SAFER**UP!**

THINKING
BEYOND THE PAVEMENT

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About

SAFERUP!

Urban areas have become a jigsaw of living spaces delineated by roads, special lanes, bike lanes, footpaths, squares and the numerous walkable surfaces that permit people's daily mobility. Urban pavements cover about 40% of urban areas and are the largest and most expensive public property on which people travel every day and they must accommodate all users in the most efficient, safe and enjoyable possible way in modern Smart Cities.

In a modern society that will aspire to more liveable cities, we need novel approaches on how urban pavements are perceived, designed, built, maintained and managed. Safety, sustainability, resilience, accessibility, smart features and aesthetics are the key characteristics that Europe should invest in, forming the new generation of European professionals that will be able to face the issues related with the aspiration of people for a better, more liveable, urban environment.

Fifteen Early Stage Researchers (ESRs) undertook their PhDs in a research and training programme designed to optimise their multidisciplinary and cross-sectoral experience through secondments and training. This included career planning, entrepreneurship, skills development, and communication.

The participants of SaferUP! created a cooperative academy-industry Training-through-Research programme that to develop more Sustainable, Accessible, Safe, Resilient, and Smart Urban Pavements. SaferUP! created a multidisciplinary European Training Network that brought together internationally known researchers and highly qualified industrial and social partners under six topics.

The specific fields of interest are: users' behaviour and protection (especially the disabled and elderly), intelligibility and accessibility of pavements, road safety and urban acoustics, pavement management systems, durable and smart paving materials (fast-repairing and self-sensing), energy harvesting and geothermal pavements, urban heat island and flood risk mitigation, bioremediation of wash-off waters, pavement and industrial waste recycling and Life Cycle Assessment of construction products and technologies.

The ESRs can now provide the European community with innovative solutions that will form the urban paved environment of the future. They are now able to provide future generations with more liveable cities by applying solutions developed through their cutting-edge research.

Footpaths, bike lanes, roads, intersections, squares and all other walkable surfaces that we all use every day will be designed, constructed and managed to meet context-sensitive criteria including safety, mobility, costs (construction and maintenance), sustainability, environmental impacts, accessibility, aesthetics, circular economy and local economy preservation.

Sergio Copetti

CALLAI

Science is innovation, and it's innovations should serve the people.

Research

My field of study focuses on how to develop a material for the pavement that both reduces traffic noise while increasing friction between the tire and the pavement - thus reducing the braking distance.

Usually when you try to make a pavement safer you compromise and produce more noise, and vice versa. It's hard to find a balance with natural materials. So we tried to create a material with a specific shape, size and texture that could reduce noise and decrease friction at the same time.

We decided to use a technique called a geopolymer, which is like a cement material - but it has some interesting properties. It's an environmentally friendly aggregate replacing the rocks in the pavement. We can use bitumen but replace the natural aggregates.

Background

I've been researching noise on pavements since my bachelor's degree. Recently I started to also study the friction aspects – I'm trying to balance these two at the same time. Usually when we engineers study roads, the first lesson is what the road should serve to connect to places and should be durable, cheap and safe. However, I believe that there should be other aspects to it. It should be environmentally friendly, provide a comfortable ride and not disturb the people living in neighbourhoods.

SaferUP! skills

I learned how to model and to prototype with 3D printing techniques. I learned some lab skills like engineering geopolymers and some chemistry. This was important because I'm not a chemist, so for me it's not common knowledge.

Future

I'm trying to move from academia into consultancy or engineering. I would like to work as project manager in engineering because I believe that these skills are transferable. If possible in the near future, I would like to work as a PM or as a consultancy job innovation site.

I had the opportunity while I was doing my masters in Brazil to develop and publish two patents. I like that idea. In my opinion science is innovation, and it's innovations should serve the people.

Commercial potential

We are a few steps behind the commercial application. If we had the opportunity to make a joint venture with a company to produce the artificial aggregates industrially we could produce different shapes, sizes, and materials in a larger scale. I believe it's foreseeable as a technique for the industry if they want to sell it.

Background

I am both a civil engineer and materials engineer with a master in infrastructure of pavements. My academic career started back in 2013, when I was researching the application of residues in asphalt mixtures. I always had an interest in sustainability subjects specially applied to constructions and the SaferUP! project gave me the opportunity to learn and apply a fundamental tool: lifecycle assessment (LCA). My role in the SaferUP project couldn't give me more joy: to evaluate sustainability of new paving materials developed within the other SaferUP projects.

Research

We decided to do this in different stages; the first step of the analysis will be evaluating the environmental and economic impacts of Münster in Germany, and if we have time we could analyse the environmental and economic impacts of the other ESRs. What I have done so far is complete the economic and environmental analysis of Münster and I'm writing my thesis about this.

