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Study on Managing and Controlling Road Dust By Using Suppersant

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ABSTRACT: Dust control in open pit mines and on urban Roads has been an area of intense research and study. To analyse the cause of dust in pavements, controlling the dust generation by capturing or consolidation and using the appropriate solution is the major concern of this study. The generation of dust occurs mainly in all activity of ore extraction to drilling mines with use of modern equipment's to transportation. Dust generation can cause environmental pollution, less visibility while driving, more accidents, breathing problem and affects vegetation. Fugitive dust emanating from vehicle traffic on unpaved roads and runways can have significant impacts on safety, health and quality of life. Managing dust provides a means of reducing these impacts. Rubbing action between the surface and vehicle tires produce dust on unpaved roads. The dust produced lead to environmental pollution and health problem. In the present study an attempt has been made to reduce the dust by using suppressants like Calcium chloride and Magnesium chloride.

KEYWORDS: Dust control, suppressants, Calcium chloride and Magnesium chloride.

I. INTRODUCTION

Roads are a vital component of transportation system as the means of getting agricultural crops to market and sustaining the lives of farmers. Hence, good road network is a key of development of any country. In India approximately 69,000 miles of these roads are stabilized with gravel or crushed limestone. The amount of dust generated is primarily based on the volume of traffic using the unpaved road as well as the speed, weight & number of wheels of vehicle. Rubbing action between the surface and vehicle tires and the climatic condition of a region is also a contributing factor affecting the dust generation. Fugitive dust from the unpaved roads is noted as major source contributor to the particulate loading in atmospheric air pollution.

In the 1990s particulate matter became part of the standardization agenda as new evidence suggested that airborne particle concentrations in cities, largely affected by vehicular traffic, were partly responsible for health effects such as cardiovascular and respiratory diseases. New statistical methods and more powerful computers made it possible to identify the small signal of air pollution effect against the background of health inequality, variability and other causes. The residents living along roads and road users get affected by this causing health problems like hair fall, fever and allergies. Crops and vegetation near unpaved roads can be covered with the air born dust causes their growth shading effect and clogging of the plants pores. Fine particles resulting from traffic action can also be washed off during precipitation events. This is carried it to nearby streams and lakes increasing their respective particulate loading. Review of these earlier studies indicate that more research is needed to control, manage dust on paved and unpaved roads. In the present study an attempt has been made to reduce the dust by using suppressants like Calcium chloride and Magnesium chloride. These suppressants possess greater efficiency, hygroscopic and deliquescent. They attract moisture from air resulting in greater density and dust free roads.

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II. RELATED WORK

Road dust control and unsealed road stabilization are significant road management issues. Although considerable experimentation on a variety of chemical additives has been carried out in the last 70 years, very little wide-scale implementation has taken place. In past studies many researchers worked on improving, managing and controlling of dust on roads.

Fox (1972)^[1] is one of the earliest dust control research projects at Iowa State University, Their study investigated the effectiveness of ammonium lignosulfonate in combination with calcitic lime or aluminium sulphate as addition dust suppression on granular surfaced secondary roads. The test was conducted by placing plastic containers along the road sides at regular intervals. By the treatment with above Suppressants, dust production was reduced to nearly 80% compared to the untreated roadways. The results of the field studies also indicated that 1% lignosulfonate treatment was as effective as 1% lignosulfonate plus 0.5% of either calcitic lime or aluminium sulphate additives, more improvement at less cost was obtained by the addition of secondary additives.

Bergeson (1972)^[2] conducted investigations on the use of cutback asphalts, latex emulsions, and cationic asphalt emulsions for use as dust suppressants and surface stabilizing agents for granular surfaced secondary roads. The study included evaluation of three cutback asphalts, two latex emulsions, and one cationic asphalt emulsion using laboratory and field testing. The field tests concluded that dust had been reduced on all treated sections and with the exception of the 2% cationic asphalt emulsion, all treated sections had improved surface stability. Although both the 4% MC 800 cationic asphalt and the 4% Redicote E-36 cationic asphalt demonstrated excellent performance and stability characteristics, the overall recommendation for superior stability and performance is 4% Redicote E-36 cationic asphalt.

