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RESEARCH ARTICLE OPEN ACCESS

An Experimental Study on Physical Characterization of Black Cotton Soil by using Non Destructive Testing Method

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Abstract:

Clayey soil is known for its high swell potential and low shear strength. Ultrasonic pulse velocity test was performed on compacted clayey soil while studying experimentally, the relationship between Velocity, Max. dry density, Optimum Moisture content, Time with varying percentage of admixtures. The soil sample was collected from Davanagere and addition to that, different percentages of admixture was added to find the variation in its density. In this paper density was determined by Standard proctor test and for the sample Ultrasonic pulse velocity test was conducted to determine p-waves. This method is fast and simple approach for determining the characteristics of compacted stabilized soil. This is a non destructive method used as an alternative to existing methods to analyse laboratory or semi field compacted soils. The empirical equations proposed in this study for predicting density, water content, velocity is encouraging.

Keywords — Ultrasonic Pulse Velocity, Wave Velocity, Water Content, Maximum Dry Density.

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I. INTRODUCTION

Soil is one of the most important material in civil engineering works. To determine the index and engineering properties of soil mostly destructive tests such as sand replacement and core cutter methods are used. These methods are tedious and time consuming and are often responsible to stop the construction. Hence in order to avoid this, non destructive test i.e. Ultrasonic pulse velocity is used in this study.

Some of the Non destructive tests are nuclear density test, electrical resistivity and cone penetration test. Though these methods are not popular as conventional methods of testing. Soil are compacted insitu for different engineering works such as cambers, embankments, pavements etc

II. MATERIALS

The materials used in this experimental work are Black cotton soil and GGBS.

Soil: The soil used in this work is black cotton soil and was collected from Davanagere.

Fig1 Black cotton soil

GGBS (Ground Granulated Blast Furnace Slag): GGBS was collected from JSW, Peenya, Bengaluru.

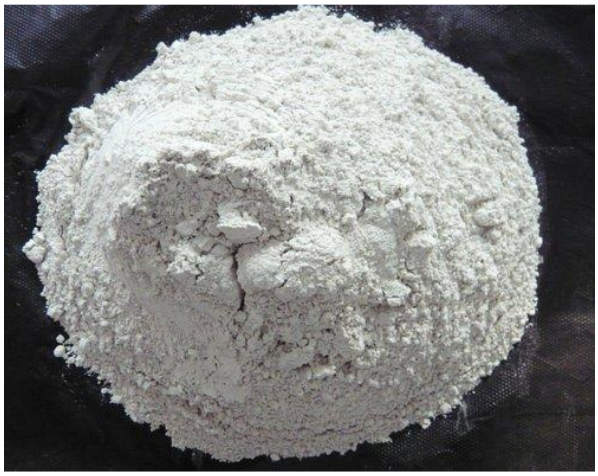

Fig2 GGBS(Ground Granulated Blast Furnace Slag)

For varying percentages of GGBS, slabs were casted with black cotton soil. The slab size was 650mm *350mm*150mm.

III. ULTRASONIC PULSE VELOCITY (UPV)

Ultrasonic pulse velocity is a non destructive test which saves the time and is easier when compared to other methods of testing. In Ultrasonic testing, an ultrasound transducer is connected to a diagnostic machine and is passed over the specimen being tested. In this testing there are two methods of receiving the ultrasound waveform: Reflection and Attenuation. In reflection mode, the transducer performs the sending and receiving of pulsed waves. In attenuation mode, the transducer sends the ultrasound through one surface and a separate receiver detects the amount that has reached it on another surface after passing through the specimen.

Fig3 Ultrasonic Pulse Velocity Instrument

Capabilities of UPV in soil:

1. The study between velocity and water content in silty clay can be determined
2. The wave propagation in dry, partially saturated and saturated sand can be studied.
3. The relationship between pulse velocity and compaction density can be determined.
4. The feasibility of determining the strength of soil by pulse velocity can be studied.
5. Various parameters such as velocity, water content, dry density, time and strength can be correlated.

IV. RESULTS AND DISCUSSIONS

In this study soil specimen were tested and pulse velocities were measured by direct transmission method.

