NATIONAL SCIENCE FAIR 2025 – OMEIAT

"SiT n LiT"

NSF-SCH2025-466

Name : MOHAMMED HAMZA .M

Class: VII B

Category : PHYSICAL SCIENCE

Level : Middle Level

School: K H Matriculation Boys Hr.Sec.School
Thennandiyalam – Melvisharam
Ranipet Dist - Tamilnadu

Generation of Electrical Energy from Road and Classroom Chair Using the Piezoelectric Effect

Introduction

Research Questions

1. How does the amount of mechanical pressure applied to a piezoelectric sensor affect the voltage and current output?
   To study the relationship between applied force and generated energy.
2. What is the difference in electrical energy generation between road-based and chair-based piezoelectric setups?
   To compare efficiency under heavy vs. light pressure conditions.
3. How does the number and arrangement (series or parallel) of piezoelectric sensors influence the total voltage output?
   To determine the best configuration for maximum energy generation.
4. Can the energy generated from piezoelectric sensors be efficiently stored and reused for small-scale applications (like LEDs or sensors)?
   To test the practical usability of the produced electricity.
5. What are the key environmental and economic benefits of implementing piezoelectric energy harvesting in public spaces?
   To analyze its potential for sustainable energy solutions.

Hypotheses

If a road surface with piezoelectric discs is pressed by wheels/footsteps, then measurable electrical energy can be harvested and stored.

1. If more pressure is applied to a piezoelectric sensor, then the generated voltage and current will increase.
   Because the piezoelectric effect produces higher electrical output when greater mechanical stress is applied.

2. If piezoelectric sensors are placed on a road surface, they will generate more electrical energy than sensors placed on a chair.
   Due to the heavier and more frequent pressure from vehicles compared to human sitting weight.

3. If the number of piezoelectric sensors increases and they are connected in series, then the total voltage output will increase significantly.

As each sensor contributes additional voltage, resulting in cumulative output.

4. If the generated energy is stored in a capacitor or battery, then it can be reused to power small devices such as LEDs or sensors.
   Demonstrating that piezoelectric systems can serve as renewable micro-energy sources.

5. If piezoelectric systems are implemented widely in roads and public places, then they can help reduce dependence on conventional energy sources and promote sustainability. Supporting eco-friendly energy harvesting and sustainable development goals

Objective:

To generate electrical energy using piezoelectric sensors by converting mechanical pressure (from vehicles or students sitting on chairs) into electrical voltage.

Piezoelectric effect

- Piezoelectric effect is a fascinating phenomenon where certain material generate an electric charge response to mechanical stress ,such as pressure or vibration . This effect is reversible, meaning that when an electric field is applied to these materials, they can change shape or produce mechanical stress.

- Real-world uses (sensors, lighters, ultrasound, etc.).
- Motivation: rising energy demand, renewable energy.
- Concept: embedding piezoelectric materials in roads to harvest energy from vehicles.

Principle / Theory:

The Piezoelectric Effect is the ability of certain materials (like quartz, lead zirconate titanate – PZT) to generate an electric voltage when mechanical stress or pressure is applied to them.

V = k x *P*
Where:

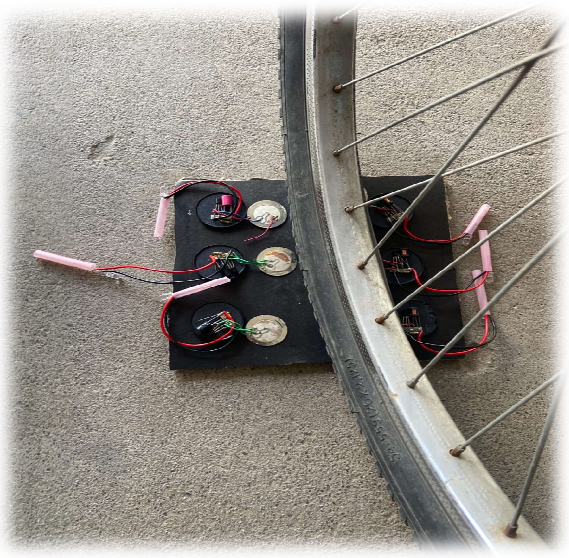
- (V) = Voltage generated
- (k) = Piezoelectric constant of the material
- (P) = Applied pressure

This effect can be used to harvest small amounts of energy from pressure sources — such as moving vehicles on roads or people sitting and standing on chairs.

Procedure:

A. Road Pressure Model:

1. Mounting Sensors:
   Place multiple piezoelectric discs under a small model road made from plywood or rubber sheet.
   Sensors are arranged in series or parallel depending on the voltage and current requirement.
2. Connecting Circuit:
   Connect all sensors to a rectifier circuit to convert AC output from sensors to DC.
   Attach a capacitor or battery for energy storage.
3. Applying Pressure:
   Apply pressure by rolling toy vehicles or by pressing the surface using a heavy object.
   Observe LED glow or measure voltage on a voltmeter.
4. Recording Data:
   Measure the voltage and current generated for different pressure levels.



B. Chair Pressure Model:

1. Fix piezoelectric discs under the **seat base** where pressure is applied when a student sits.
2. Connect them to a rectifier + capacitor circuit.
3. When a person sits, pressure causes the sensors to generate voltage.
4. Record voltage readings on a multimeter for different sitting weights.
5. Store generated energy in a small capacitor and use it to light an LED.

