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JULY 4TH • AllEnvi 2016 scientific encounters. Climate, energy and environmental transitions for a sustainable planet, at the CNRS Auditorium (Paris 16).  
http://www.allenvi.fr/actualites/2016/rencontres-scientifiques-d-allenvi

JULY 7TH – 8TH • 17th edition of the (RF)²B scientific days. French-speaking group for research and training on concrete, at IFSTTAR’s site in Marne-la-Vallée.  
http://www.rf2b.org/fr/reseaux-rf2b/journees-scientifiques.html

JULY 10TH – 13TH • ESB 2016 congress. Major event in Biomechanics, at Cité des congrès of Lyon.  

SEPT. 2ND • IENE 2016. 5th International Conference on Ecology and Transports, in Lyon.  

NOV. 9TH • Assessment of Road Safety Policies. In 2016, CEREMA and IFSTTAR will jointly organise a seminar, with the support of the French Ministry of Interior’s road and traffic safety, Paris.  

NOV. 21ST – 23RD • Entretiens Jacques Cartier: Colloquium on road safety. The Entretiens Jacques Cartier colloquium is back with a new edition hosted in Lyon.  

IN BRIEF

TAP 2016: AIR POLLUTION RESULTING FROM TRANSPORT UNDER SCRUTINY IN LYON

The 21st TAP 2016 International Transport and Air Pollution Conference was held between May 24th and 26th at the Ecole Normale Supérieure (Lyon - France). Organised by IFSTTAR and more precisely by the Transports and Environment Laboratory (LTE), this new edition gathered some 270 participants from the five continents. The theme of TAP 2016 was “Towards energy transition and cleaner transport” and their implication to air quality. Bearing in mind the environmental and climatic challenges, in particular the impacts of pollutant emissions, and in the aftermath of the COP21 Conference held in France together with the context of “Dieselgate”, air quality issues are more than ever top of the agenda. To that effect, delegates came to share their thoughts about transport-related pollutants, exhaust and non-exhaust emissions, control and technologies systems, energy consumption, greenhouse gas emissions, transport policies and mobility. Different actors from research organisations, automotive industries, legal institutions (European Commission, the World Bank, the French ADEME, public authorities, etc.) exchanged knowledge on the latest developments in terms of light-vehicle emissions, government decisions improving air quality in urban and sub-urban areas, energy transition, new fuels, abatement devices and technologies, urban traffic management, technological implementation…

The next edition should take place in two years’ time in Switzerland and will be organised by the Swiss Federal Laboratories for Materials Science and Technology ‘EMPA’ (Eidgenössische Materialprüfungs- und Forschungsanstalt).

Transports were one of the central themes at COP21

COP21 has been an opportunity for IFSTTAR to showcase its recent achievements in the field of transport-related research. New cooperation networks have been established with a view to European and global collaborative projects.

The UN climate conference held in Paris last December 2015 culminated in the signing of a milestone binding agreement for all 195-member countries. The stated objective was to contain temperature rise below 2° C and further aim for a 1.5° C cap. The agreement provides for setting up several mechanisms, among which funding, for different areas including transportation and research. In Europe one fourth of greenhouse gas (GHG) emissions are connected with the transport sector, which all the more emphasises the need to find practical and effective solutions to curb them, a long-time goal of IFSTTAR’s.

Upstream from this COP, as early as July 2015, the Institute invited its partners around ETRA (European Transport Research Alliance) to take part in a “Transport, climate change and research” workshop sponsored by the CFCC15* conference, and a number of parallel sessions. On 13 November, IFSTTAR organised a colloquium on the National Climate Change Adaptation Plan (PNACC) for transport systems and infrastructures. It also took part in the World Summit on Climate and Territories. During COP21, several IFSTTAR representatives took the floor on various themes such as Roads of the Future, sustainable mobility, the City of Tomorrow. Several solutions were thus presented: positive-energy roads and railway stations, petroleum-free roadway binders, concrete used as carbon sink, mobility and alternative energies, etc.

“We were able to showcase our solutions, compare them with international best practice and thus contribute to achieving objectives,” commented Paulina Potemski, project head for European networks at IFSTTAR. “We also reinforced cohesion and cooperation with the other European research institutes.”

Our goal is now to articulate these actions in the medium- and long-term by building on our leading areas of climate research within new international networks in particular through the World Road Association (PIARC), and the World Association for Waterborne Transport Infrastructure (PIANC).


QUESTION TO

JEAN-BERNARD KOVARIK, Deputy Director-General of IFSTTAR

AMONG YOUR PROJECTS WHICH ONES IN PARTICULAR COULD CONTRIBUTE PRACTICAL SOLUTIONS FOR THE CHALLENGES OF ENVIRONMENTAL, ENERGY AND CLIMATE TRANSITION?

