



ANNUAL REPORT 2016

FRENCH INSTITUTE OF SCIENCE AND TECHNOLOGY
FOR TRANSPORT, DEVELOPMENT AND NETWORKS



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EDITORIAL

2016, FROM CONSOLIDATING THE FOUNDATIONS TO PAVING THE WAY FOR THE FUTURE



Hélène Jacquot-Guimbal,
Managing Director of IFSTTAR



Jacques Tavernier,
Chairman of the Board of Directors

“ We have reviewed our initial scientific strategy, making choices and sometimes tough ones but needed. ”

2016 offered a major milestone to take stock and reconsider our course: we have been evaluated by Hcéres, we have looked at the outcomes of our first Goals and Performance Contract and of our scientific strategy (which we adjusted), and we also negotiated our second contract with the State. Our departments continued to produce research of very high standards, we took part in many successful IDEX or I-Site projects, and ... meanwhile our support services juggled with the Public budgeting and accounting management framework which did cause some fears.

Our organisation received a positive assessment from the Hcéres evaluation of our institute, thus completing the process initiated at department level in the previous years. The High Committee commended us for the soundness of our departments, our steering, our partnership policy, our European and international strategy but also for our implication in site-level policies.

From the scientific standpoint, we re-examined our initial scientific strategy, making choices, and sometimes tough ones but necessary if we want to keep producing research at international scale in spite of the ongoing reduction of our permanent staff (-12 % over four years).

We further enhanced our visibility by signing agreements for two international laboratories, but also by completing the cycle of “IFSTTAR Decades”, launched in Nantes, Marseilles-Salon de Provence and Lyon-Bron in 2015, then pursued in Villeneuve d’Ascq and Versailles-Satory before completing the process with Marne-la-Vallée and the opening of the Bienvenüe building. Requests from non-specialised media have been growing in numbers over the years, thus vindicating the relevance

of our research topics, which are now further complemented by photographic and audio-visual documents broadcasted via our website.

Against a difficult economic and budgetary backdrop our financial management is more than ever a major challenge. We nonetheless succeeded in working within our budget limits while at the same time beefing up our contract-based research activity with the signing of a number of emblematic agreements.

Since the end of 2016 we have become an ISO 9001-certified institution across all of our sites, a risky and hard-fought challenge which we met thanks to the efforts of all our teams, thus sending a positive signal to our partners in the same breadth.

Like the previous years, 2016 was again a very intense year, with the preparation and signing of the second Goals and Performance Contract (2017-2021) by the relevant line ministries. 2016 also saw the materialisation of large-scale projects such as Equipex Sense-City with the laying of the foundation stone of this new world-class facility.

We are particularly proud to present this activity report for this last year of a first cycle that completes with our Institute’s first Goals and Performance Contract, even though we may nurse regrets after failing to be awarded the Carnot label, which was one of the objectives in this contract. But our institution has already bounced back, again demonstrating its trademark resilience.

We would like, once more, to commend all our IFSTTAR agents for their commitment and efforts in this collective achievement.

LET'S HEAR FROM...



Laurent Girou,
Managing Director of Eiffage Routes

“ Boosting
the implementation
of new joint
research
projects. ”

WHAT JOINT PROJECTS ARE EIFFAGE AND IFSTTAR WORKING ON?

Laurent Girou: We started working together in the 1980s and this has already resulted in developing many road materials and processes. Initially geared towards high-performance materials, our joint research later turned to sustainable development, i.e. processes consuming fewer resources and with less greenhouse gas emissions. A new shift is now about to take place in our cooperation with the advent of new digital technologies that usher the interactive, and communication-enabled “Road of the Future”. On the civil-engineering side, one of our major joint achievements remains the instrumenting of the Millau Viaduct; we are now working together on deploying the monitoring part for the Bretagne-Pays de la Loire high-speed railway line. Last but not least we are also developing new ultra-high-performance fibre reinforced concretes and we are monitoring the mechanical behaviour of several bridges and wind turbines.

EIFFAGE AND IFSTTAR RECENTLY SIGNED A FRAMEWORK COOPERATION CONTRACT, WHAT IS THE MAIN OBJECTIVE OF THIS AGREEMENT?

L.G.: Of course, this new step further cements our long-lasting partnership. But more importantly, this framework contract will facilitate, boost and speed up the joint research projects we can set up in the field of roads, civil-engineering infrastructures and other engineering structures. It will soon materialise into research contracts or on-demand services provided by IFSTTAR to Eiffage:

there are many prospects in this area. Together we shall also be stronger to carry out scientific and industrial partnerships and submit bids for French or European call for tenders... Several of these, such as BioRePavation or Algoroute are already on track for the years to come, both at the domestic and international level. Others will soon follow suite, with a focus on the “Road of the Future” and its new capabilities.

IN WHAT SENSE IS IFSTTAR AN IMPORTANT PARTNER?

L.G.: IFSTTAR is a major scientific partner, and a preferred one indeed, because it boasts teams of high-standards and internationally recognised for their expertise. Moreover, the Institute owns major research facilities, such as the fatigue test track or the miniature laboratory for sustainable cities Sense-City, access to which will be facilitated and leveraged by this new framework cooperation contract. For our part, we shall provide living-labs, i.e. road segments open to traffic on which IFSTTAR may test and endorse new innovative technologies for the 5th Generation Road: predictive sensors, “smart” horizontal signalling to better visualise the road under poor weather conditions, urban roads mitigating noise pollution and urban “heat-island”, etc. The first of these living-labs will be made available to IFSTTAR by Eiffage in the Marne-la-Vallée area.



Patrik Doucet,
Dean of the faculty
of Engineering
of the University
of Sherbrooke (Quebec)

“ An international laboratory
for construction ecomaterials. ”

WHAT ARE THE LINKS BETWEEN YOUR UNIVERSITY AND IFSTTAR?

Patrik Doucet: In June 2016, University of Sherbrooke and IFSTTAR together created an International Associated Laboratory (LIA) named “Ecomat”. Objective: develop ecomaterials as alternatives to the concrete used in the building industry, transport infrastructures and civil engineering structures. Up until 2021, Ecomat will involve some forty scientists from our University’s Civil Engineering department and from IFSTTAR’s Materials and structures (Mast) department. This will also involve exchanges of researchers and students as part of joint thesis supervisions and mutualisation of large-scale scientific facilities. More broadly speaking, this LIA further strengthens and increases the visibility of this collaboration initiated in 2006 between our two institutions. It is now indeed ten years since our researchers started working together on concrete-related topics: ageing, durability, leveraging of alternative materials, etc.

WHAT ARE THE MAJOR CHALLENGES ASSOCIATED WITH THESE ECOMATERIALS?

P.D.: The main challenge of course is to mitigate the environmental impact of construction materials, in particular the greenhouse gas emissions resulting from their production. To do so, ways must be found to reuse materials eventually intended to be buried in landfills that are bursting at the seams, and to use local and biosourced products as well as industrial co-products. But for these ecomaterials not to remain confined to the stage of pure research, three major objectives will need to be achieved. First of all, they will have to be just as efficient as traditional materials with equivalent useful life, if not better. A rapid transfer of technologies will also have to be provided to make way for products that are easily usable by the industry and on building sites. Lastly, this LIA shall have to contribute to the emergence of an excellence network at international scale. Ecomat should also help our respective institutions to respond to new calls for projects and develop partnerships with industrial operators, whether domestic or international.

MORE BROADLY SPEAKING, WHAT ARE IFSTTAR’S STRENGTHS ACCORDING TO YOU?

P.D.: Like University of Sherbrooke, IFSTTAR is internationally recognised for its expertise in ecoconcretes, construction materials, the use of bio-sourced materials... or for the design and testing of structures. IFSTTAR’s track-record also boasts an interesting dual competency: infrastructures on the one hand but also expertise on the various transportation modes that can be supported by such infrastructures, all this based on a truly cross-disciplinary approach. Last but not least, this institute is really open to the world as testified by the many international programmes and partnerships. For all of these reasons, IFSTTAR is a first-choice partner for us. This is why University of Sherbrooke now wishes to broaden this partnership beyond ecomaterials to encompass the field of sustainable mobility for instance.

HIGHLIGHTS AND EVENTS

JANUARY

13 and 14 January

Encounter with Quebec Ministry of Transports (MTQ)

26 and 27 January

Les rencontres de la mobilité intelligente (Smart Mobility encounters)
Befroi de Montrouge, Paris

FEBRUARY

10 and 11 February

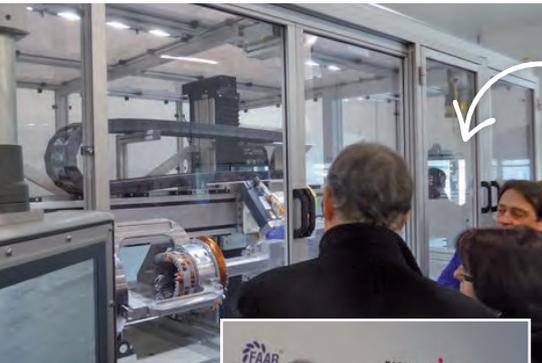
Journées techniques routes (Technical days on Roads)

16 February

Eurovia executives visit of ENPC and IFSTTAR

19 February

Silver medal award ceremony for Philippe Coussot



MARCH

10 and 11 March

IFSTTAR Decades at Villeneuve d'Ascq



14 March

Signing of the cooperation framework agreement with Andra



17 March

Opening of the Vedecom Excellence Centre

19 March

Paris Bookfair

Conference on "Writing the City of the Future"



22 and 23 March

Assises nationales des risques naturels (ANRN) - National conference on natural hazards

Palais du Pharo, Marseille 17^e - 25 m² booth shared between Cerema/Irstea/IFSTTAR

APRIL



5 April

Eiffage visit at Bougenais

11 April

Laying of the foundation stone of Equipex Sense-City in the presence of Mr Jacques Tavernier



18 to 21 April

Transport Research Arena in Poland



MAY

24 May

TAP Conference - 21st International Transport and Air Pollution Conference



25 and 26 May

Journées ouvrages d'art (Days on engineered structures)

30 May

Working session of the "Comité des 100" (Committee of the 100) on the Goals and Performance Contract

27 to 31 May

Weather and Climate Forum

Exhibition of the eco-driving simulator in front of the Paris City Hall



JUNE

7 and 8 June

Road community convention organised by DIT, Champs-sur-Marne

7 to 9 June

8th International conference of RILEM - MCD 2016, Nantes



13 June

Visit of Mr Niel Pedersen, director-general of TRB



14 to 16 June

Interoute & ville - European meeting of the road community Paris, Porte de Versailles

15 June

Visit of the Senate commission in charge of spatial planning and sustainable development



JULY

22 July

Anniversary of the Law on Energy transition for Green Growth at the Élysée palace

SEPTEMBER

8 September

Green Tech incubator in the presence of acting Minister Ségolène Royal



22 and 23 September

Décennies IDF - Aujourd'hui l'Ifsttar. (Decades of IFSTTAR) Official opening of the Bienvenüe building at Champs-sur-Marne

OCTOBER

11 October

25th Science festival: food, urban agriculture - at the Médiathèque Jean-Prévost - Bron



NOVEMBER

7 to 18 November

Exhibition of the solar road prototype at COP 22 - Marrakech

DECEMBER

8 December

Projet Ville du futur (City of the Future project): launch of the "Sensitive City" conference cycle at *Maison de la Poésie*, Paris

9 December

Re-signing of the event on Experts opening to civil society

AWARDS AND DISTINCTIONS 2016

46 awards and distinctions

AME

DEST

Jimmy Armoogum

received the “Cerema Award”, in the Cerema Outreach category, for the Mobility Surveys Network team.

Richard Grimal

was awarded the International Albertis prize for the best 2015 thesis.

LVMT

Olivier Bonin: Best short paper of the 19th AGILE international conference on geographic information science, Helsinki, June 2016. Olivier Bonin and his co-authors received the prize for the best paper rewarding an article on: “*Sonorous Cartography for Sighted and Blind People*”.

This prize is awarded every year during the Geographic Information Science Conference by the AGILE association.

Anne Aguilera and Virginie Boutueil received the “Discover China” scholarship awarded by the French Embassy in Beijing in the framework of Wei Kang’s thesis on new mobilities in China.

This scholarship will be used to do a scanning tour of Chinese laboratories in Nanjing and Shanghai working on new mobilities and services.

Gaële Lesteven and Fabien Laurent

received the prize for the best ATEC ITS invention awarded by the Scientific Committee of the *Rencontres de la mobilité Intelligente* 2016 (encounters on Smart Mobility). This prize was awarded for their presentation and paper entitled: “*Connaître la mobilité dans les territoires : explorations à travers les pays et les agglomérations*” (“*An insight into mobility in the territories: exploring countries and conurbations*”), as part of Workshop E3 – What tools for which strategies? This contribution, chosen from among 90 others, shall be published in the new review TEC MOBILITÉ.

GERS

GMG

Matthieu Blanc and Luc Thorel received the “Best Geosynthetics International paper” for 2014. Honourable mention. Blanc M., Thorel L., Girout R., Almeida M. 2014 Geosynthetic reinforcement of a granular load transfer platform above rigid inclusions: comparison between centrifuge testing and analytical modelling. *Geosynthetics international*. February 2014, Vol.21, 1, pp.37-52. DOI: 10.1680/gein.13.00033.

Luc Thorel received the “Best paper award for the year” of 2015 *Int. J. Physical Modelling in Geotechnics* Caicedo B., Tristanco J., Thorel L., Leroueil S. 2014 Experimental and Analytical Framework for Modelling Soil Compaction. *Engineering geology*, 175, 22-34.

COSYS

LICIT

Ludovic Leclercq and Florian Marczak received the “TRB Grant Mickle Award”. This is the first time, to our knowledge, that French researchers are given this distinction.

GRETTIA

Hugues Chollet and Michel Sebès

received the « George Stephenson Gold Medal » of The Institution of Mechanical Engineers.

Anne-Sarah Briand, Mohamed-Khalil El Mahrsi, Etienne Côme and Latifa Oukhellou received the prize for the best paper of the Joint French-speaking conference on “*Apprentissage Artificiel & Fouille de données*” (Machine learning and data mining) and “*Société Francophone de la classification : Science des données (défis mathématiques et algorithmiques)*” (French-speaking society of classification; data science – mathematical and algorithmic challenges).

Hugues Chollet received the 2015 SAGE Best Paper Prize for his paper “Validation of simulation models in the context of railway vehicle acceptance”. An outcome of the DYNOTRAIN project, this was the second collective publication in 2015. The proposed method was integrated into the 2016 version of the approval standard for railway vehicles.

SII

Vincent Le Cam received the ERCI prize (European Railway Clusters Initiative).

MAST

Bruno Godart, Prize of the best 2015 article published in the magazine *Structural Engineering International* authored by B. Godart, J. Berthelémy (Cerema) and JP Lucas (CD 76) on the *Pont Mathilde* fire in Rouen.

CPDM

Anaïs Grandclerc, Prize of the best poster (RF)2B – French-speaking grouping for research and training on concrete.

Marion Medevielle, Prize of the second-best poster (RF)2B - French-speaking grouping for research and training on concrete.

Marie Malbois, Prize of the second-best oral presentation (RF)2B - French-speaking grouping for research and training on concrete.

TS2

LBA

Manon Sterba, First prize of the *École Polytechnique* scientific poster contest organised in parallel with the 15th day on research at *École polytechnique de Montréal* in the PhD students category, 2016.

Manuel Taso, received the ISMRM Merit Award: Top 15 % abstracts - 2016 for his work combining the biomechanical analysis of finite elements and multiparametric MRI scans to assess mechanical and structural damage suffered in cases of cervical spondylotic myelopathy.

Florent Auriault, AMU contest Prize of the Best thesis, 2016. Annual award for the best AMU theses.

LBMC

Laurence Cheze received the prize of learned societies, “Christian Oddou” prize of the *Société de Biomécanique* (French-speaking international society of biomechanics).

P. Martin, Laurence Cheze, P. Pourcelot, L. Desquilbet, L. Duray and H. Château, Prize of the best poster: Effects of a prototype saddle (comfort panels) on the biomechanics of the equine back during rising trot: preliminary results, award by 8th International conference on canine and equine locomotion (ICEL), London, 2016.

LESCOT

Guillaume Pepin has been selected in phase one of the Valeo Innovation Prize, under the “Technological Innovation” category.

LMA

Nicolas Clabaux and Jean-Yves Fournier, winners of the CNRS images prize. €10,000 scholarship awarded to produce a film on the winners' research work. Project title: *Se faufiler dans les embouteillages : quels risques pour les usagers des deux-roues motorisés*. (Weaving one's way through traffic jams: what risks for motorised two-wheelers?).

Marc Quiertant of the EMMS laboratory, **Sylvain Chataigner, Jean-François David, Richard Michel** and **Yannick Falaise** of the SMC laboratory, **Bruno Godart** from the Mast department management team, as well as **Aghiad Khadour** and **Gonzague Six** from Cosys are the winners of the Cerema 2016 prize in the “Innovation” category for their contribution to the project entitled *“Rupture d'une poutre de type VIPP renforcée par matériaux composites (Clerval)”* (Failure of a VIPP-type beam reinforced with composite materials).

“Chaussées chauffantes et récupératrices d'énergies” (Heating pavements with energy recovery) is also another project rewarded, for which the Mit and Lames laboratories joined forces with Cerema, with **Jean-Michel Piau**, acting as pilot for IFSTTAR and who received the Cerema 2016 innovation award. A real-size heating pavement demonstrator was built in Égletons as part of this project.



IFSTTAR IN ITS ENVIRONMENT

2016 was chiefly devoted to pursuing the extensive stabilisation effort for the scientific and organisational policy, strengthening the Institute's piloting and its financial management. The aim of the 2013-2016 Goals and Performance Contract to extend ISO 9001 certification of its quality management system to all IFSTTAR centres was finalised in 2016.

This year marks the end of a cycle aimed at renewing the scientific activities framework: IFSTTAR's evaluation process was completed by Hcéres, with a very positive outcome; we prepared our Goals and Performance Contract for the 2017-2021 period; the respective management teams of four of our departments completed their term of office at the end of 2016; a new incentive tool "Federating projects" was launched with the aim of bringing together the Institute's research teams around a cross-cutting thematic focus. End of December 2016 was the 500th thesis of an IFSTTAR PhD student to be defended since the creation of the Institute.

The Institute strengthened its visibility:

- With the completion of the "IFSTTAR Decades" cycle at Villeneuve d'Ascq, Versailles-Satory and Marne-la-Vallée. All of these events were very successful, in terms of numbers of participants, interest generated and attendance of prominent figures;
- With the signing in Sherbrooke of the convention to establish the Ecomat International Associate Laboratory (LIA) with University of Sherbrooke (Quebec) focussing on low clinker content cement materials, and in Montreal the signing of the convention establishing the IlabSpine LIA with CNRS, AP-HM, *Ecole Polytechnique* of Montréal, ETS (Higher school of technology) and the CHU Sainte-Justine (university hospital) on rachis biomechanics and imaging;
- With the organisation of large-scale events such as the 21th International Conference on transports and air pollution (TAP 2016) from 24 to 26 May 2016 at ENS - Lyon in partnership with the LUTB (Transport and Mobility Systems) competitive-

ness cluster and the European Commission's Joint Research Centre (JRC); or the ESB (European Society of Biomechanics) convention chaired by the Institute which also provided the setting for the 40th anniversary of two learned societies (the European Society of Biomechanics and the French-speaking society of Biomechanics), established in 1976; or again the 8th RILEM international conference on cracking in pavements from 7 to 9 June in Nantes.

On Monday 11 April 2016, the foundation stone of Sense-City was laid, thus anchoring a solid scientific community around this project with Equipex entering a new phase full of promises. Researchers and PhD students can highlight their work thanks to photographic or audio-visual material. This production is accessible on the Pictolab photo-video library, with a collection available in streaming.

Developing relations with the social and economic world remains one of the Institute's priorities. 2016 from this standpoint was marked by a number of points and this despite the failure to secure the Carnot label: effective launch of an SME plan with the first edition of Innov'Days in May 2016: *Villes & transports en interactions* (Interacting Cities and transports) – which brought together a dozen SMEs –, and drafting of a Charter of Best Practices for partnerships between IFSTTAR and young innovative businesses.

At the close of a stressful year due to budgetary pressures, the level of activity of the research, support and management teams had nonetheless been upheld thanks to the commitment of all staff.



Jean-Paul Mizzi
Deputy managing director



jean-paul.mizzi@ifsttar.fr

INSIDE THE INSTITUTE



Serge Piperno
Scientific director

In 2016, the prioritisation of our scientific focus areas was successfully completed. In line with the Hcéres evaluation processes for the various IFSTTAR departments and the Institute per se, this exercise was designed to update the Institute's scientific strategy so that it would be more in keeping with the human and financial resources available today and in the future.

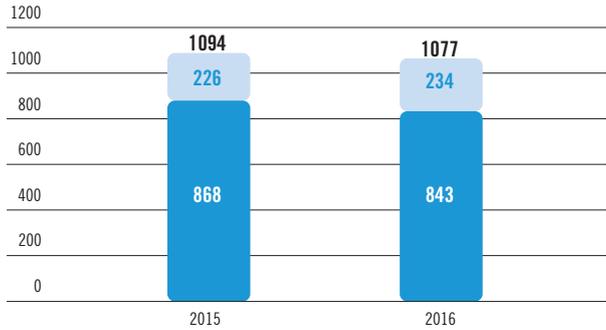
Based on the scientific focus areas identified in 2015 by the departments as the most likely to provide optimum impact (impact combining publications, leveraging, expertise, support to public policies, etc.), these "thematics" were compared and synergised to avoid overlaps between departments, and then distributed among the "10-year scientific strategy" challenges in order to lay out the scope of research topics that will be addressed by IFSTTAR in the years to come.

A "revised" scientific strategy document was gradually developed during the second half of 2016, through discussions with our partners and line ministries in order to prepare the 2017-2021 Goals and Performance Contract. This document, highlighting the "Research topics" of the "10-year scientific strategy" on which IFSTTAR believes it can maintain a significant impact, was endorsed during a Scientific Council and approved by the Board of Directors in November 2016.

HUMAN RESSOURCES

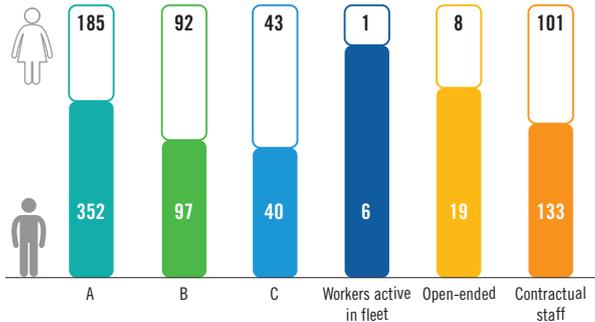
ACTUAL NUMBER OF AGENTS at 2016/12/31

Non-permanent employees ■
Permanent employees ■

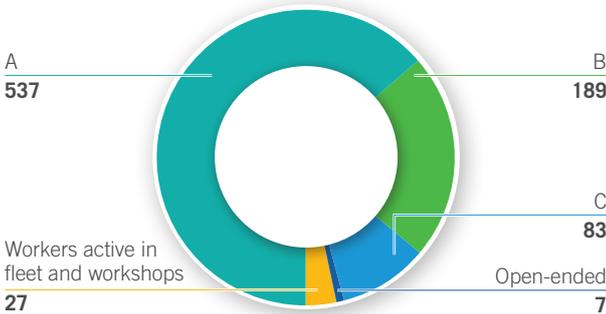


GENDER DISTRIBUTION at 2016/12/31

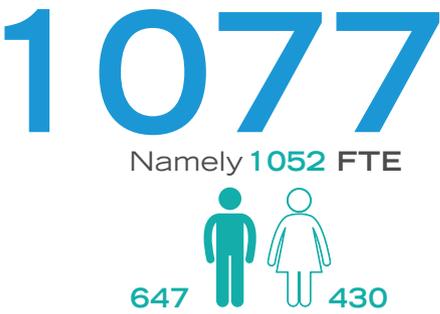
Males Females



PERMANENT AGENTS DISTRIBUTION at 2016/12/31



TOTAL NUMBER OF AGENTS at 2016/12/31



AVERAGE AGE DISTRIBUTION
at 2016/12/31



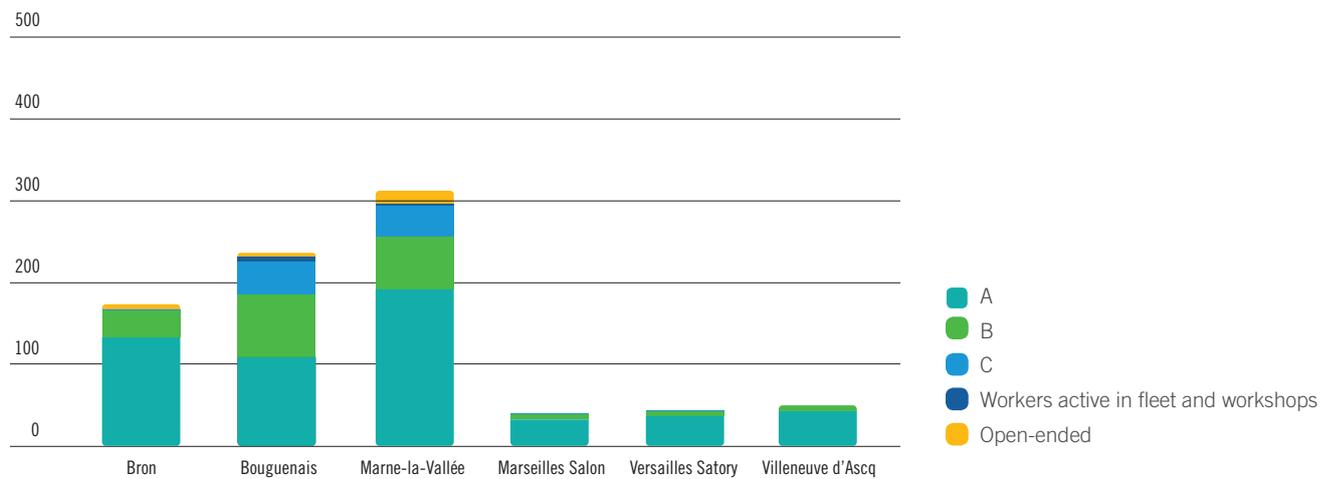
Permanent employees



Non permanent employees



DISTRIBUTION
BY IFSTTAR'S SITES
at 2016/12/31



QUALITY

In 1979, via the LCPC, IFSTTAR was one of the five founding laboratories of RNE, which later became COFRAC in 1994, hence its “COFRAC Essais” accreditation number No 1-0005. IFSTTAR has been certified ISO 9001 since 2002. Its certification was thereafter renewed every three years.

IFSTTAR's three quality diplomas

IFSTTAR's Quality Management System (QMS) is certified ISO 9001

Quality Management System for the sites of Marne-la-Vallée, Lyon, Marseilles-Salon de Provence, Nantes, Versailles-Satory and Villeneuve d'Ascq.



N° 2014/64769.3

Attestation :



IFSTTAR is accredited by COFRAC Essais as per ISO 17025 for four test programmes



Accreditations
N° 1-0005 (Paris site)
N° 1-0535 (Nantes site)
For scope see
www.cofrac.fr

IFSTTAR is accredited by COFRAC for products certification as per ISO 17065

for the CE marking of aggregates (regulation 305/2011 for construction products), notified body No. 1165, for aggregate quarries in-factory production control audits as per system 2+



Accreditation
N° 5-0533
For scope see
www.cofrac.fr

Highlights in 2016

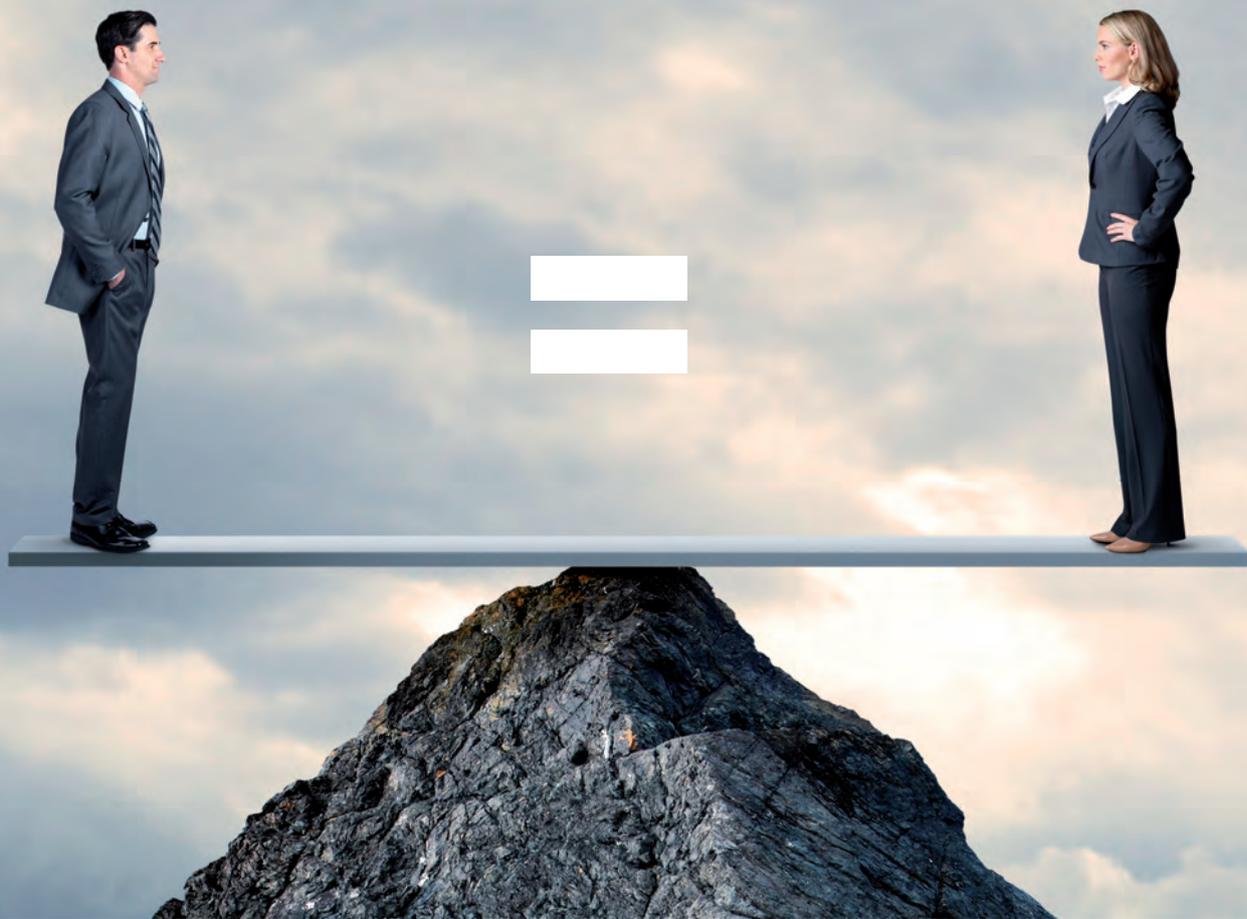
- The Goals and Performance Contract objective to extend the ISO 9001 certification of its quality management system to all IFSTTAR sites was achieved in 2016 with the integration Lyon-Bron site and of the Cosys/Tema team at Versailles-Satory during the 2016 November audit.
- The COFRAC Essais accreditation as per ISO 17025 was reduced from seven to four test programmes following the discontinuation of activities under three accredited programmes on “asphalt mixes” at the Mit laboratory of the Mast department.

Organisation of the quality policy

- The Quality, Metrology and Standardization delegation (DQMN), under the Directorate General, is in charge of the quality management system set up to address the baseline requirements of NF EN ISO 9001, NF EN ISO/CEI 17025 (COFRAC Essais), NF EN ISO/CEI 17065 (COFRAC products certification), and State notification for CE marking.
- In 2016, the delegation for quality relied on two networks: 56 quality correspondents (COQ), and 33 internal auditors (AI), working in the laboratories and support services.



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GENDER EQUALITY AT WORK



The preparation of the action plan for gender equality at IFSTTAR suffered a significant slow-down in 2016, in particular due to an under-estimation of the time needed to analyse the findings of the extensive 2015 survey of the Institute's agents, a task which should now be finalised early 2017. In 2016, apart from a study on the outcomes of the dissemination of the charter for improved work-life balance and the work conducted with trade unions to outline the conditions for implementation of teleworking at

IFSTTAR (which itself contributes to improved work-life balance), the evolution of the comparative situation of the Institute's male and female agents since 2013 was analysed in a study based amongst other things on "social balance-sheets" and which highlighted two areas for which the action plan will need to provide some adjustments: occupational gender diversity, in particular for scientific jobs, and gender diversity at the managerial and governance levels of the organisation.

PhD ACTIVITIES

PhD training

The 500th thesis defence of an “IFSTTAR PhD student” took place at the end of December 2016.

Thesis duration (2016 defences)

72 theses were defended in 2016, 45 of which were fully or partly financed by IFSTTAR, either through subsidising or backed up against research agreements.

The average duration of these 72 theses, covering all fields of research, is 3.51 years (with a median value of 3.23 years).

The life of PhD students after IFSTTAR

An additional module was developed by the IFSTTAR IT department to monitor the progress of IFSTTAR PhD students, under the stewardship of the Scientific Division and integrated into the information system dedicated to theses (PhD students’ portal).

Each PhD graduate was contacted individually and, subject to the applicable CNIL personal data protection arrangements, was thus able to alter, complement and finally sign off his/her respective data. The response rate stood above 97 %, in other words we know what becomes of 484 PhD graduates out of 500, including the 72 PhD graduates for 2016.

