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Effect Of Iron Dust On Compaction And Compressive Strength Characteristics Of Soil

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Abstract:* Clayey soil is highly problematic soil that covers almost all regions in india. Soils with poor engineering properties were usually removed and replaced or design would be changed to suit the weak soil. This would often be expensive and time consuming. In this context, soil stabilization is an attractive alternative for its simplicity and economy. Commonly used stabilizers are cement and lime. But it is not easy to apply soil stabilization to cover a large area due to increased cost of stabilizers. Cost can be minimized by replacing certain portion with industrial wastes. In present work, the effect of iron dust on compaction and compressive strength properties of soil are studied. Iron dust which is mixed with soil at different percentage (0%, 2, 4, 6 and 8%) by weight of soil. The variations in compaction (omc and mdd) and compressive strength characteristics with respect to variations in percentage of iron dust are observed by conducting standard proctor test and unconfined compression test.

***Keywords:* soil stabilization, iron dust, omc (optimum moisture content), mdd (maximum dry density), ucs.**

I. INTRODUCTION

The long-run performance of any construction project depends on the soundness of the underlying soils. Unstable soils can cause significant problems for pavements or structures. Soil stabilization is a method of transforming a natural weak soil into a purpose engineered construction material. This is done by changing it physical, chemically, biologically, or combined methods. This technique makes improvement in the natural weak soil by increase its weight bearing capabilities, shear strength, prevention of shrinkage and swelling due to moisture and other environmental stimulus. Chemical stabilization involves the use of chemical agents for initiating reactions within the soil for modification of its geotechnical properties. Cement & lime stabilization have been the most common stabilization methods adopted for soil treatment. Lime stabilization is the preferred method of treatment for plastic clays but it is ineffective in sulphate-rich clays. Although portland cement has been the most commonly and widely used binder in ground improvement soil stabilization applications, the significant environmental impacts associated with the production of portland cement in terms of high energy consumption and carbon dioxide (co_2) emissions have encouraged the investigation and application of more sustainable options. Bituminous stabilization is also used for road surfacing all over the world but it causes energy loss during heating and hazardous emissions that have negative effect on the environment and human beings. There are some nontraditional chemical stabilizers now available in the market which may offer viable alternatives for stabilizing weak soils at reduced construction cost.

Due to rapid industrialization and urbanization more than 15 million tons of waste are released to the environment each year but only 200 tons are collected, transported and treated well and the rest of the waste from industrial zones is directly disposed without treatment. These industrial waste affect the environment very badly. Industrial waste causes air, soil and water pollution that are harmful to human beings. Among these industries, giants like iron and steel manufacturers stands chief due to numerous unit processes and operations creating air, water, land and noise pollution. Iron powder metallurgy has a rich heritage under the branch of powder metallurgy. The increasing amount of waste iron is one of the major environmental issues. One of the effective method for the disposal of these industrial wastes is it to use for soil stabilization. Thus soil stabilization using industrial waste materials has become trendy from the point of view of environment and economy.

In the current work weak soil is improved by using industrial waste iron dust as an admixture.

II. Literature Review

Arash barazesh et al. (2012) studied the effect of adding iron powder on atterberg limits of clay soils. In this research, iron powder combined with clay soils in order to examine its effects on the atterberg limits of the soils. Five different types of soil with initial plasticity indices of 26, 31, 35, 39, and 49 are used for this experiment. Plasticity indices (i.e. ll, pl, and pi) of the sample soils combined with different percentages of waste iron powder examined and compared with the plasticity of the original soils.

Khatate et al., (2017) studied the stabilization of black cotton soil by using iron dust. This study endeavor to use industrial waste material like electric arc furnace dust (eafd) iron dust and dolime fine for the soil improvement.

Pandit et al., (2018) studied the effect of iron dust on compaction characteristics of soil. Black cotton soil was mixed with iron dust at different percentage (0%, 1.5%, 3%, 4.5%, 6%) by weight of soil. Addition of iron dust in the soil from 0% to 3 %, omc increases and mdd decreases. Further addition of iron dust in the soil omc get decreased and mdd increased. Result concluded that optimum point of iron dust was 3%.

III. Objectives Of The Study

- to identify and classify the natural soil by performing laboratory experiments.
- to evaluate the effectiveness of industrial waste-iron dust as a soil stabilizer.
- to study the effect of iron dust on compaction and unconfined compressive strength characteristics of soil.
- to determine the optimum percentage of iron dust for the strength of soil.

IV. Materials Used

4.1 Soil

The soil used for this investigation was brought from attingal, trivandrum, kerala.
The properties of soil are shown in table 1.

Table 1. Soil properties

Property	Value
Natural moisture content	17%
Specific gravity	2.67
Clay fraction (is 2720 part 4)	54%
Silt fraction (is 2720 part 4)	38%
Sand fraction (is 2720 part 4)	8%
Liquid limit (is 2720 part 5)	33%
Plastic limit (is 2720 part 5)	19.5%
Shrinkage limit	29.83%
Optimum moisture content (is 2720 part 7)	24%
Maximum dry density (is 2720 part 7)	1.63g/cc
Ucc strength (is 2720 part 10)	67.67kn/m^2

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4.2 Additive – Iron Dust

Industrial waste iron dust was collected from gogga minerals and chemicals, hospet, karnataka. Chemical properties of iron dust are tabulated as follows.

