LIFE E-VIA

Electric **V**ehicle no**I**se control by **A**ssessment and optimisation of tyre/ road interaction

Dissemination and participation photo album

By Vie en.ro.se. Ingegneria

With the contribution of the LIFE programme of the European Union

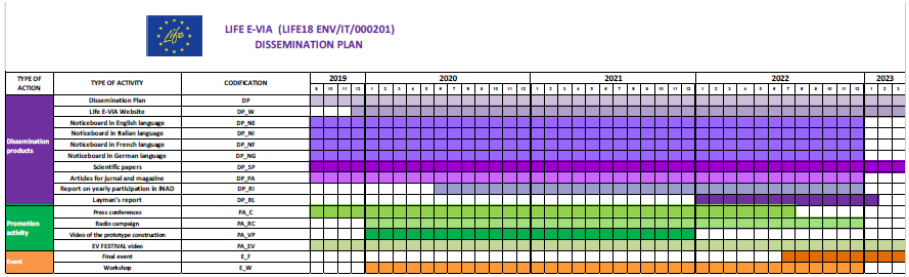
LIFE18 ENV/IT/000201

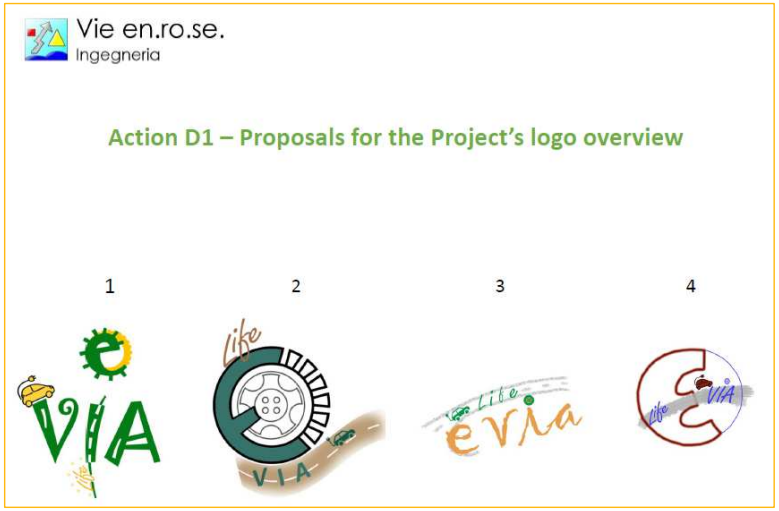
Kick off meeting of partners

Issued on: September 2019

By: All partners

MEETING





PAESAGGIO SONORO
soundscapes of WORK and of PLAY
9th international FKL symposium on soundscape

S. Cesario di Lecce, 3-6 October 2019

The lost sounds rediscovered by the students of the schools that participated in the INAD 2019 initiative

Chiara Bartalucci, Sergio Luzzi, Raffaella Bellomini,
Sara Delle Macchie, Rossella Natale

Meetings and workshops with acoustics experts
In the frame of EU-funded projects

Life MONZA
Methodologies fOr Noise low emission Zones introduction And management

Electric **V**ehicle no**I**se control by **A**ssessment and optimisation of tyre/road interaction)

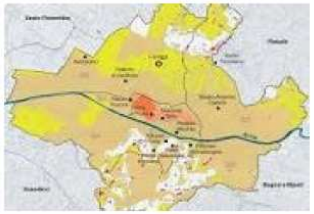
EUROCITIES- Meeting in Oslo during the Environment Forum

Issued on: October 2019

By: Comune di Firenze and Vie en.ro.se. Ingegneria

MEETINGS OF THE EUROCITIES
Code: M_1

« E-VIA » Electric Vehicle noise control by Assessment and optimisation of Tyre/road interaction



PROJECT LOCATION: Florence Italy

BUDGET INFO:

Total amount: 1.797,030 €

55% EC Co-funding: 933,295 €

DURATION: Start: 01/07/2019 - End: 31/01/2023

PROJECT'S IMPLEMENTORS:

Coordinating Beneficiary: Florence Municipality

Associated Beneficiary(ies):
Continental Reifen Deutschland
Ifsttar
Ipool S.r.l.
University of Reggio Calabria
Vie en.ro.se Ingegneria S.r.l

Eurocities Environment Forum
Oslo 23-25 Ottobre 2019

Arnaldo Melloni
Project Manager

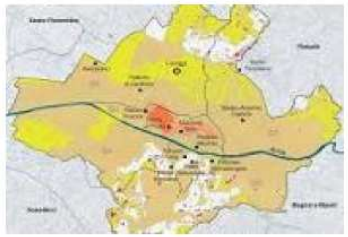
LIFE 18 ENV and GIE Welcome meeting in Brussels

Issued on: November 2019

By: Comune di Firenze

MEETING

« E-VIA » Electric Vehicle noise control by Assessment and optimisation of Tyre/road interaction



PROJECT LOCATION: Florence Italy

BUDGET INFO:

Total amount: 1.797,030 €

55% EC Co-funding: 933,295 €

DURATION: Start: 01/07/2019 - End: 31/01/2023

PROJECT'S IMPLEMENTORS:

Coordinating Beneficiary: Florence Municipality

Associated Beneficiary(ies):

Continental Reifen Deutschland
Ifsttar
Ipool S.r.l.
University of Reggio Calabria
Vie en.ro.se Ingegneria S.r.l

LIFE18 ENV and GIE Welcome Meeting, Brussels, 7-8 November 2019

Arnaldo Melloni Project Manager

Development and launch of LIFE E-VIA website

Issued on: December 2019

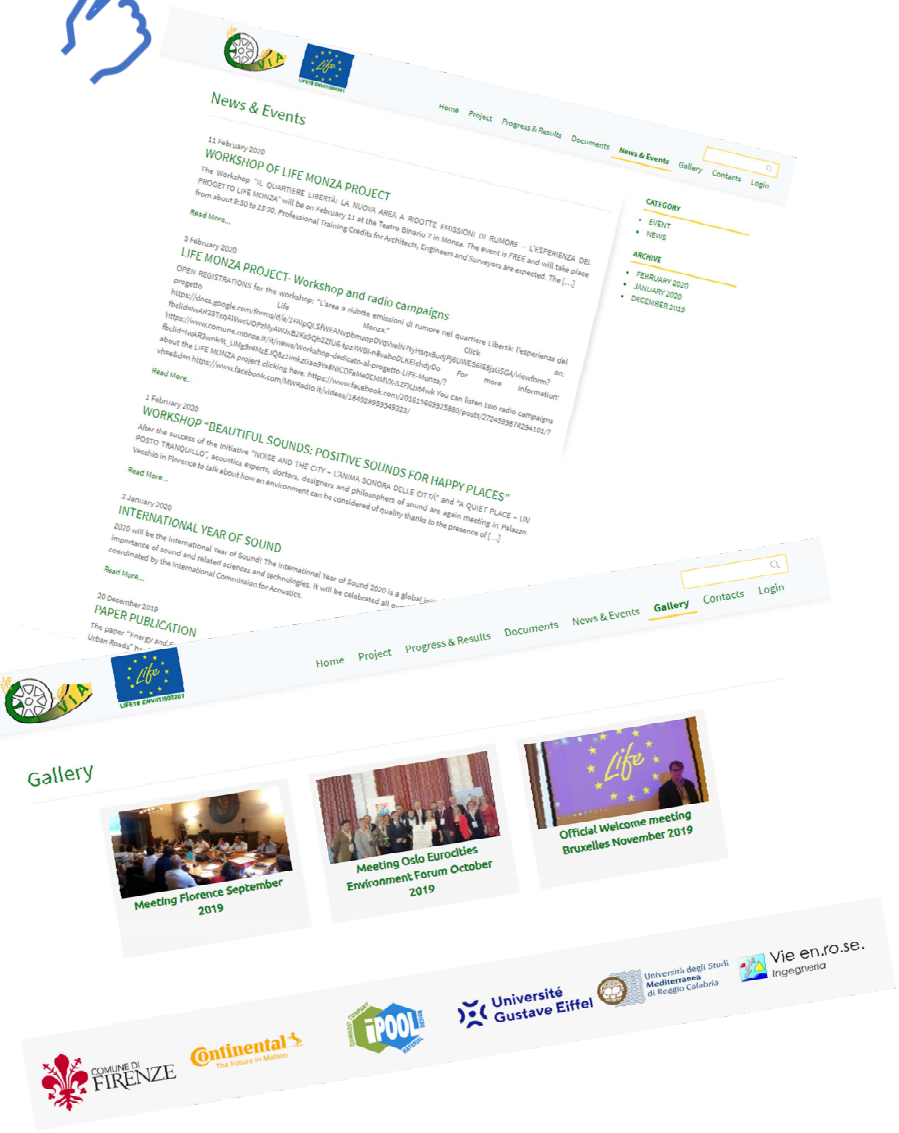
By: Vie en.ro.se. Ingegneria

Deadline: 01/12/2019

LIFE E-VIA WEBSITE

Code: 3

https://life-evia.eu/



SC4Life- SmartCity 360°
Scientific Contribution

Issued on: December 2019

By: UNIRC

Deadline: 31/03/2023

SCIENTIFIC PAPERS
Code: 36_1

SC4Life

EAI COMMUNITY THAT BUILDS YOUR CAREER
Collaborative research. Objective evaluation. Fair recognition.

HOME REGISTRATION COMMITTEES PROGRAM FOR AUTHORS CALLS PRACTICAL INFO SPONSORSHIP SMARTCITY 360°

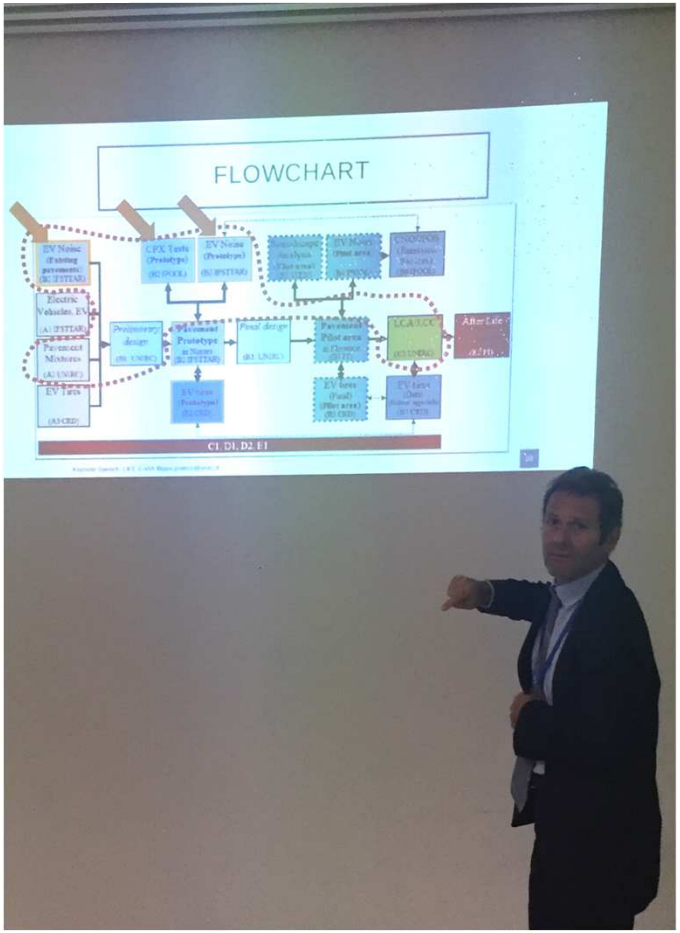
http://sc4life.org/full-program/

SESSION 1: Cities and Territory

Session Chair: Paulo Pereira

Keynote Speech: Fillipo Pràtico

Title. *LIFE E-VIA: Electric Vehicle noise control by assessment and optimisation of tyre/road interaction*



SC4Life conference will take place on the 5th December in the room #3
11:30 – 13:00 SESSION 1: Cities and Territory
Session Chair: Paulo Pereira

Keynote Speech
The LIFE E-VIA project

Electric Vehicle noise control by assessment and optimisation of tyre/road interaction
(LIFE18 ENV/IT/000201)

http://life-evia.eu http://ec.europa.eu/environment/life/project/Projects/index.cfm?fuseaction=search.dspPage&n_proj_id=7210

Filippo Giammaria Praticò,
University Mediterranea of Reggio Calabria; Italy
filippo.pratico@unirc.it

SC4Life SmartCity360° THE GATEWAY TO INNOVATION UM CITIES

Paper published on Sustainability 2020 about the sustainable pavement materials for the urban roads.

Issued on: January 2020

By: UNIRC

Deadline: 01/12/2022

ARTICLES FOR OPEN ACCESS JOURNAL

Code: 20_1

https://www.mdpi.com/2071-1050/12/2/704/htm/

sustainability

MDPI

Article

Energy and Environmental Life Cycle Assessment of Sustainable Pavement Materials and Technologies for Urban Roads

Filippo G. Praticò [1], Marinella Giunta [2,*], Marina Mistretta [3] and Teresa Maria Gulotta [4]

1 Department of Information, Infrastructure and Sustainable Energy (DIIES), Via Graziella, Feo di Vito, University Mediterranea of Reggio Calabria, 89214 Reggio Calabria, Italy; filippo.pratico@unirc.it

2 Department of Civil, Energy, Environmental and Material Engineering (DICEAM), via Graziella, Feo di Vito, University Mediterranea of Reggio Calabria, 89100 Reggio Calabria, Italy

3 Department of Heritage, Architecture, Urbanism (PAU), Via dell'Università, 25, University Mediterranea of Reggio Calabria, 89124 Reggio Calabria, Italy; marina.mistretta@unirc.it

4 Department of Engineering, Viale delle Scienze, University of Palermo, 90128 Palermo, Italy; teresa.gulotta@deim.unipa.it

* Correspondence: marinella.giunta@unirc.it; Tel.: +39-0965-169-2471

Received: 18 December 2019; Accepted: 16 January 2020; Published: 18 January 2020

check for updates

Abstract: Recycled and low-temperature materials are promising solutions to reduce the environmental burden deriving from hot mix asphalts. Despite this, there is lack of studies focusing on the assessment of the life-cycle impacts of these promising technologies. Consequently, this study deals with the life cycle assessment (LCA) of different classes of pavement technologies, based on the use of bituminous mixes (hot mix asphalt and warm mix asphalt) with recycled materials (reclaimed asphalt pavements, crumb rubber, and waste plastics), in the pursuit of assessing energy and environmental impacts. Analysis is developed based on the ISO 14040 series. Different scenarios of pavement production, construction, and maintenance are assessed and compared to a reference case involving the use of common paving materials. For all the considered scenarios, the influence of each life-cycle phase on the overall impacts is assessed to the purpose of identifying the phases and processes which produce the greatest impacts. Results show that material production involves the highest contribution (about 60–70%) in all the examined impact categories. Further, the combined use of warm mix asphalts and recycled materials in bituminous mixtures entails lower energy consumption and environmental impacts due to a reduction of virgin bitumen and aggregate consumption, which involves a decrease in the consumption of primary energy and raw materials, and reduced impacts for disposal. LCA results demonstrate that this methodology is able to help set up strategies for eco-design in the pavement sector.

all the scenarios. In detail, it accounts for more than 60% of the majority of environmental indicators, with the exception of EF_w, HT-ce, HT-nce, and ME.

The negative values of Ftox and HT-ce in Scenario 1 (addition of waste plastics in the bituminous mixture) are essentially due to the avoided impacts of virgin plastics.

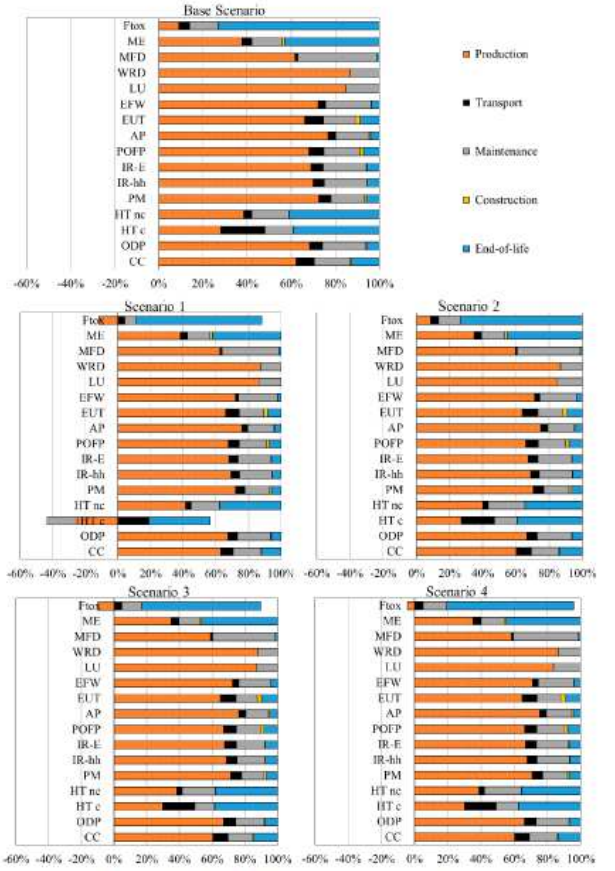


Figure 2. Contribution analysis of life-cycle environmental impacts.

LIFE E-VIA: objectives and actions

Issued on: February 2020

By: : Vie en.ro.se. Ingegneria

Deadline: 01/12/2022

NOTICEBOARD IN ENGLISH LANGUAGE

Code: 18_1

LIFE E-VIA

Electric Vehicle noIse control by Assessment and optimisation of tyre/road interaction

LIFE18 ENV/IT/000201

With the contribution of the LIFE programme of the European Union

Background

Exposure data from the European Environment Agency (EEA) demonstrate that more than 100 million EU citizens are affected by high noise levels negatively impacting human health. Traffic noise alone is harmful to the health of almost every third person in the WHO (World Health Organization) European Region. 20% of Europeans are regularly exposed to night sound levels that could significantly damage health, especially in urban areas. As emerged in Noise in Europe Conference (April 2017) and in the WHO guidelines published in October 2018, the increased stringency of EU at source standards needs to be balanced against other effective measures such as road surface and/or tyre improvements and urban planning measures as well.
One of the solutions universally recognized as the best to reduce noise in urban areas, from both the point of view of noise and air quality, is the introduction of **electric mobility**. Thus, for the changed requirements of Electric Vehicles (EVs) there is a need for in-depth investigations of tyre/road interaction. Last but not least, even for the application of the Directive 2002/49/EC, the coefficients to apply the CNOSSOS model (Directive 996/2015/EC) to new traffic spectra and new vehicles are completely missing.

