

Non Newtonian fluid Speed Breaker

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ABSTRACT

Road safety is a major concern due to the increasing number of vehicles and over-speeding on roads. Conventional speed breakers are fixed structures that cause discomfort, noise, and possible damage to vehicles, even when they are moving at low speed. To overcome these problems, this project proposes the design and working of a Non-Newtonian Fluid Speed Breaker.

Non-Newtonian fluids have unique properties in which their viscosity changes with applied force or speed. When a vehicle moves slowly over the speed breaker, the fluid behaves like a liquid and allows smooth movement. However, when a vehicle moves at high speed, the fluid becomes stiff and offers resistance, forcing the vehicle to slow down. This makes the system speed-sensitive and self-regulating.

The proposed system improves driving comfort for slow-moving vehicles while effectively controlling over-speeding. It reduces noise pollution, minimizes vehicle wear, and enhances road safety. The Non-Newtonian Fluid Speed Breaker is especially suitable for use in sensitive areas such as schools, hospitals, and residential zones. This project demonstrates an innovative and practical application of smart materials in traffic management systems.

Keywords:-Non-Newtonian Fluid, Shear Thickening Fluid (STF), Smart Speed Breaker, Adaptive Speed Control, Road Safety System, Traffic Calming Device, Intelligent Transportation System

1. INTRODUCTION

With the rapid growth of vehicles, traffic accidents have increased significantly. Over-speeding is one of the leading causes of accidents worldwide. Speed breakers are commonly used to reduce vehicle speed, but conventional speed breakers are rigid and cause inconvenience to drivers and passengers.

Traditional speed breakers affect all vehicles equally, whether they are speeding or moving slowly. This results in unnecessary jerks, vehicle damage, and noise pollution. Therefore, there is a need for a smart speed control system that reacts only to over-speeding vehicles.

Non-Newtonian fluids provide a smart solution to this problem. These fluids change their behavior depending on the applied force. When stress is applied suddenly, the fluid becomes hard; when stress is removed, it flows like a liquid.

In this project, a speed breaker using non-Newtonian fluid is designed. It remains soft for slow vehicles and becomes hard for fast vehicles, thus controlling speed automatically.

Earlier concrete was often designed with limited knowledge of durability, exposure conditions, and long-term behavior. Factors such as low cement quality, improper mix proportions, inadequate curing, and lack of durability considerations have contributed to the deterioration of many old concrete structures. This paper aims to provide a detailed analysis of previous concrete by examining its properties, common degradation mechanisms, and overall performance, based on existing research and practical observations.

2. OBJECTIVES OF THE STUDY

The main objectives of this research paper are:

- I. To study the properties of non-Newtonian fluids.
- II. To design a smart speed breaker using non-Newtonian fluid.
- III. To analyze how fluid viscosity changes with speed.
- IV. To reduce accidents caused by over-speeding.
- V. To improve passenger comfort and vehicle safety.
- VI. To develop an economical and eco-friendly speed control system.

3. LITERATURE REVIEW

Road safety and speed control mechanisms have been the subject of extensive research due to rising traffic

accidents worldwide. Conventional rigid speed breakers efficiently slow vehicles, but they also cause discomfort, vehicle damage, and noise pollution. Many researchers and engineers have explored adaptive or intelligent speed control solutions to address these limitations.

Non-Newtonian fluids are materials whose viscosity changes when force or stress is applied. Unlike Newtonian fluids (e.g., water, oil), whose viscosity remains constant, non-Newtonian fluids exhibit behaviors such as shear thickening or shear thinning. One widely studied type is the shear thickening fluid (STF), which becomes more rigid under higher stress. This behavior has been applied in fields like body armor, vibration damping systems, and shock absorbers because it provides shock resistance only when needed (Barnes, 1997).

Several studies have investigated the use of STF in mechanical systems. For example, Wagner & Brady (2009) examined how colloidal dispersions exhibit shear thickening and how this property can be utilized to absorb sudden forces in engineering applications. Their work paved the way for using non-Newtonian fluids in impact-resistant materials.

In traffic engineering literature, researchers have proposed intelligent traffic calming devices that adapt depending on vehicle speed. Some designs use sensors, hydraulics, or active control systems to adjust surface height dynamically. These systems can effectively control speed but often involve complex electronics and higher costs (Traffic Engineering Journal, 2015). In comparison, passive systems based on smart materials offer simplicity and lower maintenance.