Alsolater studies by Wahbeh (1990), investigated the use of sodium montmorillonite clay (bentonite) as a dust suppressant for limestone surfaced secondary roads. The test was conducted on three phases, resulting in bentonite treated sections show no adverse effects with respect to braking distance and can be bladed according to the normal maintenance schedule without reducing effectiveness. Results also indicated that calcium chloride treatment was very effective in the first three months of testing, but the bentonite outperformed the calcium chloride near the end of the 1.75 year testing period, as well as during dry weather (low relative humidity). Results of the cost analysis concluded that the use of bentonite is an economical treatment for dust reduction on crushed limestone surface secondary roads.

III. MATERIALS AND METHODS

Materials used in the study are:

1. Soil sample (Dust).
2. Suppressants.

Soil sample (Dust):

Collection of sample is done by considering two nearest villages - Sankanawadi and JainapurQuarry, ChikodiTaluk, Belagavi District, (KARNATAKA) where the dust generation is in large amount.

Suppressants:

The two types of chemicals used are,

- a. Calcium chloride (CaCl_2)
- b. Magnesium chloride (MgCl_2)

These suppressants possess greater efficiency compare to other however performance of both magnesium chloride and calcium chloride they are both hygroscopic (moisture absorbing) and deliquescent (moisture retaining). They attract moisture from air and promote greater density and capillary tension of fines in aggregate surfacing that helps bond the materials together. There are some significant construction advantages and resulting cost savings with dry or solid chlorides versus liquid chlorides. Although blade-mixing chlorides with a grader work, it costs more than mixing with a cross-shaft mixer or tractor-tiller.

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Calcium chloride (CaCl_2):

Calcium chloride attracts moisture from the air, keeping the road damp even under hot, dry conditions. The moisture film provides a cohesive force that binds aggregate particles together, resulting in a hard and compact surface. A beneficial residual effect accumulates with consistent application year after year. As calcium chloride becomes established deeper in the road base, stability improves and frost damage is prevented. Calcium chloride has been used for dust control applications since the early 1920's. No other dust control product comes close to this level of proven performance. The calcium chloride is shown in figure 1.

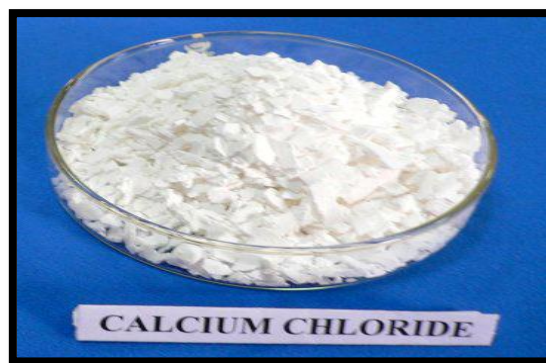


Figure 1: Calcium chloride (CaCl_2)

Magnesium chloride (MgCl_2):

Magnesium binds fine dust particles to keep roads stabilized, to slow the loss of aggregate, and to reduce the need for costly regrading. Liquid magnesium reduces erosion, makes unpaved surfaces harder and more compact, and helps to prevent surfaces from becoming uneven or developing potholes. The Magnesium chloride is shown in figure 2.



Figure 2: Magnesium chloride (MgCl_2)

TEST METHODS:

Modified proctor test:

This laboratory will employ the tamping or impact compaction method using the type of equipment and methodology developed by R. R. Proctor in 1933, therefore, the test is also known as the Proctor test. This test is used to find the optimum moisture content and maximum dry density of soil sample and varying density values by the use of suppressants like calcium chloride and Magnesium chloride. The test apparatus with accessories shown in figure 3.