My idea of working with this tool is helping not only city administrators, but stakeholders in general in the decision-making process. When building a city or a pavement, normally you take into consideration the technical properties of the road pavement - but now the economic and environmental impacts are becoming more important. Sometimes for administrators and even for public, it's hard to make decisions. Even when you have some information, you don't know how to classify the results. So, this is what I want to achieve in this project.

SaferUP! skills

We learned a lot, the collaborations between the ESRs was a nice experience. We had do a lot of training for oral presentations and develop nice material for the general public. Sometimes we are so scientifically-oriented that we do not know how to spread this information to the general public. This was one of the things we learned really well in the SaferUP! project.

Future goals

I want to learn another tool called the Building Information Modeling and apply this with the LCA tool. The goal is to gather all information regarding the processes involved along the construction period to improve outcomes of the project. I was lucky that I got an offer from my department here to continue in this area. I hope that I can develop these two skills and carry on my career.

Mayara

LIMA

My idea of working with this tool is helping not only city administrators, but stakeholders in general

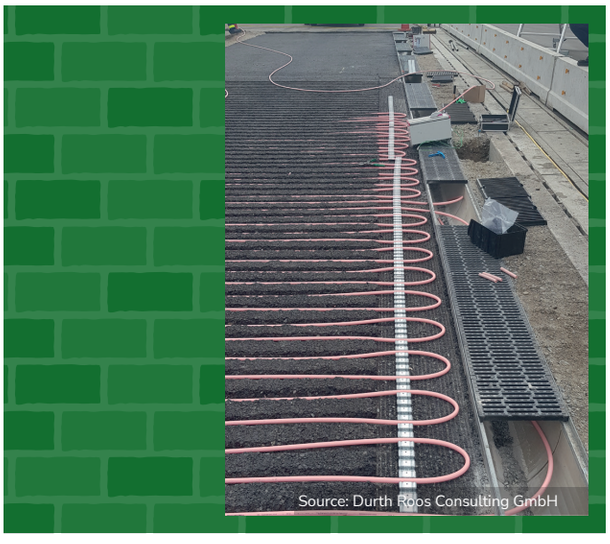
Arsel Inestroza

MERCADO

I had the opportunity to make choices that PhD students rarely do

Research

Usually asphalt pavement has problems when the temperature changes; over time heat causes rutting and cracks to appear, and icy roads in cold weather. So what I'm trying to do is to develop a pavement structure that will allow cities to control the temperature of the pavement.



Source: Durth Roos Consulting GmbH

My project included the development of a numerical model and pavement structure which includes a layer usually near the surface layer which acts as a heat exchange layer. In this case, it's a layer with a network of pipes. When it's too hot, the pipes will run cold liquid to cool the surface of the pavement. When it's very cold, warm liquid can run to warm it. This will prevent ice formation over the surface and be safer for road users.

If we combine this with the right energy technique, like geothermal energy and heat pumps, we can use the heat captured by this fluid for other uses. For example, if we run cold water when it's too hot, the warmed water creates a flow of energy. You can transform this energy to other uses like air conditioning or hot water for houses.

Background

I come from Latin America, so we don't have a lot of energy supplies. If we can get the energy from the street, it will be helpful for countries like mine. That attracted me to the project, and also working with experienced people in the research field.

Test site

I have the opportunity to participate in the development of a test site. With the test site we will validate the numerical model that we have developed over the past three years. The model will help us predict how the system perform under different conditions.

I also want to help to decrease the heat island effect, which will be one of the next research topics. There are some early estimates that this will lessen the impact of extreme heat.

SaferUP! skills

I did my secondment within Germany. My supervisor gave me the liberty to take decisions in my project - I feel pretty empowered by that. I had the opportunity to make choices that PhD students rarely do.

Future plans

In SaferUP I did my research in a company and in the university, so I experienced both work environments. I would like to go on to industry to develop the technology more.

There is already a commercial version, but they still need to understand and figure out how to improve it. So, you need to keep designing and researching which parameters to take care of.

Background

My field of study is sustainable urban drainage systems. In our urban areas, we have a majority of impermeable surfaces where water cannot penetrate the surface. That's why we have higher drainage issues which can even result in flash floods. I specialise in permeable pavements - the roads that allow water to pass inside their structure. Permeable pavements are mostly used for parking and low traffic roads, but they have the potential to be used more widely.

Research

My thesis research was on how to improve the durability of the porous asphalt mixtures used in surface layers of the pavements. The loss of particles is still a major problem in porous asphalt mixture. This occurs due to high amount of air voids, where the aggregates tend to lose contact, whenever some vehicle passes. I'm a civil engineer, so whenever I think about something, I think about how it will work mechanically. I investigated the effect of incorporation of materials to improve the performance of these mixtures.