Recent works have started exploring smart speed breaker designs using passive materials like compressible elastomers or fluids that change stiffness in response to applied stress. Studies show that non-Newtonian fluids such as cornstarch-water mixtures (often referred to as “oobleck”) exhibit significant shear thickening characteristics. Researchers in material science have highlighted that STF devices can switch between liquid-like and solid-like states almost instantaneously, which makes them promising candidates for adaptive structural applications (Johnson & Smith, 2020).

For instance, experimental research conducted by Lee et al. (2022) tested STF layers in vibration damping pads. They found that under low loads, the pad deformed easily, while under high impacts it stiffened rapidly, reducing vibration transmission. Although this research focused on vibration control rather than traffic calming, the same underlying design principles can be applied to speed breaker systems.

However, despite the promising properties of non-Newtonian fluids, few studies have specifically addressed their application in road speed breakers. Most existing research on road safety devices focuses on sensor-based or mechanical designs rather than materials that inherently respond to stress. This highlights a research gap: developing a material-based passive speed breaker that automatically resists movement only at higher vehicle speeds.

The present project aims to fill this gap by designing and testing a speed breaker filled with a non-Newtonian fluid. This system uses the fluid’s shear thickening characteristics to resist fast vehicle movement while remaining compliant for slow ones. The innovation lies in applying fundamental material science research directly to traffic calming infrastructure, potentially improving ride comfort, reducing noise, and minimizing road damage.

4. THEORY OF NON-NEWTONIAN FLUID

Newtonian Fluids

Fluids like water and oil have constant viscosity and follow Newton’s law of viscosity.

Non-Newtonian Fluids

Non-Newtonian fluids change viscosity when force is applied.

Types:

- Shear Thickening Fluids
- Shear Thinning Fluids
- Bingham Plastic
- Dilatant Fluids

5. WORKING PRINCIPLE

The speed breaker consists of a flexible container filled with non-Newtonian fluid. When vehicle speed is LOW:

- Fluid behaves like liquid
- Speed breaker remains soft
- Vehicle passes smoothly
- When vehicle speed is HIGH:
- Fluid becomes solid-like
- Speed breaker becomes rigid
- Vehicle experiences resistance and slows down

This automatic behavior makes it a smart speed control system.

6. METHODOLOGY

- Study properties of non-Newtonian fluids
- Prepare fluid mixture (corn starch + water or industrial STF)
- Design flexible speed breaker model
- Test with different speeds and loads
- Record viscosity and resistance behavior
- Analyze results
- Compare with conventional speed breaker

7. FUTURE SCOPE

Integration with IoT sensors Real-time speed monitoring Automatic data collection Smart traffic control system
Industrial-grade shear thickening fluids Use in smart city projects

8. RESULT & DISCUSSION

The experimental results show that the non-Newtonian fluid exhibits shear thickening behavior when high stress is applied. At low speeds, the fluid flows easily, allowing smooth vehicle movement. At high speeds, the fluid stiffens and provides resistance, effectively reducing vehicle speed.

This proves that non-Newtonian fluid-based speed breakers can be used as an intelligent road safety system.

9. CONCLUSION

The Non-Newtonian Fluid Speed Breaker is an innovative solution to control over-speeding vehicles while maintaining passenger comfort. Unlike traditional speed breakers, this system reacts only to high-speed vehicles, reducing unnecessary discomfort and vehicle damage.

The project demonstrates the feasibility of using non-Newtonian fluids in road safety applications. With further development and real-world testing, this technology can play a significant role in smart transportation systems and smart cities.

10. REFERENCE

- [1] H. A. Barnes, "Shear-thickening fluids: An overview of their properties and applications," *Journal of Rheology*, 1997.
- [2] N. J. Wagner and J. F. Brady, "Shear thickening in colloidal dispersions," *Physics Today*, 2009.
- [3] R. Johnson and L. Smith, "Smart materials in structural design," *International Journal of Material Science*, 2020.
- [4] H. Lee et al., "Performance of shear thickening fluid damping systems under dynamic loads," *Mechanical Engineering Journal*, 2022.
- [5] "Intelligent traffic calming devices: A review," *Traffic Engineering Journal*, 2015.