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Piezoelectric and Solar Road

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ABSTRACT: This project aims to generate electricity and decrease the consumption of fossil fuels and conserve the electricity for further use. In modern world, the technique needs amount of power for its various operations. These operations require a lot of fossil fuels, to overcome this consumption of power and fuels. In this paper we have presented method to produce pollution free electricity by the technique i.e. piezoelectric effect.

This is kind of green solution for power generation. Piezoelectric effect is the ability of a material to generate electric charge by applying mechanical stress. This report assesses to commercial status of piezoelectric based techniques in roadway. In this project we try to provide a sufficient energy as it can reduce the damage of pollution caused by power plants. Even when vehicle passing from the road, exerts pressure on the roadways and causes deformation.

I. INTRODUCTION

A. PIEZOELECTRIC ROAD: -

A piezoelectric road is a type of road surface that generates electricity when vehicles pass over it. The piezoelectric effect is the ability of certain materials to generate an electric charge in response to applied mechanical stress. Piezoelectric roads are designed to convert the energy generated by vehicles passing over them

B. SOLAR ROAD: -

A solar road is a highway with solar panels on the surface that can generate electricity while supporting vehicles. The panels can also provide lighting, heating, and other smart road functionality. The idea behind solar road technology is to be able to melt snow, power street lights, and eliminate the need to paint white or yellow lines on asphalt. Solar roads are intended to improve driving conditions for everyone

II. PURPOSES OF USING THE CONCEPT

A. PURPOSE OF PIEZOELECTRIC ROAD: -

➤ Electricity Generation: -

The main purpose is to generate electricity from the mechanical energy produced by vehicles driving over the road. This electricity can be utilized to power streetlights, traffic signals, and other roadside infrastructure, thus reducing the dependency on traditional power sources and promoting sustainability

➤ Renewable Energy: -

Piezoelectric roads contribute to renewable energy generation by utilizing a readily available energy source—vehicle movement. By converting this kinetic energy into electricity, piezoelectric roads help reduce reliance on fossil fuels and decrease carbon emissions associated with conventional power generation

➤ Research and Development: -

Piezoelectric roads also serve as a platform for research and development in the field of energy harvesting and sustainable transportation infrastructure. Continued advancements in this technology may lead to improvements in efficiency, durability, and cost-effectiveness, further enhancing its practical applications.

B. PURPOSE OF SOLAR ROAD: -

➤ **Renewable Energy Generation: -**

Solar roads primarily aim to generate electricity from sunlight. By utilizing photovoltaic technology embedded within road surfaces, solar roads convert solar energy into electrical power. This electricity can be used to power streetlights, nearby buildings, electric vehicle charging stations, or be fed back into the grid.

➤ **Economic Benefits:**

Solar roads have the potential to generate revenue through electricity sales and cost savings on traditional road maintenance and lighting. Additionally, they can create job opportunities in manufacturing, installation, and maintenance, contributing to local economic development and industry growth.

➤ **Environmental Benefits:**

By generating electricity from sunlight, solar roads help reduce reliance on fossil fuels and mitigate the environmental impacts associated with conventional energy generation, such as air and water pollution and habitat destruction. Solar roads also have the potential to reduce heat island effects by replacing dark, heat-absorbing asphalt surfaces with reflective solar panels.

III. WORKING PRINCIPAL

A.WORKING PRINCIPAL OF PIEZOELECTRIC ROAD: -

The working principle of a piezoelectric road revolves around harnessing the piezoelectric effect to convert mechanical energy from vehicles into electrical energy. The piezoelectric effect is a phenomenon exhibited by certain materials, such as crystals or ceramics, which generate an electric charge when subjected to mechanical stress or pressure. Here's how a piezoelectric road operates:

➤ **Installation of Piezoelectric Materials:**

Piezoelectric materials, typically in the form of tiles, slabs, or sensors, are embedded beneath the surface of the road. These materials are strategically placed in areas where they will experience mechanical stress or deformation from passing vehicles.

➤ **Mechanical Stress Generation:**

As vehicles travel over the road, the weight and movement of their wheels create mechanical stress or pressure on the road surface. This stress causes deformation in the piezoelectric materials embedded beneath the road, initiating the piezoelectric effect.

➤ **Electric Charge Generation:**

In response to the mechanical stress, the piezoelectric materials generate an electric charge. The deformation of the crystal lattice within the material leads to the separation of positive and negative charges, resulting in the generation of an electric potential.