The employment ratio (permanent work contracts, or “EDI” –, and temporary work contracts, or “EDD”) of the 98 IFSTTAR PhD graduates who defended their thesis in the course of 2015, was 90 % one year down the line (60 % for EDIs and 30 % for EDDs). 6 out of 10 permanent work contracts were in the public sector and most of them in France. Almost 9 out of 10 temporary contracts were in the public sector (mainly post-doctoral fellows, 1/3 of them overseas).

The employment ratio three years after thesis defence was 93 %, and 96% for those five years after their defence (2011 PhD graduates). These values are above the national statistical data currently available (employment ratio at three years = 69 %, at five years = 82 %, with response rates ranging between 53 % and 89 % depending on the surveys considered).

500

thesis defences since the creation of IFSTTAR

72

thesis defences in 2016 with an average duration of **3.23** years

8

HDR defences (accreditation to supervise research)

19

contractual PhD students, during the 2015-2016 academic year conducted:

17 teaching missions (AMU, ECN, ENTPE, ESIEE (2), Lille 1 (4), Lyon II (2), Paris-Descartes, UCBL (2), UNS, UPEM, UPMC)

3 experts’ assessment missions, as part of the research agreement to fund their thesis (Solétanche Bachy International, Toyota, ESI group)

57

new IFSTTAR PhD students joined in 2016, including:

26 subsidised PhD contracts, with

5 regional cofunding by Hauts-de-France, Pays de la Loire, Provence-Alpes-Côte d'Azur) and

2 with cofunding backed up against a research agreement (Cegep Ademe, Desbats)

7 PhD contracts backed up against research agreements (projects: ANR Micro, CE Infrastar (2), EDF RSI, ERC Magnum (2), VRU-Sim)

7 theses in joint supervision, cofunded by IFSTTAR (ENI Tunis, University of Bologna, University of Sherbrooke, Polytechnique Montréal)

20

other funding arrangements, including:

4

civil servants (1 IFSTTAR agent, 3 ITPE4A seconded to IFSTTAR)

5

CIFRE with an IFSTTAR-subsidised contract of employment (Actris, Antea Group, Eurovia, Mitsubishi Electric, SNCF)

2

scholarship students (Bosnia and Herzegovina, China)

1

Efficacity employee

8

contracts with external employers (Cerema, ESTP, Inria Rennes with IFSTTAR cofunding, IRT System X, Railenium, Université Paris-Est - labex Futurs Urbains -, University of Toulouse, Vedecom)

Employment ratio of 2015 PhD graduates after one year:

90 %

60 % EDI (open-ended contracts)

58 % in private sector
42 % in public sector

30 % EDD (fixed-term contracts)

14 % in private sector
86 % in public sector

Employment ratio of 2014 PhD graduates after two years:

86 %

61 % EDI (open-ended contracts)

Employment ratio of 2013 PhD graduates after three years:

93 %

78 % EDI (open-ended contracts)

Employment ratio of 2012 PhD graduates after four years:

98 %

85 % EDI (open-ended contracts)

Employment ratio of 2011 PhD graduates after five years :

96 %

82 % EDI (open-ended contracts)

REGIONAL SCENE

In every region where IFSTTAR is present, the Institute was involved in the State-region planning contracts by proposing a number of projects and besides it continued to strengthen its partnerships in the framework of the “Investments for the Future”. Following is a national roundup of what was done in 2016.

Île-de-France region

CHAMPS-SUR-MARNE

In 2016, for the Marne-la-Vallée site the emphasis was on joint actions with the organisations of the *Cité Descartes* campus, while most of the major events of this year saw IFSTTAR joining forces with its local and regional partners.

On 11 April 2016, the Sense-City project was under the limelight by celebrating the laying of its foundation stone. Sense-City is a “Facility of Excellence” (Equipex) project of the “Investments for the Future” program, covering the 2011-2019 period with a budget of 9 M €. This programme, steered by *Université Paris-Est*, involves IFSTTAR, ESIEE-CCIP, LPICM (UMR 7647 CNRS-École Polytechnique), CSTB, Inria and Upem. After the initial event in 2015 when the Sense-City mock-up was presented, the next phase was to launch the project full-size, the climatic hall, which was the highlight of this event that brought together academic and industrial players

around an official ceremony and a visit of the first urban scenario. Work on the climatic hall continued throughout 2016.

In September, the closing of the “IFSTTAR decades” in Île-de-France, an event entitled *Aujourd’hui l’IFSTTAR*, also marked the official opening of the *Bienvenue* building which houses the headquarters of IFSTTAR, several of its laboratories and many outstanding facilities and installations such as the structure-testing platform, chemistry labs, simulators etc. Although some parts of the *Bienvenue* building are yet to be finalised, over 4 years after the teams first settled down there, this inauguration in the presence of Mrs Laurence Monnoyer-Smith, general-commissioner for sustainable development, Mr Jean-Michel Pargade, architect of the building and Mr Philippe Tchamitchian, President of *Université Paris-Est*, was a great step

towards the completion of this exceptional building.

The main thread of 2016 for this site of Marne-la-Vallée was undoubtedly the collaboration with *Université Paris-Est* and the other entities of this Community of Universities and other Academic centres (COMUE) to promote the site’s candidacy for the second round of *Idex/I-Site* calls for projects. This initiative generated a lot of work and strategic discussions, eliciting engagement among the various players involved, while shaping the site’s actions throughout the year until it was rewarded at the beginning of 2017 when the international jury chose the project and awarded the *I-Site* label to the UPE project entitled *Future*.



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SATORY

With a strong presence of the automotive industry, the *Département des Yvelines* and the *Communauté d’agglomération de Versailles Grand Parc* have for several years joined forces to create a cluster of innovative mobilities in Versailles-Satory. To this end, and with the help of major industrial and financial operators, they have set up a semi-public company “Satory Mobilité” to handle the real-estate projects connected with this operation. Already present in this location, and as a founding member of *Védécom*, IFSTTAR, which also enjoys temporary occupation authorisations from the French Ministry of Defence, plays a key role in enabling the materialisation of this project.

Thereby, on 24 February 2017, in the presence of local elected representatives, the foundation stone was laid for the future building that will be erected right next to IFSTTAR and its test tracks to house the *Védécom* Institute, part of the laboratories and installations of IFSTTAR



Artist's rendering of the future building

as well as a number of automotive SMEs. This new building, designed by the Valero Gadan architects firm and to be built by contractor GCC, should be delivered mid-2018.

For the scientific aspects, cooperation with *Védécom* continued with the following:

- Renewed secondment of 4 agents;
- Supervision of several theses;

- Coaching of post-doctoral fellows;
- Joint publications at the IEEE ITSC 2016, and RTSI conferences;
- Participation in European projects.

For the latter point, noteworthy is the significant contribution of several IFSTTAR teams to the *Fabric* project (induction charging of electric vehicles).



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IFSTTAR decades



Launched in 2015 with events at Bouguenais (40 years of research at the site of Nantes-Bouguenais), Bron and Salon de Provence (50 years of research on road safety and the 20 years of the Registry of road traffic victims of the Rhone region), the cycle of IFSTTAR Decades then paid a visit to Villeneuve d'Ascq in March 2016 looking at "30 years of research in transports: Trajectories" before it concluded in Île-de-France with the joint events at the sites of Marne-la-Vallée and Satory (Aujourd'hui l'IFSTTAR).

This last edition of the IFSTTAR Decades had scheduled a number of lectures and round table discussions to address, among others, issues related to sustainable mobility, the city of tomorrow, risk mitigation and the preservation of road assets.

These meetings took place at IFSTTAR's "Bienvenüe" headquarters in Champs-sur-Marne, on Thursday 22 September 2016.

This 1st day saw the inauguration of the 40,000 m² "Bienvenüe" HQE building in the presence of partners and line ministries.

Situated at the heart of the Descartes cluster of *Université Paris-Est* and of the *pôle d'Excellence de la Ville durable du Grand Paris* (excellence cluster of the Greater Paris sustainable city), this new building will accommodate the various institutes working on the topics of Sustainable Cities, spatial planning and tomorrow's mobility. The physical presence of IFSTTAR within this community will thus encourage the development of domestic and international projects on these themes.

Very much involved in questions relating to future mobility, the Versailles-Satory site was also acknowledged in these conferences with round-table panels focussing on the development of bicycle-friendly cities or on the question of how to involve users in the development of transport systems. The opening session

"Can cities be sustainable?" took a cross-cutting approach to the research themes tackled by these two sites. A number of prominent speakers from different backgrounds (universities, local authorities, economy, media) came to discuss these questions and contribute their vision of the city, in the presence of philosopher Raphaël Enthoven, amongst other figures.

To showcase the diversity of their research activities, both sites of Versailles-Satory and Champs-sur-Marne opened to the public on Friday 23 September.



Raphaël Enthoven, philosophy professor, Hélène Jacquot-Guimbal, Managing-director of IFSTTAR and Philippe Tchamitchian, President of Université Paris-Est

Provence-Alpes-Côte d'Azur

IFSTTAR, A MAJOR PLAYER IN THE AREA OF NATURAL HAZARDS

The Minister for Environment, Energy and the Sea, inaugurated the 3rd edition of the National Convention on Natural Hazards during her official visit to Marseilles. This 2-day convention was for the first time organised in the PACA region, one particular prone and exposed to many natural hazards (seismic risks, ground movements, floods, forest fires, avalanches).

Over 1,000 participants convened at the Palais du Pharo in Marseilles on 22 and 23 March 2016 to attend round-table panels and workshops: representatives of government agencies, territorial organisations, community associations, insurance business and other professionals were thus able to exchange views and interact on the necessity to better address the needs of vulnerable territories.

IFSTTAR participated in different capacities: as a member of the steering committee for the organisation of this event; it also prepared and moderated a panel discussion on seismic hazards; presented scientific posters and lastly shared a joint booth with Cerema and Irstea with the three organisations presenting all of their activities in common in the field of natural hazards. IFSTTAR's drone was introduced on this occasion, showcasing the capabilities of this new system for natural hazards.

The round-table panel on seismic risk prevention was prepared by four members of AFPS – Ghislaine Verrhiest-Leblanc and Jean-François Semblat (respectively pilot and copilot of the preparation task) as well as Thierry Winter and Denis Davi (as scientific referrals) – in conjunction with DGPR (Vincent Courtray).

Four topics were covered: implementation, monitoring and evaluation of the CAPRiS¹ adaptation to coordinated, integrated and multi-partner territorial frameworks; fostering of a general and technical risk culture; better knowledge and mitigation of the vulnerability of territories; challenges and modalities for anticipating and preparing seismic crisis management (organisation, planning, drills, REX, ORSEC, PCSI, PCS, PPMS, PFMS) and post-crisis spatial planning.

IFSTTAR IN CLOSE CONNECTION WITH SMES AT REGIONAL LEVEL

IFSTTAR's GPEM laboratory (Aggregates and materials processing) develops skills and expertise in the reclamation of building materials thus meeting the requirements of the law on energy transition for green growth.

The idea is to pool together all this relevant knowledge to promote an industrial solution via partnerships with local SMEs. IFSTTAR thus initiated an industrial partnership with the Frejus-based Estérel group which specialises in the recycling and conversion of waste from the building industry. In order to boost its business, the group decided to innovate and invest very significantly (1.5 million Euros approx.) over 10 years to achieve a conversion ratio of 98 %, a value way above the average of recycling facilities currently operating on the French territory.

Today, this partnership has resulted in collaborative work for two projects to improve its current platform, respectively subsidised by Ademe and the PACA region. These projects aim to optimise the industrial process and enhance the conversion ratio, in particular by proposing recycling solutions that are yet too little used.

Implementation of such a process will be of particular relevance for major projects like the construction of the Grand Paris Express to ensure the supply of civil engineering materials and the reuse of construction and demolition waste.



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1. Regional framework for prevention actions against seismic hazard

Auvergne-Rhône-Alpes

NEWS AND PERSPECTIVES

In 2016 IFSTTAR organised two world-class events in Lyon: the 21st TAP conference 2016 (Transport and Air Pollution) and the ESB 2016 convention (European Society of Biomechanics). This gives a measure of the central role played by the capital of the Rhone region in the international scientific landscape, one that is bound to increase even more with the creation of the new greater Auvergne-Rhône-Alpes region following the 16 January 2015 law reshaping French regions.

The creation of the Transpolis mutualised platform on the Fromentaux site, some 35 km east of the Lyon metropolis will offer yet another asset for transports of the future.

IFSTTAR INITIATES WORLD-CLASS EVENTS IN LYON

24-26 May: TAP 2016 conference

Organised by IFSTTAR at ENS-Lyon, in partnership with LUTB and the European Commission's Joint Research Centre, JRC, the 21st International Conference on transports and air pollution was chaired by Salah Khaldi (research director at IFSTTAR- Ame-LTE).

The theme of TAP 2016, "Transports and air pollution at the crossroads of territorial and public policy challenges, in the face of energy transition and technological challenges", was resolutely geared to issues more than ever topical for France, but also Europe and the world at large. This event covered all kinds of aspects relating to transport-associated air pollution (whether road or other modes), from emissions to the impact on health, environment, the economy and employment.

Nearly 300 people from 30 countries, including 13 non-European countries took part in this conference which offered 130 communications and 40 posters.

10-13 July: ESB 2016 convention

The ESB 2016 convention, chaired by David Mitton (Director UdL-IFSTTAR-TS2-LBMC), was held at the *Cité des Congrès* in Lyon and jointly organised by IFSTTAR and two learned societies, the European Society of Biomechanics and the *Société de Biomécanique*, for their respective 40th anniversaries. Four international institutions were associated



ESB 2016 Convention, chaired by David Mitton (IFSTTAR – 1st from the left)

with this event: the European Society for Biomaterials, the International Society of Biomechanics, the International Society of Biomechanics in Sports, and the International Research Council on Biomechanics of Injury (IRCOBI) for their relevant scopes: "Biomaterials", "Human movement", "Sport biomechanics" and "Impact/injury biomechanics", respectively.

Close to 800 experts from 47 countries took part in this international convention with 400 communications scheduled and 210 posters covering present challenges in the field of biomechanics and connected areas.

THE NEW GREATER AUVERGNE-RHÔNE-ALPES REGION

On a geopolitical level, the AURA region, with nearly 8 million inhabitants, becomes the 10th most populated region of Europe, and the 2nd French region in terms of tax income. It boasts a population larger than that of countries like Bulgaria, Denmark or Finland, which ranks it on a par with the leading European regions such as Lower Saxony, Baden-Württemberg or Catalonia.

The Lyon metropolis, with its 1.3 million inhabitants, has now joined the big league at the 14th rank, way ahead of Grenoble (440,000), Saint-Étienne (400,000) and Clermont-Ferrand (300,000).

In terms of universities, the greater AURA region now becomes the second largest

cluster with 323,000 students enrolled in 2016 against twice as many for the Île-de-France region, and way ahead of the Occitania region, ranking third with 240,000 students.

IFSTTAR can take satisfaction in being present on this booming site though it should also be careful to take into account the dual identity (Auvergne/Rhône-Alpes) of this player. It is true that when you operate in the large and historic urban area of Lyon you tend to think in terms of Rhône-Alpes like in the old days, as if nothing had changed.

But it's now a totally different story, and the president of this new region, Laurent Wauquiez, at every opportunity will remind everyone that the merger positions both former territories on a same level. He constantly repeats that he wishes to turn it into a well-balanced region, one that sets the example in the area of innovation and support to businesses. The long-standing presence of Renault Trucks in Lyon and Michelin in Clermont-Ferrand actually puts transports at the heart of the regional policy making this sector one of its 8 pillars of excellence.

Thus, the region's networks will have to reach out to the remotest locations and in the same process IFSTTAR may extend its presence across the whole territory and thus improve its reputation and its aura.

COMPLETION OF THE TRANSPOLIS PROJECT

2016 was truly a milestone in this project initiated 7 years before. With the detailed draft project being signed off, the design studies launched as well as the official procedures leading up to public consultations, we are now just one step away from the operational phase. From the administrative point of view, the process is well underway and in 2017 the bilateral conventions will be signed with the funding institutions.

According to the provisional schedule the first preparatory work should start in the spring, with the foundation stone laid in September 2017, and the earthwork and roadwork to follow in autumn.

Completion of the works is scheduled for December 2018 with subsequent relocation of the test tracks from Saint-Exupéry to the new site in Fromentaux. In the meantime, SAS Transpolis will continue to grow and ramp up with new players onboard. Everything is gradually falling into place so that IFSTTAR and its

partners can start responding to European calls for tenders, confident that they are their new tool will be available in 2019.



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Pays de la Loire

For several years, in keeping with the Institute's thematic guidelines, the teams of the Nantes-Bouguenais site have developed their activities towards greater focus on production structures for renewable energies. A special emphasis is placed on marine energies, for which the large facilities of the Nantes site – centrifuge, cable fatigue test bench, mechanical testing platforms – offer considerable assets.

The regional strategy of Pays de la Loire leaning on smart specialisations and the regional programme for higher education, research and innovation, *via* an RFI structure (Research, Training, Innovation) to be developed on this theme, put renewable marine energies among this territory's top challenges. IFSTTAR is part and parcel of this process, by piloting and contributing to several large-scale collaborative research projects. And there has been a proposal to include all of the site's major testing facilities, assembled within a platform dedicated to the study of production structures for marine renewable energies, as part of the French national strategy of large research infrastructures.

This theme also to a large extent underpins the work of the region's research and education centres. It forms one of the pillars of the scientific platform of the I-Site Nantes Excellence Trajectory, of which IFSTTAR is one of the central partners. This initiative, driven by *Centrale Nantes*, *Université de Nantes*, the Nantes CHU and Inserm, was granted significant financial resources by the CGI in March 2017



The President and the Secretary General of SIMSG, Roger Frank and Neil Taylor, plant a "tree of knowledge" during the Eurofuge congress

to help bring these various institutions together under the umbrella of a broader body of international scope and to which IFSTTAR will be closely associated.

SCIENTIFIC EVENTS

As usual, June was propitious for international relations. IFSTTAR's Nantes site in succession hosted some thirty Australian colleagues from AAPA as part of a European scanning tour of asphalt pavements, over 80 European geotechnicians during the European Conference on Physical Modelling in Geotechnics (Eurofuge 2016) and an international workshop as part of the SETAC 2017 convention in Nantes.

Concurrently, the Cité des Congrès of Nantes hosted the 8th Rilem International Conference on Mechanisms of Cracking and Debonding in Pavements (MCD2016), whose organisation committee was chaired by Armelle Chabot, a research director at IFSTTAR. This convention offered an update on the latest research breakthroughs on the monitoring and the analysis of mechanical pavement damages. It attracted over 250 researchers from 35 countries.



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Hauts-de-France

REGIONAL BODIES

Filing of the IDEX ULNE dossier
(*Université Lille Nord Europe*)

Based on the convention with the former Nord-Pas-de-Calais region, confirmation of the partnership with the new Hauts-de-France region, whose Research Vice-President, Mr Lebas came to reaffirm the continued and unfailing support of the region as for the last 30 years.

SCIENTIFIC PARTNERSHIPS

2016 was marked by:

- Start-up of the Elsat 2020 programme (see Annual Report 2015);
- Launching of new projects: FUI (Coopol), AMI-Eway and European project H2020 in the framework of ITSS (C-Roads, InterCor, Scoop2);
- Successful work conducted with industrial partner Airbus aiming to increase the lowest usable frequency of the stirred-mode reverberation chamber;
- Experts' assessment for STRMTG, first inroad into the area of ski lifts with the development of a database on user behaviours and potentially hazardous scenarios;

- Experts' assessment, on behalf of Certifer, on the GSM-R system of the Channel Tunnel was also completed successfully in 2016;
- End of the Caronte project of the 7th framework programme and SIL2 project for EPSF;
- First response to Shift2Rail's X2RAIL call for projects under the Railenium banner;
- Launch of DGITM's Ester project on the security of land transports;
- End of the evaluation (on behalf of Certifer) of the safety and interoperability of the ERTMS system on the last segment of the LGV EST (LN8) high-speed Paris-Strasbourg TGV line;
- Start of the study on fire-smoke risks in tunnels for urban guided transport, a study commissioned by STRMTG and DGITM.

SCIENTIFIC ACHIEVEMENTS

At Least, 3 patents have been or are in the process of being filed.

Doctoral activity: no fewer than 10 theses were defended in 2016 at VDA: 1 LVMT, 5 Leost (including 3 Railenium), 4 Estas (including 2 Railenium).

To which should be added 2 distinctions received by the PhD students: Ni Zhu and Lucas Rivoirard were rewarded, the first one for the best poster presentation at the "Doctorales de Cosys", and the second for his performance at the "Ma thèse en 180 s" contest (my thesis in 180 seconds).

The electromagnetic slab designed by start-up Luxondes was selected by Orange and presented to the President of the French Republic.

In terms of international outreach, in 2016 two foreign professors were invited at Estas to work on traffic optimisation models and related matters:

- Angel Marin from the Madrid Polytechnics University as guest professor for two months;
- Rafaele Pesenti from the Venice University for 3 weeks.

Also noteworthy was the visit of a delegation from Beijing Jiaotong University's Rail Traffic Control and Safety laboratory.



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NATIONAL SCENE

Deployment of the S_VRAI project and industrial transfer

Since 2010, IFSTTAR's LMA Laboratory for accident mechanisms analysis, department TS2, has joined forces with Cerema, in the context of a vast project named S_VRAI: Saving lives through incident analysis feedback. Supported by the French Delegation for Road safety and traffic, this project aims to analyse incidentality in addition to studies on accidentality.

It is based on the development and deployment of in-vehicle recorders that collect data on incident situations, i.e. driving situations inducing strong dynamic structural loading on the vehicle, potentially at the limits of the vehicle/driver/road environment system capacities, if not beyond. These recorders, named Emma (In-vehicle recorder for accident mechanisms) or EmmaPhone for their Android smartphone version, were designed at the LMA Laboratory.

FROM 2011 TO 2015, ACTIVITIES WERE FOCUSED ON THE FIRST PHASE OF THE PROJECT

The main actions were about:

- “development” aspects: design and improvement of the recording units’ performances, development of onboard applications, technical evaluation, setting up of operating architecture, etc.;
- “deployment” aspects: installation of some fifty Emma units in vehicles operated by territorial authorities, maintenance of these units, data collection and validation, construction of incident databases. The LMA also developed an appropriate legal procedure to eventually obtain the

CNIL’s authorisation to start installing these units and implement the data collection and processing phases. Data collection began in August 2012 for a scheduled period of 18 months.

- “operational” aspects: this phase 1 of S_VRAI made it possible to collect information on over 3,000 routes covering a large part of the French territory and over 1,500 events, including 350 incidents. Many thematic operations were defined and conducted:
 - incident rate as an indicator of poor road safety;
 - improvement of accident mechanisms knowledge;
 - causal relations between incidents and infrastructure;
 - causal relations between incidents and behaviours;
 - characterisation of the dynamic parameters of driving.

A number of scientific barriers have been overcome: technical and legal procedures were developed so that, in all security, safety and respect for the drivers rights, it is now possible to deploy the recording units within fleets of state agency vehicles, to analyse the causal relations between accidents and incidents and to use incidentology as a diagnosis tool for infrastructure. These data collection methods, based on the recording units and the associated analysis methods, have also been used in other projects such as Dymoa (Diagnosis of infrastructures and vehicle dynamics for motor cars and bikes) funded by the Fondation sécurité routière (French road safety foundation). In the framework

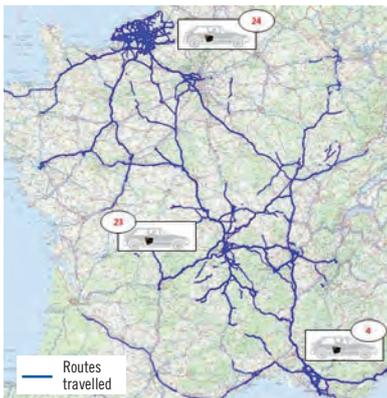


Emma units (In-vehicle accident mechanisms recording units): version 2, version 3 and “EmmaPhone” version

of this project, which essentially uses EmmaPhones, new features were added such as to cater for the specificities of motorised two-wheelers with this method, or the integration of video capture to provide even more contextual information and a speed observation facility.

Phase 2 of the S_VRAI project will look at a broader deployment of these recording units, through partnerships with local authorities, so as to expand the scope of incident analysis to a larger scale and consolidate the tools developed. Since 2016 contracts have already been signed with a number of players in the field of road safety, chiefly the departmental councils in charge of road management. A business model has been developed around this deployment and a partnership with the Logiroad was initiated to ensure the operational transfer of the methodologies developed. A guideline for compliance with the legislation in terms of personal data protection for the drivers will be submitted to CNIL in order to set up a simplified and lasting procedure to complete this project, with a view to broadening partnerships to other road management operators. Some thirty vehicles for each partnering administrative region (department) will thus be equipped to collect data over 12 months. The resulting data gathered on the types of incidents and their precise location of occurrence will be instrumental in improving local road safety policies and prioritising infrastructure upgrading programmes.

Apart from the benefits expected for each departmental council, mutualisation of the collected data will make it possible to extend incidentology analysis at a nationwide level.



Geographical distribution of equipped vehicles, routes travelled and incidents

EUROPEAN SCENE

IFSTTAR more visible and better heard in Brussels

In order to ensure IFSTTAR's representation in Brussels, Mrs Odile Arbeit de Chalendar (Division of European and International Affairs) was assigned to Clora (Club of associated research organisations) as from May 2016.

CLORA, A FRENCH PUBLIC RESEARCH PLATFORM IN BRUSSELS

Clora facilitates the action of French public research players in Brussels. This platform is designed to foster exchanges, watch, analysis and early warnings with newsletters, memos, thematic days, a website clora.eu and an alerts Twitter account @clora_eu. It is a locus for exchange of ideas and dialogue at the disposal of its members. Encounters are organized with the MENESR (Ministry of education and research), the permanent representation, the Commission and the European Parliament.

In 2016, a position paper was drafted on Horizon 2020. Among the next topics to be tabled are the 9th framework-programme (FP9) and the European Research Council (ERC). Clora brings together a total 32 members, state research bodies and representatives of French universities. IFSTTAR is part of the first circle of 10 members who have a physical representation in Brussels while remaining in touch with researchers.



Claude Marin-Lamellet (deputy director of European and International affairs), Odile Arbeit de Chalendar and Jean-Paul Mizzi (Deputy Managing Director) at Clora

NEW BENEFITS FOR IFSTTAR

The Brussels representation within Clora gives access to more strategic level information (legislative work, European news, major challenges). Depending on its content, this information is circulated to the General Directorate, the research departments, or on Twitter. European project owners can also get help on demand in order to tune up their projects to the European context. Lastly, IFSTTAR extends its influence with European institutions through encounters.



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INTERNATIONAL SCENE

Boosting idea sharing during major conventions

IFSTTAR regularly organises side events during or in parallel with major international conventions that bring together many European and international experts and pave the way for cooperation topics in the years to come. These encounters are organized in France, whether they are held here or elsewhere.

In 2016, this type of event took place in conjunction with the TRA 2016 (Warsaw) for transports, Setac 2016 (Nantes) on the theme of roads, the city and the environment, TAP 2016 (Lyon) for clean vehicles and air. The discussions revolved around these themes from different angles: science, innovation, mutualisation of testing or computing

facilities and the objectives of the various partners across the world, in order to factor in shared topics of interest into the H2020 programmatic framework and take into account the funding mechanisms of research in the various countries.

Various side events were thus staged this year and helped better coordinate the various possible contributions to the European Commission's framework-programme in the field of transport, energy, environment and the city. This "upstream" approach fully integrates the associations IFSTTAR takes part in.



Feedback on the 8th Rilem International Conference on Mechanisms of Cracking and Debonding in Pavements, held from 7 to 9 June at the Cité des Congrès in Nantes

Scorching sun, massive strikes of June, terrorist threats, nothing could derail the commitment of the 230 speakers from 33 foreign countries who came to attend the MCD2016 conference. This was an ideal opportunity to visit IFSTTAR's facilities in Nantes. Jointly organised by the 241th technical committee of Rilem (TC241-MCD) and IFSTTAR, this 8th edition, chaired by Armelle Chabot from the Mast department,

was devoted to state-of-the-art models and tools to better understand the mechanisms at play in the cracking and debonding phenomena between pavement layers. 6 renowned lecturers reported on their research work focussed on the conference themes as piloted by the TC241-MCD, around 4 workshops and 106 presentations (oral ones and poster selected and published by Springer (Rilem Bookseries volume 3

of heavy loads in the context of climate change, and the use of new sensors (damage detection) that could be pervasive in future roads.

15 exhibition booths and 10 sponsors helped finance friendly moments of interaction, whether at the *Cité des Congrès*, in the old town or at the Stereolux in the creative arts district. Following the MCD2016 conference, some twenty detailed papers will be published in 3 special magazine issues (to be finalised in 2017). Several contacts were made and others strengthened with the academic partners of I-Site NEXt on crack simulation and detection methods, including with American counterparts such as in the context of Professor Bill Buttlar's new laboratory on smart roads (MAPIL: Missouri Asphalt Pavement and Innovation Lab).



8th Rilem MCD2016, 7-9 June Nantes





SCIENTIFIC ACTIVITY RESEARCH/EXPERTISE

2016 marked the end of a cycle aiming to renew the framework of IFSTTAR's scientific activities. First of all, IFSTTAR's evaluation cycle by Hcéres was completed and with a very positive outcome regarding the organization of our research into five departments of approximately 200 people (Mast, Gers, Cosys, TS2 and Ame), their scientific production, but also the very organization of our institute as such. Besides, in 2016 we finalized the "reprioritization of our scientific focus areas", in line with the projects of our departments but also with the expectations of our partners and line ministries, while taking into account the prospects of human and financial resources for the next few years. This endeavor materialized in the form of a "detailed scientific strategy document" and was conducted alongside discussions with both the central administration's general directorates and our partners with a view to drafting our 2017-2021 Goals and Performance Contract. By the end of 2016, IFSTTAR was thus endowed with a renewed framework. Besides, the management teams of four of our departments were coming to the end of their term of office at the end of 2016. They were all reappointed for a 5-year mandate, *via* an open procedure, similar to that of the previous year, and which included the development of a leadership and management project, exchanges with the laboratories, general meetings for each site, opinion solicited from the departmental councils, projects submitted to the executive committee and to the Scientific Council respectively. Concerning scientific support, 2016 saw the emergence of "overarching projects", a new incentive tool designed to federate IFSTTAR's research teams around a cross-cutting theme while at the same time spurring exchanges and scientific encounters, but also designed to reinforce IFSTTAR's image for external communication purposes, keen to showcase broad research programs liable to address our fellow citizens' practical concerns, such as successfully demonstrated by the "R5G" project. Throughout the year a number of research themes were

gradually identified in conjunction with the research structures and four projects should thus be launched in 2017.

Also note that in 2016 the management of the sustainable development research teams gradually took shape to reach its cruising speed with a complete cycle of tasks (promotions, emeritus honors, competitions, minor and major evaluations). In 2016 the diversity of scientific distinctions reflected the broad spectrum of the Institute's activities while numbers also spoke for the breadth of the year's output: some 385 articles published in international journals (2015 indicator), 3 patents, 9 software programs filed, 2 databases, plus 72 IFSTTAR theses and 8 HDRs (accreditation to supervise research) defended.



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Scientific director



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Antoine Frémont
Deputy Scientific director



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MATERIALS AND STRUCTURES DEPARTMENT

The department develops its research and expertise on materials, transport infrastructures and large civil engineering structures, in particular in the area of power generation and transportation. It stands at the interface between upstream academic research and downstream applications related to its fields of expertise. The department owns a number of large-size research facilities requiring big technical teams. Its research activities, some of which are highlighted below for 2016, are based around three core themes:

- Sustainability of strategic infrastructures
- Development of circular economy in construction
- Disruptive innovations in transport infrastructures

Durability of strategic infrastructures (transports, networks, power generation)

Instrumentation, testing, monitoring and management of infrastructures and engineered structures

- Laboratory validation of the monitoring system for offshore windfarms' corrosion and fatigue (SURFFEOL Program with the *Pays de la Loire* region);
- Instrumentation and experimentation of the strength of a composite-reinforced VIPP (independent-span and post-tensioned prestressed) beam, as part of Cerema's CLERVAL project (Cerema's 2016 innovation prize);
- Completion of the ANR-EVADEOS (non-destructive evaluation for the prediction of structures degradation and optimization of their monitoring) project in January 2016;
- Completion of the APOS (Testing of reliable engineered structures) and MCV (Control of Engineered structures lifecycle) research operations; deliverables in the form of interactive proceedings;
- Development of the Web application for the Virtual Road Networks (RRV) simulator and for the Simplified Road Management System (GSR) (to optimize road works efficiency).

Internal swelling reactions in concrete (RGI)

- Nam Nghia Bui's defense of thesis on ettringite precipitation and crystal growth mechanism (RSI or external attack);
- End of his 2-year stay for Y. Kawabata, guest researcher from PARI (Japan): study and modelling of creep effect on the behavior of structures affected by RGI and influence of RGI on the hydric transfer properties of materials.

Durability of cementitious materials

- Study of abiotic interactions between H₂S and the various cementitious materials in sewage networks with a view to developing an accelerated testing process;
- Rim Ragoug's defense of thesis on "External sulphate attack on cementitious materials – Impacts of age, binder composition and presence of chlorides" (better knowledge of the durability of concrete in early contact with sea water).

Durability of polymers, cables and reinforcements

- Experimentation on the relaxation and temperature behavior of prestressing cables of nuclear enclosures as part of the ANR MACENA project (controlling the confinement of a damaged enclosure);
- Commencement of the renovation of a major IFSTTAR facility ("cable fatigue bench") in the framework of the PIA-Ademe OCEAGEN project.