There are many potential solutions to explore: “positive-energy roads”, “positive-energy railway stations”, processes and infrastructure life-cycle analysis, new fossil-hydrocarbon free binders for roadways, electric-, driverless and communication-enabled vehicles, new mobility solutions for people or the concept of “physical Internet” for freight activities …

Let’s take the example of recycled concrete: the huge potential of this carbon sink is still pretty much unknown. We are developing a process to speed up the (natural) phenomenon of cement recarbonation in concrete. By mainstreaming the recycling of concrete and with this new technique, in France it would become possible to capture and store some fifteen million tonnes of CO2 per annum. This is equivalent to a 10% reduction of GHG emissions in transport.”

* Positive energy road is one of the components of the 5th generation Road
Focus on non-destructive evaluation

Since 2013, IFSTTAR has shared its expertise in this area.

Non-destructive evaluation (NDE) is in a constant state of renewal. Its aim is to develop technologies – instrumentations, physical methods, information processing, aid-to-decision tools – to help determine, actively or passively, the condition of an infrastructure without altering it. Many of the tools developed in laboratories are still little known or under-used. Since 2013, R&D in this area has been fostered and structured within the NDE GERi (IFSTTAR’s Research and Discussion Group). “This group brings together representatives of three of the five IFSTTAR departments*. It was set up in order to make available all of the Institute’s expertise to those in charge of a project”, explains Odile Abraham, co-chair of the GERi steering committee. It also helps giving more external visibility on IFSTTAR’s work thanks to the annual sessions devoted to NDE innovations in civil engineering and welcoming industrial players. The latest of these was organised on 15 March 2016 and attracted some fifty specialists at Nantes’ site. The participants were able to take stock on the latest advances in the area of sensors as well as for various physical methods suitable to identify or monitor the possible degradation of an engineering structure: radar, ultrasound, electrical…

* COSYS (Components and Systems), GERS (Geotechnical engineering, Environment, Natural hazards and Earth sciences) and MAST (Materials and Structures).

NGV or diesel: making the right choice

As part of an on-going experimentation project, IFSTTAR has been developing an aid-to-decision making tool for transportation companies.

An experimentation project aimed at assessing the potential benefits of switching a fleet of lorries to natural gas has involved two IFSTTAR laboratories since last February: Transport and Traffic Engineering Laboratory (LICIT) and Transport and Environment Laboratory (LTE). This forms part of the Équilibre project conducted and funded by six road freight transport SMEs which monitors the movements of fifteen vehicles across three regions (Rhône-Alpes, Provence-Alpes-Côte d’Azur and Switzerland): nine full gas lorries, one dual fuel and five diesel ones. The idea is to compare their performance, both in terms of economics and environmental impact (CO₂ and NOx emission).

This operation, coordinated by Pascal Megevand from Megevand Transport, one of the partnering SMEs, has received support from ADEME (French Environment and Energy Management Agency) and GrDF which supplies the gas from its network of stations in the Rhône valley and Lyon. “Based on the measurements made by CRMT*, which equipped the lorries with sensors, the operating data collected by Truckonline* plus traffic, topography, meteorological and other information such as on NGV composition, we develop an aid-to-decision making tool that objectivises the use of NGV for road hauliers, as Nour-Eddin El Faouzi, director of LICIT explained to us. Haulage contractors will thus be able to determine in advance which type of vehicle is best suited for a given type of freight mission.”

* CRMT and Truckonline are two partner laboratories for this project.
The question of seniors driving

The SafeMove project sheds light on several aspects of seniors driving after the age of 70. Amongst other things it has highlighted the benefits of some technological aids such as lane change support.

Drivers above the age of 70 are not responsible for more accidents than others. However, some of them do overestimate their capacities when in actual fact the latter tend to diminish with age. Other drivers, on the contrary, underestimate their capacities and unnecessarily restrict their car usage. Can seniors be helped in properly evaluating their own driving capacities? Can any form of training help them improve such capacities? This was the focus of the ANR SafeMove project jointly conducted with a Swedish team. “This project had three goals: to establish whether there was a link between the seniors’ estimated cognitive capacity and their perception of their driving capacities, to improve their driving performances through cognitive training, and lastly to evaluate the potential benefits of technical driver assistance systems”, explains Claude Marin-Lamellet, project coordinator. This project, which involved some 1,200 seventy-plussers, showed that some seniors do overestimate their cognitive and driving capacities, while others do the contrary. Finally it was also demonstrated that cognitive training can improve the perception people have of their own cognitive capacities.

On the technological side, seniors praised the use of navigation aids, speed control and lane change decision aid systems.

Claude Marin-Lamellet, claudemarin-lamellet@ifsttar.fr

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Bicycle + train: the winning combination!