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Figure 3: Modified proctor test

California Bearing Ratio(CBR)(As per IS 2720-1990 (Part 31)):

It is the ratio of the force per unit area required to penetrate a soil mass with a standard circular piston at the rate of 1.25mm/min to that required for corresponding penetration of a standard material. The test may be performed on undisturbed specimens and on remolded specimens which may be compacted either statically or dynamically. This test is carried out to determine the pavement thickness. This test is a penetration test developed by the California Division of Highway, as a method for evaluating the stability of soil subgrade. The C.B.R test apparatus is shown in figure 4.

$$C.B.R. = \frac{\text{Test load}}{\text{Standard load}} \times 100$$



Figure 4: California Bearing Ratio testing apparatus

IV. EXPERIMENTAL STUDY

A. Modified proctor test:

a. Variation in density values of sample without using suppressants:

This test is performed to determine the relationship between the moisture content and the dry density of a soil for a specified compactive effect. Experimental results are shown in below Tables 1, its related graph is shown in below figure 5 giving values of maximum dry density & optimum moisture content for soil sample without using suppressants.

Table 1: Variation in density values of sample without using suppressants.

Moisture content (%)	5	7.5	10	12.5	15
Dry density (gm/cc)	2.11	2.18	2.23	2.21	2.16

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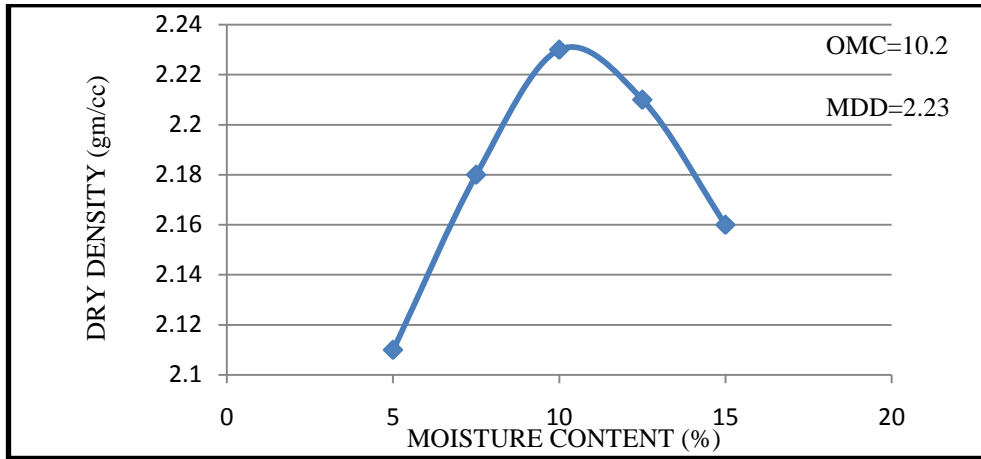


Figure 5: Graph showing variation in density without using suppressants.

b. Variation in density values of sample with percentage of CaCl₂:

With the addition of suppressant CaCl₂, density of the soil sample increases to 2.42 gm/cc at 6.5 % addition of CaCl₂ solution with soil sample. The experimental results are shown in below Table 2 and its related graph shown in below figure 6 giving the value of maximum dry density and optimum moisture content for the soil sample with the percentage addition of CaCl₂.

Table 2: Variation of density values with percentage of CaCl₂

CaCl ₂ (%)	1	2.5	5	7.5	10
Dry density (gm/cc)	2.2	2.28	2.3	2.4	2.23

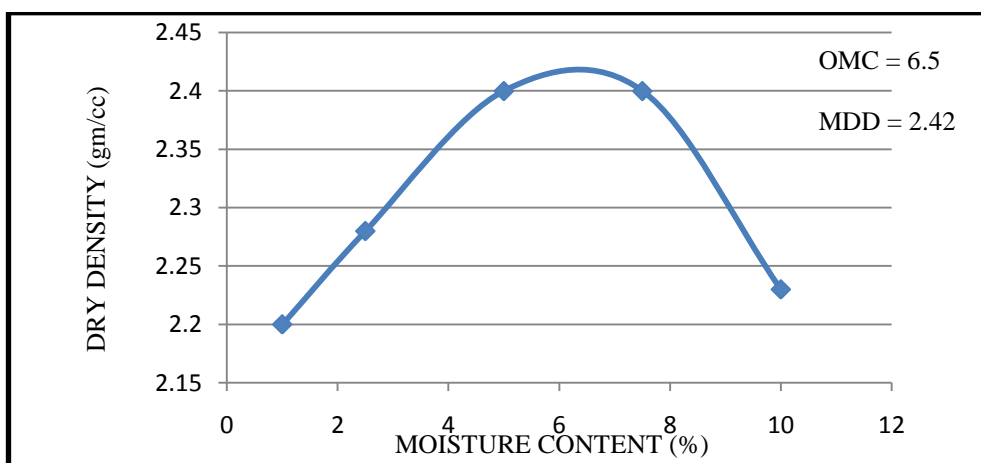


Figure 6: Graph showing variation in density with percentage of CaCl₂

c. Variation in density values of sample with percentage of MgCl₂:

