



RFP Patch Using Non-Newtonian Fluid

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Abstract: A tropical country like India has only one resource available naturally to keep them of the scorching heat-the Monsoon Season or the rainy season as it is often called. But instead of enjoying these rains, people living in the city of Mumbai have another problem on their hands. Yes, the POTHOLEs. These potholes create havoc in lives of people and family. From fatal accidents to permanent disability and upon all the mental torcher, they need something to solve this huge problem. In a city where people don't have time for themselves and the corrupt government keeps taking advantage of such situation, it is the need of the hour to create a solution which takes away the possibility of corruption from the authorities and provide a beautiful time in the rains for the people to enjoy. The possible solution for the problem has been created by us. We call it the 'RFP PATCH'. It is an environment friendly patch created from organic material and is of economical cost. It is a Non- Newtonian Fluid contained in a specially designed geosynthetics bag which will help it to maintain its shape and prevent it from contamination.

Keywords: Non-Newtonian Fluid, Potholes, Geosynthetics, Accidents, Economical, Eco friendly

I. INTRODUCTION

A. Background

India as a fast-developing nation is growing in every field from education to women empowerment and even in infrastructure. One of the most important infrastructures in a progressing country are the communication routes. The roads comprising and carrying almost 85% of the total passenger traffic plays an important role in communication routes. But one of the striking underlying facts is the condition of the roads. India is home to several bad roads. Bad road conditions are nothing new to India and the problem is being addressed since the last 30 years. Since roads indirectly contribute to the economic growth of the country, it is extremely essential that the roads are well laid out and strong. India has a total of about 2 million kilometers of roads out of which 960,000 kilometers are surfaced roads and about 1 million kilometers of roads in India are the poorly constructed one^[1]. One of the major issues in bad road is Potholes. Potholes cause an average of 30 Deaths per day^[3]. And the number is increasing day by day. These numbers are higher in Monsoon season as there is no repair work due to rain. Major cities facing issues due to this problem is Mumbai, Delhi, Bangalore Etc. Potholes are not just an issue now but a matter of life and death.

B. Potholes

A pothole 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.^[7] Introduction of water to the underlying soil structure first weakens the supporting soil. Traffic then fatigues and breaks the weakly supported asphalt surface in the affected area. Continued traffic action ejects both asphalt and the underlying soil matter to create a hole in the pavement. Pothole patching methods may be either temporary or semi-permanent. Temporary patching is reserved for weather conditions that are not favorable to a more permanent solution and usually uses a cold mix asphalt patching compound placed in an expedient manner to temporarily restore pavement smoothness. Semi-permanent patching uses more care in reconstructing the perimeter of the failed area to blend with the surrounding pavement and usually employs a hot-mix asphalt fill above replacement of appropriate base materials.

II. OBJECTIVE

As common to almost all the cities, Mumbai has been witnessing traffic congestion and pothole problem in the past few years. With the increasing traffic flow in the city, the occurrence of potholes on the city street is increasing. In Mumbai,



it has been observed that potholes are being found even on the newest roads constructed hence it is imperative to provide a solution which guarantees a smooth and safe ride for the commuters of the city. So, we have come up with a method that is workable throughout the year to cure pothole by making patch arrangement which is also cost effective, time saving and eco-friendly.

□ RFP Patch

The solution to the pothole problem is the RFP (Relief from Pothole) Patch. It contains an organic and environment friendly material which behaves as a Non-Newtonian Fluid. This means that the material will behave like a liquid unless and until a load is applied. This behavior of the material will help the drivers of different vehicles negotiate a pothole without damaging the vehicle as well as themselves. To make it more efficient and also to increase the life of the product, the Non-Newtonian

Fluid will be contained in a specially designed Geo synthetics bag.

This will serve two purposes:

- It will help the product maintain its ratio of the constituents.
- It will make the patch look like a part of the road so as not to distract the drivers.

Also, as a Civil Engineer, it is important to take the nature with the developing world and geosynthetics help us do just that. Their durability helps in decreasing the amount of material required. The Non-Newtonian Fluid contained is of Shear Thickening type which is also known as Dilatant. It means that the viscosity of the fluid will increase with increased stress. The RFP Patch is basically divided or made up of two parts:

- a. Dilatant Fluid (Non – Newtonian Fluid)
- b. Geosynthetics Bag.

The performance and usefulness of the patch depends upon the performance of these two and hence they were test both individually and together as a complete patch. Detailed information on both these constituents is given below.

C Dilatant Fluid

A dilatant fluid is a fluid whose viscosity is variable based on applied stress or force. The physical behavior of Dilatant fluid depends on the forces acting on it from second to second.