Afterwards, with the use of GIS, I mapped the areas that are vulnerable, and then implemented these pavements based on the total risk. I considered factors like traffic, rainfall, and soil characteristics to check their influence on runoff during occurrence of floods.

SaferUP! skills

I was born and brought up in Delhi. When I came to Spain, I met with very different and kind people. SaferUp! gave me an incredible opportunity that helped me in networking and collaboration with leading institutions. A lot of the researchers I've talked to have given me feedback about my work and it's been really great just to communicate with experts from different fields as well.

Despite the COVID-19 pandemic, I still feel that I had the chance and the opportunity to present my work at seminars and collaborate with institutions where I'd never imagine that I could have done.

Future goals

I think that I want to be at a research institution where I can learn more about sustainable urban drainage systems and share my learnings. I believe that permeable pavements have very high potential, and it is needed to explore them in depth. I would like to continue my journey in this field.

Anik

GUPTA

Permeable pavements are majorly used for parking and low traffic roads, but they have the potential to be used more widely

Christina
MAKOUNDOU

> *It was very interesting for me to see all those different approaches and different worlds coming together*

Research

My background is in chemistry, and I then went into the civil engineering world. The interesting part for me is to apply material chemistry into innovative products that will be implemented in the cities of the future!

The goal in my project was to produce a paving material using recycled rubber from tires and incorporate it in the formulation of traditional asphalts to make them softer. This means they can absorb impacts better, which can save lives during a fall or accident on the pavement.

There were two sides for this research. The first was researching the chemistry of the material to incorporate significantly more rubber; reincorporating material from tires is also a way to foster the circular economy. The other side was user centric - to make the vulnerable users such as cyclists, pedestrians and the elderly to feel safer to go on the street and

reduce their injuries if they fall. This material exists already in a way in the playground, but I wanted to make the material stronger to support daily walking or biking.

SaferUP! skills

During the SaferUP! project I had the opportunity to collaborate with the other early-stage researchers. It was very interesting for me to see all those different approaches and different worlds coming together. We wrote papers together and we learned a lot about how we can connect our expertise to come up with stronger research ideas.

Future goals

I wish to join a research institute - I had the chance during my project to collaborate with the Swedish Institute of Research. I'm seeing myself more in this kind of research; developing the product in the laboratory, and then applying it directly to test sites. I also really enjoy working with people from different backgrounds, both cultural and professional. I think this is something that I will try to seek for the future as well.

We had the chance to lay down a small portion of this material in Imola, a town in Italy. I had the chance to follow all the stages of the development, from the lab to the application and now the maintenance. In fact we are still checking it through the control phase. After being able to lay the material, it would be great to see how it can scale up to larger portions and monitor the effects over years on injury reduction.

Background

Constructing buildings and roads has reformed the natural flow pathways of rain and stormwater in cities. This has led to an accumulation of different organic and inorganic compounds such as heavy metals and hydrocarbons. In turn this creates a possible pathway to the food chain, damaging human health.

Sustainable Drainage Systems (SuDS) have been used to manage the urban stormwater as quickly as possible with minimum environmental impacts. They use physical, chemical and biological processes to remediate contaminated runoff and increase the water quality.

My research during my Marie Curie fellowship was in remediation of contaminated urban runoff using nature-based solutions including biological agents. I want to design urban pavements and drainage systems to function as similarly as possible to natural conditions.

SuDS research

SuDS devices are designed to reduce the amount of runoff and to control water pollution. But the science of the bioremediation within SuDS devices have been under-investigated. My research has begun to unravel some of the unknown bioremediation processes, including biosorption of heavy metals.

My research was also committed to finding in-situ remediation strategies to prevent water contamination from new materials in landscaping. These include new urban paving materials using nanoparticles, metals (e.g., for heat conductive frost resistant paving) microplastics and admixtures for increasing recycled content. The environmental risk from these new materials in water runoff must be understood, and there's a big need to design countermeasures to prevent non-point source pollution and installing source control.

SaferUP! skills

The SAFERUP! project helped me to improve my skills in several important academic aspects. My analytical chemistry skills including using HPLC-MS, GC-MS and ICP-MS instrument has improved during my SAFERUP! research. I have also been involved in teaching and supervision of MSc students. My communication and dissemination skills have also been improved after participating in SAFERUP! workshops.

