

SMART ROAD - A SUSTAINABLE TECHNOLOGY FOR PRESENT AND FUTURE

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ABSTRACT:

Historically, road is a thoroughfare mode of conveyance on land. Over the last few years, the use of the term “smart” has become a wide spread practice at all levels. From smart phones, smart cities, smart energy to even smart buildings, technology has its mark. Roads must transform themselves in order to play a relevant role in this “revolution” to bring about a smart mobility. There are proposals to construct smart roads for generating solar energy, for improving the operation of automobiles, for lighting through sensor, for monitoring road condition to name a few. Through this paper, the authors propose to discuss different technologies for these future roads and their possibility in countries like India.

Keywords : glowing roadway lines, smart roads, solar roads, wind powered lights.

1. INTRODUCTION:

Roads are the arteries through which the economy pulses. By linking producers to markets, workers to jobs, students to school, and the sick to hospitals, roads are vital to any development agenda. Since 2002, the World Bank has constructed or rehabilitated more than 260,000 km of roads. It lends more for roads than for education, health, and social services combined. However, while roads bring economic and social benefits, they can also come with social costs such as pollution or deforestation. Roads are the main source which connects all the villages, cities, states and countries and enhances communication among all parts of the world.

On an average, 2 billion people use roads for their transport everyday. The present roads which we are using are the age old ones and have not been developed in any aspect. Now a days, there is up gradation in all aspects of life but roads are the only ones which have not

been modernised in our country. Roads have been technologically developed in all other parts of the world based on their requirements. Infrastructure has always mattered. The industrial revolution was not just the story of cotton mills and iron foundries. It was about canals, railways and roads. Big changes to the way people and goods could move around the country boosted growth and transformed the economy. The roads which are now in practice in all parts of the world are the ones which not only provide transport but also support us by providing power by using wind energy and solar energy. These roads are called SMART ROADS.

Smart roads-highways studded with sensors that monitor wear and tear and "feel" vehicles like fingers on a touchpad, and that are connected to the internet to alert motorists to traffic jams and automatically summon help when accidents occur. The roads which contribute to the power generation and ease the way of driving for a driver are called "smart roads". Smart roads are also equipped with IOT for a better tracking of traffic on roads. This innovative initiative is based on providing drivers with valuable feedback without requiring additional electronics or onboard systems that can be costly and reduce the performance of vehicles.

'Smart roads' or 'Smart highways' gaining ground in the developed world essentially use a suite of technologies that are intended to be both interactive and largely self-powering. Road infrastructure affects the flexibility and mobility of the workforce, which is reflected in the employment level. Moreover, higher employment level makes the standard of living grow. The degree to which the road infrastructure is developed has an impact on several areas, such as for instance the development of tourism, influx of foreign investments, regional development, etc.

The idea behind developing smart highways has lead designers and engineers to work on improving methods to illuminate roads in sustainable and intelligent ways. Leveraging existing roadway infrastructure is a great way to reduce maintenance costs and eliminate unnecessary construction expenses associated with many highway improvement projects. The Smart Highway project is focused on ways to use light on public roadways to communicate traffic information directly with drivers. Many engineers and roadway safety managers believe that focusing on ways to improve vehicle navigation systems and onboard systems is only half of the equation. Here are a few ways that roadway safety engineers are improving driver safety with advanced systems that could be implemented into Smart Highways of the future.

An innovative project tested in the Netherlands called “Smart Highway” is an interactive system of roadways being developed to push the limits of existing infrastructure. This project combines interactive and sustainable roadway designs to improve public safety and give drivers additional information as they travel along roads at night or in dark environments.

2. SMART ROADS:

Smart roads have been classified based on safety, ease of driving, power generation etc.

Safety	Ease of driving	Power generation
Weather and traffic detection	Glowing roadway lines	Solar roads
Self healing concrete roads	Traffic adaptive road signs	Wind powered lights
Interactive light	Dynamic paint	
Electric priority lane	Snow clearing roads	

Table 1.1

2.1 SAFETY:

Road safety is very important because of it many people are loosing their lives and the also because of the banking of roads and angle at which the roads are being laid, accidents occur. Taking all these instances into consideration smart roads in safety aspects have been designed in such a way that the number of accidents are reduced.

2.1.1 Weather and traffic detection:

Within section control systems on motorways drivers get information about adequate speed limits during adverse weather situations. Therefore road weather data are necessary. To detect the danger of aqua- planning measurements of precipitation intensity and water film thickness as well as the status of the road surface are needed. To detect these atmospheric data different weather sensors are located near the motorway. There are two different sensor systems available which detect these measurements at the moment. For the detection of the status of the road surface, like dry, moist or wet, the sensor is embedded directly in the road surface in most cases. The other sensor system is non-invasive which can be installed next to

or over the road. Non invasive sensors and embedded type are the type of sensors used to detect the road temperature and weather condition of a particular road. Their usage is also possible on bridges and road surfaces that cannot be cut, e.g. open porous asphalt. The measuring method used in these sensors is an optical spectroscopy which is either laser or infrared based. The road temperature is measured using a pyrometer.

