Final Report Summary - NR2C (New Road Construction Concept)

The NR2C project aimed to generate future-orientated initiatives for accessibility problems and issues related to road infrastructure. Its objectives were, in dialogue and cooperation with all actors concerned such as road infrastructure owners, decisions makers, experts, users, road industry:

1 - firstly, to provide long term perspectives for the road infrastructure (vision 2040), which reconciles future transport needs, expected users and social demands, and sustainability goals; this means to develop new concepts for the road of the future (high quality, cost-effective, low noise, environmentally friendly, safer, risk mitigating, low maintenance, while facilitating traffic mobility and inter-modality).

2 - secondly, to implement concrete short term actions by developing specific innovations that will support this long term vision, these innovations being relevant to three fields: urban infrastructure, interurban infrastructure and civil engineering structures.

Concerning NR2C timing, three main phases can be identified:
- Phase 1: survey and analysis
- Phase 2: assessment and selection
- Phase 3: testing and recommendations.

The NR2C project was divided into four work packages (WPs), dedicated to the global concept and each of the three specialised fields:
- WP 0: Development of new concepts for the road of the future
- WP 1: Innovations for urban and suburban infrastructure
- WP 2: Innovations for interurban infrastructure
- WP 3: Innovations for civil engineering
- WP 4: Clustering, communication, coordination and utilisation
- WP 5: Management.

'Multimodal and multilevel design models' of streets form a new conceptual instrument whose main purpose is to support cooperation in street design. Throughout the work of defining, evolving and refining a street project, the NR2C approach provides all ‘co-designers’ with:

(1) a method for organising the design tasks and processes in such a way as to initiate both technical and political cooperations between the various people involved, and

(2) some constellations of well-built, well-thought and well-tried models of streets, avenues, bus lanes, sidewalks, districts, arcades, boulevards meant to constitute reliable supports and rich resources for the running of such a method.

One of the priorities has been the conceptual definition and development of innovative technological solutions are mainly
addressed to the control / abatement of acoustic pollution which are also synergic and consistent with continuously
improvements in the company's overall environmental performance. Some of these studies and researches were developed,
implemented and tested on the motorway in urban and suburban traffic conditions, during the European project NR2C, for
research on innovative noise mitigating road infrastructures designed to perform different acoustic pollution abatement
functions according to different road morphologies such as free fields, embankments and U sections.

Ecotechnic road systems (ERS) is a modular concept of nuisance mitigating solutions concerning mainly an appropriate
combination and integration of low noise pavement and anti-noise barrier subsystems. These were chosen with a view to the
monitoring existing innovative pavements over time and the carrying out studies on the capacities of innovative developed
noise reduction devices while taking into account infrastructure type and operating road scenario. Low noise pavement and
anti-noise barrier subsystems were monitored over time while new ones were developed from feasibility studies, and
preliminary and detailed designs for a holistic and fullscale control and abatement of road noise pollution. Others solutions
dealing with air and water pollutants control / abatement were studied and developed through the definition of original
assessment methodologies and calculation models in order to study the phenomenon scientifically and technically with the
use of laboratory prototypes. Feasibility studies were conducted on innovative nuisance mitigating solutions, able to control /
abate the road traffic pollutants.

Structural behaviour of the solutions was modelled by FEM to assess performances and possible evolutions. The six years
euphonic monitoring at full scale confirms the simulation results from the original FEM model. For the ecotechnic type, the
original FEM model of disconnection steel sheet innovative panel, pointed out the excessive deflection of shaped sheets which
require higher values of their thickness, to avoid panel fatigue damaging and upper bituminous layer deformation, or changing
geometry or materials.

ZAG focused on the bedding layer onto which the cement concrete blocks were placed. A decision was also to choose a
pavement structure where poroelastic layer is put on concrete (paving) blocks. In this way the critical gluing was made in
more controlled and proper manner and environment, in laboratory. The entire pavement structure was designed to be as
‘strong’ as possible to avoid bearing capacity failures, but the intention was also to have it as traditional as possible.

Although the concrete blocks were laid into the sand layer and compacted as much as possible, it seems that the load applied
to the pavement was distributed much more uniformly to lower layers through the screed bedding layer than through the sand
layer. This is attributed to higher stiffness and compactness of the screed layer, compared to the sand layer. Registered
deflections of the pavement with concrete blocks on screed bedding layer were relatively very uniform, what was not the case
with the sand bedding layer pavement. Even if the pavement with screed bedding layer has been deforming under load
applied more than the pavement with sand bedding layer for the first part of experiment, the trend changed radically and
deflections of this pavement stayed almost at the same level throughout the next part (when water was poured into the
pavement). Contrary, deflections of the sand bedding layer pavement increased for all the loading time ending with the
deflections (much) higher than the other pavement. There was a limited effect of watering the pavement with screed bedding
layer and almost no difference in the effect of the two successive ‘heavy rains’. On the other hand, the second ‘heavy rain’
affected the pavement with the sand bedding layer for much longer time and with considerable increase in deflections
compared to the first one and to the other pavement.

All together the pavement where concrete blocks with poroelastic cover were placed into a cementitious screed layer has
shown considerably better performance under applied conditions, compared to the sand bedding layer pavement. Considering
these results it is advisable to continue with further experiments on this pavement. The research should be oriented to the
field tests focusing on stability and suction forces under the typical traffic conditions.

