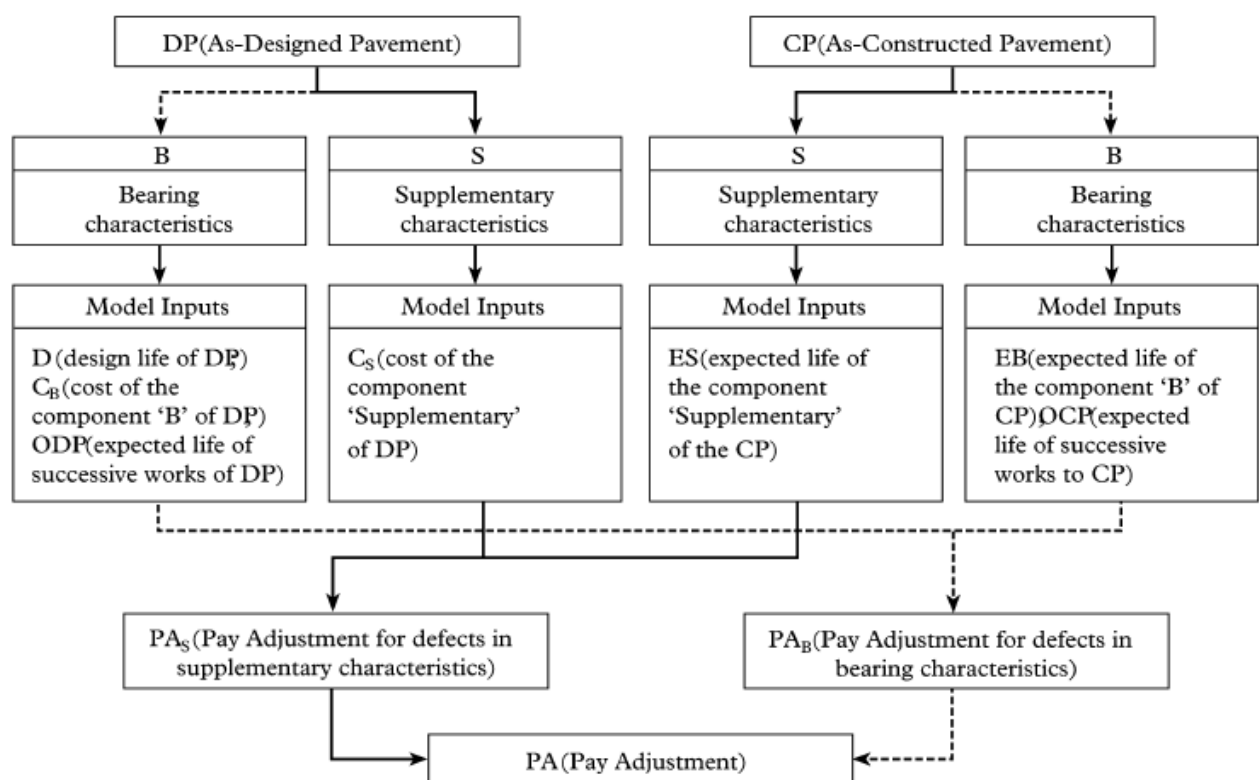**Keywords:** Quality assurance, cost, roads, contract administration, life cycle

Figure 1 A synthesis of the model. *Note*: symbols are listed in the Appendix.

Abstract. The goal of this paper is confined to the derivation of an equation for the analysis of the phenomenon of water flows along an asphalt pavement. By referring to the general theory for the percolation of water in rigid porous materials, we propose the theoretical derivation of models for some tests on asphalts. In order to validate the formalized models and to analyze the relationships among the main indicators introduced, in-field experiments were designed and performed. As our main results, we develop a model for tests on asphalts and validate it partially by means of our experimental results.

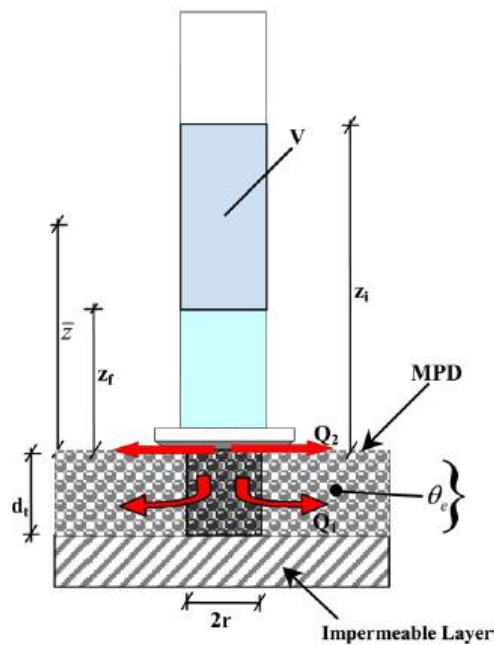**Keywords:** Water; Asphalt; Continuity; Model; Drainometer

Fig. 2. Example of falling head test on porous European mixes.

$$\Delta t = V \left(2\pi r d_t \theta_e a\bar{z} + b_1 \mathrm{MPD} 2\pi r b_2 \bar{z}\right)^{-1} = \left[V \left(2\pi r \bar{z}\right)^{-1}\right] \left(a d_t \theta_e + b\mathrm{MPD}\right)^{-1} = \frac{D_C}{H_C},$$

.

Abstract: Bulk specific gravity, G_{mb}, is of outstanding importance in bituminous mixes. Life cycle costs, contract requirements, and Quality Control/Quality Assurance procedures are strongly dependent on the effective G_{mb} obtained by suitable design and construction, and compliance with a number of boundary conditions. There are many ways to estimate G_{mb}, and within-method variance is appreciable. The "transportability" of a G_{mb} determined according to a given standard to another standard is therefore a critical issue. Our objective was to study relationships between G_{mb} values determined using a given standard to G_{mb} estimates calculated by applying other standards. We derived a model, and conducted experiments using five different methods. The model evaluates the elementary volumes that contribute to differences among the five considered methods. A tendency toward a common maximum value is assumed. The results are analyzed and interpreted, and the conceptual framework validated. Useful relationships between specific gravities determined by different methods are derived and analyzed. Power-asymptotic curve analysis yielded an algorithm well-grounded in logic to solve the issue of G_{mb} transportability.

Key words: Bulk specific gravity; Hot mix asphalts; Osculatory volume.

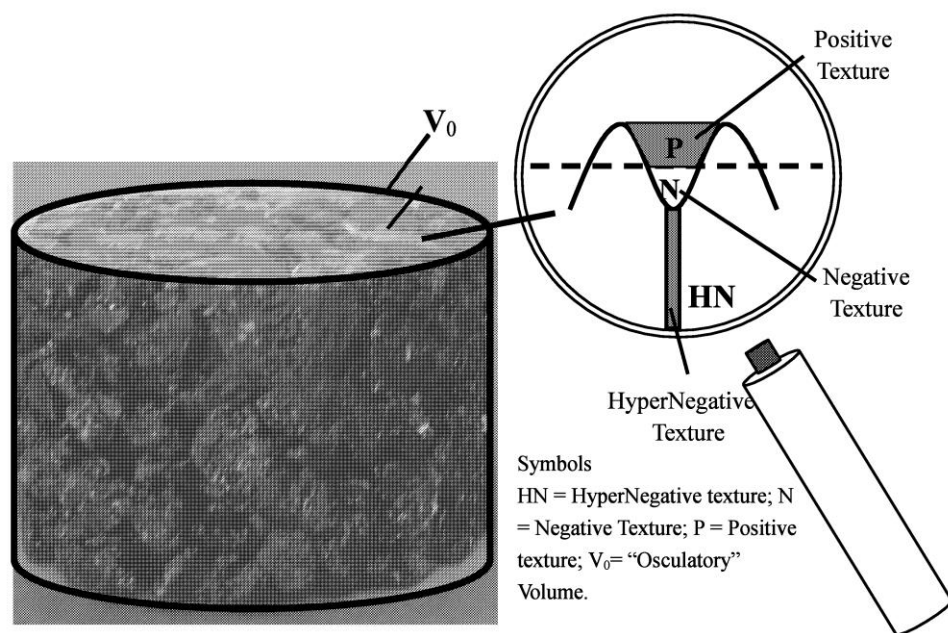$$G_{mbSSD} > G_{mbFIN} > G_{mbCOR} > G_{mbFILM} > G_{mbDIM}.$$



Fig. 1. Osculatory Volume of a HMA Specimen.

Abstract. It is well known that the implementation of contractor quality control/agency quality assurance (QC/QA) can support quality improvements in hot mix asphalt (HMA) pavements, both for porous European mixes (PEMs) and dense-graded friction courses (DGFCs). On the other hand, many reasons and reports highlight the importance of proper in situ air voids content, due to major influence on service properties (rate of rutting, fatigue life, structural strength, permeability, ravelling, etc.). Another relevant standpoint is that in-lab determinations of density, though often reliable and accurate, are low-speed tests. All these facts outline the potential role of field measurement of density through non-nuclear density gauges. In the light of the above facts, the main object of the paper was confined as the study of factors affecting variance and bias of non-nuclear density gauges both for PEMs and DGFCs. Bias, variance and parameters' dependence resulted to be appreciably affected by mix typology and characteristics. In particular, when related to mix type, monovariate regressions with low-speed methods resulted able to provide a useful tool in QC/QA procedures and road asset management. Further practical applications have been outlined.

Keywords: quality assurance, quality control, non-nuclear density gauge, porous European mix (PEM), dense-graded friction course (DGFC).

