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Rebuilding the infrastructure: Solar roadway for JSPM's college campus

Vishakha O. Shirsat [1], Arti P. Chavan [2], Shreya S. Bhegade [2], Kshitija S. Kalam [2], Namrata M. Suradkar [2] and Aakanksha B. Bhegade [2]

[1] *Professor, Department of civil engineering, JSPM's, RSCOEP, Tathawade Pune-33, India.*
[2] *UG student, Department of civil engineering, JSPM's, RSCOEP, Tathawade Pune-33, India.*

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Abstract

This paper proposes the implementation of solar roadway on the JSPM campus, integrating renewable energy generation, intelligent transportation systems, and smart infrastructure. The solar roadway will harness solar energy to provide electricity to roadside street lamps reducing reliance on conventional energy sources. Additionally, the System will incorporate speed detection technology to monitor and manage vehicular traffic, enhancing road safety and reducing accidents. The proposed system will be designed, simulated, and analyzed to evaluate Its technical feasibility, economic viability, and environmental benefits. The findings of this study will provide valuable insights into the potential of solar roadway to transform the JSPM's campus from "main gate to canteen Gate" into a sustainable, smart, and energy-efficient community.

Keywords: Smart Roads; Speed Detection; Road Surface Layer; Electronic Layer; LED'S Layer

1. Introduction

The JSPM's campus is set to revolutionize its transportation infrastructure with the introduction of Solar Roadway, a cutting-edge technology that integrates solar panels, smart sensors, and energy harvesting to create a sustainable and intelligent transportation system. This innovative project aims to provide a clean source of electricity to the nearby area, powering streetlights, homes, and businesses. Additionally, the Solar Roadway system will be equipped with advanced speed detection technology, enabling real-time monitoring and management of traffic flow, reducing accidents, and enhancing overall road safety. By harnessing the power of solar energy and leveraging smart technology, the JSPM's campus will set a new standard for sustainable and intelligent transportation infrastructure.

1.1. Body of paper

The proposed Solar Roadways system at JSPM's campus will integrate solar panels within the road surface to generate clean energy for nearby areas. It consists of three layers: the road surface layer (durable, textured glass for traction and sunlight absorption), the electronics layer (solar panels, micro-inverters, and electronics), and the base plate layer (providing structural support). This system will reduce fossil fuel dependence, lower carbon emissions, and enhance road safety with real-time speed detection technology. Additionally, it will provide valuable traffic and energy data for optimizing energy use and improving infrastructure planning. By combining sustainability with smart technology, the Solar Roadways system has the potential to transform JSPM's campus into an eco-friendly, intelligent, and connected community.

* Corresponding author: Arti Panjabrao Chavan

2. literature review

[1] The implementation of solar roads is currently not feasible due to high initial costs, requiring three to five times that of asphalt roads. While offering energy and environmental benefits, large government grants are needed. As solar technology advances, increased efficiency and reduced costs may make solar roads viable within 10–15 years. [2] Solar roadways use solar panels, LEDs, and microprocessors in durable surfaces to generate electricity, enhance safety, and promote sustainability. Developed by Solar Roadways Inc., They reduce pollution, melt snow, and support smart grids, providing an eco-friendly alternative to asphalt as fossil fuel reserves decline. [3] Researchers aim to develop solar roads for India, overcoming cost and durability challenges with innovation and government support. [4] India can boost its economy and infrastructure by adopting solar roads, which provide clean energy, reduce global warming, enhance safety, and enable smart traffic communication. [5] Solar road panels and smart roads offer clean energy, reduce carbon footprints, enhance safety, optimize traffic, and justify costs through environmental and social benefits. [6] This research highlights not only surplus electricity generation but also other benefits of smart roadways. These intelligent roads enhance safety by alerting drivers to accidents, obstacles, or They reduce pollution, melt snow, and support smart grids, providing an eco-friendly alternative to asphalt as fossil fuel reserves decline. [3] Researchers aim to develop solar roads for India, overcoming cost and durability challenges with innovation and government support. [4] India can boost its economy and infrastructure by adopting solar roads, which provide clean energy, reduce global warming, enhance safety, and enable smart traffic communication. [5] Solar road panels and smart roads offer clean energy, reduce carbon footprints, enhance safety, optimize traffic, and Justify costs through environmental and social benefits. [6] This research highlights not only surplus electricity generation but also other benefits of smart roadways. These intelligent roads enhance safety by alerting drivers to accidents, obstacles, or natural calamities. Upgrading existing roads with this technology can create jobs, boost revenue, and attract private investment with minimal additional costs.