Fig 1. Iron dust

Table 2. Properties of iron dust (source : from manufacturer)

Properties	Percentage (%)
Ferric oxide(fe2o3)	98.06
Silica (sio2)	0.27
Alumina (al2o3)	0.83
Sulphur (s)	0.008
Specific gravity	3.5

V. Methodology

Collected soil was loose, wet and it was pulverized manually by hammer. Soil was screened through the sieve of 4.75 mm aperture before preparing the specimens for testing and also oven dried the soil at 110˚c for 24 hours before using specimen. Iron dust was added to the soil at varying percentage of 2, 4, 6 and 8% by dry weight of the soil. Test conducted were proctor compaction test and unconfined compression test.

VI. Results and discussion

6.1 Effect of iron dust on compaction characteristics of soil

Compaction of soil with different proportions of iron dust was tested and results were obtained are shown below.

Replacement of iron dust in soil (%)	Omc (%)	Mdd (g/cc)
0	24	1.63
2	23.7	1.74
4	22.4	1.82
6	21.76	1.73
8	21.2	1.67

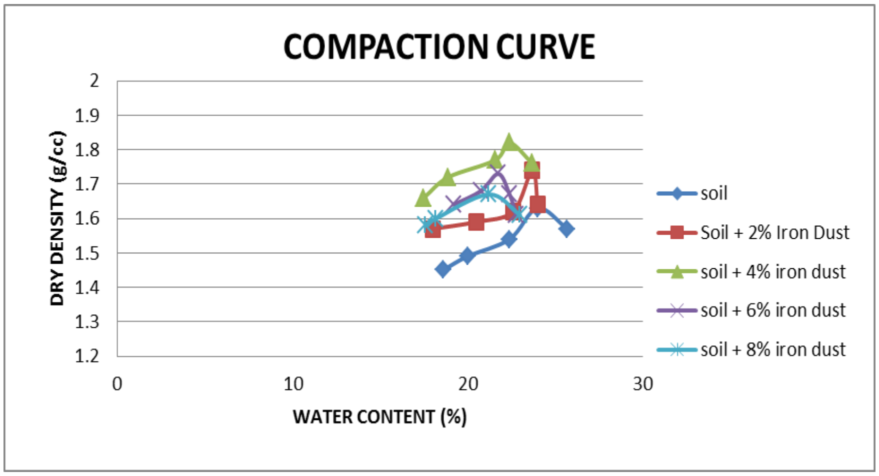

Fig 2. Variation of compaction characteristics of soil mixed with different percentage of iron dust

The optimum water content decreases from 24 to 21.2% when percentage of iron dust increases. Also the maximum dry density increases up to 4%. After 4%, further increase in iron dust decreases maximum dry density. The mdd obtained was 1.82g/cc.

1.1 Effect of iron dust on unconfined compressive strength of soil

Unconfined compressive strength of soil with different proportions of iron dust was tested and results were obtained are shown below.

Table 4. Value of ucs with variation in percentage of iron dust

Replacement of iron dust in soil (%)	Ucs (kn/m^2)
0	67.67
2	169.5
4	224.09
6	211.7
8	195.6

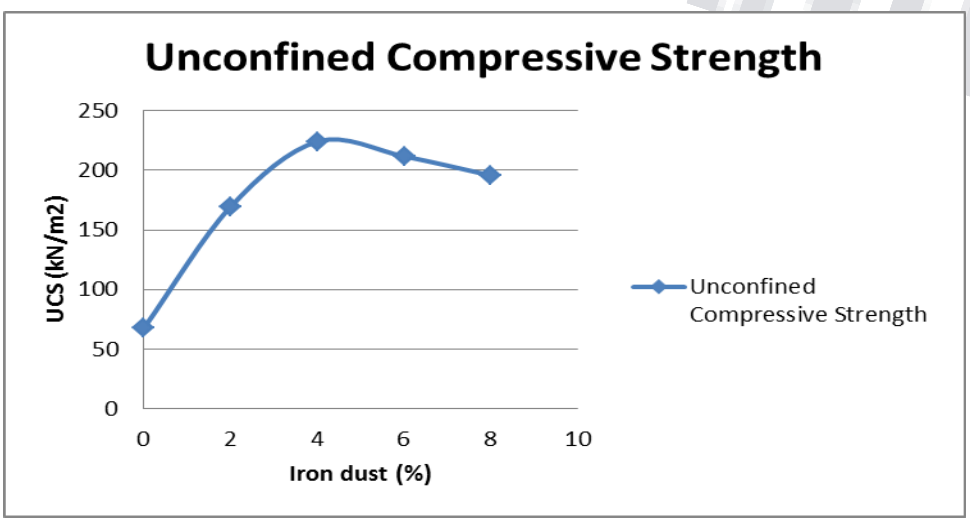

Fig 3. Variation of unconfined compressive strength characteristics of soil mixed with different percentage of iron dust

From the test results, the ucs value of soil increases from 67.67 to 224.09 kn/m^2 up to 4%. Further addition of iron dust decreases the strength of soil. The optimum percentage of iron dust required for maximum compressive strength of cl soil was 4%.

VII. Conclusions

The following conclusions are drawn from this study;

- Results indicate a decrease in omc with the increase in percentage of iron dust.
- Maximum dry density shows an increase up to 4% after that it gets decreases.
- Similarly ucs value increased till 4% replacement of iron dust and decreased further.
- Optimum percentage of iron dust that gives maximum dry density and strength in cl soil was 4%.

The primary benefits of using iron dust for soil stabilization are cost savings and availability. Also this reduce the environmental impact due to the disposal of industrial waste iron dust.

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