➤ **Electricity Harvesting:**

The electric charge produced by the piezoelectric materials is collected and harnessed as electricity. This electrical energy can be stored in batteries or capacitors, or it can be directly utilized to power nearby infrastructure, such as streetlights, traffic signals, or electric vehicle charging stations.

➤ **Continuous Energy Generation:**

As vehicles continue to traverse the road, the mechanical stress on the piezoelectric materials is cyclically applied and released, leading to the continuous generation of electrical energy. This process allows for the sustained production of electricity as long as vehicles are present on the road.

Overall, the working principle of a piezoelectric road relies on the ability of piezoelectric materials to convert mechanical energy from vehicle traffic into electrical energy through the piezoelectric effect. By harnessing this renewable energy source, piezoelectric roads offer a sustainable solution for generating electricity and powering various roadside amenities and infrastructure.

B. WORKING PRINCIPAL OF SOLAR ROAD: -

The working principle of a solar road involves integrating solar panels directly into the surface of roadways to capture sunlight and convert it into electricity. Here's how a solar road operates:

- **Installation of Solar Panels:**
Solar panels, typically made of photovoltaic cells, are installed directly onto the surface of roadways. These panels are made of durable materials capable of withstanding vehicular traffic and environmental conditions.
- **Sunlight Absorption:**
During daylight hours, the solar panels absorb sunlight that falls onto the road surface. The photovoltaic cells within the solar panels contain semiconductor materials, such as silicon, which have the property of generating an electric current when exposed to sunlight.
- **Generation of Electricity:**
When sunlight strikes the surface of the solar panels, it excites electrons within the semiconductor material, creating an imbalance of electrons between the two sides of the cell. This imbalance generates an electric voltage, causing electrons to flow through an external circuit, thus creating an electric current.
- **Energy Harvesting and Distribution:**
The electricity generated by the solar panels is collected and can be used to power nearby infrastructure, such as streetlights, traffic signals, electric vehicle charging stations, or can be fed into the electrical grid for wider distribution.
- **Continuous Energy Production:**
As long as sunlight is available, the solar panels continue to generate electricity. Even on cloudy days or in partial shade, solar panels can still produce electricity, albeit at a reduced rate.

Overall, the working principle of a solar road relies on the photovoltaic effect, where solar panels convert sunlight directly into electricity. By integrating solar panels into road surfaces, solar roads offer a sustainable solution for generating clean energy and powering various roadside amenities and infrastructure while utilizing existing transportation infrastructure.

IV. APPLICATIONS

A. APPLICATIONS OF PIEZOELECTRIC ROAD: -

- **Urban Roads and Highways:**
Piezoelectric roads can be installed on urban roads, highways, and expressways with high traffic volumes. These roads can generate electricity from the constant movement of vehicles, providing a renewable energy source for powering streetlights, traffic signals, and other roadside infrastructure.
- **Bike Lanes and Sidewalks:**
Piezoelectric technology can be incorporated into bike lanes and sidewalks to capture energy from pedestrians and cyclists. This energy can be used to power lighting, signage, or charging stations for electric bicycles and mobile devices, enhancing safety and convenience for non-motorized transportation users.
- **Parking Lots and Garages:**
Piezoelectric Road systems can be installed in parking lots and garages to capture energy from vehicles entering and exiting parking spaces. The electricity generated can be used to power lighting, security cameras, and electric vehicle charging stations, reducing reliance on grid electricity and enhancing sustainability.

B. APPLICATIONS OF SOLAR ROAD: -

➤ Urban Roads and Highways:

Solar roads can be installed on urban roads, highways, and expressways to harness solar energy and generate electricity from sunlight. This renewable energy source can power streetlights, traffic signals, and other roadside infrastructure, reducing reliance on grid electricity and lowering carbon emissions.

➤ Parking Lots and Garages:

Solar Road panels can be integrated into parking lots and garages to provide shaded parking spaces while generating clean energy. The electricity generated can be used to power lighting, electric vehicle charging stations, and other amenities, making parking facilities more sustainable and cost-effective.