Mechanical behavior of engineered structures

- Improving the probabilistic modelling of cracked reinforced concrete: taking heterogeneity into account;
- Combined transfer/cracking tests in reinforced concrete structures (ANR MACENA);
- Development of a fracture mechanics method to check the strength of masonry walls; organization of the first national days of masonry.

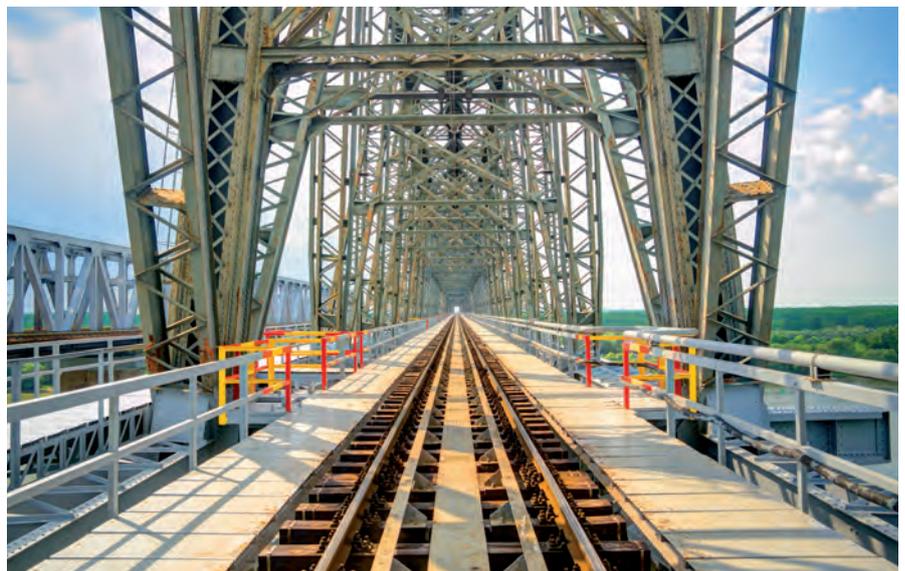
Roads modelling and durability

- Analysis of cracked pavements: defense of the thesis by Hanan Nasser on resolving multi-particular modelling of discontinuous pavements; collaboration with Colas (FABAC accelerated tests); Lames/Gem thesis (ECN);
- Analysis of pavement reinforcement by glass grids in the ANR SolDuGri project (carrousel tests + bonding thesis);

- Analysis of the combined action of freezing/thawing, rain and traffic (Post-Doctoral thesis in conjunction with the Quebec Ministry of Transport);
- Continuation of the ITN European project on Sustainable Pavement and Railway (Thesis on durability of recycled asphalt mixes);
- In June organization of the 8th RILEM international conference in Nantes - MCD 2016 on cracking and debonding mechanisms in pavements (mcd2016.sciencesconf.org) – Publication of Rilem Book series (Springer).

Repair, reinforcement and risk mitigation

- Defense of Astrid Billon's thesis on the development of a non-destructive pull-off test designed to check the bonding of reinforcements by composite materials;
- Commencement of the FASST bridge European project comprising a study on the sizing of bonded assemblies and their durability.



Developing a circular economy in the construction industry

Alternative materials for infrastructures and buildings

- Opening of the ECOMAT international associated laboratory (LIA) with University of Sherbrooke (Quebec) on low-clinker content cementitious materials; beginning of a co-supervised thesis on the use of alternative materials for cement (ground glass + calcinated sludge);
- Defense of Hajjer Rabii's thesis on durability of natural-fiber reinforced composites;
- Development of road binders from biomass (ANR Algoroute project, European Infravation project Biorepavation).

Life-cycle and recycling

- Defense of Aurélien Neveu's thesis on the fracturing of granular materials: application to the optimization of crushing, in particular during recycling;
- Start of a thesis on rediscovered traditional raw earth-based construction processes.

Processes, fluids and complex materials

- Study of the drying of stacked grains of different sizes (from nanometer to millimeter), saturated with a simple liquid or a fluid;
- Test bench study on fatal heat recovery and optimization of humid granular materials injection in rotary kilns.

Innovative transport infrastructures

Innovative roads

- In the framework of the H2020 FOX European project, latest innovations in the area of pavement testing methods, materials, structures and recycling;
- Artificial turf compounds covered with protective slabs tested on the fatigue carousel. These compounds are designed for heavy road vehicles (for the Arena 92 rugby stadium);
- Completion of the concrete slab pavement tests on the fatigue test track, with induction charge devices for electric vehicles;
- Testing of the defrosting pavement demonstrator conducted in Egletons with Cerema;
- Development of a solar pavement mock-up, installed in Sense-City.

Innovative structures

- Development of structural bonding (FASSTbridge project) and hybrid materials (with ISAT);
- Wood-based composites: finalization of a thesis on wood pellets-based concrete;
- Winding of the RGCU BADIFOPS project, publication of product and design standards pertaining to UHPFRC concrete and in particular paraseismic design;
- Defense of Thomas Guenet's thesis on the development of an advanced computing tool for UHPFRC structures explicitly allowing for fiber orientation and distribution.

Innovative railways

- FUI Reves project: in March 2016 beginning of Octavio Perez's CIFRE SNCF thesis to develop a creep model for asphalt mixes (visco-plastic model) as an alternative for the ballast;
- Defense of Omar Moreno's thesis on the behavior of cracked masonry vaults (RATP), development of a model in CESAR-LCPC.



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DEPARTEMENT ORGANISATION

MAST

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 Deputy Director (MLV): **Jean-Michel Torrenti**
 Deputy Director (Nantes): **Christian Tessier**
 Deputy Director (International): **Bruno Godart**
 Technical and innovative actions Manager: **Fabienne Anfosso-Ledee**
 Administrative Manager: **Valérie Fournier**

SCIENTIFIC MANAGEMENT

R&D Deputy Director: **François Toutlemonde**
 Navier Scientific Director: **Jean-Noël Roux**
 (ARD facilitators)

FM2D

MIX-DESIGN, MICROSTRUCTURE, MODELLING AND DURABILITY OF BUILDING MATERIALS LABORATORY

Director: **Teddy Fen-Chong**
 Deputy Director: **Véronique Baroghel-Bouny**

CPDM

PHYSICAL-CHEMICAL BEHAVIOUR AND DURABILITY OF MATERIALS LABORATORY

Director: **Loïc Divet**
 Deputy Director: **Thierry Chaussadent**

NAVIER LABORATORY

Director: **Karam Sab**
 Deputy Director: **François Chevoir**

GPEM

AGGREGATES AND MATERIALS PROCESSING LABORATORY

Director: **Grigore Cazacliu**
 Deputy Director: **Patrick Richard**

MIT

ADVANCED MATERIALS FOR TRANSPORTATION INFRASTRUCTURE LABORATORY

Director: **Ferhat Hammoum**
 Deputy Director: **Thierry Sedran**

SDOA

SAFETY AND DURABILITY OF STRUCTURES LABORATORY

Director: **Pierre Argoul**
 Deputy Director: **André Orcesi**

EMMS

EXPERIMENTAL AND NUMERICAL ANALYSIS OF MATERIALS AND STRUCTURES LABORATORY

Director: **Pierre Marchand**
 Deputy Director: **Renaud-Pierre Martin**

SMC

METALLIC STRUCTURES AND CABLES LABORATORY

Director: **Laurent Gaillet**
 Deputy Director: **Lamine Dieng**

LAMES

MODELLING, EXPERIMENTATION AND SURVEY OF TRANSPORT INFRASTRUCTURES LABORATORY

Director: **Pierre Hornych**

GEOTECHNICAL ENGINEERING, ENVIRONMENT, NATURAL HAZARDS AND EARTH SCIENCES DEPARTMENT



The department's core activity is geosciences as applied to civil engineering and spatial planning. It spans most of the skills harbored at IFSTTAR: geotechnics, geology, hydrology, environmental chemistry, geophysics and testing. The department has six in-house laboratories and takes parts in two mixed research units. Its teams are distributed across several IFSTTAR sites: Nantes-Bouguenais (60%), Marne-la-Vallée (30%), Bron (7%), with another four agents based in Grenoble at the UMR ISTerre.

The Gers department agents conduct finalized research in four pillar areas under IFSTTAR's Goals and Performance Contract:

- Geotechnical engineering and in particular the development of technologies for foundations, anchoring and supporting structures, the design of earthfills or improvement of earthwork techniques;

- Prevention of natural hazards from the knowledge, modelling and forecasting of hazards (seismic, hydraulic or rockfalls) to the study of construction design strength and the designing of protection mechanisms;
- Water and urban planning with two main focus areas, i.e. the influence of urban planning facilities on the associated water and heat balances as well as on the quality of surface

- and underground waters including the evaluation of pollution resulting from the use of recycled materials in civil engineering works;
- Development of geophysical techniques and innovative non-destructive methods for investigating near-surface layers and monitoring civil engineering structures.

The research projects are often applications-oriented and combine laboratory characterization of material properties, testing on small-scale models, in-situ experimental follow-up, digital models, and sometimes even development of hardware.

The department possesses outstanding scientific facilities, including a geotechnical centrifuge equipped with an earthquake simulator to conduct tests on small-scale models, a rockfall station designed to test the rock-shed protective equipment, an ultrasound measurement bench to test new geophysical measurement methods on small-scale models and laboratories specializing in soil mechanics and chemistry. Participating in, and steering miscellaneous scientific and technical associations, scientific councils as well as standardization and experts' assessments are typically part of the activities of the department's agents. These activities are indeed essential to nurture exchanges with professional circles and bring to the fore scientific issues related to applications and responding to operational needs.



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2016 AT A GLANCE

3RD EUROFUGE CONGRESS, 1 TO 3 JUNE, IN NANTES

With the IFSTTAR centrifuge, the *Ecole Normale's* water tunnels and wave tanks and the CSTB's wind tunnel, Nantes is the European city boasting the largest number of facilities for physical modelling. The latter can be used to study at low cost, and on small-scale models, the behavior of real-scale engineered structures.

The 3rd Eurofuge Congress, organized at the IFSTTAR site in Nantes, brought together some one hundred experts who came to share ideas on infrastructures and physical modelling equipment as well as how to use the latter to study natural hazards and for the design of renewable energy generation infrastructures.

8TH BIENNAL RAP CONFERENCE, 4 TO 10 NOVEMBER IN GUADELOUPE

RAP (Permanent accelerometer network), created in 1995 under the aegis of the French Ministry of Environment, is a component of the RESIF Equipex. It is headed by Philippe Guéguen, a research director at IFSTTAR, currently assigned to the ISTerre joint research unit (UMR).

RAP is a network of monitoring instruments designed for seismic activity and induced movements in the ground and constructions. It is one of the spearheads of French seismic research. Every two years the community of RAP's data users convenes for a scientific and technical conference. The 8th edition was organized in the French West Indies, at the heart of the most earthquake-prone area of the French territories.

DISTRIBUTED FORECAST OF SUDDEN FLOODS: TOWARDS AN ESTIMATE OF POTENTIAL IMPACTS

Through a partnership with Cerema and a reinsurance fund (*Caisse centrale de réassurance - CCR*), and as part of a PhD thesis, IFSTTAR has developed a prototype forecast model for the potential impact of sudden floods: number of buildings in the expected flooded area. In due course, the idea would be to provide crisis managers with readily operational data to identify the priorities and facilitate decision-making.

The prototype was applied to the administrative departments of Gard and Var.

A comparison of listed flood events – CCR database – against the prototype's output data for recent major floods confirmed the potential of this approach.

ANR MENTOR PROJECT: IMPROVING MEASUREMENTS IN URBAN SEWAGE SYSTEMS

The MENTOR project (<http://www.gemcea.org/projets/mentor>), which is coordinated by IFSTTAR, was designed to improve measurement practices for water and pollutant flows in urban sewage systems. Ten partners (IFSTTAR, Insa - LGCIE, IMFS – HU, Insa – LMFA, Leesu, EVS, Nantes Métropole, Lyonnaise des eaux, Grand Lyon, GEMCEA) took part in this project with the closing session taking place on 4 February 2016. The findings were published in scientific and technical reviews in the form of technical guidelines for managers, design and engineering firms and State-run water agencies.

EXPERTS' INVESTIGATION INTO THE VIBRATION LEVELS EXPECTED AROUND THE ROUEN BYPASS

A study was commissioned from IFSTTAR by *Dreal Normandie* with a view to estimating the vibration levels expected in the vicinity of the future motorway bypass in Rouen, in particular close to the DGA's (French defense procurement agency) hydrodynamic technical test center which lies close to the plotted bypass. After extensive geophysical investigations on site, a digital model was used to analyze the propagation of typical vibrations expected on this thoroughfare. The detailed study highlighted the topographical effects and the mitigating role of backfill materials in terms of vibration propagation.

It concluded that the expected level of vibration was quite low, barely background noise.



FOCUS ON 2016

OFFSHORE WIND TURBINES: THREE IFSTTAR PROJECTS SELECTED AS PART OF THE WEAMEC 2016 CALL FOR TENDERS

The Pays de la Loire region is resolutely positioned as a leading French territory in terms of innovation and development for renewable marine energies. In 2015, the region initiated the West Atlantic Marine Energy Centre (WeAMEC), bringing together several research and industrial centers to support this ambition. For the first call for tenders launched by WeAMEC in 2016, all three projects coordinated by IFSTTAR/Gers researchers were selected. This is further proof, if need be, of the relevance of IFSTTAR's research and innovation offering in the area of renewable energies.

The three chosen projects that will underpin the activities of the Gers department in the three years to come for renewable marine energies are first of all REDENV-EOL, a project involving researchers from *École centrale* in Nantes and University of Saint-Nazaire, and aiming to develop a reference experimental database for the design and sizing of floating wind turbine anchoring systems based on centrifuge tests. The detailed study of the effect of cyclic tractions on the behavior of anchorages will be the main focus of this research. Secondly, the OMCEND project, with researchers from *École centrale* in Nantes, is looking at ways to transfer the guided waves technology, developed by IFSTTAR for testing metallic structural cables, to the non-destructive evaluation of floating wind turbines. This research will combine digital and experimental approaches to better understand and control the propagation of acoustic waves of special design electric cables. In due course, the objective is to propose operational testing techniques for cable connections exposed to high stresses due to the movement of structures, for early detection of potential breakage. The third project, PROSE, aims to optimize geophysical, electrical and seismic near-surface imaging methods when they are applied to nearshore offshore configurations, in particular by offering new appropriate seismic sources. The idea is to improve exploratory survey methods for the siting of wind turbine structures and their connection cables. This project, which involves research teams of *École centrale* and Nantes University, will be based on digital modelling, small-scale experimental studies (IFSTTAR's MUSC bench and acoustic tank) and on-site tests at the SEMREV experimentation rig, off the coast of Saint-Nazaire.

DEPARTEMENT ORGANISATION

GERS

GEOTECHNICAL ENGINEERING,
ENVIRONMENT, NATURAL HAZARDS
AND EARTH SCIENCES DEPARTMENT

Director: **Eric Gaume**

Administrative Manager: **Jeannine Leroy**

Deputy Directors: **Philippe Cote**

(Nantes, in charge of contracts),

Jean-Pierre Rajot

(Bron, geotechnical engineering),

Jean-François Semblat

(Marne-la-Vallée, Natural hazards)

GÉOEND

ASSESSMENT AND IMAGING
LABORATORY

Director: **Odile Abraham**

LEE

WATER AND ENVIRONMENT
LABORATORY

Director: **Claude Joannis**

Deputy Director: **Véronique Ruban**

GMG

GEOMATERIALS AND GEOTECHNICAL
MODELLING LABORATORY

Director: **Luc Thorel**

Deputy Director: **Thierry Dubreucq**

SRO

SOILS, ROCKS AND GEOTECHNICAL
STRUCTURES LABORATORY

Director: **Christophe Chevalier**

SV

EARTHQUAKES AND VIBRATIONS
LABORATORY

Director: **Jean-François Semblat**

RRO

ROCKFALL HAZARDS AND DESIGN
OF GEOTECHNICAL STRUCTURES
LABORATORY

Director: **Jean-Pierre Rajot**

Deputy Director: **Patrick Joffrin**

NAVIER LABORATORY

(UMR 8205 Ecole des Ponts / Ifsttar / CNRS)

Director: **Karam Sab**

ISTERRE

INSTITUTE OF EARTH SCIENCES

(UMR 5275 Université Joseph Fourier / CNRS /

Université Savoie Mont Blanc / IRD / Ifsttar)

Director: **Stéphane Guillot**

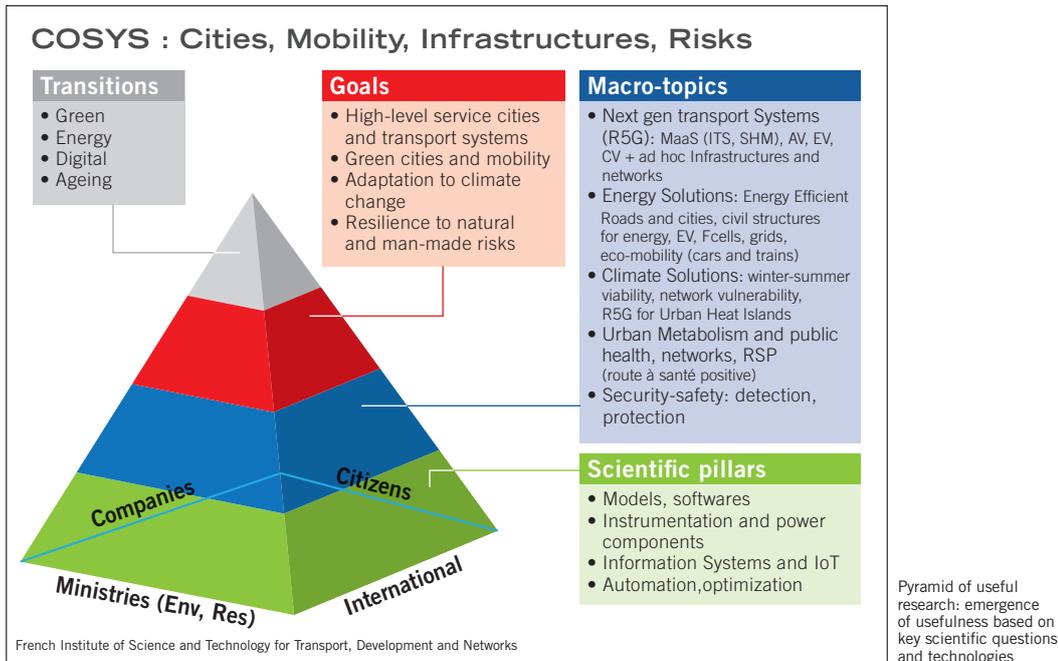
COMPONENTS AND SYSTEMS DEPARTMENT



COSYS, the Components and Systems department, ambitions to develop the concepts and tools needed to improve the basic knowledge, methods, technologies and operational systems for a renewed understanding of mobility, infrastructure networks and large urban systems.

The department thus aims to improve on several criteria: effectiveness, safety, security, resilience, carbon footprint and impacts on the environment and health. Contributing to the effectiveness, low-carbon consumption and resilience of cities and transport systems which play a central role at the service of the whole economy, offering high value-added services to make territories even more attractive for both business and quality of life, are the targets identified by COSYS. These are the objectives that underpin the roadmap of the 5th-Generation Road (R5G) steered by the department.





Knowledge production inspired by breakthrough practices, transforming such knowledge into useful products and providing theoretical rationale for public policies and evaluation of the changes brought about by innovations within its remit are all in the department's DNA. Its staff comprises 270 people in all, including 80 PhD students, across 7 sites, and Cosys also boasts 10 laboratories covering a wide spectrum of scientific disciplines from information sciences and technologies to engineering sciences.

The department has been involved in the I4S (Inference for Structures), a joint project team with INRIA Rennes Bretagne Atlantique since 2013, in two "mixed units", Licit with ENTPE and the Satie's Tema team, but also in two joint research teams with CEA-LETI (CARMIN) and *École Polytechnique* (NACRE).

It also takes part in two GIS scientific panels (ITS and DURSI), providing for the presidency of the scientific council and coordination tasks.

The department takes a very active part in European and international action. It steers or co-steers Eurnex, Nearctis and Hycon2 excellence networks and contributes to technological platforms or councils such as ECTP or Errac. It gave its input to over 45 projects of 7th FRDP (Framework Research

and Development Program) while continuing its work within H2020. Finally, the department is strongly involved in the Future Investments program: it coordinates TRI Technological research institutes (Railenium, SystemX and Jules Verne) and ETI Energy transition institutes (VéDéCom and Efficacity, Equipex Sense-City). It plays an active role in the industrial relationship with businesses of all sizes in the fields of transports, infrastructure, energy and telecommunications.

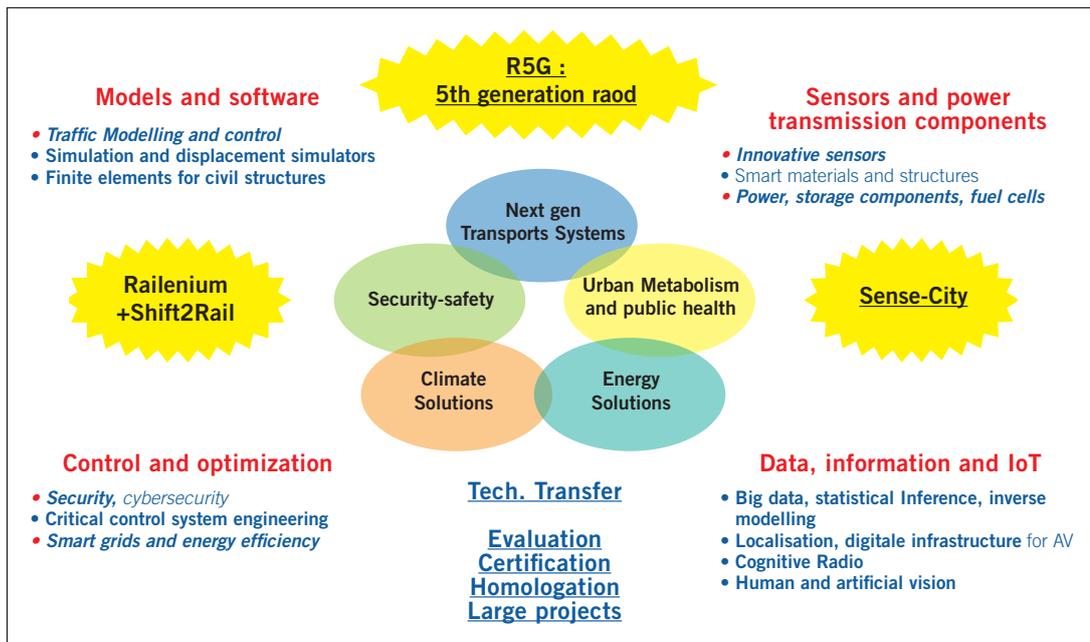
One of the core ambitions of Cosys is also to create jobs through start-ups or more generally encourage transfers of technologies.

The department's scientific mission statement is based around four pillars designed to address some of the major societal and economic challenges identified. These macro-themes provide a link between these pillars and the societal challenges addressed by IFSTTAR. More specifically they ambition to support the deployment of self-driving vehicles and new mobility services, energy-climate solutions, the articulation between the city, transport and healthcare, not to mention safety and security. Remarkable outcomes were achieved this year, with an emphasis on the digital and environmental transition of transports. In the area of smart network management,

a simulation demonstrated the feasibility of doubling the capacity of railway networks to handle freight through regulation based on detailed digital modelling (this was done on a 100-km long segment of the Paris-Le Havre rail line). On urban motorways, access regulation also made its point in practice by ending congestions on motorway A25, following similar earlier successful attempts in Île-de-France region which had convinced the Dirif (Île de France Interdepartmental Road Directorate) to extend such access regulation to all the greater Paris expressways with the help of Cosys. This experimentation provided proof of the concept in real-life conditions for on-board floating car data (FCD) in replacement of, or in addition to fixed loops.

In the area of infrastructures, Cesar now has new dynamic computing tools for reinforced earthwall structures to support TGV rail-tracks, which is a key milestone in ensuring that SNCF signs off these low-cost and small footprint structures.

Besides, the digital transition of transports and the city materialized with a series of results obtained in terms of mass data analysis for urban mobility and networks which provide a new insight into daily consumption profiles and their trends, thus helping operators optimize their management of transport systems or water production.



Macro-themes as a lever to mobilize skills

The Internet of Things for security-related applications in railways has also been quite successful in terms of European innovations.

Simulation of partly-delegated driving has made a new decisive step forward for the joint-venture with ESI with the decision to showcase IFSTTAR’s technologies at the Las Vegas CES 2017. In-town geopositioning combining GNSS and 3D maps succeeded in reducing the integrity risk by a factor of 10, which is a ground-breaking advance in introducing self-driving vehicles.

The success stories of Luxondes and Stanley Robotics, two IFSTTAR start-ups run by the department’s researchers, have confirmed the relevance of the underlying knowledge base and tools as well as the momentum shown by the people in charge.

The department continued its innovation effort in the digital area with the creation of start-up Ecotropy which evaluates in advance the performance of energy-efficiency renovations of buildings and offers digital tools to be used for energy performance guarantee. Also to be mentioned is the maturation project SmartR which could potentially give birth to a start-up specializing in low-cost vehicle weighing by nanomaterial. 7 patents were registered in 2016 to prepare tomorrow’s innovation.

The Hybrid Solar Road presented at COP21 and COP22, smart defrosting

of subway tracks, deployment of an ultra-dense mesh of air quality sensors, real-time calculation of dynamic maps of traffic-related pollution underpinning the ITS4Climate initiative, smart grid for railway stations with Efficacity, and urban lighting by LEDs are as many innovation drivers for the environmental and energy transition of transports and the cities.

The 5G Road has confirmed its potential to change practices in the field of territorial innovation with the launch of the great living labs for open innovation such as the LGV BPL, the transformation of county road RD199 into a new generation urban boulevard in Champs-sur-Marne, launching of the Open Highway Innovation Lab A355 in Strasbourg and contribution to the Laboratory of usages in Nouvelle Aquitaine.

A very visible marker of the department’s commitment to energy transition and the mutation of transports, in France and abroad, the 5G Road brought together a number of industrial operators in a very challenging and potentially defining response to Ademe’s *Route du Futur* (“Road of the Future”) call for projects. 2016 therefore initiated a change of scale for innovations conducive to the deployment of cooperative, electric, autonomous mobility and also of mobility as a service, as well as for the Internet of Things.

Overseas, the new MOU with *Politecnico de Milano* includes crossed doctoral training. Three high-level experts’ assessments for the Shanghai-based Tongji University and the Beijing Jiaotong University, including the State Key Laboratory of Rail Traffic Control and Safety, generated very interesting exchanges with several teams.

In addition to several European projects that started this year, the grounds were laid with Railenium for some other projects in the framework of Shift2Rail. This ramping up of international visibility was also reflected by Mitsubishi’s visit to Satory, as recognition of the Institute’s distinctive competencies in terms of understanding and evaluating the ageing of power components.

All of these elements of knowledge crystallized in digital tools can help improve the operation of transport systems, better evaluate pollutions linked with motor traffic or urban activity, prepare the transition towards environmentally-friendly mobility and positive-energy territories, and foster active mobility of all people irrespective of age.

Transport players require this capacity of expertise, simulation and data processing made available by this knowledge and these tools.



FOCUS ON 2016

TRAFFIC REGULATION

Optimal operation of existing transport infrastructures helps territorial stakeholders better manage the public space and enhance the capacity of these infrastructures at low cost. To this end, IFSTTAR has developed and tested in real-life conditions concepts and tools of high maturity: virtual prototyping of traffic regulation strategies on the expressways in Île-de-France and Hauts-de-France regions, thanks to the Magister platform, evaluation of regulation strategies or dynamic traffic lane management, including using emergency lanes, multimodal supervision of mobility at the scale of a whole territory.

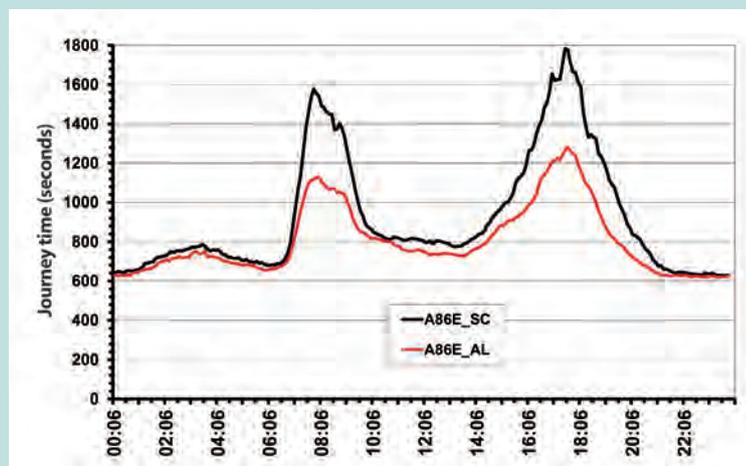
The Magister general simulation platform makes it possible to anticipate strategies for dynamic access control and dynamic speed management, users' guidance and crossroads regulation. The Alinea access control strategy is already operational for the whole east part of Île-de-France motorways, in the Netherlands (Amsterdam ringroad), Glasgow (UK) and Australia (VIC).

These operating tools have revealed their potential: regulation on the A86E highlighted a significant potential improvement of traffic conditions (10 % gain on several



Example of access regulation

indicators), dynamic regulation for speed and access on a segment of the A25 drastically enhanced traffic fluidity, if not altogether cancelling out congestions, while providing mobility for a greater number of people.



Improved journey time on the A86E

Building up on this successful experience, in 2016 Dirif started extending regulation to 75 accesses across all expressways of the Île-de-France region.

This is a world premiere. Finally, the Abertis industrial chair on the operation of transport infrastructures reflects the international recognition of this thorough expertise on a posteriori evaluation of urban traffic regulation strategies at the scale of metropolitan areas, an expertise which was nurtured by the dynamic traffic lane management strategies experimented in Île-de-France.



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DEPARTEMENT ORGANISATION

COSYS

COMPONENTS AND SYSTEMS

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Deputy Director: **Marion Berbineau**

Administrative Manager: **Annick Bertrand**

ESTAS

EVALUATION OF AUTOMATED
TRANSPORT SYSTEMS
AND THEIR SAFETY LABORATORY

Director: **Joaquin Rodriguez**

GEOLOC

GEOPOSITIONING LABORATORY

Director: **Valérie Renaudin**

GRETTIA

ENGINEERING OF SURFACE
TRANSPORTATION NETWORKS
AND ADVANCED COMPUTING
LABORATORY

Director: **Jean-Patrick Lebacque**

Deputy Director: **Régine Seidowsky**

LEOST

ELECTRONICS, WAVES AND SIGNAL
PROCESSING FOR TRANSPORT
LABORATORY

Director: **Charles Tatkeu**

LEPSIS

ROAD OPERATIONS, PERCEPTION,
SIMULATORS AND SIMULATIONS
LABORATORY

Director: **Didier Aubert**

Deputy Director: **Éric Dumont**

LICIT

TRANSPORT AND TRAFFIC ENGINEERING
LABORATORY

Director: **Nour-Eddin El Faouzi**

Deputy Director: **Ludovic Leclercq**

LISIS

INSTRUMENTATION, SCIENTIFIC
INFORMATICS AND SIMULATION
LABORATORY

Director: **Patrice Chatellier**

Deputy Director: **François Derx**

LIVIC

VEHICLE INFRASTRUCTURE DRIVER
INTERACTIONS LABORATORY

Director: **Dominique Gruyer**

Deputy Director: **Olivier Orfila**

LTN

LABORATORY OF NEW TECHNOLOGIES

Director: **Zoubir Khatir**

MACSI

MATERIALS ASSEMBLIES COMPOSITES
FOR INTELLIGENT STRUCTURES
LABORATORY

Director: **Monsef Drissi-Habti**

SII

STRUCTURES AND INSTRUMENTATION
LABORATORY

Director: **Louis-Marie Cottineau**

Deputy Director: **Vincent le Cam**

TRANSPORT, HEALTH, SAFETY DEPARTMENT



The TS2 department is where most of the IFSTTAR teams working in the field of health and/or safety for transport can work together.



A leading emphasis of the department is that of ground transportation safety, especially road transport. In terms of safety, associated factors can be ascribed to the vehicle, infrastructure or the user himself: the department especially strives to understand human factors and their interactions with the vehicle and only to a lesser extent with the infrastructure. The department also delves into the aspect of injuries (whether lethal or not) caused by road accidents, the injury mechanisms behind them while also appraising potential protection tools and methods. A third emphasis is on what happens to the victims (and their relatives) in the aftermath. This unfolds into 7 strategic areas of research:

1. **Assessment and aid to decision-making in the field of transport;**
2. **Primary road safety factors and man-machine interactions;**
3. **Consequences of mobility on morbidity;**
4. **The virtual human being;**
5. **Users of self-driving and connected cars;**
6. **Mobility for weakened people, ageing and handicaps;**
7. **Healthcare and day-to-day mobility.**

TS2 is a very multidisciplinary department, both by nature and out of necessity in order to address the above-mentioned priorities. It combines disciplines pertaining to Human and Social Sciences with Engineering or Life Sciences.

With its 3 UMRs, it is strongly anchored in the world of academia.

In 2016, the outcomes of many research projects and theses defended have provided further insight into these topics, as illustrated in the focus and news-in-brief of the pages below. Also to be noted is vehicle automation, for individual cars or heavy vehicles, which has now become a core issue and questioned the previous debate opposing private vehicles and collective transports. Vehicle automation obviously raises important questions of road safety, whether about vehicle traffic, in the transition phase with both these new vehicles and the traditional ones sharing the roads, interactions with vulnerable users (pedestrians, 2-wheelers, etc.) or the new uses of these vehicles, in which there is no reason to believe for instance that passenger postures should remain the same as today's. Questions such as how and when the driver potentially reassumes control of the vehicle in the event of danger, or for other reasons, should also be considered. Large-scale

automation can only take place once safety issues have been addressed. And much remains to be done in this area. The TS2 department is therefore quite naturally involved in the think tank launched by IFSTTAR in 2016 on *Mobilitéé 3.0*, as well as the prospective workshop on "mobility without driver" initiated by the mission on intelligent transports (under DGITM, French Ministry of Environment, Energy and Sea). Last but not least, the department's teams take part in 3 cross-cutting projects initiated at the Institute's level, including the "Virtual traveller" project which includes work on the virtual human being and man-vehicle interactions.