Future research

In the next few years, I hope to get funding to continue my research on remediation of contaminated runoff using living biofilms in permeable pavement systems. I will look for efficiencies of living biofilms that degrade organic compounds including Polycyclic Aromatic Hydrocarbons (PAHs), pesticides and pharmaceuticals in aqueous solution. Investigating the how biological agents remove organic contaminants and their potential in urban pavements can reduce the release of such contaminants into the environment. Commercial groups can also employ the proposed biotechnology to reduce pollution, protect water bodies, and further enhance water quality for safe human and ecological use.

Alireza

FATHOLLAHI

I want to design urban pavements and drainage systems to function as similarly as possible to natural conditions

Murad

SHOMAN

> *We're not just asking people how they feel, we're trying to evaluate their safety through sensors*

Background

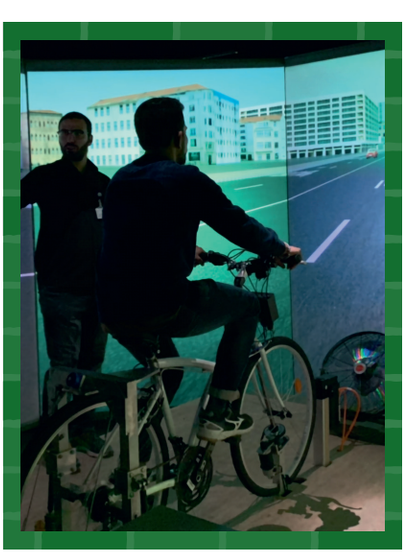
My focus is on cycling safety, specifically road surface characteristics and geometries that affect the road user's behaviour. If we adopt the geometric design of the road, we can make it safe and we can improve the behaviour of cyclists.

I noticed that a lot of cities redesigned or rebuilt their cycle networks during COVID lockdowns, though not always properly. Simply painting some new paths does not make the infrastructure safe. They need more physical changes, like physical barriers between cyclists and cars. Other times streets don't suit cycling infrastructure – for example an intersection layout not adapted geometrically to bicycles. If we want to encourage people to cycle, we should build safer infrastructure.

Research

My project included two stages; the first part was running experiments on a bicycle simulator in Paris, and the second stage of my study was to compare the results of the simulator to the results of the real world experiments in Stockholm and Madrid.

The goal was to study the cyclists' behaviour by using sensors and trackers. These give us an idea of the vertical stability of the cyclist on different surfaces and everything related to the dynamics of the bicycle. For example in Stockholm we did an experiment on snowy conditions to evaluate their safety on snow, since a decrease in friction can affect the bicycle's dynamics like braking and acceleration.



It's interesting to study psychology through engineering; we're not just asking people how they feel, we're trying to evaluate their safety through sensors.

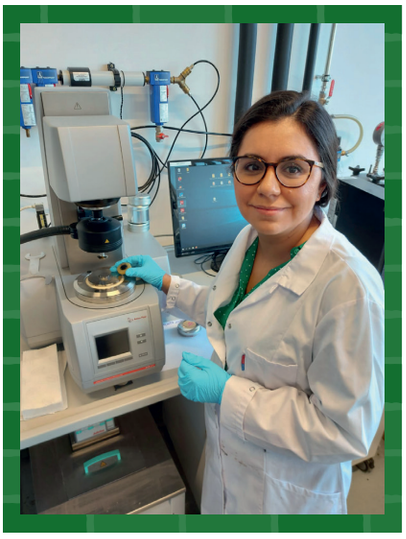
SaferUP! skills

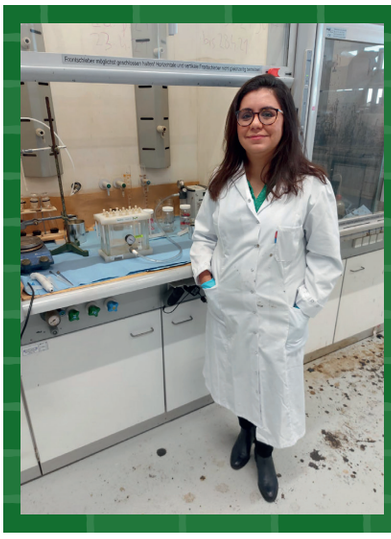
My research during SaferUP! was the first time I worked with sensors and equipment for bicycles, and also working with specialist software. For example we built a 3D model of Stockholm streets for the bicycle simulator, including reproducing the traffic to test different scenarios.

I liked working in different environments for my research. For example, while my thesis was based in France I spent six months in Stockholm at RISE, the Research Institutes of Sweden. It was a great opportunity to build bridges with researchers there. I also spent time with an NGO in Madrid called FONCE. There I focused on the behaviour of special needs road users; for example, wheelchair users and how they interact with cyclists, to understand how to improve the infrastructure for both.