Model	Equation
Model (I)	$G_{mb} = P_{CE} + \alpha \times W + \beta \times T$
Model (II)	$G_{mb} = P_{CE} + \alpha \times W + \beta \times T + \varepsilon \times W_{OA}$
Model (III)	$G_{mb} = \mu \times P_{CE} + \alpha \times W + \beta \times T + \lambda$
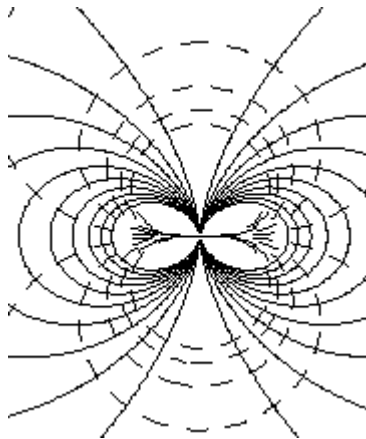
Abstract. Fire extinguishers must be maintained at regular intervals and many problems arise when fire-resistant dry powders need replacement. We analyze the potential of fire extinguisher powder (termed REP) as a filler in bituminous mixes. REP and REP-admixed bituminous mixes were subjected to chemical analysis, and the mechanical properties and environmental performances of the mixes were tested. Mixes with different REP contents were prepared. Mechanical performance was adequate and environmental compatibility was achieved. Practical applications and perspectives in rehabilitation, maintenance, and research are outlined.
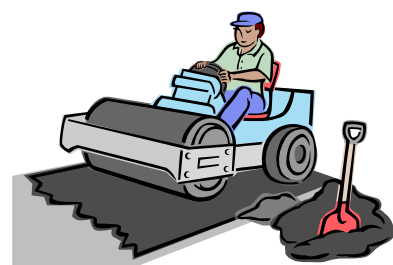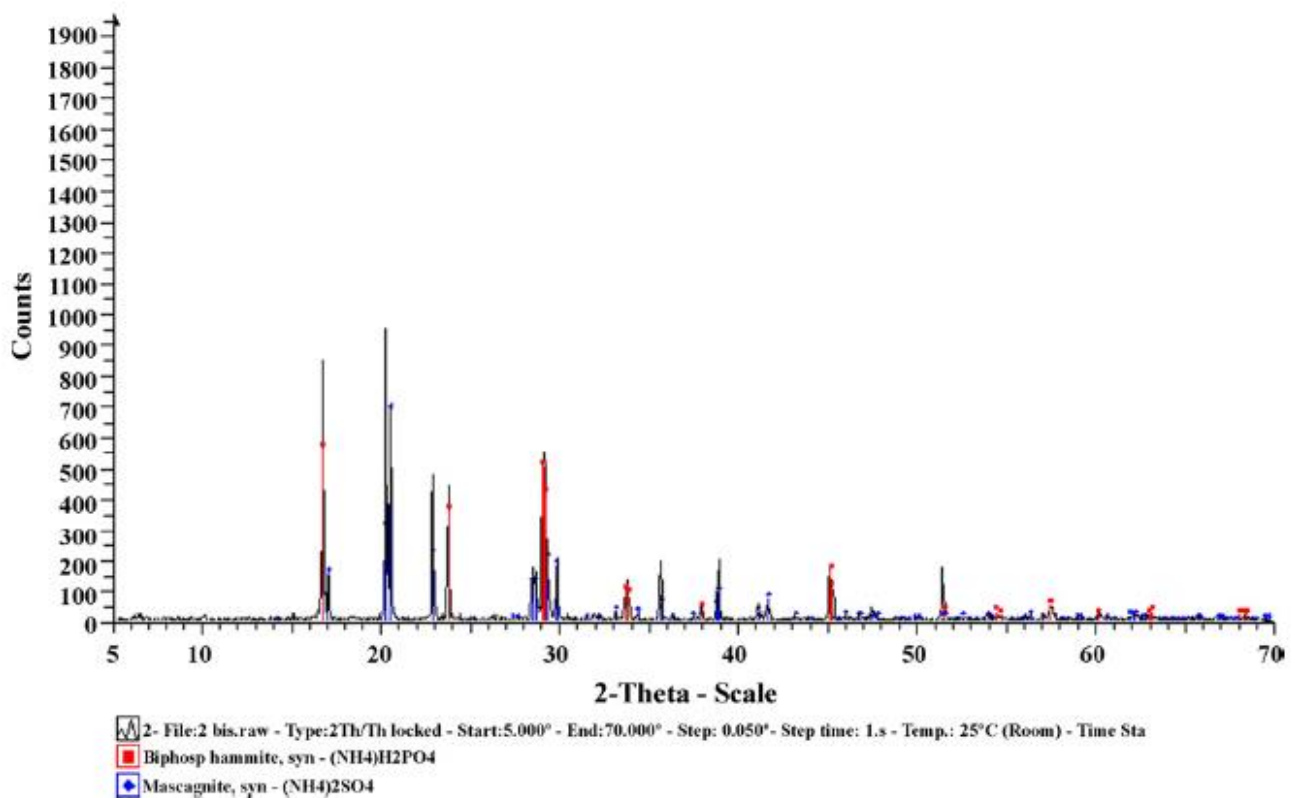
Abstract. Electromagnetic sensors can be exploited to determine properties (i.e. density) of Hot Mix Asphalts (HMAs) by observing the surface polarization effects that occur in the radio frequency range of the electromagnetic spectrum. A challenge is the modelling of electromagnetic sensors, which do not require penetrating probes to perform the measurement. Moreover, cores extraction is time-consuming and subjected to technical and operator errors. In this paper, in order to model an electromagnetic sensor for HMAs density measurement, a Finite Element code modelling a particular case-of-study has been exploited. A subsequent objective has been to determine electrical characteristic of the samples material and its relation with density values obtained with a non-nuclear device evaluating in-place HMA pavement. An experimental plan has been designed. The obtained results demonstrate that the implemented model is able to explain the relationship between density and electrical properties of HMA layers. Practical applications and recommendation have been outlined.

Keywords: FEM, electromagnetic, sensor, HMA, material properties.
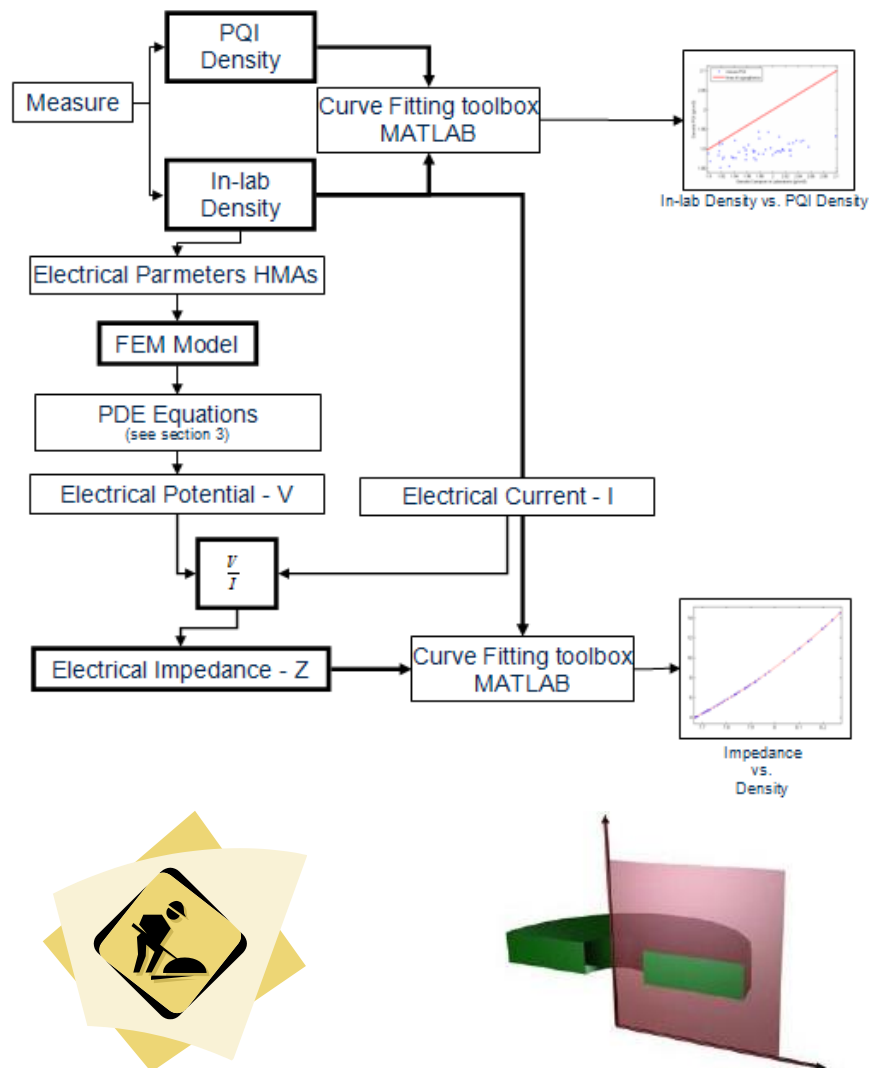
Abstract. Wear at the interface between flexible pavements and tires influences pavement life, pavement cycle costs, and tire consumption, and is a source of environmental harm. Wear related processes evolve over time and are affected by a number of boundary conditions, such as interface fluids, water and fuels. We develop a model explaining and predicting mass losses in flexible pavements under carefully controlled conditions, and with estimation of the related environmental costs. We also employed an accelerated loading test. Under normal conditions, the environmental impact of pavement wear is not greatly influenced by mix type or volumetrics. Indeed, the presence of hazmat materials, traditional, dense mixes have an environmental impact that is appreciably lower than that of porous European mixes.

