FRAMEWORK FOR CONSTRUCTION OF A SMART ROAD FOR JAMMU -SRINAGAR HIGHWAY

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Abstract— With the current large-scale construction of paved roads, continuous development of science and technology, and higher service requirements, Smart roads are becoming the research hotspot in the world. But the most present researches concentrate on some single intelligent functions of roads or some specific technology such as snow-melting, solar energy harvesting, etc. There is no explicit definition or integrated framework for smart roads. In this paper, the basis of related concepts of smart roads are put forward at home and combined with some demonstration programs and trials. This finally can be implemented in the four laning of Srinagar-Jammu Highway which is prone to fatal accidents due to its treacherous route.

Index Terms—Smart Roads, Solar Energy Harvesting, Traffic Monitoring, urban infrastructure.

I. INTRODUCTION

Srinagar Jammu National Highway is the part of National Highway 1A (India) system and connects Srinagar (Kashmir) with Jammu City. The distance between Jammu Tawi and Srinagar is 295 km. It is one of the two road links (other being Mughal road) that connects Kashmir Valley with rest of India. The traffic on the highway is controlled by two control rooms, one in Srinagar and other in Jammu.

Traffic problems are very annoying or in some cases severely dangerous in India. Road traffic accidents kill more than 12 million people and injure more than 50 million people worldwide every year. The global annual cost due to RTAs is a whopping 2,30,000 million US dollars. In India, 1,20,000 people die and 12,70,000 sustain serious injuries every year in Road Traffic Accidents. There is one death on the Indian road every six minutes and this is expected to rise in future. [1] The deaths in Jammu and Kashmir, due to road accidents on the Jammu-Srinagar Highway were reported to be 69.6% in 2013. [2]

It is thus extremely important to devise a network of roads that will not only prevent these accidents and provide early warnings to the driver to prevent risky driving but will also contribute to other parameters of road infrastructures: mobility efficiency, environmental performance, advanced traffic control technology, life-cycle analysis of construction and maintenance costs and energy inputs, user-oriented designs, safety and security performance, and long-term financing solutions.

At the end of the day, Smart Roads must address the people’s highest expectations in relation to road transport and, in so doing, define a model for a highway of tomorrow that adapts to societal demands.

II. ATTRIBUTES OF SMART ROADS

We must distinguish the attributes with a direct influence on road design, construction and maintenance.

1) Structural attributes: Smart Roads are associated with structural aspects such as, although not limited to, the following:

i. Optimal environmental integration and energy efficiency: This refers to the capacity of our road systems to respect high environmental protection levels, minimising the associated environmental impacts, developing optimised models for the lowest possible energy consumption and emission levels & maximizing the use of recycled and waste materials.

ii. Optimal service quality: Through advanced traffic management it is possible to optimise the use of existing road networks, limiting congestion during hours of peak demand, and at the same time distributing traffic as evenly as possible to maximise the service levels offered at all times.

iii. Economic sustainability: Highways designed for the mass transport of people and goods are economically justified in most of the cases. This principle is all the more important when it comes to evaluating the cost of operating and maintaining this type of infrastructures. It is therefore highly advised to proceed with detailed cost-benefit analyses with a view to justifying the usefulness of every road project.

iv. Improved safety: This means following internationally-recognised best practices in the design of new road infrastructures and in the implementation of the best possible safety solutions - for all users - in the maintenance, upgrading and modernisation of existing infrastructure.

v. Coverage of externalities: The external costs arising from the movement of people and goods on roads must be kept to a minimum through the development of technologies to absorb emissions and noise, minimise the...
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2) Emotional Attributes: It is also possible to identify a series of emotional attributes associated with the Smart Roads concept, insofar as they are linked closely to the structural aspects set out above, notably

i. Reliability: Roads should provide assurance in terms of predictable travel time and, by extension, free traffic flow for as much of the day as possible.

ii. Safety: Roads should offer the highest safety levels that technical and technological progress to date allows, with a view to securing mobility with the lowest possible risk and minimising the probability of and mitigating the potential effects of accidents.

iii. Security: Roads should be the most important part of an integrated system managing the risks associated to natural and man-made disasters, and in addition providing an adequate response and recovery time to all kinds of incidents.

iv. Comfort: Good driving conditions are an essential parameter for ensuring user satisfaction and must take into account adequate road visibility and signalling, even pavements and proper services alongside roads.

v. Modernity: Insofar as no specific model has been defined for every possible typology for road travel, users do not generally classify roads as an "advanced" transport mode. Making a distinction between passenger and goods transport, between short, frequent trips and long-haul travel, etc., are key challenges to design a system perceived as modern and attractive by the public opinion.