Riding one’s bike to the station reduces car use in suburban areas. Provided a few aspects are accommodated…

Bicycle is the ideal complement to train for home-to-station or station-to-workplace journeys, when the distance involved is below 5 kilometres (namely 20-minute rides approximately). This is the alternative usage of bicycle that was studied by the VERT* project, looking more specifically at suburban territories where train users may be far away from the nearest station. “The economic savings of using bicycle as an alternative mode would be € 2,000 per year per commuter versus car usage, says Francis Papon, head of the Economic and Social Dynamics of Transport Laboratory (DEST). The community would save € 500 on the cost of parking, while the user would save € 1,100 by not having to own a second car and € 400 in terms of health benefits by practising physical exercise daily.”

IFSTTAR’s researchers honed in on the region of Amboise (Val de Loire), by interviewing the local stakeholders, in particular the municipalities and SNCF (national railway operator). They also observed the behaviour of users and interviewed some of them. The aim: better understand how to promote bicycle as an alternative mode. “We realised that the key factor was to ensure the safety of both the itinerary and parking at destination”, highlighted Francis Papon. Municipalities and SNCF now both know what remains to be done…

Francis Papon, francis.papon@ifsttar.fr

* http://www.predit.prd.fr/predit4/projet/45150
In Montréal like in Marseille, the teams work in a hospital environment. The strength of our structure lies in the fact it brings together various partners who can rely on our infrastructures and local networks. This multidisciplinary cooperation between engineers, biomechanics, imaging physicists, surgeons and industry specialists is extremely rich: it provides access to the patients clinical data, to experimental data on animals and data from our industrial partners. But it is also about a friendship. I met Pierre-Jean Arnoux over ten years ago. As we were already both working on spine biomechanics we decided to set up a post-doctoral internship. Over the years we developed a unique platform of expertise around spine modelling. This platform has already trained 10 doctoral students, 8 post-doctoral and 9 masters’ students.

**Users safety**

In the field of transportation, and more particularly for motorcyclists, “we contribute to the development of neck and back protections up to the implementation of evaluation standards for such devices,” points out Pierre-Jean Arnoux, deputy director of the Laboratory of Biomechanics and Application (LBA) in Marseille. We also helped an aeronautics equipment manufacturer in the design of new aircraft seats optimized for the spine curves.” In the area of sports performance, the researchers have developed harnessing systems for acrobats (Cirque du soleil) and specific systems for slidding sports (ski, skeleton).

“From a clinical point of view, our work concerns the handling of victims, with new spine immobilization devices, he goes on to say. Last but not least, we have developed emblematic surgery simulation tools allowing specialists to plan the various steps in spine surgery.” These tools can already enable surgeons to improve their surgical planning and strategies.

**iLab-Spine, a new laboratory of excellence on both sides of the Atlantic**

iLab–Spine conducts research on imaging, modelling and biomechanics with its main focus on the spine and spinal cord. Objectives: to better understand spine diseases and traumas, prevent them and improve their treatment.

Dual inauguration for iLab-Spine! In October 2015, at the headquarters of Aix-Marseille University and, in June 2016, in Montréal with both the French and the Quebec prime ministers. This “laboratory without walls” brings together researchers from the École Polytechnique, the University Hospital Center Sainte-Justine, the École de technologie supérieure (ETS, Montreal), the Sacré-Cœur hospital on the Montreal side, and on the French side researchers from the Assistance publique-Hôpitaux de Marseille (AP-HM), CNRS, IFSTTAR and Aix-Marseille University. iLab–Spine has received the support of the initiative of excellence A-Midex*.

The purpose of these researches is to better understand the biomechanics and physiology of spine and spinal cord diseases, in order to improve the treatment of injuries incurring in transportation systems, during sports or domestic accidents, etc. It also aims to prevent the emergence of ageing pathologies or deformations such as scoliosis. Beyond the incapacities the latter may cause, these traumas are responsible for very high treatment costs.

**QUESTIONS TO CARL-ÉRIC AUBIN, Professor at École polytechnique in Montréal, researcher at the University Hospital Center Sainte-Justine. Mr Aubin holds both the Canada Research chair for orthopaedic engineering and the NSERC/Medtronic Industrial Research Chair in Spine Biomechanics.**

HOW HAS THE I-LAB-SPINE SECURED A KEY STATUS IN THE FIELD OF SPINE BIOMECHANICS AND IMAGING?
BETTER PROTECTION FOR OUR RAIL INFRASTRUCTURES

Very easily accessible, used by millions of passengers, and increasingly connected... our rail infrastructures are an ideal target for terrorist, criminal and other anti-social actions. Against these threats IFSTTAR researchers are investigating multiple solutions.