With the addition of suppressant MgCl₂, density of the soil sample increases to 2.35 gm/cc at 7.0 % addition of MgCl₂ solution with soil sample. The experimental results are shown in below Table 3 and its related graph shown in

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below figure 7 giving the value of maximum dry density and optimum moisture content for the soil sample with the percentage addition of MgCl₂.

Table 3: Variation of density values with percentage of MgCl₂

MgCl₂ (%)	1	2.5	5	7.5	10
Dry density (gm/cc)	2.2	2.27	2.33	2.34	2.23

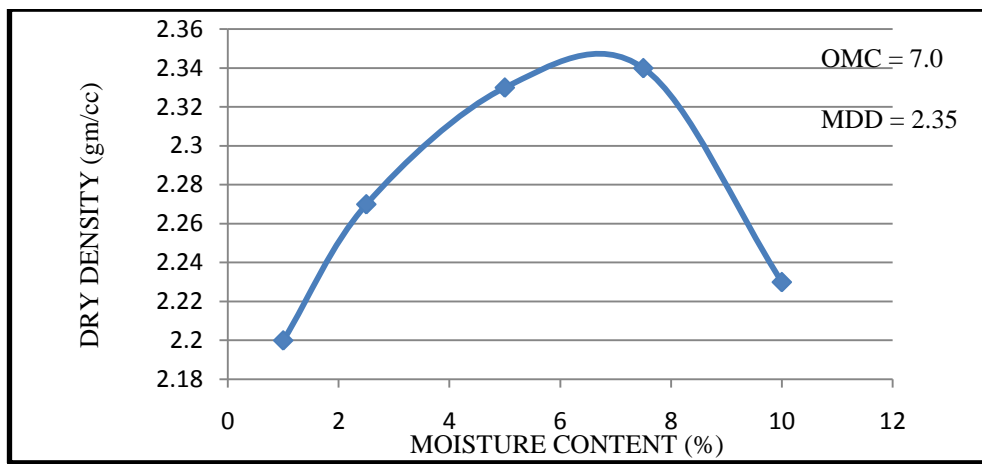


Figure 7: Graph showing variation in density with percentage of MgCl₂

B. California Bearing Ratio Test (C.B.R): (As per IS 2720-1990 (Part 31)):

Bearing Ratio (Generally known as C.B.R). The ratio of the force per unit area required to penetrate a soil mass with a standard circular piston at the rate of 1.25 mm/min to that required for corresponding penetration of a standard material. Experimental results are shown in below table 4.

Table 4: C.B.R value of normal soil

CBR value at	Un-soaked
OMC (10.0 %)	19.5%
CaCl ₂ (6.50 %)	24.0 %
MgCl ₂ (7.00 %)	23.0 %

C. Comparative results for Maximum Dry Density:

Comparing result of water, magnesium chloride and calcium chloride. Maximum dry density obtained high for calcium chloride in the following cases as shown below.

- a. Water : Soil (dust) +10 % water = 2.23gm/cc
- b. Calcium chloride : Soil (dust) +6.5% calcium chloride = 2.42gm/cc
- c. Magnesium chloride : Soil (dust) +7.0 % magnesium chloride = 2.35gm/cc

V. CONCLUSION

On the basis of the results obtained in the experimental investigation it is clear that The suppressants magnesium chloride and calcium chloride are both hygroscopic and deliquescent in nature, they attract moisture from air resulting in greater density values resulting a dust free roads. Chloride material are an effective dust abatement product, as well as

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a stabilization agent. Hence the use of suppressants likemagnesium chloride and calcium chloridereduces the environmental pollution and public health hazardous on human body.

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BIOGRAPHY

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