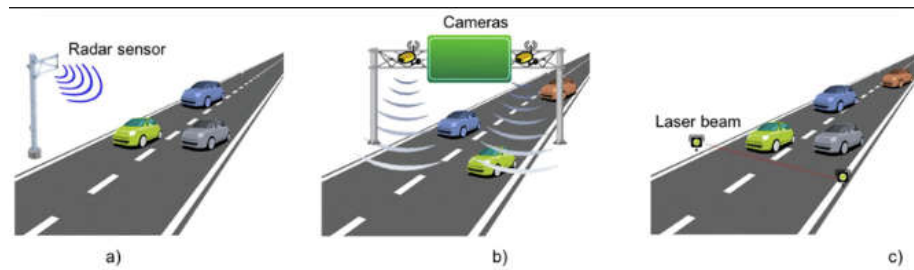


fig.1(a) weather and traffic detecting roads

2.1.2 Self healing concrete roads:

Self-healing technology is a new field within material technology. It represents a revolution in materials engineering and is changing the way that materials behave. Incorporating self-healing technology into the road design process has the potential to transform road construction and maintenance processes by increasing the lifespan of roads and eliminating the need for road maintenance. By decreasing the unnecessary premature ageing of asphalt pavements, self-healing asphalt can reduce the amount of natural resources used to maintain road networks, decrease the traffic disruption caused by road maintenance processes, decrease CO₂ emissions during the road maintenance process and increase road safety. In addition to environmental savings, self-healing materials have the potential to deliver significant cost savings for road network maintenance across the EU. There are three main self-healing technologies available for asphalt pavement design: nanoparticles, induction heating and rejuvenation.

Asphalt is a mixture of gravel and sand held together by bitumen, a thick, viscous mixture that acts as a glue. As roads age, the bitumen wears down and pieces of asphalt erode, causing small cracks that soon balloon into big potholes. This process of erosion, called raveling, is caused by oxidation, UV rays, freeze-thaw cycles and other factors.

To combat raveling, asphalt is heated using an induction machine and rebinding the bitumen to the gravel. This is done by mixing tiny bits of steel wool into bitumen. This makes the bitumen conductive, or able to receive and transmit electrical energy. Once the asphalt is poured and set, the bitumen can be heated with an induction machine so it rebinds to the

stones and gravel in the asphalt. The induction process creates a magnetic field so only the bitumen is heated.

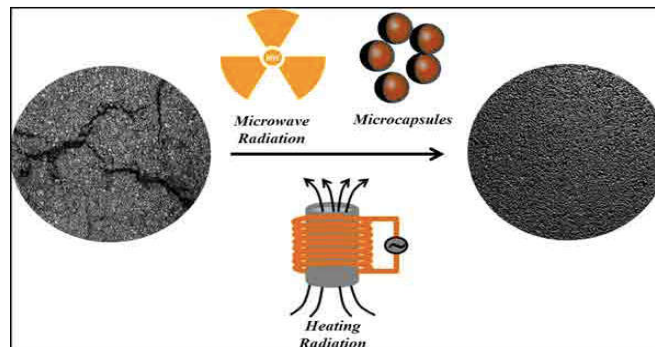


fig.1(b) self healing concrete roads

2.1.3 Interactive lights:

One of the most important features of the road, baring in mind the energy challenges from today, are the interactive streetlights that switch on when cars pass by and fade out when they pass by. By using such lights millions of watts of electricity can be saved. These lights are so helpful that they are 10 times brighter than the lights which we are using now. This will help the driver see clearly and the number of accidents can be reduced. They are also cost efficient. In India, such lights would help reduce the electricity required for roads and this can be used in many other aspects.



fig.1(c) roads with interactive lights

2.1.4 Electric priority lanes:

These days, due to the unavailability of renewable sources such as crude oil, petrol, diesel and LPG, electric cars i.e. smart cars have come into existence and they require electricity for

their usage. The charging ports are not that accessible and it is also time consuming for a person travelling from one place to another. In order to overcome this difficulty, electric priority lanes have come into existence. There is a lane provided on the roads where underneath the road surface, this priority lane is equipped with induction coils which enables electric cars to recharge as they drive over.



fig.1(d) electric priority lane roads

2.2 EASE OF DRIVING:

Ease of driving plays a major role in transport and that's when the road is said to be safer and safety measures come into practice. Driver should be comfortable during driving and the road should be laid in such away that the angle of banking should be precise such that no accidents take place.