Keywords: pavement wear, environmental costs, traffic, hazardous material
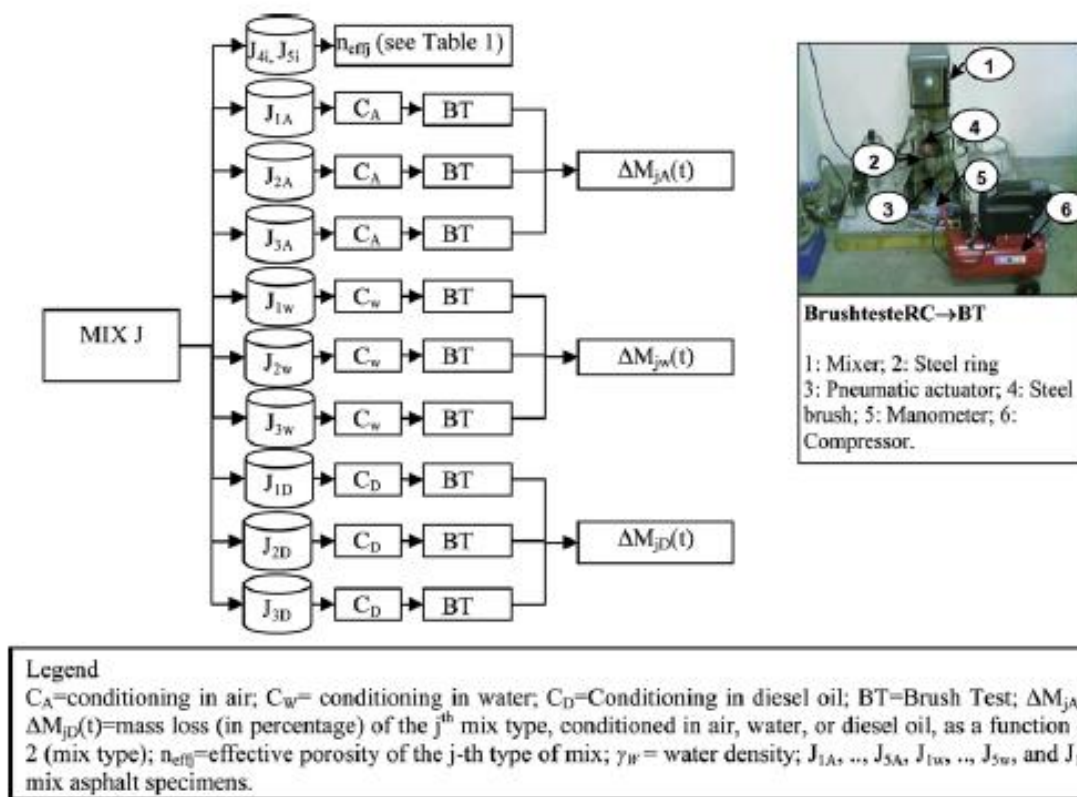

BrushtesteRC→BT

1: Mixer; 2: Steel ring
3: Pneumatic actuator; 4: Steel brush; 5: Manometer; 6: Compressor.

Legend
C_A=conditioning in air; C_w= conditioning in water; C_D=Conditioning in diesel oil; BT=Brush Test; $\Delta M_{jA}(t)$, $\Delta M_{jw}(t)$, $\Delta M_{jD}(t)$=mass loss (in percentage) of the jth mix type, conditioned in air, water, or diesel oil, as a function of time; J=1, 2 (mix type); n_{effj}=effective porosity of the j-th type of mix; γ_w= water density; J_{1A}, .., J_{5A}, J_{1w}, .., J_{5w}, and J_{1D}, .., J_{5D}: hot mix asphalt specimens.

Fig. 1. Experimental plan.

Abstract. The life cycle of hot mix asphalt (HMA) depends on the material density. Bulk specific gravity and air void content are crucial factors for quality control and quality assurance (QC/QA) procedures used to evaluate contract specifications. Densities measured in the laboratory are reliable and accurate but are obtained very slowly. On-site measurements are made using non-nuclear portable devices and are often considered biased and unreliable. The object of this work was to evaluate a proposed theoretical framework for interpreting in-lab and on-site measurements and to propose strategies for using non-nuclear portable devices in QC/QA. A decrease in porosity yielded in-lab specific gravities that converged. In contrast, due to the high dielectric constant of water the divergence of in-site measures was observed. A conceptual framework and two practical equations are provided.

Keywords: Quality assurance, quality control, density, non-nuclear density gauge, porous European mix (PEM), dense-graded friction course (DGFC)
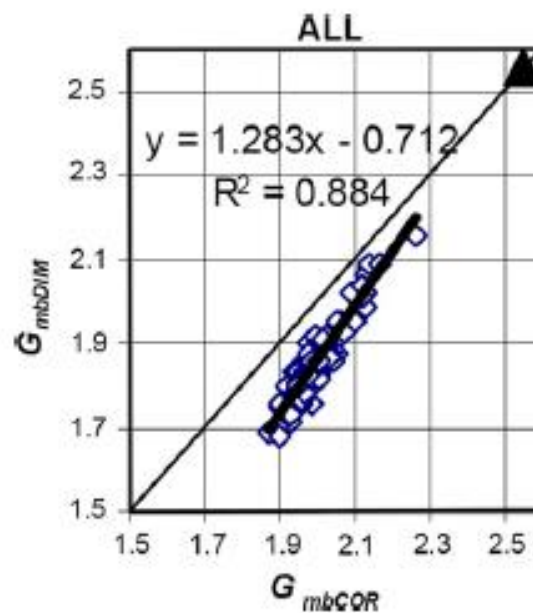
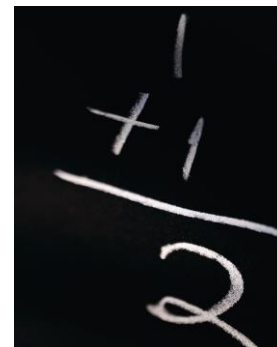Fig. 2 G_{mbCOR} vs. G_{mbDIM} (ALL).

Extraction: b(%) (CNR n. 38/73; ASTM 6307)	Sieves, screens, sieve shaker: G (CNR n. 4/53)	Vacuum Sealing: G_{mb}, G_{mbAO}, n_{eff} (ASTM D6752; D6857)	Non-nuclear portable device: P

Abstract: Quality control/quality assurance tests can be used to demonstrate that an as-constructed pavement has characteristics different from the contracted specifications of the as-designed pavement because the bitumen employed was of insufficient quality. Many different issues affect asphalt binder quality. Such problems can significantly increase the pavement life-cycle cost, which means that a pay adjustment PA is needed. Unfortunately, the quantitative analysis of this issue is very complex. The objectives of this study were to model the dependence of the pavement life-cycle cost on asphalt binder quality and to determine the quantitative relationship between bitumen viscosity and the PA for a given class of boundary conditions. In addition to modeling this problem theoretically, experiments and simulations were carried out through the use of the Mechanistic-Empirical Pavement Design Guide. We then derived the consequences of these effects on life-cycle cost by using a specific life-cycle cost model. Our results demonstrate that asphalt binder viscosity can strongly affect the expected pavement life and the PA, and thus needs to be taken into account in contract and construction management.

Keywords: Pavement, asphalt pavements, construction management, life cycle, costs, quality control, binders, material

Symbols
L1 = Layer 1; L2 = Layer 2; L3 = Layer 3; LT = Layer Thickness; AM = Asphalt Mix; AB = Asphalt Binder; GP = General Properties; LC = Longitudinal Cracking; AC$_r$ = Alligator Cracking, ACR = AC Rutting; ULR = Unbound Layer Rutting, TR = Total Rutting; IRI = International Roughness Index; INT, INF, OCP, ODP, EB = Parameters of PA equation (see Table 1)
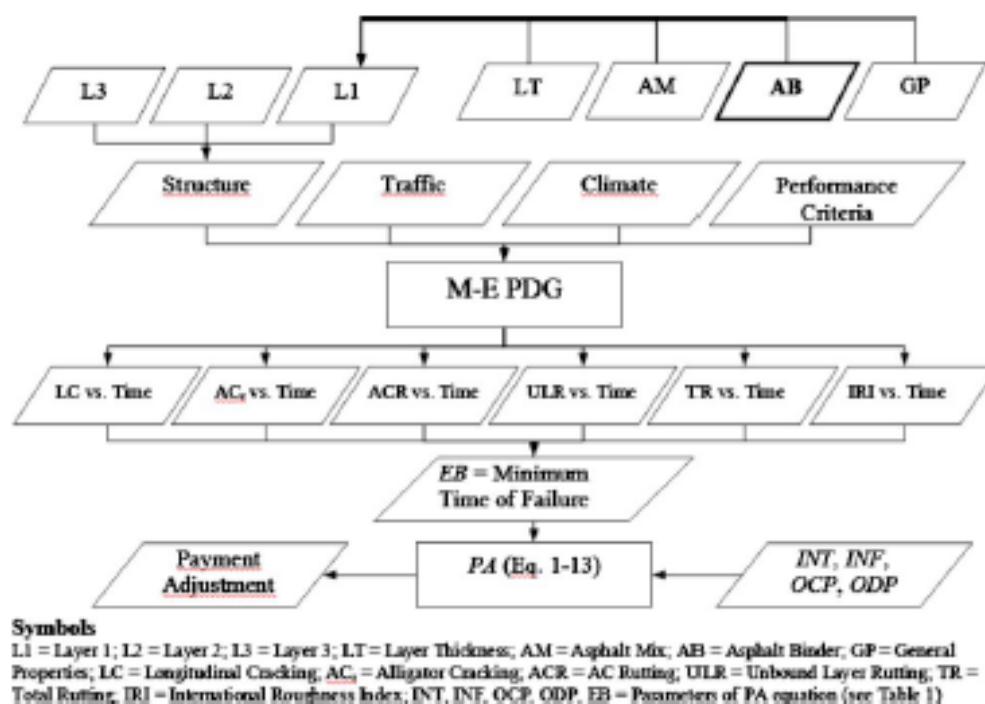
Fig. 2. Flowchart for the simulations

Abstract:

Low-volume roads can be defined as facilities outside built-up areas with a traffic volume of less than 400 annual average daily traffic. Although of lower use because of their location, low-volume roads play an important social and economic role and sometimes represent a large part of the regional and national road network. Regarding their geometric and structural features, they usually have not changed since they were built, and improvement according to current design standards can be uneconomical because the needs are great and the funds insufficient. To this purpose, less restrictive design criteria can be used. Design practices for low-volume roads should be as well addressed as those for high-volume roads. The current speed on low-volume roads appears to be a crucial parameter in reconstruction or rehabilitation design. The present study is focused on analysis of the speed distribution on low-volume roads in comparison with the design speed in order to establish fitting design criteria in rehabilitation. An experimental investigation was carried out on a low-volume road in the province of Reggio Calabria, in southern Italy. The speed distribution was assessed for different conditions of horizontal and vertical alignment in order to understand and possibly quantify the influence of road geometric features. Results demonstrated that under specific conditions, the speed distribution can be predicted on the basis of geometric features. Further, on the basis of operating speed, it was possible to derive information that could be relevant in terms of rehabilitation design criteria.