Railroad infrastructures are not only about the rail tracks used by freight or passenger trains. They also include the catenaries powering them from the energy grids, the stations where they stop, the wireless radio systems and aerials they use for intra-communications or communication with the control centres, etc. These are as many critical links in a complex chain system and liable to severe damage during extreme weather events... but also when targeted by terrorist attacks, criminal actions and other misdemeanours. Faced with these multiple potential threats, IFSTTAR scientists are exploring various solutions: detection and alarm systems, ultra-high resistance high-tech materials, smart and reconfigurable means of communication, etc. All the areas of research share the same purpose: increasing the resilience of railway infrastructures.
HST LINES: PREVENTING TERRORIST ATTACKS

HST lines rank among the top potential targets of terrorist attacks. Security systems such as checkpoints, luggage scans or ticket checks at platform level are beginning to be implemented in certain places like at the Gare du Nord (Paris). But in order to maintain their efficiency, high-speed railways need to remain “open” systems, i.e. with multiple points of access to the train and with smooth passenger flow. What are the best solutions to meet these seemingly contradictory requirements: “secure traffic with no congestion”? This is one of the challenges the French-German project Re(h)strain has chosen to embrace. On the German side, the project is steered by the Munich University while on the French side IFSTTAR has teamed up with the Armines-Ecole nationale supérieure des mines of Alès. “Launched at the end of 2015, this project is funded by the French national research agency (ANR) and its German counterpart BMBF. Its aim is to reduce the risk of terrorist attacks on the French-German high-speed railway network... and the impact of such attacks, if unfortunately they did materialise”, confides Monssef Drissi-Habti, assistant director of IFSTTAR’s Components and Systems department (COSYS), and also head of the scientific interest grouping on the sustainability of smart structures (DURSI) and co-pilot of the Re(h)strain project, on the French side.

For instance, the researchers are developing smart composite structures containing light and ultra-resistant nanomaterials capable of resisting an explosion or a fire. They are also stuffed with sensors of all kinds to detect the presence of toxic gasses even in minute concentrations. Gasses that may leak out from explosive devices, or so-called “dirty” bombs packed with chemical, biological or radioactive substances. The idea is to incorporate these “structures” in strategic components of the HSTs: access doors to the coaches, passenger seats, toilet doors or bowls, tables in the restaurant coach, etc. In terms of prevention, as support to security forces in the event such gasses are detected, sensors would send an alarm to the competent authorities. This solution would avoid individual searches on each passenger, as is done at airports, a time-consuming practice unlikely to promote smooth railway traffic. “Expected for the end of 2017, the findings of Re(h)strain will lead up to recommendations to bolster the security of the French-German high-speed railway network, while allowing for the specifics of both countries”, concludes Monssef Drissi-Habti. These recommendations could go as far as formulating a field implementation strategy, factoring in the various economic, regulatory and societal requirements.

Illustration of the use of smart composite structures that are bi-reinforced (by continuous fibers and carbon nanotubes). These structures have embedded sensors and they are installed in strategic and well-defined locations of a high-speed train. They can detect harmful substances (chemical, radioactive, bacteriological...). The basic concept is the support of the security forces with a discreet warning, without triggering an alarm.

1 The main French partners are the Central Laboratory of the Préfecture de Paris and Efectis.
2 Bundesministerium für Bildung und Forschung, federal ministry for Training and Research.
COMBATTING CYBER-ATTACKS

These attacks may also be of the electromagnetic sort, i.e. attempts to scramble the trains’ communication systems, for it is true that in railways an increasing number of functions are reliant on wireless communications: instrumentation and control system, internal operations check, signalling, track monitoring, maintenance, etc. The railway network’s extensive scope and easy access further compound its vulnerability, which the harmonisation of wireless communications between trains currently being deployed at European scale will do nothing to offset. By scrambling these communications, malevolent individuals (terrorists, thieves, activists) may delay trains, if not altogether bring them to a complete halt in between stations in order to mug passengers in the manner of a 21st century postal coach attack. And looking beyond the threat of simple scrambling, one cannot rule out the sophisticated electromagnetic attacks that might one day enable wrongdoers to take control of a train and perhaps cause it to derail or in other ways provoke accidents. We are not there yet but it is worth recalling that a few years back, in Poland, a young man had managed to actuate the rail switches with a remote control!

“To fend off these very real cyber-threats, IFSTTAR joined in the European project, Secret, which came to completion in 2015”, points out Virginie Deniau, who steered this initiative from the Laboratory on Electronics, Waves and Signal Processing for Transport (LEOST) of the COSYS department (IFSTTAR, Lille). In a first stage, the researchers evaluated various types of tests measuring the interference susceptibility of the train’s key components in the event of electromagnetic attacks of diverse intensities. They also identified the most likely attack scenarios, taking into account the different profiles of hackers and the type of scrambling equipment known to date. The project also evaluated some fixed and mobile instruments used for detecting malevolent electromagnetic scrambling. “More importantly, the teams of Secret have developed a communication architecture capable of withstanding malignant scrambling by reconfiguring after detection of said scrambling”, she points out. Based on various algorithms and sensors, this architecture, as soon as it has detected an attack on a communication link switches it over to another frequency and informs the control centre thereof. More generally speaking, Secret suggests some forty avenues to be explored in order to better prevent, detect and mitigate the impact of electromagnetic attacks: nature, number and positioning of antennas, size of the radio cells, electromagnetic insulation of the train coaches, methods to test the strength of certain components versus electromagnetic attacks, frequency hopping, etc. “The research conducted in the framework of Secret could also prove instrumental for all other transportation modes where wireless communications are increasingly used, and in particular in the automotive industry, forecasts Virginie Deniau. The systematic monitoring of their electromagnetic environment will also become paramount.”
SMART RADIO