➤ Bike Lanes and Pedestrian Walkways:

Solar Road technology can be applied to bike lanes and pedestrian walkways to generate electricity from sunlight and foot traffic. This energy can be used to power lighting, signage, and safety features, enhancing visibility and safety for cyclists and pedestrians, especially during nighttime

V. MATERIAL REQUIRED

A. MATERIAL USED FOR PIEZOELECTRIC ROAD: -

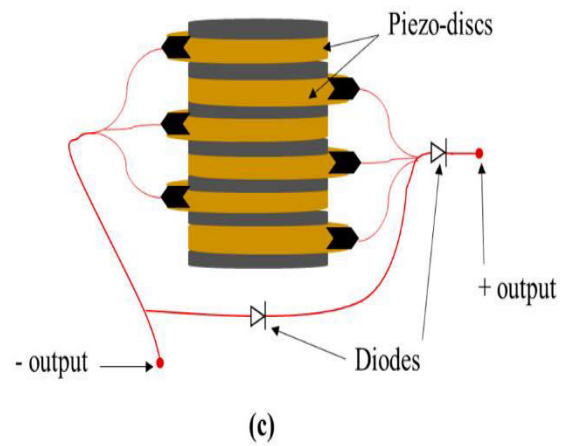
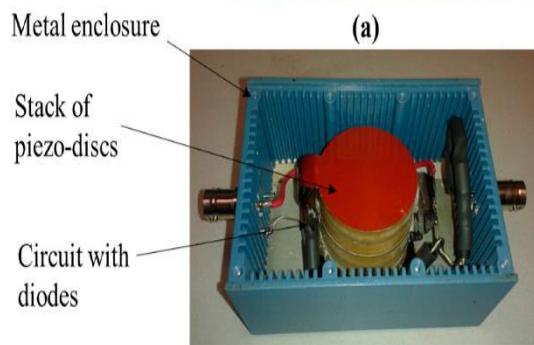
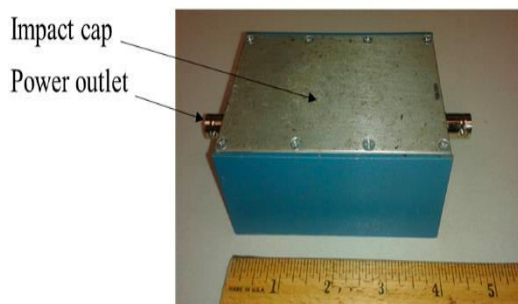
AT – Cut Quartz Crystal



