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eRoads Group (from a pavement point of view)

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► **To cite this version:**

Armelle Chabot, Talita de Freitas Alves, Thomas Gabet, Malal Kane, Pierre Hornych. eRoads Group (from a pavement point of view). 2nd seminar of Ifsttar PF - ITE, Nov 2019, Marne la Vallée, France. , 2019. ⟨hal-02388176⟩

HAL Id: hal-02388176

<https://hal.science/hal-02388176v1>

Submitted on 2 Dec 2019

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Context : in order to attain the reduction of CO2 emissions under the objectives of European Energy Agency (EEA 2016), a promising solution is the development of electrified Roads (eRoads) → **Challenge for 2030!**



Induction

A first solution, for inductive charging, is the development of prefabricated concrete slabs, incorporating inductive charging loops. This solution was evaluated on the IFSTTAR APT (Pérez *et al.*, 2016) (Fig. 1).

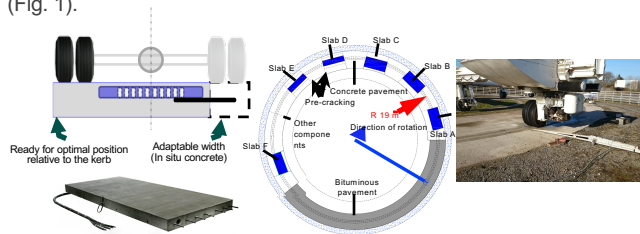


Fig 1. Full scale testing of prefabricated slabs for inductive charging

Dynamic charging of electric vehicles by induction can be achieved through a prefabricated Charging Unit (CU) placed underneath the top asphalt layer (AC) of existing flexible pavements. However, such a box inclusion generates a material discontinuity in the pavement layer and points of singularities, inducing failure in the materials under heavy moving loads (Fig. 2). The shape of the box can be optimized to avoid top corner singularities (Chen *et al.*, 2019). But in any cases, the problems to be solved include finding pavement structural solutions to avoid a possible debonding phenomenon between the CU inclusion and other pavement materials (Chabot & Deep, 2019).

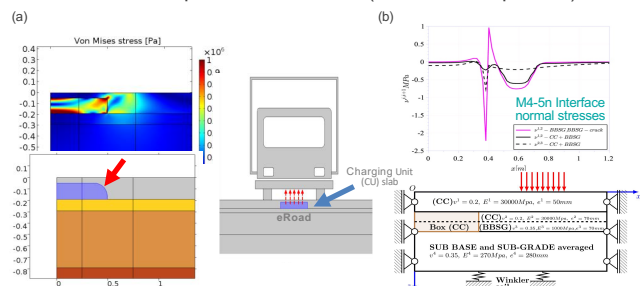


Fig 2. 2D mechanical study of an eRoad with a CU inclusion covered by a top AC layer
a) Box Shape proposed by Chen PHD thesis 2016 (Chen *et al.*, 2019)
b) Materials and Pavement Solution to limit debonding (Chabot and Deep, 2019)

Conduction

The ground module is the key of the in-road live rail ERS conductive solution. It is an original system that contains rails protected by an elastomeric material embedded on the pavement's surface. The power transfer between the electric power source and the vehicles is ensured by the direct contact of a Pick-up unit with the segmented electrified rails embedded longitudinally on the road infrastructure. First ERS prototype sections tested on site and in laboratory showed different types of damage: rutting and interface debonding due to traffic as well as thermal cracking due to daily temperature variations (Hornych *et al.*, 2020). The inclusion of other materials inside an AC can generate differential stresses and strains fields which can cause premature failure. A thermal cycling test was developed at Ifsttar in order to simulate the behaviour of the ERS conductive solution under daily thermal solicitations (de Freitas Alves *et al.*, 2020) (Fig. 3).

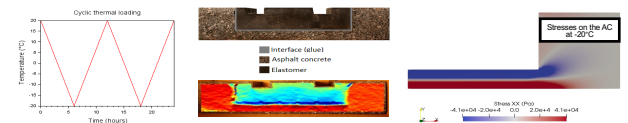


Fig 3. Thermal cyclic tests and numerical simulations
Analysis of the thermic and mechanical behaviour of asphalt concretes (AC) including rigid components (de Freitas Alves PhD thesis 2019-2022 – Ifsttar Supervisors: Hammouf F., Gabet T. & Simonin JM.)

Triboelectricity

Triboelectricity could be one of the possible options converting the mechanical energy from the contact of the tires of vehicles with the roadway (Fan *et al.*, 2012) (Kane & Basset, 2019) (Fig. 4). The idea is to develop a system generating sufficient energy from the tire-road contact zone after each passage of vehicle to allow sending, by low-power wireless communication, a sensor information, for example for the triggering a safety signal in a risky zone, or information on the type and / or weight of a vehicle, the humidity of the roadway, etc.

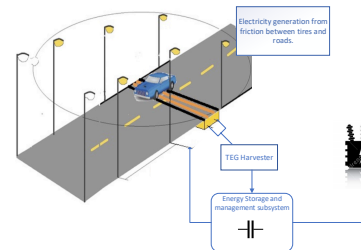
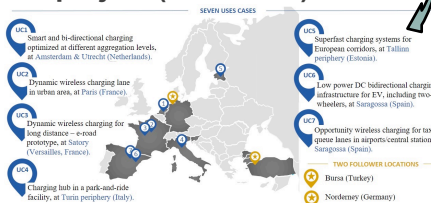


Fig 4. The conceptual view (Picture taken from the FRONT F EU open project proposal)

INCIT-EV project (2020-2023)

Large European project (33 partners) which aims to demonstrate different innovative charging infrastructures, technologies, associated business models and user perception



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