Objectives

1. To **reduce noise** for roads inside very populated urban areas through the implementation of a mitigation measure aimed at **optimizing road surfaces and tyres of EVs**. Two road surfaces, at least 5 different EV types, one reference ICE Vehicle (ICEV) and at least 3 types of tyres per vehicle type (including tyres specifically designed for EVs) will be tested
2. To **estimate the mitigation efficiency** and **potential** of **tyres**, **pavements** and **traffic** (traffic spectrum, speeds, handling conditions) at a higher and comprehensive level: a Life Cycle Analysis (**LCA**) and a Life Cycle Cost Analysis (**LCCA**) will be performed to demonstrate the individual and synergistic efficiency of pavement surfaces, tyres and vehicles (including the comparison between internal combustion vehicles, mixed traffic, and EV traffic)
3. To contribute to **EU legislation effective implementation** (EU Directives 2002/49/EC and 2015/996/EC), providing rolling noise coefficients within the Common Noise Assessment Method (**CNOSSOS-EU**), specifically tuned for EVs which are actually in need of data for practitioners, agencies, and departments aiming at developing future scenarios
4. To contribute to **national and Italian regional policies**, issuing **guidelines** about use and application of the methodology output of the project, which will be adopted, through the Regional Env. Agency (ARPAT), supporting the project, by Tuscany Region. Calabria Region and Città of Reggio Calabria also expressed their interest.
5. To **raise people's awareness** of noise pollution and health effects explaining the opportunities provided by EVs through specific dissemination and promotional events, also investigating people perception regarding noise in terms of soundscape methodology and involving them in noise data acquisition.
6. To demonstrate and **promote sustainable road transport mobility (electric)**, reducing noise emission by 5 dB(A) at receivers' roadside and achieving also CO2 emissions reduction (21%), based on the Italian context (LPG, CNG, Hybrid, EV, petrol cars, diesel cars) and the concerned literature
7. To **encourage low-noise surfaces implementation in further EU and extra-EU scenarios**, demonstrating durability and sustainability, through in-depth LCA&LCCA

Actions

A. Preparatory actions
A1 Electric vehicles and their noise emission
A2 Quiet pavement technologies and their performance over time
A3 Tyre role in the new context of EV and ICEV

B. Implementation actions
B1 Tracks design
B2 Tyre-pavement coupling study and prototype implementation
B3 Pilot area: Implementation, Replication and transferability
B4 Track efficiency tests in the pilot area
B5 Soundscape analysis
B6 Evaluation of EV noise emissions
B7 Holistic performances of tyres

C. Monitoring of the impact of the project actions
C1 Monitoring of the impact of the project actions
C2 Life cycle analysis (LCA) and life cycle costing (LCC)

D. Public awareness and dissemination of results
D1 Information and awareness raising activities
D2 Technical dissemination activities to stakeholders

E. Project management

Project website: https://life-evia.eu/

With the contribution of the LIFE programme of the European Union
LIFE18 ENV/IT/000201

NOTICEBOARD IN ENGLISH LANGUAGE
Code: 18_2

LIFE E-VIA

Electric Vehicle noIse control by Assessment and optimisation of tyre/road interaction

Coordinating beneficiary

Comune di Firenze

Partners

Continental · Université Gustave Eiffel · IPOOL · Università degli Studi Mediterranea di Reggio Calabria · Vie en.ro.se. Ingegneria

Journées Techniques Acoustique et Vibrations

"LIFE E-VIA: noise control of electric vehicles by optimizing tire-road interaction"

Issued on: March 2020

By: : Université Gustave Eiffel

Deadline: 01/03/2023

SCIENTIFIC PRESENTATION IN NATIONAL CONGRESS

Code: 36_2

umr ae

Journées Techniques Acoustique et Vibrations
Lille – France – 11-12 mars 2020

jt av JOURNEES TECHNIQUES ACOUSTIQUE ET VIBRATIONS

LIFE E-VIA : contrôle du bruit des véhicules électriques par optimisation de l'interaction pneumatique-chaussée

Julien CESBRON, Marie-Agnès PALLAS, Philippe KLEIN, Simon BIANCHETTI, Adrien LE BELLEC, Vincent GARY

Université Gustave Eiffel – UMRAE

Université Gustave Eiffel Cerema

Action B21 - Acoustical characterization of EVs

- Planned vehicles:
  - One ICE Vehicle (Renault Kangoo Diesel)
  - Several EVs (Renault Kangoo ZE, Renault Zoe, C-Zero, Nissan Leaf, BMW i3, Tesla Model 3)
- Already tested in August 2019:
  - Renault Kangoos (ICEV and EV) and Renault Zoe

Action B22 – Prototype construction

- Construction of a B1-based test track prototype:
  - Located on IFSTTAR reference test track in Nantes
  - Call for tender planned in April 2020 based on B1 recommendations
  - Construction planned in July 2020

11th International Conference "Environmental Engineering"
Vilnius Gediminas Technical University
Lithuania, 21–22 May 2020
Section: Environmental Protection and Water Engineering
http://enviro.vgtu.lt

eISSN 2029-7092 / eISBN 978-609-476-232-1

Article ID: enviro.2020.622
https://doi.org/10.3846/enviro.2020.622

Particulate Matter from Non-exhaust Sources

Filippo G. Praticò, Paolo G. Briante*

Department of Information Engineering, Infrastructure and Sustainable Energy (DIIES), Mediterranea University, Reggio Calabria, Italy

Received 04 February 2020; accepted 24 March 2020

Abstract. Air pollution is an important issue worldwide. Solid components in air (particulate matter, PM) originate from a variety of natural or anthropogenic sources and have different morphological, physical, and chemical properties. Their presence in the air also depends on meteorological conditions, such as humidity, rainfall, and wind speed. PM pollution has adverse effects on environment and human health. Therefore, it is very important to address sources and processes involved in PM generation. Among the existing sources, a special attention must be paid to PM emissions from road traffic, i.e., exhaust sources (e.g., fuel combustion) and non-exhaust sources (e.g., road, tyre, brakes). These traffic-related sources contribute to PM concentrations in cities, and this calls for research into new possible systems and/or mitigation measures. In light of the facts above, the objectives of this study are 1) To evaluate the contribution to PM emission from traffic-related sources. 2) To evaluate existing mitigation measures and to identify new ones to reduce PM production. First results show that: 1) Non-exhaust sources have a different role in PM generation and they differently affect PM_{10}, $PM_{2.5}$, and $PM_{0.1}$. 2) Even if emissions-related regulations have led to reductions in exhaust emissions from road traffic, other mitigation measures could reduce the non-exhaust part of emissions (e.g., brakes wear, road wear, and tyre wear). 3) New technologies could be developed to reduce PM from non-exhaust sources.

Keywords: particulate matter, non-exhaust sources, tyre wear, road wear, brake wear, mitigation measures.

Author Proof

Smart Road Infrastructures Through Vibro-Acoustic Signature Analyses

Rosario Fedele

Department of Information Engineering, Infrastructures and Sustainable Energy (DIIES), University Mediterranea of Reggio Calabria,
Via Graziella - Feo di Vito, snc, 89122 Reggio Calabria, Italy
rosario.fedele@unirc.it

Abstract. Smart cities need "intelligent" infrastructures designed or managed bearing in mind crucial characteristics, such as sustainability, efficiency, safety, and resiliency. Several solutions can be adopted, but the key factor for the success of the solution selected is its ability of improving the management process. The objective of the study described in this paper is to develop a solution that can be used to make smarter the road pavement monitoring and maintenance. In particular, a Non-Destructive Test (NDT)-based method is presented and applied aiming at extracting crucial information about the Structural Health Status (SHS) of the monitored road pavement. Results show that the method is able to recognize the presence and the growing of induced cracks using meaningful features extracted from the vibro-acoustic signatures (acoustic signals) of the road pavement loaded by a light vehicle. The above-mentioned features can be used to build innovative P-F curves able to improve the road pavement management process.

Keywords: Smart roads · Sustainability · Vibro-acoustic signature

Acoustic Impact of Electric Vehicles

Filippo G. Praticò
Department of Information Engineering, Infrastructures, and Sustainable Energy (DIIES)
University "Mediterranea"
Reggio Calabria, Italy
filippo.pratico@unirc.it

Paolo G. Briante
Department of Information Engineering, Infrastructures, and Sustainable Energy (DIIES)
University "Mediterranea"
Reggio Calabria, Italy
0000-0002-0209-7024

Greta Speranza
Department of Information Engineering, Infrastructures, and Sustainable Energy (DIIES)
University "Mediterranea"
Reggio Calabria, Italy
0000-0002-2018-0198

***Abstract*— Electric vehicles (EV) diffusion depends on many factors among which policies, people options, and economic factors. Their noise-related performance could appear favourable. This notwithstanding, despite partisan opinions, the analyses carried out suggest that research and industry will have to minimise the collateral issues posed by a quite probable EV diffusion. The objective of the study presented in this paper is to analyse the acoustic impact of electric vehicles (EV) and to set up an overall framework for an effective management of their diffusion. After the objectives, EV overall characteristics are analysed. EV acoustic performance are then analysed. In the final discussion, the main characteristics of the required holistic approach are highlighted. This can benefit both researchers and practitioners.**

Keywords*— *Electric Vehicle, Noise, Surface Properties, Environmental Impact

LIFE E-VIA PROJECT: NOISE, ELECTRIC VEHICLES AND TYRES

Arnaldo Melloni[1] Gessica Pecchioni[1] Sergio Luzzi[2] Raffaella Bellomini[2]
[1] Comune di Firenze, Firenze, Italy
[2] Vie en.ro.se Ingegneria srl, Firenze, Italy
gessica.pecchioni@comune.fi.it

ABSTRACT

The LIFE E-VIA project tackles noise pollution from road traffic noise focusing on a future perspective in which electric and hybrid vehicles will be a consistent portion of traffic flow. Others main objectives of the project consist in: the combination of knowledge of road optimization and tyre development in order to test an optimized solution for reducing noise in urban areas and Life Cycle Cost with respect to actual best; the noise reduction for roads inside very populated urban areas through the implementation of a mitigation measure aimed at optimizing road surfaces and tyres of EVs (electric vehicles). From a practical point of view, two road surfaces, and at least five different EVs (including tyres specifically designed for EVs) will be tested. Finally, the soundscape holistic approach will be used to evaluate the performance of EV vs ICEV in the newly built scenario.

LIFE18 ENV/IT/000201
With financial support from the EU LIFE programme

e-Forum Acusticum 2020
Dec 7-11, 2020

COMUNE DI FIRENZE

Vie en.ro.se. Ingegneria

LIFE E-VIA PROJECT: NOISE, ELECTRIC VEHICLES AND TYRES

Arnaldo Melloni, Gessica Pecchioni – Municipality of Florence (Italy)
Sergio Luzzi, Raffaella Bellomini – Vie en.ro.se Ingegneria s.r.l, Florence (Italy)
gessica.pecchioni@comune.fi.it

IYS2020 Steering Committee Meeting
16 January 2021

Student competition and Italian events
State of the Art

Sergio Luzzi
Chiara Bartalucci

Promotion – EU Projects

LIFE18 ENV/IT/000201 Electric Vehicle noise control by Assessment and optimization of tyre/road interaction
2019- ongoing
Organization of a student contest for high schools and music academy teachers/students to develop a proposal for the optimal "EV sound" (low-speed issue).

1

Creative Europe AURA Auralisation of acoustic heritage sites using Augmented and Virtual Reality
2021-ongoing
With the project AURA, music and opera houses in Berlin, Florence and Lviv – supported by tech and marketing partners – strive to tap into the potentials that auralisation opens up for music performing arts and establishments. Three use cases will show auralisation experiences with 3D-models of the music venues, creating perfect replica and producing exciting new ways of experiencing music.

Other EU/International projects about "positive sound" to be related to IYS?

9

Articles published on Italian journals

Issued on: March 2021

NETWORKING ACTIVITIES

Articles published on Italian journals

Issued on: April 2021

NETWORKING ACTIVITIES

la Repubblica FIRENZE

Dir. Resp.: Maurizio Molinari

Tiratura: 0 - Diffusione: 14521 - Lettori: 109000: da enti certificatori o autocertificati

Via Paisiello

L'esperimento dell'asfalto che riduce i rumori del traffico

Ridurre il rumore del traffico nelle strade urbane grazie a un nuovo asfalto

LA NAZIONE FIRENZE

Dir. Resp.: Agnese Pini

Asfalto silenzi… La sperimenta… parte da via Pa…

Anche i cittadini dovranno esprimere le p…

Poi saranno scelte altre aree della città d…

FIRENZE

Ridurre il rumore del traffico nelle strade urbane grazie a un nuovo asfalto a bassa emissione. E' l'obiettivo del progetto europeo *Life E-Via*, che vede Firenze città capofila e caso pilota per la sperimentazione: il nuovo asfalto sarà steso durante l'estate in via Paisiello a San Jacopino. Dopo i test sulle prestazioni, saranno individuate altre tre aree per la sperimentazione in città e poi per la diffusione in Italia e in Europa. «Grazie al progetto *Life* che come Direzione Ambiente ci siamo aggiudicati lo scorso anno – ha detto l'assessore all'Ambiente Cecilia Del Re – possiamo dare il via alla sperimentazione del nuovo asfalto antirumore per contribuire a ridurre l'inquinamento acustico nelle aree urbane. Partiremo da via Paisiello per poi individuare altre aree analoghe e verificare i risultati della sperimentazione con l'obiettivo di rendere Firenze più confortevole dal punto di vista acustico. I progetti europei sono una grandissima opportunità per innovare gli strumenti di intervento e dare risposte sempre più efficienti a temi urgenti e complessi come quelli ambientali».

«**Partiamo** da una viabilità da ripristinare e risanare – ha aggiun-

to l'assessore … Giorgetti – … che riduca i r… dalla strada o… to e pneumati… zi che transita… **Il progetto** *L…* inoltre il coinv… tadini attraver… formazione su… mi della mobilità elettrica e so… stenibile, ma anche attraverso passeggiate sonore e interviste per capire come cambia la percezione del rumore al variare della tipologia di asfalto e di veicoli e pneumatici. Le interviste saranno realizzate anche su autobus e taxi elettrici coinvolti nell'iniziativa. L'implementazione del caso pilota nella città di Firenze è prevista durante l'estate 2021, in via Paisiello. Il Progetto *Life E-Via* affronta il tema dell'inquinamento acustico dovuto al rumore del traffico stradale, concentrandosi su una prospettiva futura in cui i veicoli elettrici e ibridi saranno una parte consistente del flusso di traffico. L'obiettivo è ottimizzare asfalti e pneumatici per ridurre il rumore nelle aree urbane. Il Progetto, co-finanziato dall'Unione europea attraverso il programma *Life*, ha avuto inizio a luglio 2019 e terminerà a gennaio 2023.

Asfalto anti rumore a Firenze, collabora l'Università Mediterranea

L'ateneo di Reggio Calabria tra i partner del progetto Life E-Via. Sperimentazione per ridurre l'inquinamento acustico

Pubblicato il: 04/04/2021 – 9:17

FIRENZE Ridurre … asfalto a bassa e… città capofila e ca… durante l'estate i…

FIRENZETODAY ≡ Sezioni life

life

San Jacopino: arriva l'asfalto anti rumore: Firenze città pilota in Europa per la sperimentazione

Si parte in estate da via Paisiello per poi estendere il progetto ad altre aree

Redazione

05 APRILE 2021 10:45

I più letti di oggi

1 San Jacopino: arriva l'asfalto anti rumore: Firenze città pilota in Europa per la sperimentazione

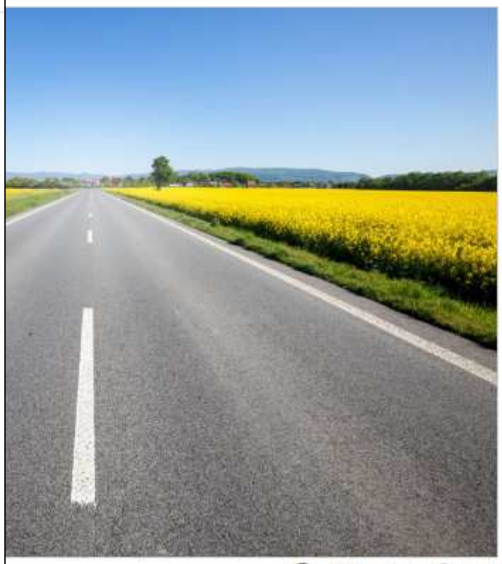
Ridurre il rumore del traffico nelle strade urbane grazie a un nuovo asfalto a bassa emissione. E' l'obiettivo del progetto Life E-Via, che vede Firenze città capofila e caso pilota per la sperimentazione: il nuovo asfalto sarà steso durante l'estate in via Paisiello a San Jacopino. Dopo i test sulle prestazioni, saranno individuate altre tre aree per la sperimentazione in città e poi per la diffusione in Italia e in Europa.

METROPOLITANO.it

notizie e storie di valore

…zioni Ecosostenibili APRI

…e sperimenta un asfalto in grado …rre l'inquinamento acustico



Condividi l'articolo:

Asfalto anti rumore, Firenze lo testa per l'Europa

si tratta di un nuovo asfalto a ba
Jacopino. Dopo i test sulle prest
poi per la diffusione in Italia e i

"Grazie al progetto Life che co
l'assessore all'Ambiente Cecili
anti rumore per contribuire a ri
Paisiello per poi individuare alt
l'obiettivo di rendere Firenze p
grandissima opportunità per inn
temi urgenti e complessi come
ha aggiunto l'assessore alla Mo
provenienti dalla strada ottimiz

Il progetto Life E-Via prevede i
per capire come cambia la perce
pneumatici. Le interviste saran

Il Progetto, co-finanziato dall'U
2019 e terminerà a gennaio 202
partner l'Università Mediterran
Gustave Eiffel e I-Pool.

A San Jacopino arriva l'asfalto anti rumore

Si parte in estate da via Paisiello. Consolidamento di un muro in via Bolognese, ri-pavimentazione in via di Castelnuovo

Redazione Nove da Firenze
03 aprile 2021 16:20

Arriva l'asfalto anti rumore, Firenze città pilota in Europa per la sperimentazione

Si parte in estate da via Paisiello a San Jacopino per poi estendere il progetto ad altre aree

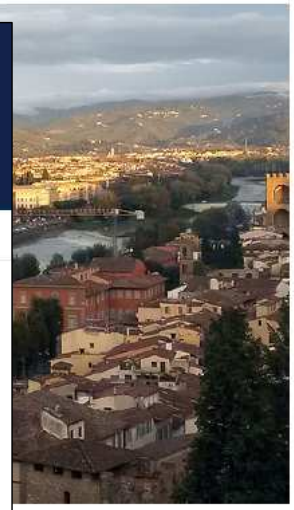
nelle strade urbane
o del progetto Life E-
a sperimentazione: il
San Jacopino.

ANSA2030

Asfalto anti rumore, Firenze città pilota in Europa

Per sperimentazione progetto Life E-Via dalla prossima estate

Redazione ANSA FIRENZE 03 aprile 2021 18:30



La Martinella

Un altro modo di raccontare Firenze

HOME | ATTUALITÀ E POLITICA | ARTE E CULTURA | SOCIALE | INCHIESTE | INTERVENTI | IL PUNTO DEL DIRETTORE | SPORT | SPETTACOLI

Life E-via

A S. Jacopino arriva l'asfalto anti rumore:

3 APRILE 2021 // La Martinella Di Firenze

Firenze città pilota in Europa per la sperimentazione del progetto Life E-via. Si parte in estate da via Paisiello per poi estendere il progetto ad altre aree

Cerca in questo sito web

Seguici Su Facebook

La Martinella di Firenze
1038 "Mi piace"
La Martinella
Un altro modo di raccontare Firenze
Mi piace | Invia un messaggio

Il Punto Del Direttore

Press release: "A San Jacopino arriva l'asfalto anti rumore: Firenze città pilota in Europa per la sperimentazione"

Issued on: April 2021

By: Comune di Firenze

Deadline: 31/07/2022

PRESS CONFERENCES

Code: 11_a

Il Comune Servizi Ambiente Cultura Educazione Tutti gli argomenti

A San Jacopino arriva l'asfalto anti rumore: Firenze città pilota in Europa per la sperimentazione

ambiente

03 aprile 2021

Si parte in estate da via Paisiello per poi estendere il progetto ad altre aree

Ridurre il rumore del traffico nelle strade urbane grazie a un nuovo asfalto a bassa emissione. E' l'obiettivo del progetto Life E-Via, che vede Firenze città capofila e caso pilota per la sperimentazione: il nuovo asfalto sarà steso durante l'estate in via Paisiello a San Jacopino. Dopo i test sulle prestazioni, saranno individuate altre tre aree per la sperimentazione in città e poi per la diffusione in Italia e in Europa.

"Grazie al progetto Life che come Direzione Ambiente ci siamo aggiudicati lo scorso anno - ha detto l'assessore all'Ambiente Cecilia Del Re - possiamo dare il via alla sperimentazione del nuovo asfalto anti rumore per contribuire a ridurre l'inquinamento acustico nelle aree urbane. Partiremo da via Paisiello per poi individuare altre aree analoghe e verificare i risultati della sperimentazione con l'obiettivo di rendere Firenze più confortevole dal punto di vista acustico. I progetti europei sono una grandissima opportunità per innovare gli strumenti di intervento e dare risposte sempre più efficienti a temi urgenti e complessi come quelli ambientali".

https://www.comune.fi.it/comunicati-stampa/san-jacopino-arriva-lasfalto-anti-rumore-firenze-citta-pilota-europa-la

LIFE E-VIA: objectives and actions (IT)

Issued on: May 2021

By: Vie en.ro.se. Ingegneria

Deadline: 31/12/2022

NOTICEBOARD IN ITALIAN LANGUAGE

Code: 23_1

LIFE18 ENV/IT/000201

With the contribution of the LIFE programme of the European Union

LIFE E-VIA

Electric Vehicle noIse control by Assessment and optimisation of tyre/road interaction

Background

I dati sull'esposizione dell'Agenzia europea dell'ambiente (EAA) dimostrano che più di 100 milioni di cittadini dell'UE sono esposti ad elevati livelli di rumore che hanno un impatto negativo sulla salute umana. Il solo rumore del traffico stradale è dannoso per la salute di quasi una persona su tre nella regione europea dell'OMS (Organizzazione Mondiale della Sanità). Il 20% dei cittadini europei è regolarmente esposto a livelli sonori notturni che potrebbero danneggiare significativamente la loro salute, soprattutto nelle aree urbane. Come emerso nella conferenza Noise in Europe (aprile 2017) e nelle linee guida dell'OMS pubblicate nell'ottobre 2018, la maggiore severità delle norme UE riferite alla sorgente di rumore deve essere bilanciata con altre misure efficaci come il miglioramento della superficie stradale e/o dei pneumatici e anche misure di pianificazione urbana. Una delle soluzioni universalmente riconosciute come la migliore per ridurre il rumore nelle aree urbane, sia dal punto di vista del rumore che della qualità dell'aria, è l'introduzione della **mobilità elettrica**. Quindi, per le mutate esigenze dei veicoli elettrici (EV) c'è bisogno di indagini approfondite sull'interazione pneumatico/strada. Infine, anche per l'applicazione della direttiva 2002/49/CE, risultano attualmente assenti i coefficienti necessari per applicare il modello CNOSSOS (Direttiva 996/2015/CE), in riferimento ai nuovi spettri di traffico e ai nuovi veicoli.