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2016 KEY NUMBERS

190

AGENTS INCLUDING 130 PERMANENT

5

LABORATORIES INCLUDING 3 UMRs (Joint research Units)



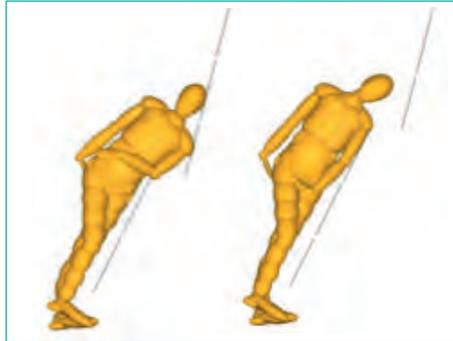
2/3 AGENTS IN RHÔNE-ALPES



1/3 AGENTS IN PROVENCE-ALPES-CÔTE D'AZUR

2016 AT A GLANCE

PTRAM-PEDESTRIAN SHOCK PROJECT (LBMC)



Kinematic of a pedestrian hit by a tram: the head may hit the windshield (left) inducing a serious risk of injuries but reinforcing the shoulder and giving the front-end a slant at head level (right) helps reducing the risk

This project conducted at IFSTTAR (LBMC) at the request of STRMTG looked at the scenario of an accident between a tram running at 20 km/hr and a pedestrian crossing the tracks. The aim was to study via digital simulation whether certain geometrical criteria on the front-end's design were liable to mitigate risks for pedestrians. A simplified front-end generation tool was developed for this purpose. Close to 10,000 simulations, including a study looking at the sensitivity to pedestrian height and impact speed resulted in a classification of various geometries. The latter would for instance suggest that reinforcing the shoulder whilst at the same time giving the front-end a slant at the level of the head would reduce the risk. The findings were analyzed by STRMTG to provide a baseline for tram manufacturers.

ACTUSAM PROJECT (FINANCED BY DSCR)

IFSTTAR's nationwide SAM study (Umrestte) on deadly accidents in the 2001-2003 period had made it possible to appraise the additional risk of accident for drivers under the influence of narcotics. The 2011 data of the "Voiesur" ANR project are now analyzed in the framework of the ActuSAM study, financed by DSCR, to update the previous findings. The prevalence of driving after cannabis use is estimated at 3.3 %. After adjustments, the additional risk associated with cannabis driving is put at 1.65 (IC95 %: 1.16-2.34), under the influence of alcohol at 17.8 (12.1-26.1), and opiates at 2.21 (1.02-4.78). No significant extra risk was highlighted for amphetamines or cocaine. The share of lethal accidents ascribable to cannabis is 4.2 %, versus 27.7 % for alcohol and 0.7 % for opiates. Compared against SAM, the effect of cannabis remains stable and by far inferior to alcohol. The share of accidents ascribable to cannabis versus those associated with alcohol remained unchanged. The main issue with cannabis remains its association with alcohol.

HOLIDES PROJECT (FINANCED BY FUI)

The aim of this project was to devise human-centered design software methods and tools for future "Adaptive and cooperative" (i. e. AdCoS) assistance systems capable of supervising human operators (motor-vehicle driving, control room operators, aircraft pilots or medical staff) and to assist them as required according to the context. IFSTTAR (Lescot, in partnership with Livic, ESI/Civitec and Intempora) developed an integrated virtual design platform based on the model of the Cosmodrive driver (assisted or not by an AdCoS) and thus making it possible to simulate the future uses and effects of these driving assistance systems (partly based on automated driving). This V-HCD (for Virtual Human Centered Design) platform is currently being transferred to the industry, in partnership with ESI/ Civitec. The first prototype of this platform was presented last January on the ESI group booth, during the Las Vegas CES2017 event (<https://www.esi-group.com/fr/entreprise/presse/communiqués-de-presse/decouvrez-le-virtual-human-loop-au-ces-de-las-vegas>).

HEDI HAMDANE THESIS (LBA AND LMA) - IMPROVING PEDESTRIAN SAFETY: VALIDATION OF ACTIVE SAFETY SYSTEMS VIA RECONSTRUCTION OF REAL ACCIDENTS

Road safety systems are being developed on vehicles to help identify the presence of pedestrians on the pavement and prevent potential collision through emergency braking. Such driver assistance systems have very seldom been validated in real-world accident configurations and therefore the objective was to confront them against a hundred or so cases. The results have cast some light on the spatial and temporal issues at stake: 1 sec prior to impact, most pedestrians are within 20 m from the vehicle. With a detection system featuring a 35° angle of vision and triggering braking 1 sec before the shock, over 50 % of such accidents could be avoided. In cases where the pedestrian is no longer avoidable, impact speed would be reduced by 20 km/hr approx. This work was conducted as part of a co-supervised thesis with the University of Adelaide's CASR department (Australia) on the one hand, and the LMA and LBA labs of IFSTTAR/THS on the other.



FOCUS ON 2016

FRANCK TECHER THESIS (LESCOT): IMPACT OF ANGER ON RISK-TAKING AND INFORMATION PROCESSING IN SIMULATED DRIVING

Anger is a negative emotion that can result in aggressive driving, underestimating risks and not abiding by the highway code rules. Some of these behavioral changes could be linked with a poor perception of the environment or a form of distraction caused by anger. The objective of this thesis was to study the influence of anger on attention as well as its repercussion on driving performance. The first study of this thesis showed that anger could improve the efficiency of the warning attentional network. This enhancement of the attentional network was observed during a computerized task, while a second experiment allowed checking whether the same effect was observed during a simulated driving task using behavioral and electroencephalographic measurements. The findings showed that anger disturbed trajectory control and diminished the attention devoted to the sensory processing of information. The last study, also using a simulator, finally revealed that anger could impair responsiveness during a vehicle-monitoring task, whilst having a positive impact on pedestrian detection.

The results of this thesis further highlight the benefits of taking the driver's state into consideration, i.e. all of the internal variables, including emotions, distraction or again wandering thoughts. Future vehicles or driving assistance systems could thus benefit from taking into account variations in the driver's state.



DEPARTEMENT ORGANISATION

TS2

TRANSPORT, HEALTH, SAFETY

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LBA

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LABORATORY

(UMR IFSTTAR/ Aix-Marseille University)

Director: **Stéphane Berdah**

Deputy Director: **Pierre-jean Arnoux**

LBMC

BIOMECHANICS AND IMPACT
MECHANICS LABORATORY

(UMR Ifsttar/Lyon University)

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Deputy Director: **Laurence Chèze**

LESCOT

ERGONOMICS AND COGNITIVE
SCIENCES APPLIED TO TRANSPORT
LABORATORY

Director: **Hélène Tattegrain**

Deputy Director: **Aline Alauzet**

LMA

ACCIDENT MECHANISM ANALYSIS
LABORATORY

Director: **Catherine Berthelon**

Deputy Directors: **Michèle Guilbot, Thierry Serre**

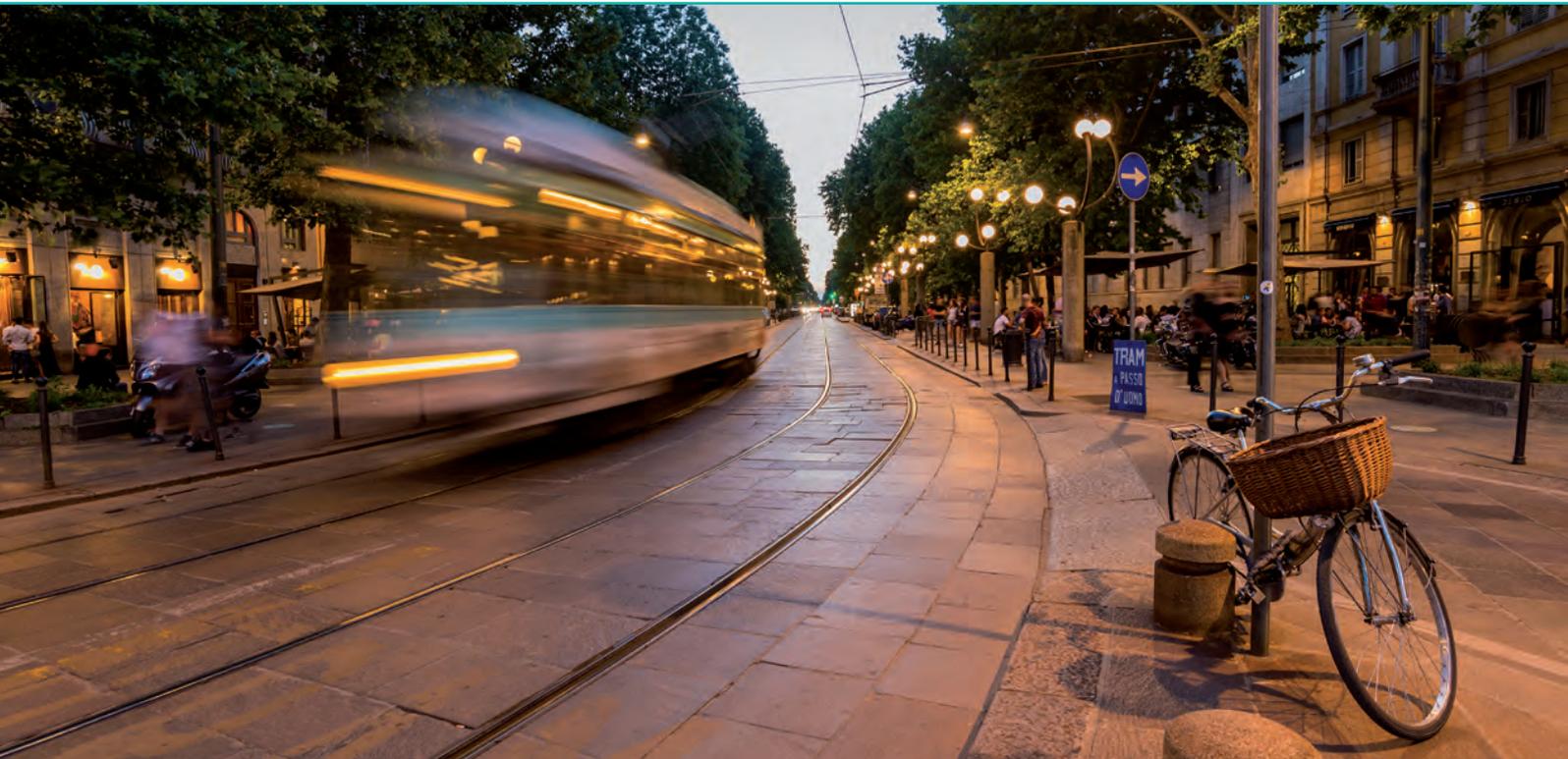
UMRESTTE

EPIDEMIOLOGICAL RESEARCH AND
SURVEILLANCE UNIT IN TRANSPORT,
OCCUPATION AND ENVIRONMENT

(UMR Ifsttar/Lyon University)

Director: **Martine Hours**

Deputy Directors: **Barbara Charbotel, Jean-Louis Martin**



PLANNING, MOBILITIES AND ENVIRONMENT



The AME department lies at the crossroads of most research work at IFSTTAR as it involves Human and Social Sciences, Environmental Sciences and Engineering Sciences from the angle of transports and mobility and their interconnection with social and economic dynamics, the environment, the territories and the spatial planning policies.

The Ame department has seven laboratories contributing to IFSTTAR's outreach at domestic and international level in the following areas:

- mobility-related knowledge, taking into account all of the determinants, including psycho-cognitive;
- evaluation of the effects, in particular environmental, of mobilities and transport systems, including the infrastructures supporting mobility;
- insight into the relationships between mobility and transport practices on the one hand and territories on the other hand;
- identification of the role of innovations, in particular technological innovations, on mobility and transport practices.

The scientific scope covered by the Ame department therefore lies at the heart of contemporary societal and political dimensions of the mobility and sustainable transport issues.

Besides, on a more crosscutting level are a number of deep-lying trends and stakes, amongst which the evolution of lifestyles and consumption modes (with the development of e-commerce for instance), the growing importance of remote work and the sharing economy, in particular with the emergence of new mobility services which are all of direct relevance to the research conducted at Ame. In addition to this, technological innovations in the area of motorization *inter alia*, often involve a new market structure, the emergence of new industries and new competitors, even new forms of regulations that need to be factored in.

As the management mandates were being renewed, in 2016 the Ame department initiated a reflection on the evolution of its scientific project for the next five years. This project will therefore focus on the interactions between transport and mobility in both its natural and built-up environments. In terms

of natural and built-up environments a distinction is made between the natural environment made up of resources (biodiversity, air, water) and socio-technical systems: stakeholder systems (institutions, industrial players, operators, users) and technical systems (infrastructures, vehicles, information systems). The core societal challenges specific to each one of these environments shall have to be identified and addressed, in particular:

- spatial and temporal variations of environmental externalities;
- interactions between intelligent transport systems and uses;
- issues of digital transition, deregulation, collaborative economy and their respective influence on the evolution of mobility practices and transport strategies.



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2016 AT A GLANCE

SEMINAR ON THE “ANALYSIS AND GEOGRAPHICAL REPRESENTATION OF ENVIRONMENTAL DATA”

In the framework of the department’s cross-cutting approach to its scientific activities, a seminar was held on 15 September 2016 in Nantes on the “Analysis and geographical representation of environmental data”. This event was part of a number of studies on environmental issues, in particular in urban areas (exposure and impact on inhabitants and ecosystems), which involve many different players, from academic and applied research to operational engineering (multi-nuisance and multi-criteria impact studies). From this angle, the spatial and temporal analysis as well as the map representation (2D or 3D, static or dynamic) of specialized/georeferenced data or indicators is now a significant scientific (diagnosis and prospective) and societal challenge (working out scenarios and fostering participatory debates, reporting back scientific results to the public at large, aid to decision-making, etc.). Whatever the subject-matter and nature of data considered, the question of map representation is currently at the center of several research and tool development endeavors (GIS, virtual reality, etc.). These spatial representation techniques, very closely associated with the recent evolution of needs and means (sensor networks, data bases, crowd funding, big data, etc.), have seen a rapid growth. The seminar gathered some 50 participants.

INTERNATIONAL CONFERENCE ON TRANSPORTS AND AIR POLLUTION (TAP)

In France, the transport industry (1,000 billion km/annum) is a strategic vector of social and economic activity in the territories. Technological, political and spatial-planning developments in the area of transports should take into account impacts on the environment and populations (air quality). This sector is responsible for over one third of GHG emissions, 20 % of particles emissions and a fourth of dioxin emissions. There are existing solutions to further boost technologies, ideas and behavior changes... towards cleaner and more environmentally-friendly transport.

In this perspective, IFSTTAR and in particular the LTE laboratory partnered with LUTB and the joint research center of the European Commission (JRC), to organize the 21st International Conference on Transports and Air Pollution (TAP 2016) from 24 to 26 May 2016 at ENS - Lyon. The theme of this TAP2016 edition was “Transports and air pollution at the crossroads of territorial and public policy challenges, towards energy transition and cleaner transports”. This event covered all the aspects relating to air pollution from transports (road and non-road), from their emissions all the way to their impacts on healthcare, environment, economy and employment.

Close to 300 people took part in this conference during which 177 communications were presented, whether oral or in poster form.

LAURENT CARNIS, RESEARCHER AT THE AME DEPARTMENT, ON THE THEME OF ECONOMIC POLICY OF ROAD SAFETY; PIERRE OLIVIER VANDANJON ON APPLICATIONS OF ROBOT-BASED IDENTIFICATION TECHNIQUES TO CIVIL ENGINEERING PROBLEMS; AND VÉRONIQUE CEREZO FOR HER CONTRIBUTION TO THE SAFETY DIAGNOSIS OF INFRASTRUCTURES, RECEIVED THEIR RESPECTIVE ACCREDITATIONS TO SUPERVISE RESEARCH ON THE ABOVE THEMES.

DAY ON “OBSERVATION OF LOGISTICS”

The importance of logistics for development is not only due to its contribution to GDP in developed countries but also to the flexibility it gives to, or on the contrary how it inhibits, the overall operation of economic circuits. Logistics is thus key to the functioning of our economies. Besides, the way the supply-chain spreads its mesh responds to economic and technical requirements and generates a polarization of business settlements on the outskirts of large conurbations, interconnected *via* big corridors. In turn, this means there is a need for differentiated action from territorial authorities to attract and promote logistics activities.

Finally, logistics is a branch of the economy that is structured in quite a specific manner. Over time it has been observed that big French logistics operators had experienced growth, broadening their range of services and expanding overseas, while small French-based road freight hauliers had lost their share of the international market.

These many challenges confirm the necessity of a nationwide strategy for logistics as stated during the 2015 National Conference of Logistics.

To contribute to this debate, IFSTTAR’s Splott laboratory organized a full-day meeting on “Observation of logistics”. The aim was to promote networking between public and private logistics players, producers and users of related information, to exchange on the need for logistics data and indicators, the ways to collect them and their analysis challenges. A number of foreign experiences of logistics observatories were presented and discussed.



FOCUS ON 2016

TRANSPORT INFRASTRUCTURES AND BIODIVERSITY

Against the backdrop of a general decline of pollinating insects, the Pollinaire project jointly conducted with Inra aims to evaluate, explain and possibly develop the potential of green patches around land transport infrastructures as habitat and as a source of wild pollinating insects (bees and butterflies). Green areas or “corridors” around highway infrastructures cover several thousands of hectares at national level. It is possible to take advantage of a fairly preserved part of this space to offer a habitat to now depleted pollinating species. From 6 sites located in different contexts and contrasted corridor management modes (extensive vs. intensive), the study analyses on the one hand the characteristics of these green corridors and their use by wild pollinating insects and on the other hand the capacity of the host populations of these corridors to exploit the surrounding landscape. These results will nurture the knowledge base on the environmental factors that influence the presence of wild pollinating insects in these green corridors and on their pollinating potential for the surrounding landscape mosaic (green belt and crops). Beyond this, the idea is to formulate operational recommendations for the stakeholders, in and outside these corridors, and to devise the environmental engineering to backup this approach. A spatial planning guide for green areas around highway infrastructures co-written by IFSTTAR and Inra resulted from this project.

DEPARTEMENT ORGANISATION

AME

PLANNING, MOBILITIES
AND ENVIRONMENT

Director: **Gérard Hégron**

Deputy Directors: **Anne Aguilera,
Michel Bérengier, Michel André**

Administrative Manager: **Alexandra Richard**

DEST

ECONOMIC AND SOCIAL DYNAMICS
OF TRANSPORT LABORATORY

Director: **Francis Papon**

Deputy Director: **Laurent Hivert**

EASE

ENVIRONMENT, PLANNING, SAFETY
AND ECO-DESIGN LABORATORY

Director: **Véronique Cerezo**

LAE

ENVIRONMENTAL ACOUSTICS
LABORATORY

Director: **Judicaël Picaut**

Deputy Director: **Joël Lelong**

LPC

MOBILITY AND BEHAVIOUR
PSYCHOLOGY LABORATORY

Director: **Valérie Gyselincq**

LTE

TRANSPORT AND ENVIRONMENT
LABORATORY

Director: **Serge Pélissier**

LVMT

CITY, MOBILITY AND TRANSPORT
LABORATORY

(UMR University Paris-Est Marne-la-Vallée/
École des ponts ParisTech/IFSTTAR)

Director: **Pierre Zembri**

Deputy Directors: **Olivier Bonin, Fabien Leurent**

SPLOTT

PRODUCTION SYSTEMS, LOGISTICS,
TRANSPORT ORGANIZATION AND WORK

Director: **Corinne Blanquart**



AXIS
1

INVENTING SUSTAINABLE MOBILITY

How effective airbag jackets really are for motorcyclists?

The protection of motorized two-wheeler users (M2W) is indeed enhanced by wearing airbag jackets. There are several triggering systems for these: “wired” (a cord attached to the jacket and to the M2W snaps loose when the biker is ejected, which in turn triggers airbag inflation), “radio” (sensors placed on the M2W detect the fall or shock and trigger the inflating process) and “autonomous” (the sensors are sewn into the jacket).

The purpose of this study was to assess the protection levels provided by these jackets. It combined a field analysis of real accidents with in-lab reconstructions and biomechanical experimentations.

The field analysis shows that the majority of accident victims wearing an airbag jacket consider it prevented

injuries. These cases are mostly falls with subsequent sliding but little direct impacts against obstacles. Digital reconstructions of accidents have showed that a fall at 60 km/hr or an impact at 40 km/hr may cause severe injuries to the torso even if wearing the airbag jacket.

Experimental tests have showed that these jackets offer a greater protection than a conventional back protection but beyond 50 joules, the protection limit is rapidly reached for those jackets with the lowest inflation pressure. The “radio” type jackets detect the shocks earlier.

The airbag jacket provides the same level of protection for the torso as a helmet for the head.



Motorcycle crash-test with airbag jacket



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Access regulation: an effective operating tool to limit traffic congestions on Île-de-France motorways



Regulated access on A86 E motorway (Vélizy) commissioned in December 2016

In the framework of the Île-de-France motorway operating system (Sirius), access regulation was identified as one of the main drivers to act upon traffic demand. The aim is to maintain the operation of the infrastructure around its capacity by installing traffic lights on motorway access ramps.

An adaptive algorithm (Alinea) was developed by IFSTTAR to support such regulation by traffic light cycles.

In 2010, Dirif deployed 21 access controllers across the south-east quadrant of Île-de-France. The evaluation of the impact on traffic of this first slate showed gains ranging between 10 %

and 20 % on journey time, 1 % and 2.5 % more in terms of range, 8 % saved in congestion volumes, and plus 8 % to 15 % in speed.

In 2015, Dirif undertook to deploy the system across another 54 accesses covering the rest of the Île-de-France motorway non-concession network. Egis acts as the main contractor while a second company, Actenium, is in charge of developing the software and IFSTTAR remains the algorithm supplier. Completion of the work is scheduled in 2018.

IFSTTAR and Dirif signed a research convention in this context, the goals being to improve the calibration process of Alinea, to develop, by way of simulation, a coordination strategy to leverage the gains already achieved and finally conduct an *in-situ* evaluation.



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Determinants of phone use while driving: TSICA project (Telephone and Information systems in the context of driving)

The TSICA project, financed by MAIF foundation (2014-2016), focuses on the usage of telephone and information systems while driving.

A number of focus groups were held to list the various usages, explain them and better understand what the telephone represents as an object, how and why it is introduced in vehicles.

A survey was then conducted with a sample of 3,189 respondents representative of the French population, 2,843 of whom being drivers.

This study revealed the emergence of:

- new dynamic contents that combine text, image and sound;
- new types of interaction *via* the instant messaging facilities of social media.

Smartphones have asserted their role in supporting functions that were thus far provided by dedicated devices (GPS,

radio...): 21 % of drivers use a guidance application.

These cause increasing solicitations and divert the driver's attention, often for much longer than the driver might have thought initially: 22 % of drivers have thus already had a good fright using their phone at the wheel.

The drivers' attitude to their phone, how comfortable their claim to be using it at the wheel, or their awareness that they are at risk when doing so, are as many factors that influence these practices.

Consideration has recently been given to publishing this survey on a regular basis so as to follow up the results over



time. Another DSCR project is also underway to address phone usage by professionals.

<http://www.fondation-maif.fr/nos-projets.php>



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EcoDriver: an assistance system to learn ecodriving

Between 2011 and 2016, the FP7 ecoDriver European project had as its objective to reduce fuel consumption on different types of vehicles (light combustion engine or electric vehicles, hybrid vehicles including lorries or buses) by advising drivers on their actions in a fun way. The information displayed comes from precise mapping data processing for the topographical part and from radar measurement for surrounding vehicles.

In the framework of this project, IFSTTAR helped develop a consumption model for light vehicles as well as the smartphone implementation of a serious game as a learning tool for ecodriving. The systems developed during the project were then evaluated within a task force coordinated by Cosys-Livic (G. Saint Pierre) in a program distributed across 7 sites.

Amongst other things, Livic developed a novel experimentation in natural driving conditions with the smartphone-supported ecodriving software. All of the collected data were centrally processed in Spain and supervised by Livic, from the definition of performance indicators all the way to the final analysis of results. After travelling an aggregate 500,000 km, of which 80,000 km in France, the global fuel consumption reduction was estimated between 2 and 6 %. IFSTTAR's successful input to this project was followed up in 2017 with a new H2020 project on the gamification of ecodriving assistance: GamECAR.

<http://www.ecodriver-project.eu/>

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Demonstration of the ecodriving assistance Android application developed by IFSTTAR

Microscopic model contributions to the establishment of a timetable and planning of railway infrastructure maintenance activities



Rail-grinding during rail-switch replacement operations at night

The establishment of railway timetables follows a complex process that distributes the infrastructure's capacity in the form of departure and arrival times for each station of the network. Besides, conducting maintenance tasks requires neutralizing segments of tracks, which may upset the capacity demands for these transport services. To prevent any deadlocks, part of the capacity is earmarked for these maintenance activities right from the planning phase. This thesis addresses the problem of the pre-operational phase adaptation of the time grid as soon as track neutralization slots have been confirmed, including temporary speed limitations close to the track works areas and the track maintenance coaches required to carry equipment to the location. The objective is to minimize gaps with the initial demand and very finely define the capacity used by the

new choices affecting train itineraries and scheduling. A formulation of the problem in mathematical programming further enhanced the Recife platform. The validity of this method was then proven with real-life scenarios on a section of the Paris-Le Havre railway line, showing that a microscopic approach can also be used for traffic management on a line segment with several stations. This is the first microscopic approach to be published in the literature to address this type of problem.

<http://www.estas.ifsstar.fr/linstitut/cosys/laboratoires/estas-ifsstar/equipements/plateforme-logicielle-recife/>

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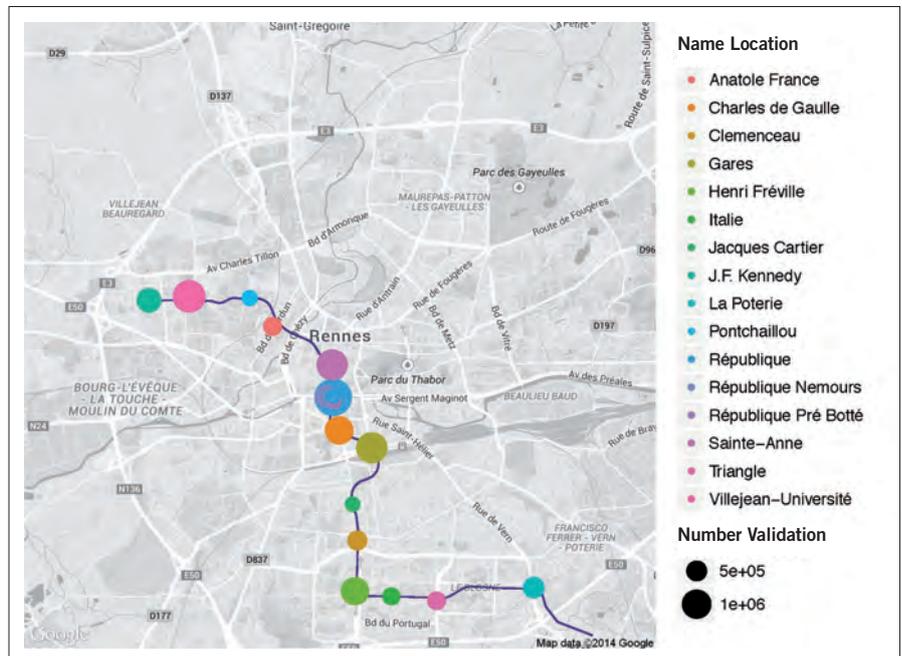
Mobilletic project: ticketing data and mobility analysis in mass transport networks, the Rennes case

Funded by Predit, the Mobilletic project aimed at proposing tools for the analysis and visualization of large mobility traces generated through ticketing data.

This IFSTTAR-coordinated project relied on a crossdisciplinary approach: data sciences (Cosys-Grettia), urban economy (Ame-LVMT), as well as geography and spatial planning (Cerema Nord-Picardie). Keolis Rennes and Rennes Métropole were also involved as data provision partners.

This project helped better characterize the demand by identifying typical profiles of time-dependent activities for homogenous groups of users based on their mass transport usage.

A leading operational public policy measure in Rennes since 2012 has resulted in shifting the university's class schedules so as to limit congestion in the metro. The analysis of ticketing data was instrumental in fine-tuning the measurement of its impact. The project also helped characterizing the dynamics of intermodality across the bus-metro network through ticketing data. More globally speaking it highlighted the benefits of big data and the potential of ticketing in addition to other sources of data (mobility survey for instance), to get a better insight into urban mobilities and in particular take into account the space- and time-specific aspects. The wealth of this data opens new prospects in terms of analyzing both the transportation networks and the territories.



Map of the STAR network in Rennes showing the 15 busiest bus and metro stations (April-October 2014)

<http://mobilletic.ifsttar.fr/>



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Intelligent axle counter

Among the multiple links established between SNCF and IFSTTAR, one notable advance concerns “track-mounted” railway device instrumentation. In the framework of the Demeter contract, SNCF Réseau and IFSTTAR are working to turn axle counters into intelligent and communication-enabled (wireless) devices. Being able to predict and detect in real time the failure of a train’s axle gauge (number, phase, radius...) or to pilot the intrinsic operational status of the axle counter is strategic information for railway operators. Several of IFSTTAR’s off-the-shelf technological bricks were evaluated to be relevant for use on these new devices: the Pegase-2 Linux embedded generic instrumentation electronic boards as well as the generic Supervisor supporting real-time operation (backup, display, alarms...) of data on the Cloud. IFSTTAR proposed and implemented a number of control algorithms enabling



Instrumentation of two axle counters on the Paris-Orléans railway line using IFSTTAR technological bricks and algorithms

SNCF to pilot the behavior of axle counters. Subsequently, these algorithms made it possible to extend the reported data to:

- Recognition of the type of locomotive (by automatic recognition of the gauge);
- Measurement of the wagons’ speed gradients for the same train passage in order to improve knowledge of the train’s so-called “car body flapping”.

More generally, the SNCF Réseau-IFSTTAR partnership aims to evaluate the benefits and impact of the Internet of Things on real-time and predictive maintenance of its extensive base of signaling devices which are paramount to the network’s safety.



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- Telecom system for urban transports of the future

The Systuf project aimed to demonstrate the feasibility of using a single telecommunications network (LTE- Long Term Evolution or 4G), shared among several players and simultaneously meeting the requirements of critical and non-critical applications of a guided transport operator.

IFSTTAR's contribution focused on discrete-event simulation of command-control and video surveillance performances.

Three telecommunication system architectures were compared: dedicated, shared with the fire fighters, and shared with a telecom operator. Performance can depend on how the system has been



Final demonstrator on RATP line 14

sized to meet the needs of the transport operator.

IFSTTAR also conducted a preliminary operating security analysis for a simple telecom system architecture consisting in an evaluation of the availability and safety of the Automatic Train Protection functions. Petri network modelling was

used with performance indicators such as error rates and handover times. With the first results, it was possible to determine an appropriate value for the interval between two trains in order to limit the occurrence of trains being halted due to communication errors. Deployment of a dedicated LTE network on RATP's line 14 of the Paris metro provided the industrial operators involved with *in-situ* performance analyses.

<http://systuf.ifsttar.fr/>



Abdomen modelling for automobile shocks: detailed female model from the GHBMC

The Global Human Body Model Consortium (GHBMC) is an international consortium essentially comprised of automotive manufacturers. Its purpose is to develop advanced human models for automobile shocks. Its work is co-funded by the National Highway Traffic Safety Administration and is distributed across six academic expertise centers selected

in 2007. LBMC is in charge of the center on abdomen research, which is the only one based outside North America.

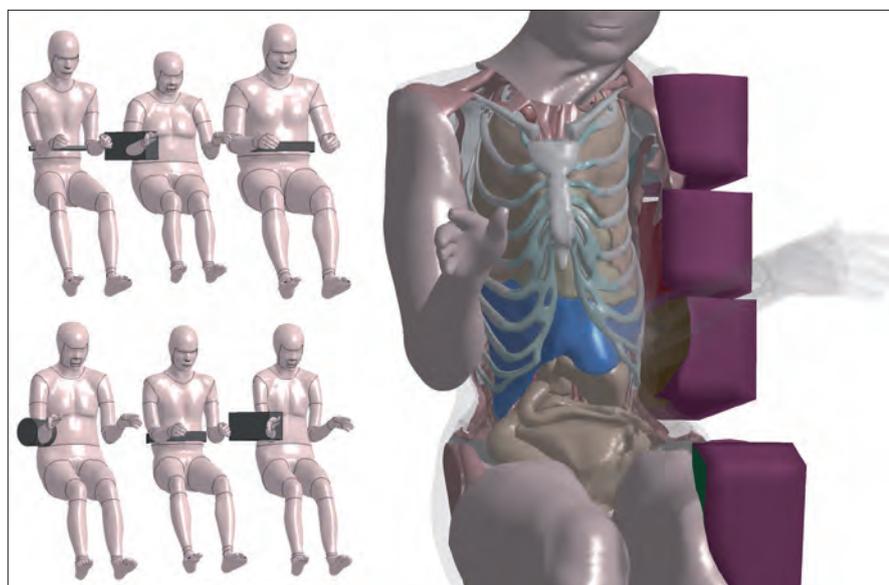
Following the work that resulted in the first detailed model of the GHBMC representing an average-size man (2011), in 2015-2016 the endeavors turned to the development of a detailed

model representing a small-height woman (5th percentile). For LBMC, this work jointly conducted with Transpolis SA, brought some significant advances on questions more upstream such as validation of the abdomen's internal response (thanks to ultra-fast echography carried out at the LBMC) or on the effect of size and anatomy. In fine, the teams were thus able to develop curbs to assess potential injuries to the liver and the spleen using the GHBMC's detailed models.