Coaxial Cable



Lithium Battery Storage and Collectable Device



Bitumen Surface



MATERIAL USED FOR SOLAR ROAD: -

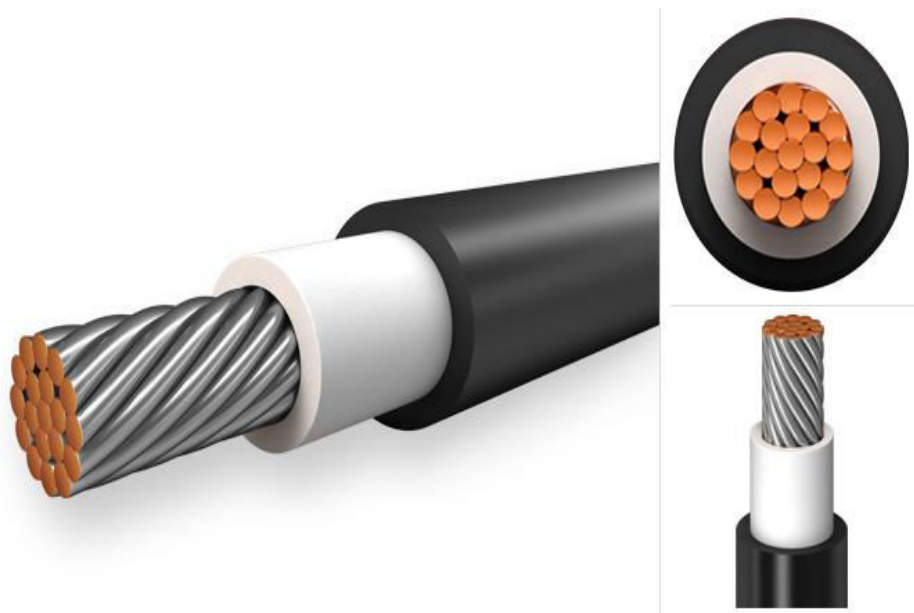
Solar Tile



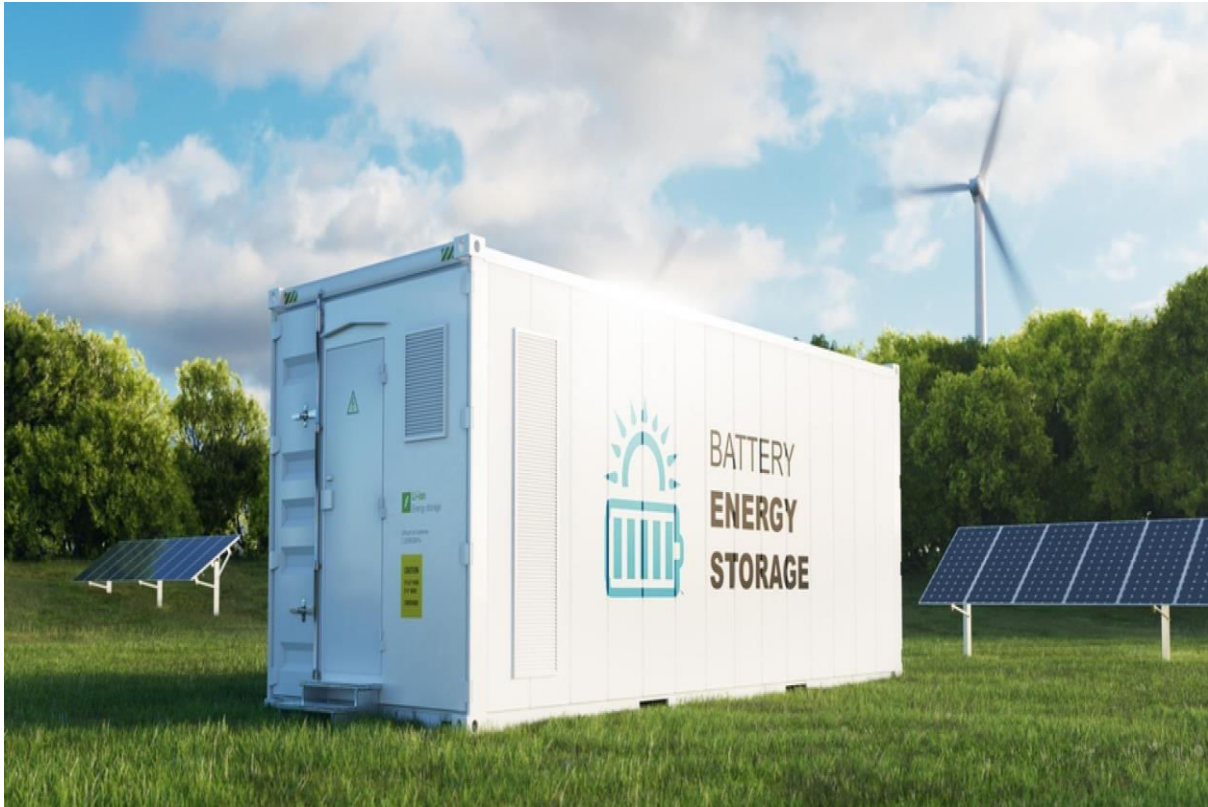
Toughened Glass Protective Layer



Photovoltaic Cable (P. C.)