2.2.1 Glowing roadway lines:

The road is painted with photo-luminous paint. During the day this paint absorbs the sunlight, at night the paint re-emits this stored light to indicate the driving lanes. This photo illuminator paint can light up the road for up to 10 hours at a time. By using such paints, road width and lanes can be known which will make the transport easier. The first highway with glow roadway lines was started in Netherlands. Glowing Lines is aimed at increasing visibility and safety. The road markings have higher visibility than those using standard paint, whilst still not requiring electricity. The concept itself has been developed through several iterations and has been tested for durability and user experience.



fig.1(e) glowing road way line roads

2.2.2 Traffic adaptive road signs:

Due to the world's population and the number of cars being used everyday across the globe, traffic jams are common and tedious. The road signs are dynamic. They can be changed according to the current traffic situation. When there is heavy traffic the dotted lines can be changed to continuous lines to prevent cars from switching lanes.

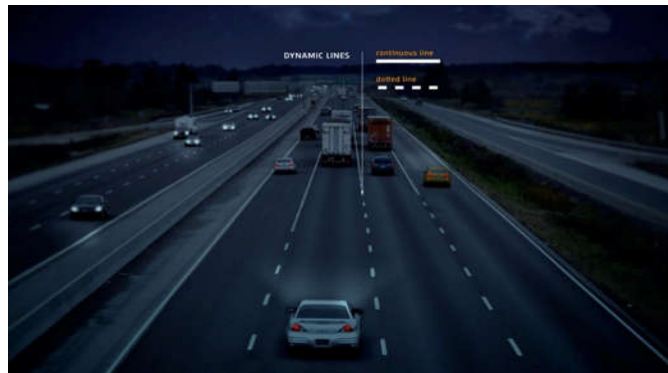


fig.1(f) traffic adaptive roads

2.2.3 Dynamic paint:

In countries like Canada, temperature drop is frequently observed and it makes the roads wet due to the snow formation and it will be difficult for the driver to continue driving. To alert

drivers of the temperature dropping below zero, the Smart Highway is painted with temperature-responsive road paint. When temperature goes below zero, the road shows images of snowflakes. You now know when to step off the gas pedal and start being more cautious.



fig.1(g) roads with dynamic paint

2.2.4 Snow clearing roads:

In the northern hemisphere, snow fall is observed and due which the roads get blocked due to the accumulated snow which will affect the roads. The roads become wet and thereby moisture content increases. A technology is being practiced to get clear roads where solar panels are placed on the roads to melt the formed ice. Each encased panel generates 7.6 kilowatt hours of electricity per day, and can be connected to smart grids to power homes and business. Wireless LED lights embedded in the glass create road signs and weight-sensitive crosswalks. They also contain heating elements that can melt snow and ice. The technology to make snow plowing obsolete is similar to what's already used in automobile windshields. Heating elements in the glass melt existing snow or ice and prevent accumulation from developing.



fig.1(h) snow clearing roads

2.3 POWER GENERATION:

Millions of watts of power is generated through the cars everyday across the globe which is not being used. Smart roads have come up in order to use this energy and convert it into power and supply it to the industries and for domestic purpose.

2.3.1 Solar roads:

This is a great initiative where the solar panels are placed on the roads and the sun light is absorbed and this energy can be used for street lights, can be sent to the industries and can also be used for domestic purpose. Smart Solar roads combine different solutions in one – it can help us to improve energy production from solar panels, to collect and distribute rain water, to provide a digital platform for Smart city, to facilitate emerging electric cars and driver-less cars. Their technology combines a transparent driving surface with underlying solar cells, electronics and sensors to act as a solar array with programmable capability. The idea is not only to collect solar energy and rain water but to also make smart roads. Roads that illuminate themselves at night, heat themselves in the winter and are easily programmable to direct drivers. But much more, the potentials of the technology allow us to further contribute to some more green concepts as smart city, the connected things and IoT, smart grid applications, hybrid and electric cars and other.



fig.1(i) roads with solar panels

2.3.2 Wind powered lights:

So when there is no traffic, there is no energy consumption. In addition, the road is accompanied of the so called “wind lights” next to the road. These wind lights obtain energy from pinwheels that spin round when vehicles pass by. The energy produced from the wind powered lights can be used in many ways.



fig.1(j) wind powered lights

3. CONCLUSION:

Smart roads which is a sustainable technology in the present and future is said to be a revolution as it changed the way of life. Smart roads are safe, modern and reliable. Smart roads are environment friendly and they contribute a lot to the upgrading technology and are eco-friendly. Smart roads are designed in such a way that they are cost efficient and user oriented.

Roads such as solar roads, wind powered lights, traffic and weather sensors can be used in our country based on our needs and economic conditions. By using solar roads and wind powered lights, amount of power generation can be increased. As India is ranked 2nd populated country in the world, traffic jams are also faced in our country everyday so traffic sensing sensors would serve our needs and traffic jams could be controlled.

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