It will be clear by now that wireless communications have become a strategic component aboard HSTs, with various types of needs that have brought about a multiplication of heterogeneous communication networks oftentimes incompatible with one another. In the Ile-de-France region alone, a dozen networks have been deployed; and the bottom line is an overloaded frequency spectrum that causes much interference, but also degraded performances. Moreover, because of their lack of flexibility and frequency availability, some of these networks have already grown obsolete, such as the GSM-Railway used for the instrumentation and control system of high-speed trains. And things should not be improving with the estimated trebling of high-speed railways forecasted by 2030.

“In the framework of the ANR Corridor project steered by IFSTTAR, we have evaluated a solution, called Smart Radio, to address this problem”, adds Marion Berbineau, deputy director of the COSYS department at IFSTTAR and project coordinator. It is based on a new type of wireless communications capable of monitoring the electromagnetic environment of the train in order to detect radio frequencies remaining unused on existing networks and autonomously reconfiguring their operational parameters, which experts call “spectrum sensing”. And even better than this, as it is constantly observing the spectrum, the system memorises the slots most often available at a given time of day or place. The system is also capable of detecting malevolent signal transmissions. Electromagnetic attacks or scrambling on an over-solicited network, ground antenna damaged by bad weather, power failures over a given area: all these are as many problems which smart radio could overcome by using available frequencies on other wireless networks. This would significantly improve the resilience of telecommunication infrastructures for high-speed trains!

“A RESEARCH AGENDA FOR THE SECURITY OF ALL LAND TRANSPORTATION SYSTEMS

Rail, roads, rivers... Where is it most urgent to conduct research to protect land transports against risks of attacks? “This is the key question which the European project Caronte has been tackling”, says Mohamed Ghazel, IFSTTAR researcher in Lille. Scientists started by analysing in detail all the risks and threats, but also existing and potential solutions including their respective rated efficiency. They were thus able to draw up a list of risks and threats that were still not covered or not sufficiently so. They went on to build up a proper research agenda listing the most urgent areas to be addressed. For example: ensuring resilience in the event of a major cyber-attack, protecting future self-driving vehicles, making passengers and staff more aware of security considerations, striking a better balance between security and privacy, etc. Disclosed last 19 February in Brussels, this agenda also aims to avoid redundant work in this area.

“Within the Corridor project, the IFSTTAR teams associated with other partners have contributed to developing six “spectrum sensing” algorithms and filed a patent for a specific ultra-broadband antenna concept”, points out Marion Berbineau. The system was tested on an SNCF test train running at 300 km/h near Chartres. It proved its efficiency in supporting high bitrates and detecting the presence of electromagnetic scramblers. Following these encouraging results the research team is now looking forward to new funding via the Shift2Rail programme, the new public-private funding platform for railway research in Europe. Lastly, beyond high-speed railways, smart radio could also prove instrumental in cutting the infrastructure costs for the telecommunications of regional lines. Some would even consider implementing it for other transportation modes: automobile, air, etc. To be continued!

Read also “wireless technology, more integration” - Sept. 7th., 2015: http://www.internationalinnovation.com/wireless-technology-more-integration/
VEDECOM and IFSTTAR on the same track

With several researchers made available, doctoral and post-doctoral students, plus facilities and shared premises, IFSTTAR is one of the major public partners of the VEDECOM Institute, which specialises in individual, carbon-free and sustainable mobility.

IFSTTAR is heavily involved in VEDECOM, a partnership foundation conducting research in the area of electric vehicles, self-driving cars and connected infrastructures and services. Several IFSTTAR researchers were thus seconded to this institute: three are from the Laboratory for Vehicle Infrastructure Driver Interactions (LIVIC) and work on self-driving cars, and two others come from the Laboratory of New Technologies (LTN) and focus on vehicle electrification. The latter are in particular involved in the European Fabric project to develop dynamic contactless charging stations (up to 80 km/hr) for all types of vehicles. This system is currently being installed at the Versailles-Satory site, where VEDECOM has just inaugurated a prototyping centre (see below).