III. VISUALISING THE SMART ROADS

IV. DEVELOPING THE SMART ROAD

Ecotechnic Road System (Ecotechnic Road System (ERS)) is a concept of an integrated infrastructure, based on the most innovative technologies in order to minimize globally pollution and disturbance due to traffic (noise, vibrations, air and water pollution). The nuisance mitigating road infrastructure solutions defined as ERS, are composed by three subsystems: - Pavements subsystem (i.e. resilient, resonant and reservoir pavements); - Barriers subsystem (i.e. anti noise, air depollutant, safety and green barriers); - Auxiliary subsystem (i.e. air cleaning unit, ventilation unit, ground catalyser, photo catalytic material and TiO2 coating). [3]

Noise: different solutions are available in order to reduce noise nuisance via road pavement and barrier. Optimised solutions reaching 12 dBA can be obtained with contribution from 3 to 6 dBA from road pavement and till 8 dBA from barriers.

Pavements: It is recognized that quiet pavement systems develop effective noise-controlling pavements concentrating on sound absorbing properties, micro- and macro-texture characteristics. Here, experimental pavements using resilient and resonant technology (euphonic and ecotechnic types) originally conceived, lab prototyped and small & full scale implemented during SIRUUS (Silent Roads for Urban and Extra-Urban Use) project taking into account an idea by the Romans 1700 years ago to control low frequency noise.

- The resilient type, with "dumping" behaviour, is constituted by a bituminous porous double layer (2 cm of 0-6mm on 4 cm of 0-16mm) on the light-weight aggregate bituminous mixture road base course (15 cm of 0-25mm) as energy absorbing semi-porous lower layer in order to decrease the mechanical impedance reflecting also on the acoustical behaviour improvement.

- The euphonic and ecotechnic types of the SIRUUS pavement concepts are variations of the resonant typology that consists of two layers of porous asphalt (constituted by a porous wearing course 0/6mm and a porous base course 0/16mm) connected to a concrete road base course with localised Helmholtz resonators. The third layer can be obtained also as transition or disconnection layer carried out by diffused resonant cavities obtained by light-weight cement mortar. The Helmholtz resonators are designed to absorb noise over the range from 100 to 250 Hz widening the absorption range of 400 Hz – 1200 Hz carried out by the double layer at the top.

- The Ecotechnic pavement which was originally developed for street traffic, is a multi-layer
pavement including a top layer of porous asphalt 0/5mm, a base layer of porous asphalt 0/24mm, and a metallic panel disconnection layer.

Barriers: innovative barrier solutions have been developed
- coupling the traditional antinoise barrier types, eventually with self adaptive height and inclination with acoustic changing characteristics by folding panels, and restrain integrated road safety system, eventually with dirty avoidable characteristics by sprayed TiO2 (screen close to source);
- improving the performance characteristics trough new materials and/or structure types as light weight concrete vertical panels constructed using expanded clay as aggregates (novel-shaped noise (barriers & optimisation of acoustic absorption properties);
- adding new functions as atmospheric pollution control/abatement (as active carbon particle) and traffic management carrying out an active integration in the nuisance mitigating infrastructure (novel shaped noise barriers & optimisation of acoustic absorption properties).

V. OVERCOMING THE PROBLEM OF ICY ROADS

In order for the system to be able to warn drivers about the potential dangers ahead, such situations need to be identified. There are various methods for detecting different kinds of events (e.g. ice on the road, fog). Two alternative approaches to perform ice-on-road detection optically are introduced in this paper. The first calculates changes in polarisation planes of back-scattered lighting and the second calculates the amount of light reflected in the medium infrared band (1000 – 1600 nm). Detection by utilizing the polarization plane changes of reflected light. For this reason drivers are also recommended to wear polarised sun glasses in order to minimise the glare from a puddle or an engine bonnet. The same phenomenon can be used to detect an icy road by subtracting the horizontally polarised light (Ih) compared to the vertical (Iv): h v R = I – I (1) If the difference (R) is high, it can indicate a reflecting surface, which could be ice. An alternative way of detecting ice on the road is to utilise light detection in the near-infrared band. The tests presented below show that ice reflects light effectively in the 1500 nm band while snow appears to diminish the reflection almost completely. The most prominent and robust approach would be a fusion of the previously presented polarisation concept with near infra-red (NIR) imaging.

REFERENCES

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