Future goals

I would like to continue in academia and expand to road safety in general. Right now, my priority is to finish my PhD and apply to some universities and research institutes, who have already said they are interested in my work.





Research

My SaferUP! project aimed to enhance the durability of urban roads. In the first initial study, we observed that oxidative aging might be one of the leading causes of the hardening of asphalt binders. So for the following studies, we focused on the use of antioxidants in binders. Then in the last study, we observed that one of the antioxidants that we used showed significant potential to restore the properties of reclaimed asphalt (RAP), improving the recyclability of RAP binders.

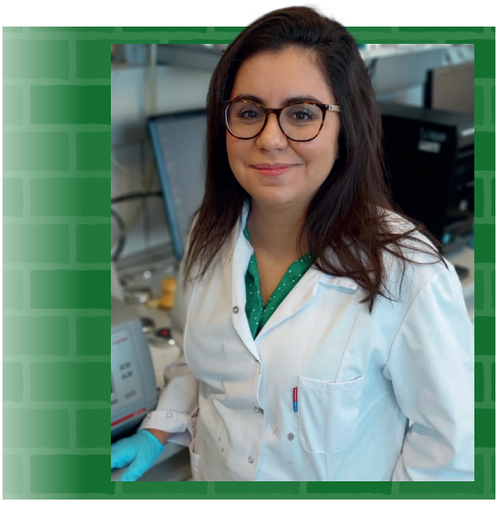
I am interested in using RAP in urban construction because if you reuse material, you reduce the pressure on new raw materials. Then it can save energy, reduce the emission of greenhouse gases, and minor traffic disturbance due to maintenance. Consequently, it will improve the quality of life of people.

SaferUP! skills

I think the project improved my skills a lot. It opened the opportunity to work with the Marie Curie Alumni from Austria and interact with other scientists. It's really open and then the chance to go abroad, for example to the US to do my secondment. I also got a lot of knowledge not just for me, but also for the laboratory - we adapted some of the methods I had to develop in the US, and now they can use that knowledge too. I think it's good not just for me but also for all partners of SaferUP!

Future goals

There is the possibility apply for grant funding, but it is still open. But I would love to check the feasibility of using the additive to restore the properties of RAP binders at the mixture level. If it works well, I would also go for the field test itself.



Ingrid

CAMARGO

"It's a small parcel that we can do in our field to improve the quality of life of people

Octavio Zamudio

LOPEZ

I believe that cities, citizens and the environment are indescribably knotted organisms

Research

Planning for cities that foster wellbeing requires a better understanding of how our bodies react to different environments, and to consider how urban infrastructure may contribute to mismatch diseases. I am using computer simulations to investigate the possible long-term effects in knee cartilage caused by walking on hard surfaces like concrete. My research project is a unique intersection of techniques and theories from civil engineering, urban design, biomechanics and human evolutionary biology.

The main problem is the lack of evidence to determine if concrete surfaces, compared with impact-absorbing ones, interact differently with our bodies in long-lasting scenarios. We are attempting for the first time to develop a computational framework to evaluate different surfaces from a long-term musculoskeletal perspective away from the medical field, where patient-specific models are the norm.

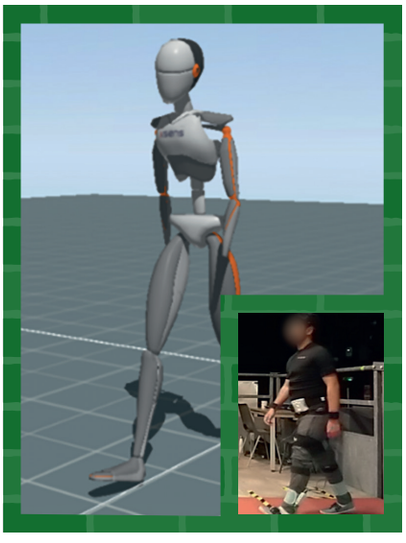
I believe that cities, citizens and the environment are indescribably knotted organisms, whose entanglements are starting to be exposed in different ways. We need to understand if these new concrete savannas, land of the "homo-civitatis", affect our health, and if so, how.

Background

This study is an amalgamation of my interests in transport, specifically active modes and accessible design, and personal interest in lifelong wellbeing. This opportunity was perfect for me, and working with Prof Nick Tyler and the team from UCL's Centre for Transport Studies, PAMELA (now PEARL) have convinced me that there is too much work left to do.

SaferUP! skills

During my time in SaferUP!, I was able to learn skills on motion capture systems and musculoskeletal modelling. The doctoral skills development programme and the project offered me a comprehensive list, community outreach, entrepreneurship funding, academic module design, grant writing, creative thinking, networking with other European projects, access to the Horizon Booster Programme, participating at dissemination events, being part of PEARL's design stages, and an invaluable network of like-minded researchers to work with!



