

## Use of Non-Newtonian Fluid To Fill Potholes

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**Abstract**—A Country like India has been witnessing traffic congestion and potholes problem in the past few years. A potholes is a structural failure in a road surface caused by failure chiefly in asphalt pavement due to the presence of water in the underlying soil structure and the presence of traffic passing over the affected area. City like Mumbai, the occurrence of potholes on the city street is increasing day by day. The possible solution for the problem has been created by us for filling the potholes by placing a specially designed bag which is made of tarpaulin sheets which is filled by a shear thickening Non-Newtonian fluid which will help it to maintain its shape and prevent it from contamination. The method is economical, relatively less taxing than conventional methods of repairing potholes. It is also environmentally friendly as the fluid is organic. This method provides a solution which guarantees a smooth and safe ride for the commuters of the city. This method is also cost effective, time saving.

**Keywords**—Potholes, Shear thickening Non-Newtonian fluid, Viscosity, Container bag, Compressive strength test, Viscosity variation test, Decay test.

### I. INTRODUCTION

#### 1.1 General

A hole in a road surface that result from gradual damage caused by traffic or weather. A pothole is a hole in the roadway pavement that vary in size and shape. A deep natural underground cave formed by the erosion of rock, especially by the action of water or a depression or hollow in a road surface caused by wear or subsidence. The unprecedented development of potholes during the 2009/2010 summer rainfall season on particularly the Indian provincial and metropolitan roads with bituminous surfacing led to widespread concern among road users and significant media reporting.

- Numerous claims were laid against road authorities for vehicle damage caused by potholes and even for serious vehicle accidents resulting from excessively large potholes.
- Potholes have always been a problem on sealed/paved roads, but never to the extent experienced during the summer of 2009/2010. The causes of the large increase in the degree and extent of potholes during this period were many, but can probably be attributed mainly to the following insufficient routine, periodic or preventative maintenance leading up to the summer.
- Unusually wet conditions for sustained periods. Ineffective or no repair of existing pothole

#### 1.2 Introduction of Non-Newtonian Fluids

- When shear stress is applied to Non Non-Newtonian fluid, the viscosity of the fluid changes.
- The fluid does not follow the Newton Law of viscosity.
- Newton's Law of viscosity "The shear stress between adjacent fluid layers is proportional to the velocity gradients between the two layers"

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## II. LITERATURE REVIEW

### 2.1.1 "RFP Patch using Non-Newtonian Fluid", Arpit Vyas, Rahul S Gupta, Rishabh Gupta (International Advanced Research Journal in Science, Engineering and Technology (IARJSET) ) 3<sup>rd</sup> February 2018.[5]

The presence of water is that the primary reason for potholes, their formation differs somewhat counting on the road pavement structure and materials used. When testing the merchandise, the Non-Newtonian material ready gave sensible results to achieving the objectives like pertinency in fixing potholes, time saving, simply mobile, etc.

### 2.1.2 "Use of Non-Newtonian Fluid To fill Potholes" Deepak Vishwakarma, Rahul Yadav, Sameer Mehdi (International Journal Of Research In Science And Engineering) 3<sup>rd</sup> March 2017[2]

In most cases non-Newtonian characteristics square measure ascertained within the therefore known as structured fluids, however there's an on the spot link between the kind and extent of non-Newtonian fluid behavior and therefore the influence of the outwardly applied stress on the state of the structure. Therefore, the activity of non-Newtonian characteristics is often accustomed ascertain the state of structure in a very fluid. Conversely, one will engineer the structure of a sub-stance to impart the required rheologic properties to a product. However, before examining the role of structure, it's helpful to review 2 key assumptions inherent the thought of shear or elongation or complicated viscousness.

### 2.1.3 "Patch A Potholes with Some Corn Starch and Water" Brad Mccarty, (Science Mag) 6th April 2012[3]

One of the foremost wonderful things is non-Newtonian fluid. This batter-like mixture, typically comprised of amylum and water, turns into a rock-hard surface once it's fleetly wedged. Chances are high that you've seen demonstrations wherever folks can see pools crammed with the sludge, solely to sink after they stop. In step with Science magazine, that's specifically what a bunch of faculty students hope to accomplish. By filling baggage with non-Newtonian fluid, then inserting them into a hollow and covering them, they're making temporary fixes till a lot of permanent repair may be created. " What they came up with could be a pulverized mixture that's hold on in specially designed waterproof baggage, that square measure made from a robust fiber like Kevlar lined with polymer. To supply a ready-made hollow patch, town employees would merely add water and seal the bag."