Several doctoral and post-doctoral theses are also underway, in particular on energy-efficient self-driving, a theme for which IFSTTAR (LIVIC) contributes its expertise in many topics: detection and monitoring of obstacles via laser telemetry, detection and monitoring of road marking and traffic lanes, position-tracking, fitting of prototypes with on-board sensors, data analysis, safe pathway planning, self-driving simulation prior to trials on track, impact of automation on energy consumption, etc. For the last two years, VEDECOM has been using the LIVIC prototype equipment workshop and both institutes will continue to mutualise their testing facilities. At the beginning of 2018, LIVIC will even share workshops and offices with VEDECOM inside a new building.

ANTOINE MULLENDER managing director of VEDECOM

On 17 March 2016, VEDECOM inaugurated its Centre of Excellence on Electrification in the premises offered by IFSTTAR at their Versailles-Satory site.

WHAT IS SO EXCEPTIONAL ABOUT THIS WORKSHOP?

Antoine Mullender: It gathers all of the industrial tools required to design an electric motor, from cutting out the metal sheets to motor assembly, which allows you in a record time to jump from an idea to its materialisation, integration into a vehicle and proceed to track trials on one and the same site.

HOW WILL IT BE USED?

A. M.: Apart from research, it will be available to our members and be used as a training centre and for the production of components subcontracted for SMEs or other larger businesses.

WHAT ARE THE OBJECTIVES FOR VEDECOM?

A. M.: We have set 3-, 5- and 10-years objectives in terms of the size-, weight- and cost-reduction of electric motors, amongst other things through the integration of power electronics. The other objective is to increase electric range to 500 km by reducing power consumption (air-conditioning, heat loss, etc.), optimising recharge and eco-driving.
An overview of our 2016 research

Like every year, IFSTTAR publishes its research program. This document provides a good overview of the work in progress and its organisation. It covers all aspects from research projects to major scientific events and other scientific activities.

Research institutes traditionally report on their activities in the form of an annual report or activity report. IFSTTAR is no exception to this rule. In addition to this, as per its goals and performance contract (COP), every year in March the Institute publishes an agenda for current and upcoming activities. Although this year’s document only covers one third of the projects conducted, like the previous ones, this fourth edition offers a true reflection of IFSTTAR’s scientific activity in both scope and diversity.

The document proposes a selection of research projects underway, ranging from internal projects to large crosscutting projects in partnership, in particular in the framework of Investments for the Future (ITE-Energy Transition Institute, IRT-Technological Research Institute and other Idex or Equipex). They are presented by department, based on the themes identified as priorities, and then by strategic directions*, they span various types: some result from calls for tenders (from the French national research agency, or the Single Interministerial Fund (FUI)...), others are international, European, national or regional, while others again are carried out with institutional, industrial and public partners. The document also covers some of the major scientific events held in 2016, such as the ESB biomechanics Congress** or the 8th Rilem international conference***

It should be noted that this year, the research incentive mechanisms implemented in 2013 to promote cross-disciplinary projects or address new areas, have been defined anew. Acronyms (Geri, Orsi, R2I) are replaced by actions initiated: the cross-disciplinary topics handled internally or externally within multidisciplinary scientific networks are now brought together under the heading “Networking”; cooperation actions with the scientific and technical network, and primarily with CEREMA, are entitled “Core scientific cooperation”; support to young researchers, new ideas being tested and new concepts are grouped under “targeted initiatives”. Lastly, in 2016, the scientific division wishes to engage the Institute in large-scale projects of federative nature (see opposite).

* Sustainable and responsible mobility, efficient and sustainable infrastructures, Climate change and environment, Cities and territories.
** European Society of Biomechanics.
*** Mechanisms of Cracking and Debonding in Pavements.

For details, see the COP 2013/2015 IFSTTAR: http://www.ifsttar.fr/en/online-resources/key-documents/goals-and-performance-contract/
Interview with Hussein Mouzannar
of RRO Laboratory

A doctoral student at IFSTTAR’s Rock Hazards and Geotechnical Structures Laboratory, Hussein Mouzannar works on dam resistance to sliding against rock foundation. His thesis, funded by EDF, studies the interaction between concrete and its underlying rock. He is due to defend it on 14 September 2016.

WHAT DO YOUR EXPERIMENTS LOOK LIKE?
I use “test samples” of different sizes, laboratory samples reproducing the interfaces between concrete and the rock, granite in my case. These are prepared by casting concrete over a rock block with a natural surface roughness. Each test block is placed in a “shear test apparatus”, a machine that measures resistance to shearing, by applying stresses until breaking point. The larger samples have been instrumented to better understand the failure initiation and propagation, and how the stresses are distributed. We thus inserted some optical fibers into the concrete to measure its deformation and piezoelectric sensors on the concrete surface to detect the acoustic waves and thereby identify the crack locations. Lastly, we placed a number of deformation gauges at certain precise points on the surface.