These results and methodological advances pave the way for research to improve predictions and extend them to other organs.

After the development phase was over, the new female model was added to the GHBMC family which is used worldwide in both academic and industrial research.

<http://www.ghbmc.com>
<http://lbmc.ifsttar.fr>
<http://www.transpolis.fr>



Non-linear scaling of models (left) provided a better insight into the effects of size and anatomy on response to shocks and injury risk to better validate the behavior of the new 5th percentile GHBMC female model (right)



ESB 2016 international convention in Lyon

The ESB 2016 organization committee was chaired by LBMC (UMR_T 9406 IFSTTAR-UCBL) and involved the laboratories in Lyon, Saint-Étienne and Grenoble. During this joint congress of the European Society of Biomechanics and Société de Biomécanique (French-speaking), both learned societies established in 1976 were thus able to celebrate their 40th anniversary.

On this occasion, 4 four international learned societies had been invited to take part in the organization: the European Society for Biomaterials, the International Society of Biomechanics, the International Society of Biomechanics in Sports, and the International Research Council on Biomechanics of Injury (IRCOBI) on the respective themes of “Biomaterials”, “Human movement”,

“Sport biomechanics” and “Impact/injury biomechanics”.

From 10 to 13 July 2016, this event brought together 780 participants from 47 pays, at the *Cité des Congrès* in Lyon.

Four guest lecturers (Prof. G. Courtine, Prof. R. Pettigrew, Prof. C. Jacobs and Dr. P. Laugier) and 18 “perspectives talks” tackled the current challenges in biomechanics and connected fields. The convention’s communications (403 oral and 210 poster communications) are available in open access on the website: www.esbiomech2016.org

In all, 29 industrialists and 8 institutions brought their financial support to this event which will remain as a landmark in the history of both learned societies!

<http://www.esbiomech2016.org>
<http://lbmc.ifsttar.fr>



ESB 2016: opening ceremony cocktail on stage



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Theses

AME-DEST

THAO PHAM THI HUONG

Contributions and difficulties of data collection using GPS receivers to conduct a survey on mobility

TS2-LBMC

ROMAIN DESBATS

Abdomen Behavior and Injury Mechanisms During a Crash: Definition of a New Injury Criterion Transferable to Anthropomorphic Test Devices

AME-LVMT

FRANÇOIS ADOUE

Connected mobility in everyday life. Smartphone uses in public transportation in Île-de-France (Paris metropolitan region)

COSYS-LEOST

MOHAMED RAOUF KOURSRI

Development and evaluation of an analysis tool specifically designed to railway electromagnetic compatibility issues

TS2-LBMC

VIDJANNAGNI KODJO

Design and Assessment of Motorcyclists Restraint Systems

TS2-LBMC

AGATHE NEROT

Subject-specific geometric modelling of the human body (external and internal) from External data

TS2-LBA

NICOLAS BAILLY

Towards the improvement of head safety devices for alpine skiing users

COSYS-GEOLC

CHRISTOPHE COMBETTES

Walking direction estimation with handheld inertial and magnetic sensors

COSYS-LIVIC

CÂMILA FREITAS SALGUEIREDO

Biomimicry and the low carbon vehicle generation of innovative bio-inspired concepts using the C-K theory

TS2-LESCOT

FRANCK TECHER

Impact of anger on risk taking and information processing in simulated driving

TS2-LBMC

ANICET LE RUYET

Internal response of the abdomen during an impact: validation of the internal response of human body models based on ultrafast ultrasound imaging

COSYS-LICIT

RAPHAËL DELHOME

Travel time variability modelling and integration into stochastic shortest path problem algorithms

TS2-LESCOT

CAROLINE PIGEON

Attentional mobilization in blind pedestrians: effects of age, age of blindness onset, and the type of mobility aid used

COSYS-ESTAS

ABDERRAOUF BOUSSIF

Contributions to diagnostic *via* discrete model-based of complex systems

COSYS-GRETTIA

MONCEF TOUMI

Numerical modelling of the wheel-rail contact for the study of the parameters influencing Kalker's coefficients: Application to the railway dynamics

TS2-LMA

HÉDI HAMDANE

Improvement of pedestrian safety: validation of active safety system by real accidents' reconstruction

TS2-LBMC

VINCENT RICHARD

Multi-body optimization method for the estimation of joint kinematics: prospects of improvement

TS2-LMA

KARYN PRAVOSSODOVITCH

Male drivers, female drivers: the influence of sex stereotypes on driving behavior, whether self-reported or actual

TS2-LESCOT

MARION HAY

Effects of a cognitive training and a virtual reality immersion on older adults' cognition and driving abilities

COSYS-ESTAS

RAHMA YANGUI

UML/B modelling for the safety requirements validation of railway operating rules

COSYS-LIVIC

VINCENT JUDALET

Robust architecture for the shared control of by-wire vehicles

COSYS-GRETTIA

AMINE OTHMAN

Multiagent simulation of traveler information on transit networks

TS2-LBMC

JÉRÉMY DALLARD

Fingertip modelling in a grasping context: numerical and experimental approaches

COSYS-ESTAS

LUIS DIEGO ARENAS PIMENTEL

Contributions on microscopic approaches to solve the train timetabling problem and its integration to the performance of infrastructure maintenance activities

COSYS-ESTAS

CYRIL LEGRAND

Contribution to the safety evaluation of railway localization systems based on GNSS by formalizing extended integrity concepts

COSYS-LIVIC

MARC REVILLOUD

Adaptive perception architecture for multi-lane detection and tracking



HDR*

AME-DEST

LAURENT CARNIS

Political Economy of Road Safety: Theoretical and Empirical Studies
Lille University,
25 January 2016

TS2-LESCOT

CATHERINE GABAUDE

Investigations, observations and analysis of the activity among older drivers: understanding barriers to better act (critical review, theoretical position and research opportunities)
Lyon 2 University,
19 December 2016

*Accreditation to supervise research



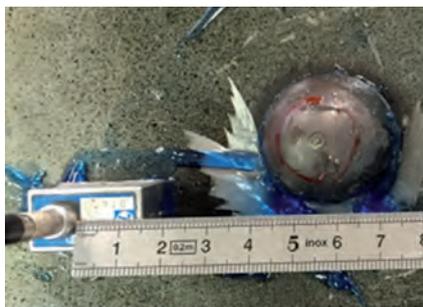
AXIS
2

ADAPTING INFRASTRUCTURES

Non-destructive testing, monitoring and sustainable management, outcome of the Apos (testing for reliable structures) and MCV (controlled structure lifecycle) research operations

Controlling the sustainability and structural risk across the lifecycle of infrastructures is a major challenge for project owners and/or managers of ageing assets. In a cost-conscious environment, the development and integration of tools (methodologies, measurement techniques, modelling, software) are becoming crucial to support decision-making for asset monitoring and management.

Apos has contributed to a comprehensive approach to the non-destructive evaluation of materials and structures in order to fool-proof diagnoses and thus improve maintenance and durability. This project looked at metallic assemblies, bonded and wooden assemblies, the sustainability of concrete reinforcements, cables, the relation between indicators



and observable elements, the results variability of lifecycle models depending on concrete degradation, the evaluation of mechanical properties for concrete in its early stages.

The ambition of MCV was to come up with a comprehensive approach including structural risk, degradation

mechanisms, and the inspection, diagnosis, monitoring and management methods of structures. Research was thus conducted on the lifecycle analysis of networks of engineered structures, structural monitoring and diagnosis as well as aid to maintenance. Close to one hundred contributors, most of whom from IFSTTAR and Cerema chipped in for the publication of the Interactive Proceedings released at the end of 2016.

<http://www.ifsttar.fr/collections/ActesInteractifs/AI11/index.html>



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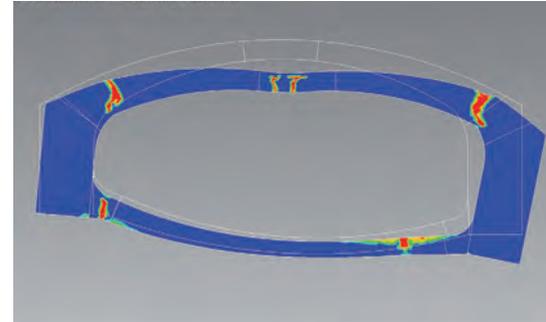
An insight into the behavior of masonry arches in the Paris metro: laboratory-characterization and finite-element modelling

Every day, the Paris metro carries some five million passengers. Its network includes numerous old tunnels with masonry arches. Although these structures are liable to withstand important deformations, their modelling proves rather difficult. It is therefore crucial to improve the computing models used, via digital simulations, in order to define alert thresholds for maintenance or other works to take place in the vicinity of tunnels.

IFSTTAR and RATP conducted a laboratory testing campaign (CIFRE thesis by O. Moreno Regan) on 172 test cylinders extracted from a tunnel on Line 3. The wealth of data collected made it possible to use advanced digital models. In parallel, deterioration models specific to masonry arches were introduced into the Cesar-LCPC computing code.

These models made it possible to digitally simulate the behavior of a metro station that has suffered important disorders over the years and to find other convergent values of the same magnitude (several dozen millimeters) as those observed by RATP. The simulation also showed that tunnel collapse results from the formation of a succession of hinges in the arch and apron.

For masonry assets, knowledge of this material's mechanical behavior is a major stake, as demonstrated by the success of the first national masonry days organized at IFSTTAR (Marne-la-Vallée) on 17 and 18 March 2016.



Deformed geometry and isovalues of the deterioration variable within the structure. The red areas are fully deteriorated (hinges)



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CEOS.fr nationwide project: Behavior and assessment of special structures, cracking– shrinkage

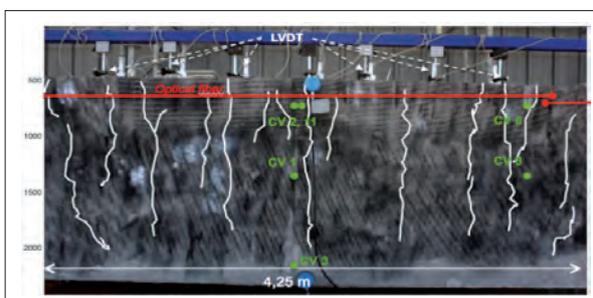
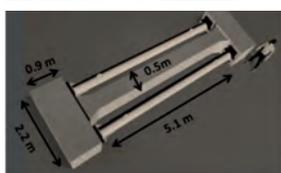
Controlling cracks in reinforced and prestressed concrete is vital for the reliability of structures just as much as certain properties such as air- or water-tightness, and resistance to extreme strains. The current regulations, Eurocode 2 or code Modèle, do not address the behavior of massive elements for which thermo-hydro-mechanical (THM) effects, scale effects and structural effects induce specific cracking patterns.

Over 8 years (2008 to 2016) the nationwide CEOS.fr project, financed by the Ministry of Environment (MEEM) DRI and its partners, and co-piloted by EDF and IFSTTAR, gathered 41 French partners (laboratories, research institutions, engineering and design firms, building companies, industrialists, project owners and main contractors) to delve into these questions and come up with recommendations for design engineers and project practitioners.

Through the study of specific strains (monotonic, cyclical, THM loading), and the study of experimental tests representative at a scale of 1 or 1/3, of feedback from structures still in operation and advanced modelling (in conjunction with ANR MEFISTO), it was possible to study the major phenomena and their consequences on the cracking of evaluated structures.

A summary of the project's findings was published in English in August 2016: *Control of Cracking in Reinforced Concrete Structures* (ISBN: 9781786300522)

<http://www.ceosfr.irex.asso.fr>



Obstructed shrinkage beam (scale 1) – Instrumentation applied to the central part during the bending test (long base fiber optic, CV: vibrating-wire sensor, LVDT). @CEOS.fr

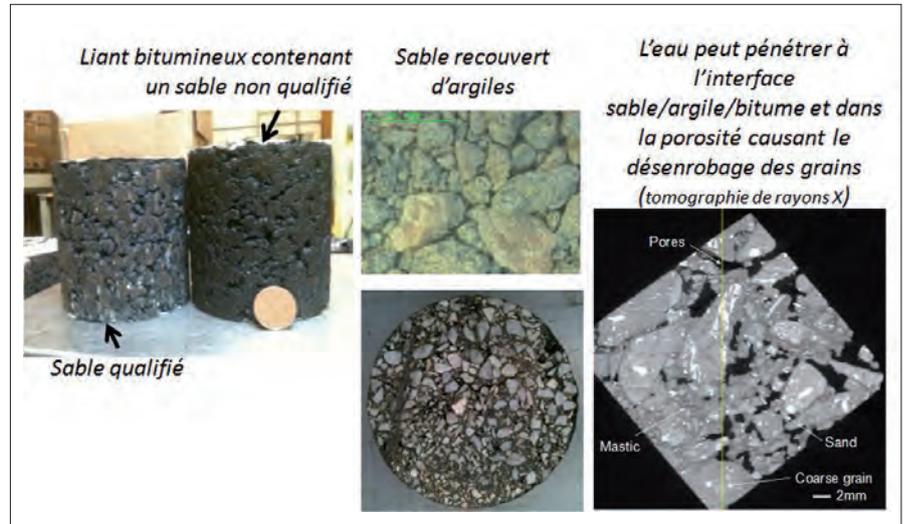


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Conversion of non-qualified clayey sands in asphalt road surface layers

With the support of UNPG, IFSTTAR contributed to Chi Wei Chen's thesis (2012-2016) on the topic of clayey sands. The outcome of this work made it possible to:

- put into practice the identification and quantification methods of the mineral phases found in quarry sands (and in particular of the clay phases, which can cause pathologies) whilst outlining the limits of these methods (notably the Rietveld method coupled with X-ray diffraction);
- develop and specify the interconnection between mineralogical nature of the clays (illite, montmorillonite...) and the corresponding blue values. Blue value (MB) is the test used to qualify a given sand type, i.e. to determine whether it is or not acceptable for a given civil engineering application. The studies have showed that in certain cases the limit value of MB = 2 could be exceeded;
- compare the microstructural properties of clays and their mineralogical nature in the phenomenon of adherence and stripping of binder when in contact



Clays: pollutants for sands in bituminous binders

with asphalt, as evidenced at the micro (sessile drop method) and macro (Duriez tests) scales.

Finally, a new methodology was proposed, based on MB (1st level of test), for the cationic exchange capacity (2nd level of test), sand mineralogy (3rd)

and for the Duriez test as a last level. With this new methodology, it should be possible to extend the range of sands that can be used in bituminous binders.

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Biosourced and natural materials for sustainable constructions



Du matériau au bâti («From material to frame») (Maison du tourisme de Troyes @Carole Belle; X-ray wood microtomography @IFSTTAR-ENPC-CNRS; hemp-based concrete)

The Mabionat research program is the fruit of cooperation between the laboratories of IFSTTAR and Cerema on the topic of biosourced and natural materials used in the building industry. Its aim is to contribute to a better understanding of the behavior of materials or structures under complex strains in order to derive methodological tools and improve construction rules. Different aspects were delved into, in particular:

- estimated lifetime of the various types of materials (composites with organic matrix reinforced with vegetal fibers, insulating materials based on vegetal aggregates, paint formulae based on agro resources);
 - multimaterial construction systems based on wood and straw;
 - hygrothermal behavior of biosourced construction materials.
- Multi-scale and cross-disciplinary approaches were used for all of these

topics in order to derive a global vision of the materials properties. A summary document presents the results of Mabionat, organized around four main themes:

- materials properties;
- durability;
- instrumentation of real-world buildings;
- environmental evaluation and end of life.

The seminar held on 19 and 20 May 2016 provided an update on the work so far and further perspectives. Summaries of this research is available on the Mabionat project website.

<http://mabionat.ifsttar.fr>

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Towards European harmonization of the evaluation of usage properties for road-surfacing



Comparative tests at IFSTTAR's test-track in Nantes

The Rosanne European project aims to define a common practice across Europe for the measurement of road usage properties such as grip, noise and roll resistance. This project, funded by the European Commission, took the form of a consortium of eleven road research laboratories (2013 – 2016). Concerning grip, numerous tools and methods are used across Europe making it difficult to compare the results. Two crossed test campaigns carried out on IFSTTAR's PRER test track in Nantes (for road research and experimentation) helped define a common indicator whose robustness and relevance were later confirmed on roads open to public traffic. Regarding rolling noise, two methods are in use at European level. The research made it possible to fine-tune their mutual matching and to propose an evaluation methodology for the acoustic properties

of road surfaces compatible with noise mapping methods. Finally, roll resistance research is still in its early days and there are only few measuring devices available in Europe. This project resulted in the proposal of a procedure for device calibration and *in-situ* measurements. Tests on the PRER track in Nantes demonstrated the good reliability of some of the devices. All of these results will form the basis of draft standards to be examined by the European standardization bodies.

<http://www.rosanne-project.eu>



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Advances in the field of automatic detection of cracks in pavements and civil engineering works

This paper uses two illustrations to present the progress made in the area of automatic detection of surface cracks in concrete and pavement materials. Measuring the crack is crucial in diagnosing the structural health of civil engineering works. In this context, the objective is to automate crack reading by means of image-processing tools. Figure 1 presents the improvements made to the MPS (Minimal Path Selection) algorithm, jointly developed in 2014 with IRCCyN, Irit and IFSTTAR for automatic pavement crack detection. By improving the “pixels-cracks” connectedness of images, MPS proved to perform better than other algorithms tested in the past. The parallelized version of MPS developed under GPU in 2016 drastically reduces run-time, whilst also improving the quality of segmenting. With the latest run-time achieved it would be possible to consider real-time processing of pavement images collected at traffic speed. In parallel, image-scanning tools were developed for civil engineering

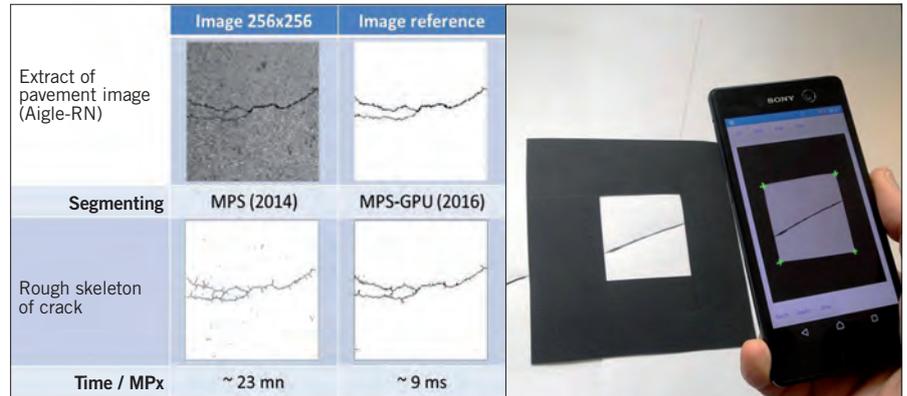


Figure 1 – Automatic detection of crack skeleton over a 256 x 256 portion of pavement image using the initial MPS algorithm running on Matlab (left-hand side) and its parallelized version under GPU (right-hand side)

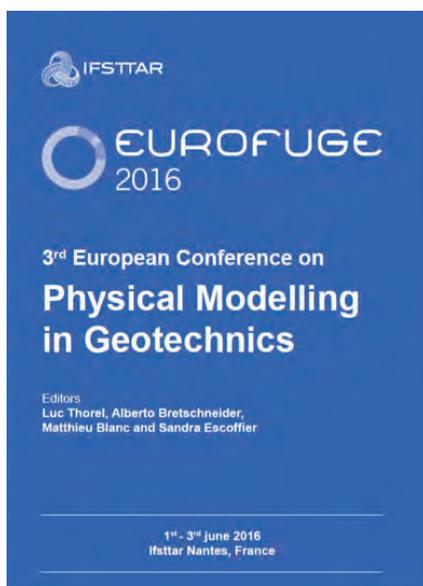
Figure 2 – Android-base “Crackmeter” application for on-site measurement of isolated crack width on concrete

applications, in particular to measure the crack index (CI). This work will now be followed up by the integration of image-processing tools into an Android-type smartphone. The purpose is here to provide compact measurement solutions, adapted to on-site operations on the structures in addition to the agents’ eye inspections. For instance, figure

2 presents the width measured for an isolated crack for which we are trying to adapt ergonomics to operational constraints.

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Eurofuge 2016 congress, 3rd European Conference on Physical Modelling in Geotechnics



Physical Modelling In Geotechnics, Thorel, Bretschneider, Blanc & Escoffier (Eds) Nantes, ISBN 978-2-85782-716-0

The 3rd European Congress on Physical Modelling in Geotechnics, Eurofuge 2016, was organized by IFSTTAR at its Nantes site from 1 June to 3 June 2016, under the aegis of the TC104 “Physical Modelling in Geotechnics” technical committee of the International Society for Soil Mechanics and Geotechnical Engineering. Supported by the French Committee for Soil mechanics and geotechnical engineering, the Actidyn company and Nantes Métropole, this congress attracted some 85 attendees from 20 countries. Various experts came to discuss the five themes selected: natural hazards, renewable energies, infrastructures and physical modelling equipment. In a nutshell...

56 communications were gathered in the 392-pages proceedings pack, which also features the contents of two special lectures given respectively by:

- Professor Cristina Tsuha from the Sao Paulo University (Brazil) on “Physical Modelling of the Behavior of Helical Anchors”;
- Professor Masaki Kitazume from the Tokyo Institute of Technology (Japan) on “Applications of Centrifuge Modelling to Liquefaction Mitigation Techniques”.

The copyright-free proceedings will be circulated in the next few months in digital format on the Eurofuge congress website and on the SIMSG website.

<http://eurofuge2016.ifsttar.fr>

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National Masonry days – JNM 2016

The first-ever National Masonry Days took place on 17 and 18 March 2016 at the IFSTTAR site of Marne-la-Vallée. The objective of these two days jointly organized by IFSTTAR and ENPC with the backing of the French Ministry of Environment (MEEM), was to gather the stakeholders in charge at national level for heritage conservation, new constructions, the regulations and analysis pertaining to masonry structures. The JNM masonry days attracted over 200 participants from various backgrounds – project owners, prime contractors, design and engineering firms, architects, experts, researchers, industrialists or artisans, and saw a great number of fruitful discussions on the theme. After an introduction

by H el ene Jacquot-Guimbal, managing director of IFSTTAR, Fran oise Pr eteux, research director at ENPC, and Patrice Bueso, deputy director of the MEEM research department, 42 oral and 12 poster presentations were made on issues revolving around modelling



National Masonry Days – IFSTTAR, Marne-la-Vall ee site

and experimentation, but also heritage management, pathologies and repairs, or new-built constructions and sustainable development. The day was concluded by a round-table session moderated by Jean-Fran ois Seignol on the Future of masonry: at the crossroads between science and practice. During the conclusion, Bruno Godart and Karam Sab highlighted the positives of these two days that had gathered many stakeholders and echoing the importance of this domain.

<http://jnm2016.ifsttar.fr>



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Measurement of active tie-backs tension and performance evaluation of measurement techniques

Hydraulic structures are or will be equipped with active tie-backs for back-up purposes (geotechnical ties). Likewise, some of these tie-backs are or will be equipped with tension-measuring devices (mostly vibrating-wire sensors and oil-pressure sensors) to be fitted between

the supporting plate and the anchor head. Magnetostrictive sensors are deemed to allow measuring tie-back tension by virtue of their position around the cable or strand, but these sensors, not being accessible, cannot be replaced any more easily than the others.

At the request of EDF, the French utility company, the SMC laboratory carried out a study on the tension of active tie-backs with a view to getting a better insight into the performance of measurement means and techniques and examine the influence of various parameters on these technical means:

- qualification of the metrological performances of sensors deemed to provide a measurement of the tension of cable-type active tie-backs (confined to system of loads);
- analysis of the action of a few parameters influencing tension measurements;
- analysis of the relevance of the impedance-based testing technique, deemed to provide a measurement of the free length of a tie-back and its tension.

An experimental mechanism was set up to test the measuring means available according to various testing configurations on a multi-strand tie-back (T15.7) submitted to variable loads.

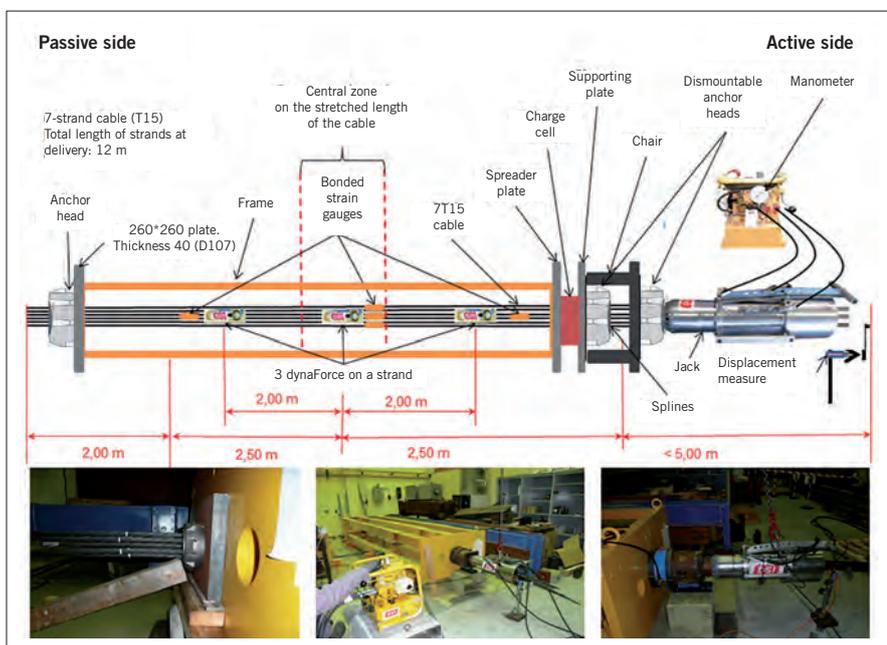


Diagram of the experimental mechanism



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Theses

GERS-RR0

HUSSEIN MOUZANNAR

Characterization of shear strength and behavior of interfaces between concrete and rock foundation of hydraulic structures

COSYS-LISIS

LÉA CHACCOUR

Development of a dual-frequency VECSEL source for measure of the Brillouin effect in optical fibers

GERS-SRO / GERS-GMG

ZINEB ABCHIR

Contribution to the study of pile behavior submitted to monotonic and cyclic axial loads

COSYS-LISIS

NICOLAS GILLERON

Method for predicting settlements due to urban tunneling with presupport influence

MAST-NAVIER

JENNIFER FUSIER

Flocculated ideal suspensions: From characterization to modelling

MAST-NAVIER

YOUSRA TIMOUNAY

Rheology of grain-loaded liquid/air interfaces: towards the consolidation of an aerated medium

MAST-NAVIER

MOHAMED HASSAN KHALILI

Tracking and modelling small motions at grain scale in granular materials under compression by X-Ray micro tomography and discrete simulations

MAST-MIT

LAURE BOUCARD

Destabilization of bitumen emulsions and evaluation of the behavior at the oil / water interface

MAST-NAVIER / MAST-EMMS

ASTRID BILLON

Method for a nondestructive testing of the bond quality of composite reinforcement systems on concrete structures

MAST-GPEM

AURÉLIEN NEVEU

Numerical simulation of the fragmentation of aggregates

MAST-LAMES

HANAN NASSER

Solving M4-5n by a Mixed Finite Element method for the analysis of pavements with discontinuities

MAST-EMMS

BRICE DELSAUTE

New approach for monitoring and modelling of the creep and shrinkage behavior of cement pastes, mortars and concretes since setting time

COSYS-LISIS / MAST-NAVIER

ARNAUD PACITTI

Nonlinear modelling of elastic cables: Experimental data-based tension identification via static inverse problem

MAST-EMMS

THOMAS GUENET

Micromechanics-based modelling of the UHPFRC behavior: fibers orientation effects at the structural scale

MAST-SDOA / COSYS-LISIS

OMAR MORENO REGAN

Study of the behavior of the masonry tunnels of the Paris subway system

MAST-FM2D

RIM RAGOUG

External sulfate attack-Impact of different parameters: age, binder, and presence of chloride

MAST-SDOA

SOPHIE CAPDEVIELLE

Introduction of warping in multi-fiber finite elements for non-linear modelling of reinforced concrete structures

MAST-NAVIER

NGHIA BUI NAM

Expansion and stresses induced by crystallization in cement-based materials in presence of sulfates

GERS-GEOEND

VINCENT METAIS

Auscultation with surface waves of very heterogeneous materials

COSYS-SII

NILS ARTIGES

From instrumentation to optimal predictive control towards buildings energy efficiency

MAST-CPDM

HAJER RABII

Study of natural fibers reinforced composites ageing: building Application

GERS-SRO / MAST-GPEM / MAST-MIT

CHI-WEI CHEN

A mineralogical approach to use the non-qualified fine aggregates in asphalt concrete pavement

GERS-NAVIER

FRANCISCO LAMAS LOPEZ

Field and laboratory investigation on the dynamic behavior of conventional railway track-bed materials in the context of traffic growth

MAST-NAVIER

JENNIFER NAEL

Water absorption of porous aggregates: measurement and consequences on mortars and concrete formulation

AME-EASE / ERA 30

WALID CHEBBI

Methodological approach for the valorization of an industrial co-product in the road



GERS-SRO

SÉBASTIEN BURLON

Taking into account the soil-structure interaction for the calculation of geotechnical structures
University Paris-Est,
8 March 2016

MAST-SDOA

VÉRONIQUE BOUTEILLER

Study of the corrosion of reinforced concrete structures and their repair by electrochemical treatments for a better management of structures
University Paris-Est,
17 May 2016

MAST-SMC

SYLVAIN CHATAIGNER

Structural adhesive bonding and composite materials in civil engineering: theoretical contributions and applications
University Paris-Est,
26 September 2016

*Accreditation to supervise research



AXIS
3

CONTROLLING NATURAL HAZARDS AND ENVIRONMENTAL IMPACTS

RS2E-OSUNA program: an update on soil pollution in the watersheds close to the Loire estuary

This work looks at the management of contaminated soils: vineyards in the Nantes region (with issues related to use of the “Bordeaux mixture” and land re-use), urban soils with the landfill in Prairie de Mauves (and the question of contaminants transferred towards the Loire river).

A plot of land that is subject to a grubbing-up operation was characterized for copper content. A fine-grain mapping of the contamination was performed through on-site measurements using a handheld X-ray fluorescence spectrometer. Besides, work was done to identify the phases controlling the speciation of copper by means of granulometric fractionation combined with X-ray micro-fluorescence analyses. Results have showed that copper



On-site measurement using an X-ray fluorescence spectrometer

concentrations range between 40 and 300 mg.kg⁻¹. Copper, associated with iron and manganese oxides, may be remobilized in colloidal form following rain water ingress. The underground waters of the *Prairie*

de Mauves site were monitored for quality to get some insight into the transfer of contaminants towards the Loire.

The findings showed that the pollutants plume did reach the river. Moreover, the landfill has been showed to also involve pollution from pharmaceutical, phytosanitary and other emergent substances. These molecules belong to various families such as analgesics and endocrine disruptors. Concentrations upstream from the site stand at above 0.1 µg.L⁻¹.

<http://www.osuna.univ-nantes.fr/rs2e-osuna>



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Potential of green corridors backed up against linear transportation infrastructures for wild pollinators

In the current context of depleted populations of pollinating insects, with their habitat being fragmented or altogether destroyed and the effect of pesticides, is it possible that the large areas created by the green corridors (GC) of linear transportation infrastructures (LTI) may provide an opportunity to preserve these species and improve the environmental budget of LTIs? The Pollinéaire project (part of the Ittecop 2014 program), carried out in conjunction with Inra and Cerema, ambioned to assess, explain – and propose operational solutions to harness – this potential habitat (food, nesting) and source of dispersion (displacements) towards the surrounding landscape, for wild bees and common day butterflies. Field studies were conducted on the one hand in GCs of highways situated close to attractive crops (canola fields) in Brittany and *Pays de la Loire* (study of the source



Development of the local flora favorable to pollinating insects in a roadside green corridor

function), and on the other hand in the GCs of high-voltage power networks running across large forest tracts (habitat function) in the Dordogne and Limousin regions.

The populations of pollinating insects respond favorably to the preservation of flower-rich open environments through

appropriate maintenance of the GCs. Operational recommendations were formulated for road planners and managers.