### 2.1.4 Potholes: A technical guide to their causes, identification and repairs", S. Komba (CSIR Built Environment ISBN987-0-79885594-5) 10th December 2010[4]

Although the presence of water is that the primary reason for potholes, their formation differs somewhat counting on the road pavement structure and materials used. Potholes will, of course, conjointly result from numerous, non-structural causes like diesel (or alternative chemical) spillages; mechanical injury to egress from vehicle rims and/or accidents and fires.

### 2.1.5 "Prototype of Non Newtonian Fluid To Fix Potholes", Damien Gayle And MayankSaxena (Case Western University Cleveland, Ohio, U.S.A.) 12th March 2012[1]

The process consists of a pulverized mixture hold on in specially designed waterproof baggage made from a robust fiber like Kevlar and lined with polymer. they'll be carried around within the boots of police cars or road maintenance vans and, once a hollow is noticed, all that has to be done is add water, seal the bag and drop it into place. the baggage square measure designed to be durable enough to even get up to cold winters and, once permanent repairs square measure finally created, they'll be removed and reused.

### 2.1.6 "System and methods employing Non-Newtonian fluids", Nicholas H. Barron (Hole Patch llc journal) 12th September 2013[8]

A system and methodology for briefly filling surface voids, like cracks, potholes or alternative surface breaches includes a versatile instrumentality, like a bag. The bag is crammed with Associate in Nursing built viscousness fluid. The fluid

properties square measure chosen in accordance with a specific application in accordance factors as well as hole properties, anticipated traffic properties and close temperature. A bag with acceptable properties is placed in a very void, and provides a brief travel surface. Embodiments embrace fluids with built viscousness properties, as well as non-Newtonian fluids. further embodiments embrace by selection crammed, by selection drained, or multiple baggage. Another embodiment includes hollow, versatile containers move size in accordance with hole characteristics..

### **2.1.7 “Application of Non-Newtonian Fluid to Fix Potholes”, MitaliKandalgaonkar,Ruturaj Mane(ICGTI) March 2017[10]**

From test perform it can be concluded that Cornstarch + water (2:1)can be used to fix potholes. This method can be used where hot mix method is inefficient especially during monsoon season. The life span of the material is 30-40 days. Hence it is a temporary method to fix pothole. With further study and research the life span can be increased by adding admixtures to the material. According to gazette published by ministry of road transport government of India the maximum axial load permitted on Indian roads is 35.7 tons. Hence this method can be used for all vehicle loading conditions.

## **III. MATERIAL AND METHOD**

### **3.1 Materials**

The material we used in this project are cornstarch, water and Tarpaulin. To prepare the shear thickening non Newtonian fluid we used cornstarch and water as per volumetric proportions. To make homogenous mixture take water and cornstarch in volumetric proportion and mixed it vigorously.

#### **3.1.1Tarpaulin:-**

A tarpaulin, or tarp, is a large sheet of strong, flexible, water-resistant or waterproof material, often cloth such as canvas or polyester coated with polyurethane, or made of plastics such as polyethylene. Tarpaulins often have reinforced grommets at the corners and along the sides to form attachment points for rope.

#### **3.1.2Water:-**

Water is a transparent, tasteless, odorless, and nearly colorless chemical substance, which is the main constituent of Earth's streams, lakes, and oceans, and the fluids of most living organisms. Organic nutrients.

#### **3.1.3Cornstarch:-**

Cornstarch or maize starch is the starch derived from the corn grain. The starch is obtained from the endosperm of the kernel. Corn starch is a common food ingredient, used in thickening sauces or soups, and in making corn syrup and other sugars. It is versatile, easily modified, and finds many uses in industry as adhesives, in paper products, as an anti-sticking agent, and textile manufacturing.