Observation :

Constant : NH HIGHWAY

Variable : VEHICLES

Non variable : ENERGY GENERATION

	Capacitance (µF)	Voltage (V)	Energy (µJ)
10	10	0.6	0.5
50	10	1.2	7.2
100	10	2.0	20.0

A) Road Pressure Model

Vehicle/min	Average Pressure (N)	Voltage (V)	Current (mA)	Power (mW)
1	50	0.8	1.2	0.96
3	150	2.2	2.5	5.5
5	250	3.8	3.2	12.16
10	500	6.0	4.5	27.0

B) Chair Model

Constant : Chair

Variable : Pressure given by students

Non variable : Energy Generation

Mass (Kg)	Pressure (N)	Voltage (V)	Current (mA)	LED Glow
30	300	0.5	0.8	Dim
50	500	1.1	1.3	Medium
70	700	1.8	1.9	Bright
90	900	2.4	2.5	Very Bright

Data Analysis:

1. Voltage vs Pressure Relationship:

   The generated voltage increases proportionally with applied pressure.

   - **Heavier vehicles or higher weights produce more electrical energy.**

2. Effect of Sensor Count:

   - More sensors connected in series → higher voltage output.
   - More sensors in parallel → higher current output.

3. Efficiency Observation:

   - Road system produced higher energy due to greater force from vehicles.
   - Chair model generated smaller but consistent voltage, enough to power small LEDs or sensors.

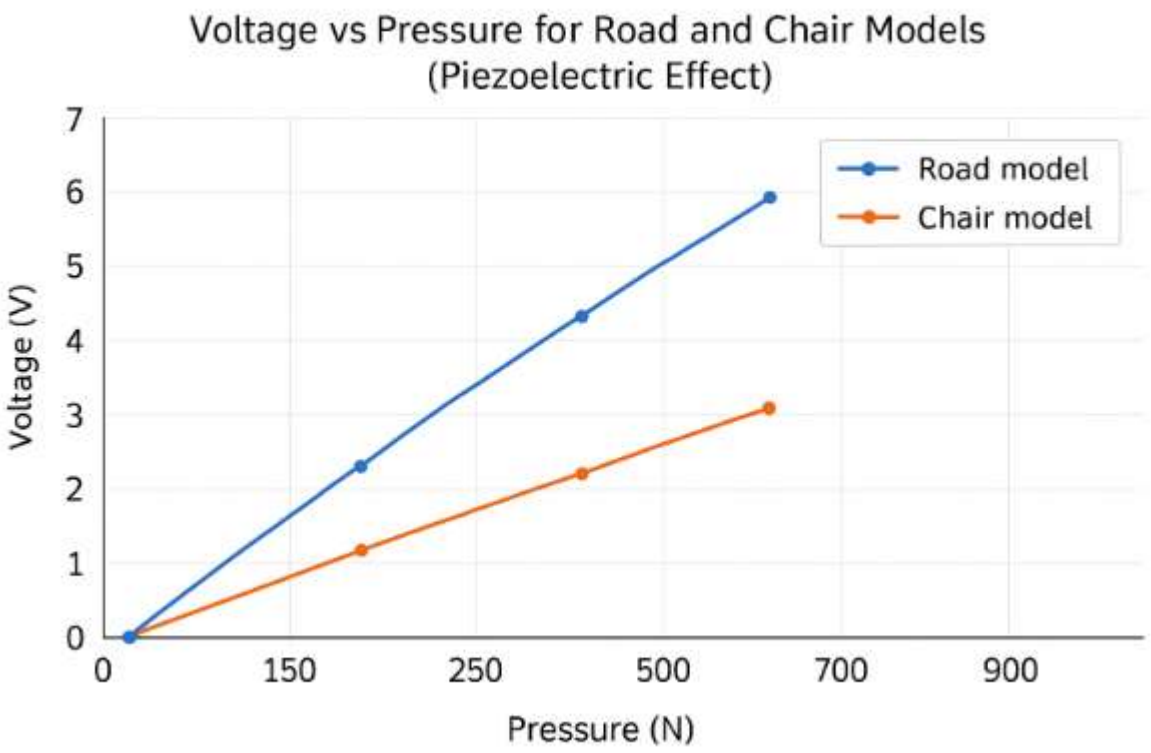
4. Energy Conversion:

   Example calculation:
   For 5 vehicles, (V = 3.8V), (I = 3.2mA)
   P = V x I = 12.16 mW

   - Energy per minute = 12.16 mW x 60 = 729.6 mJ

5. Conclusion from Data:

   - The system effectively converts mechanical stress into electrical energy.
   - Energy generated can be stored and used for small-scale lighting or sensors.
   - Scaling up the design can help power street lights, traffic sensors, or charging stations.



Conclusion:

This experiment successfully demonstrates generation of electrical energy from mechanical pressure using the piezoelectric effect.

- On roads → vehicle pressure can produce measurable voltage.
- On chairs → human sitting movement can produce low-power energy for sensors.
  This supports the concept of self-powered smart infrastructure and sustainable energy harvesting.

Discussions :
My hypotheses becomes true and I got the expected results.

For future :

Huge amount of piezo plate can be placed on roads and can generate electrical energy which will be at least useful for post lights .

Reference :

- From Science textbook for piezo electric effect content and its applications.

- **Priya, S., & Inman, D. J. (2009).**
Energy Harvesting Technologies. Springer Science & Business Media.
→ Comprehensive overview of piezoelectric and other energy-harvesting methods.

- **Kumar, A., & Patel, V. (2017).**
Generation of electricity using piezoelectric material.
International Journal of Engineering Research & Technology (IJERT), 6(5), 102–106.

- **Sarkar, S., & Khatun, M. (2018).**
Piezoelectric energy harvesting from vehicle movement on roads.
International Journal of Scientific & Engineering Research, 9(3), 121–126.

- **Sutar, S. P., & Patil, S. (2019).**
Generation of electrical energy from footstep and road pressure using piezoelectric sensors.
International Research Journal of Engineering and Technology (IRJET), 6(4), 2873–2878