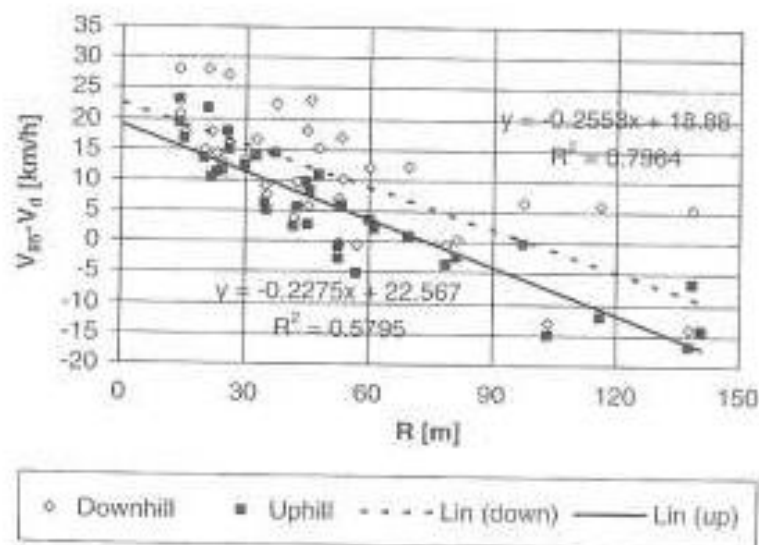**Keywords**: operating speed; low volume roads; rehabilitation; transportation infrastructures.


FIGURE 11 $V_{85} - V_d$ versus R.

Abstract:

Low-volume roads (LVRs), such as rural, farm-to-market, and less-used local and city roads, are an important part of the world's transportation infrastructure. LVRs have been credited as a direct cause of the socio-economic development of rural communities. It has been estimated that 60% of the road network in the United States is made up of low-volume roads. The construction, maintenance, and rehabilitation of these roads are major tasks that result in about 54% of the total annual expenditure of transportation agencies in the United States. Better design and construction methods will lead to lower maintenance and rehabilitation costs of LVRs. Stabilization of weak subgrade soils to support LVRs is a widely accepted method of improving their performance. However, the selection of a stabilization alternative on the basis of cost–benefit analysis is a crucial task for a transportation agency and one that has not been addressed in a systematic manner. In this paper, a new conceptual engineering economics tool–based life-cycle cost analysis (LCCA) is developed to optimize and to select the best stabilizer and the stabilization technique for a given subgrade soil and given traffic conditions. In this analysis, agency, user, and externality costs are addressed. Two case studies are analyzed for European and U.S. road conditions to validate the LCCA model. Results demonstrate that, under specific boundary conditions, soil stabilization can play an important role, merging the environmental and mechanical effectiveness of low-volume roads.

Keywords: Life cycle cost analysis; stabilization alternatives; low volume roads; costs; rehabilitation; transportation infrastructures.
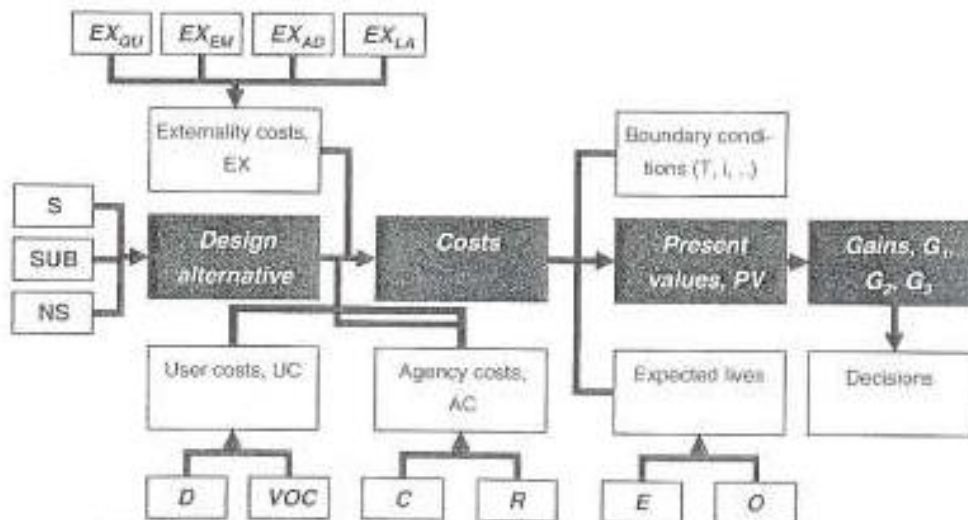
Symbols. EX_{EM}: Emission-related costs (eq.10); EX_{AD}: Additional externality costs (eq.9); EX_{QU}: Quarry-related costs (eq.11); EX_{LA}: Landfill-related costs (eq.12); VOC: Vehicle operating costs (eq.5); D: Delay-related costs (eq. 6); R: Rehabilitation costs (eq.4); C: Construction costs (eq.4); E: expected life; O: expected life of successive rehabilitations; S: soil stabilization; SUB: soil substitution; NS: neither S nor SUB; if $G_1=PV_{NS}-PV_S>0$ then S is better than NS; if $G_2=PV_{SUB}-PV_S>0$ then S is better than SUB; if $G_3=PV_{SUB}-PV_{NS}>0$ then NS is better than SUB.

FIGURE 1   Schematic diagram of proposed LCCA model.

Abstract. Assessing the air void content of hot mix asphalts (HMAs) is a vital and crucial factor for quality control and quality assurance (QC/QA) procedures. Layer geometry, mix composition, aggregate and asphalt binder specific gravities, and compaction characteristics (i.e., energy) together determine the air void content. The experimental measurements used to determine specific gravity may influence the results. Asphalt samples of a given core diameter and thickness must be tested to verify compliance with contract requirements and specifications. To decrease the time required for the survey and to reduce costs, it would be advantageous to collect smaller cores. The measurements are essential for assessing the economic value of the HMA as a function of air void content. Payment may be adjusted according to the extent of on-site air void content, and the costs associated with the QC/QA procedures depend on the method used. In light of these concerns, attention was focused on the assessment of the impact of measurement methodology and specimen diameter on HMA air void content. The analysis showed that both measurement methodology and core diameter can substantially affect the specific gravity determination and, as a consequence, the air void content estimate. The dependence of the results on measurement methodology and core diameter was discussed. Method-derived and diameter superposition effects substantially biased the results. Differences in estimates of the air void content were as high as 10%. Large diameter, dimensionally derived (DIM) values and small diameter, paraffin-coated values (FIN) were found to be the most distant and least comparable measurements in the factorial plan of experiments. Based on the results, it is imperative that very specific guidance for the derivation of AV be provided to minimize the potential for between-user differences and QC/QA consequences (acceptance procedures, pay adjustment). Further evaluation of the predictive capabilities of the two-zones model is needed. Further enhancement of the micro and macrotexture analysis of lateral and upper surface is recommended.

Keywords: Air void, bulk specific gravity, core diameter
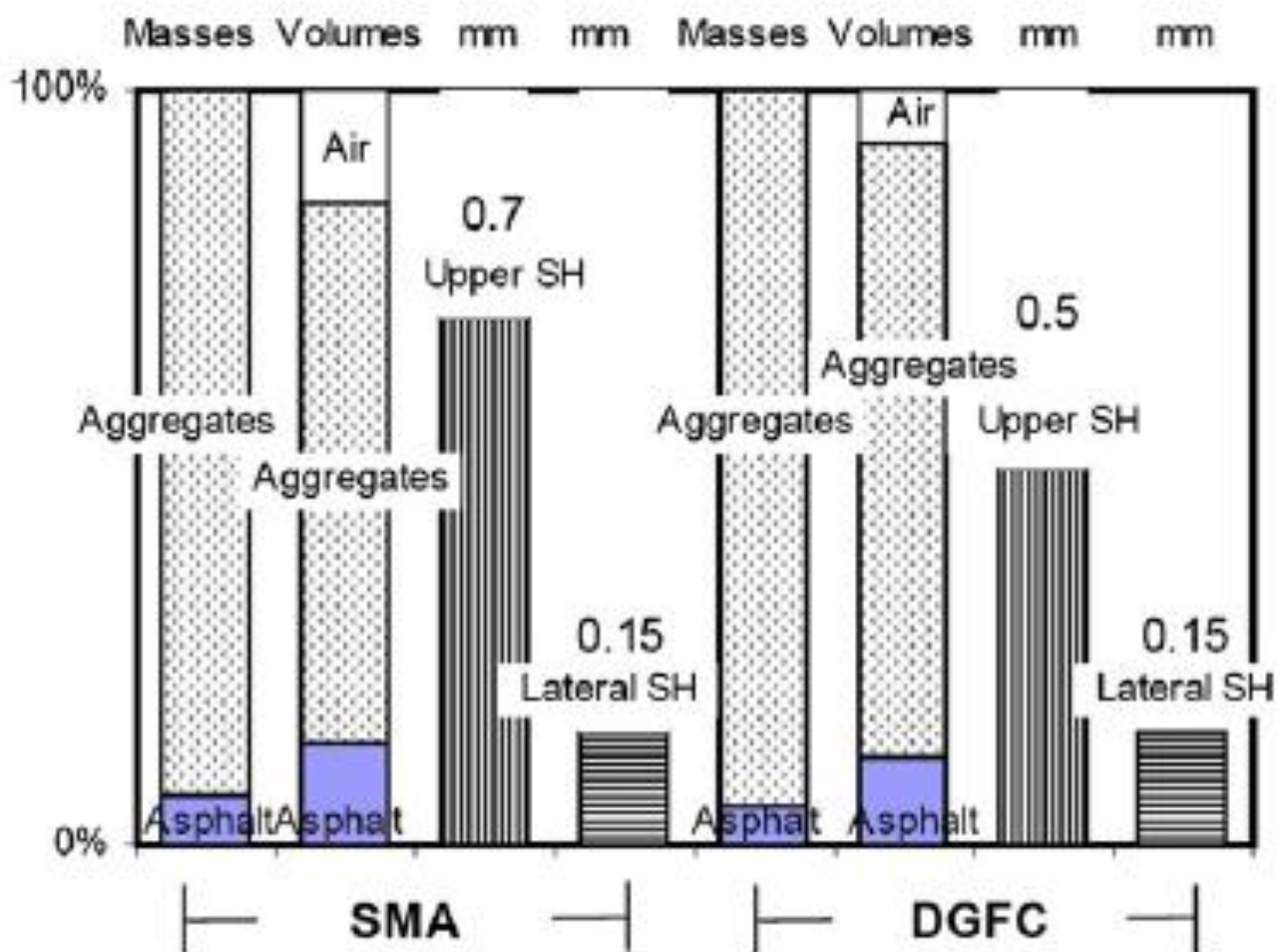
Abstract. Regional airports have received great attention in the last decades due to the opportunity of using their spare capacity in order to reduce congestion at main hubs. This paper illustrates the application of the Multiple-Criteria Decision-Making (MCDM) methods to a regional multi-airport system (MAS) so as to verify the role/position of each airport within the MAS. The test case refers to a regional MAS located in the North East of Italy. The analysis has been carried out on a reference time period so as to study the airports' performance variations over several years.