WHAT ARE YOUR MAIN RESULTS?
For the first time we have been able to experimentally confirm that shearing strength diminishes with the size of the test sample: for the same given pressure you have to apply a stress of 280 tonnes/m² in order to break up the interface between concrete and the rock with an 8-cm diameter test block, versus only 120 tonnes/m² when the sample measures over one metre. We have also showed that the undulations on the rock surface improved the shear strength at the concrete/rock interface. The test results are currently being analysed in order to model the resistance of these interfaces taking into account the rock surface undulations.

WHY ARE WE NOW INTERESTED IN THE STRENGTH OF DAMS WHEN THEY HAVE BEEN IN PLACE FOR DECADES?
The rules have changed in terms of taking into account floods and earthquakes. In certain regions, the dam operator (EDF) must be able to prove that their structures are stable, even if an earthquake or floods are more severe than initially calculated. Hence the need to review their resistance against sliding.

WHAT IS IT ALL ABOUT MORE PRECISELY?
A “gravity dam” is a concrete structure constructed on a rock foundation. With its mass it counteracts the pressure of water. In this context, I look at the way the rock foundation of the dam offers resistance to shearing, in other words the sliding movement of concrete against the rock foundation. Any failure in this foundation would release a massive amount of water downstream from the dam. I therefore focus my work on the resistance to sliding between the concrete and the rock, and this I do at different scales to consider the effect of rock surface irregularities.

AT THIS STAGE, WHAT ARE YOUR CONCLUSIONS AS TO THE STRENGTH OF DAMS?
In designing a dam, the cohesive part corresponding to concrete/rock adherence is ignored in practice. We have showed that this cohesion element does exist and is far from negligible. By taking into account the obtained cohesion value or a fraction of it, existing dams should remain stable against sliding at the concrete/rock interface. EDF will be able to make use of these results for its evaluations.

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Badifops: a “ultra-high performance” concrete project against earthquakes effects

The Badifops project, led by IFSTTAR, laid down the foundations for an earthquake-resistant design or strengthening methodology using ultra-high performance fibre-reinforced concrete. Its results have just been integrated into the new French standard.

Ultra-high performance fibre-reinforced concretes (UHPFRC) are low-porosity concretes based on a micrometric internal structure; they have been used for some twelve years. They have outstanding mechanical and durability characteristics that enable light, material-saving and sustainable structures. These qualities make it the ideal choice for the rehabilitation or design of earthquake-resistant structures. To get a better insight into their behaviour when they are associated with passive reinforcing bars, the Badifops* joint R&D project supported by the French Ministry of the Environment, was launched in 2010. Hitherto, the use of UHPFRC in buildings and engineering structures requiring earthquake-resistant design was rather limited as their ductility**, a fundamental requirement in the event of earthquakes, was difficult to quantify: no reliable method allowed predicting the cracks opening and spacing. Hence the interest of the methodology developed within the Badifops project. “For the first time, specific experiments were carried out, explains François Toutlemonde, the scientific coordinator of the project. To precisely measure the deformations with high spatial resolution within the millimetre range, we equipped the reinforcing bars with fibre optic sensors. These measurements enabled to understand the behaviour of UHPFRC and determine the basic conditions for crack control.” The methodology was incorporated into the new French standard for the design of UHPFRC structures (NF P 18-710).

UHPFRC in quake-prone areas

“We conducted several tests, with repeated or alternate loadings over a number of cycles, as happens during quakes. No degradation of the re-bars bond was noted”, F. Toutlemonde points out. To highlight the benefits of UHPFRC for quake-resistant structures, a case study was carried out on two bridges reinforced with UHPFRC (piers jacketing). Encouraged by the positive results, EIFFAGE launched a project to develop this new application of UHPFRC (see below).

*Partners: CEREMA, CSTB, EIFFAGE TP and IFSTTAR.

**Ductility is the ability of a given material or structural component to undergo large deformation (yielding) without breaking.

QUESTION TO

ALAIN SIMON, Head of Department, Division of Engineering, Eiffage Infrastructures.

IN WHAT RESPECT WAS YOUR PARTNERSHIP WITH IFSTTAR MISSION-CRITICAL?

Benefits of our partnership lies in our complementarity. We contributed our knowledge of high value-added materials in the area of construction, as well as our expertise in the design and implementation of civil structures; while IFSTTAR brought its extensive experience in experimental validation of innovative solutions. To follow up on this Badifops project, we launched the R6PONT project (bridges seismic retrofitting by UHPFRC jacketing of the piers), in order to develop this technically promising and cost-efficient technique. This project recently won the competition of the Road and Streets Innovation Committee (CIRR 2015).
Online guide for inspection and monitoring engineering structures

To determine the condition of bridges, tunnels and civil engineering works, a diagnosis is needed in every case. This is why IFSTTAR and CEREMA have published a practical guide reviewing the various diagnosis tools and methods.