Obiettivi

1. **Ridurre il rumore da traffico stradale** all'interno di aree urbane densamente abitate, attraverso l'attuazione di una misura di mitigazione volta a **ottimizzare le superfici stradali e i pneumatici dei veicoli elettrici**. Saranno testati due superfici stradali, almeno 5 diversi tipi di EV, un veicolo con motore a combustione interna di riferimento (ICEV) e almeno 3 tipi di pneumatici per tipo di veicolo (compresi i pneumatici specificamente progettati per EV).
2. **Stimare l'efficienza e il potenziale di mitigazione di pneumatici, asfalti e traffico** (spettro di traffico, velocità, condizioni di movimentazione) ad un livello più alto e completo: saranno eseguite un'analisi del ciclo di vita (**LCA**) e un'analisi dei costi del ciclo di vita (LCCA) per dimostrare l'efficienza individuale e sinergica di superfici, pneumatici e veicoli (incluso il confronto tra veicoli a combustione interna, traffico misto e traffico EV).
3. Contribuire all'**effettiva implementazione della legislazione UE** (Direttive UE 2002/49/CE e 2015/996/CE), fornendo coefficienti di rumore di rotolamento all'interno del metodo comune di valutazione del rumore (**CNOSSOS-EU**), specificamente per i veicoli elettrici, per i quali i professionisti, le agenzie e i dipartimenti che mirano a sviluppare scenari futuri necessitano di dati.
4. Contribuire alle **politiche nazionali e regionali italiane**, emettendo **linee guida** sull'uso e l'applicazione della metodologia prodotta dal progetto, che sarà adottata, attraverso l'Agenzia Regionale per l'Ambiente (ARPAT) e la Regione Toscana. Anche la Regione Calabria e la Città di Reggio Calabria hanno espresso il loro interesse.
5. **Sensibilizzare le persone sull'inquinamento acustico e sugli effetti di quest'ultimo sulla salute**, spiegando le opportunità offerte dai veicoli elettrici attraverso specifici eventi divulgativi e promozionali, indagando anche la percezione delle persone riguardo al rumore in termini di paesaggio sonoro e coinvolgendole nell'acquisizione dei dati sul rumore.
6. Dimostrare e promuovere la **mobilità sostenibile del trasporto su strada (mobilità elettrica)**, riducendo l'emissione di rumore di 5 dB(A) in corrispondenza dei ricettori a bordo strada e raggiungendo anche la riduzione delle emissioni di CO_2 (21%), sulla base del contesto italiano (GPL, CNG, Hybrid, EV, auto a benzina, auto diesel) e la letteratura in materia.
7. **Incoraggiare l'implementazione di superfici a bassa rumorosità in ulteriori scenari UE ed extra-UE**, dimostrando durata e sostenibilità, attraverso un'approfondita LCA&LCCA.

Azioni

A. Azioni preparatorie
A1 Veicoli elettrici e la loro emissione di rumore
A2 Pavimentazione a bassa emissione di rumore e performance nel tempo
A3 Ruolo dei pneumatici nel nuovo contesto di EV e ICEV

B. **Azioni implementative**
B1 Progettazione degli asfalti
B2 Studio dell'accoppiamento pneumatico-pavimentazione e realizzazione del prototipo
B3 Area pilota: Attuazione. Replicazione e trasferibilità
B4 Test di efficienza dell'asfalto nell'area pilota
B5 Analisi del paesaggio sonoro
B6 Valutazione delle emissioni acustiche dei veicoli elettrici
B7 Prestazioni olistiche dei pneumatici

C. **Monitoraggio dell'impatto delle azioni del progetto**
C1 Monitoraggio dell'impatto delle azioni del progetto
C2 Analisi del ciclo di vita (LCA) e calcolo dei costi del ciclo di vita (LCC)

D. **Sensibilizzazione del pubblico e diffusione dei risultati**
D1 Attività di informazione e sensibilizzazione
D2 Attività di divulgazione tecnica alle parti interessate

E. Project management

Stakeholders

Sito web: https://life-evia.eu/

LIFE E-VIA: objectives and actions (DE)

Issued on: May 2021

By: : Continental

Deadline: 31/12/2022

NOTICEBOARD IN GERMAN LANGUAGE

Code: 22_1

LIFE18 ENV/IT/000201

Mit Unterstützung des LIFE-Förderprogramms der Europäischen Union

LIFE E-VIA

Electric Vehicle noIse control by Assessment and optimisation of tyre/road interaction

Hintergrund

Belastungsdaten der Europäischen Umweltagentur (EEA) zeigen, dass mehr als 100 Millionen EU-Bürger durch gesundheitsbelastende Geräuschpegel beeinträchtigt sind. Laut Weltgesundheitsorganisation (WHO) ist dabei in etwa jede dritte Person in der Europäischen Region Verkehrslärm ausgesetzt, der ungesund ist. 20 % aller Europäer, insbesondere in urbanen Gebieten, sind regelmäßig nächtlichen Schalldruckpegeln ausgesetzt, die gesundheitsschädlich sein können. Wie in der *Noise in Europe Conference* (April 2017) und den WHO Richtlinien (Okt. 2018) ausgeführt wird, müssen EU-Regeln zur Schallquellennormierung auch mit weiteren effektiven Maßnahmen wie Verbesserungen an Straßenoberflächen oder Reifen, und städtebaulichen Maßnahmen kombiniert werden.
Eine Maßnahme, die allgemein als der beste Ansatz zur Geräuschreduzierung und Minimierung gesundheitsschädlicher Luftverschmutzungen im städtischen Umfeld angesehen wird, ist die Einführung der Elektromobilität. Aufgrund der im Vergleich zu klassischen Verbrennungsfahrzeugen geänderten Eigenschaften von Elektrofahrzeugen (EV) gibt es einen Bedarf zur Untersuchung der Reifen-/Fahrbahninteraktion. Weiterhin fehlen, selbst unter Berücksichtigung der Richtlinie 2002/49/EC, entsprechende Koeffizienten, um das CNOSSOS-Model (Richtlinie 996/2015/EC) für die neuen Fahrzeugtypen und Geräuschspektren anwenden zu können.

Ziele

1. Eine Lärmreduzierung für dichtbesiedelte urbane Gebiete durch die Implementierung von Minderungsmaßnahmen die auf **optimierte Straßenbeläge und Reifen für EVs** abzielen. Zwei Straßenoberflächen, mindestens fünf verschiedene Elektrofahrzeuge, ein Referenzfahrzeug mit Verbrennungsmotor und mindestes drei verschiedene Reifen pro Fahrzeugklasse (inkl. spezieller EV-Reifen) werden getestet
2. Eine Abschätzung der **Minderungseffektivität und -potentials** von **Reifen**, **Fahrbahnbelägen** und **Verkehrseigenschaften** (z.B. Verkehrsspektren, Geschwindigkeiten, Fahrweisen) auf einem höheren Verständnisniveau: Lebenszyklus-/Lebenszykluskostenanalyse (**LCA** und **LCCA**) werden durchgeführt um die individuelle und synergetische Effizienz verschiedener Fahrbahnbeläge, Reifen und Fahrzeugen zu zeigen, inkl. eines Vergleichs zwischen reinem Verbrennungs-, Misch- und reinem EV-Verkehr).
3. Beizutragen zur **effektiven Umsetzung von EU-Gesetzgebung** (EU Richtlinien 2002/49/EC und 2015/996/EC) durch die Bereitstellung von speziell für elektrische Fahrzeuge angepasste Rollgeräusch-Koeffizienten für die Common Noise Assessment Methode (**CNOSSOS-EU**). Dies ermöglicht beratenden, planenden und umsetzenden Personen und Organisationen die Betrachtung zukünftiger Szenarien.
4. Beizutragen zur **National-** und **Regionalpolitik** durch die Herausgabe von **Richtlinien** und **Empfehlungen** zur Nutzung und Anwendung der Projektergebnisse. In Kollaboration mit dem Projekt wird beispielsweise durch die regionale Umweltbehörde der Toskana (ARPAT) geschehen. Weitere italienische Kommunen und Regionen haben ebenfalls ihr Interesse bezeugt.
5. Eine **Verbesserung des öffentlichen Bewusstseins** für schädliche Geräuschbelastungen, die daraus resultierenden Gesundheitsgefahren und die damit zusammenhängenden Möglichkeiten der Elektromobilität, mittels zielgerichteter Informationskampagnen und -veranstaltungen, sowie einer Beteiligung der Bevölkerung durch Soundscape-Befragungen und einer der Einbeziehung in die Geräuschdatenerfassung..
6. Das **Demonstrieren** und **Bewerben** eines **nachhaltigen (elektrischen) Straßenverkehrs** durch Reduzierung der Schallbelastung um 5 dB(A) im Bereich der straßenzugewandten Außenfassade bei gleichzeitiger Reduzierung der CO2-Emissionen um 21 % (Werte im Kontext der Gegebenheiten der italienischen Pilotanwendung und des Stands der entsprechenden Literatur)
7. Eine **Förderung** der **Nutzung geräuschoptimierter Straßenoberflächen** in entsprechenden Szenarien **innerhalb** und **außerhalb der EU** durch die Zuschaustellung der Haltbarkeit und Nachhaltigkeit entsprechender Lösungen mittels LCA und LCCA

Maßnahmen

A. Vorbereitende Maßnahmen
A1 Elektrofahrzeuge und ihre Geräuschemissionen
A2 Technologien für leise Fahrbahnbeläge und ihre zeitliche Leistungsfähigkeit
A3 Die Rolles des Reifens im neuen Kontext von Elektro- vs. Verbrennungsfahrzeugen

B. Implementierungsmaßnahmen
B1 Fahrbahnoberflächendesign
B2 Reifen-Fahrbahninteraktionsstudie und Prototypimplementierung
B3 Pilotanwendung, Implementierung, Replikation und Transferierbarkeit
B4 Fahrbahneffizienztests im Rahmen der Pilotanwendung
B5 Soundscape-Analyse
B6 Auswertung von EV-Geräuschemissionen
B7 Holistische Leistungseigenschaften von Reifen

C. Monitoring der Wirkung der Projektmaßnahmen
C1 Monitoring der Wirkung der Projektmaßnahmen
C2 Lebenszyklusanalyse (LCA) und Lebenszykluskosten (LCC)

D. Öffentliches Bewusstsein und Verbreitung der Ergebnisse
D1 Informations- und Sensibilisierungsmaßnahmen
D2 Verbreitungsmaßnahmen and technische Interessengruppen

E. Projektmanagement

Interessengruppen

Projektwebsite: https://life-evia.eu/

LIFE E-VIA

Electric Vehicle noIse control by Assessment and optimisation of tyre/road interaction

WEBINAR: 'Mobilità elettrica e asfalti a bassa emissione di rumore: il progetto LIFE E-VIA e altri contributi'

Issued on: May 2021

By: Comune di Firenze, Vie en.ro.se. Ingegneria, UNIRC

EVENTS
Code: E_3

LIFE/ENV/IT000201 LIFE E-VIA
Project co-funded by the European Commission into the LIFE+2018 Programme.

Con il patrocinio di

organizzano il

WEBINAR

Mobilità elettrica e asfalti a bassa emissione di rumore: il progetto LIFE E-VIA e altri contributi

14 maggio 2021 h 14.00-16.10

In modalità online sulla piattaforma Microsoft Teams

In collaborazione con

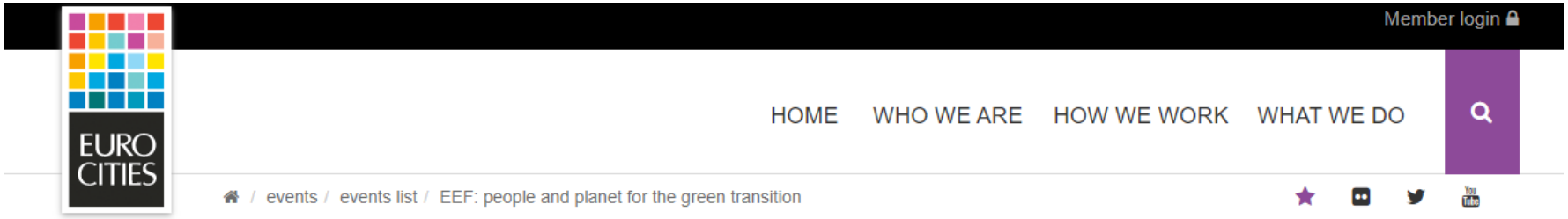
2 ore di aggiornamento per Tecnici Competenti in Acustica

L'aggiornamento per i TCA è riservato ai primi 36 iscritti

Il corso è riconosciuto dalla Regione Toscana con Prot. n. 0177764 del 21/04/2021

EUROCITIES: ENVIRONMENTAL FORUM
Issued on: April 2021
By: Comune di Firenze

MEETING



related issues

air quality circular economy citizens cohesion policy economic development energy efficiency funding & investment governance jobs participation procurement sustainability urban planning water

EEF: people and planet for the green transition (28-30 April)

Tweet

forums	
date	17-03-2021
publication date	17-03-2021
document type	
start date	28-04-2021
end date	30-04-2021

We are delighted to announce the theme of our EEF hosted online by Porto and Guimaraes as "people and planet for a green transition". Join us for three mornings between **28, 29 and 30 April** as we discuss what it means to transition to a healthy and thriving city for all, explore case studies and analyse how we can achieve the status of a thriving city moving forward.

Registrations will open very soon. Watch this space! A hint of what's to come? Oh alright…

Driving the green transition through recovery

Wednesday 28 April @ 09.30-13.30 CET

What does it mean to have a 'green transition'? How can we use recovery strategies to drive the green transition?

Join us as we explore what is means to transition, hold a high-level political debate on driving the transition through recovery and network with our cities to learn how we can localise the European Green Deal through a city showcase (open call – got something to showcase? Get in touch!).

How to enact the green transition locally

Thursday 29 April @ 09.30-12.20 CET

http://members.eurocities.eu/eurocities/calendar/events_list/EEF-people-and-planet-for-the-green-transition-28-30-April-WEBP-BZ7C6B

Paper submitted to AIA Congress
"IL PROGETTO LIFE E-VIA"

Issued on: May 2021

By: Comune di Firenze, Vie en.ro.se. Ingegneria, UNIRC

Deadline: 31/03/2023

SCIENTIFIC PAPERS
Code: 36_7

Associazione Italiana di Acustica
47° Convegno Nazionale
24-28 maggio 2021

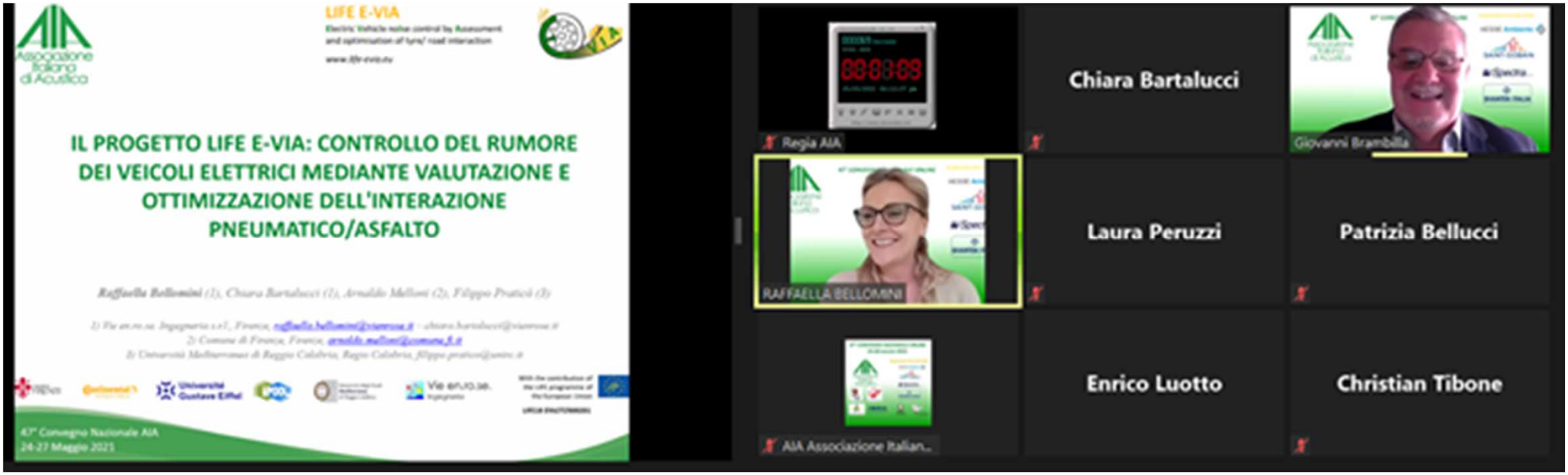
IL PROGETTO LIFE E-VIA: CONTROLLO DEL RUMORE DEI VEICOLI ELETTRICI MEDIANTE VALUTAZIONE E OTTIMIZZAZIONE DELL'INTERAZIONE PNEUMATICO/ASFALTO

Raffaella Bellomini (1), Chiara Bartalucci (1), Arnaldo Melloni (2), Filippo G. Praticò (3)

1) Vie en.ro.se. Ingegneria s.r.l., Firenze, raffaella.bellomini@vienrose.it – chiara.bartalucci@vienrose.it
2) Comune di Firenze, Firenze, arnaldo.melloni@comune.fi.it
3) Università Mediterranea di Reggio Calabria, Regio Calabria, filippo.pratico@unirc.it

SOMMARIO

Il progetto Life E-VIA "Electric Vehicle noIse control by Assessment and optimisation of tyre/road interaction", co-finanziato nell'ambito dell'obiettivo prioritario del Programma Life2018 collegato all'inquinamento acustico, affronta la problematica del rumore da traffico stradale, ponendosi in una prospettiva futura in cui i veicoli elettrici e ibridi saranno una parte consistente del traffico stradale e combinando asfalti a bassa rumorosità con pneumatici specifici per i veicoli elettrici.



Presentation of the project to the European Tire and Rim Technical Organisation (ETRTO)

Issued on: May 2021

By: Continental

Deadline: 31/03/2023

SCIENTIFIC PAPERS

Code: 36_8

LIFE E-VIA

Electric Vehicle noIse control by Assessment and optimisation of tyre/road interaction

LIFE18 ENV/IT/000201
With the contribution of the LIFE programme of the European Union

Carsten Hoever – Continental Reifen Deutschland GmbH
carsten.hoever@conti.de

Objectives

1. To **reduce noise** for roads inside very populated urban areas through the implementation of a mitigation measure aimed at **optimizing road surfaces and tyres of EVs**.

Objectives

3. To contribute to **EU legislation effective implementation** providing rolling noise coefficients within the Common Noise Assessment Method (**CNOSSOS-EU**), specifically tuned for EVs, aiming at helping to developing **future scenarios.**

Pilot Area Florence

- As a pilot implementation a section of a road in Florence will be paved with the new low-noise road surface.
- The pilot area will be the focus of further actions relating to
  - performance and wear/ageing monitoring of the new surface,
  - LCA/LCAA analysis,
  - Soundscape analysis,
  - ...
- The re-pavement of the road will also be linked to an EV festival planned to be held in Florence which shall promote Electric Mobility.

Lesson carried out by CRD to students the University of Applied Sciences in Hanover

Issued on: June 2021

AWARENESS ACTIVITIES

LIFE E-VIA

LIFE18 ENV/IT/000201
With the contribution of the LIFE programme of the European Union

Electric Vehicle noIse control by Assessment and optimisation of tyre/road interaction

Carsten Hoever – Continental Reifen Deutschland GmbH
carsten.hoever@conti.de

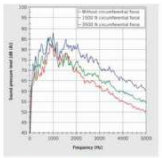
Warum besondere Anforderungen an Reifen und Straße für Elektrofahrzeuge?