A sophisticated methodology has been used, based on mix design software, different laboratory performance tests and also
ALT testing. Hence, a lot of performance characteristics under several circumstances have been investigated through these
tests, to obtain as much as possible information about the performances of the different mixes. High performance mixtures were obtained with equivalent performance for mixes with RA than mixes without RA, provided that an optimisation of the mix design was performed based on the analytical mix design study and on the results of the performance tests.

No failure was observed and mixes with RA showed equivalent performance as mixes without RA. It was shown that the use of high percentage of reclaimed asphalt in base layers has no negative effect on the laboratory mix performance. ALT, wheel tracking tests, tests in DART and also laboratory tests on cores and binders samples came to the same conclusion that no negative effect of a high percentage of RA could be identified so far. The encouraging results obtained allow us to think about 50 % or 60 % recycling material.

This innovation concerning road maintenance consists in the development of new maintenance techniques and procedures aiming at expanding the overall conditions of application of mixtures for pavements. The benefit of such an innovation is to reduce the impact of the weather conditions on the quality of placing of pavement mixtures, and consequently on the mechanical properties and behaviour of the road structure. Another benefit is the reduction of the impact of road closure due to maintenance on the road users, as it would be more likely to carry out pavement maintenance at more opportune times or periods throughout the year.

The solutions provided for enlarging the overall conditions of application have been founded only for the following climatic parameters: cold, rain, wind heat and loading. Some consequences of climatic parameters such as water on support, film of water on tack-coat have not been solved with original solutions. No original solutions have been provided for enlarging the overall conditions of application due to the fact that there is no means to smooth influence of cold, rain or wind. The opportunity of enlarging the overall condition of pavement materials application is not an authorization for working when the risk of failure or damage is too high. It is only a controlled opportunity.

The sandwich road construction consists of three layers: a glass fibre-reinforced polymer composite (GFRP) sheet with Tupstands for the tensile skin, lightweight concrete (LC) for the core and a thin layer of ultra-high performance fibre-reinforced concrete (UHPFRC) as a compression skin. Mechanical tests on long and short-span hybrid beams were performed using two types of LC with different fracture mechanics properties and two types of FRP-LC interface: unbonded (only mechanical interlocking of LC between T-upstands) and bonded with an epoxy adhesive. The experiments showed that ultimate load is determined by the shear strength of the LC core. A fracture mechanics-based shear strength prediction method was therefore developed. The experimental results and modelling highlighted the importance of considering not only static strength, but also fracture mechanics properties such as the LC characteristic length. Moreover, a design concept was developed demonstrating the feasibility of the suggested hybrid bridge deck and allowing the definition of the required LC material properties according to the transverse bridge span.

Results obtained with the emissivity measurement apparatus has been used to make numerical simulations with the infrared simulation tool developed for simplified road geometries. Based on the Mie theory, calculations of absorption and scattering coefficients were developed from experimental water droplet size distribution data acquired in a fog tunnel. Recovering energy from road could be a sustainable solution to generate active thermal elements for on board infrared vision system.

There are 'five elementary qualities' which comprise a way to describe and to consider in a systemic manner the qualities and performances that society expects from streets and public spaces: vitality, reliability, firmness, accessibility, sympathy.

These five elementary qualities are moreover organised so that there are two types of processes which explain their production:

1. A relation of generation: vitality generates reliability which generates firmness which generates accessibility which generates sympathy which generates vitality, and so on.
2. A relation of mastering: vitality masters firmness which masters sympathy which masters reliability which masters
accessibility which masters vitality, and so on.

Thus, no design model of a street or a public space is more 'reliable' or more 'sympathetic' than any another. Rather, the operator of the five elementary qualities makes it possible to imagine the different ways by which each of these design models can achieve 'sympathy', 'reliability', 'accessibility', etc.

NR2C specific innovations can be summarised as follows:
- towards more human infrastructure: new design-models for arrangement and development of multi-modal streets, that can be used as a tool for dialogue and co-design between actors.
- towards greener infrastructure: eco-road system - an integrated road concept, combining new technologies for the reduction of traffic nuisance (noise, air and water pollution), with in addition a special focus of TiO2 as air purifier; roads underlayers with a high percentage of reuse to preserve rare resources. Crack free-semi-rigid pavement using industrial by-products, etc.
- towards more reliable infrastructure: as regard roads, new maintenance road processes allowing to perform maintenance works even under bad weather conditions and consequently to reduce traffic congestion by extending possible maintenance seasons; as regard bridges, several solutions of innovative small and medium span bridges, light, durable, easy to prefabricate and assemble on site.
- towards safer and smarter infrastructure: the use of infrared technology to improve drivers' vision under bad weather conditions; in complex urban environments, the improvement of road safety through urban design - interest of design models.

Related information

<table>
<thead>
<tr>
<th>Result In Brief</th>
<th>Lowering the volume on noise pollution</th>
</tr>
</thead>
<tbody>
<tr>
<td>Documents and Publications</td>
<td>Final Report - NR2C (New Road Construction Concept)</td>
</tr>
</tbody>
</table>

Reported by

LABORATOIRE CENTRAL DES PONTS ET CHAUSSEES
PARIS
France
See on map

Subjects

Construction Technology - Industrial Manufacture - Safety - Transport

Last updated on 2011-04-14
Retrieved on 2019-07-24

© European Union, 2019