Settlement of flexible pavement of Sangli-Islampur road- A case study

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1. Abstract – *Now day people are facing some problems regarding traveling or transportation in the sangli-islampur city because of the bad condition of the road. There are potholes on road due to black cotton soil is proved to be seriously founded on it. It has high swelling and shrinkage properties. Because of its high swelling due to water percolation in the rainy season and shrinkage due to water evaporating in the summer season, when we construct the structure on black cotton soil, it gets cracked. In the past decades, we found stabilization techniques to reduce the swelling and shrinkage property of soil. So in this project, we stabilize the soil using brick dust and also find the causes of road cracks and remedial measures of it.*

***Key Words*: Black cotton soil, brick dust, causes of settlement of road, remedial measures of it.**

2. Introduction :

Recently, traffic and transportation systems are increased in the Sangli district. So most of the vehicles are goes on Sangli Islampur road. Recently this road is converted into a national highway. So it is necessary to keep it in good condition and maintenance. Most of the time that road is constructed but that road is frequently deteriorated and get cracks. So people are facing problems while traveling on that road. To solve that problem we choose this project, so in this project, we will find the causes of road deterioration and remedial measures of it.

Fig 1 : Before Rainfall

Fig 2 : After Rainfall

3. OBJECTIVE & SCOPE

3.1 Objective:

1) To study of current condition of road and surrounding area.
2) To study of black cotton soil.
3) To study causes of settlement and suggest remedial measures for that road.

3.2 Scope:

1) Permanent solution for black cotton soil road.
2) New technics used in soil stabilization.

4. METHODOLOGY

4.1 Study of current condition of road:-

We surveyed Sangli –Islampur road and found that it turns out that the road is damaged in little- little patches throughout entire its span.

Following are the failures occurred in road:-

1) Fatigue cracks.
2) Longitudinal cracks.
3) Edge cracks.
4) Potholes.

4.2 Fatigue cracking:-

Fatigue crack is also called as map cracking. It is the most common type of distress in flexible pavement. It is commonly found at interconnection and traffic loading.

Fig 3 : Fatigue cracking

4.3 Longitudinal cracking :

Longitudinal cracks become similar to the midline of the roadway. They can be caused by: poorly constructed joint, Asphalt layer shrinkage, Cracks reflected from the underlying layer, And longitudinal separation due to improper paving operation.

Fig 4 : Longitudinal cracking

4.4 Edge Cracking:-

Edge cracks travel within one or two feet of the internal edge of the roadway surface. The most common cause of this type of crack is unfortunate drainage conditions and lack of support on the sidewalk. As a result, the base material becomes stagnant and weak.

Fig 4 : Edge Cracking

4.5 Slippage cracks:-

Slippage cracks are crescent-shaped or crescent-shaped cracks with two ends running away from traffic. They form when the sidewalk surface slides and deforms due to braking or turning wheels.

Fig 5 : Slippage cracks

4.6 Potholes :-

Due to insufficient strength in single or more layers of roadway, usually due to the occurrence of water, pits are formed when the pavement degrades in the loading of traffic. Most of the pits will not happen if the root cause is repaired before the pits develop.

Fig 6 : Potholes

4.7 Causes of settlement of road:-

1. Nature of soil - black cotton soil:-

Roads run on black cotton soils are known for poor condition and unpredictable behavior for which the nature of the soil contributes to some extent. The nature of black cotton soil is discussed here.

BC soils absorb large amounts of water, swell, soften, lose strength, are easily compressed, and tend to germinate in wet conditions.

BC soils are depleted and fall apart in summer. They are characterized by extreme hardness and cracking when dries.

When the free swell index is more than 50%, the soil is called high expander. Large changes occur in such soils that cause

sidewalks to deform, crack, and cause general unevenness due to seasonal wetness and dryness.

BC produces 2 to 5% CBR value if the soil is efficiently compacted.

2. Drainage system :-

There is no drainage system. So the water that falls on the road. That water is stored on the road and it is percolate into the road. Percolated water create movement in sub grade course (i.e changes properties of black cotton soil). And cracks and potholes form in the road.

Fig 7 : No Drainage system

3. Weather condition along the year:-

Every surface, including asphalt, is exposed to weather. Although the sun's intense rays can damage the asphalt, torrential rains and excessive rainfall can cause even more damage. The last thing you need is moisture to get into your tar. Temperature changes that cause freezing and thawing can also affect asphalt. Due to temperature water is evaporated, soil is shrinkage and due to heavy rainfall water is percolated in soil and it is swelled.