Making health checks at regular intervals allows us to detect early on potential “diseases” and treat them more efficaciously. For engineering structures, this “predictive medicine” is very useful. “To manage engineering structures we need to evaluate their condition and sound them,” adds Bruno Godart, deputy director of the Mast department at IFSTTAR. But up to now there was no reference book on this. Hence this guidebook*, jointly published by IFSTTAR and CEREMA**, and meant to help all those who commission or conduct these diagnoses: contracting authorities (State, motorway operators, regions...), prime contractors, the French Ministry for Environment’s scientific and technical network, as well as testing companies, engineering firms or departments...

“Many engineering structures are subject to ageing and at the same time operating stresses are increasing, particularly with the heavier mass of lorries whose maximum load has grown from 40 to 44 tonnes, and soon 48 tonnes perhaps, as Bruno Godart points out. The use of very aggressive de-icing salts also compounds the problem.” All this makes a quality diagnosis even more crucial.

This guide, which is freely accessible on the IFSTTAR website, comes in two parts. The first part is a compilation of some hundred fact sheets, each one describing a testing method, its principle, the equipment to be used, its accuracy, cost as well as pros and cons. It’s all practical information in essence, with examples and photo illustrations. Only those methods that have been validated are included. The second part, still in the making, will dwell on the testing methods to be used for a given diagnosis. “This guide is meant to evolve over time, which is the great thing about the Internet, says Bruno Godart. The forms will be regularly updated and new ones added. On the website we have also planned to dedicate a section to answers to cybernauts’ questions.”


** Research and assessment centre on risks, environment, mobility and spatial planning.

Bruno Godart, bruno.godart@ifsttar.fr
Audrey Linkenheld, MP for the Nord region

Elected in Lille as a member of Parliament for the Nord constituency, Audrey Linkenheld sits on the Commissions for Economic affairs and European affairs of the National Assembly, at the National council for habitat and the National commission for spatial planning, town-planning and real-estate. She has been several times rapporteur at the National Assembly for a number of laws relating to housing and town-planning.

IFSTTAR INVITES US TO THINK TOGETHER AND IDENTIFY POTENTIAL TRANSPORTATION SOLUTIONS FOR THE FUTURE IN SUSTAINABLE CITIES.

WHAT DOES IFSTTAR BRINGS TO YOUR REGION WITH ITS SITE IN LILLE-VILLENEUVE D’ASCQ?

Audrey Linkenheld: IFSTTAR is part of our research ecosystem, one that is quite dynamic in Villeneuve d’Ascq. The long-term presence of such a research organisation on our territory has a significant impact in terms of attractiveness, job and co-operation prospects for our region’s students and elsewhere, as well as for the research community and businesses. Its proximity with the University of Lille 1 - Sciences et Technology offers bridging opportunities between the world of academia and that of research. There is a long history of links between IFSTTAR’s local teams* and our territory. The institute was already involved in the Lille metro, the first to use the VAL system 35 years ago! Acknowledged for its solid field experience, it has since contributed to many other novel automated transport systems, whether in France or abroad. Our territorial authorities are very much in demand for – and ready to fund — research projects on the interactions between the city and transport, for instance concerning the logistic challenges on short distances, mass catering delivery, and other topics for which best practices can later be shared with other territories.

WHAT DO YOU EXPECT FROM AN INSTITUTE LIKE THIS?

A. L.: IFSTTAR’s presence and its research work give us an opportunity to think together about future-proof solutions to address the challenges for sustainable cities. The topics on which IFSTTAR focuses – mobility, intra- or inter-city transit, state-of-the-art transport technologies – are closely related to the issues of spatial and town-planning, housing etc. These are all important issues to me. We expect a lot from such research projects as for developing less polluting, safer, more comfortable and faster mass transportation systems, while keeping their cost down. This, in particular, is the objective of the Railenium technological research institute established in 2011 in the Nord Pas de Calais region to develop railway infrastructures of the future. IFSTTAR is one of its ten founding members and Lille-Villeneuve d’Ascq one of the secondary campuses (the main one being in Valenciennes). The region is keen to build up on this research work and thus maintain its leading edge in the field of railways. We also hope to get some windfall from the innovative projects conducted within the i-Trans competitiveness cluster in the area of automobile, railways and multimodal transport, one where IFSTTAR is also involved.

HOW CAN IFSTTAR CONTRIBUTE TO SHOWCASE THE REGION’S ACHIEVEMENTS IN EUROPE?

A. L.: Its location in Villeneuve d’Ascq, on the outskirts of the Lille metropolitan area places IFSTTAR at the very heart of Europe, where most of the research work is now being carried out. We should take advantage of this position and build up on it by applying for institutional funding. Institutes such as IFSTTAR, which enjoy good visibility in Europe and are used to running European-wide projects can help us do so.

* ESTAS (Evaluation of Automated Transport Systems and their Safety Laboratory) and LEOST (Laboratory on Electronics, Waves and Signal Processing for Transport).