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ANALYSIS THE EFFECT OF STUBLLE BURING ON THE ENGINEERING PROPERTIES OF THE SOIL

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ABSTRACT
Stubble burning in northern India, particularly in Punjab, Haryana, and Rajasthan, poses significant engineering challenges. The practice, driven by the difficulty of storing paddy stubble, results in substantial air pollution that forms smog, impacting large regions including Delhi. From an engineering perspective, stubble burning severely affects soil properties: it increases carbon, nitrogen, and sulfur levels, leading to reduced soil fertility and altered physical characteristics. The burning process results in higher bulk density and soil compaction while decreasing porosity and adhesion between soil particles. These changes impair the soil's structural integrity, affecting its compaction, permeability, and overall engineering properties. Consequently, repeated stubble burning contributes to soil degradation, reduced agricultural productivity, and long-term challenges in soil management and land use.

KEYWORDS:- Soil, Stubble Burning, strength

I. INTRODUCTION

Stubble burning is a major problem in northern India purposely in Punjab, Haryana and Rajasthan. After harvest of wheat and paddy crop, big amount of scum is left known as stubble, is too difficult to store by farmers. Stubble generate from wheat crop is practically useful to farmers since they are used mainly for animal nourish therefore stored by them for elongated time. But in case of paddy crop stubble, it becomes a frantic task that can be stored for longer time. Due to this, farmers desire to burn stubble than to store. It becomes a day-to-day practice for farmers and for their own expediency they keep burning without ensuring that it pollutes the whole environment.

The stubble burning has put the state government as well as the central government in deep thoughts. The smoke from the fields comes in contact with the air and forms a haze which collectively moves towards the south and affects the entire region of North India including Delhi. Sometimes it becomes very difficult to breathe and the public is forced to use breathing masks to avoid the entry of toxic gas into their lungs. Breathing such gaseous air is equivalent to smoking ten cigarettes at a time, the study said. The concern does not prohibit environmental degradation, but has led geologists to think about issues related to low fertility and drastic changes in the engineering properties of soils. To find out the major changes in the engineering properties, this issue has been taken up.

II. MATERIALS

The area used in this study Mari Kamboke is a village in Bhikhiwind-13 tehsil, Tarn Taran district, Punjab, India. It is located 3 km towards west from district headquarters Tarn Taran Sahib, 7 km from Bhikhiwind, 253 km from state capitals Chandigarh, 500 km from national capital Delhi, 74 km from National Highway (NH-15), 9 km from State Highway (SH) Amritsar. There is no railway station in less than 10 km near Mari Kamboke. The reason behind choosing this area is that a large amount of stubble is left in the harvesting of the paddy crop. It is very difficult for farmers to store it. That is why farmers prefer to burn stubble than shop. Farmers in this region do not have good resources and equipment to handle stubble. So in the end they have only the last resort of stubble burning which causes a lot of damage to the soil. In this area two method of stubble burning is used. Those two methods are listed below.

- Cutting the stubble with reaper (machine) from the ground level
- Cutting the paddy crop plant from half the length during harvesting.

III. METHODOLOGY

A) Processing of Soil Samples

Soil in sufficient amount was brought from local village. Wooden hammer was used to pulverize soil to break lumps and was dried in air under covered area. The dried soil was sieved through 2.25mm sieve and was mixed thoroughly and was then stored in polythene bags. Required quantity of soil was taken from polythene bags and was dried in oven at 105℃ ± 5℃ for 24 hours. The soil was allowed to cool at room temperature. Hydrated lime and sodium silicate powder were taken lumps were broken by the use of wooden hammer and sieved through 2.35mm IS sieve. The several tests that have been performed, details of equipment's used and a variety of tests have been described in detail in the following sections

B) Tests Executed on Sub-Grade Soil

a) Liquid limit test

b) Plastic limit test

c) Sieve Analysis

d) Specific Gravity Test

e) Standard Proctor Compaction Test for determination of Optimum Moisture

Content (O.M.C) and Maximum Dry Density (MDD)

a) Liquid Limit Test

The water content in a soil at which it behaves almost as a liquid, but possesses almost zero shear strength is called as the liquid limit of that soil. It flows to join the cut portion in just 25 no. of blows in Casagrande's liquid limit apparatus.

b) Plastic Limit Test

Plastic limit of soil is determined by Plastic limit test as per IS: 2720 (Part 5) – 1985.The plastic limit of cohesive soil is the amount of moisture content of the soil below which plasticity disappears. It starts to crack when rolled into thin threads of 3mm dia. The method to obtain the plastic limit is given as under: Procedure to Determine Plastic Limit: Consider about 20gm of the soil and add a small amount of water in the soil, mix it thoroughly.

Now after mixing, on a glass plate roll the soil with fingers. The rate of rolling is kept in the range of 85 to 95 strokes / minute to obtain 3mm diameter.