Future goals

I'm interested in collecting and analysing data from natural surfaces and terrains, and exploring the possibilities of using longitudinal data. Also reaching out to other evolutionary biology institutions and departments, and creating a dissemination and outreach programme to work on the topic at policy-making levels. I would like to see policy-makers take an active stance on this, and enable the implementation of new infrastructure oriented to support and promote wellbeing for all ages, as per the SDG3.

Background

The pavement engineer in me hates cracks and potholes with a passion and has always wished that they could be filled as soon as they occur. Those wishes pertain to my vision for the future of roads, which is to see them as a safe, more sustainable asset that can be built and maintained with little human involvement.

Asphalt is the most common road paving material, but it degrades over time. As of now, the majority of repairs are performed manually, which puts workers at risk for accidents. Additionally, the repairs are wasteful and may not be consistent.

The goal is to automate these repair techniques in order to minimize human involvement. In order to achieve this, a robot will be designed that will drive autonomously through a road to detect and close cracks and potholes. In this procedure, asphalt mixtures are computationally designed and then autonomously extruded and placed using robotic arms.

Research

Our primary goal is to reduce the need for human intervention in maintaining roads. As a result of this, workers on our highways would be spared accidents while performing these dirty and exhausting jobs. Furthermore, robotic repairs would increase precision and reduce waste.

The findings from this study confirm the feasibility of full automation of crack repair and may lead to a quantum leap in automating road repair works. More interestingly, the repair robots are estimated to measure about one meter wide (the width of an arm) and will not require lane closures. Automating road repairs will eventually contribute to sustainable smart cities.

Future goals

Next, the research team intends to develop the concept from the present Technology Readiness Level 3 to Level 9 by coordinating with the EU or other interested institutions and commercial automobile companies. It would also mean getting a professional opinion on both technical and non-technical concerns and incorporating them into the technology development process. Regulatory/ policy evaluations and professional perception evaluations are also required.

Frank Kofi Asamoah

AWUAH

> *This study ... may lead to a quantum leap in automating road repair works*

Ioannis

KOUSIS

Urban overheating is the tip of the iceberg

Research

My main field of my studies covers overheating within urban environments, and how we can mitigate it by applying cooling materials to the urban pavement infrastructure. By that I mean materials that can maintain a lower superficial temperature during hot periods of the year compared to conventional materials like asphalt or concrete.

One area of my research is creating novel pavement materials that can reject solar radiation while incorporating waste, recycled or eco-friendly materials. Another part is how we can efficiently evaluate these materials among research groups; how you can perform an efficient in-lab, experimental campaign, and then go to bigger scales, and implement these materials in a real life, interurban scale. To do that, we have to develop common monitoring protocols. The results of each study are not comparable because each research group follows its own protocol, so a comparison analysis would be prone to biases. I am seeing how to create an efficient monitoring protocol for each scale of experiment.

Background

I had a very passionate professor on this topic during my bachelor years, who talked about how we can mitigate urban overheating in cities. These lectures made me passionate about how we can mitigate or adapt solutions against climate change on a city-wide scale. I think it's an interesting topic in general since the results can be seen quite easily. Unfortunately, urban overheating is the tip of the iceberg, because at the same time there is air and noise pollution, and in some cases also light pollution in many cities worldwide.

SaferUP! skills

For the first time we early stage researchers learned how to collaborate with industry. Typically, a researcher is like a dreamer, let's say; it's quite easy to think and set goals that may or may not succeed, but these goals can always change. When it comes to industry, things are more fixed. You have to think within limits, but you evaluate better your way of thinking and your results. And in the end, you become a better scientist. This project gave that experience to us.

Future goals

For the moment, I really enjoy being between industry and academia. I also think there is a lot of potential for this research because we will someday be obliged to incorporate waste or recycled materials into paving infrastructure. So, depending on the regional demand and supply, we can target different waste materials. It's something that's really simple and cost effective.

Background

Before my undergraduate studies, I had the experience of visiting construction sites and observing different construction stages from foundation to service, as my father was an architect. Throughout my undergraduate and then my graduate studies, my interest was more directed towards civil engineering materials and later on to mechanical engineering through participating in different research projects. I believe that the knowledge of engineering gives us the power to invent and build systems that can tackle real-life issues and improve the quality of life, and that is exciting.

Research

In the SaferUP! network, my project was 'Energy Harvesting from Road Pavements.' In this project different possibilities of harvesting energy from roads were investigated and eventually a mechanical system to convert the wasted kinetic energy of the road to electricity was invented.