LIFE18 ENV/IT/000201

Im Vergleich zu Fahrzeugen mit Verbrennungsmotoren...

Akustische Aspekte
Weitere relevante Aspekte

- ...sind EVs schwerer.
  - Höhere Reifenlast → höheres Rollgeräusch.
  - Stärkere Abnutzung von Reifen und Straße.
- ...haben EVs in einem weiten Drehzahlbereich ein höheres Drehmoment.
  - Zusätzliche Rollgeräusch-Anregemechanismen.
  - Stärkere Abnutzung von Reifen und Straße.
- ...gibt es einen nochmals verstärkten Fokus auf niedrigem Rollwiderstand.
  - Niedrigerer Rollwiderstand →höhere Fahrzeugreichweite →höhere Kundenakzeptanz.



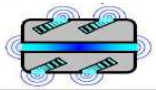
Quelle: F. Stalter et al.: Influence of driving torque on tyre noise, Auto Tech Review 10/2013, 34-38.

Absorbierende Straßenbeläge

LIFE18 ENV/IT/000201

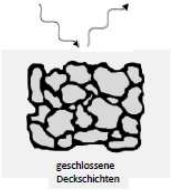
Absorption entlang der Luftschallausbreitung

Minderung von akustischen Resonanzen in der Aufstands-fläche



Reduzierung des Horneffektes

Horneffekt: effiziente Abstrahlung aufgrund kontinuierlicher Impedanzanpassung in der Horngeometrie



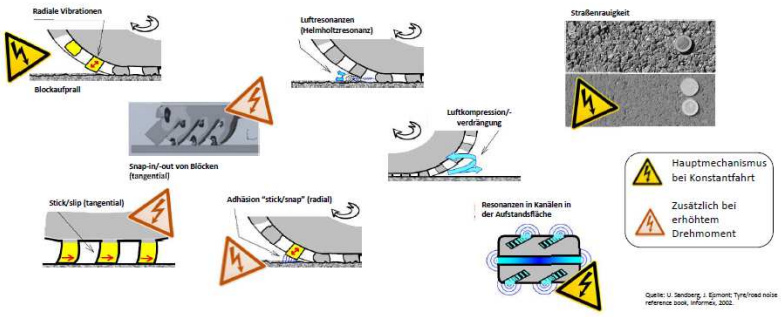
Auftreffender Schall wird nahezu komplett reflektiert

Ein Teil des Schalls dringt in die Deckschicht ein und durch viskose Reibung dissipiert

Nachteile:
- Verstopfung der Poren
- Kürzere mechanische Lebensdauer

Anregungsmechanismen des Reifen-/ Fahrbahngeräusches

LIFE18 ENV/IT/000201



Quelle: U. Sandberg, J. Ejsmont: Tyre/road noise reference book, Informex, 2002.

Article published in an open access journal

NOISE MAPPING

Issued on: June 2021

By: Universitè Gustave Eiffel

Deadline: 31/12/2022

ARTICLE IN A TOP RANKED JOURNAL

Code: 15

Open Access Published by De Gruyter Open Access on June 4, 2021

Road surface influence on electric vehicle noise emission at urban speed

Julien Cesbron, Simon Bianchetti, Marie-Agnès Pallas, Adrien Le Bellec, Vincent Gary and Philippe Klein

https://doi.org/10.1515/noise-2021-0017

https://doi.org/10.1515/noise-2021-0017

Cite this

DE GRUYTER Noise Mapp. 2021; 8:217–227

Research Article

Julien Cesbron*, Simon Bianchetti, Marie-Agnès Pallas, Adrien Le Bellec, Vincent Gary, and Philippe Klein

Road surface influence on electric vehicle noise emission at urban speed

https://doi.org/10.1515/noise-2021-0017
Received Jan 29, 2021; accepted Apr 23, 2021

Abstract: Considering the relative quietness of electric motors, tyre/road interaction has become the prominent source of noise emission from Electric Vehicles (EVs). This study deals with the potential influence of the road surface on EV noise emission, especially in urban area. A pass-by noise measurement campaign has been carried out on a reference test track, involving six different road surfaces and five electric passenger car models in different vehicle segments. The immunity of sound recordings to background noise was considered with care. The overall and spectral pass-by noise levels have been analysed as a function of the vehicle speed for each couple of road surface and EV model. It was found that the type of EV has few influence on the noise classification of the road surfaces at 50 km/h. However, the noise level difference between the quietest and the loudest road surface depends on the EV model, with an average close to 6 dBA, showing the potential effect of the road surface on noise reduction in the context of growing EV fleet in urban area. The perspective based on an average

the European area, where about 2.5 million of electric passenger cars were in circulation at the end of 2020. This figure comprises battery electric vehicles (BEVs) and plug-in electric vehicles (PHEVs). The market share of new EV registrations over the European area has been reaching 9.4% in 2020 against 3.7% in 2019. Depending on projection scenarios [2], it is expected to reach 15% to 30% of the global vehicle fleet by 2030.

A main advantage of EVs is that there is no exhaust emission while driving in pure electric mode, locally improving air-quality. EVs also contribute to the reduction of CO2 emission in the struggle against global warming [3]. Another key asset of EVs is the relative quietness of electric motors. This leads to the predominance of tyre/road noise from about 20 km/h at steady speed [4, 5]. According to EEA [6], in 2019 at least 20% of the European population was still exposed to noise levels that are considered harmful to human health. This burden is mainly due to road traffic noise, with more than 100 million EU citizens affected by high noise levels exceeding WHO recommendation [7]. Therefore, the development of low emission zones

Journées Techniques Acoustique et Vibrations JTAV 2021

"Projet LIFE E-VIA : Influence du revêtement de chaussée sur l'émission sonore des véhicules électriques"

Issued on: June 2021

By: : Université Gustave Eiffel

Deadline: 31/03/2023

SCIENTIFIC PRESENTATION IN NATIONAL CONGRESS

Code: 36_9

JTAV 2021 - SÉMINAIRE DE TRANSFERT COP ▾ ARCHIVES ▾

Accueil (/jtav-2021-seminaire-de-transfert-cop/) / JTAV 2021 - Séminaire de transfert COP (/jtav-2021-seminaire-de-transfert-cop/) / Programme

JTAV 2021 - SÉMINAIRE DE TRANSFERT COP

(/JTAV-2021-SEMINAIRE-DE-TRANSFERT-COP/)

PROGRAMME (/JTAV-2021-SEMINAIRE-DE-TRANSFERT-COP/PROGRAMME/)

ARCHIVES ▾

(/ARCHIVES/JTAV-2020/)

Programme

Lundi 7 juin (séminaire de transfert COP)

- 9h30 - 9h40 Présentation du COP - Axe 3 *J. Lelong (Univ. G. Eiffel/UMRAE)*
- 9h40 - 10h05 Présentation de l'UMRAE *J. Picaut (Univ. G. Eiffel/UMRAE)*
- 10h05 - 10h45 Elaboration de modèles d'émission sonore représentatifs de nouvelles catégories de sources routières *M.-A. Pallas (Univ. G. Eiffel/UMRAE)*
- 10h45 - 11h25 Amélioration des méthodes de caractérisation des émissions de bruit ferroviaire *O. Chiello & M.-A. Pallas (Univ. G. Eiffel/UMRAE)*
- *Pause*
- 13h30 - 14h30 Présentation de NoiseModelling - Utilisation dans le cadre de la recherche
  - Présentation de NoiseModelling et application *P. Aumond (Univ. G. Eiffel/UMRAE)*
  - Couplage Symuvia/MatSim *A. Can @ V. Lebescond (Univ. G. Eiffel/UMRAE)*
  - Nouveaux développements pour la prise en compte des façades végétalisées *B. Gauvreau (Univ. G. Eiffel/UMRAE)*
- 14h30 - 14h50 Présentation de l'outil PLAMADE et couplage avec NoiseModelling *S. Carlou (Cerema/DTecITM) & D. Ecotière (Cerema/DterEst/UMRAE)*
- 14h50 - 15h30 Impact du bruit des avions sur la santé : le projet DEBATS *A.-S. Evrard (Univ. G. Eiffel/UMRESTTE)*
- 15h30 Table ronde *A. Kavaj & M.-C. Bihoreau (DGITM), Ph. Maraval & F. Leray (DGPR), XX (DGAC)*

Mardi 8 juin (JTAV)

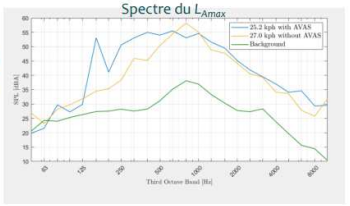
- 9h30 - 9h55 Projet LIFE E-VIA : Influence du revêtement de chaussée sur l'émission sonore des véhicules électriques *J. Cesbron - S. Bianchetti, M.-A. Pallas, A. Le Bellec, V. Gary, Ph. Klein (Univ. G. Eiffel/UMRAE)*
- 9h55 - 10h20 Projet LIFE Cool & Low Noise Asphalt : suivi des performances acoustiques des revêtements de chaussée à faible bruit dans le centre ville de Paris *C. Ribeiro (BruitParif)*
- 10h20 - 10h45 Méthode d'estimation des incertitudes du bruit éolien en conditions favorables à la propagation *B. Kayser (Univ. G. Eiffel/UMRAE)*
- 10h45 - 11h10 Estimation du coefficient d'absorption acoustique moyen par des méthodes de machine learning *C. Foy (Cerema/DterEst/UMRAE) A. Deleforge & D. Di Carlo (INRIA)*
- 11h10 - 11h35 Evaluation environnementale d'une conduite autonome : méthodologie acoustique et vibratoire *Ph. Dunez (Cerema/DterNP/TEER/ABV)*
- *Pause*
- 13h30 -13h55 Création d'une base de données des Points Noirs du Bruit dans les Quartiers Prioritaires du NPNRU *L. Mazouz Cerema/DterNP/TEER/ABV)*
- 13h55 - 14h20 Réseau à grand nombre de microphones et problèmes inverses mis en jeu *Ch. Vanwinsberghe (ISEN Yncréa Ouest)*
- 14h20 - 14h55 Plate-forme expérimentale de mesures acoustiques en temps réel *S. Carra, V. Janillon (Acoucité)*
- 14h55 - 15h20 Prédiagnostic sonore en milieu industriel : développement d'un "kit smartphone" *Isabelle Smith Yamane & A. Alarcon (EDF)*
- 15h20 Questions diverses - clôture des JTAV 2021

Des recherches en cours à l'UMRAE

- **Projet européen LIFE E-VIA (2019-2023) :**
  - Electric Vehicle Noise Control by Assessment and Optimisation of Tyre/Road Interaction
  - Julien Cesbron et al., Projet LIFE E-VIA : *influence du revêtement de chaussée sur l'émission sonore des véhicules électriques*, JTAV 2021, 8/06/2021
  - https://life-evia.eu/
- **Signal d'alerte AVAS** : caractérisation sous une approche environnementale
  - Comparaison aux niveaux d'émission CNOSSOS-EU / CNOSSOS-FR

Spectre avec AVAS

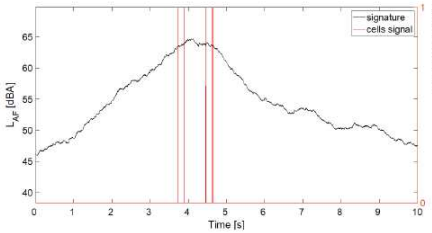
Spectre sans AVAS

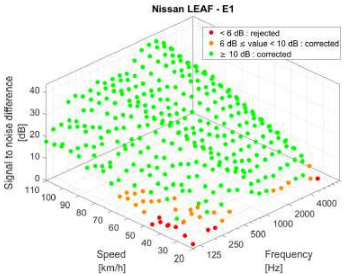


Séminaire COP - Univ. Eiffel 25 7/06/2021

Noise analysis

- L_{Amax} identification from the time signature for each run
- Spectra in 1/3 octave frequency band between 100Hz and 5000Hz
- Correction of background noise level (SNR<6dBA rejected)





JTAV 2021 – Visio-conférence 11 08/06/2021

Video of the prototype construction in Nantes

"Low-noise road surface prototype for electric vehicles"

Issued on: June 2021

By: Universitè Gustave Eiffel

Deadline: 31/12/2022

VIDEO OF THE PROTOTYPE CONSTRUCTION

Code: 8

Video available on the official YouTube channel of UMRAE-UniEiffel and on the UMRAE website

Low noise road surface prototype for electric vehicles (EU LIFE E-Via project, LIFE18 ENV/IT/000201) - YouTube

LIFE E-VIA: objectives and actions (FR)

Issued on: July 2021

By: Vie en.ro.se. Ingegneria

Deadline: 31/12/2022

NOTICEBOARD IN FRENCH LANGUAGE

Code: 21_1

LIFE E-VIA

Contrôle du bruit des Véhicules Électriques par l'évaluation et l'optimisation de l'interaction pneumatique/chaussée

Contexte

Les données d'exposition de l'Agence Européenne pour l'Environnement (AEE) montrent que plus de 100 millions de citoyens de l'UE sont affectés par des niveaux de bruit élevés ayant un impact négatif sur la santé de la population. A lui seul, le bruit de la circulation routière est néfaste pour la santé de près d'une personne sur trois en Europe, d'après l'Organisation Mondiale de la Santé (OMS). 20 % des Européens sont régulièrement exposés à des niveaux sonores nocturnes susceptibles de nuire considérablement à la santé, en particulier dans les zones urbaines. Comme cela a été mis en évidence lors de la conférence Noise in Europe (avril 2017) et dans les recommandations de l'OMS publiées en octobre 2018, le dommagement des normes européennes à la source doit être complété par d'autres mesures efficaces telles que l'amélioration des revêtements routiers et/ou des pneumatiques, ainsi que l'aménagement urbain.

L'une des solutions universellement reconnues comme efficaces pour réduire le bruit en milieu urbain, tant en matière de bruit que de qualité de l'air, est l'introduction de la **mobilité électrique**. Ainsi, pour répondre aux nouvelles exigences des véhicules électriques (VE), il est nécessaire d'approfondir les connaissances sur l'interaction pneumatique/chaussée. De plus, pour la mise en œuvre de la directive européenne 2002/49/CE, les coefficients permettant d'appliquer le modèle CNOSSOS (directive 996/2015/CE) aux nouveaux spectres de bruits et aux nouveaux véhicules restent totalement inexistants.

Objectifs

1. **Réduire le bruit** routier au sein des zones urbaines très peuplées par la mise en œuvre d'une solution visant à **optimiser les revêtements routiers et les pneumatiques des véhicules électriques (VE)**. Deux revêtements routiers, au moins 5 modèles de VE, un véhicule à moteur thermique (VMT) de référence et 3 types de pneumatiques (y compris des pneus spécialement conçus pour les VE) seront testés pour chaque technologie de véhicule.
2. Estimer **l'efficacité et le gain potentiel de réduction des pneus, des revêtements et du trafic** (spectre du trafic, vitesses, conditions de conduite) à une échelle plus complète : Les Analyse du Cycle de Vie (**ACV**) et Les Analyse du Coût du Cycle de Vie (**ACCV**) seront réalisées pour démontrer l'efficacité respective et synergique des revêtements de chaussée, des pneus et des véhicules (y compris la comparaison entre trafics constitués de véhicules thermiques uniquement, de véhicules électriques ou mixtes).
3. Contribuer à la **mise en œuvre effective de la législation européenne** (directives 2002/49/CE et 2015/996/CE), en fournissant des coefficients de bruit de roulement pour la méthode commune d'évaluation du bruit (**CNOSSOS-EU**), spécifiquement adaptés aux VE, données encore non disponibles pour les professionnels, les organismes et les ministères en charge d'élaborer des scénarios futurs.
4. Contribuer aux **politiques nationales et régionales italiennes**, en publiant des **recommandations** sur l'utilisation et l'application de la méthodologie issue du projet, qui seront adoptées par la Région Toscane, via l'Agence Régionale pour l'Environnement de Toscane (ARPAT) soutenant le projet. La Région de Calabre et la ville Reggio de Calabre ont également exprimé leur intérêt.
5. **Sensibiliser** le public à la pollution sonore et aux effets sur la santé en expliquant les possibilités offertes par les véhicules électriques par le biais d'événements de communication et de promotion spécifiques, tout en étudiant la perception des personnes vis-à-vis du bruit dans l'angle méthodologique du paysage sonore et en les impliquant dans l'acquisition de données sur le bruit.
6. Démontrer et promouvoir la **mobilité routière durable (électrique)**, en réduisant les émissions sonores de 3 dB(A) en bord de route et simultanément celles de CO2 (21%), sur la base du contexte Italien (véhicules EPL, ENC, hybrides, électriques, à essence, diesel) et de la littérature spécialisée.
7. **Encourager la mise en œuvre de revêtements à faible niveau de bruit dans d'autres scénarios européens et extra-européens**, en démontrant leur durabilité et leur pérennité, grâce à une analyse du cycle de vie (ACV) et une évaluation du coût du cycle de vie (CCV) appropriées.

Actions

A. Actions préparatoires
A1 Les véhicules électriques et leurs émissions sonores
A2 Les technologies de chaussées peu bruyantes et la pérennité de leurs performances
A3 Le rôle du pneumatique dans le nouveau contexte des VE et des VMT

B. Actions de mise en œuvre
B1 Conception de la formulation du revêtement de chaussée
B2 Étude du couplage pneumatique-chaussée et réalisation du prototype
B3 Zone pilote : Mise en œuvre, Reproductive et transférabilité
B4 Tests d'efficacité des voies dans la zone pilote
B5 Analyse du paysage sonore
B6 Évaluation des émissions sonores des VE
B7 Performance routière des prototypes

C. Suivi de l'impact des actions du projet
C1 Suivi de l'impact des actions du projet
C2 Analyse du cycle de vie (ACV) et coût du cycle de vie (CCV)

D. Sensibilisation du public et diffusion des résultats
D1 Activités d'information et de sensibilisation
D2 Activités de diffusion technique auprès des parties prenantes

E. Gestion du projet

PARTIES PRENANTES

Site web du projet: https://life-evia.eu/

LIFE E-VIA

Electric Vehicle noise control by Assessment and optimisation of tyre/road interaction

MP

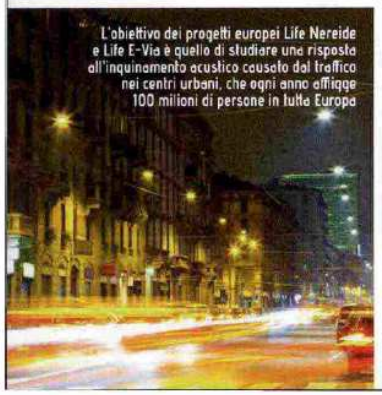
Bimestrale

Data 07-2021
Pagina 74
Foglio 1

PROGETTI EUROPEI LIFE NEREIDE E LIFE E-VIA

Asfalti con materiali riciclati contro l'inquinamento acustico e a favore della mobilità elettrica

In Italia sono in corso due progetti europei, Life Nereide e Life E-Via, che intendono proporre soluzioni contro l'inquinamento acustico: uno dei problemi ambientali che toccano maggiormente la salute e la qualità della vita della popolazione europea. L'Agenzia Europea dell'Ambiente (EEA) stima infatti che siano oltre 100 milioni i cittadini europei esposti in maniera prolungata a livelli di rumore eccessivi e che, per questo, rischino conseguenze anche gravi per la salute. Stima inoltre che l'inquinamento acustico stradale notturno, ancora più dannoso per la salute, colpisca almeno il 20% della popolazione europea che vive nelle aree urbane.



L'obiettivo dei progetti europei Life Nereide e Life E-Via è quello di studiare una risposta all'inquinamento acustico causato dal traffico nei centri urbani, che ogni anno affligge 100 milioni di persone in tutta Europa

Alcune tra le azioni più efficaci introdotte per risolvere questo problema riguardano la realizzazione di pavimentazioni stradali a bassa emissione sonora, ottenute anche con materiali di riciclo, e la progressiva diffusione della mobilità elettrica. Nati per analizzare i benefici possibili derivanti da tali soluzioni, Life Nereide e Life E-Via sono due progetti finanziati dal programma Life, volto a sostenere azioni a favore dell'ambiente e del clima.