3. Technology solutions

The Solar Roadways system at JSPM's campus will integrate photovoltaic cells to generate and store electricity, supplying power to nearby areas. It will feature radar sensors and cameras for real-time traffic monitoring and speed detection, enhancing road safety. Smart energy management software will optimize energy production, reducing waste and ensuring efficient power distribution. The durable, textured glass surface will provide vehicle traction and withstand extreme weather conditions. Equipped with automatic emergency response systems, the system ensures safety and reliability. This innovative infrastructure will transform JSPM campus into a sustainable, smart, and energy-efficient environment..

3.1. Structure of solar roadway

There are three layers involved

- Surface layer,
- Electronics layer,
- Base plate layer.

3.1.1. Surface layer

The top layer of solar roadways is made of transparent concrete. Transparent concrete consists of fine concrete and optical fibers. It can withstand 10 times more pressure than normal concrete. Transparent concrete offers fire protection and high UV resistance.

3.1.2. Electronics layer

The second layer contains microprocessor, electrical chips and wires. It transfers energy from solar cell to the battery. LEDs are connected to this layer and are controlled by a day-night sensor. The layer includes sensor that alerts drivers 100m away about animals or people on the road to prevent accidents.

3.1.3. Base plate layer

The third layer provides secondary strength to the road. The base plates distributes solar energy to connected buildings. The structural design of solar roadways includes a water collecting basin. The basin collects rainwater for later use

4. Road survey for smart infrastructure

Figure 1 Road survey performing at JSPM's campus

Location: JSPM's campus "main gate to canteen gate".

Date of survey: 14th February 2025, Length of road: 350m, Width of road: 12m, Area of road: 4200m^2, No. Of lamps provided along the road: 40 nos.

5. Result

Standard size of solar panel: 3.658m ×3.658m = 13.380m ^{2} [Hexagonal shape] , The price of one solar panel is $285.63 is in IRN 24,750 rupees only approximately , How much solar panel required? Area of road ÷ Size of one Solar panel= 4200 ÷ 13.380= 314 nos., The approximately Cost= no. of solar panel × Cost of one solar panel= 314× 24,750=77,71,500rs.

6. Conclusion

The Solar Roadways system proposed for the JSPM's campus offers a revolutionary solution for generating clean energy, improving road safety, and enhancing the overall campus experience. By harnessing the power of solar energy and leveraging advanced technologies, the system can provide a sustainable and reliable source of electricity to nearby areas, while also detecting and preventing speeding-related accidents. With its numerous benefits, including reduced greenhouse gas emissions, improved energy efficiency, and enhanced safety, the Solar Roadways system has the potential to transform the JSPM campus into a model for sustainable and smart infrastructure development. As the world continues to urbanize and grapple with the challenges of climate change, the Solar Roadways system offers a beacon of hope for a cleaner, safer, and more sustainable future.

Compliance with Ethical Standards

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Disclosure of conflict of interest

The authors have no financial or personal relationships that could influence this research.

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Authors short Biography

Prof.. Vishakha Omprakash Shirsat (BE)Civil Engineering (ME)construction Management "Civil Department" JSPM's College of Engineering Tathawade Pune . Paper published:03	
Ms. Arti Panjabrao Chavan Pursuing Diploma in civil engineering third year, At JSPM'S, Rajarshi shahu college of engineering and polytechnic, Tathawade, Pune-33.	
Ms. Shreya Shantaram Bhegade. Pursuing Diploma in civil engineering third year, At JSPM'S, Rajarshi shahu college of engineering and polytechnic Tathawade, Pune -33.	
Ms. Kshitija Sunil Kalam Pursuing diploma in civil engineering third year, At JSPM'S, Rajarshi shahu college of engineering and polytechnic, Tathawade, Pune-33.	

Ms. Namrata Madanpal Suradkar Pursuing Diploma in civil engineering third year At JSPM'S, Rajarshi shahu college of engineering and polytechnic, Tathawade, Pune-33.	
Ms. Aakanksha Baburao Bhegade Pursuing diploma in civil engineering third year, At JSPM'S, Rajarshi shahu college of engineering and polytechnic, Tathawade, Pune-33.