TABLE 1
DATA ACQUISITION

% OF GGBS	WATER CONTENT (%)	MDD (g/cc)	VELOCITY (m/sec)	TIME (micro secs)
	13	1.56	578	475
	13.5	1.57	579.5	473.5
0%	14	1.58	581	472
	14.5	1.59	584.75	469
	15	1.6	588.5	466
	15.5	1.61	592.25	463
	16	1.62	596	460
	16.5	1.61	597.75	458.75
	17	1.63	599.5	457.5
	17.5	1.635	601.25	456.25
	18	1.64	603	455
	18.5	1.647	606	453
	19	1.655	609	451
	19.5	1.662	612	449
	20	1.67	615	447
	20.5	1.665	613	448.25
	21	1.66	611	449.5
	21.5	1.655	609	450.75
	22	1.65	607	452
	22.5	1.645	604.25	454
	23	1.64	601.5	456
	23.5	1.65	600	457
	24	1.655	598.5	457.5
	13	1.61	600	470

	13.5	1.615	601	469
5	14	1.62	602	468
	14.5	1.632	606.75	464.25
	15	1.645	611.5	460.5
	15.5	1.657	616.25	456.75
	16	1.67	621	453
	16.5	1.672	622	452.5
	17	1.675	623	452
	17.5	1.677	624	451.5
	18	1.68	625	451
	18.5	1.675	623	452.25
	19	1.67	621	453.5
	19.5	1.665	619	454.75
	20	1.66	617	456
	20.5	1.652	614.25	458.25
	21	1.645	611.5	460.5
	21.5	1.637	608.75	462.75
	22	1.63	606	465
	22.5	1.631	605	466.5
	23	1.632	604	468
	13	1.64	840	348
	13.5	1.645	841.5	347
10	14	1.65	843	346
	14.5	1.66	848	344
	15	1.67	853	342
	15.5	1.68	858	340
	16	1.69	863	338
	16.5	1.695	865.75	337
	17	1.7	868.5	336
	17.5	1.705	871.25	335
	18	1.71	874	334
	18.5	1.702	870	335.5
	19	1.695	866	337
	19.5	1.687	862	338.5
	20	1.68	858	340
	20.5	1.675	855.5	341
	21	1.67	853	342
	21.5	1.665	850.5	343
	22	1.66	848	344
	22.5	1.655	846.5	345
	23	1.65	845	346

	13	1.68	870	263
	13.5	1.685	875.5	262
15	14	1.69	881	261
	14.5	1.702	887.5	259
	15	1.715	894	257
	15.5	1.727	900.5	255
	16	1.74	907	253
	16.5	1.75	912.25	251.75
	17	1.76	917.5	250.5
	17.5	1.77	922.75	249.25
	18	1.78	928	248
	18.5	1.767	921.25	249.75
	19	1.755	914.5	251.5
	19.5	1.742	907.75	253.25
	20	1.73	901	255
	20.5	1.725	898.5	255.75
	21	1.72	896	256.5
	21.5	1.715	893.5	257.25
	22	1.71	891	258
	22.5	1.705	888	259
	23	1.7	885	260
	13	1.7	950	195
	13.5	1.705	958.5	193.5
20	14	1.71	967	192
	14.5	1.722	974.25	190.75
	15	1.735	981.5	189.5
	15.5	1.747	988.75	188.25
	16	1.76	996	187
	16.5	1.767	1000.25	186.25
	17	1.775	1004.5	185.5
	17.5	1.782	1008.75	184.75
	18	1.79	1013	184
	18.5	1.785	1010	184.5
	19	1.78	1007	185
	19.5	1.775	1004	185.5
	20	1.77	1001	186
	20.5	1.762	996.75	186.75
	21	1.755	992.5	187.5
	21.5	1.747	988.25	188.25
	22	1.74	984	189

	22.5	1.735	982	191
	23	1.73	980	193
	13	1.76	1075	140
	13.5	1.77	1078	139.5
25	14	1.78	1081	139
	14.5	1.787	1085.75	138.5
	15	1.795	1090.5	138
	15.5	1.802	1095.25	137.5
	16	1.81	1100	137
	16.5	1.805	1096.75	137.25
	17	1.8	1093.5	137.5
	17.5	1.795	1090.25	137.75
	18	1.79	1087	138
	18.5	1.78	1081	138.75
	19	1.77	1075	139.5
	19.5	1.76	1069	140.25
	20	1.75	1063	141
	20.5	1.747	1057.5	143
	21	1.745	1052	145
	21.5	1.737	1048.5	146.5
	22	1.73	1045	148
	22.5	1.725	1037.5	149
	23	1.72	1030	150