If without any crumbles on soil, the diameter of the threads can be reduced up to smaller than 3mm, it means that the moisture content is higher than the plastic limit. Mold the soil sample to reduce the moisture content and again roll it into a thread. Repeat kneading and rolling alternately till the thread crumbles. The crumbled soil thread collected and holds the pieces in the pan used to obtain the water content. Continue the procedure for at least two times using fresh soil samples every time.

c) Sieve Analysis

The gradation of soil was performed on the soil sample. Small lumps were there but it was broken with the help of wooden hammer. A set of sieves was arranged with largest size sieve on the top and the smallest size sieve at the bottom. The soil was passed through different mm I.S sieves like 4.75mm, 2.36mm, 1.18mm, 600µ, 300µ, 150µ, 75µ. A pan was placed under the stack of I.S sieves for the collection of passed soils. The stack of I.S sieves was shaken with the help of sieve shaker for about 12 minutes. Weights of the soil retained on all the I.S sieves were accurately measured.

d) Specific Gravity Test

The mass of a unit volume of soil at a given temperature divided by the mass of the same volume of gas-free distilled water at the same temperature is known as specific gravity. In the phase relationship of air, water, and solids in a given volume of soil, the specific gravity of the soil is utilized. The test was carried out by Pycnometer as per IS 2720 Part 3 (1980). The Specific Gravity of quartz-rich soils can be calculated to be around 2.65, whereas silty and clayey soils can range from 2.6 to 2.9.

e) Proctor test

Height adjusts on top of the mould and detachable bottom is used. The rammer utilized in this test weighs 2.6 kg with a fall of 310 mm and it has50mm face dia.

About 2.55 kg of oven-dried soil sample was held. Sample was blended uniformly with almost 9% of distilled water by mass. Sample (soil water mix) was kept in an air sealed container for almost 10 hours. The mould was wiped clean and dry, greased very lightly. The empty mould was weighed after being attached. The mould being attached to the collar is filled with soil sample in such a way that after compaction by rammer with 25 evenly distributed blows. Height is about one-third. The upper of the first layer was scratched by a knife and then compacting the second layer. The procedure is repeated for second and third layers.

Remove the collar of the mould, extra soil was trimmed off using the help of straight knife. The soil sample with mould and bottom plate was weighed A representative sample from the centre of the compacted soil specimen was drawn out for its moisture content estimation. Procedure was continued 5-7 times, after 2%increase in moisture quantity than the previous one till a decrease or no change in the weight of moist compacted soil in the mould found. Dry density and Moisture content was estimated for every set and then graph gives the OMC and MDD. The steps were continued for estimating optimum water content and maximum dry density of sample of soil-lime mix and soil-lime-sodium silicate mix.

IV. RESULTS

1. Result of Plasticity Index

Plasticity index is the difference of liquid limit and plastic limit

Table 1 Plasticity index result area 1, 2 and 3 before stubble burning

AREA	LIQUID LIMIT (LL)	PLASTIC LIMIT (P.L)	PLASTICITY INDEX
1	22.5	20	2.5
2	20	14.28	5.72
3	22.5	17.64	4.86

Table 2 Plasticity index result area 1, 2 and 3 after stubble burning

AREA	LIQUID LIMIT (LL)	PLASTIC LIMIT (P.L)	PLASTICITY INDEX
1	22.5	20	2.5
2	20	14.28	5.72
3	22.5	17.64	4.86

2. Result of Specific Gravity

Specific gravity tests were performed on three areas before and after stubble burning. Using 200gm of soil with one sample test was performed on 1 area.

Table 3 Specific gravity test result area 1, 2 and 3 before stubble burning

AREA	Mass of empty pycnometer (M1) (grams)	Mass of pycnometer and dry soil (M2) (grams)	Mass of pycnometer, soil, water(M3) (grams)	Mass of pycnometer and water(M4) (grams)	Specific gravity M2-M1/(M2-M1)-(M3M4)
1	632	849	929	805	2.33
2	632	847	930	790	2.59
3	632	828	926	798	2.882

Table 4 Specific gravity test result area 1,2 and 3 after stubble burning

AREA	Mass of empty pycnometer (M1) (grams)	Mass of pycnometer and dry soil (M2) (grams)	Mass of pycnometer, soil, water(M3) (grams)	Mass of pycnometer and water(M4) (grams)	Specific gravity M2-M1/(M2-M1)-(M3M4)
1	632	836	900	796	2.04
2	632	847	932	811	2.287
3	632	831	911	782	2.8428

3. Result of Optimum Moisture Content

Optimum moisture content test were performed on 3 areas before and after stubble burning. Using 20 gram of soil with one sample test was performed on an area.

Table 5 Results of the optimum moisture content of the study areas

AREA	BEFORE	AFTER
1	17.64	11.11
2	11.11	10.31
3	14.79	12.23
Average	14.51	11.22

Table 6 Average result of the index properties for three areas after stubble burning

AREA	SPECIFIC GRAVITY	MC in %	TIC LIMIT in %	LIQUID LIMIT In %
1	2.04	11.11	15.38	20

2	2.287	10.31	11.11	19.5
3	2.842	12.23	15.83	18.5
Average	2.37	11.22	14.11	19.33

4. Result of Sieve Analysis Test

Sieve analysis tests were conducted in 3 areas before and after stubble burning. 1.00 kg of soil was used with a sample test on 1 area.