I was focused on inventing a system that could provide sustainable and on-demand energy to the low power facilities of smart city infrastructures. It is crucial to ensure that the performance of these infrastructures is not interrupted due to power shortage or their location in off-grid areas. It is also essential to consider a sustainable and environmentally friendly power source for smart city facilities and devices.

My project addresses this issue by designing and demonstrating a new power harvesting device that can convert the wasted kinetic energy of the roads to electricity. This device can be implemented on most urban roads and is compatible with both low and high-speed range of vehicles, providing enough and on-demand power to run the smart city devices such as LEDs and sensors in real-time.

SaferUP! skills

Prior to SaferUP! project, my expertise was in cement and concrete materials. Through working on my SaferUP project, I had the chance to learn mechanical design, simulation (finite element and motion), coding and basic electrical engineering. I also learned about Life Cycle Assessment and pavement materials.

Future goals

The future step of this project is to prepare the harvester for a field demonstration and studying the harvester for its fatigue and creep properties under different traffic loads. Further steps are developing it for different pathways and traffic zones and studying the vehicle- harvester interaction to estimate a realistic life span. Each harvester unit currently provides enough electricity to run low-power devices; however, there is also the potential for further and larger-scale applications such as illumination.

The harvester has a great potential to be commercially available for large scale production and implementation in different urban zones. It has a compact design with a simple production process. It also addresses a crucial issue which is providing sustainable energy to devices and features of smart cities, which are developing and employing more sophisticated features every year.

Niloufar

ZABIHI

Engineering gives us the power to invent and build systems that can tackle real-life issues

Mukul

RATHORE

I believe that cities, citizens and the environment are indescribably knotted organisms

Research

In this project, my main work was to improve asphalt recycling methodologies. One part was to improve the recycling methodologies, and the other part was to increase the content of recycled asphalt. We are actually using a lot of recycled asphalt, but not in great proportions. For example, now we are using 20 to 30%, mostly the top asphalt layer - but in our research, we focused on using 100%.

We have a method for the conventional asphalt mixtures, but not for the recycled ones. We thought we should have a unique method that would be specific for reclaimed asphalt mixtures so that we can be able to compare different mixtures using a better index and more accurate indicator of the performance.

Background

When I was working in India, we were already doing some research with asphalt recycling, and I was reading a lot of papers from other countries. My current PhD supervisor (Martins Zaumanis) is really popular in this field. When I found out I would get this opportunity to work with him, I got really interested in this project.

SaferUP! skills

I come from a civil engineering background, but there are a lot of different aspects. When we deal with asphalt, we look into the chemistry of our material, which is something which I was not aware of before coming to this project. There are a lot of people in the SaferUP! consortium whom we could go to for testing materials. The people from the chemistry field helped me a lot in my research. It was a great opportunity in terms of networking.

Future goals

My next focus is to develop a tool which can actually be implemented in industry. I think we can increase the amount of reclaimed asphalt, but it will not be effectively optimized. I think we need a lot of more demonstration of our technology, and not just in terms of research papers; we need to understand the main reasons obstructing use of high recycled content mixtures. We need to conduct lifecycle assessment studies that are actually important to see the benefits. Those studies will help policymakers to increase the recycled content in the mixtures.

If we work more on this, we can develop more methods and make it widely used in the asphalt industry. A lot of asphalt producers are okay with having uniformity in their asphalt mixtures. Creating a tool will allow them to test and rank these recycled asphalt mixtures, which will make recycled asphalt uptake a smoother process.

Research

My field of study is developing and characterising smart self-sensing pavement materials. Smart materials are multifunctional materials that can assess the condition of roads and pavements, including cracks, imperfections, and strains inside the material.

Preventing catastrophic failures on road infrastructures requires regular monitoring, but this requires a lot of labour force and instrumentation costs. Weigh-in-motion (WIM) is a practice of traffic monitoring, but the off-the-shelf systems are expensive and delicate.

I'm developing a sustainable WIM system where the traffic load sensors are the pavements made of smart material. My research uses an optimised amount of carbon-based particles to create smart composite pavement materials for increased self-sensing performance. When attached to a dedicated electrical circuit, the smart material generates voltage signals that transmit information about these aforementioned conditions. Regular pavement materials are not effective for this monitoring technology, so they need to be mixed with conductive particles.

Benefits

The outcomes of my research revealed that the system can minimise the instrumentation costs, maintain the accuracy, can operate at low energy demand, can function under various environmental conditions and the environmental impact can be low. The system is suitable for widespread use in the cities and therefore more accurate service life assessment can be made for road infrastructures.