Classification of Non – Newtonian Fluid

4. Time independent

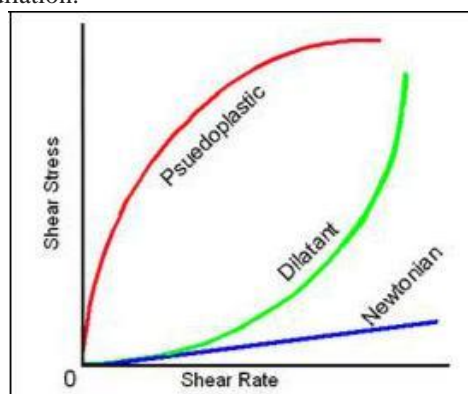
Shear thinning (pseudo plastic or power law) Shear thickening (dilatant)

Bingham

Herschel bulkley

5. Time dependent Thixotropic Rheopectic

When punching a bucket full of non-Newtonian fluid, the stress or the force acting causes the atoms in the fluid to rearrange such that it behaves like a solid. Your hand will not go through. If you shove your hand into the fluid slowly by applying some extra force, however, it will penetrate successfully. If you pull your hand out abruptly, it will again behave like a solid. There are different types of Non-Newtonian Fluid. We at present are looking at the Shear Thickening Fluid. A shear thickening fluid (STF) is a material whose viscosity increases dramatically when the shear rate is above a critical value. It is an example of a non-Newtonian fluid and also termed a dilatant fluid. At low shear rates, the liquid has low viscosity and acts as a lubricant, and it flows easily; however, at higher shear rates, the liquid isn't able to fill the gaps and the viscosity increases. In shear thickening behaviors, the shear rate increases as well as the viscosity increases. This is because the system crystallizes under stress and starts behaving like a solid rather than a solution. The viscosity of a solution is often affected by the presence of suspended particles. In fact, with some changes in the particles, a Newtonian fluid can show or exhibit Non-Newtonian behavior. The shear thickening effect is due to mechanisms of hydrodynamics or dilation.





. This is shown by all suspensions under certain conditions. Although it has been known that shear thickening is a specific type of behavior, but recently a contradiction that shear thickening can be affected by yield stress and also be recovered when the yield stress is decreased below a threshold. The attractions in suspensions are mainly due to the surface tension between the particle and the fluid. Apart from the surface tension, different other properties such as roughness, particle size and surrounding conditions play a role in the shear thickening effect.

5. Geosynthetics

Definition: Geosynthetics are defined as civil engineering materials that are designed for use with geological materials like soil, rock or any other civil engineering related materials to improve or modify its behavior, bringing out revolutionary benefits in numerous areas. They are permeable textile materials of nonwoven, woven or knitted. Their rise in growth during the past fifteen years has been nothing short of awesome.

Geosynthetics are state-of-the-art construction products that can be used in transportation (rural roads, national and state highway, seaports, airports), infrastructures (reinforcement of weak soil) environmental projects (waste containment, drainage composites) marine works. There are some types of Geosynthetics which are as follows:

- Geotextile Geogrid
- Geomembrane Geotube
- Geopipe Geonet Geomat

Functions

1. Filtration
2. Drainage
3. Separation
4. Protection
5. Impermeabilization
6. Reinforcement of walls/steep slopes
7. Reinforcement of soft soil
8. Reinforcement of concrete, asphalt
9. Confinement



Table 1. Data Sheet of Geo-Synthetic Samples Used

SR.NO.	OBSERVATIONS			
	ENGINEERING PROPERTIES	UNIT	PN500	PPN500
1.	Mass per Unit Area	GSM	500	500
2.	Thickness	Mm	3.2	3.2
3.	Tensile strength-CD	KN/m	20	30
4.	Tensile strength-	KN/m	18	25



	MD			
5.	Tear strength	N	590	715
6.	Puncture Strength	N	2600	5100
7.	Apparent opening size	μ	<75	<75

III. TESTING

To test the efficiency of our product and to see the scope of improvement we decide to test our product. The following steps were followed:

Step 1- A suitable pothole was identified which was situated in front of Thakur Public School, Kandivali, Mumbai. It was then cleaned i.e. all the loose aggregates from the concrete patch were removed and the pothole was then cleaned with water and brush.

The pothole identified had the following characteristics and dimensions:

SHAPE: Irregular.

DIAMETER: 30cms (approx.)

HEIGHT: 4cm (approx.)

AREA: 1962.5cm².



step 2- After that we took 2kg of material with a proper calculated amount of water and then mixed properly with trowel, it was mixed till proper uniformity of the paste was formed.

Step 3- After mixing the paste, it was properly placed in layers into the pothole.



Step 4- After placing slurry into the pothole, various tests were conducted they are as follows:

- A) Human weight.
- B) Bike weight.



- C) Car/Truck weight.
A) In Human weight, we made a person to stand on it for a period of 2 minutes. After that we also made him jump on that patch. Observation was that load of a person was easily taken by the product.



- B) After that we kept the weight of the bike on it to check the amount of load taken by patch, again we got successful results for it.

STEP 5- To test the material's behaviour during the monsoon, we tried to depict the rains by pouring water over the pothole and fully submerging it. After 10 minutes of observation, the results were up to the mark as no water was absorbed by the material and vehicles could easily stand over it for the time frame.

STEP 6- So the final step in the testing process was to put the material in the geosynthetic bag and place it over the pothole. This was done to see if the geosynthetic bag was true to its engineering properties in practical conditions.

CONCLUSION

After testing the product, we came to the conclusion that the Non-Newtonian material prepared by us gave good results and brought us a step closer in achieving our objective. Also, the geosynthetic material, (more specifically 'geotextile') that we used was of 500 GSM which didn't performed as expected and hence a material of higher GSM is thought of being used.

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