Keywords: Regional multi-airport system, airport choice, leading airport, multi-criteria analysis
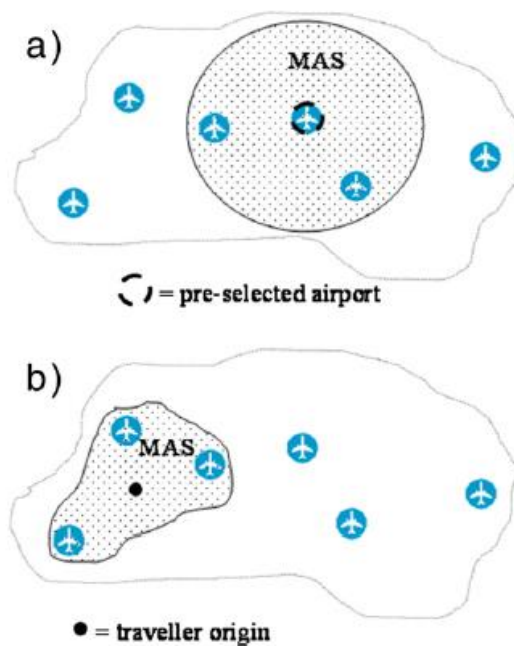
Fig. 1. Regional MAS identification.

Class c	Attributes x_{nmy} (Source of data: Airport operators; www.assaeroport.it; ISTAT socio-economic data base)
Location and facilities ($c=1$)	1. CLO_n, closeness[a] of the catchment area to the given n-th airport (distance^{-1})
	2. D_{MI}, weighted distance of the n-th demographic basin from the hub of Milan
	3. D_{RM}, weighted distance of the n-th demographic basin from the hub of Rome
	4. Np, number of parking slots at the n-th airport
	5. Cf, time-closeness of the n-th airport to the closest railway station (time^{-1})
Outcome ($c=2$)	1. P_T, annual number of passengers on national and international flights
	2. $R_T = R_A + R_B$ airport annual revenues, where R_A stands for aeronautical revenues and R_B for non-aeronautical revenues
	3. P_T/F, ratio of the number of passengers on the number of total flights
	4. P_T/CI, ratio of the total number of passengers on the invested money
Effectiveness and efficiency ($c=3$)	1. ROS, Return on Sales, the ratio of operating income (sometimes termed operating profit) divided by net sales, usually presented in percent
	2. ROI, Return on Investment, the ratio of money gained (net income) or lost (net loss) on an investment (or asset) relative to the amount of money invested
	3. ROE, Return on Equity, the ratio of net incomes (after tax) on shareholders' equity[b]
	4. P_T/C, ratio of total number of annual passengers on the total annual expenses
	5. R_B/P_T, ratio of non-aeronautical revenues on total number of passengers

Abstract. In the last decades several studies were conducted in order to develop operating speed prediction models for two-lane rural roads. Many factors were found to affect the operating speed, such as radius of horizontal curve or curvature changes rate, grade, length of horizontal curve, deflection angle, sight distance, superelevation rate, side friction factor, and pavement conditions. Though this, many issues arise when there is an appreciable and continuous variance of geometric features along the road and, for example, short and long tangents coexist in the same road. In such conditions, assessing homogeneous sections, calibrating robust algorithms aimed at V85 prediction is a severe task and safety goals are not easily achieved. In the light of the abovementioned facts, objective and scopes of this work were confined into the quantifications of the effect of past, present, and future geometric elements on operating speeds. In particular, attention was focused on the consistency of the assumption of an environmental speed as a reference value for both short (dependent) and long (independent) tangents. Authors proposed a new operating speed model in which the geometric features of the previous and oncoming alignment were explicitly considered. The proposed speed prediction algorithm was validated on the basis of a wide experimental survey carried out in a rural road of the Province of Reggio Calabria – southern Italy. Problem modelling, experimental plan and results discussion are reported. Results proved the validity of the proposed model even if further experiments are needed to make the model able to predict the operating speed in different type of roads.

Keywords: operating speed, rural road, radius, length, present past and oncoming alignment.

$$V_{85} = \left[\frac{-108}{R^{0.1}} + \alpha_i 268 - \alpha_i 0.12 g_i \right] + \frac{-103}{R^{0.1}_{i-1}};$$

$$\alpha_i = 1 - \frac{1}{1 + \left(\dfrac{L_i}{100} \right)^{0.095}}$$

Abstract. This paper presents a theoretical and experimental study dealing with the dynamical reconstruction of longitudinal road profiles. The non-linear time series analysis method is used; it is based on the concept of deterministic chaos to detect anomalies. For this purpose, attractors, recurrence plots and recurrence quantification analysis are performed to detect anomalies on road pavements. In particular, modification of attractor and presence of vertical and horizontal lines in recurrence plots allow us to detect the above-mentioned local irregularities. Therefore, on the basis of the available database, it is possible to detect local irregularities to design and perform pavement rehabilitation and/or maintenance.

Keywords: Road profiles, non-linear analysis, chaos theory, recurrence plot, recurrence quantification analysis, mutual information
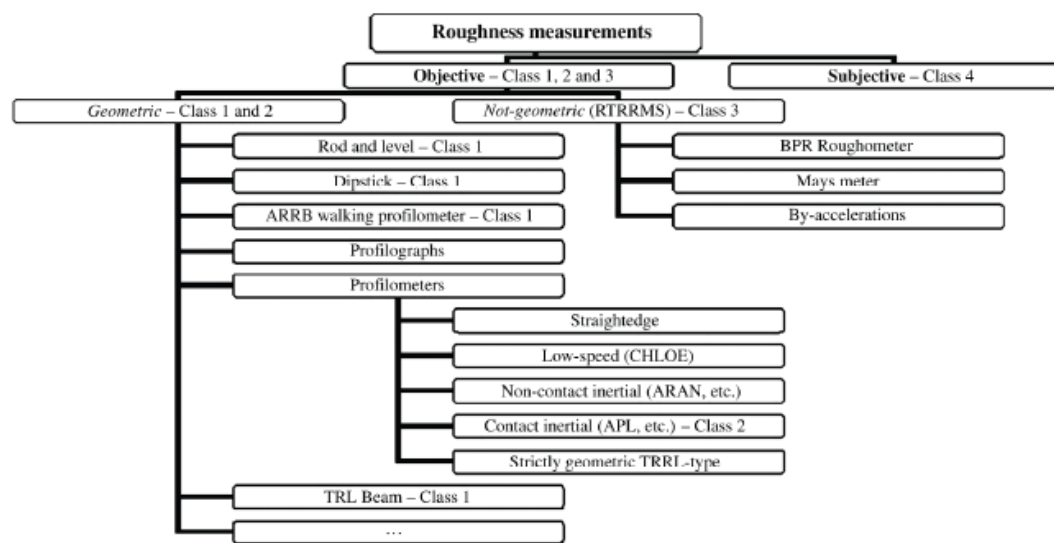
Figure 1. Roughness – main techniques, devices and classes.
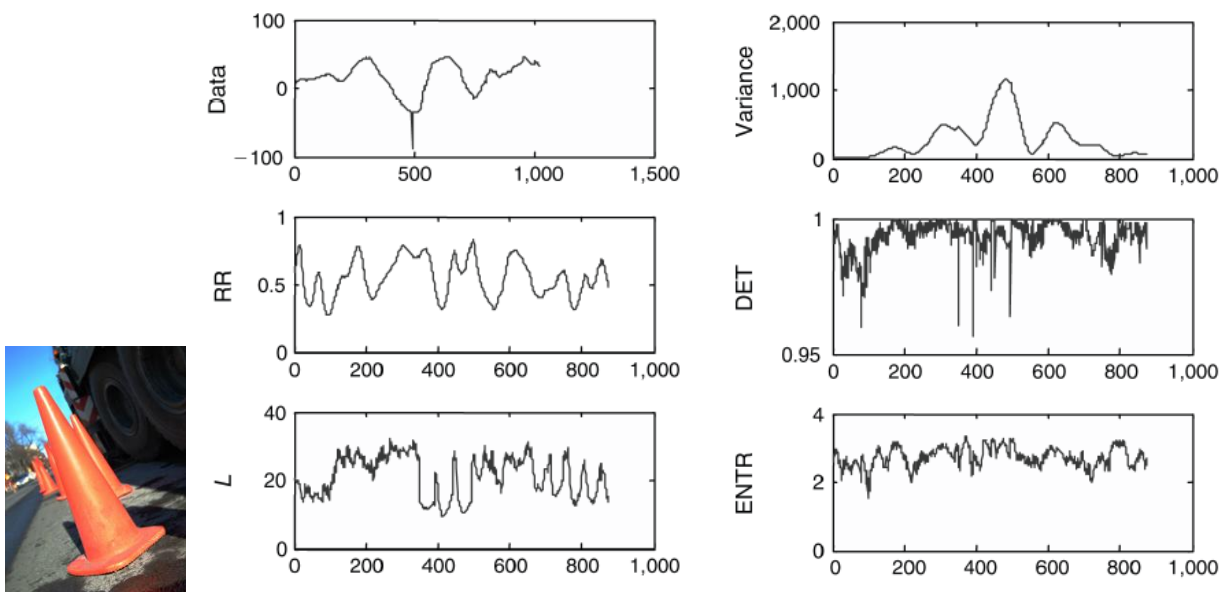
Abstract. The main purpose of this study was to analyze the volumetric and surface characteristics of hot mix asphalt (HMA) specimens as a function of compaction process. Specimens were produced in the laboratory by two different compaction devices, a gyratory compactor and a roller compactor. The volumetric and surface characteristics (air void content, bulk specific gravity) of these specimens, as well as the relationships among surface texture, volumetrics and compaction, were investigated. Analysis of these results may allow determinations of how material movements under compaction determine volumetrics distribution and variations and surface properties. A tentative theoretical framework for synergistically pursuing texture and volumetric targets was formulated. Outcomes of this study are expected to benefit both practitioners and researchers.