Il progetto Life Nereide, che si sta avviando alla conclusione, ha portato alla definizione delle migliori soluzioni per realizzare pavimentazioni estremamente silenziose e sostenibili, capaci di ridurre il rumore del traffico fino a 5 dB grazie a un uso intelligente di materiali quali il polverino di gomma riciclata e il fresato d'asfalto, ottenuto dalla rimozione di vecchie pavimentazioni. Il progetto è guidato dal Dipartimento d'Ingegneria Civile e Industriale dell'Università di Pisa e vede come partner la Regione Toscana e l'agenzia regionale Arpat, il centro di ricerca belga BRRC, l'Idasc-CNR e il consorzio Ecopneus. Grazie al progetto sono state definite 12 differenti mescole bituminose, posate su diverse strade della Toscana; sono state poi effettuate misurazioni acustiche sulle pavimentazioni e indagini sulla popolazione, per conoscere gli effetti concreti su chi vive nei pressi di strade a elevato scorrimento. Dal canto suo, il progetto Life E-Via si sta invece concentrando sui veicoli elettrici e ibridi, studiandone l'interazione pneumatico-strada per individuare e implementare misure di mitigazione del rumore attraverso l'ottimizzazione sia degli pneumatici sia del fondo stradale, anche attraverso lo sviluppo di un nuovo asfalto "silenzioso" messo a punto grazie a un approccio simile a quello adottato da Life Nereide. Il progetto vede coinvolti il Comune di Firenze, in qualità di coordinatore, e i partner: Continental, iPool, Université Gustave Eiffel, Università degli Studi Mediterranea di Reggio Calabria e Vie En.Ro.Se. Ingegneria.

DATA STAMPA
www.datastampa.it

LA NAZIONE FIRENZE
Dir. Resp.: Agnese Pini
Tiratura: N.D. Diffusione: 19762 Lettori: 120000 (0005822)

15-LUG-2021
da pag. 1-9 / foglio 2 / 2

IN VIA PAISIELLO

Arriva l'asfalto anti rumore

Sono iniziati ieri i lavori di asfaltatura in via Paisiello. Non si tratta di semplice bitume, ma di un nuovo asfalto anti rumore che viene sperimentato proprio a Firenze. Un materiale, che permette una riduzione delle emissioni rumorose prodotte dalle auto e rientra nel progetto Life E-Via, che vede Firenze città capofila. I lavori proseguiranno fino a venerdì con restringimenti di carreggiata su via Paisiello tra via Rinuccini e via Lagorio e chiusure delle traverse laterali. «**Grazie** a questo progetto – hanno detto l'assessore all'Ambiente Cecilia Del Re e l'assessore alla Mobilità Stefano Giorgetti – possiamo contribuire a ridurre l'inquinamento acustico nelle aree urbane». L'obiettivo è quello di ottimizzare asfalti e pneumatici per ridurre il rumore. Il Progetto, co-finanziato dall'Unione europea ha avuto inizio a luglio 2019 e terminerà a gennaio 2023.

Un passo avanti per la costruzione del sistema tramviario dell'area metropolitana

Report INAD Italia 2020-2021 (ITA)

Issued on: July 2021

By: Vie en.ro.se. Ingegneria

Deadline: 31/12/2022

REPORT ON YEARLY PARTICIPATION IN INAD

Code: 25_1

Associazione Italiana di Acustica

INTERNATIONAL

NOISE AWARENESS DAY

INAD Italia 2020-21

"AscoltiAMO i suoni"

Report finale

È stata inoltre svolta una intensa comunicazione sui social network e attraverso contatti diretti con molte redazioni giornalistiche, con scuole musicali e conservatori italiani.

LIFE E-VIA project (LIFE18 ENV/IT/000201): il progetto, finanziato dall'Unione Europea, si concentra sulle potenzialità di utilizzo dei veicoli elettrici ed ibridi, che in futuro avranno un ruolo importante nel mercato automobilistico. Il progetto studia l'interazione pneumatico-strada per individuare ed implementare misure di mitigazione del rumore, attraverso l'ottimizzazione sia degli pneumatici dei veicoli elettrici sia del fondo stradale. Inoltre il progetto prevede un'intensa attività di disseminazione e sensibilizzazione sul tema del rumore, organizzando anche attività negli istituti scolastici, in accordo e in collaborazione anche con l'attività portate avanti nelle diverse Nazioni dei partner del Progetto (Italia, Francia e Germania) nell'ambito di INAD.

L'evento è stato diffuso principalmente attraverso i seguenti canali:

CONVEGNI:

- Convegno Nazionale AIA – Online 24-28/05/2021

- IYS 2020-2021 Steering Committee Meeting – Online 16/01/ 2021

WEB:

- siti internet di: Associazione Italiana di Acustica, EAA, Documenta Acustica, IYS 2020-21
- siti internet delle scuole e degli Enti partecipanti.

SOCIAL NETWORK:

- pagina facebook: INAD Italia;
- gruppo facebook: Noise Awareness Day Italia;
- pagina facebook: Intenational Year of Sound.

https://acustica-aia.it/inad/#1579087438323-0-39cf2-c675844d-d32b

Abstract submitted to 11th International Conference on the Bearing Capacity of Roads, Railways and Airfields (BCRRA).

Authors: *Praticò F.G., Briante P.G., Colicchio G., Fedele R.*

Abstract: The interaction among electric vehicles (EVs) and road pavements affects road performance in a different way with respect to internal combustion engine vehicles (ICEVs). Consequently, the design of asphalt concrete road pavements for EVs should take into account both functional and mechanistic characteristics. In particular, porosity, resistivity, tortuosity and thickness should be considered to estimate the acoustic absorption, while surface texture should be measured to characterize road pavements consisting in both traditional and recycled materials. Unfortunately, there is still lack of methods to consider both functional and mechanistic characteristics for EVs. Based on the above, the main objective of the study here presented is to set up and apply a method to predict the acoustic and mechanistic performance of road pavements to face EV-related problems. GAP graded and Dense graded (i.e., GAP – AC6o, and DGFC – AC6d) mixtures, with different crumb rubber percentages, were produced using the gyratory compactor. Consequently, experimental investigations were carried out to derive acoustic and mechanic properties (including acoustic absorption, airflow resistivity, skid resistance, permeability, and surface texture.
Finally, the prediction model was set up and validated using the experimental results. Results show that the proposed model is helpful in selecting and ranking bituminous mixtures based on requirements.

Keywords: Electric vehicle, Road Pavement, Acoustic Absorption, Airflow resistivity, Recycled materials.

Paper submitted to BCRRA2021 will be presented the next year at BCRRA 2022.

27th International Congress on Sound and Vibration
The annual congress of the International Institute of Acoustics and Vibration (IIAV)
11-16 July, 2021
ICSV27
Annual Congress of the International Institute of Acoustics and Vibration (IIAV)

THE INTERNATIONAL YEAR OF SOUND: WORLDWIDE PROJECTS AND INITIATIVES

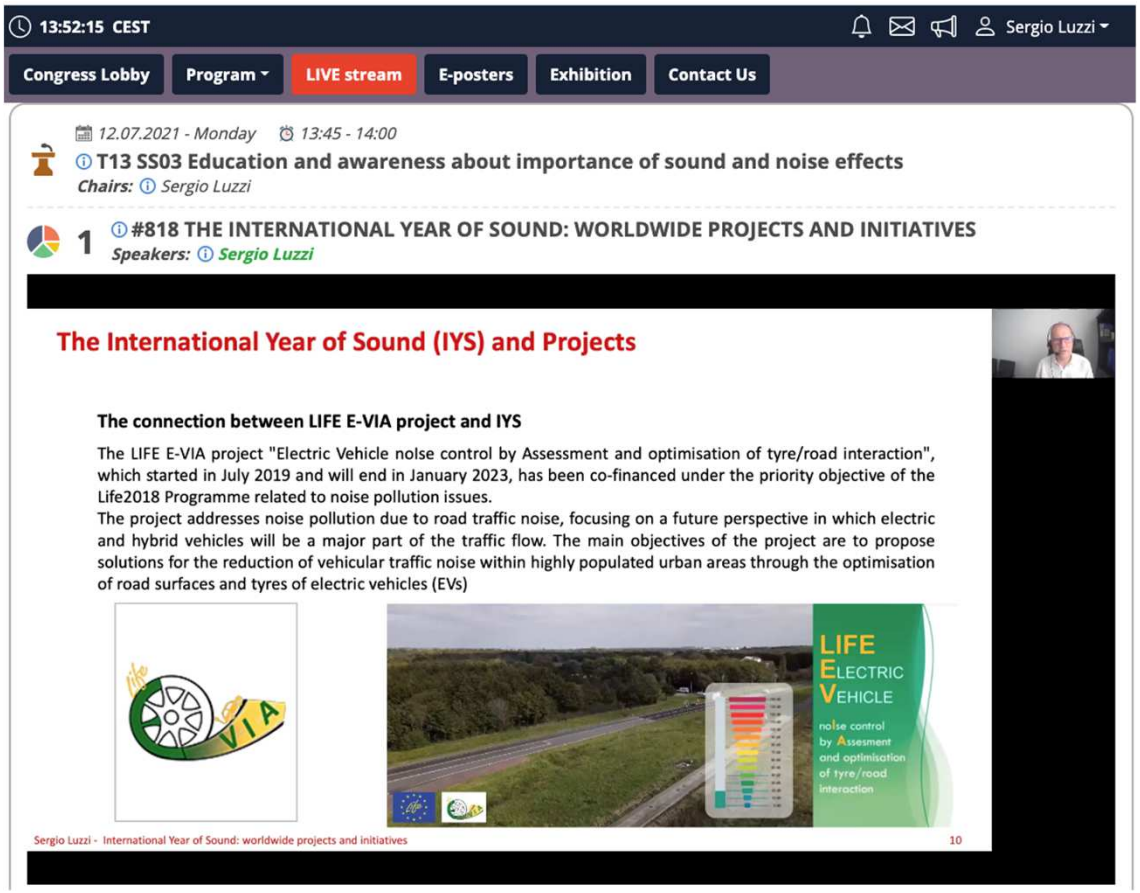
Sergio Luzzi
Vie en.ro.se Ingegneria, Florence, Italy
e-mail: sergio.luzzi@vienrose.it

Raffaella Bellomini
Vie en.ro.se Ingegneria, Florence, Italy
e-mail: raffaella.bellomini@vienrose.it

Chiara Bartalucci
Vie en.ro.se Ingegneria, Florence, Italy
e-mail: chiara.bartalucci@vienrose.it

Sara Delle Macchie
Vie en.ro.se Ingegneria, Florence, Italy
e-mail: sara.dellemacchie@vienrose.it

Sound plays an important role in the enjoyment of landscapes as well as in all human activities included education and it is also an essential part of communication between humans, in the form of speech and listening, creative sounds and music. The International Year of Sound (IYS) is a global initiative under the UNESCO Charter of Sound No. 39C/59. Its purpose is to highlight the importance of sound and the related sciences and technologies in the society and the world, considering landscape aspects and noise control in nature, in the built environment and in workplaces. IYS 2020-21 includes activities organized at the regional, national and international level by the International Commission for Acoustics (ICA). Among them there is a competition for students from around the world on the theme of "My World of Sounds". In particular, primary and middle school students are asked to produce drawings, images, patchwork, collages and similar related to their world of sounds, while high school students are asked to write a verse of the song entitled "We are the sounds of our world", inspired by the melody and refrain of the latter. Moreover, several events such as conferences, seminars, workshops but also performances, exhibitions had been included in the program of national IYS initiatives, as long as they are consistent with the message of the initiative. Due to the spread of the Covid-19 pandemic, only few initiatives took place, nevertheless some international projects have been carried on. In this paper a general updated overview on activities organised in the frame of the IYS is given and the state of implementation of some projects connected with IYS are shown.
Keywords: International Year of Sound, UNESCO, worldwide activities, LIFE projects



Paper submitted to ICSV27
"THE LIFE E-VIA PROJECT"

Issued on: July 2021

By: Comune di Firenze, Vie en.ro.se. Ingegneria

Deadline: 31/03/2023

SCIENTIFIC PAPERS
Code: 36_12

27th International Congress on Sound and Vibration
The annual congress of the International Institute of Acoustics and Vibration (IIAV)
11-16 July, 2021
ICSV27

Annual Congress of the International Institute of Acoustics and Vibration (IIAV)

THE LIFE E-VIA PROJECT: NOISE CONTROL OF ELECTRIC VEHICLES THROUGH ASSESSMENT AND OPTIMISATION OF TYRE/ASPHALT INTERACTION

Arnaldo Melloni
Comune di Firenze, Florence, Italy
e-mail: arnaldo.melloni@comune.fi.it

Gessica Pecchioni
Comune di Firenze, Florence, Italy
e-mail: gessica.pecchioni@comune.fi.it

Raffaella Bellomini
Vie en.ro.se Ingegneria, Florence, Italy
e-mail: raffaella.bellomini@vienrose.it

Sergio Luzzi
Vie en.ro.se Ingegneria, Florence, Italy
e-mail: sergio.luzzi@vienrose.it

Chiara Bartalucci
Vie en.ro.se Ingegneria, Florence, Italy
e-mail: chiara.bartalucci@vienrose.it

European Environment Agency (EEA) data shows that some 100 million EU citizens are affected by high noise levels, negatively impacting their health. Traffic noise alone is harmful to the health of 40 million EU citizens of which 8 million are regularly exposed to high traffic noise level at night. European policies to reduce environmental noise, and in particular road traffic noise, in densely populated cities are focused on the introduction of low-noise asphalts and a progressive increase in the use of electric vehicles. The LIFE E-VIA "Electric Vehicle noIse control by Assessment and optimization of tyre/road interaction" project, co-funded under the priority objective of the Life2018 Programme related to noise pollution, addresses the issue of road traffic noise. Specifically, it looks ahead to a future where electric and hybrid vehicles will be a major part of road traffic and combining low-noise asphalts with tyres specifically for electric vehicles. The LIFE E-VIA project, started in July 2019 with a foreseen duration of 42 months, will foster the application of Directive 2002/49/EC on the assessment and management of environmental noise and of Directive 996/2015/EC on establishing common noise assessment methods (CNOSSOS model), in the context of the promotion and use of electric vehicles (EVs) and hybrid vehicles. The project will seek to develop a solution to reduce the rolling noise of electric and hybrid vehicle tyres in urban areas, taking account of the current best practices, also addressing the soundscape analysis and citizens involvement.
In the present article, after an introduction on the future policies for the reduction of road traffic noise in Europe, the objectives of the LIFE E-VIA project and its methodology are described, demonstrating how the expected results are in line with European strategies. Finally, recent preliminary results achieved by some key actions of the project are mentioned.
Keywords: Rolling noise, electric vehicles, EU policies.

Presentation/ paper at the DAGA 2021 - 47. Jahrestagung für Akustik

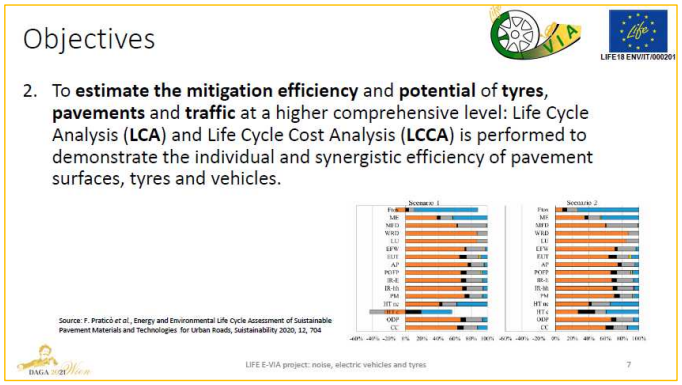
Issued on: August 2021

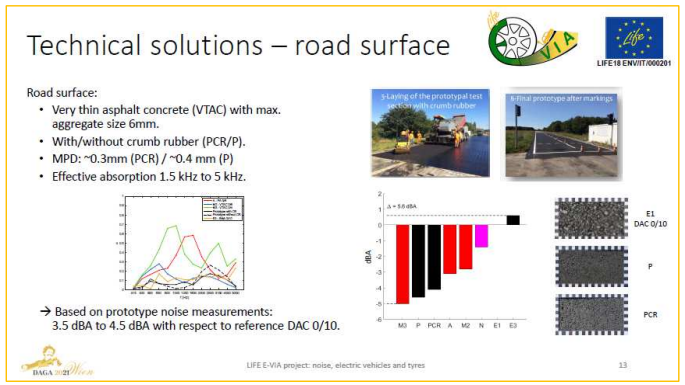
By: CONTINENTAL

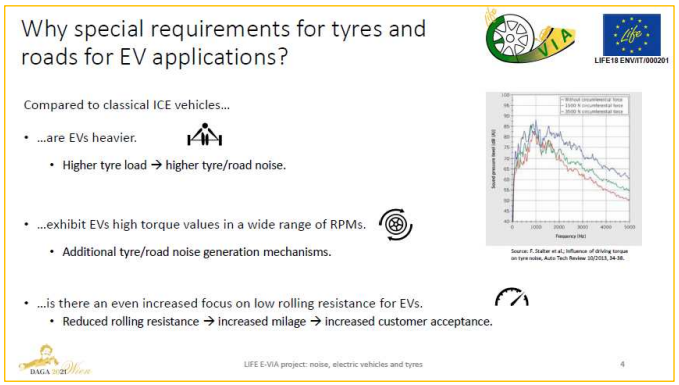
Deadline: 31/03/2023

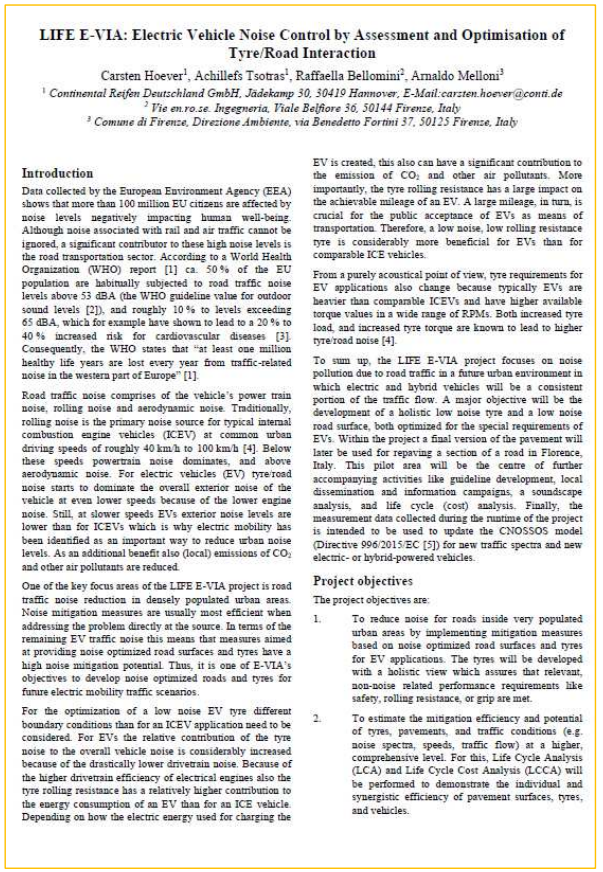
SCIENTIFIC PAPERS

Code: 36_13









LIFE E-VIA: Electric Vehicle Noise Control by Assessment and Optimisation of Tyre/Road Interaction

Carsten Hoever[1], Achilleʃs Tsotras[1], Raffaella Bellomini[2], Arnaldo Melloni[3]
[1] *Continental Reifen Deutschland GmbH, Jädekamp 30, 30419 Hannover, E-Mail:carsten.hoever@conti.de*
[2] *Vie en.ro.se. Ingegneria, Viale Belfiore 36, 50144 Firenze, Italy*
[3] *Comune di Firenze, Direzione Ambiente, via Benedetto Fortini 37, 50125 Firenze, Italy*

Introduction

Data collected by the European Environment Agency (EEA) shows that more than 100 million EU citizens are affected by noise levels negatively impacting human well-being. Although noise associated with rail and air traffic cannot be ignored, a significant contributor to these high noise levels is the road transportation sector. According to a World Health Organization (WHO) report [1] ca. 50 % of the EU population are habitually subjected to road traffic noise levels above 53 dBA (the WHO guideline value for outdoor sound levels [2]), and roughly 10 % to levels exceeding 65 dBA, which for example have shown to lead to a 20 % to 40 % increased risk for cardiovascular diseases [3]. Consequently, the WHO states that "at least one million healthy life years are lost every year from traffic-related noise in the western part of Europe" [1].

Road traffic noise comprises of the vehicle's power train noise, rolling noise and aerodynamic noise. Traditionally, rolling noise is the primary noise source for typical internal combustion engine vehicles (ICEV) at common urban driving speeds of roughly 40 km/h to 100 km/h [4]. Below these speeds powertrain noise dominates, and above aerodynamic noise. For electric vehicles (EV) tyre/road noise starts to dominate the overall exterior noise of the vehicle at even lower speeds because of the lower engine noise. Still, at slower speeds EVs exterior noise levels are lower than for ICEVs which is why electric mobility has been identified as an important way to reduce urban noise levels. As an additional benefit also (local) emissions of CO_2 and other air pollutants are reduced.