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RepExtrem: temperatures in habitats during heatwaves

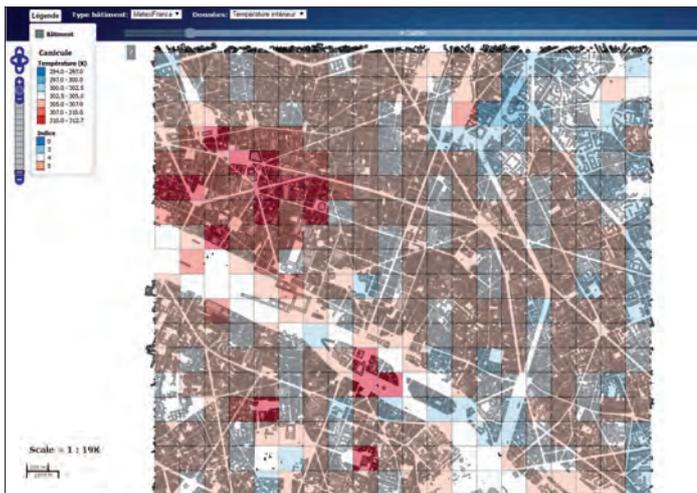
Heatwaves have been growing in numbers in the last 20 years. In 2003 in particular, a heatwave contingency plan was triggered. In 2015, the public body *Santé publique France* still recorded over 3,300 fatalities ascribed to the July heatwave episodes in France. With Météo-France's GAME laboratory, IFSTTAR conducted

the RepExtrem research project in response to the MEEM's call for projects aimed at better understanding the real temperatures urban populations experience during heatwaves. For people staying at home, the stake was to estimate the indoor temperatures (as experienced) depending on the type of apartment flat, based on computations

with the SURFEX-TEB model plus field observations in selected homes. The findings are quite amazing: in periods of high temperatures, including heatwave episodes, some homes with poor ventilation and effective insulation may rate a few degrees more (up to 4 °C) than other flats in the same neighborhood, and thus remain at 27 degrees, both night and day, over several weeks.

A hazardousness index was proposed to differentiate these situations and improve the actions targeted for people most in need. The proposed index includes the length of the phenomenon, its intensity, the type of apartment flat and the vulnerability of people. A website was designed to rerun the 2015 episode and study the space and time differentiations of this event.

<http://representation-phenomenes.ifsttar.fr/assets/canicule/canicule.html>



Night-time indoor temperature on July 2015 Haussmann-type apartment flats

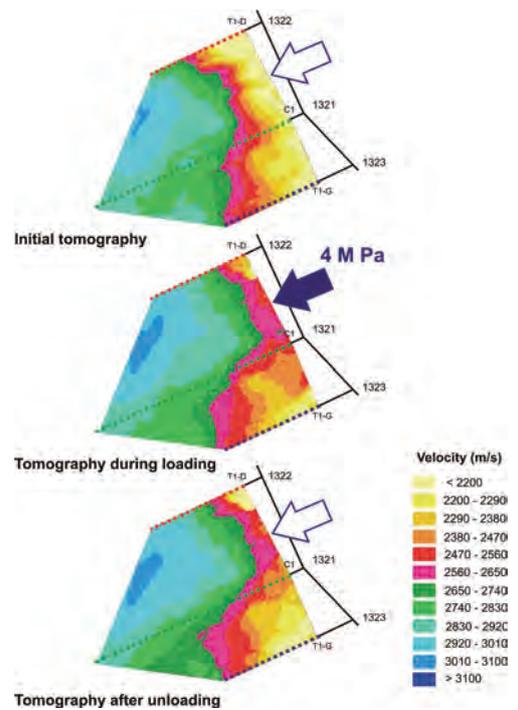
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Monitoring the evolution of damaged areas around underground structures

As part of an experimentation campaign by Andra to assess the constructability, security-safety and reversibility of a deep-storage of radioactive waste in Callovo-Oxfordian argillites, medium-term monitoring methods had to be developed for the damaged parts of the rock near excavations (galleries, pits). This is of great importance in view of the hydraulic conductivity differential between the healthy block and the damaged sections. Seismic methods are instrumental in monitoring the evolution of mechanical properties within the rock mass. IFSTTAR, in association with Andra, has for several years been working on the monitoring of rock condition *via* seismic tomography tailored to the “CDZ” Andra experimentation framework. The latter is designed to observe the effects of mechanical compression and hydration on the damaged zone of gallery walls.

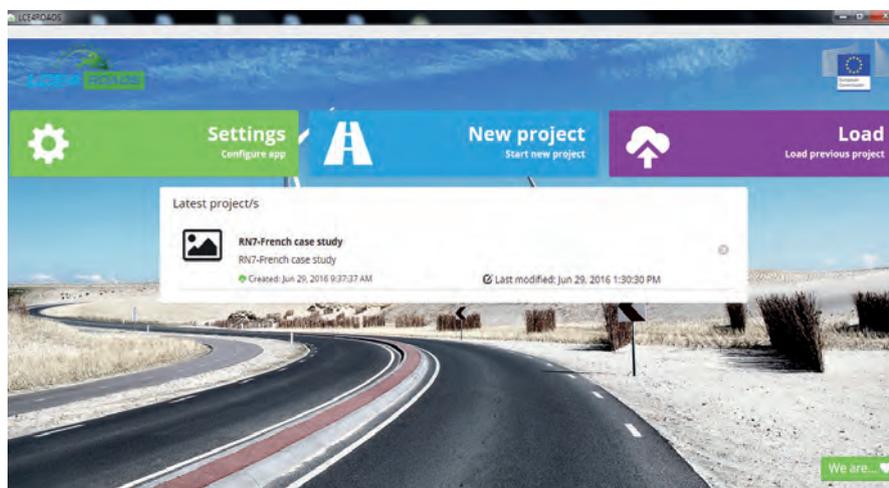
The measurements made highlighted the significant sensitivity of seismic speeds to the various compression/hydration phases of the rock mass, with speed showed to increase locally in the damaged area, which is interpreted to be caused by the clogging of microcracks under the action of mechanical pressure and/or rehydration of the rock. The next steps in this work will attempt to overcome the current limitations in accuracy for very small variations (in the order of or inferior to the percentage point) by fitting sustainable source and sensor systems within dedicated wells.

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Horizontal tomographic cross-sections made for various steps in the compression of a gallery wall

Towards a European-wide “sustainable development” certification for road infrastructures



Interface of the “LCE4ROADS” certification tool

The LCE4ROADS European project (2013 – 2016), coordinated by ACCIONA (Spain) brought together a consortium of thirteen European partners, from the worlds of research (IFSTTAR, Chalmers, etc.) and industry (IECA, NAPE, etc.). Its aim was to devise a certification method

for road infrastructures based on “sustainable development” criteria and the associated evaluation tool. This certification methodology was developed for the core European road network and is applicable to both new and rehabilitated infrastructures. Two certification levels were proposed (light

and comprehensive) for each of the three moments identified for certification (draft-project, construction and after a period of operation, the duration of which the road manager is left free to determine). Certification covers four domains: environmental, technical, social and economic. For each domain, a set of indicators was selected based inter alia on the content of European standards and “Green Public Procurements”, on existing labels and evaluation tools as well as on the results of national and international research projects. A country-specific data base was also established so as to take local specifics into account, in particular in computing the environmental impact indicators. The methodology and the tool were tested and validated on several case studies across Europe.

<http://www.lce4roads.eu>

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CIBEFHY EDF-IFSTTAR project:

Characterization of the shear strength and behavior of interfaces between concrete and the rock base of hydraulic structures – PhD thesis of Hussein Mouzannar, defended in September 2016

Establishing the stability of a gravity dam built upon a rock base involves checking the stability vis-à-vis potential slippage at the interface between concrete and the rock.

The shear strength of this interface depends on the normal stress applied at the base, how deformation-prone the rock and concrete are, the morphology of

the rock surface and how clean it was when the concrete was cast. At the request of EDF's central geotechnical engineering office, and with a view to correlating the shear strength observed in the laboratory on small-size core samples with the resistance observed at the base of a dam, the thesis studied the scale effect on the behavior

and resistance of interfaces between the rock and concrete. Besides the complex question of how to ensure the objective characterization of a topography at different scales, direct shear tests were made at various scales, some of which on metric test-pieces requiring the use of Cerema's exceptional world-class equipment in Lyon. Lastly, a digital model, first cohesive with degradation and then with friction between two brittle behavior solids with localized plasticity, to simulate contact between concrete and the rock, was developed to analyze the results. The phenomenon of scale effect on shear strength at the rock-concrete interface was for the first time evidenced while the various parameters influencing breakage at the interface were also identified.



Setting up of a metric test-piece in Cerema's large-size direct shear unit

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Example of mapping produced in the framework of the Trafipollu project on the relative distribution (fuchsia-coloured circles) of a pollutant (in this case copper) from automotive traffic, at the outlets of the studied rainwater networks flowing into the Marne river. It can be noted that the organization of the zone's sewage network tends to redistribute and concentrate the pollution, which is essentially emitted along the roadway at the center of this domain, upstream from the Marne

Trafipollu project

The objectives of the Trafipollu project (ANR 2013-2016) are to develop tools to model and locate the pollutants generated by urban road traffic at various space resolutions. To achieve this, modelling chains were implemented at various urban scales (street, district, city) in order to predict:

- traffic behavior;
- associated pollutant emissions;
- pollutant dispersion in the atmosphere;
- pollutant deposits;
- their transfer into water and the soils.

At street scale, the Water and Environment Laboratory developed a modelling approach for water transfer into the soil and made some experimentations to determine the nature and quantity of pollutants deposited on the road network (dry deposits on the roadway, pavements and street gutters) and on the ground by the roadsides, on the site of Le Perreux

which typically experiences heavy traffic. At city scale, an automatic hydrographic network reconstruction tool (sewage networks and rivers) was developed, in either comprehensive or simplified version, based on commonly available and reliable information from urban databanks.

Simplified parameterization of the conservative transfer of pollutants into water was developed within a distributed hydrological model based on the reconstructed network.

The closing seminar took place on 21 November at the premises of IFSTTAR in Champs-sur-Marne.

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The electric vehicles Geri: outcome of 6 years of sharing and encounters

IFSTTAR's exchange and research group on electric vehicles (Geri VE), was created in 2010 and brought together IFSTTAR's staff whose activities revolved around the design, use and deployment of electric vehicles. The topics covered both engineering and physical sciences (EPS) and human and social sciences (HSS). Geri's goal was not so much to promote electric cars as to confront diverging approaches. Close to a dozen IFSTTAR laboratories were involved and took part in the work sessions.

On average two meetings were organized annually to exchange information, share experiences, launch research projects... In February 2012, a whole day dedicated to the "Environmental budget of EVs" attracted 36 people and in November 2015 another 20 agents exchanged on the theme of "What kind of research should be dedicated to what kind of recharge?" The idea of the EVREST

project came about during a Geri VE session in January 2011.

This project was then funded by the European institutions in the framework of the ERANET+ Electromobility call for projects and involved both EPS and HSS competences including 3 French laboratories (LTE and DEST for IFSTTAR + 1 CNRS laboratory), 4 German and 1 Austrian laboratories, and 1 industrial player. Their work focused on the technological optimization and environmental evaluation of a range extender solution adapted to scenarios built around mobility data from several countries. All the reports submitted by Geri VE are available on line.

<http://actions-incitatives.ifsttar.fr/geri/ve/>



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21st International conference on Transports and Air Pollution (TAP 2016)

Transportation is a strategic sector for social and economic activity in OECD countries. Technological, political and spatial planning activities should all take into account the local and global impacts of transports on environment and health.

In this perspective, IFSTTAR organized the 21st International conference on Transports and Air Pollution (TAP 2016) from 24 to 26 May 2016 in Lyon. The theme of TAP 2016 was "Transports and air pollution at the crossroads of territorial and public policy challenges, in the face of energy transition and technological challenges". This event covered all aspects relating to transport-associated air pollution, from emissions to the impact on health, environment, the economy and employment. TAP 2016 attracted a significant number of participants from the scientific and technological communities, but also industrial firms, politicians and non-governmental bodies (300 participants from 30 countries including 17 European states, 177 scientific presentations).



TAP 2016 gave an update on transport-associated pollutants, the various technologies proposed to mitigate their effects, air quality and the impact of public policies. In parallel with TAP 2016, IFSTTAR organized the plenary session of the ERMES group ("European Research on Mobile Emission Sources")

and a "networking event" for the H2020 Transportation national contact point.

<https://tap2016.sciencesconf.org/>
<http://tap2016.ifsttar.fr/>



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MAST-NAVIER
RÉMY MENSIRE

Hydrodynamics of oil in contact with aqueous foam: Wetting, imbibition dynamics and flow in rough confined media

AME-LAE
YUANFANG ZHANG

Study on a test rig of dynamic tire/road contact forces at the origin of rolling noise

GERS-EE
GUILLAUME LE BIHAN

Distributed flash flood forecasts based on regional hydrological models: Towards the forecast of flood possible impacts and damages

MAST-NAVIER
ALIZÉE LEHOUX

Magnetic resonance imaging of transport and retention of colloids in soils

GERS-SV
ELIF ORAL

Multi-dimensional modelling of seismic wave propagation in linear and nonlinear media

COSYS-LEOST
ADIL EL ABBOUBI

Study and evaluation of the consumption of a railway beacon based on UWB and time reversal

MAST-NAVIER
RAPHAËL BRIERE

LCA study of demolition sites for the purpose of preserving resources: Focus on the transport and landfill processes

GERS-GEOEND
CLARA JODRY

Methodological developments for imaging and monitoring by geoelectric methods of flood protection structures

GERS-NAVIER / GERS-SRO
RACHID FELLAG

Phenomena of internal erosion in gravel and coarse soils: Application to dykes and dams



AME-EASE
PIERRE-OLIVIER VANDANJON
Some Applications of Robotic Identification Techniques to Civil Engineering Problems
Nantes University,
29 April 2016

AME-EASE
VÉRONIQUE CEREZO
Contribution to infrastructure security diagnostic methods,
Insa de Lyon,
5 September 2016

*Accreditation to supervise research



AXIS
4

DESIGNING AND PLANNING CITIES AND TERRITORIES

Ride your bike and rail the rest, a train of good thoughts

Combining bicycle and train to go to work is an idea IFSTTAR researchers had already investigated with the “Port-Vert” project. The “Vert” project, led jointly with *Jean-Marie Beauvais Consultants* and funded by the research and

innovation division of the French ministry of environment, took this idea a few steps further by carrying out an economic evaluation of the potential gains obtained by transferring regular train users from car to bicycle for their transit between home and the station (local feeder routes). The gains are worth considering: approximately 2,000 euros per passenger and per year, and this includes, amongst other things, savings on parking facilities, on the transit journey, let alone health benefits through physical exercise for users switching to the bicycle. The “Vert” project then applied its model to a case-study for the city of Amboise in the Loire region, with two bicycle-based scenarios, including folding bikes that can easily be taken onboard the train, ‘electrically

assisted pedal cycles’ (EAPCs) which can help riding uphill (a useful feature in this region!). The final report includes recommendations to all decision-making levels and to SNCF to promote bike-train intermodality, in particular with bicycle parking in railway stations and local feeder routes. This Port-Vert project resulted in the publication of several scientific papers and generated interest among professionals.

<http://www.predit.prd.fr/predit4/projet/45150>



The bicycle parking facility of the Monfort-sur-Meu station right by the rail tracks



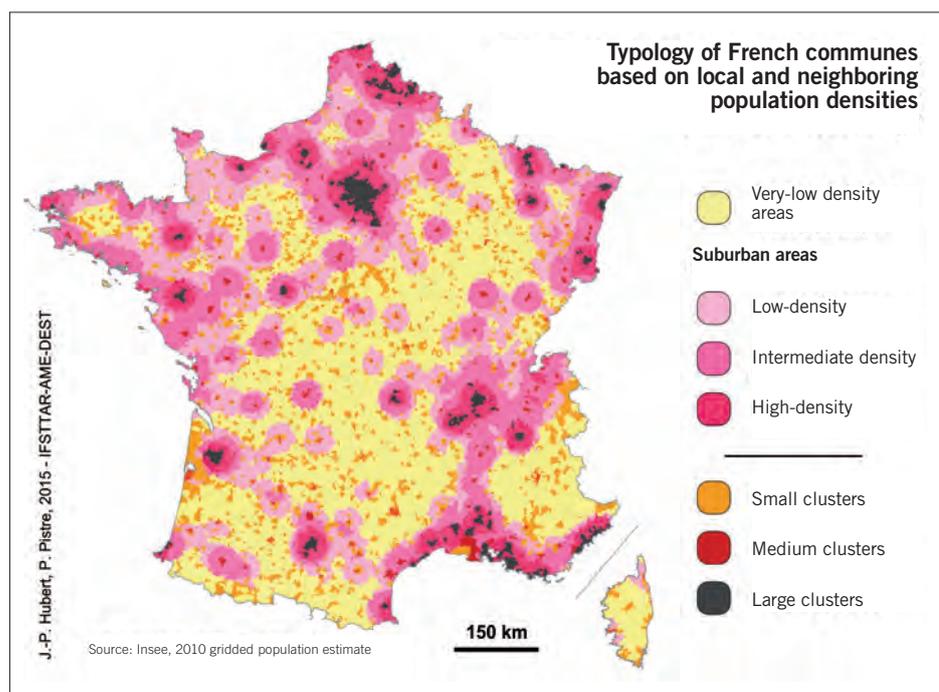
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The hidden side of mobility's momentum: role of sparsely populated areas in the long-term evolution of territories and mobility

Mobility and automobile usage in low-density, suburban or countryside areas, have been poorly covered by statistics so far. Whereas numbers have shown a clear drop in automobility in large towns since 2005, it remained more difficult to characterise the evolution of behaviors outside densely populated areas and determine how the gradual hike in

fuel prices since 2000 had impacted transportation budgets. Thanks to the data banks of Inrets, INSEE and CASD (French center for secure data access), data sets have been gathered to provide individual data on mobility representing types of sparsely populated areas that have been assigned a communal code, so as to include geographical typologies specifically designed for the project. A first study gave an insight as to how the mileage covered by households had decreased since 2000 in low-density areas (data from ParcAuto, Sofres and "Budget des Familles", Insee) while at the same time motorisation and home-to-work distances continued to grow (data from the INSEE population census). Other studies completed the picture of low-density areas and their dynamics, in relation with neighborhood density. Transportation budgets were thus shown to be the highest in suburban areas closest to towns while, from 1995 to 2006, transportation spends in low-density areas grew much more than in conurbations.

Communal typology of low-density areas
(Authors: Pierre Pistre and Jean-Paul Hubert, IFSTTAR
Ame Dest)



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Developments in the waterway transport industry

The project, funded by *Conseil régional des Hauts-de-France*, involves IFSTTAR-Splott, Cerema and the *Travail et culture* association. Its purpose is to understand how supply chains develop and change over time, i.e. how the agents in these supply chains reshape their jobs, activities and their systems of relations. In turn, this would help analyze whether these evolutions are favorable or not to the modal transfer towards waterways, and facilitate this process if needed. This study showed that choosing waterway transport does not only stem

from a rational calculation to optimize transportation costs and times, but rather also depends on the carriers' perception of the comparative efficiency of the various modes, a more "social" dimension of waterway transport. Lastly, on the supply side, the conditions of waterway transport performance should be further qualified as they are not only based on the availability of infrastructures and services, but also the production conditions of said services, work organization on the transshipment hubs or again evolutions in the barge-transport industry.

Financed in the framework of the researchers-citizens mechanism, this project brings together researchers but also artists, in order to better figure out the changes and mutations of labor in the Escaut river region with the future opening of the Seine/North Europe canal. Both the research and the artistic work were presented on 28 September 2016 to the employees, business managers, trade-unionists, elected representatives and inhabitants of the territories concerned.

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Sense-City lays the first stone

The foundation stone of Sense-City was laid on Monday 11 April 2016. One year after the presentation of the outdoor mini-city which initially allowed a solid scientific community to come together around this project, the Equipex enters a new phase full of promises.

Gathered on the site of the future climatic hall, the directors and other officers in charge of the various organizations partnering in this project shared their strategic vision of Sense-City. Addressing increasingly topical scientific and social issues, this equipment of excellence will

play a key role in the Campus Descartes' research strategy. A panel of researchers had gathered on this occasion to showcase their work in relation with the Sense-City scientific program. Relevant and diverse topics were thus covered, from the Road of the future to air pollution and the deployment of sensors in urban environments. These are as many research topics on which the climate chamber will help hone in. With its architecture and the integration of novel technologies, the scientific teams will have a tool whose climatic variables (temperature, rainfall, gas pollution, sunshine, humidity) can all be parameterized. This is a unique piece of equipment to help researchers test out their prototypes, so that we may look forward to a more sustainable urban model.

<http://sense-city.ifsttar.fr/>

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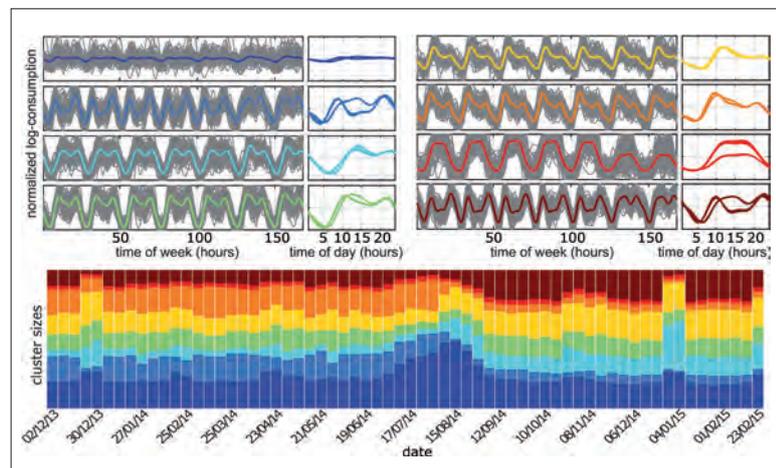
Vedif project: analysis of massive data remotely collected from water meters for smart drinking water management

Thanks to information and communication technologies, smart water grids now provide for optimal, reliable and responsible management of drinking water resources. Beside their technological component, these networks require developing state-of-the-art techniques to analyze the massive spatial and temporal data generated in order to ensure finer monitoring of drinking water quality and usage. Grettia actually tackled this analytical component of Vedif, alongside the Île-de-France water management company Veolia Eau, another party to this project. The main focus addressed was the automatic time series aggregation of drinking water consumption in order to deduce a typology of profiles best reflecting the main consumption habits. An algorithm was developed to this end, combining data classification to Fourier series modelling. This approach made

it possible to objectivize the weekly consumption profiles based on data derived from the smart meters deployed across the network of Syndicat des Eaux d'Île-de-France. The resulting profiles

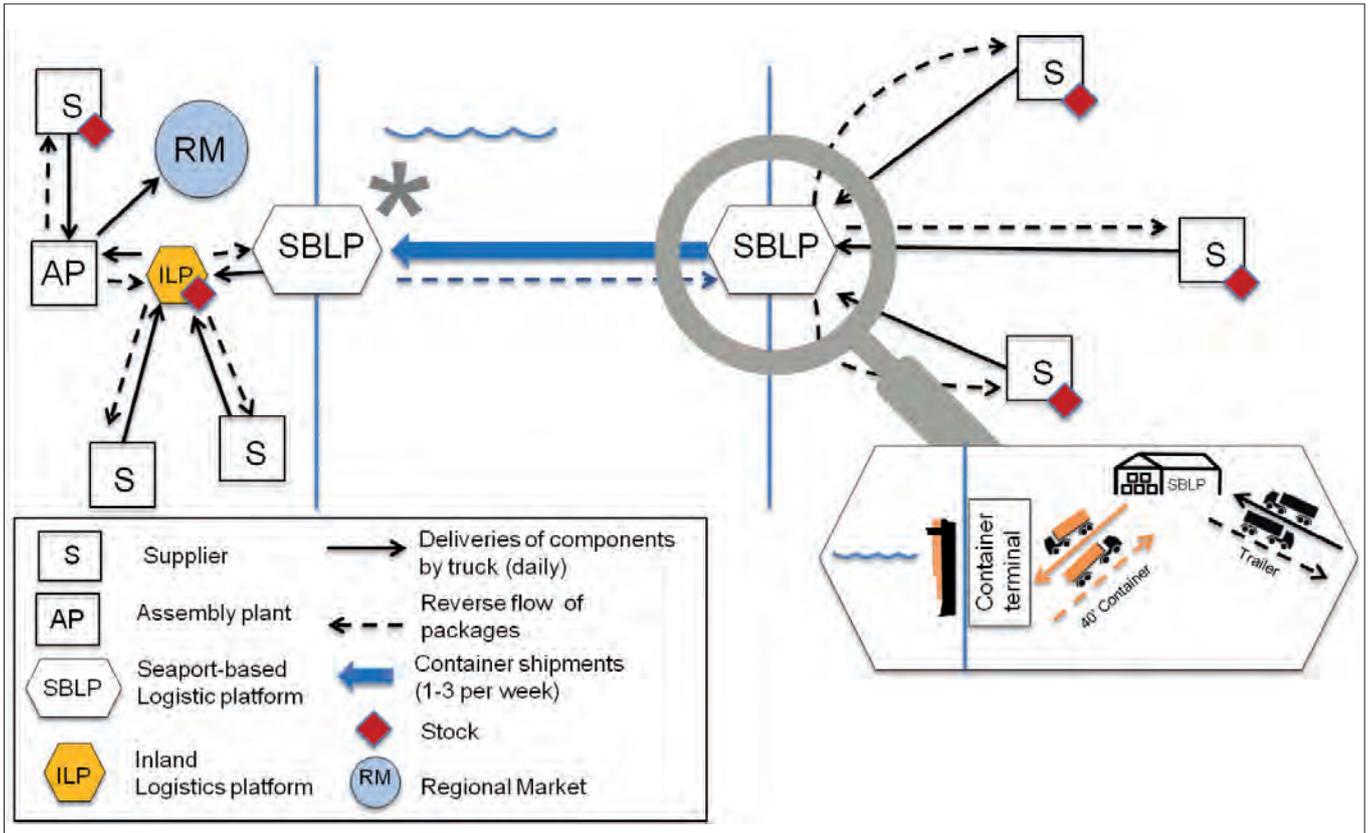
will serve as a baseline in detecting anomalies in drinking water usage.

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Automatic aggregation of water consumption readings into eight weekly clusters

The new role of ports in the automobile supply chain



To ramp up their vehicle production capacity in emerging markets, auto makers heavily rely on their network of contractors in their major incumbent markets in Europe, United States and Japan. This new production organization involves a momentous logistic challenge, as it requires regular long-haul supplies between thousands of respective local suppliers and the overseas assembly plants. This was made possible thanks to the development of networks of consolidation centers to which the various supplier flows are routed by truck before they are consolidated into 40-ft containers that will be shipped by boat and then again trucks to the various plants of European car makers in emerging economies

In the context of an ever-more global automotive industry, container ports play a pivotal part between local suppliers in industrialized countries and assembly plants in emerging economies where component flows are consolidated either by the original car makers themselves or by their logistics suppliers in logistic hubs (see diagram); the components collected from the various suppliers are thus consolidated into 40-ft containers (~12.1 m). This intermediate reloading phase is often used to repackage the components or undertake more

sophisticated operations such as pre-assembly of components or battery charging for hybrid vehicles. For container ports the stake is to develop retention among regular customers whose volumes often reach up to several dozens of thousands TEU (Twenty-foot Equivalent Unit for containers) per annum. For port territories in the process of industrial reconversion, the development of this type of value-added operations is seen as a chance to anchor global supply chains at their local level. Field surveys conducted by IFSTTAR in

France and Japan between May 2015 and September 2016 have highlighted the increasing importance of these consolidation centers in the sourcing strategies of car makers. However, the level of sophistication varies considerably depending on the car maker, the location and direction of sourcing. It would thus appear that value-creation opportunities would be greater for imports than for exports.

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Real-time and weather-sensitive characterization of the vulnerability of a semi-urban network

The quantification of weather effects on road traffic has attracted growing interest of late with the dramatic and highly mediated blocking of road infrastructures during episodes of heavy snow or rainfall. The frequency and severity of such events are likely to increase with global climate change.

The work done on this topic has confirmed there is a significant impact of poor weather conditions on service quality and driver behaviors. Weather events such as rain, snow, wind or fog influence the quality of traffic flow (e.g. speed or time between vehicles) with the result of situations of increased risk.

Past studies, however, are too often based on statistical analyses of rather coarse meteorological or traffic data. New communication technologies (GPS, Bluetooth, GSM...) provide new sources of information, with larger quantities of meaningful data available in real time. And finer analyses are thus possible.

These large amounts of data and their shorter time-steps (in the context of big data) help implement machine-learning methods both for the characterization and the forecasting of traffic conditions as well as their variability at the scale of a whole network.



Impact of downgraded weather conditions on the vulnerability of road networks



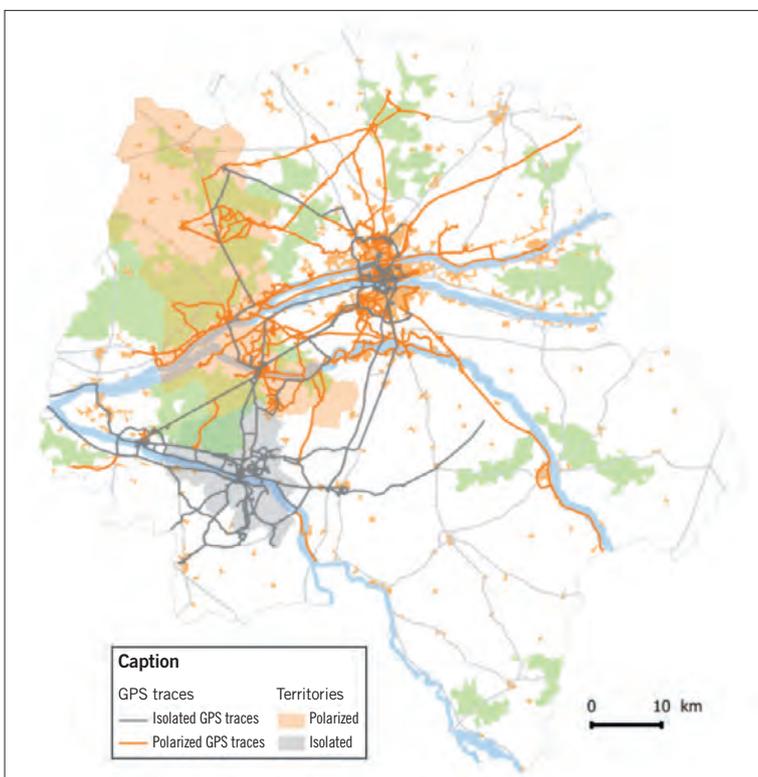
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Mobility and the dynamics of rural territories (Mobiter)

Financed via Predit, Mobiter is a research project steered by LVMT and the Citeres laboratory (Tours University) that took place between 2013 and

2015 with the aim of analyzing mobility practices in rural areas (isolated or polarized around an urban cluster), and sharing the lessons with the policy-

makers in charge of territorial planning and the organization of mobility. In terms of methodology, a GPS-based household monitoring protocol was used, with interviews conducted in parallel to get an insight into the rationale underpinning the organization of movements in space and time, in particular for short-range journeys. The findings pointed to a number of actions that could on the one hand facilitate the local anchoring of daily activities, in depth and over time, and on the other hand foster the use of "soft modes", more car-sharing and even perhaps encourage certain households to let go of their second car. These actions concern just as much the planning of rural territories, in particular the spatial and functional organization of trades and services used on a day-to-day basis, as the policies directly aimed at mobility practices, at the local and larger scales, which calls for new coordination modalities between public and private stakeholders and a redefinition of their respective scopes.



Geography of the traces of the 57 volunteers tracked by GPS



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Observation of logistics in France and worldwide



Following the conclusions of the National logistics conference held in 2015, and in view of the implementation of the France Logistique 2025 strategy, on 24 May 2016 IFSTTAR's Splott laboratory organized a seminar on the observation of logistics.

The importance of logistics for development is not only due to its contribution to GDP but also to its role in the overall operation of economic circuits. Logistics is thus key to the functioning of our economies. Besides, the way the supply-chain spreads its mesh responds to economic and technical requirements and generates a polarization of business settlements on the outskirts of large conurbations, which raises territorial planning issues. Finally, logistics is a branch of the economy with a specific structure and it has

been observed that big French logistics operators had experienced growth, and expanded overseas, while small French-based road freight hauliers had lost their share of the international market. These many challenges confirm the need for data to underpin strategic choices. The aim of the seminar was therefore to promote networking between public and private logistics players, producers and users of related information, to exchange on the need for logistics data and indicators, the ways to collect them and their analysis challenges. A number of foreign experiences of logistics observatories were also to be presented.



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Theses

COSYS-LISIS **HEECHUL WOO**

The selective low cost gas sensor based on functionalized graphene

GERS-EE **STÉPHANE BATANY**

Influence of a macropore on flow and solute transport in porous media: Experiments on macroporous model soil and numerical simulations

COSYS-LISIS **LAURA PINSON**

Analysis and representation of the episodes of heat waves on the scale of districts- From the duration to the design of a danger index

AME-EASE / MAST-NAVIER **YAAROB AUDI**

Development of a methodology for assessing the sustainability of underground constructions

COSYS-LICIT
PIERRE-ANTOINE LAHAROTTE
Contributions to short-term, multi-scale and multi-variable forecasting by statistical caching of road traffic

AME-LVMT **LIU LIU**

Urban Corridors and Transit Oriented Development: Learning from an integrated modelling of transports and land use, applied to the Lille metropolis

AME-LVMT / AME-DEST **CYRIL PIVANO**

Spatial disaggregation of mobility data from population census, applied to region Île-de-France

AME-LVMT **BENOIT CONTI**

The mobility of French intercity commuters in the face of climate change: Socioeconomic characterization, spatial analysis and modal shift potentials

AME-SPLOTT **MARION MAGNAN**

Development and management of industrial and logistic port spaces – Main French seaports: infrastructural space managers

AME-LPC **PETER RICHARD**

Impact of transportation users participation in creative co-design process of solutions for mobility

AME-LVMT
RICHARD ZELEZNY
Influence of public transportation systems on the urban structure of the city

MAST-NAVIER
BACHAR KABALAN
Crowd dynamics: Modelling pedestrian movement and associated generated forces



HDR*

COSYS-LISIS
BÉRENGÈRE LEBENTAL
Nano sensors for a sustainable city, from fundamentals to deployments
Paris Sud University,
19 October 2016

*Accreditation to supervise research

EXPERTISES

Urban lighting: assessing the visual comfort of LED lanterns

LED lighting is gradually gaining ground in the context of energy transition. However, it remains necessary to control its associated nuisances, and glare in particular. In this context, the Thorn Lighting company was commissioned to perform a visual comfort assessment for pedestrians under different urban lighting LED lanterns. Subjective judgments were collected from panels of observers and photometric measurements made during two field experiments in the town of Andelys (Department 27). Beside the development of a comparison protocol to assess the lantern based on the formers' discomfort level, to meet the commission's request this project also looked at the link between the photometry of the visual scene

and the pedestrians' discomfort glare, and tested the relevance of existing models in the literature. This benchmarking exercise denoted a number of limitations. In particular, these models were developed in ideal laboratory conditions and for specific applications (e.g. car drivers). Now, this study showed that these models globally overrate the average discomfort level of pedestrians. Moreover, it came out that there were difficulties in estimating the models' variables from the photometric measurements made in real-life conditions. This study therefore opened up interesting research perspectives to improve the prediction of discomfort glare, notably for pedestrians in the context of urban lighting.