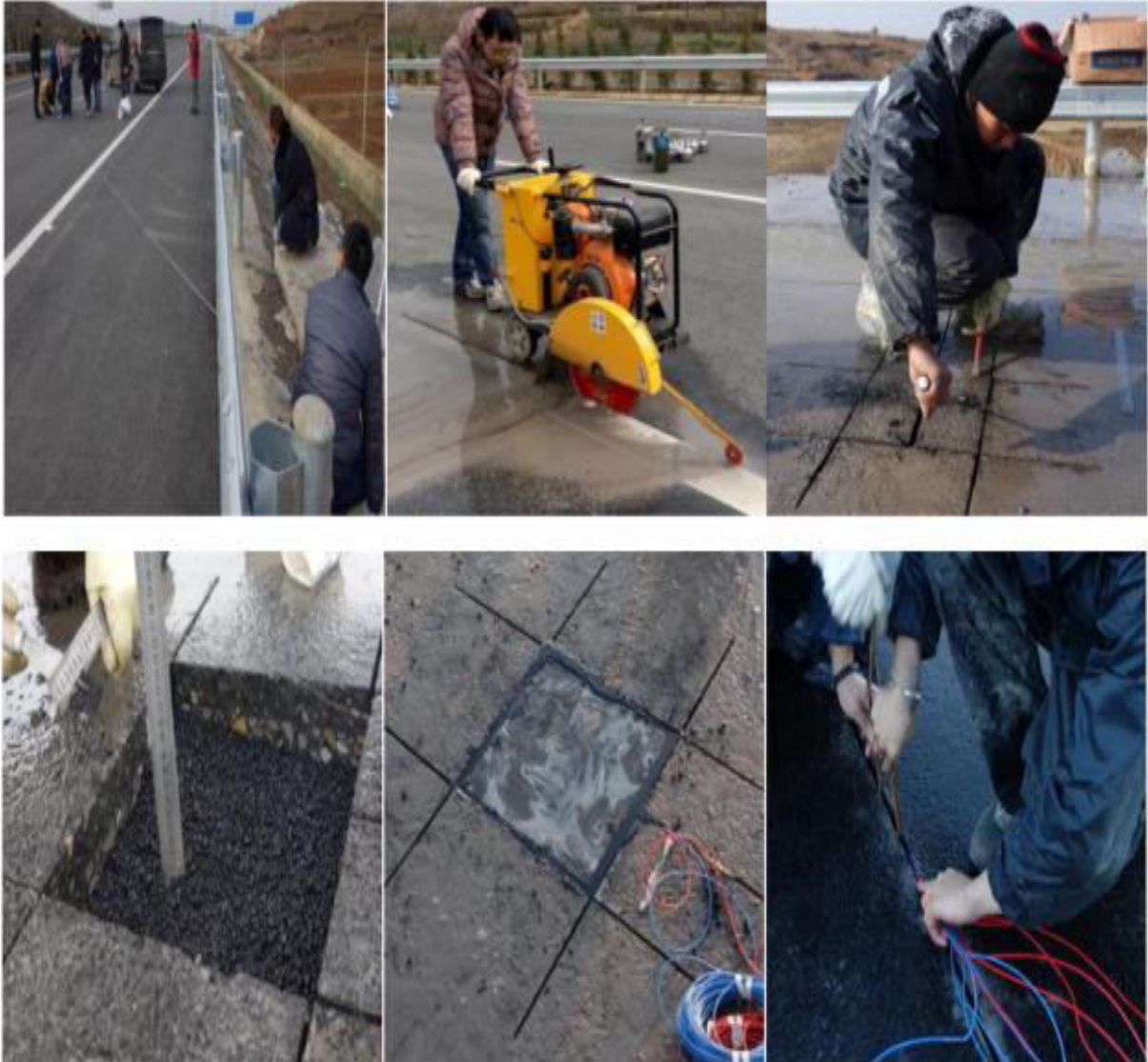
Solar Battery Storage

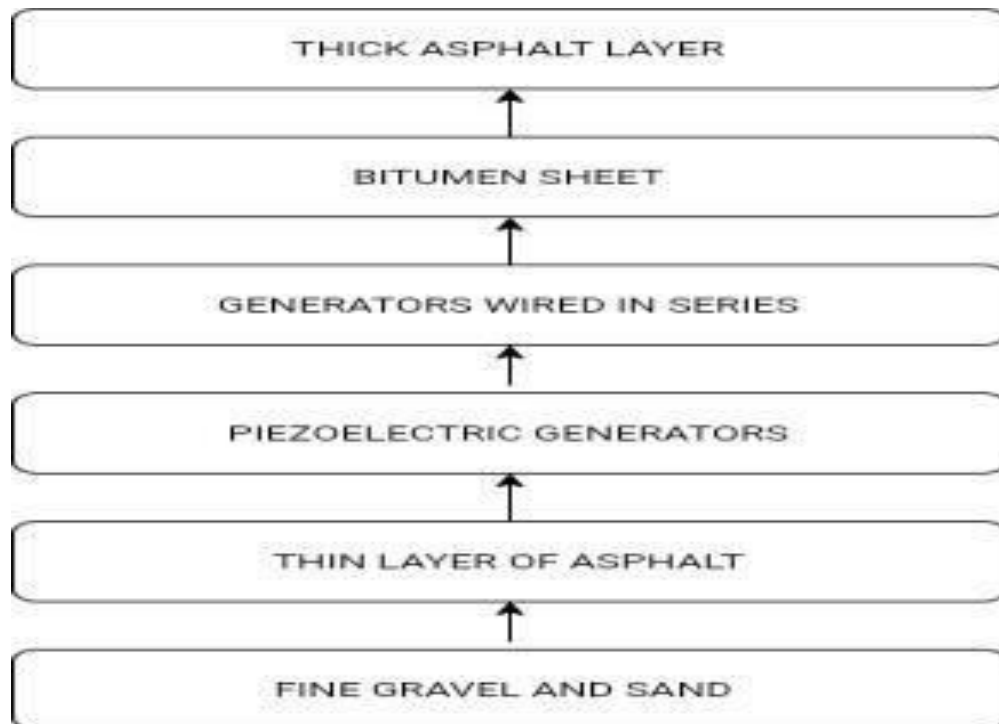


VI. CONSTRUCTION PROCESS

A. CONSTRUCTION PROCESS OF PIEZOELECTRIC ROAD: -

- A layer of fine gravel and sand is to be laid firstly.
- A thin layer of asphalt is laid that acts as a strong base for the generators.
- The piezoelectric generators are placed in a quick drying concrete as per design and they are left for 30 min.
- All the generators are wired in series for getting collective output.
- Bitumen sheet is used for covering the generators that provide a good adhesion of concrete and asphalt.
- And then lastly, the thick asphalt layer is laid that finishes the construction.



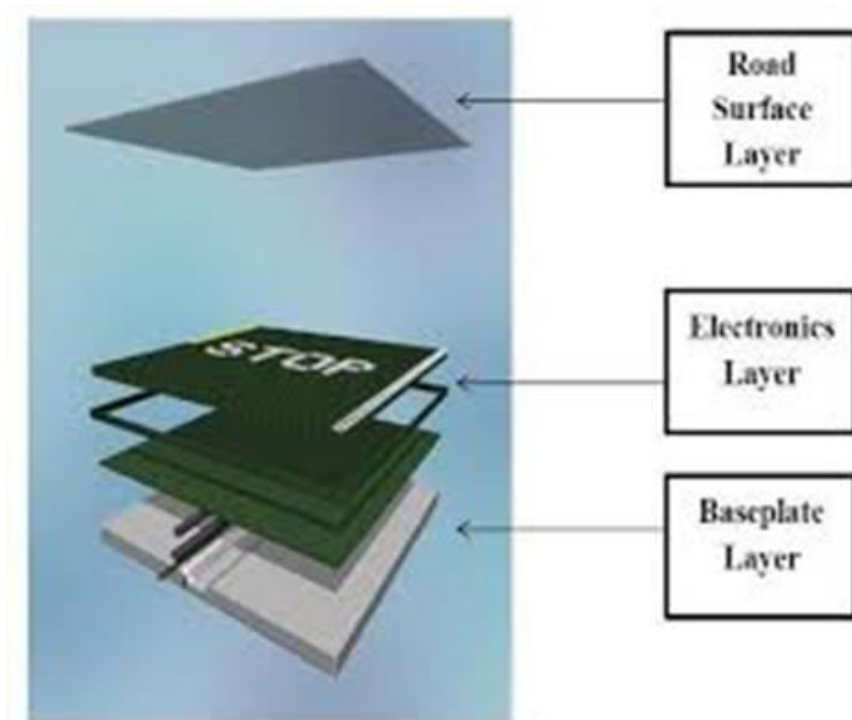


CONSTRUCTION OF PIEZOELECTRIC ROADS

B. CONSTRUCTION PROCESS OF SOLAR ROAD: -

Solar roads are made up of engineered solar panels that are connected to form a road. The panels are usually 12 ft x 12 ft and are made up of three layers:

- Glass layer: A high-strength, textured glass layer that provides traction for vehicles
- Solar cells: An array of cells that gather energy
- Base plate: A layer that distributes the collected power



VII. CONCLUSION

The culmination of our piezoelectric and solar road project underscores the transformative potential of combining innovative technologies for sustainable infrastructure. By harnessing the kinetic energy from passing vehicles and the abundant solar radiation, we've created a synergy that not only generates renewable electricity but also enhances road functionality. This holistic approach not only reduces our dependence on fossil fuels but also contributes to mitigating environmental impact. Furthermore, our findings suggest promising avenues for widespread implementation, signaling a paradigm shift towards more resilient, efficient, and eco-friendly transportation systems that pave the way for a brighter, greener future.

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