The research findings can be quite competitive in the market, especially if considered the costs are dramatically low and the sensing material has high durability since it is a smart composite made of regular pavement material.

Background

Throughout my studies, I have been interested in multidisciplinary engineering fields rather than focusing on one. Developing sensors made of smart structural materials includes material science, civil engineering, software-hardware development, and sensor communications. The novelty of the topic, the technology's potential, and the possibility of creating something new that may influence future cities were strong motivations to work in this field.

SaferUP work

It was an extremely fruitful time for me during the SaferUP! project. I developed the skills and experience of working in an international environment, and also the skills required for systematic research and dissemination. Working with my colleagues from various research topics expanded my horizons toward new research areas and possible future collaborations.

Future goals

My next research aim is to receive the necessary licensing for the developed products and make them commercially available. It would be a nice achievement for me if people get benefits from my research outcomes.

My research goals are now to make the material production simpler and easy to repeat, reduce the cost of the sensing and data acquisition systems, increase the accuracy of the load and condition estimates, reduce the environmental impact, and make the sensor communications and sensing networks for smart pavements more efficient.

Hasan Borke

BIRKIN

Throughout my studies, I have been interested in multidisciplinary engineering

Abbas

SOLOUKI

> *Our next generations most definitely will see and feel this*

Background

During my studies I really liked civil engineering, though when I looked around, I felt there were too many others looking to make tall, anti-earthquake skyscrapers and all that stuff. That's why I chose to be a highway and transportation engineer - to have more opportunities. And then I started liking it more as I went along.

Research

My SaferUP! research was an industrial PhD, because I was directly linked to SAPABA, the company at which I'm working and studying. It has an asphalt and aggregate plant with local limestone quarries. During the washing process dirt, dust and mud particles from the aggregates are collected into settling tanks, so the water can be reused for washing. After a while, silt builds up and is pumped into sedimentation lakes 100 to 200 meters away from the plant.

My job was to find novel ways of introducing silt into asphalt pavements. I started with making and recycling them to cement and concrete paving blocks, and then engineering geopolymers –they can give you the same properties of cement but even better. We made porous pavements and then we filled the material with the geopolymers to make them stiff so they behave and act better than normal pavements.

If we don't recycle now, we won't start learning improve the process. The sooner we start, the sooner it will pay off. Maybe we will not see it, but the next generations most definitely will see and feel this knowledge that we've put out to the world.

SaferUP!

The SaferUP! project just by itself gave us the chance to be friends with 15 like-minded scientists, which then led to a lot of collaborations. I was also able to work on my presentation skills, the networking, and engaging in social networks. We had training programs to either tell our story in 30 seconds or three minutes. All of those were special things that one may not get in a normal PhD.

Future goals

I would really love to stay in academia and continue working on this asphalt that I have worked on during my PhD. The geopolymer section that I got introduced to during my PhD is really fascinating, though convincing people to use this and promoting it is quite hard and challenging.

Sergio Copetti Callai

High Friction & Acoustic Surfacing for Pavements (Hi-FASP)

Mayara Lima

Sustainability Potential Of Innovative Urban Paving Materials (SustaIM)

Arsel Inestroza Mercado

Safer Hydronic Urban Pavements (SaferHP)

Anik Gupta

Resilient And Sustainable Permeable Pavements For Urban Flood Mitigation (RePP4FM)

Christina Makoundou

Vulnerable users protection with advanced recycling paving materials (PROTECTVU)

Alireza Fathollahi

Assessing Environmental Suitability Of New Permeable Pavements In Sustainable Drainage Systems (EnviSuPP)

Murad Shoman

Effects of road surface characteristics & geometries on safer users' behaviour (SaferUB)

Ingrid Camargo

Enhanced Durability Of Bituminous Layers By Studying Binders' Microstructure (DuraBM)

Octavio Zamudio Lopez

Accessible urban surfaces (AccessUS)

Frank Kofi Asamoah Awuah

Robotic Fast Repair Of Asphalt Concretes (RoboFRAC)

Ioannis Kousis

Cool Pavements For Urban Heat Island Effect Mitigation (CoolUM)

Niloufar Zabihi

Energy Harvesting From Road Pavements (NrgHRP)

Mukul Rathore

100% Recycled Asphalt (RA) For Urban Surfaces (100%RAUS)

Hasan Borke Birgin

Nanotechnologies For Self-Sensing & Self-Inspecting Smart Urban Pavements (NanoSUP)

Abbas Solouki

Waste Mineral Filler Recycling In New Pavement Solutions (WasteRP)

CONTACT

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Beneficiaries

Partner Organisations

This project has received funding from the European Union's Horizon 2020 research and innovation program under the Marie Skłodowska-Curie grant agreement Nº 765057