One of the key focus areas of the LIFE E-VIA project is road traffic noise reduction in densely populated urban areas. Noise mitigation measures are usually most efficient when addressing the problem directly at the source. In terms of the remaining EV traffic noise this means that measures aimed at providing noise optimized road surfaces and tyres have a high noise mitigation potential. Thus, it is one of E-VIA's objectives to develop noise optimized roads and tyres for future electric mobility traffic scenarios.

For the optimization of a low noise EV tyre different boundary conditions than for an ICEV application need to be considered. For EVs the relative contribution of the tyre noise to the overall vehicle noise is considerably increased because of the drastically lower drivetrain noise. Because of the higher drivetrain efficiency of electrical engines also the tyre rolling resistance has a relatively higher contribution to the energy consumption of an EV than for an ICE vehicle. Depending on how the electric energy used for charging the EV is created, this also can have a significant contribution to the emission of CO_2 and other air pollutants. More importantly, the tyre rolling resistance has a large impact on the achievable mileage of an EV. A large mileage, in turn, is crucial for the public acceptance of EVs as means of transportation. Therefore, a low noise, low rolling resistance tyre is considerably more beneficial for EVs than for comparable ICE vehicles.

From a purely acoustical point of view, tyre requirements for EV applications also change because typically EVs are heavier than comparable ICEVs and have higher available torque values in a wide range of RPMs. Both increased tyre load, and increased tyre torque are known to lead to higher tyre/road noise [4].

To sum up, the LIFE E-VIA project focuses on noise pollution due to road traffic in a future urban environment in which electric and hybrid vehicles will be a consistent portion of the traffic flow. A major objective will be the development of a holistic low noise tyre and a low noise road surface, both optimized for the special requirements of EVs. Within the project a final version of the pavement will later be used for repaving a section of a road in Florence, Italy. This pilot area will be the centre of further accompanying activities like guideline development, local dissemination and information campaigns, a soundscape analysis, and life cycle (cost) analysis. Finally, the measurement data collected during the runtime of the project is intended to be used to update the CNOSSOS model (Directive 996/2015/EC [5]) for new traffic spectra and new electric- or hybrid-powered vehicles.

Project objectives

The project objectives are:

1. To reduce noise for roads inside very populated urban areas by implementing mitigation measures based on noise optimized road surfaces and tyres for EV applications. The tyres will be developed with a holistic view which assures that relevant, non-noise related performance requirements like safety, rolling resistance, or grip are met.
2. To estimate the mitigation efficiency and potential of tyres, pavements, and traffic conditions (e.g. noise spectra, speeds, traffic flow) at a higher, comprehensive level. For this, Life Cycle Analysis (LCA) and Life Cycle Cost Analysis (LCCA) will be performed to demonstrate the individual and synergistic efficiency of pavement surfaces, tyres, and vehicles.

LIFE E-VIA: the pilot case (IT)

Issued on: September 2021

By: Vie en.ro.se. Ingegneria

Deadline: 31/12/2022

NOTICEBOARD IN ITALIAN LANGUAGE

Code: 23_2

LIFE18 ENV/IT/000201

With the contribution of the LIFE programme of the European Union

LIFE E-VIA

Electric Vehicle noIse control by Assessment and optimisation of tyre/road interaction

Il caso pilota

Dopo una fase progettuale seguita da una serie di accurati esperimenti di laboratorio, sono state selezionate due miscele di asfalto che sono state testate, durante il passaggio di veicoli elettrici, presso l'area di sperimentazione a Nantes. Al termine delle misure svolte in Francia, è stata scelta la miscela più efficace, contenente polverino di gomma da pneumatici riciclati. Quest'ultima è stata utilizzata presso il caso pilota individuato nella Città di Firenze, al fine di analizzare il beneficio apportato in termini di abbattimento del rumore da traffico veicolare. L'area pilota è stata identificata in Via Paisiello, caratterizzata da una significativa densità di abitazione. Il tratto di strada interessato dall'intervento è rettilineo e a senso unico di marcia. Inoltre, l'area pilota è caratterizzata da un elevato flusso di traffico dovuto alla vicinanza con il centro e alla presenza di uffici pubblici. Nelle vicinanze si trovano, inoltre, un importante parco pubblico (Cascine), interventi di riqualificazione urbana (Ex. Manifattura Tabacchi) e vari servizi pubblici, quali scuole, esercizi commerciali, impianti sportivi.

Inquadramento Stato ante operam

Lavori di asfaltatura

Rimozione asfalto

Stesura nuovo asfalto

Verifiche della tessitura

Stato post operam

Sito web: https://life-evia.eu/

LIFE E-VIA: the pilot case (EN)

Issued on: September 2021

By: Vie en.ro.se. Ingegneria

Deadline: 31/12/2022

NOTICEBOARD IN ENGLISH LANGUAGE

Code: 18_3

LIFE18 ENV/IT/000201

With the contribution of the LIFE programme of the European Union

LIFE E-VIA

Electric Vehicle noIse control by Assessment and optimisation of tyre/road interaction

The Pilot case

After an initial designing stage followed by careful laboratory experiments, two different asphalt mixtures have been selected and tested in the experimental area in Nantes, during the electric vehicles passages. The measurements carried out in France allowed to choose the most efficient mixture. This asphalt mixture contains crumb rubber from recycled tyres and it has been used in the pilot case in Firenze in order to analyse the benefits it provides to reduce traffic noise. Via Paisiello has been selected as a pilot area. It is characterized by a significant housing density. The section of the street where the asphalting works have been carried out, is straight and one-way. Moreover, the pilot area is characterized by a high level of traffic caused to its proximity to the city center and the presence of public offices. In the neighbourhood there are also an important public park (Cascine), urban regeneration interventions (Ex. Manifattura Tabacchi) and several public services, such as schools, commercial activities and sport installations.

Ante operam status

Asphalting works

Asphalt removal

Laying a new asphalt

Texture check

Post operam status

Sito web: https://life-evia.eu/

LIFE E-VIA: the pilot case (FR)

Issued on: September 2021

By: Université Gustave Eiffel

Deadline: 31/12/2022

NOTICEBOARD IN FRENCH LANGUAGE

Code: 21_2

LIFE E-VIA

Contrôle du bruit des Véhicules Électriques par l'évaluation et l'optimisation de l'interaction pneumatique/chaussée

Le projet pilote

Après une première phase de conception suivie d'expériences en laboratoire détaillées, deux enrobés ont été sélectionnés et testés sur la zone expérimentale de Nantes, au passage de véhicules électriques. Les mesures effectuées en France ont permis d'identifier le mélange le plus performant. Cette formule de béton bitumineux contient de la gomme provenant de pneus recyclés et a été utilisée dans le projet pilote à Florence afin d'analyser les avantages en matière de réduction du bruit de trafic. La rue Paisiello a été sélectionnée comme zone pilote. Elle se caractérise par une forte densité de logements. La section où les travaux de pose du béton bitumineux ont été réalisés est rectiligne et à sens unique. De plus, elle présente un niveau élevé de trafic dû à la proximité du centre ville et à la présence d'établissements publics. Dans le quartier, on trouve également un important parc public (Cascine), des opérations de réhabilitation urbaine (Ex. Manifattura Tabacchi) et divers établissements publics, tels que des écoles, des activités commerciales et des installations sportives.

État initial

Section du projet pilote

RUE PAISIELLO

Mise en œuvre du nouvel enrobé bitumineux

Élimination de l'ancien revêtement routier

Pose du nouveau béton bitumineux

Contrôle de la texture

État final

Site web: https://life-evia.eu/

LIFE E-VIA

Electric Vehicle noise control by Assessment and optimisation of tyre/road interaction

LIFE E-VIA: the pilot case (DE)

Issued on: September 2021

By: CONTINENTAL

Deadline: 31/12/2022

NOTICEBOARD IN GERMAN LANGUAGE

Code: 22_2

LIFE E-VIA: Laboratory experiments(EN)

Issued on: September 2021

By: UNIRC

Deadline: 31/12/2022

NOTICEBOARD IN ENGLISH LANGUAGE

Code: 18_4

EXPOMOVE21 'Conferenza internazionale mobilità sostenibile: uno sguardo europeo'

Issued on: October 2021

By: Comune di Firenze, Vie en.ro.se. Ingegneria, UNIRC

EVENTS
Code: E_4

LIFE E-VIA: Leaflet (EN)

Issued on: October 2021

By: Vie en.ro.se. Ingegneria

ADDITIONAL DOCUMENT

Objectives of the LIFE E-VIA project

1. To reduce noise for roads inside very populated urban areas through the implementation of a mitigation measure aimed at optimizing road surfaces and tyres of EVs.
2. To estimate the mitigation efficiency and potential of tyres, pavements and traffic (traffic spectrum, speeds, handling conditions) at a higher and comprehensive level.
3. To contribute to EU legislation effective implementation (EU Directives 2002/49/EC and 2015/996/EC), providing rolling noise coefficients within the Common Noise Assessment Method (CNOSSOS-EU).
4. To contribute to national and Italian regional policies, issuing guidelines about use and application of the methodology output of the project.
5. To raise people's awareness of noise pollution and health effects.
6. To demonstrate and promote sustainable road transport mobility (electric), reducing noise emission by 5 dB(A) at receivers' roadside and achieving also CO_2 emissions reduction.
7. To encourage low-noise surfaces implementation in further EU and extra-EU scenarios.

LIFE18 ENV/IT/000201

www.life-evia.eu

life18.evia@gmail.com

With the contribution of the LIFE programme of the European Union

LIFE E-VIA

Electric Vehicle noIse control by Assessment and optimisation of tyre/ road interaction

With the contribution of the LIFE programme of the European Union

ExpoMove 21-22 edition

13th - 14th October 2021, Florence

Backgroud

Which are the solutions to reduce noise in our cities? Are electric vehicles totally silent? How citizens can be involved in proactive good practices for noise reduction? These are some of the questions that the European LIFE E-VIA project aims to answer in depth.

Exposure data from the European Environment Agency demonstrate that more than 100 million EU citizens are affected by high noise levels negatively impacting human health. Traffic noise alone is harmful to the health of almost every third person in the World Health Organization European Region. 20% of Europeans are regularly exposed to night sound levels that could significantly damage health, especially in urban areas. The introduction of electric mobility is widely viewed as having the potential to reduce noise in urban areas, but the noise generated by tyres rolling on the road nevertheless needs careful study and further reduction.

Whitin this context, the project intends to:

- tackle noise pollution from road traffic noise focusing on a future perspective in which electric and hybrid vehicles will be a consistent portion of the flow;

- combine knowledge of road optimization and tyre development in order to test an optimized solution for reducing noise in urban areas and Life Cycle Cost with respect to actual best practices.

Actions

LIFE E-VIA started in July 2019 and will end in January 2023. The project is coordinated by the Municipality of Firenze and involves as partners the Mediterranean University of Reggio Calabria, Continental, Vie en.ro.se Ingegneria, University Gustave Eiffel and I-POOL. Specifically, the project has:

- built in Nantes a test road surface designed for the specific context of electric vehicles (EVs) and their tyres. Different EV types have been tested on this surface, with different tyre types per vehicle, to identify the optimal combination for noise reduction. An internal combustion engine vehicle has been used as reference;

- carried out further testing in a pilot area in Florence (Via Paisiello), with the construction of two road surfaces, an optimised and a reference one.

On-going activities:

- estimation of the noise mitigation efficiency and potential of tyres, road surfaces and traffic through a life-cycle and a life-cycle cost analysis;

- calculation of rolling noise coefficients according to the EU CNOSSOS model for the EV fleet in order to define guidelines on the application of the project's results;

- involvement of citizens through targeted information initiatives on electric and sustainable mobility and through soundwalks and interviews.

LIFE HEATLAND PROJECT WORKSHOP "URBAN HEAT ISLAND AND NOISE: OUR NOT SO INVISIBLE ENEMIES"

Issued on: November 2021

By: Comune di Firenze

EVENTS

Code: E_5

HEATLAND

URBAN HEAT ISLAND AND NOISE: OUR NOT SO INVISIBLE ENEMIES

17th November 2021 17:00h CET - Online

17:00 Welcome.

Vladimir Gumilar. Director at Construction Cluster of Slovenia.

17:10 Cool Pavements for Future Cities. Bye Bye Heat & Noise. **LIFE HEATLAND** project.

Francisco Miguel Moral. Head of Energy and Insulation Area, CTCON.

17:30 Fight against noise and heat in the city. **LIFE COOL & LOW NOISE IMPACT** project.

Giulia Custodi. Environmental Health Impact Division, Paris City Council.

Mailys Chanial. Paris City Hall, Water and Sanitation &. Roads and Traffic Divisions.

18:00 Reducing noise for roads inside very populated urban areas. **LIFE E-VIA** project.

Arnaldo Melloni. Environmental Management, Municipality of Florence.

18:30 Cool pavement technology in Arizona. **CITY OF PHOENIX COOL PAVEMENT** Program.

Ryan Stevens. PE, Civil Engineer III, City of Phoenix Street Transportation Department.

Rubben Lolly. PE, CCPM, Special Projects Administrator, City of Phoenix Street Transportation Department.

19:00 Cooling LA's Neighborhoods. **COOL STREETS LA** program.

Greg Spotts. Assistant Director and Chief Sustainability Officer StreetsLA.

19:30 Closure

Click here for registration

« E-VIA » Electric Vehicle noise control by Assessment and optimisation of Tyre/road interaction

PROJECT LOCATION: Florence Italy

BUDGET INFO:

Total amount: 1.797,030 €

55% EC Co-funding: 933,295 €

DURATION: Start: 01/07/2019 - End: 31/01/2023

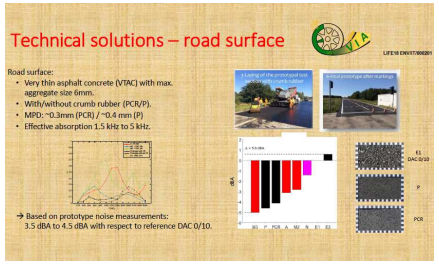
PROJECT'S IMPLEMENTORS:

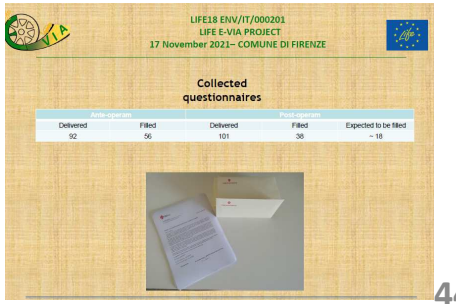
Coordinating Beneficiary: Florence Municipality

Associated Beneficiary(ies):
Continental Reifen Deutschland
Ifsttar
Ipool S.r.l.
University of Reggio Calabria
Vie en.ro.se Ingegneria S.r.l

URBAN HEAT ISLAND AND NOISE: OUR NOT SO INVISIBLE ENEMIES

Arnaldo Melloni
Project Manager





Acoustical characterization of low-noise prototype asphalt concretes for electric vehicles

Julien Cesbron[1], Simon Bianchetti[2], Marie-Agnès Pallas[2], Filippo G. Praticò[3], Rosario Fedele[3], Gianfranco Pellicano[3], Antonino Moro[4], Francesco Bianco[4]

[1] UMRAE, Univ Gustave Eiffel, IFSTTAR, CEREMA, Bouguenais, France
julien.cesbron@univ-eiffel.fr
[2] UMRAE, Univ Gustave Eiffel, IFSTTAR, CEREMA, Univ Lyon, F-69675, Lyon, France
simon.bianchetti@univ-eiffel.fr, marie-agnes.pallas@univ-eiffel.fr
[3] DIIES Department, University Mediterranea of Reggio Calabria, Reggio Calabria, Italy
filippo.pratico@unirc.it, eng.rosfedele@gmail.com, gia.pellicano@gmail.com
[4] IPOOL S.r.l., Via Antonio Cocchi, 7, 56121 Pisa, Italy
antonino.moro@i-pool.it, francesco.bianco@i-pool.it

Abstract

The paper deals with the acoustical characterization of low-noise asphalt concretes developed for noise reduction in urban areas within the LIFE E-VIA project (LIFE18 ENV/IT/000201). With the perspective of an increasing number of electric vehicles (EVs) in urban area, the asphalt concrete mixes have been optimized considering Life Cycle Cost with respect to actual best practices. Two very thin asphalt concretes (VTAC) of 6 mm maximum aggregate size have been implemented on a reference test track in France. Both are based on the same formulation, but one mix contains 1.9% crumb rubber by weight. The noise performance of these prototype test sections has been evaluated by means of close-proximity (CPX) tests and controlled pass-by (CPB) noise measurements for two EV models. CPX results have shown a noise reduction of about 3 dB(A) by comparison with a reference dense asphalt concrete 0/10, while an average pass-by noise reduction of about 4 dB(A) has been observed for the sample of EVs tested.

Keywords: electric vehicles noise, tyre/road noise, low-noise asphalt concrete, life cycle analysis.

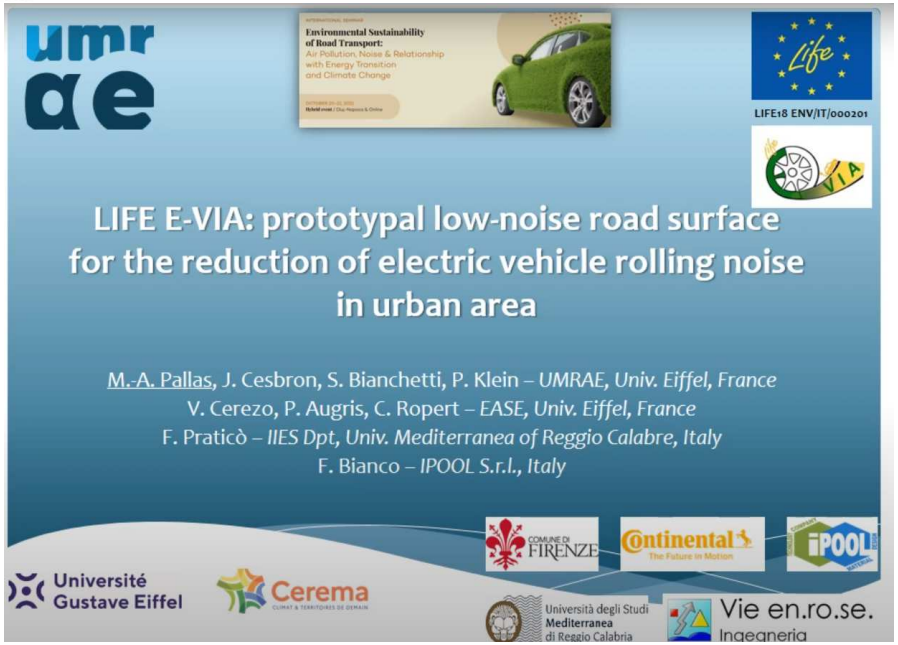
Abstract/ presentation submitted to PIARC International Sustainability of Road Transport