Observers during the field experiment



Terre Armée – SNCF: observation of the dynamic behavior of a tall-height reinforced earth wall on high-speed line LGV SEA at PK 106+428, SDM 1064

To meet the rising demand for geotechnical improvements, *Terre Armée International* chose to strengthen its strategic positioning by developing an offering for railway developments. In order to check the good behavior of this type of structure to passing high-

speed trains, a major retaining wall of the LGV SEA line built according to the *Terre Armée* process was instrumented by the RRO laboratory to make dynamic measurements at the passage of trains by the said structure, during the line trial phase with trains gradually ramping

their speed up to 352 km/hr. This was done at a location called *Saut de Mouton* SDM 1064 near the Fontaine-le-Comte connection. This structure is a 14-metre high vertical wall in reinforced soil with a cladding of reinforced concrete scales. Metallic stripes linked to these scales are placed at different heights, corresponding to the various successive construction layers of the reinforced earth fill. Different series of rapid dynamic response measurements were made at the passage of trains.

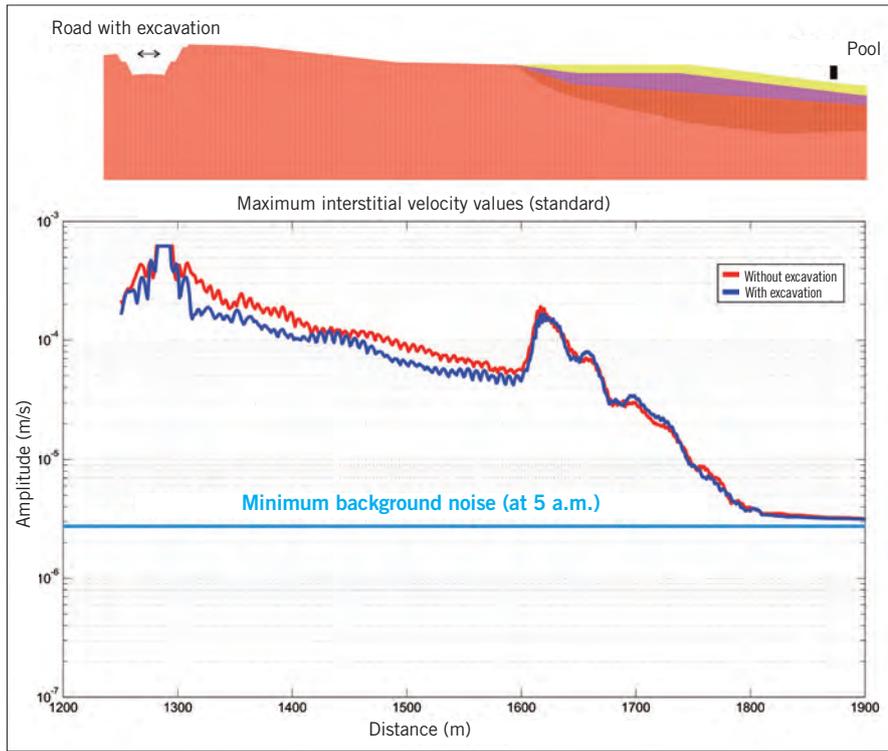
The instrumentation included over 40 measurement channels: accelerometers placed inside the body of the earthwork, strain gauges on the reinforcements at various distances from the cladding and accelerometers mounted on the surface of the cladding's reinforced concrete scales.



Connection of the reinforced earthwork block (*Terre Armée* process) instrumentation to observe its rapid dynamic response to passing TGV high-speed trains



Assessment of the vibration levels predicted around the future Rouen bypass



Peak values of interstitial velocity along the T profile obtained by finite differences (FD) modelling with FLAC software. From top to bottom, the considered domain, peak values for the horizontal and the vertical components, and the interstitial velocity standard, assuming the future roadway is without excavation (red) and with excavation (blue); the site's minimum background noise is also noted (cyan)

This study was commissioned by Dreal Normandie to determine *ex-ante* vibration levels expected at the future Rouen bypass. Following in-depth geophysical and geotechnical investigations of the site, a digital model was devised to analyze the propagation of typical traffic vibrations to be expected *in fine*. The interstitial velocity values estimated along the T profile are given in the figure above: the standard velocity values close to the roadway are in the order of 10^{-3} m/s and approximately $3 \cdot 10^{-6}$ m/s close to the water test tunnel. The filling soils therefore tend to strongly

mitigate vibrations although damping is only in the order of 3 %. For rock, which prevails in this profile, damping is approximately 0.5 %. There is also a very strong topographical effect at the layer's edge. The study concluded that the resulting vibration level is quite low as it is merely in the same order of magnitude as background noise.



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Evaluation of GSM-R deployment in the Channel tunnel

In the Channel tunnel, which is a section of the PBKAL link – Paris, Brussels, Koln, Amsterdam and London –, operated by Eurotunnel as part of a binational concession between France and United Kingdom, the operations have begun to replace the ground-train radio and the concession radio by the GSM-R digital mobile communication system. Deployment of such a system must be evaluated and approved by an independent body as per applicable standards and legislation so that the requester (Eurotunnel) may be granted an operating license by the competent national authority (IGC – the inter-governmental commission in this case) before it can be used on a country's railway system. To this end, a call for projects was launched by Eurotunnel and the project was subsequently awarded to Certifer, a notified certification body.

In this process, the latter resorted to the competencies of IFSTTAR's researchers from the Cosys-Léost laboratory, acting as independent experts to carry out the evaluation work based on the Certifer procedures. To do so, at the beginning of this mission they defined a detailed evaluation plan specifying, amongst other things, the scope of evaluation and the baseline used. Meetings were organized with Eurotunnel and Certifer, either face-to-face or conference calls to follow up the design, integration, testing and other phases. The various design documents provided by Eurotunnel were analyzed by Léost, as well as the test reports from on-site trials. The conclusions and findings were encapsulated in confidential reports handed over to Eurotunnel.



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Service tunnel equipped with GSM-P/R system for rescue services and maintenance agents



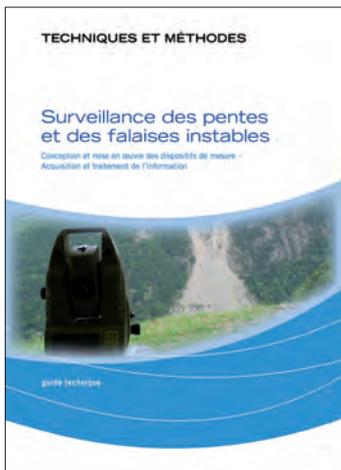
EDITORIAL POLICY

Opening science to society

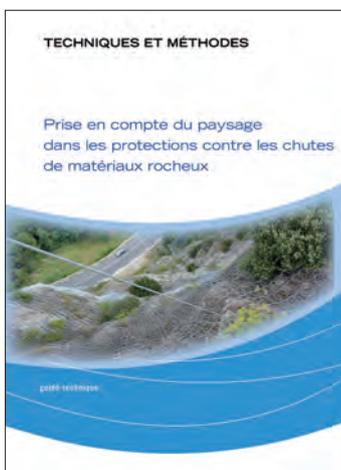
Disseminating and sharing knowledge

IFSTTAR has pursued its proactive editorial policy to push for open access. All of the documents published in 2016 in IFSTTAR's collections are freely circulated under the Creative Commons license (CC BY-NC-ND 4.0) on the digital library's website.

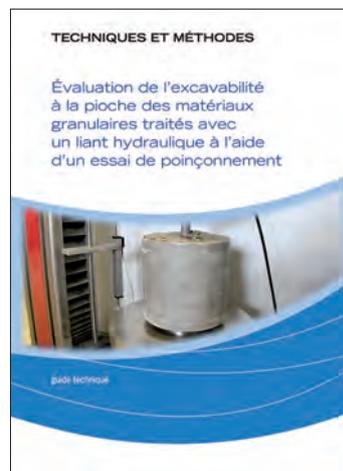
- IFSTTAR and Cerema, Supervision of slopes and unstable cliffs: Design and implementation of devices of measure - Acquisition and data processing. Collection techniques et méthodes de l'Ifsttar, GTI1, 172 pages.



- IFSTTAR and Cerema, Integration of landscape into rockfall mitigations. Collection techniques et méthodes de l'Ifsttar, GTI2, 196 pages.



- IFSTTAR and Engie, Assessment of the excavation by pickaxe of granular materials treated with a hydraulic binder using a punching test. Collection techniques et méthodes de l'Ifsttar, GTI3, 36 pages.



- IFSTTAR and Cerema, Results of APOS and MCV research operations [Online]. Collection actes interactifs de l'Ifsttar, AI11.



IFSTTAR also lived up to its commitment to open its back-catalogue to cybernauts: 19 additional works published in 2010 were added to the 599 others already available in open access. In 2016, 1,500 cybernauts visited IFSTTAR's digital library, 70 % from France and 30 % from French-speaking countries including Morocco, Algeria, Canada or Senegal. Over 1,000 publications were downloaded free-of-charge from the library's site. IFSTTAR's publications are for half circulated in digital format while the rest is still in the form of softcover books.

Following the signing of the law for a Digital Republic (*loi pour une République numérique*) in France and the evolution of research data related challenges, work was launched to roll out a controlled policy for the management and opening of research data to ensure the protection of sensitive data.

The Science and Society web space, with its 4,000 annual visitors, acts as a backbone for the circulation of the Institute's research work to the public at large. Several actions were initiated to make sure this showcase can be accessible to the largest number of cybernauts:

- For better international visibility, all of the thematic dossiers were translated into English language;
- Pursuant to our commitment to opening up to Society, the Creative Commons license (CC BY-SA 3.0) was granted to the above-mentioned dossiers so they may be shared freely and re-used subject to certain conditions;
- To reach out to an even broader audience, new multimedia contents have also been added.

Leveraging research through image

IFSTTAR now enables its researchers and PhD students to optimize their work with photo reports and audio-visual documents. In 2016, 18 videos were thus produced. All this material is now available on the Pictolab photo and video library, with a collection of 109 videos available in streaming. Since 2015, the “*IFSTTAR vidéos*” Youtube channel has also helped disseminate these productions with 91 subscribers and 13,905 views to date, mostly young French-speaking viewers.

A video series, *Focus Métiers*, produced by IFSTTAR aimed at helping Internet users discover the diversity of research streams at IFSTTAR. From 2015 to 2016, 18 researchers, PhD students, research engineers and laboratory technicians took part in this exercise and presented their professional career and their work at IFSTTAR in front of a camera.

Creating places of exchange in the territories



In 2016, the National scientific encounters in Bron (RNSB) “Sustainable, social and citizen City” celebrated their 4th anniversary.

IFSTTAR and *Ville de Bron* together with ENTPE, Aperau* and Lyon University invited the citizens of Bron to come and meet the researchers, interact with them and explore societal issues. The RNSB encounters are mainly focused around 3 activities:

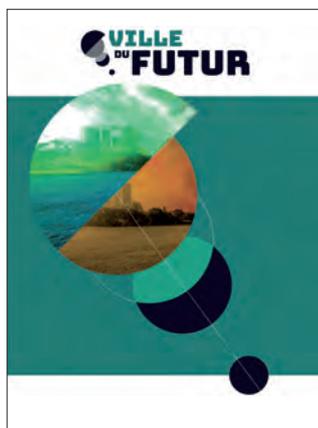
- A knowledge university with an annual cycle of 5 evening conferences with the input of one or two researchers;
- Citizen-workshops held throughout the year to help young people, adults or seniors discover and delve into a scientific question;
- A full-day public debate once a year to report back to the inhabitants of Bron on the output of the above citizen-workshops.

Before ushering in a new multi-annual cycle, it was important to take stock. With this in mind, a national day of exchanges on the theme “Sharing science to serve to City” was held on 29 November 2016 and gathered researchers, teachers, mediation stakeholders and citizens involved in Science and Society actions in order to discuss solutions to better share scientific knowledge.

In Île-de-France, IFSTTAR has joined forces with 3 cultural operators, ARCADl (public institution of regional action for artistic creation and dissemination in the Île-de-France region), the MOTif (Observatory of books and writings) and Paris municipality’s *Maison de la Poésie* (Poetry house) as well as *École d’urbanisme de Paris* (town-planning

school), *Laboratoires d’excellence Futurs Urbains* (urban futures laboratories) and Paris-Est University to build up an original project around scientific culture. The City of the future project (“*Ville du futur*”), includes:

- Lectures and panel discussions with crossed approaches from scientists, artists and authors on the same topic;
- A prospective ideas incubator where people in charge of cultural centers or institutions, researchers, artists and authors will discuss about tomorrow’s loci of culture;
- Prototyping a forum venue and a stage for cultural performances located on the “Ville durable” campus of Marne-la-Vallée, in connection with Paris-Est University.



On 8 December 2016, the *Maison de la Poésie*’s Italian-style theatre hosted the opening lecture-panel discussion on “Sensitive mapping: how to map the city differently” in front of a packed house. Three further events have already been scheduled in 2017 to continue this discussion on mapping.

* Association for the promotion of education and research in the area of spatial and urban planning

On 9 December 2016, IFSTTAR reasserted its commitment to open science to society by co-signing with Anses, BRGM, Ineris, IRSN, Irstea and *Santé publique France*, a charter for the opening to society of the public agencies in charge of research, assessment and evaluation of sanitary and environmental risks.

By adopting this charter, the signatories undertook to continue to foster the opening and transparency of their processes for research, assessments and/or evaluation of risks, to improve the sharing of available scientific certainties and any uncertainties still remaining around them, and better take into account the contribution of society’s stakeholders to risk evaluation and/or research processes.



Photo of the Managing Directors having signed the charter: Jean-Marc Bournigal, DG of Irstea; Roget Genet, DG of Anses; Jean-Christophe Niel, DG of IRSN; Hélène Jacquot-Guimbal, DG of IFSTTAR; Pierre Toulhoat, DG of BRGM; Raymond Cointe, DG of Ineris; Martial Mettendorff, deputy DG of Santé publique France (national public health agency)





LEVERAGING RESEARCH, RELATIONS WITH THE INDUSTRY

Working for society at large, IFSTTAR constantly strives to put the fruit of its research work and its large-size, and often exceptional, scientific equipment assets at the service of the economy.

To imagine, create and at each step find the best partners to develop and implement the new solutions is a pre-requisite for success. Moving from an idea of research to practical results, transforming them, combining them with other research outcomes to form the building blocks that may be assembled into innovative technological solutions that are economically viable, or be used to offer brand new services, is a lengthy and arduous process.

To accompany this reflection and the researchers themselves in their endeavors, by nurturing an entrepreneurial and innovation-focused culture, is a major challenge for the Institute, one that lies at the heart of the mission of the support teams that help setting up partnerships or leveraging operations.

Scientific assets, whether large facilities, experimentation sites, databases or software, must meet the requirements of the economic and industrial world, as well as civil society's, in order to study, test and at the end of the day validate and optimize the solutions that will be implemented on site tomorrow. At the time of digital transition, they also form as many sources of information that are key to both the design and the validation of innovative computer models and simulators.

In terms of leveraging, 2016 saw the following achievements in particular:

- Signing of three framework-contracts with Andra, IRSN and more recently Eiffage;
- The actual start-up of an SME plan with the first edition of Innov'Days in May 2016: "Cities and transports in interaction", with a dozen SMEs taking part;
- Drafting of a charter of best practices for partnerships between IFSTTAR and young innovative enterprises;
- Drafting of a guideline about the Institute's scientific investments policy for use by the researchers.

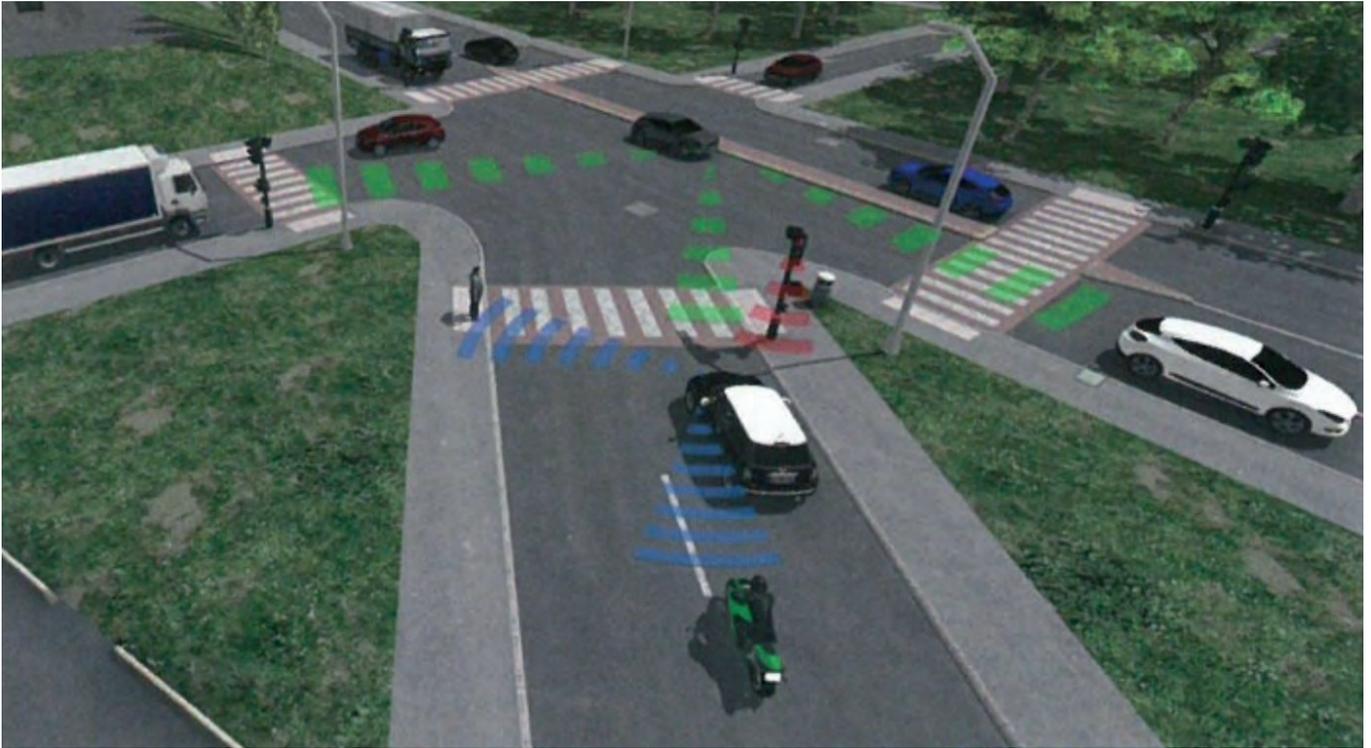


Brigitte Mahut
Head of partnerships
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CIVITEC's first sales in Asia and North America



THANKS TO THE CIVITEC SUBSIDIARY SHARED BY ESI AND IFSTTAR AND SPECIALISING IN THE QUALIFICATION OF ONBOARD PERCEPTION SIMULATOR SYSTEMS, FRENCH GROUP ESI, A WORLDWIDE LEADER IN VIRTUAL PROTOTYPING, CAN NOW APPLY ITS KNOW-HOW TO SELF-DRIVING CONNECTED VEHICLES. THE PRO-SiVIC® SOLUTION DEVELOPED BY CIVITEC CAN TEST THE SENSORS OF THESE VEHICLES IN AN ULTRA-REALISTIC 3D ENVIRONMENT.

ESI's solutions ensure that its customers can safely send their products to pre-certification tests – whilst drastically reducing the number of 'real-life' prototypes. Combined with virtual reality, virtual prototyping becomes both immersive and interactive, and with the new expertise developed within the Civitec company, a spinoff from IFSTTAR's Livic laboratory, this technology can now be used to evaluate onboard sensor systems from the design stage all the way to the final performance test.

UNIQUE EXPERTISE

"Thanks to the Pro-SiVIC product, it is now possible to design, integrate and validate ADAS driving assistance systems and review the decision-making chain in all safety" explains Serge Laverdure, head of the virtual systems & inspection and head of the self-driving vehicle division created early 2016 at ESI Group. Virtually, external parameters such as lighting and weather conditions, and the presence of other road users can be represented precisely. Pro-SiVIC is therefore used to build up complex 3D scenarios and experiment them interactively in real time.

"While car makers should in principle run their vehicles for hundreds of millions km, if not billions, it is thus possible to spare physical prototypes and model the tests" emphasizes this engineer. Implementation of this type of module is extremely complex, as it requires 3D modelling of ultra-realistic environmental conditions, let alone their digital transcription using sensor simulation, all of which is done within an optimized interface capable of improving the perception of operators such as the drivers themselves.

BUSINESS HAS ALREADY STARTED IN THE UNITED STATES

Thanks to this expertise, ESI Group was selected among the winners of the "Ubimobility Connected Cars" program led by Bpifrance, in partnership with Business France. Since 2015, this program has enabled 8 innovative firms of the French automobile industry to meet key counterparts in the fields of connected cars, self-driving vehicles and intelligent transport in the United States. And what's more, ESI was among the companies selected in 2016 for a road-show between Detroit and San Francisco. *"This program was a real boost as it allowed us to start our self-driving car business in the US"* Serge Laverdure points out.

SALES IN EUROPE AND ASIA

"With this Pro-SiViC technology, we are now considered among the best in the world for sensor simulation and we are already preparing the next generation with IFSTTAR.

Besides we also continue to be involved in European-wide collaborative projects to promote this new technology with automakers" he goes on to add.

AND WHAT ABOUT TOMORROW? SIMULATION: A SOLUTION FOR EURO NCAP TESTS?

The concept of active safety has gradually been incorporated into the Euro NCAP certification tests. ESI Group holds it that in all likelihood the demand of automakers for these Pro-SiViC solutions should increase markedly due to the mainstreaming of technologies and connectivity onboard vehicles.

For transport stakeholders, this is an important challenge as the price of a product development campaign to meet the requirements of so-called active safety standards, can reach up to 10 to 30 million euros per annum if no sensors or virtual prototyping tools are used. This figure is due to the multiple iterations involved in the qualification of the vehicle in order to factor in the unlimited number of possible environments.

Simulation also makes it possible to reduce lead-times. *"Aeronautics, which pioneered automation, could afford several years to certify an aircraft whereas for road vehicles the lead-time is extremely short,"* adds our expert.

ESI Group and the Civitec team in charge of these solutions can thus help industrialists overcome these problems by helping them in the optimal design phase and with an evaluation of these configurations validated early on by these virtual tests.

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TRANSPOLIS launches its experimentations on the laboratory city dedicated to urban mobility and successfully starts selling the APTS® technology developed by LBMC

CREATED IN 2011, TRANSPOLIS IS BUILDING AND FITTING AN EXPERIMENTATION FIELD FACILITATING THE DEVELOPMENT AND IMPLEMENTATION OF TEST PROGRAMMES, UNDER CONTROLLED CONDITIONS CLOSE TO REAL-LIFE, TO EVALUATE AND DEVELOP TECHNOLOGIES FOR THE CREATION OF URBAN TRANSPORT SYSTEMS SUCH AS SELF-DRIVING VEHICLES CONNECTED TO INFRASTRUCTURES.

A genuinely novel platform, Transpolis SAS in 2016 invited all mobility stakeholders (civil society associations, industrialists, researchers, local authorities, users, instructors, government agencies) to use and improve its first scale-1 mock-up of a town center named "City Lab". The objective was also to validate the options to be chosen for the new site of Fromentaux under construction.

In 2016, Transpolis thus invited its first high-volume freight transport clients and driverless shuttle clients to take part in fine-tuning tests close to real-life physical conditions albeit in a safe and controlled environment. Among the assets tested were: traffic lights, roundabouts, parking lots and a range of technologies for connection between vehicles and infrastructures.

Several experiments with electric vehicles and connected vehicles – synchronized with a dozen traffic lights – made it possible to demonstrate the sound operation of the protocols intended to optimize traffic fluidity, cut down the consumption of industrial vehicles and their exhaust emissions.

Transpolis also significantly boosted its sales of "abdomen sensors" in 2016. Transpolis exploits the APTS – Abdomen

Pressure Twin Sensors – technology developed and patented by IFSTTAR's LBMC laboratory.

These APTS sensors were developed to equip the series of "Q-Dummies" representing kids aged 1 to 10. The sensors were implanted vertically by pairs into the dummies' abdomen. During crash tests on child restraint systems, these sensors were used to measure the pressure experienced by the dummy at abdomen level in order to evaluate the risk and severity of abdominal injuries.

This technology was selected to assess the compliance to the requirements of the new ECE R129 regulation (in replacement of the former ECE R44/04). Companies such as Dorel Juvenile and organizations like ADAC already use these sensors.

The range features three models:

- APTS30: 30-mm diameter sensors for the abdomen of dummy Q1/1.5;
- APTS40: 40-mm diameter sensors for the abdomen of dummies Q3 and Q6;
- APTS50: 50-mm diameter sensors for the abdomen of dummy Q10.

For more information:

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Philippe Beillas, a researcher at the LBMC laboratory reminds us that abdomen injuries caused by car accidents proved to be a significant cause of mortality for young children in the 1990s.

The crash-test dummy used to test the efficiency of the car seat was altered (2006 – 2008) to add an abdomen sensor (pressure measurement representative of the perceived shock) designed and initially manufactured by IFSTTAR. This abdomen sensor facilitated the evaluation of the injury risk incurred during a shock for a child protected by his/her car seat. This risk changes according to the design of the seat. This possibility was integrated by the new regulation published end of 2016 thanks to the research work and an awareness-raising policy demonstrating the usefulness of the measurement provided by the sensor.

This project started over 10 years ago and since then 2 patents have been filed, a European project was launched (Casper) as well as a Single Interministerial Fund (IDForCar) with car seat manufacturers, while a partnership agreement was set up with the sensor manufacturer and distributor (Transpolis, a subsidiary of IFSTTAR).



CITIOLOG, a spinoff company of IFSTTAR



Traffic data collection



Junction management



Video management

ESTABLISHED IN 1997, CITIOLOG, HAS SINCE DEVELOPED OVERSEAS WITH A TURNOVER IN EXCESS OF M€ 5.5 IN 2015. IN 2016, CITIOLOG BOLSTERED ITS DEVELOPMENT CAPACITIES BY JOINING WITH ITS SWEDISH PARTNER, A SUPPLIER OF IP CAMERAS.

After becoming a spinoff of IFSTTAR in 1997, Citilog, a company specializing in the automated detection of road incidents through image processing, soon became the international benchmark in intelligent tunnel video-surveillance for incident detection (DAI) with an 80 % market share.

Today, Citilog designs and proposes intelligent transport solutions that enable millions of drivers the world over to travel more efficiently and in full safety.

The Citilog systems are deployed in many well-known sites across the world: Lincoln and Holland tunnels in New-York, Lupu, NanPu and Yanpu bridges in Shanghai, Madrid's M30 motorway, the Mont-Blanc tunnel in France and Italy and 900 other locations. Citilog is headquartered in Paris, France with offices in the United States, Hong-Kong and Spain.

Their products are used in many countries to monitor motorways, tunnels, bridges and other infrastructures, as well as in cities for urban traffic optimization. They improve road safety while curbing risks linked with traffic and reducing journey time. For every type of incident and in the event of traffic congestion, alarms are generated to help operators

optimize their response time in real time. Video footage is recorded and may be analyzed *a posteriori* to check what exactly happened and measure performance in terms of safety.

On 31 January 2016, Swedish company Axis Communications, a world leader for video over IP, announced the purchase of Citilog, a supplier of smart traffic management solutions in real time. By acquiring this state-of-the-art technology from the experienced teams of Citilog, Axis strengthened its common transport solutions and extended its expertise to the booming market of traffic-dedicated video analysis.

Axis contributes a large number of staff with 2,000 employees across 40 countries and the company boasts an extensive network of over 75,000 partners in 179 countries. Established in 1984, Axis is a Swedish company listed at the Stockholm Nasdaq under the brand name Axis.

For more information: www.citilog.com



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CONTRACTS

Development of relations with the social and economic players is enshrined in the objectives of the Institute

For its 3rd year of existence, the young team of AMP (support to project set up) continues its maturing within the institute.

2016 was marked by the launch of a framework agreement deployment policy; a charter to help define the rules of a framework agreement was drawn up with the corresponding monitoring process put in place. Early 2017, three new framework agreements were signed (Andra, Eiffage, IRSN) so that there is now a total of 12 such agreements with major groups, i.e. a 25% increase year on year. These framework agreements consolidate customer loyalty and speed up contractualisation. They are one of the reasons why IFSTTAR was able to maintain, if not increase, its own resources at about M€ 13 of business, that is a total 157 annual agreements. The Institute's own resources recorded a 13% increase in volume over the 2013- 2016 period.

IFSTTAR's partners basically come from three markets:

- a) transport (road & rail),
- b) infrastructures and construction and
- c) energy (nuclear and offshore).

These partners entrust the Institute with projects corresponding to 4 scientific themes that are key to the Institute around the circular economy, the recognition of risks, new technologies around the 5GR road, and finally design issues around the self-driving vehicle pertaining to ergonomics and new technologies.

Among the 400 annual projects handled by the Institute, one interesting example is Ademe's "Eco-responsible Data Centre" project awarded at the end of the year and which aims to study and produce a demonstrator equipped with a raw earth heat exchanger. This indeed is a perfect example of successful cooperation between IFSTTAR and an SME. APL, a company specializing in the design of Data Centers shows that from a laboratory-validated concept, it is possible to open a new field of research and development in the area of energy

optimization generated through better use of "raw earth" as a technological material.

In terms of SME/ETI, 2016 saw the launch of the first Innov'Days, an event promoting thematic communication (this year "interaction between transports and the city") between SMEs, large industrial groups and IFSTTAR's laboratories. These days are very much in line with the policy to foster social and economic relations and dialogue, potentially contractual exchanges between IFSTTAR and the industry, and in particular SME/ETI.

At European level, and more specifically in terms of setting up projects, 2016 saw 37 H2020 projects registered. Beyond the "Transports" challenge, the Institute is now also involved in other areas such as "Infrastructures", as illustrated by the new projects "Steering" aiming to upgrade a number of European research infrastructures– road and rail – to test the behavior of infrastructures under extreme climatic conditions and their adaptation to new hybrid, guided and self-driving vehicles. Besides, IFSTTAR took part with its partners (industrial players, academics and local authorities) in the preparation of the Urban Mobility KIC (Knowledge and Innovation Communities).

In 2016, IFSTTAR continued its work within the Energy Transition Institutes (ETI Efficacity and Vedecom) as well as in the Technological Research Institutes (TRI Railenium, System-X, Jules Verne) by seconding near to 7 full-time equivalents as part of its manpower contribution.

Intensification of scientific collaborations with business partners is now part of the Goals and Performance Contract, the COP 2017-2021, signed at the end of 2016. Let's trust that this objective, now written into the DNA of IFSTTAR and shared by all of its agents, will help better share the Institute's knowledge with the economic players through research partnerships.



PATENTS

Surveillance of coastal engineered structures through passive seismic monitoring

The diagnosis of sea defense facilities involves critical security and economic challenges. Most of these assets are now ageing and poorly documented.

Their monitoring is essentially based on eye-inspection, which does not always ensure that it will be possible to identify potential internal anomalies jeopardizing their sustainability in the event of an extreme climatic event.

Monitoring ambient seismic noise generated by swell offers a non-invasive diagnosis tool that is easy to implement. Vibration sensors are fitted at the

top of the asset for part or the whole duration of a tidal cycle. Processing the measurements made can help evidence possible variations in the internal mechanical properties of the asset and its base, in response to the change in water height and the resulting alteration in the propagation pattern of seismic waves between certain sensors.

Zones with significant variations are identified as being the seat of internal erosion phenomena due to water ingress, and may be designated to the asset's managers as the preferred target for a

reinforcement operation. This method can be made available to design and engineering firms solicited for flood prevention schemes.



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Acquisition system deployed on a seawall



Patent to improve the efficiency of metamaterials-based miniature antennae

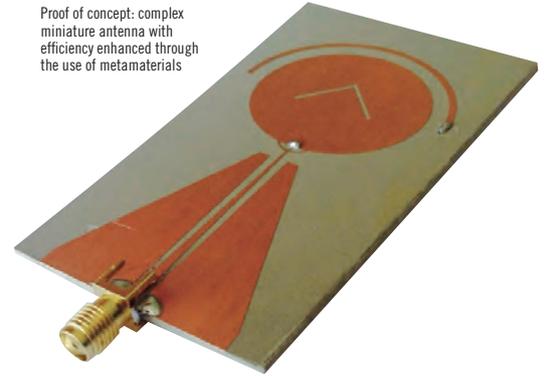
Current and emerging telecommunication systems use small-size antennae that are built into more complex systems. Now the miniaturization of an antenna necessarily calls for a performance compromise in terms of broadband and efficiency. Previous work has shown that adding a specific metamaterials inclusion into a given antenna could enhance its radiation efficiency. However, these academic studies only considered elementary sources, which do not address the question of system designers as to the choice of the type of inclusion to be preferred for a specific antenna whose geometry is often irregular so that it can be integrated into a restricted space.