Keywords: surface characteristics, volumetric characteristics, laser profilometer, gyratory compactor, slab roller compactor

Table 3
Summary of samples produced by the GC and USRC devices in experimental survey.

Mixes		MA			MB		
Devices		GC	USRC		GC	USRC	
Specimens		∅15 cm	3 cm-thick Slab	6 cm-thick slab	∅15 cm	3 cm-thick slab	6 cm-thick slab
Levels of compaction	%G_{mm}@10	2	2	2	2	2	2
	%G_{mm}@60	2	2	2	2	2	2
	%G_{mm}@200	2	2	2	2	2	2
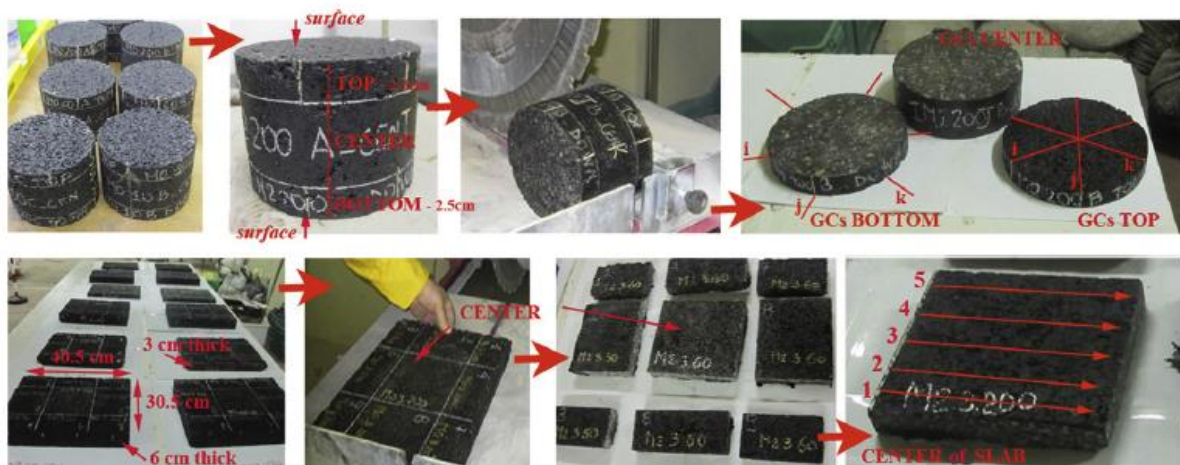
Fig. 2. Gyratory compactor specimens (above) and USRC slab samples (below).
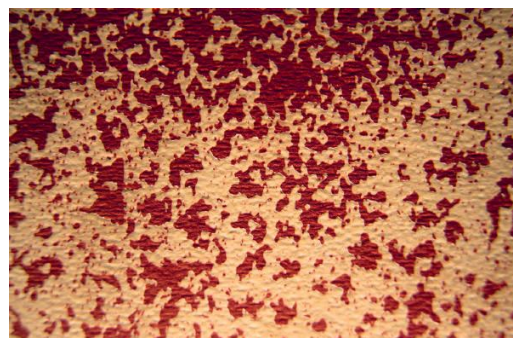
Abstract. Assessing the volumetrics of hot-mix asphalts (HMAs) is an important aspect of quality-control and quality-assurance procedures. The economic value of HMAs is usually assessed in terms of their mix bulk specific gravity (Gmb), air-void content, voids in mineral aggregate, and voids filled with asphalt. However, the results for specific gravity can vary with the coring process and method used in the experimental measurements. In light of these concerns, this study focused on the assessment of the dependence of the measured volumetrics of HMA-wearing courses on the testing and coring procedures. A wide range of methods for the measurement of specific gravities and surface texture was considered. Analyses showed that the coring process, measurement methodology, and core diameter can all substantially affect the results of HMA volumetrics measurements; the effects of the selection of the testing technique are not negligible and can be critical. At the same time, results demonstrate that there is potential for reducing the cost and duration of massive coring processes, as well as other negative impacts (e.g., roadsurface defects and environmental diseconomies).

Keywords: Hot-mix asphalt; Specific gravity; Coring; Air-void content; Voids in mineral aggregate; Voids filled with asphalt; Permeable friction course.
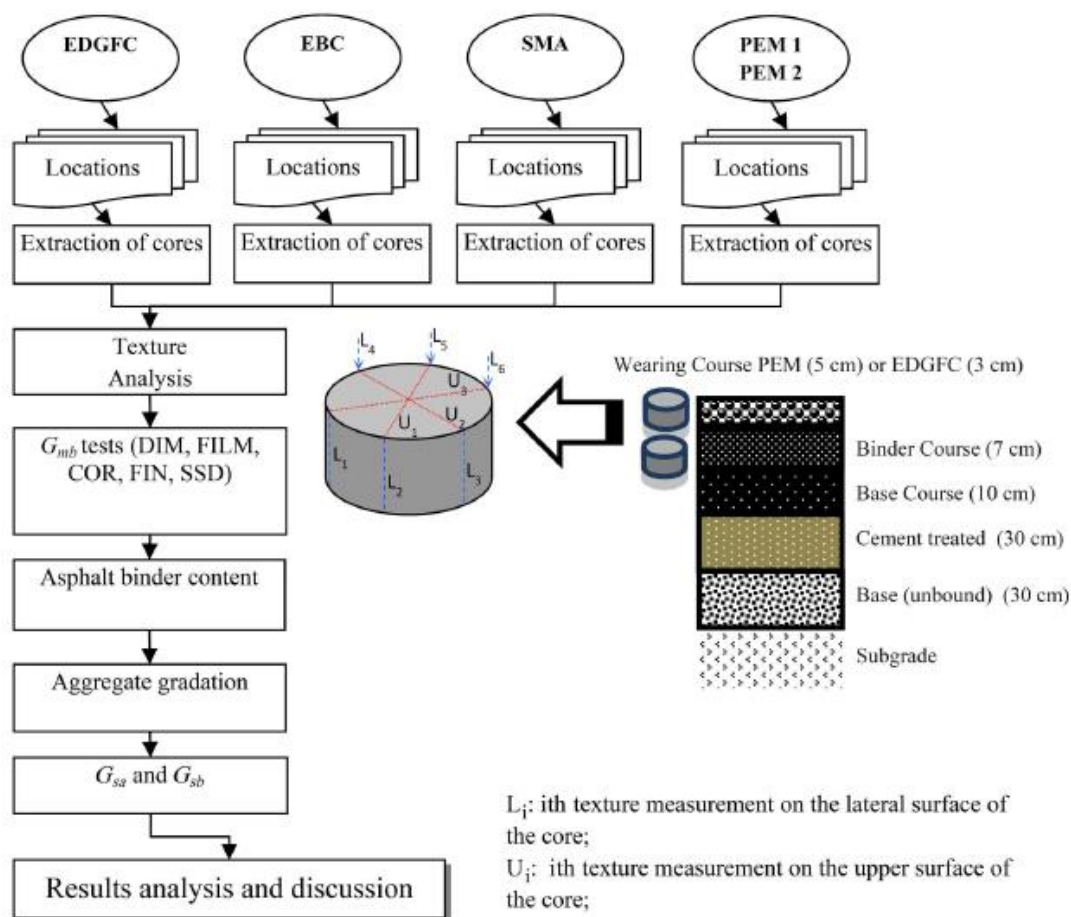
Fig. 1. Design of experiments

Abstract. The performance of road and airport wearing courses does not depend only on their bearing capacity. Many of the properties and characteristics of a pavement, such as its friction, drainability, and acoustic absorption, influence its real and perceived economic value. Thus, research is needed to develop reliable contracts and acceptance criteria for wearing courses, taking into account a variety of characteristics. The goal of the study described in this paper was to formalize and validate a model for determining pay adjustments on the basis of traditional and "premium" qualities. A new quality measure and a new and comprehensive algorithm, based on performance-related specifications and life-cycle cost analysis, were formulated and applied to a case study. The algorithm can also be applied to porous asphalt concretes or similar open-graded friction courses. Analyses and validation demonstrate that the proposed algorithm can efficiently solve typical problems that arise in contract administration for which decisions based on objective criteria are needed.

Keywords: Porous friction courses; Quality assurance; Life-cycle cost analysis; Sustainability; Performance-related specifications; Friction; Drainability; Acoustic absorption; Water storage; Percent defective; Construction materials and methods.
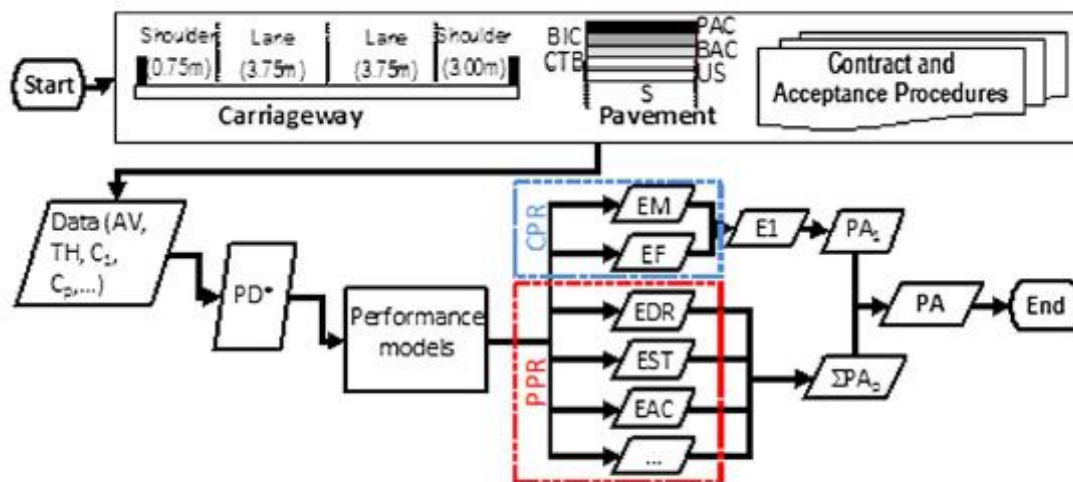
Symbols.
Pavement strata: PAC: Porous asphalt concrete; BIC: bituminous binder course; BAC: bituminous base course; CTC cement-treated course; US: unbound subbase; S subgrade.
Inputs and outputs: AV: air voids content; TH: thickness; C_1: cost of compulsory properties; C_p: cost of the p-th premium property; PD*: percent defective (with a sign); CPR, PPR: compulsory and premium properties; EM, EF, EDR, EST, EAC, E1: expected lives; PA1, ΣPA_p, PA: pay adjustments.