### 3.2 Methodology

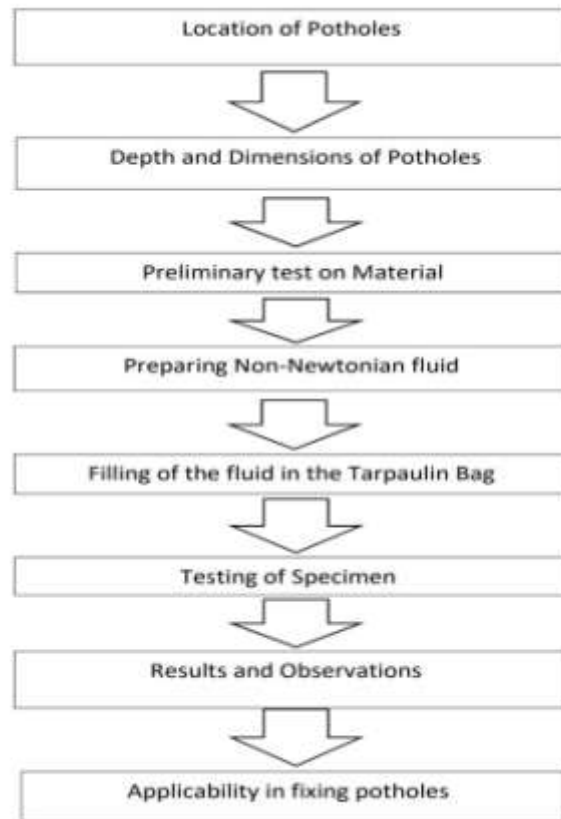


FIGURE 1: FLOWCHART OF PROPOSED WORK

### 3.3 Test to Be Performed

- Fineness test  
Fineness of material is measured by sieving cement on standard sieve. The proportion of material of which the material particle sizes are greater than the 90 micron is determined.
- Specific gravity – pycnometer method  
Pycnometer test is done to determine the specific gravity of the soil. It is the most common and easiest method to test specific gravity of cornstarch as well.
- Decay test  
In this test a sample of the fluid with standard mix proportion is prepared and left open to atmosphere for 10 days and the condition of the fluid is then evaluated
- Compression test on UTM  
A universal testing machine (UTM), also known as a universal tester, materials testing machine or materials test frame, is used to test the tensile strength and compressive strength of materials.
- Non Destructive test – Ultrasonic pulse velocity meter  
This test is conducted by passing a pulse of ultrasonic through material to be tested and measuring the time taken by pulse to get through the structure. Higher velocities indicate good quality and continuity of the material, while slower velocities may indicate material with many cracks or voids.
- Live demonstration on site

In this test the unit of bag filled with the Non-Newtonian fluid is placed in a pothole of appropriate size and it is tested by being run over by vehicles of increasing loading.

### 3.4 Proposed Work

#### 3.4.1 Introduction

We did survey at Vasai-Virar. There we found different dimensions of potholes. Then we conduct several preliminary test on material such as fineness test & specific gravity using pycnometer.

**TABLE 1**  
**DIMENSION OF POTHOLE**

Sr. no.	Diameter(cm) approx..	Depth (cm)	Volume (cubic cm)
1.	30	4	2827.43
2	17	1.25	283.72
3.	43	5.5	7988

#### 3.4.2 Fineness Test on Corn-Starch

Basically Fineness test is done to determine the particle size of the cement. It is the most common and easiest method to test fineness of cornstarch.

##### 3.4.2.1 The fineness of Cornstarch Formula:-

$$\% \text{ of cornstarch retained on sieve} = \frac{W_2}{W_1} \times 100 = \frac{7.5+6.5+7}{3 \times 100} \times 100 = 7\%$$

**TABLE 2**  
**DIMENSION OF POTHOLE**

Sample per 100g	Sieve size	% retained	% pass
Sample 1	90 micron	7.5	92.5
Sample 2	90 micron	6.5	93.5
Sample 3	90micron	7	93

Results: The fineness test of cornstarch is avg of all sample is (7%) when sieved with the 90 micron sieve. which is below than IS code 4031 (part 1)-1996 result (10%) ,therefore it is good quality/condition of cornstarch.

### IV. CONCLUSION

From the above test it can be concluded that cornstarch which we used as the material for preparing the mixture is finer by the method of fineness test. Finer material offers greater surface area for hydration and also faster the development of strength and we also got the density of cornstarch for the calculation of volumetric proportion of mixtures by using the pycnometer test. this method can be used where hot mix method is inefficient specially during monsoon season. The life span of this can be increased by adding admixtures to the material. hence this method can be used for all vehicle loading conditions.

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