4.8 Study of black cotton soil:-

Definition:

Black cotton soil is heavy clay soil, varying from clay to clay; it is usually light to dark gray in color. Cotton grows in such soils. This soil is commonly found in central and southern parts of India. The most important feature of soil is that when it is dry it shrinks and is as hard as stone and its endurance is very high. Large cracks form in the soil. The entire area splits and cracks form up to a depth of 3.0 to 3.5 m and a width of 150 mm. But when the soil is moist, it expands, becomes too soft and loses its ability to hold. Due to its wide character, it increases from 20% to 30% of the original size and brings pressure. The upward pressure is so great that it lifts the base upwards. Foundations are added to this vomit paradox. The wet ones are narrow at the bottom and wide at the bottom. The basic condition of the soil was to build in such soils. A special method of laying the foundation is required in such soils.

Fig 7 : Black cotton soil

4.9 Properties of black cotton soil:-

1) It has high swelling and shrinkage Limit.
2) Clayey texture and high fertile.
3) High retentive of moisture content.
4) Extremely compact and forceful when wet.

Contractible and develop deep wide cracks on drying.

5. TESTING

5.1 Test on black cotton soil

5.1.1 Liquid limit test on black cotton soil.

Liquid limit (WL):- The liquid limit is conceptually defined as the water content at which the behavior of a clayey soil changes from plastic to liquid. But experimentally it is defined as the minimum water content at which two separated grooved soil parts mixed together under 25 blows of Casagrande's Liquid Limit Apparatus.

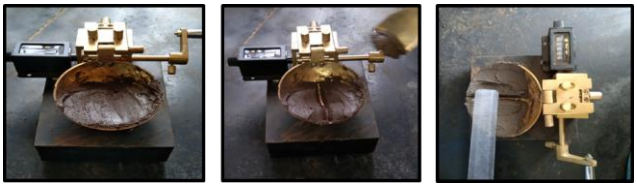

Fig 8 : Liquid limit test

Procedure :-

1) Take about 120 grams. Sample of air dried soil passing through 425 micron IS sieve Metal tray.

2) Add 20% distilled water to the soil sample to make a uniform clay paste.

3) Place this clay paste in the brass cup of Cassagrande's tool and spread horizontally In part with a few strokes of the spatula.

4) Trim the soil to a depth of 1 cm and remove excess soil.

5) Make strong strokes along the side of the grooving tool in two parts of the soil sample Brass cup in the center of the diameter so that the right sharp groove will be clean Dimensions are created.

6) Rotate the handle of the Cassagrande device at a speed of 2 cycles per second. The two pieces of soil will come in contact with each other for a length of about 12 mm Only by flow.

7) Measure the number of turns required to close the groove up to about 12 mm. This is it Recorded as n.

8) To determine the amount of water, take a representative part of the soil w%.

9) Repeat all the above steps by changing the water in the soil sample to get the number of strokes Between 10 and 50. Record the number of strokes and the amount of water associated various tests.

10) Draw the flow curve is the number of strokes required against the abscess (log scale) the amount of water determined as an ordinate (natural scale) on a semi-logarithmic graph paper.

11) Find the amount of water corresponding to 25 strokes from the graph as a liquid limit (WL) of a given soil sample.

Fig 9 : Liquid limit test Performed

5.1.2 OMC and MDD of black cotton soil

Optimum Moisture Content (O.M.C): It is the water content corresponding to maximum dry density of soil, is called as Optimum Moister Content.

Maximum Dry Density (M.D.D): It is the Maximum value of dry density obtained in compaction curve, is known as Maximum Dry Density.

Fig 10 : OMC and MDD of black cotton soil

Procedure

1) Take about 5 kg. De-aerated soil through a 20 mm sieve in the tray.

2) Add about 4% water (approximately 120 ml) to the soil and mix well with a trowel and cover the soil with a damp cloth for 24 hours to ensure that the water is completely mixed.

3) Note the dimensions of the proctor mold, collar and base plate.

4) Take the empty weight of the mold (without collar and base plate).

5) Apply a thin layer of grease on the inside of the mold.

6) Put the mold on the base plate with the help of wing nuts, put the collar on the mold.

7) Determine the density of the proctor and give until the soil in the mold in three equal layers. Using a standard hammer, hit each layer 25 times. Scrape on the compacted top surface Layer before placing the next layer of soil. Make sure after third compaction Layer, compacted soil level slightly above the top of the mold.

8) Remove the collar, trim the soil with straight edges, disconnect the mold from the base plate and take its weight.