Fig. 1. Flowchart of the model
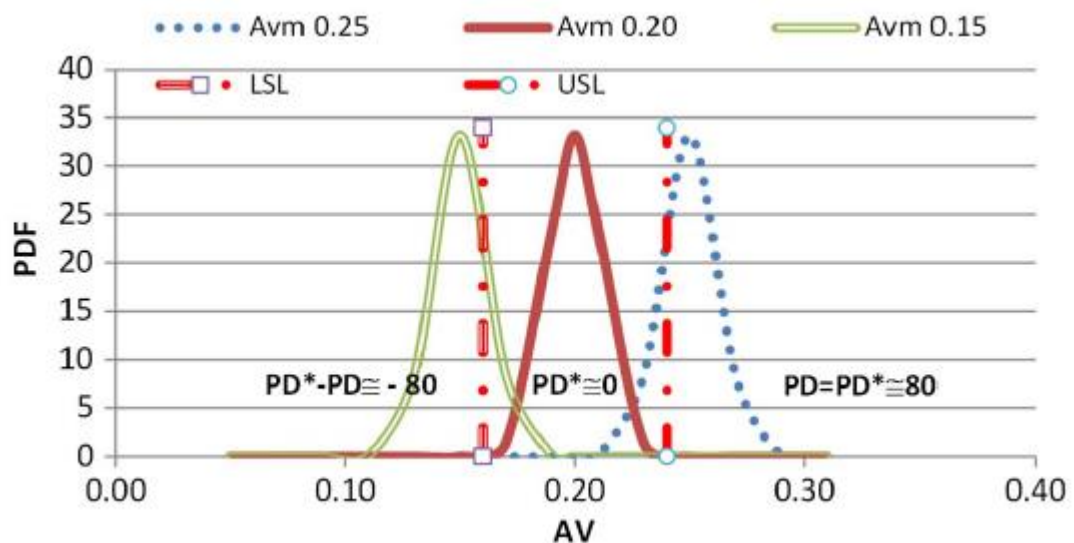
Abstract: The main objective of this research is the formalization of strategies and technical procedures for recycling porous European mixes (PEMs) back to permeable wearing courses. A number of issues were studied: mitigating the drawback of clogging and its related consequences (decay of acoustic and permeability performance over time); preserving traditional (bearing properties, skid resistance) and premium (quietness, permeability) performance; recycling high percentages of cold-milled reclaimed asphalt pavement (RAP) from PEM; and investigating the collateral effects in terms of sustainability. To investigate the aforementioned issues, an experimental plan was designed. Mixes with high RAP contents were produced and tested. Design and construction features, including mix design and mixing procedures, were addressed. Even if other experiments are needed, mechanical and environmental properties are promising. Furthermore, the tests carried out are encouraging regarding the possibility of achieving a satisfactory level of surface performance. Practical applications for rehabilitation intervention are outlined.
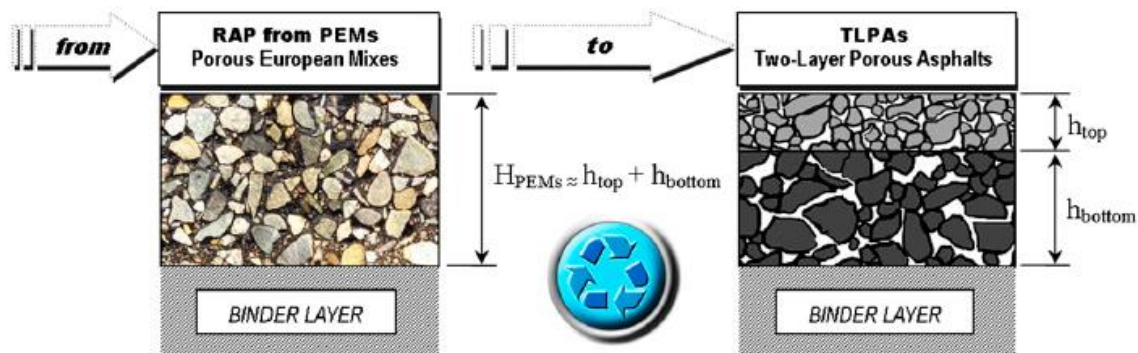
Fig. 1. Schematic of the Italian National Research Project (PRIN) 2008 Drenante da drenante (porous asphalt from porous asphalt)

Abstract. Acoustic-based mix design is still far from achieving a clear and accepted rationale. The three main dominions (generation, absorption, propagation) which affect pavement acoustic performance involve a number of acoustic parameters. Their relationship with pavement properties is scarcely or insufficiently known. In more detail, the parameters that define the acoustic coupling between the two phases that comprise a porous material are: porosity, resistivity, tortuosity, and viscous and thermal factors. Consequently, the spectrum of a pavement absorption coefficient depends, in particular, on tortuosity, whose relationship with HMA (hot mix asphalt) bulk properties is still an issue.

Given that, the study described in this paper aimed at: i) assessing the effect of the tortuosity on the absorption coefficient of a pavement layer; ii) assessing the dependence of tortuosity on mix design parameters and/or mix properties; iii) deriving a straightforward algorithm to estimate the effect of tortuosity-related properties on the absorption coefficient. Based on the above issues, an experimental plan was designed and carried out in order to study these relationships and set out a tentative theoretical and practical framework. The relationships between acoustic and traditional bulk properties of pavement mixtures were analysed. Acoustic models and hydraulic analogies were considered and, based on them, relationships were formalised and submitted to experimental validations. A simple relationship to derive tortuosity from nominal maximum aggregate size and thickness was derived. This relationship was used to derive the frequency of the first peak of the absorption spectrum, based on HMA properties. Nominal maximum aggregate size and lift thickness emerged as key factors in patterning peak frequency.

Keywords: traffic noise; acoustic absorption; porous asphalt concrete; mix design

→ Strong correlation

⇢ Weak correlation

✗ No correlation

s_ρ, s_k: viscous and thermal factors;

R_s: resistivity (Ns/m^4);

Ω: porosity;

q^2: tortuosity;

NMAS: nominal maximum aggregate size (mm);

TH: thickness (mm).

Pavement engineering

Acoustics

Fig. 2. Summary of results.

Autori: Santagata Felice, Baglieri Orazio, Baldo Nicola, Bassani Marco, Bocci Maurizio, Bosurgi Gaetano, Bucchi Alberto, Cafiso Salvatore, Canestrari Francesco, Cantisani Giuseppe, Capiluppi Gianfranco, Caposio Guido, Cardone Fabrizio, Celauro Bernardo, Celauro Clara, Cerni Gianluca, Colagrande Sandro, Colonna Pasquale, D'Andrea Antonino, D'Andrea Antonio, Dell'Acqua Gianluca, Mascio Paola Di, Mino Salvatore Di, Ferrotti Gilda, Giuffrè Orazio, Giuliani Felice, Graziani Andrea, Loprencipe Giuseppe, Losa Massimo, Mauro Raffaele, Montepara Antonio, Pasetto Marco, Pasquini Emiliano, Pisciotta Massimandrea, **Praticò Filippo G**., Ranzo Alessandro, Paolo Riviera Pier, Sangiorgi Cesare, Santagata Ezio, Vaiana Rosolino, Virgili Amedeo, A cura di Santagata, F.A.,

Titolo: STRADE- TEORIA E TECNICA DELLE COSTRUZIONI STRADALI - vol.1 – Progettazione. Vol.II - Costruzione, gestione e manutenzione, Pearson, 2016, ISBN: 9788891903044 (Book in Italian).