Table 7 Results of the Uniformity Coefficient of the study areas before and after stubble burning

AREA	Uniformity Coefficient before stubble burning	Uniformity Coefficient after stubble burning
1	22.5	11.82
2	7.56	16.9
3	15.56	13.1
Average	15.20	13.94

Table 8 Results of the Coefficient of Curvature of the study area before and after stubble burnings

AREA	Coefficient of Curvature before stubble burning	Coefficient of Curvature after stubble burning
1	0.001	0.0086
	0.0076	0.02
3	0.041	0.006
Average	0.016534	0.011534

Table 9 Average results of the Dry density of the study area before and after stubble burning

AREA	BEFORE	AFTER
1.	24.03 KN/m3	23.13 KN/m3
2.	24.034 KN/m3	22.89 KN/m3
3.	23.83 KN/m3	23.02 KN/m3
Average	23.96 KN/m3	23.01 KN/m3

5. Result of Direct Shear Test

Direct shear test were performed on 3 areas before and after stubble burning. Three sample tests were performed on each area.

Table 10 Average Results of the direct shear test results of Cohesion of soil before and stubble burning in all study area

AREA	Cohesion of soil before stubble burning	Cohesion of soil after stubble burning
1.	51.23 KN/m2	46.8 KN/m2

2.	56 KN/m2	49.4 KN/m2
3.	51.2 KN/m2	45.2 KN/m2
Average	52.81 KN/m2	47.13 KN/m2

Table 11 Results of the direct shear test results of Angle of internal friction of soil before and after stubble burning in all study area

AREA	Angle of internal friction before stubble burning	Angle of internal friction after stubble burning
1.	290	300
2.	26.50	27.30
3.	27.60	28.30
Average	27.70	28.530

6. Result of Unconfined Compression Test

Unconfined compression tests were performed on 3 areas before and after stubble burning. Three samples were prepared to perform test on each area.

Table 12 Average Results of the Unconfined compression test shows result of Compressive stress of soil before and stubble burning in all study area

AREA	BEFORE	AFTER
1.	55.7 Kn/m^2	52.4 Kn/m^2
2.	55.7 Kn/m^2	54 Kn/m^2
3.	55 Kn/m^2	52.4 Kn/m^2
Average	55.4 Kn/m^2	52.9 Kn/m^2

CONCLUSIONS

It is clear to predict from the graphs before and after the burning that the burning hardly has any effect on the specific gravity of the soil samples. Similar characteristic properties are found in the case of optimal moisture content, but surprisingly after burning there is a significant change in the plastic limit as well as the liquid limit. An interesting fact about the liquid limit is that there are different values before stubble burning, but in the case of post-burning all the three samples show almost similar values. The analysis of the sieve size of the samples is very interesting to note. The two graphs do not have much variation in the beginning, but later they vary a lot, but at a later stage the graphs keep converging. This index reflects the more or less clinical status of the properties. Ultimately it can be concluded that the stubble condition of the index properties. Ultimately it can be concluded that stubble burning does not have much impact on the index properties, but the results are quite remarkable and typical for a marginal decline.

Engineering Properties

Engineering properties are taken into account; from the results it can be clearly shown that the dry density and the cohesion of the soil decrease while the angle of internal friction between the soil particles increases. Samples from all three locations show an increase in shear stress when the normal pressure on the soil increases. Despite informing farmers about the degradation of soil characteristics, it has become a social issue where farmers need to be educated about the ill-effects of stubble burning. Geologists need to remain fascinated about this kind of degradation of soil characteristics that can create a barrier when a structure needs to be designed.

REFERENCES

1. IS 2720: PART X: 1991, Determination of unconfined compressive strength
2. IS 2720: PART XIII: 1986, Determination of direct shear test
3. Zihmas S.G. Understanding the effects of high temperature process on the engineering properties of soil(2013),pp.3427-3430
4. EiEi Mon, ShoichiroHamamotoTemperatureffcts on geotechnical properties of kaolin clay simultaneous measurement of consolidation characteristics, shear stiffeneces and permeability using a modified oedometer(2013), vol-1,pp.1-10
5. Nguyen Song Tung , impact of rice straw methods on soil temperature and microorganism distribution in the paddy soil ecosystem (2014),vol-9,pp.157-160
6. G. S. Eldiabani , W. H.G. Hale,C. P. Heron(2014):- the effect of forest fire on physical properties and magnetic suceptibility of arid soil(2014), vol-8,pp.54-60
7. Boyer, D.E. and Dell , J.D. Fire effects on pacific Northwest Forest Soils.WM 04
8. Arocena, J.M. and opio,C.(20030 Prescribed fire- induced changes in properties of subboreal forest soils.vol-113,pp.1-16
9. Boyer, D.E. and Dell , J.D. Fire effects on pacific Northwest Forest Soils.WM 040 1980
10. Onwuka, B.M., effect of soil temperature on some soil properties and plant growth
11. (2016),vol-6(3),pp.89-93
12. Goforth, B.R. Spatial distribution and properties of ash and thermally altered soils after high-severityforestfire,vol-14 ,pp. 34