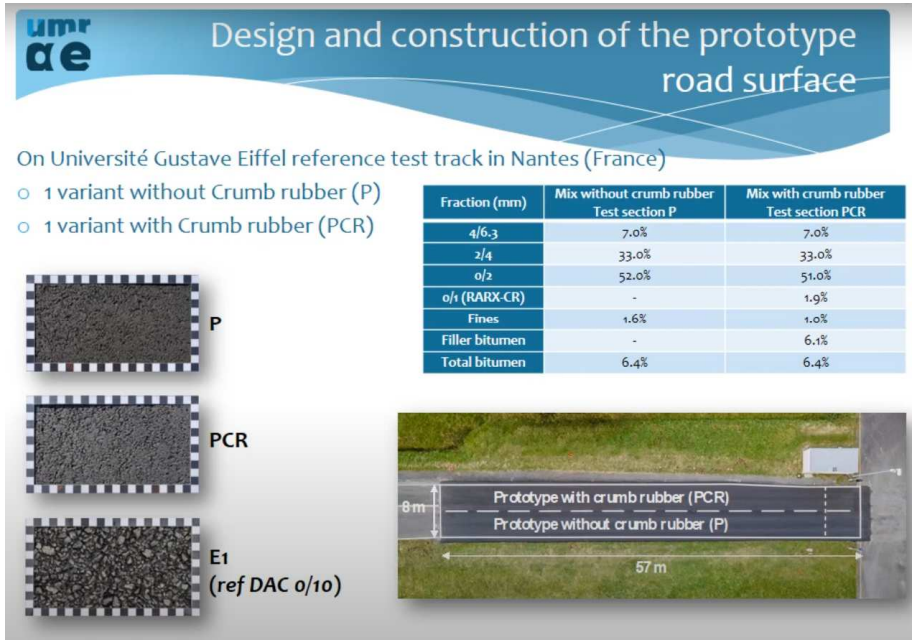
Issued on: October 2021

By: Université Gustave Eiffel, UNIRC, IPOOL

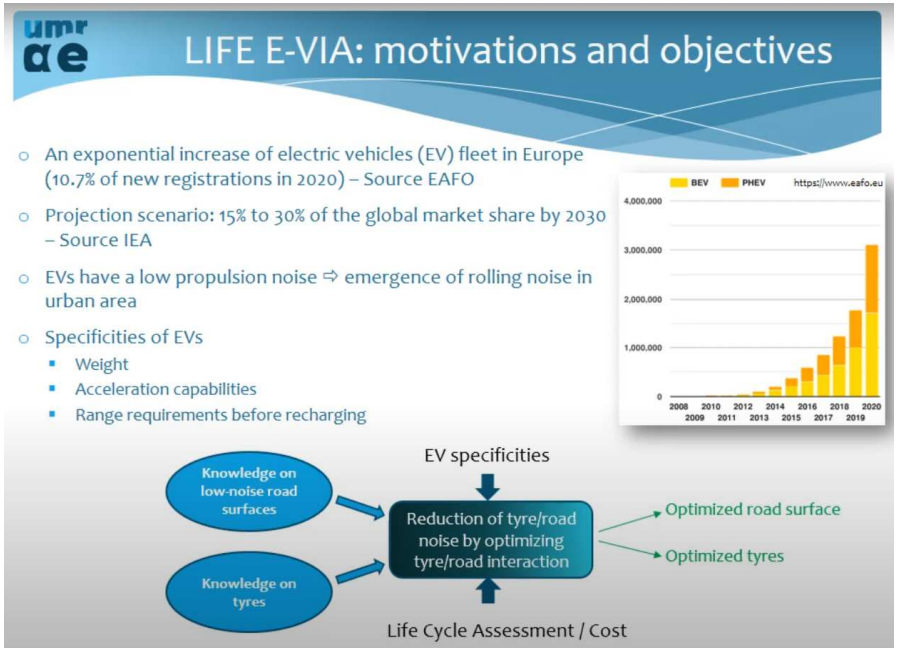
Deadline: 31/03/2023

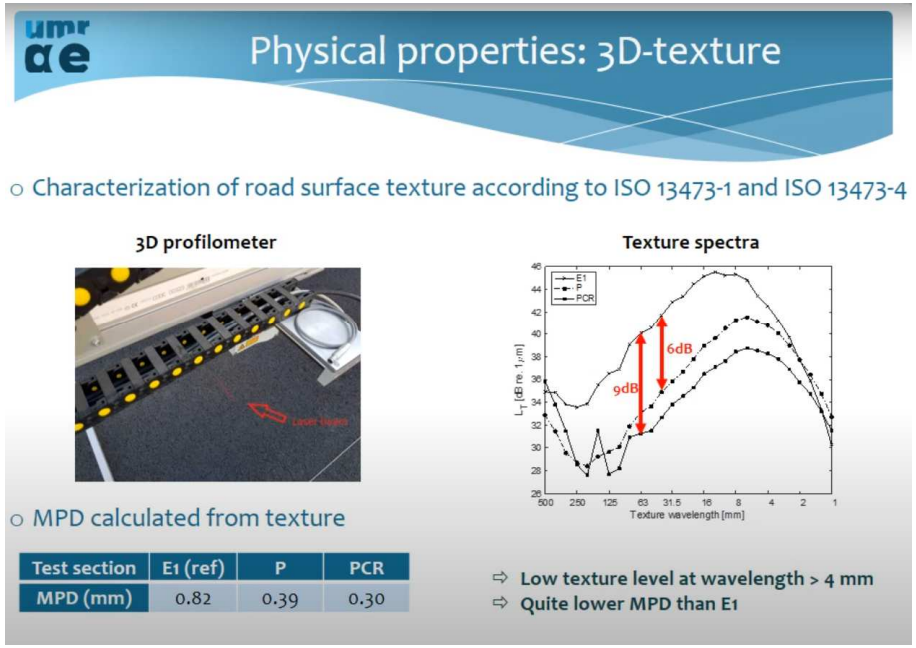
SCIENTIFIC PAPERS
Code: 36_15





Fraction (mm)	Mix without crumb rubber Test section P	Mix with crumb rubber Test section PCR
4/6.3	7.0%	7.0%
2/4	33.0%	33.0%
0/2	52.0%	51.0%
0/1 (RARX-CR)	-	1.9%
Fines	1.6%	1.0%
Filler bitumen	-	6.1%
Total bitumen	6.4%	6.4%





Test section	E1 (ref)	P	PCR
MPD (mm)	0.82	0.39	0.30

Paper submitted to EURONOISE 2021
"Low-noise road mixtures for electric vehicles"

Issued on: October 2021

By: UNIRC

Deadline: 31/03/2023

SCIENTIFIC PAPERS
Code: 36_16

euronoise 2021 25th to 27th of October Madeira, Portugal - online

Low-noise road mixtures for electric vehicles

Filippo G. Praticò[1], Gianfranco Pellicano[1] and Rosario Fedele[1]

[1]DIIES Department, University Mediterranea of Reggio Calabria, Reggio Calabria, Italy
filippo.pratico@unirc.it; gia.pellicano@gmail.com; rosario.fedele@unirc.it

Abstract

The road pavements of the future should be designed to take into account the variation of the traffic noise due to traffic increase and electric vehicles (EVs) diffusion. Indeed, EVs are very different from internal combustion engine vehicles. Importantly, they could be quieter than traditional vehicles at low frequencies, but could be noisier at high frequencies. This study aims at presenting the acoustic and mechanical performance of two asphalt concretes that were designed to reduce the problem mentioned above. In more detail, an experimental investigation was carried out to test samples of asphalt concretes with low nominal maximum aggregate sizes, with and without crumb rubber, added applying the dry method. A gyratory compactor was used to make the samples and acoustic and mechanic properties were tested. Results show that mechanistic-related strategies such as the addition of crumb rubber could improve the acoustic performance. Consequently, there is probably room for improving design criteria.

Keywords: traffic noise, electric vehicles, low-noise road mixtures, acoustic and mechanical performances, crumb rubber.

Task 2) Design/creation of mixtures/samples with and without TCR (1/1)

- Based on the Superpave mix design method, the optimum %B was 5%. Hence, three percentages of bitumen per mix type were considered (about 3%, 5%, and 7%).
- The gyratory compactor revolution number was maintained constant (i.e., 210).
- The TCR was added applying the dry process. TCR seems to negatively affect the compaction level of the samples (cf. G_{mb_DIM}). Hence, %TCR = 2.

Table 2 – Samples' compaction and features.

Type of mixture	Sample ID	Bitumen by mix weight [%]	TCR by mix weight [%]	Gyratory compactor revolution number	Sample dimensions (thickness × diameter) [mm × mm]	Sample weight [g]	G_{mb_DIM} [-]
AC6*	AC6o_3%B_0%TCR_21	3.2	0.0	210	117.4 × 97.5	2066.09	2.36
AC6*	AC6o_5%B_0%TCR_22	5.2	0.0	210	117.2 × 97.5	2109.57	2.41
AC6*	AC6o_7%B_0%TCR_23	7.2	0.0	210	119.6 × 97.5	2154.78	2.41
AC6**	AC6o_3%B_2%TCR_24	3.0	2.0	210	123.7 × 97.5	2105.22	2.28
AC6**	AC6o_5%B_2%TCR_25	5.0	2.0	210	107.0 × 97.5	2151.30	2.39
AC6**	AC6o_7%B_2%TCR_26	7.0	2.0	210	123.9 × 97.5	2198.26	2.36

Symbols. AC6 = Asphalt Concrete with Nominal Maximum Aggregate Size of 6 mm. 3%B = Percentage of bitumen of 3% (w/w by the total weight of the mixture). 0%TCR = Percentage of TCR of 0%. $G_{mb\ DIM}$ = Bulk Specific Gravity calculated considering the characteristics of the sample (dimensions and weight).

Figure 1 – Upper surfaces of samples.

6

Task 3) Testing of samples with and without TCR (1/1)

- Six samples (with or without TCR) were tested using the devices in Figure 2.
- The method and the system used to measure both mechanical and acoustic responses were developed by the authors of the paper.

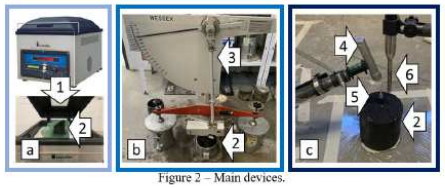


Figure 2 – Main devices.

Notes. 1: Corelok machine. 2: Samples. 3: Pendulum tester. 4: Impact hammer. 5: Accelerometer. 6: Microphone.

Legend: Test → Parameter

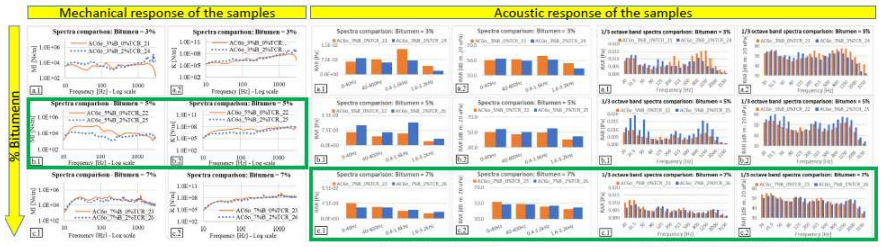
a → $G_{mb\_Corelok}$

b → PTV

c → K = Force/Displacement;
MI = Force/Velocity;
RAR = Acoustic response to an impact hammer hit.

7

Task 4) Analysis of the results (5/5)



12

LIFE E-VIA: laboratory experiments (IT)

Issued on: December 2021

By: Vie en.ro.se. Ingegneria

Deadline: 31/12/2022

NOTICEBOARD IN ITALIAN LANGUAGE

Code: 23_3

LIFE18 ENV/IT/000201

With the contribution of the LIFE programme of the European Union

LIFE E-VIA

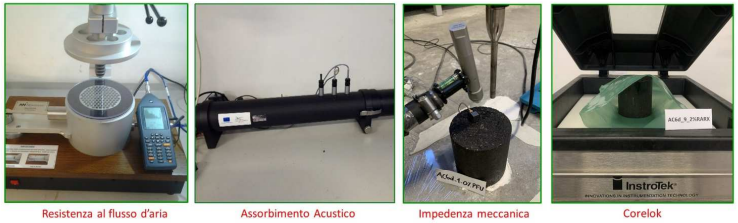
Electric Vehicle noIse control by Assessment and optimisation of tyre/road interaction

Progettazione della miscela

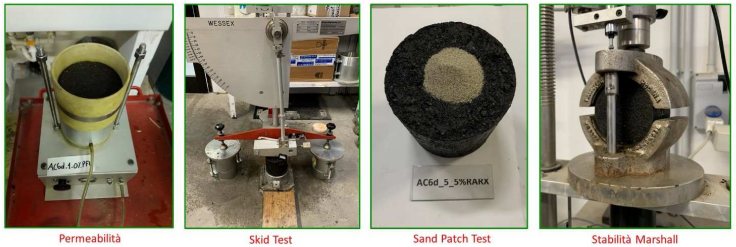
L'Università 'MEDITERRANEA' di Reggio Calabria (UNIRC) ha analizzato più di 150 soluzioni presenti in letteratura (*strati di usura*), basandosi su *performance* acustiche e non acustiche, con l'obiettivo di selezionare le soluzioni più appropriate. Sono stati considerati le caratteristiche e gli impatti di ogni soluzione, e sono stati condotti dei test preliminari. Da un totale di 150 conglomerati bituminosi, sono state selezionate nove miscele, sulla base delle seguenti caratteristiche: 1) Risposta Acustica; 2) "Durata di vita", facendo riferimento alle attività Meccaniche; 3) Permeabilità; 4) Frizione; 5) Valore ENDT. Sulla base di queste caratteristiche, sono stati selezionati conglomerati bituminosi con aggregato massimo nominale di 6 mm (AC6).
Un accurato piano di esperimenti ha permesso di progettare e validare le miscele scelte. Infine sono state progettate e testate due tipologie di miscele (AC6 con e senza polverino di gomma).

Compattazione metodo Superpave

Esperimenti di Laboratorio



Resistenza al flusso d'aria | Assorbimento Acustico | Impedenza meccanica | Corelok



Permeabilità | Skid Test | Sand Patch Test | Stabilità Marshall

Sito web: https://life-evia.eu/

LIFE E-VIA: survey ante/post operam (IT)

Issued on: December 2021

By: Vie en.ro.se. Ingegneria

Deadline: 31/12/2022

NOTICEBOARD IN ITALIAN LANGUAGE

Code: 23_4

LIFE18 ENV/IT/000201

With the contribution of the LIFE programme of the European Union

LIFE E-VIA

Electric Vehicle noIse control by Assessment and optimisation of tyre/road interaction

Il Caso Pilota

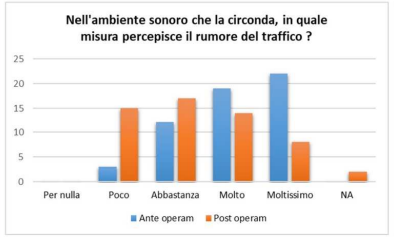
Nella seconda metà del mese di luglio 2021 sono stati realizzati gli interventi nel caso pilota di via Paisiello (Firenze): su un tratto di strada è stato steso un innovativo asfalto a bassa emissione sonora per ridurre l'inquinamento acustico. Al fine di valutare la percezione dei cittadini, prima e dopo la realizzazione dei lavori, sono stati somministrati questionari ai residenti nel tratto di strada interessato. Ad inizio luglio, sono stati consegnati 92 questionari ante-operam, di questi, 56 sono stati restituiti compilati. Successivamente alla realizzazione dei lavori (settembre), sono stati consegnati 101 questionari post-operam, dei quali 56 sono stati riconsegnati compilati. L'analisi dei dati mostra che la stesa dell'asfalto a bassa emissione acustica ha avuto un impatto positivo per quanto riguarda la percezione del rumore. In particolare, il 77% degli intervistati ha valutato in maniera positiva gli effetti dell'asfalto sviluppato dal progetto sulla riduzione del rumore causato dal traffico.

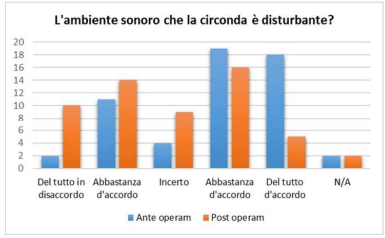
Contesto e strumento metodologico

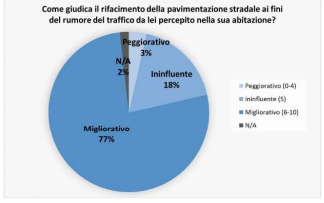
Il caso pilota a Firenze

Questionari ante-operam

Analisi dei dati







Sito web: https://life-evia.eu/

LIFE E-VIA: survey ante/post operam (EN)

Issued on: December 2021

By: Vie en.ro.se. Ingegneria

Deadline: 31/12/2022

NOTICEBOARD IN ENGLISH LANGUAGE

Code: 18_5

LIFE18 ENV/IT/000201

With the contribution of the LIFE programme of the European Union

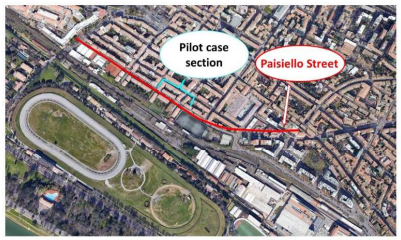
LIFE E-VIA

Electric Vehicle noIse control by Assessment and optimisation of tyre/road interaction

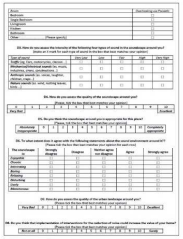
The Pilot case

The interventions in the pilot case located in Paisiello street (Florence) have taken place in mid July 2021: an innovative low-noise asphalt that aims to reduce traffic noise pollution was laid down in a portion of the street. In order to evaluate citizens soundscape perception before and after the pilot intervention realization, ante-operam and post-operam questionnaires were submitted to Paisiello street's residents. In particular, 92 ante-operam questionnaires were delivered, and 56 completed questionnaires were returned. In September, 101 post-operam questionnaires were delivered and 56 returned. The analysis shows a positive subjective impact of the low-noise asphalt implementation. As an illustration, according to 77% of the respondents the re-paving reduced the traffic noise perceived in their home.

Context and Methods

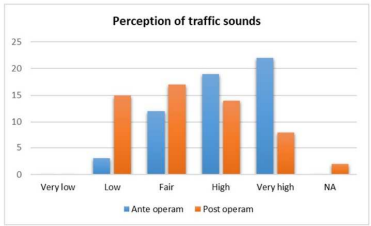


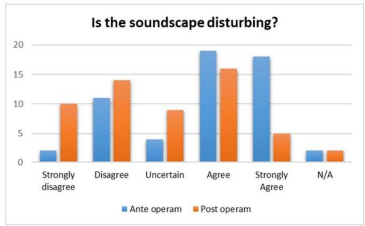
The pilot case in Florence

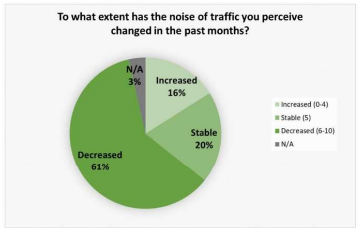


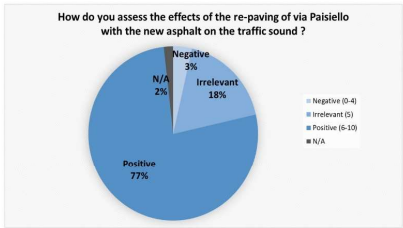
Delivered Questionnaires

Survey' Analysis









Website: https://life-evia.eu/

LIFE E-VIA: laboratory experiments (DE)

Issued on: December 2021

By: Continental

Deadline: 31/12/2022

NOTICEBOARD IN GERMAN LANGUAGE

Code: 22_3

LIFE18 ENV/IT/000201

Mit Unterstützung des LIFE Förderprogramms der Europäischen Union

LIFE E-VIA

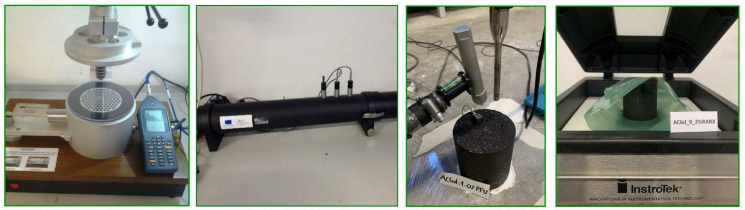
Electric Vehicle noIse control by Assessment and optimisation of tyre/road interaction

Mischungs-design

Die Università Mediterranea Di Reggio Calabria (UNIRC) hat zur Findung eines optimalen Straßenbelags mehr als 150 in der einschlägigen Literatur erwähnte Deckschichten auf ihre akustischen und nicht-akustischen Leistungsfähigkeiten untersucht. Weiterhin wurde die Umweltverträglichkeit berücksichtigt und eine Reihe von Vortests durchgeführt. Auf dieser Basis wurden von den 150 Vorschlägen neun Asphaltbetonmischungen ausgewählt, wobei besonderer Fokus auf (1) die akustischen Eigenschaften; (2) die auf Basis der mechanischen Eigenschaften zu erwarteten Lebensdauer; (3) die Permeabilität; (4) die Friktionseigenschaften; und (5) den END_T-Wert (gemäß ISO 10844) gelegt wurde. Aus diesen wurden dann Asphaltbetonmischungen mit einer maximalen nominalen Korngröße von 6 mm (AC6) ausgewählt. Mittels einer detaillierten Reihe von Experimenten wurden schließlich die finalen zwei Mischungen entwickelt und validiert. Es handelt sich dabei um zwei AC6-Mischungen mit/ohne Gummigranulatanteil.