Introduzione. "L'ideazione di questo trattato di Ingegneria Civile sulle Strade si concretizza negli anni della maturità della mia vita di universitario. L'iniziativa editoriale ha avuto origine nella Scuola di Ingegneria delle Infrastrutture Viarie dell'Università di Ancona e nasce come lavoro di gruppo cui hanno aderito colleghi di elevata esperienza, titolari di cattedra di numerose Università Italiane: Ancona, Bari-Politecnico, Bologna, Catania, Cosenza, L' Aquila, Messina, Napoli Federico II, Padova, Palermo, Parma, Perugia, Pisa, Reggio Calabria, Roma Sapienza, Torino-Politecnico, Trento, Udine. 'Strade' si rivolge ai professionisti e ai tecnici del settore e costituisce il testo base per la didattica di tutti gli insegnamenti inseriti nei Curricula di Laurea (triennale e magistrale) dell'Ingegneria delle Infrastrutture Viarie e dei Trasporti. Il primo volume riguarda la progettazione geometrica, le intersezioni, le strade urbane, la geotecnica stradale, i materiali, il progetto della sovrastruttura e le pavimentazioni storiche. Il secondo volume tratta la formazione del corpo stradale, la costruzione della sovrastruttura, le opere d'arte minori, i dispositivi di ritenuta, la segnaletica, la sicurezza, il monitoraggio, il controllo, il riciclaggio, la manutenzione, l'adeguamento e il cantiere. Per scelta editoriale, pur costituendo argomenti di fondamentale importanza nella formazione culturale e professionale dell'ingegnere civile, non vengono trattati il traffico e le problematiche ambientali, in quanto ampiamente affrontati in numerosi altri testi di riferimento. Identico criterio è stato adottato per le opere d' arte maggiori (ponti e gallerie) che, pur rivestendo un ruolo primario nella definizione del tracciato da parte del progettista stradale, richiedono competenze specialistiche proprie dell' ingegneria strutturale e della meccanica delle rocce. Pertanto, per la loro specifica trattazione, si rinvia ai testi di pertinenza."
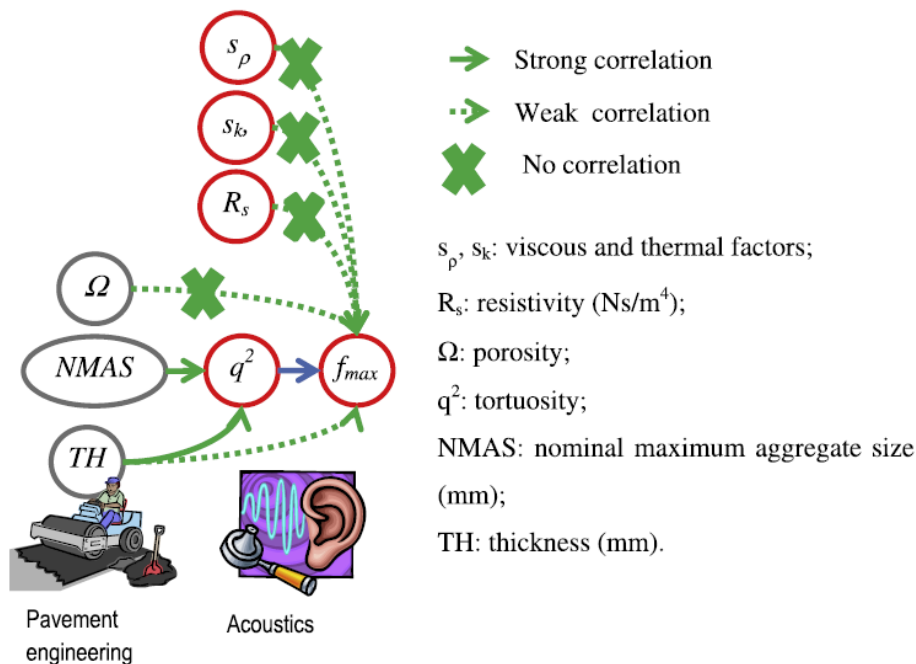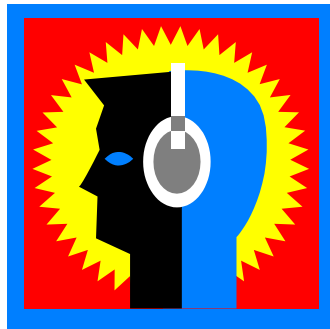
Praticò, F.G., Vaiana, R., Iuele, T., Macrotexture modeling and experimental validation for pavement surface treatments, Construction and Building Materials 95 (2015) 658–666.

Abstract. A macrotexture prediction model for pavement surface treatments is proposed. The model provides a system of 3 equations given several main technological inputs. A set of training data was used to test for model reasonableness. A set of verification data was used to assess model accurateness. Experimental data well fit the statistical model.
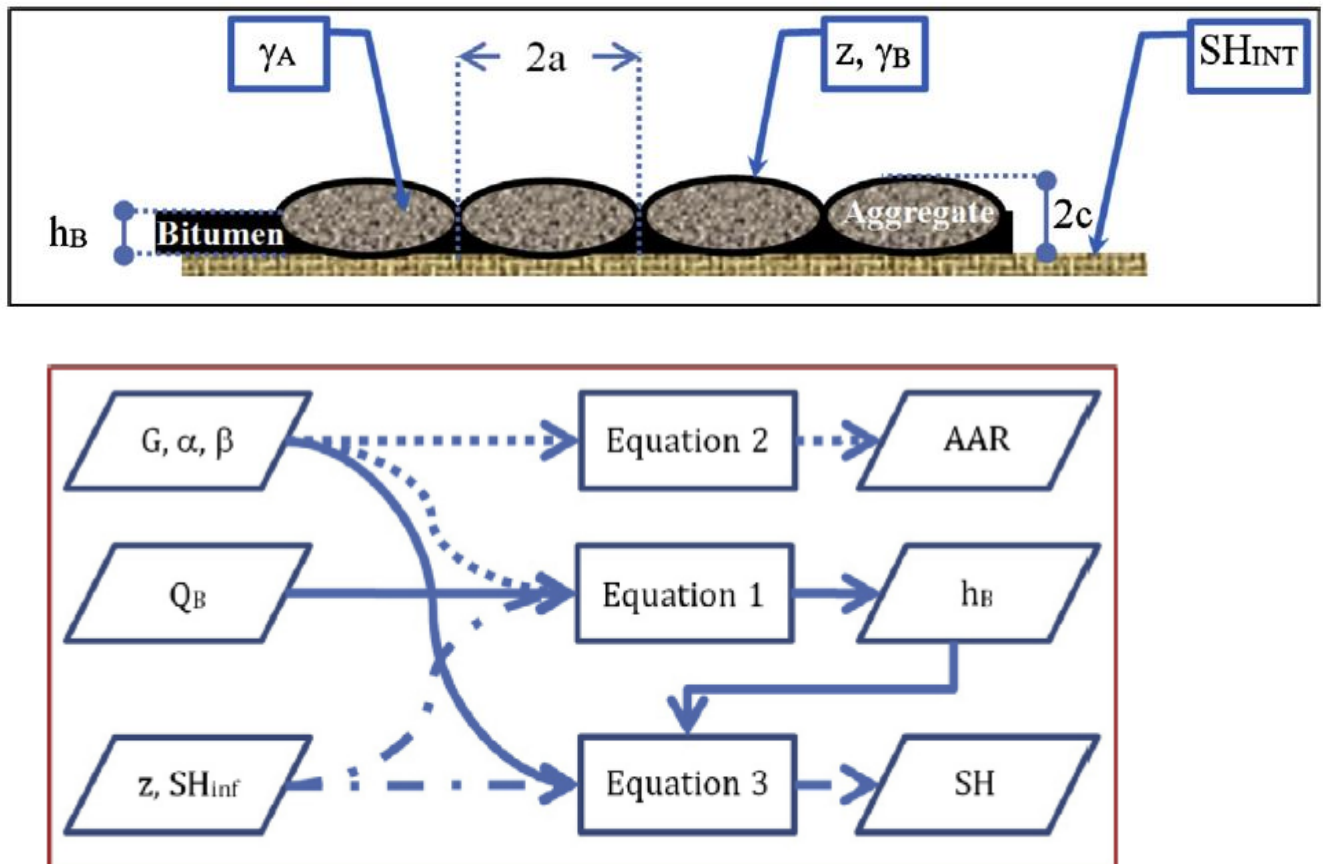
Fig. 5. Use of the closed-form equations to design a bituminous surface treatment based on surface properties.

Praticò, F.G., Vaiana, R., A study on the relationship between mean texture depth and mean profile depth of asphalt pavements Construction and Building Materials, Volume 101, 30 December 2015, Pages 72-79.

Abstract. Safety, skid resistance and noise of roads highly depend on the characteristics of pavement surface texture, for both porous and dense-graded wearing courses. In the light of the above facts, the objective of the study was to model the relationship between laser-based and volumetric-type measurements of the surface macro-texture of a pavement. In more detail, the study focused on the mean profile depth (MPD, as per ISO 13473-1:1997 and ASTM E1845-01) and on the mean texture depth (MTD, as known as sand patch texture, as per ASTM E965-96 and EN 13036-1). Different types of surface textures were considered: dense-graded friction courses (DGFC), splittmastic asphalts (SMA), open-graded friction courses (OGFC), porous European mixes (PEM). A generalised simple model has been set up, calibrated and validated. The proposed model fits the data of many types of wearing courses without neglecting the basic achievements which refer to the curves previously derived.
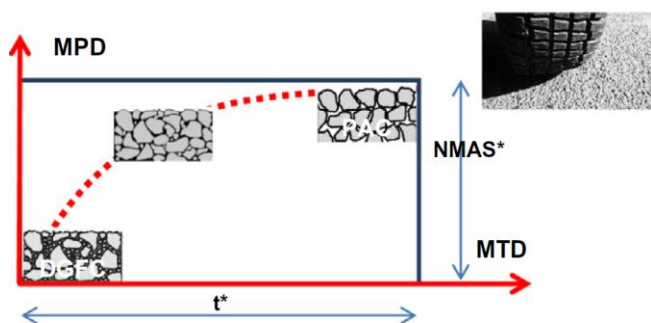
Symbols.
MPD: mean profile depth (ISO 13473-1 [1]; ASTM E 1845 [2]).
MTD: mean texture depth (ASTM E 965 [3]; EN 13036-1 [4]).
NMAS*: fraction of the nominal maximum aggregate size.
t*: fraction of the thickness of the wearing course.
DGFC: dense-graded friction course. PAC: porous asphalt concrete.

F.G. Praticò, R. Vaiana / Construction and Building Materials 101 (2015) 72–79

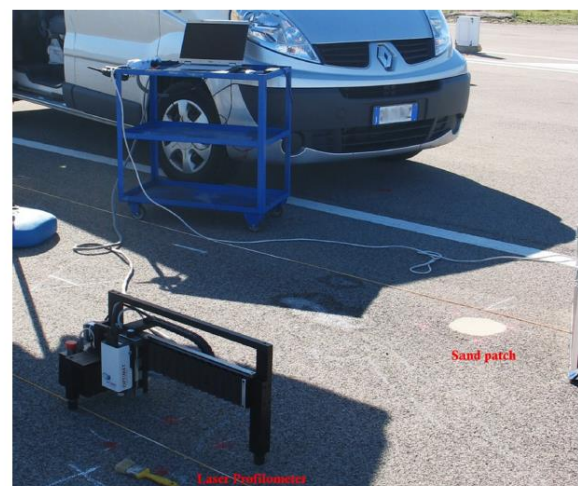**Fig. 4.** Sand height (left) and laser profilometer measurements (right).

Fig. 4. Sand patch (right) and laser (left) measurements for surface S2 (see Table 1).