The work conducted at Léost, which resulted in a patent filing, proposes a

generic analysis and synthesis that can be applied to a couple of electrically small antennae, of indifferent type and with non-canonical inclusion of metamaterials, and of arbitrary geometry and nature. This systematic process relies on a calculation of the energy stored by the considered antenna and the search for a metamaterials inclusion liable to compensate this energy, both quantitatively and qualitatively. As proof of the concept, a complex miniature antenna, with enhanced efficiency was designed as the constituent element of an electromagnetic field level measurement sensor.

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Proof of concept: complex miniature antenna with efficiency enhanced through the use of metamaterials



Thermoroute 2, for a new approach to thermal mapping

The winter-time viability of a network (highways, motorways, urban areas ...) requires some knowledge of its thermo-hygrometric behavior in order to identify preferential zones where ice patches will build-up. This approach in use since the 1990s, and known as “thermal mapping”, requires an instrumented vehicle capable of running across these networks right amidst the rest of the traffic. Having become obsolete, the first Thermoroute vehicle was awaiting its successor. As part of two IFSTTAR research operations, Cerema Est and Cerema Normandie Centre (CECP Rouen) drafted new specifications and devised an instrumented Thermoroute 2, whose measurements (surface and air

temperature, relative humidity ...) and processing by a dedicated piece of software provide an indicator of this susceptibility, commonly known as winter risk. Equipped with measuring devices running on an APO platform of the CECP, it has already produced thousands of miles of measurements for various principals, whether departmental councils or Paris and the *Aéroports de Paris* platforms. These latest developments, combined with the outcome of recent research, pave the way for GIS-based predictive mapping of this winter risk.

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DATA BASES

Databases play a key role in IFSTTAR's scientific approach. Most of the time they remain internal tools for the purpose of research. Whenever it is possible in terms of contractual agreements, intellectual property rights and personal data protection (CNIL), IFSTTAR makes data sets available based on an Open Data strategy. The objective is then to maximize their dissemination and facilitate their reuse by the largest number of people.



European databases for the surface characteristics (grip, rolling resistance) of IFSTTAR's reference test-track in Nantes are being built up as part of **European project ROSANNE**

IFSTTAR's road experimentation and reference test track

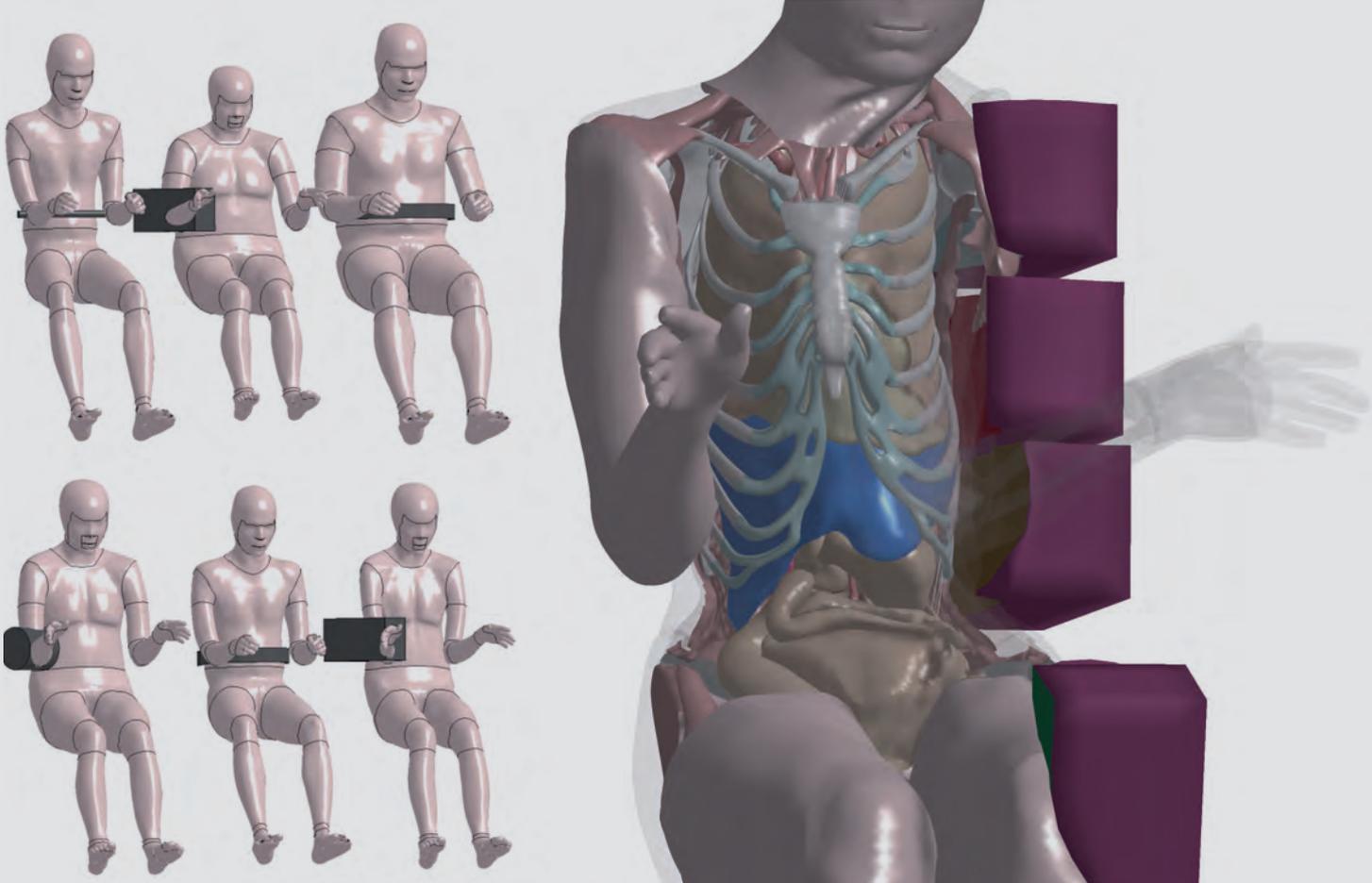


The ROSANNE (ROLLing resistance, Skid resistance, ANd Noise Emission measurement standards for road surfaces) European project aims to define common practices shared across Europe in terms of measurements of road usage properties such as grip, or skid resistance, noise and rolling resistance. This pre-standardization project (2013-2016) made it possible inter alia to conduct several skid and rolling resistance measurement campaigns of IFSTTAR's test track surface in Nantes.

These measurements were made by a panel of over fifteen testing vehicles representative of the current practice across Europe and over a dozen different surfaces at speeds ranging from 30 to 80 km/hr depending on the vehicles. In addition, a circuit comprising seven segments was characterized. All of the data collected on the IFSTTAR test-track and on the roads made it possible to create a large database that addressed two separate purposes. On the one hand, it was possible to study the impact of different parameters (velocity, vehicle, etc.) on the skid and rolling resistance measurement, and accordingly come up with measuring method recommendations. On the other hand, tapping into the skid resistance data base resulted in a single indicator being identified to which the various friction devices can now be linked. These findings will now feed into the work on future European standards.

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Abdomen modelling for car crashes: detailed female model of GHBMC



The non-linear scaling of models (LH side) provided an insight into the size and anatomy effects on response to the shock and the injury risk and helped better validate the behavior of the new 5th percentile female model of GHBMC (RH side)

The Global Human Body Model Consortium (GHBMC) is a worldwide consortium of automakers essentially. Its purpose is to develop advanced human models for automobile shocks.

The programs are cofounded by the National Highway Traffic Safety Administration and conducted by six academic expertise centers selected in 2007. LBMC is in charge of the center on abdomen research, which is the only one based in North America.

Subsequent to the work that resulted in the first detailed model of the GHBMC representing an average-size man (2011), in 2015-2016 their efforts focused on developing a detailed model representing a small-size woman (5th percentile).

For LBMC, this work, conducted jointly with Transpolis SA, brought some

significant breakthroughs on more upstream questions such as validation of the abdomen's internal response (based on observations by ultrafast imaging at the LBMC) or the effect of size and anatomy. *In fine*, curves were generated to assess the injury risks to the liver and spleen with the detailed GHBMC models. These results and methodological developments pave the way for further research to improve predictions and extend them to other organs.

After the development phase was completed, the new female model was added to the GHBMC family which is widely used amongst academic and industrial circles.



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CERTIFICATION

The covenant signed on 15 July 2014 between IFSTTAR and Cerema renewed the close partnership of IFSTTAR with the network of CETEs for certification activities. IFSTTAR and Cerema were thus building upon their long experience of audits-inspections and tests, jointly conducted for the certification of products essentially intended for civil engineering works, to extend their cooperation. To further strengthen this close link, a specific cooperation agreement was signed to enshrine the covenant's provisions into a longer-term framework. This specific agreement was signed on 25 November 2016 by IFSTTAR's Managing Director, Mrs H  l  ne Jacquot-Guimbal and Cerema's Managing Director Cerema, Mr Bernard Larrouturou.

This agreement reinforces IFSTTAR's role as a notified certification body under reference No. 1165, for the application of the attestation of conformity procedures associated with the CE marking of several product families such as aggregates, drop-on materials,

retro-reflecting pavement markers and rockfall protection kits. This agreement also confirms IFSTTAR's association with Cerema as a body providing audit and testing services for and on behalf of certification bodies (Afnor Certification, Cerib, Afcab, ATCG, ASQPE and ACQPA) across a broad range of areas including concrete constituent materials, iron in engineered works or anti-corrosion paint on metallic structures.

All in all, no fewer than thirty sectorial applications are thus managed, each of which by a dedicated sector manager, either from IFSTTAR or Cerema. They call upon more than 130 auditors from both institutes who carried out some 1,000 days of audits in 2016. And since the signing of the above covenant another 36 new auditors have been trained.

A fruitful cooperation indeed!



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START-UP

The research work of the Nacre team benefits from a maturation program of Satt Paris-Saclay and prepares the grounds for the **creation of a new company, AltaRoad.**

Objective: a smarter road for more sustainability and more safety

The joint research team Nacre - Nanotechnologies for environmentally-friendly cities – comprising researchers and staff from IFSTTAR, *École Polytechnique*, CNRS and Mines ParisTech, has developed a new nanosensor technology to facilitate the instrumentation of infrastructures and their networking together.

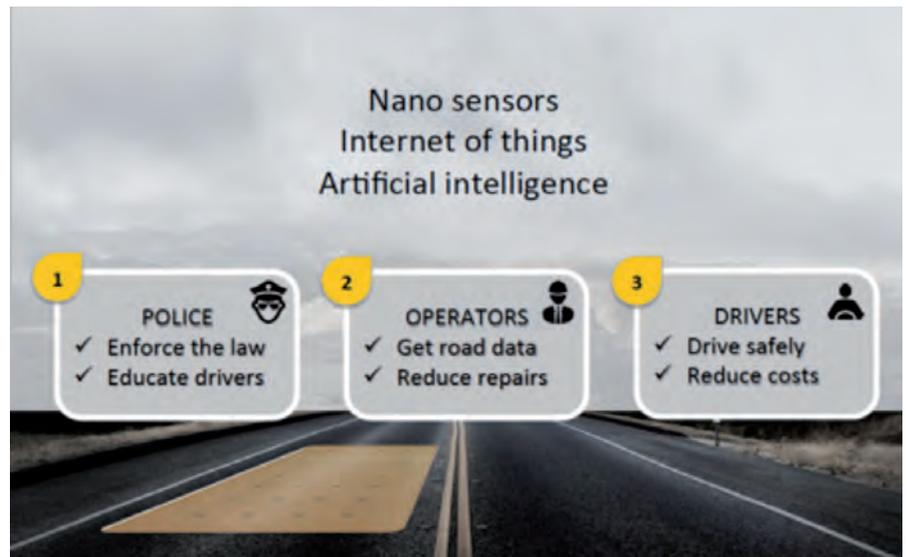
This team can avail itself of prototyping equipment and infrastructures for the performance evaluation of micro and nanosensors designed for sustainable cities in particular.

Noteworthy among these outstanding scientific infrastructures are:

- the “Platine” sensor reliability platform at *École Polytechnique* and
- the mini-laboratory city “Sense-City” at IFSTTAR, which is used to validate realistic demonstrators for a sustainable city under controlled environment.

The results of this research project, conducted by Mrs Bérengère Lebental, head of research at IFSTTAR and project manager for the Cosys/IFSTTAR department and the LPICM/Polytechnique laboratory, have benefitted from a co-maturation program between the various units and the Satt Paris-Saclay since 2016. This program is supported by Satt Paris-Saclay with a funding of 452 k€ over 18 months.

The objective is to instrument tomorrow’s roads with layers of pressure nanosensors to provide ongoing diagnoses on the state of the roadway and traffic activity. By processing the data supplied by these networks of sensors it will be possible in fine to arrange for a more sustainable use of infrastructures and ensure better safety for road users.



These topics form the backbone of Mrs Cécile Villette’s project to create the future “AltaRoad” start-up in order to leverage these investments and promote the nanosensor technology. The company thus wishes to develop these new connected solutions for road monitoring. AltaRoad will propose an end-to-end solution to road infrastructure operators: qualitative and quantitative data will thus be collected and transmitted to facilitate their decision-making in managing tomorrow’s roads.

APPENDIX

GOVERNANCE

BOARD OF DIRECTORS AS OF 12/31/2016

Chairman: Jacques TAVERNIER

Chairwoman: Christine BOUCHET

Representative of the state

Ministry in charge of public works:

Deputy member seat under replacement
Jean-Philippe TORTEROTOT (deputy member), *Ministry of Environment, Energy and Sea*



Jacques Tavernier,
Chairman of the Board of Directors



Corinne Gendron,
Chairwoman of the Scientific Board

Ministry in charge of transports:

Christine BOUCHET (full member), *Ministry of Environment, Energy and Sea*
Xavier DELACHE (deputy member), *Ministry of Environment, Energy and Sea*

Ministry in charge of the environment:

Philippe GUILLARD (full member), *Ministry of Environment, Energy and Sea*
Thierry HUBERT (deputy member), *Ministry of Environment, Energy and Sea*

Ministry in charge of research:

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Philippe TOUSSAINT (deputy member), *Ministry of Education, Higher Education and Research*

Ministry in charge of higher education:

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Jean-Baptiste VERLHAC (deputy member), *Ministry of Education, Higher Education and Research*

Ministry in charge of the budget:

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Manuelle SALATHE (full member), *Ministry of the Interior*
Pierre VAISS (deputy member), *Ministry of the Interior*

Ministry in charge of defence:

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Rémi CASSIER (deputy member), *Ministry of Defence*

Qualified individuals

Marie-Claude DUPUIS, *RATP*
Anne-Marie HERBOURG, *ADSTD*
Pierre IZARD, *SNCF*
Carole LE GALL, *Engie*
Yves METZ, *Ingerop*
Guy SIDOS, *Vicat*
Diane SIMIU, *WWF France*
Jacques TAVERNIER, *Usirf*

Employee representatives

SUD Recherche EPST-Solidaires:

Christine BUISSON (full member),
Maryse BASSEPORTE (deputy member)

SUD Recherche EPST-Solidaires:

Christophe GRANSART (full member),
Philippe BON (deputy member)

UNSA: Laurent LÉBOUC (full member),
Franziska SCHMIDT (deputy member)

CGT: Paul MARSAC (full member),
Nathalie BOTTICCHIO (deputy member)

The Chairman of the Scientific Board, the Managing Director, the Scientific Director, the budgetary control authority and the accounting officer attend the meetings in an advisory capacity.

SCIENTIFIC BOARD AS OF 12/31/2016

Chairwoman: Corinne GENDRON

Vice-chairman: Pierre-Olivier VANDANJON

Scientific and Technical individuals

Sylvain ALLANO, *PSA*
 Brigitte BARIOL-MATHAIS, *FNAU*
 Bénédicte BUCHER, *IGN*
 Daniel CLEMENT, *Ademe*
 Pierre-Etienne GAUTIER, *Systra*
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Université Paris-Est Créteil
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Catherine PEREZ,
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Employee representatives

CFDT: Alexandre de BERNARDINIS (full member), Fabrice VIENNE (deputy member); Pierre-Olivier VANDANJON (full member), Etienne LEMAIRE (deputy member)

CGT: Divitha SEETHARAMDOO (full member), Jean-Michel FOURNIAU (deputy member)

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 Juliette KAUV (deputy member)

Unsa : Lamine DIENG (full member),
 Malal KANE (deputy member)

EXECUTIVE BOARD AS OF 12/31/2016

Managing Direction

Hélène JACQUOT-GUIMBAL,
managing director
 Jean-Bernard KOVARIK,
deputy managing director
 Jean-Paul MIZZI,
deputy managing director
 Claire SALLENAVE, *director of the office*
and communication manager
 Thierry FRAGNET, *head of the office*

Deputy Directorate

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director of Versailles-Satory site
 Jean-Paul MIZZI, *deputy director*
of Marseille-Salon-de-Provence site
 Gérard COUVREUR, *temporary deputy*
director of Villeneuve-d'Ascq site
 Claire SALLENAVE, *deputy director*
of Marne-la-Vallée site
 Philippe TAMAGNY, *deputy director*
of Nantes site
 Marc TASSONE, *deputy director*
of Bron site

Operational Directorate

Directorate for European and International Affairs

Agnès JULLIEN, *director*
 Claude MARIN-LAMELLET,
deputy director

Directorate for Partnership and Resources

Brigitte MAHUT, *director*

Scientific Directorate

Serge PIPERNO, *director*
 Antoine FREMONT, *deputy director*

Secretary General

Anne-Marie LE GUERN,
secretary general
 Eric GELINEAU, *head of legal*
affairs and governance bodies

Departments

Materials and structures (Mast)

Thierry KRETZ, *director*
 Bruno GODARD, *deputy director*
on Marne-la-Vallée site
 Christian TESSIER, *deputy*
director on Nantes site
 Jean-Michel TORRENTI, *deputy*
director for research and development

Geotechnical engineering, environment, natural hazards and earth sciences (Gers)

Eric GAUME, *director*
 Philippe COTE, *deputy director*
 Jean-Pierre RAJOT, *deputy director*
 Jean-François SEMBLAT,
deputy director

Components and systems (Cosys)

Frédéric BOURQUIN, *director*
 Marion BERBINEAU, *deputy director*

Transport, health, safety (TS2)

Dominique MIGNOT, *director*
 Philippe VEZIN, *deputy director*
for research policy
 Joël YERPEZ, *deputy director*
for public/expertise policy

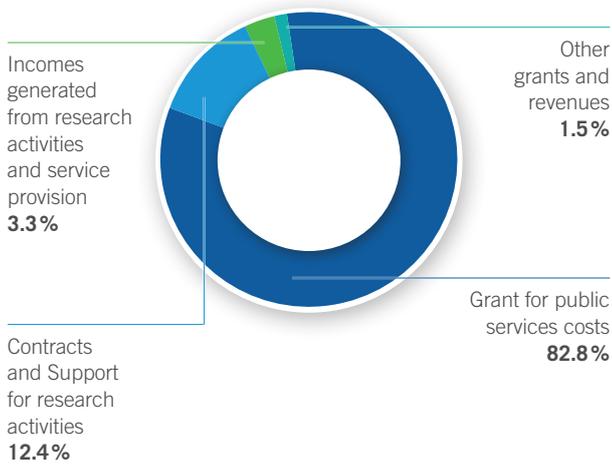
Planning, mobility and environment (Ame)

Gérard HEGRON, *director*
 Anne AGUILERA, *deputy director*
in charge of scientific program
 Michel ANDRE, *deputy director*
in charge of partnership and valorisation
 Michel BERENGIER, *deputy director*
in charge of organization and quality

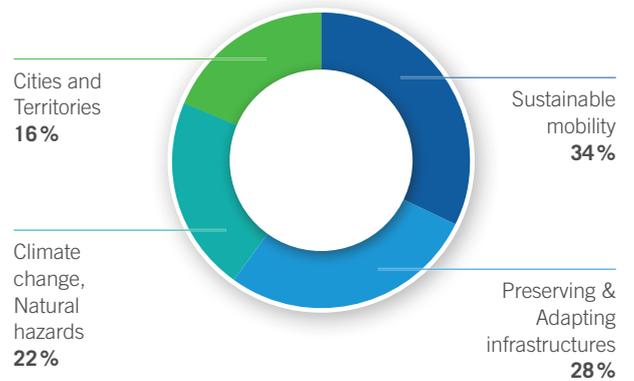
OUTGOINGS AND INCOMINGS

Financial Resources and Expenses excl. depreciation

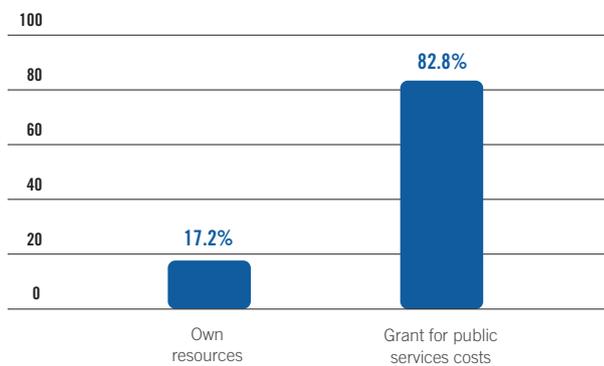
BREAKDOWN OF INCOMES 2016 IMPLEMENTED BUDGET



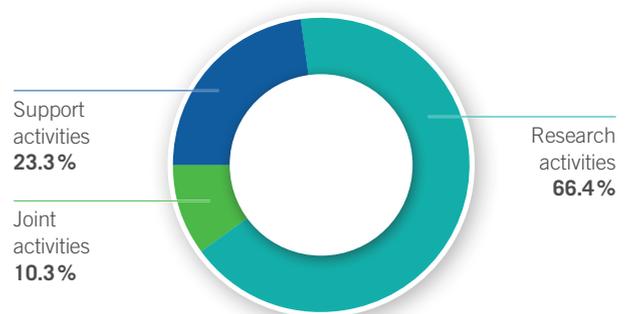
BREAKDOWN OF AUTHORISED EXPENSES PER RESEARCH UNITS



BREAKDOWN BETWEEN GRANT FOR PUBLIC SERVICES COSTS AND OWN RESOURCES



BREAKDOWN OF AUTHORISED EXPENSES PER DESTINATION



Financial Resources and Expenses excl. depreciation

REVENUES	EUROS	%
Ministry of Environment, Energy and Sea	83,496,321 €	82.8 %
Grant for public services costs	83,496,321 €	
Contracts and Support for research activities	12,551,246 €	12.4 %
Research contracts with public or private third parties	2,753,922 €	
Grant for project or research programs	9,797,324 €	
Incomes generated from research activities and service provision	3,291,825 €	3.3 %
Fees for patents and licenses	68,461 €	
Service provision	2,807,081 €	
Product sales	416,284 €	
Other grants and revenues	1,506,451 €	1.5 %
Other grants	763,459 €	
Financial revenue and other daily management income	643,223 €	
Extraordinary income	99,768 €	
TOTAL REVENUES	100,845,842 €	100 %
TOTAL RESSOURCES	100,845,842 €	

AUTHORIZED EXPENSES

BREAKDOWN OF AUTHORIZED EXPENSES PER DESTINATION

	EUROS	%
Activities performed by research units	69,370,940 €	66.4 %
Sustainable mobility	23,439,276 €	
Preserving and Adapting infrastructures	19,781,067 €	
Climate change, Natural hazards	15,001,226 €	
Cities and Territories	11,149,371 €	
Joint activities	10,787,194 €	10.3 %
Major research facilities	4,516,328 €	
Research leveraging	660,989 €	
International exchanges	870,875 €	
Scientific and technical information	2,830,707 €	
Scientific partnership	1,544,583 €	
Continuing education	363,713 €	
Support activities	24,336,492 €	23.3 %
Social action	1,117,467 €	
IT shared resources	4,191,173 €	
Real estate - maintenance	513,723 €	
Real estate - major renovations, acquisitions, constructions	675,344 €	
Head office overheads	7,426,701 €	
Research units overheads	10,252,454 €	
Financial operations		
Other general expenses	159,630 €	
TOTAL EXPENSES	104,494,626 €	100 %
TOTAL	104,494,626 €	

BREAKDOWN OF AUTHORIZED EXPENSES PER NATURE

	EUROS	%
Staff expenses on subsidy for public services	74,112,362 €	70.9 %
Other staff expenses (expenses on research contracts)	4,198,177 €	4.0 %
Unprogrammed operating and investments	21,680,074 €	20.7 %
Programmed investments	4,504,013 €	4.3 %
TOTAL EXPENSES	104,494,626 €	100 %

LABORATORIES LOCATION

BELFORT

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ISTerre

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Research units:
ESTAS, LEOST

LYON-BRON

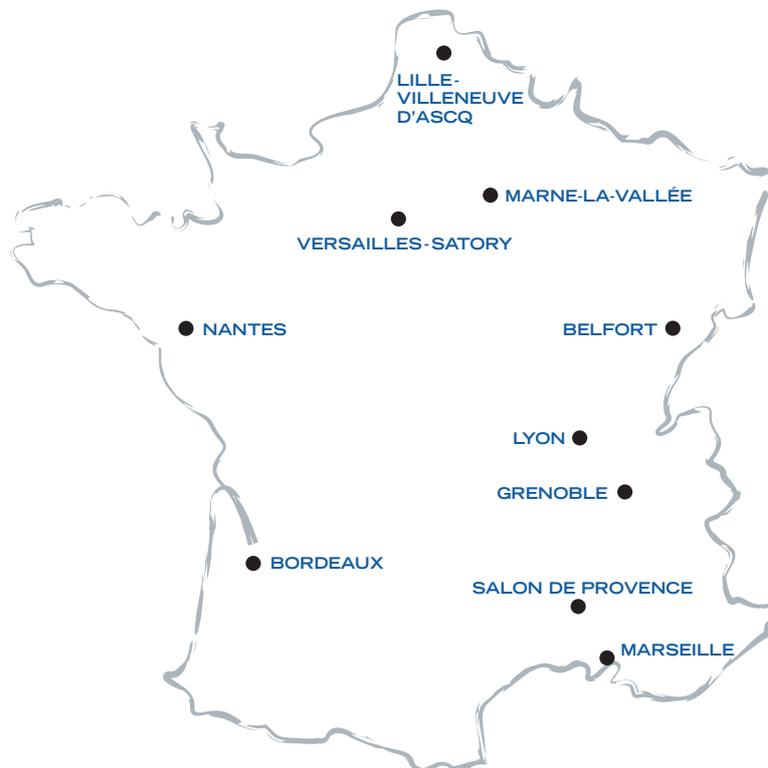
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EE, GEOLOC, MACSI, SII, EASE, LAE

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Research units: LEPSIS, LMA

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Fax: +33(0)130844001

Research units:
TEMA, LPC, LIVIC, LEPSIS

ACRONYMS

2RM	Motorised Two wheelers	Dursi	Durability of intelligent structural composite materials	LCPC	<i>Laboratoire central des ponts et chaussées</i>
AAPA	Australian Asphalt Pavement Association	ECTP	European Construction Technology Platform	LEESU	<i>Laboratoire eau environnement et systèmes urbains</i>
ACQPA	French Association for certification and qualification of anti-corrosion paint	ENS de Lyon	<i>École normale supérieure de Lyon</i>	LGCIÉ	<i>Laboratoire de génie civil et ingénierie environnementale</i>
ADAC	Allgemeiner Deutscher Automobil-Club	ENTPE	<i>École nationale des travaux publics de l'État</i>	LGV	High Speed Line (HSL)
ADAS	Advanced Driver-Assistance Systems	EPSF	French authority for railway safety	LMFA	<i>Laboratoire de mécanique des fluides et d'acoustique</i>
AFCAB	French national body that certifies the reinforcing steels for concrete	ERC	European Research Council	LPICM	Laboratory of physics of interfaces and thin films
AFPS	French Association for Earthquake Engineering	ERRAC	European Rail Research Advisory Council	LTE	Long Term Evolution
ANDRA	French National Radioactive Waste Management Agency	ERTMS	European Railway Traffic Management System	LUTB	Lyon Urban Truck and Bus
ANR	French National Research Agency	ESB	European Society of Biomechanics	MAPIL	Missouri Asphalt Pavement and Innovation Lab
ANSES	French Agency for Food, Environmental and Occupational Health & Safety	ESIEE-CCIP	Engineering school managed by chamber of commerce and industry of Paris Île-de-France region	MCV	Life cycle monitoring
APERAU	French Association for Dissemination of eEducation and Research in Planning and Urban Planning	ETI	Intermediate-sized enterprise	MEEM	Ministry of Environment, Energy and Sea
APOS	Monitoring for safe engineering structure	EVP	20-foot equivalent unit (TEU)	MENESR	Ministry of Education, Higher Education and Research
ARCADI	Action for artistic creation and dissemination in Île-de-France region	EVS	Environment City Society	MOU	Memorandum of Understanding
ASQPE	Independent certification body for the qualification in the field of prestressing and of building as well as civil engineering works	FUI	R&D fund for competitiveness clusters	MUSC	Non-contact ultrasonic measurements
ATCG	Technical Association for the Aggregates' Certification	GERI	IFSTTAR exchange and research group	NAPE	<i>Narodowa Agencja Poszanowania Energii SA</i>
BAU	Emergency lane	GES	Greenhouse gas (GHG)	NASDAQ	National Association of Securities Dealers Automated Quotations
BRGM	French Geological Survey Institute	GEMCEA	Group for the assessment of continuous measurements in water and sewage system	OCDE	Organisation for Economic Co-operation and Development (OECD)
BTP	Building and Civil engineering Industry	GHBMC	Global Human Body Model Consortium	ORSEC	Organization of the civil security response
CAPRIS	Regional framework for seismic risk prevention	GIS	Group of scientific interest	PCRD	Framework Programme for Research and Technological Development
CASD	Secure Data Access Center	GNSS	Global Navigation Satellite System	PCS	<i>Plan communal de sauvegarde</i>
CASR	Centre for Automotive Safety Research	GSM	Global System for Mobile communication	PCSI	<i>Plan de continuité d'activité et système d'information</i>
CCR	Public-sector reinsurer	HCÉRES	High Council for Evaluation of Research and Higher Education	PFMS	<i>Plan familial de mise en sûreté</i>
CEA	French Alternative Energies and Atomic Energy Commission	HU	Urban Hydraulics	PIB	Gross Domestic Product (GDP)
CECP	Center for prototypes' studies and construction	I4S	Inference For Structure	PME	Small and Medium-sized Enterprises (SMEs)
CEREMA	Center for Studies and Expertise on Risks, the Environment, Mobility and Urban planning	IECA	<i>Instituto Español del Cemento y sus Aplicaciones</i>	PMS	<i>Plan particulier de mise en sûreté</i>
CERIB	Center for Studies and Research on precast concrete	IMFS	Institute of Mechanics of Fluids and Solids - Strasbourg	PREDIT	Programme of Research, Experimentation and Innovation in Land Transport
CETE	<i>Centres d'études techniques de l'équipement</i>	INERIS	French national institute for industrial environment and risks	RAP	Permanent accelerometric network
CGI	<i>Commissariat général à l'investissement</i>	INRA	French National Institute for Agricultural Research	RATP	<i>Régie autonome des transports parisiens</i>
CIG	Intergovernmental Commission	INRETS	National Research Institute on Transportation and Safety	REX	Lessons-learned process
CLORA	Club of associated research organizations	INSA de Lyon	<i>Institut national des sciences appliquées de Lyon</i>	RFI	Research-Training-Innovation
CNIL	French National commission to protect personal data & preserve individual liberties	INSEE	National Institute for Statistics and Economic Studies	SATT	<i>Société d'accélération du transfert de technologies</i>
CNRS	French National Center for Scientific Research	INSERM	French National Institute for Health and Medical Research	SHS	Social Sciences and Humanities (SSH)
DGITM	French General Directorate for Infrastructure, Transport and Maritime Affairs	IRRCyN	Research institute in communication and cybernetic – Nantes	SIG	Geographic Information System (GIC)
DGPR	Directorate General for Risk Prevention	IRIT	Toulouse Institute of Computer Science Research	SIMSG	International Society for Soil Mechanics and Geotechnical Engineering (ISSMGE)
DIRIF	Île-de-France region	IRSN	Institute of Radiation Protection and Nuclear Safety	SNCF	French National Railway Company
DIT	Interdepartmental Road Directorate	IRSTEA	National Research Institute of Science and Technology for Environment and Agriculture	SPI	Engineering science
DREAL	Regional Directorate for Environment, Planning and Housing	IRT	Technological Research Institute	STRMTG	National Technical Agency for Ropeway and Guided Transport Safety
DSCR	<i>Direction de la sécurité et de la circulation routières</i>	ISAT	<i>Institut supérieur de l'automobile et des transports</i>	TGV	High Speed Train
		ITE	Energetic Transition Institute	ULNE	University of Lille Nord Europe
		ITS	Intelligent Transport Systems	UNPG	Nationale Aggregates Association
		JRC	Joint Research Centre	UMR	Mixed Research Unit
		KIC	Knowledge and Innovation Communities	UPE	University Paris-Est in Marne-la-Vallée
				WEAMEC	West Atlantic Marine Energy Center



**This document is the result
of a collective work.
May all contributors be gratefully
acknowledged.**

Document published by IFSTTAR

Legal submission:

ISSN: 2285-9902

Publication Director:

Hélène Jacquot-Guimbal

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Photo credit: Sophie Jeannin,
Daniel Bourbotte, Pierre Zembri,
I-Stock, Fotolia.

Graphic design:

www.grouperougevif.fr - ROUGE VIF

24694 - 2017 December

Editing: IFSTTAR and Canopy

Printed by: Jouve