Asphaltbeton-verfestigung

Labor-experimente



Strömungswiderstand | Akustische Absorption | Mechanische Impedanz | Corelok

Permeabilität | Reibungsmessung | Sandfleckverfahren | Marshall-Stabilität

Webseite: https://life-evia.eu/

LIFE E-VIA: laboratory experiments (FR)

Issued on: January 2022

By: Università Gustave Eiffel

Deadline: 31/12/2022

NOTICEBOARD IN ITALIAN LANGUAGE

Code: 21_3

LIFE18 ENV/IT/000201

With the contribution of the LIFE programme of the European Union

LIFE E-VIA

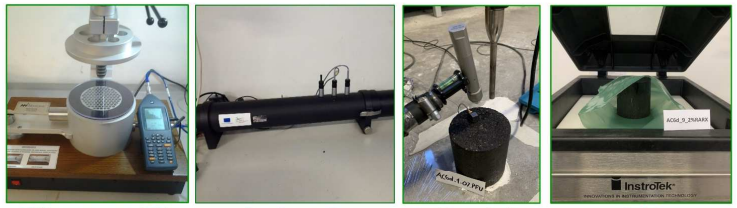
Contrôle du bruit des Véhicules Électriques par l'évaluation et l'optimisation de l'interaction pneumatique/chaussée

Conception du mélange

L'Université « méditerranéenne » de Reggio de Calabre (UNIRC) a analysé plus de 150 solutions de surface routière disponibles dans la littérature, sur la base de leurs performances acoustiques et non acoustiques, pour sélectionner les solutions pertinentes. Leurs caractéristiques et impacts ont été considérés et des tests préliminaires ont été effectués. À partir des 150 bétons bitumineux, neuf formulations ont été retenues, selon de nombreux critères incluant : 1) la réponse acoustique; 2) la durée de vie relativement aux propriétés mécaniques; 3) la perméabilité; 4) l'adhérence; 5) la valeur ENDT (« Expected pass-by Noise level Difference from Texture level variation of the road surface »).
Pour cette dernière, des bétons bitumineux ouverts de taille nominale de granulats 6 mm (AC6) ont été retenus.
Un plan d'expérience précis a été élaboré et appliqué pour concevoir et valider la formulation définitive. Deux variantes ont finalement été réalisées et testées (AC6 avec et sans poudrette de caoutchouc).

Compactage Superpave

Tests en laboratoire



Résistance au passage de l'air | Absorption acoustique | Impédance mécanique | Corelok

Perméabilité | Essais d'adhérence | Mesure de la tache au sable | Stabilité Marshall

Site web: https://life-evia.eu/

La responsabilité du contenu des communications/publications incombe exclusivement à leurs auteurs. Il ne reflète pas nécessairement l'opinion de l'Union européenne. Ni le CINEA ni la Commission Européenne ne sont responsables de l'usage qui pourrait être fait des informations qui y sont contenues.

LIFE E-VIA

Electric Vehicle noise control by Assessment and optimisation of tyre/road interaction

LIFE E-VIA: Tyre role in the context of EV and ICEV (EN)

Issued on: January 2022

By: Continental

Deadline: 31/12/2022

NOTICEBOARD IN ENGLISH LANGUAGE

Code: 18_6

LIFE18 ENV/IT/000201

With the contribution of the LIFE programme of the European Union

LIFE E-VIA

Electric Vehicle noIse control by Assessment and optimisation of tyre/road interaction

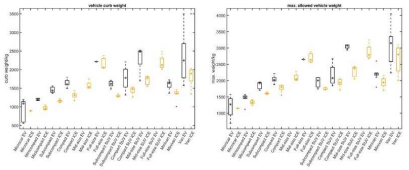
Tyre role in the context of EV and ICEV

Electric vehicles (EV) differ from their traditional internal combustion engine (ICEV) counterparts in many technical or design features. Some of these changes can influence the rolling noise created by the interaction of the tyre with the road. These parameters are for example increased vehicle loads due to the battery weight which is necessary to provide acceptable mileage, special acceleration/deceleration behaviour due to the different torque characteristic of electrical motors and the recuperation, possible new tyre size trends ("tall-and-narrow") being introduced for mileage, handling or aesthetic reasons, etc. In an analysis of the current and future European EV market it has thus been assessed whether there are systematic differences between EVs and ICEVs which would affect tyre/road noise by any of the previously described mechanisms.

Vehicle weight

Background: Commonly, an increase in tyre load can be associated with an increase in tyre/road noise. While the extend of this load influence on rolling noise depends on tyre type, speed, road surface and inflation pressure, an increase in SPL of 0.5 dB to 2.5 dB per load doubling is typically reported in literature. If an increase in tyre loads necessitates an increase in tyre inflation pressure or tyre construction, further negative effects on tyre/road noise can be expected.

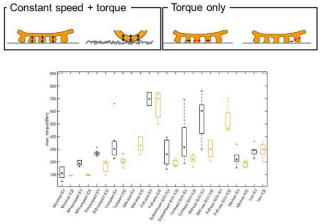
Observations: The results indicate that on average EVs are between 20 % and 25 % heavier than ICEVs in curb weight and roughly 10 % to 15 % in maximum weight. This will negatively influence tyre/road noise generation. Often this is accompanied by an increase in tyre inflation pressure – either for load carrying or rolling resistance reasons – which will further increase rolling noise.



Vehicle torque

Background: Compared to constant speed driving, tyre torque due to acceleration or braking can increase tyre/road noise by several dB. Again, the extend of this increase depends highly on tyre design and operating conditions. This noise increase is caused by micro-scale adhesion and friction mechanisms which are responsible for phenomena like stick/slip and stick/snap which lead to additional tangential vibrations of the tread blocks which are of minor importance under free rolling.

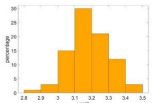
Observations: Definite conclusions regarding EV tyre torque are difficult because of a lack of specific data and the large influence of electronic control systems and driving behaviour. Engine torque is in nearly all cases higher for EVs, both in terms of maximum torque as well as the RPM range where this is available. Assuming similar vehicle control systems and driving behaviour to ICEVs this means that tyre torque is potentially also higher for EVs. Combined with reports that over a third of EV fleet users exhibit a more aggressive driving behaviour a worst-case assumption of increased tyre torque for EVs seems reasonable.



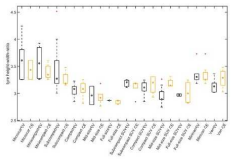
Tyre sizes

Background: The sound radiation from the area close to the tyre/road contact patch is amplified by the horn-like geometry formed between tyre and road. This amplification is frequency dependent with average amplifications of 5 dB to 12 dB per third-octave band having been reported for complex pass-by situations. The amplification is strongly affected by tyre width, with smaller tyres reducing the amplification effect. Tall-and-narrow tyre concepts as used by some EVs (e.g. BMW i3) have a significant influence on the amplification from the horn effect, affecting both the frequency and the amplitude of the peak amplification.

Observations: New tyre size concepts, for example tall-and-narrow, are not widely employed for EVs. Contrary, for EVs based on an ICEV platform usually no changes in tyre size are observed. For new EV platforms often only slight adjustments in tyre sizes are noticeable, typically in form of a small increase in tyre diameter and/or width. The relation between tyre height and width, defined here as height-width-ratio HWR = tyre diameter/tyre width, which is important for the amplification of the sound radiation, mostly stays in the same range as established for classical ICEV applications.



Height-width-ratio for the typical tyre sizes used by the 50 most sold ICEVs in the European market in 2019.



Web site: https://life-evia.eu/

LIFE E-VIA: Tyre role in the context of EV and ICEV (DE)

Issued on: January 2022

By: Continental

Deadline: 31/12/2022

NOTICEBOARD IN GERMAN LANGUAGE

Code: 22_4

LIFE E-VIA

LIFE18 ENV/IT/000201

Mit Unterstützung des LIFE-Förderprogramms der Europäischen Union

Electric Vehicle noIse control by Assessment and optimisation of tyre/road interaction

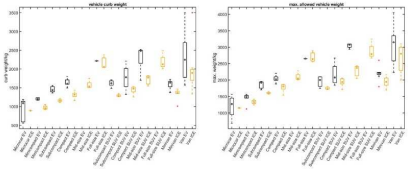
Die Rolle des Reifens im Kontext des Wechsels von ICEVs zu EVs

Elektrofahrzeuge (EV) unterscheiden sich von ihren Gegenstücken mit Verbrennungsmotor (ICEV) in vielen Technik- und Designaspekten. Einige dieser Unterschiede können einen Einfluss auf das durch die Reifen-/Fahrbahninteraktion verursachte Rollgeräusch haben. Dabei handelt es sich z.B. um erhöhte Fahrzeuglasten aufgrund des für akzeptable Reichweiten nötigen Batteriegewichtes; spezielles Beschleunigungs-/Bremsverhalten aufgrund der speziellen Drehmomenteigenschaften von elektrischen Motoren und der Rekuperation; oder neue Reifengrößen (*tall-and-narrow*) welche aus Gründen der Reichweite, des Handlings oder der Ästhetik eingeführt werden. In einer Analyse des europäischen EV Marktes wurde deswegen untersucht, inwieweit es systematische Unterschiede zwischen EVs und ICEVs gibt, die das Reifen-/Fahrbahngeräusch durch die genannten Mechanismen beeinflussen können.

Fahrzeug-gewicht

Ausgangslage: Eine erhöhte Reifenlast kann mit einer Zunahme des Reifen-/Fahrbahngeräusches in Verbindung gebracht werden. Der Umfang dieses Lasteinflusses hängt u.a. vom Reifen, dem Fülldruck, der Geschwindigkeit und dem Straßenbelag ab. In der Literatur wird typischerweise eine Zunahme des Gesamt-schalldruckpegels um 0,5 dB bis 2,5 dB pro Lastverdopplung berichtet. Falls eine Erhöhung der Reifenlast auch einen erhöhten Fülldruck oder eine geänderte Reifenkonstruktion verlangt, ist mit einer weiteren Zunahme des Rollgeräusches zu rechnen.

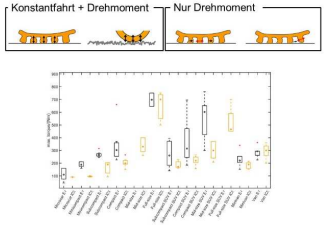
Beobachtung: Die Ergebnisse zeigen, dass EVs im Durchschnitt ein 20 % bis 25 % höheres Leergewicht als ICEVs haben und ein etwa 10 % bis 15 % höheres Maximalgewicht. Dies hat einen negativen Einfluss auf das Reifen-/Fahrbahngeräusch. Oftmals liegt zusätzlich – aus Gründen der Lastkapazität oder der Reichweite – ein erhöhter Fülldruck vor, durch den das Rollgeräusch potenziell weiter zunimmt.



Drehmoment

Ausgangslage: Im Vergleich zur Konstantfahrt kann ein Reifendrehmoment durch Beschleunigung oder Bremsen das Rollgeräusch um mehrere dB(A) erhöhen. Der Umfang dieser Zunahme hängt wiederum vom Reifendesign und den Betriebsbedingungen ab. Verursacht wird diese Zunahme durch kleinskalige Adhäsions- und Friktions-prozesse welche zu Phänomenen wie stick/slip oder stick/snap führen. Diese erzeugen zusätzliche tangentiale Vibrationen der Profilblöcke, die unter freien Rollen nur von geringer Bedeutung sind.

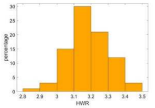
Beobachtung: Aufgrund mangelnder Daten zum EV-Reifendrehmoment, und des Einflusses von elektrischen Kontrollsystemen und dem Fahrverhalten ist eine konkrete Aussage schwierig. Das Motordrehmoment ist für EVs nahezu immer höher, sowohl als Maximalwert als auch als Umdrehungszahlbereich in dem dieser erreicht wird. Wird von ähnlichen Kontrollsystemen und zumindest nicht deutlich passiverem Fahrverhalten ausgegangen, bedeutet dies, dass das Reifendrehmoment von EVs mit großer Wahrscheinlichkeit auch höher ist.



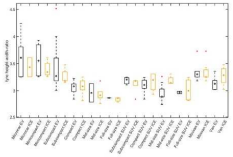
Reifengröße

Ausgangslage: Die Schallabstrahlung aus der unmittelbaren Umgebung des Reifen-/Fahrbahnkontaktes wird durch die einem Horn ähnelnde Geometrie zwischen Reifen und Fahrbahn verstärkt. Für diese frequenzabhängige Verstärkung sind für komplexe Vorbeifahrtsituationen Erhöhungen von 5 dB bis 12 dB pro Terzband beobachtet worden. Der Effekt hängt stark von der Reifenbreite ab, wobei schmalere Reifen zu einer geringeren Erhöhung führen. Tall-and-narrow Reifenkonzepte, wie sie von einigen EVs (z.B. BMW i3) genutzt werden, haben einen signifikanten Einfluss auf die verstärkte Schallabstrahlung durch den Horneffekt. Dabei wird sowohl die maximale Verstärkung als auch der relevante Frequenzbereich beeinflusst.

Beobachtung: Neue Reifengrößenkonzepte, z.B. tall-and-narrow, werden nicht in großen Umfang von Evs benutzt. Im Gegenteil, für EVs die auf klassischen ICEV-Plattformen basieren, ist im Normalfall keine Änderung der Reifengröße zu beobachten. Für neue EV-Plattformen ergeben sich oftmals nur geringe Anpassungen der Reifendimensionen, typischerweise in Form einer leichten Zunahme von Reifenbreite und/oder Felgendurchmesser. Das Verhältnis zwischen Reifenhöhe und –breite, hier definiert als height-width-ratio $HWR = \text{Reifendurchmesser}/\text{Reifenbreite}$, welches für die Verstärkung der Schallabstrahlung von Bedeutung ist, liegt Größtenteils im selben Bereich wie für klassische ICEVs.



Height-width-ratio für die typischen Reifengrößen, die von den 50 meist-verkauften Fahrzeugen auf dem europäischen Markt in 2019 benutzt wurden.



Webseite: https://life-evia.eu/

Paper published in an open access journal
NOISE MAPPING
Issued on: December 2021
By: UNIRC
Deadline: 01/12/2022

ARTICLES FOR OPEN ACCESS JOURNAL
Code: 20_2

https://www.degruyter.com/document/doi/10.1515/noise-2021-0023/html

DE GRUYTER Noise Mapp. 2021; 8:281–294

Research Article

Filippo Giammaria Praticò and Rosario Fedele*

Electric vehicles diffusion: changing pavement acoustic design?

https://doi.org/10.1515/noise-2021-0023
Received May 11, 2021; accepted Oct 31, 2021

Abstract: Electric vehicles (EVs) are progressively entering into the current noisy urban ecosystem. Even though EVs are apparently quieter than traditional Internal Combustion Engine Vehicles (ICEVs), they have an impact on noise maps and road pavement designers should take this into consideration when designing future low-noise road pavements. Consequently, the main objective of this study is to define what are the most important aspects that road pavement designers should take into account. For this reason, in this paper, the noise emitted by EVs was analysed, considering parameters (*e.g.*, speed and frequency) and comparisons, in order to identify crucial characteristics. Results show that EV noise could call for the improvement of pavement acoustic design due to the Acoustic Vehicle Alerting System (AVAS), high-frequency peaks, and noise vibration harshness.

Keywords: Internal combustion engine vehicles, Electric vehicle, Traffic noise, Road pavement design

1 Introduction

We tend to think that Electric vehicles (EVs) are quite silent, but it was amply proved that electric motors can emit noise [1]. The advent of EVs into the current traffic-noise-related ecosystem can be compared to the introduction of a new species in a given ecosystem [2], which need to be studied considering different points of view, *i.e.*, of authorities, pedestrians, drivers, and designers. Hence, designers should consider the impact of EVs on noise maps (especially in urban contexts), and take this into consideration when designing future low-noise road pavements [3].

The first outcome of the studies mentioned above refers to the "excessive quietness" of EVs, especially at low speeds, *e.g.*, Sound Pressure Levels lower than 56 dB @about 10 km/h, cf. also [4]. This may affect the safety of pedestrians, riders, and Internal Combustion Engine Vehicles (ICEVs) drivers [4–6]. In order to solve this problem, regulation and systems have been proposed as discussed in the following (see Section 1.3).

Another important aspect related to the noise produced by vehicles (including EVs) is the tire/road interaction. Hence, solutions related to tires and roads were proposed.

Focusing on tires designed for EVs, Ejsmont *et al.* (2015) [7] concluded that these special tires generate noise similar to general use tires, and that a small noise reduction can be possible if narrow tires with big outer diameter are used. In 2016, Pallas *et al.* (2016) and Czuka *et al.* (2016) [8, 9], within the FOREVER project, investigated the tire/road noise of EVs, and the "low-noise tires" concept (using one EV and nine different tire sets) concluding that:

1. The rolling noise of light EVs does not differ from the one of conventional vehicles.
2. Ecological tires (*i.e.*, which reduce consumption) and current tires for EVs do not reduce significantly the rolling noise.

Mohammadi and Ohadi (2021) [10] proposed a novel approach to design quiet tires, based on multi-objective minimization of generated noise. In this latter study, all the predominant mechanisms related to tire/road noise (texture impact, tread impact, air pumping, pipe resonance, Helmholtz resonance, air cavity resonance, and horn effect) were included in the model. On average, this allowed reducing of about 2 dB(A) the total noise (corresponding to 80% reduction of the normalized texture impact noise), and of 27% the average normalized sound of a patterned tire, by modifying of about the 10% its structural and tread pattern parameters.

For quiet asphalt pavements, it is important to point out that their sound absorption can be modelled [11, 12] and measured using in-lab and on-site methods [13]. Furthermore, road sound absorption is related to several parameters (*i.e.*, thickness, porosity, air flow resistivity, and tortuosity), and more attention should be paid on the im-

*Corresponding Author: Rosario Fedele: University Mediterranea of Reggio Calabria, Reggio Calabria, Italy; Email: rosario.fedele@unirc.it
Filippo Giammaria Praticò: University Mediterranea of Reggio Calabria, Reggio Calabria, Italy

within the range 500 Hz–1.6 kHz, while for heavy EVs is within 630 Hz and 2.5 kHz).

5. Based on measured data, the equivalent frequency (*i.e.*, the frequency, selected among all the center frequencies of 1/3 bands between 350 Hz and 2500 Hz, that is more often associated to the maximum A-weighted sound pressure level) of light EVs and light ICEVs is 1000 Hz and 800 Hz, respectively. While the same parameter for heavy EVs and heavy ICEVs is 1000 Hz and 630 Hz, respectively.
6. Simulations showed that if the percentage of EVs increases of 10%, the noise of the traffic flow decreases of 7 dB(A).

The following figures (Figures 3-5) show several noise spectra related to both light and heavy ICEVs and EVs [31, 32, 37, 45, 52]. In particular, these figures report the A-weighted Sound Pressure Level of:

1. ICEVs (see Figure 3) and EVs (see Figure 4), moving at different speeds (9–70 km/h), measured applying the Statistical Pass-By method (ISO 11819-1:1997).
2. EVs (see Figure 5) moving at constant speeds, derived applying the method described in the ISO 362-1-1:2015.

Note that the measurements related to heavy vehicles were pointed out by using asterisks.

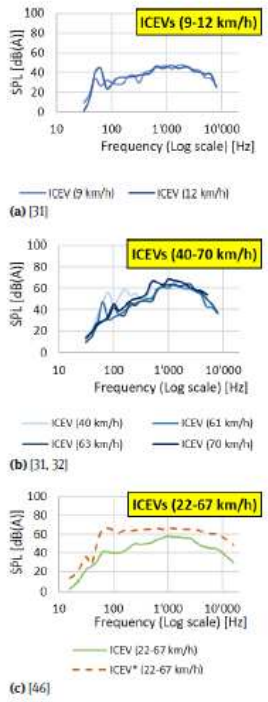


Figure 3: A-weighted Sound Pressure Level (Statistical Pass-By method, ISO 11819-1:1997) of ICEVs at different speeds (* – heavy vehicle) [31, 32, 45].

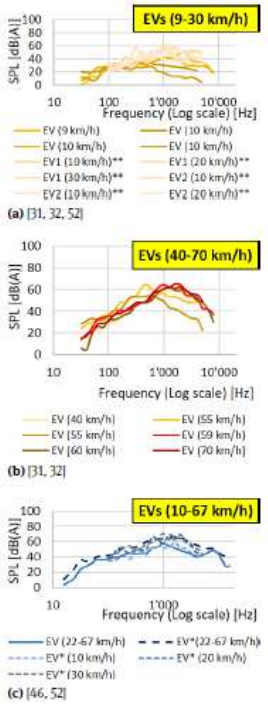


Figure 4: A-weighted Sound Pressure Level (Statistical Pass-By method, ISO 11819-1:1997) of EVs at different speeds (* – heavy vehicle; ** – motorcycle) [31, 32, 45, 52].