9) Remove the compaction soil from the mold.

10) Collect a sample in the middle of the mold to determine the amount of water.

11) Repeat steps 5 to 10, taking fresh sample of the same soil, adding 3 to 4% more water than previously

added water. Repeat these steps for no. Times for soil weight loss for at least two consecutive readings.

12) Measure the bulk density of compacted soil for each test.

13) Determine the maximum dry density and optimum humidity relative to standard Procter compaction by plotting graph water content v / s. Dry density. Also plot constant degrees of saturation lines for 100%, 90%, 80% saturation on the same graph. Calculate the degree of saturation relative to the maximum dry density as OMC and MDD of a given soil sample.

6. Preparation Of model

6.1 Without using brick dust

1) First we prepare the tow road section using ply.

2) In first section spread black cotton soil up to 25 mm thick layer and compacted it.

3) Second spread murum up to 25 mm thick layer and compacted it.

4) Then we apply coarse aggregate 25 mm layer on the murum and compacted it.

5) Then we apply 15 mm thick layer of asphalt.

6) Then we spread bitumen layer of 10 mm thick on the top of the surface

Fig 11 : Model without using brick dust

6.2 With using brick dust

1) First we prepare the tow road section using ply.

2) In second section spread black cotton soil up to 25 mm thick layer and compacted it.

3) Second spread murum up to 25 mm thick layer and compacted it.

4) Then we apply brick dust layer up to 25 mm thick on the murum and compacted it.

5) Then we apply coarse aggregate 25 mm layer on the murum and compacted it.

6) Then we apply 15 mm thick layer of asphalt.

7) Then we spread bitumen layer of 10 mm thick on the top of the surface

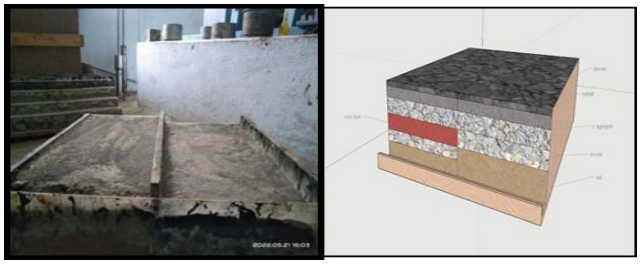

Fig 12 : Model with using brick dust

7. RESULTS

7.1 Test on black cotton soil

Sr.No.	Name of Tests	Result
1	Liquid limit in (%)	54.33
2	Optimum moisture content (%)	17.96
3	Dry density (gm/cc)	1.80

Chart No. 1

7.2 Liquid limit test of black cotton soil + brick dust

Sr. No.	Samples	Liquid limit in (%)
1	Black cotton soil	54.33
2	Black cotton soil (90%) + brick dust (10%):-	50.53
3	Black cotton soil (80%) + brick dust (20%):-	48.00
4	Black cotton soil (70%) + brick dust (30%):-	42.55

Chart No. 2

Chart shows effect of brick dust on liquid limit of black cotton soil.

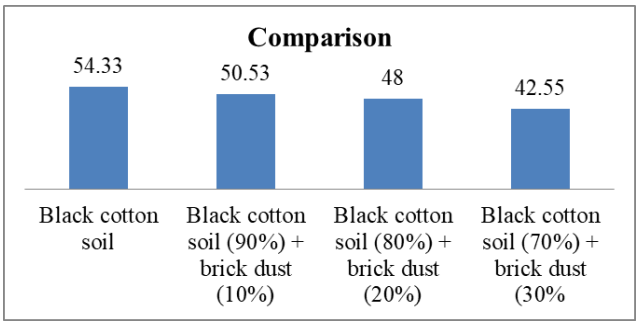

Chart No. 3

7.2 Water percolation test on model

Procedure :

1) We retained 500 ml water on both road sections up to 24 hours.

2) After 24 hours we observed, the water is percolate into road section where brick dust is not used.

Fig 12 : Water percolation test on model

8. CONCLUSION

1) We visit the Islampur Sangli road and we studied the current condition of road and surrounding area we found that totally area is covered with black cotton soil.

2) We took sample of black cotton soil and check the various properties of black cotton soil like liquid limit, OMC, MDD. We found that due to black cotton properties shrinkage and swelling occurs and road settlement due to heavy load vehicles.

3) Black cotton soil is main cause of settlement of road so we need to improve stability of black cotton soil.

4) With the help of brick dust we improve the stability of black cotton soil and it is observed that brick dust partially mix with black cotton soil and reduce the water content.

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