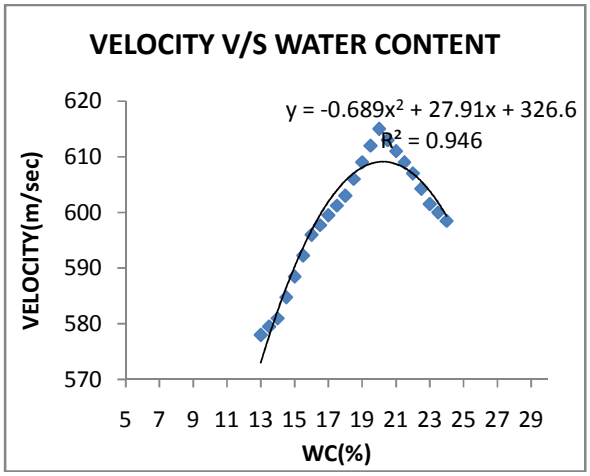

Fig5 Variation of Velocity with water content

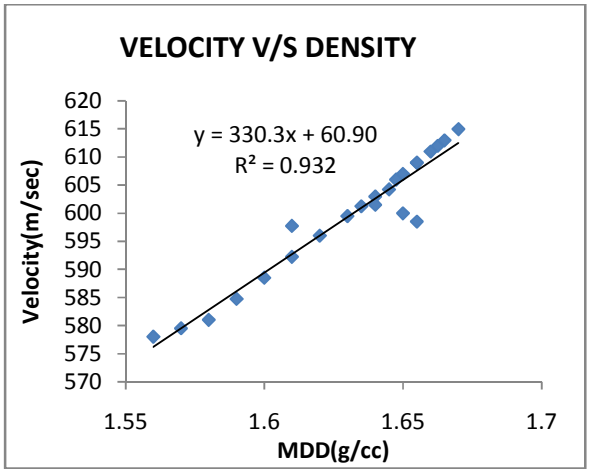

Fig6 Variation of Velocity with Density

DEVELOPMENT OF CALIBRATION CURVES

1) FOR 0% GGBS:

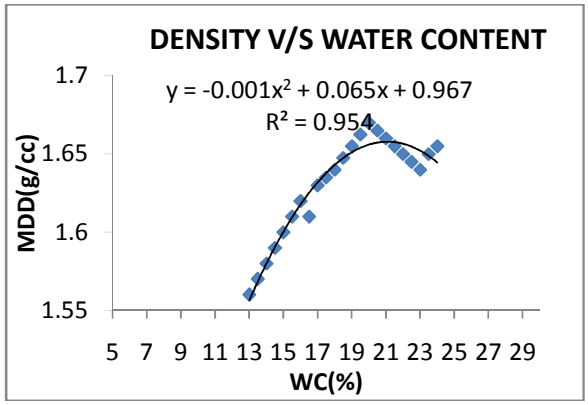

Fig4 Variation of Density with water content

2)FOR 5% GGBS:

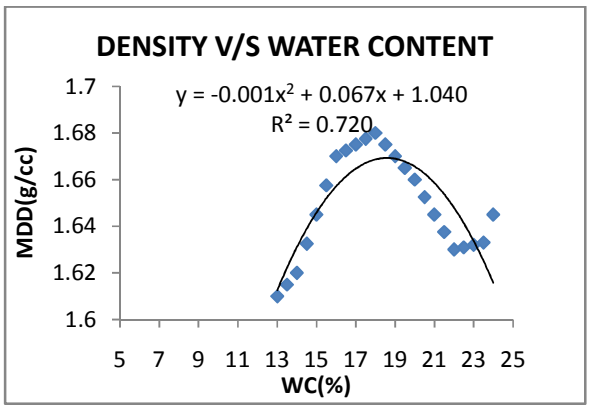

Fig7 Variation of Density with water content

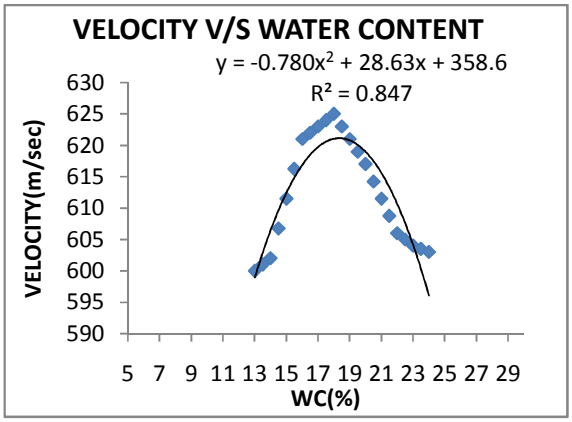

Fig8 Variation of Velocity with water content

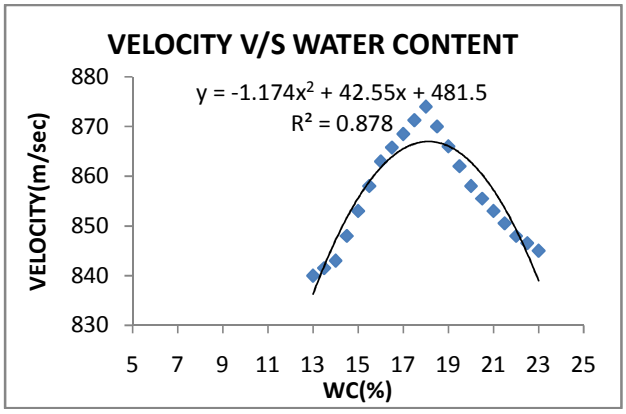

Fig11 Variation of Velocity with water content

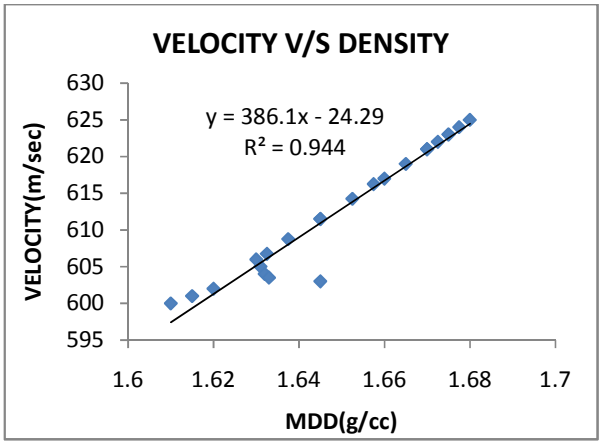

Fig9 Variation of Velocity with Density

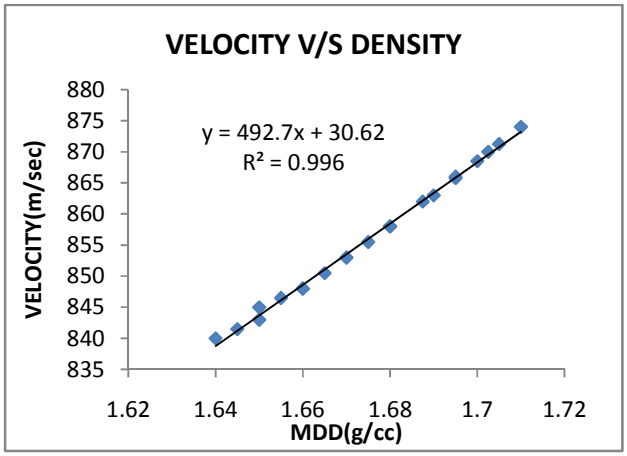

Fig12 Variation of Velocity with Density

3)FOR 10% GGBS:

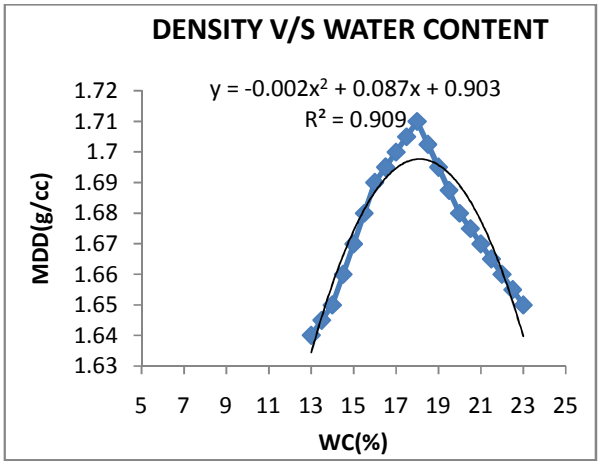

Fig10 Variation of Density with water content

4)FOR 15% GGBS:

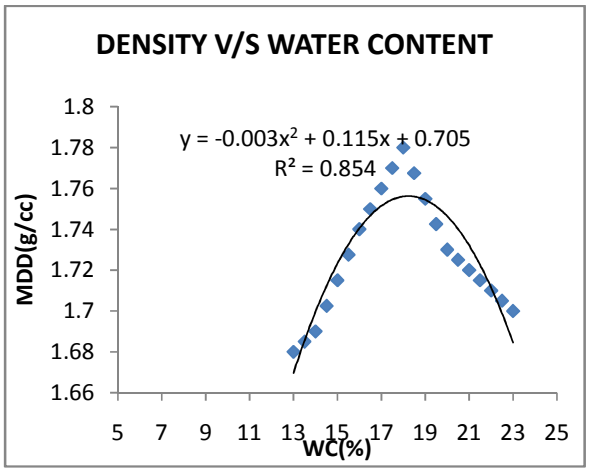

Fig13 Variation of Density with water content

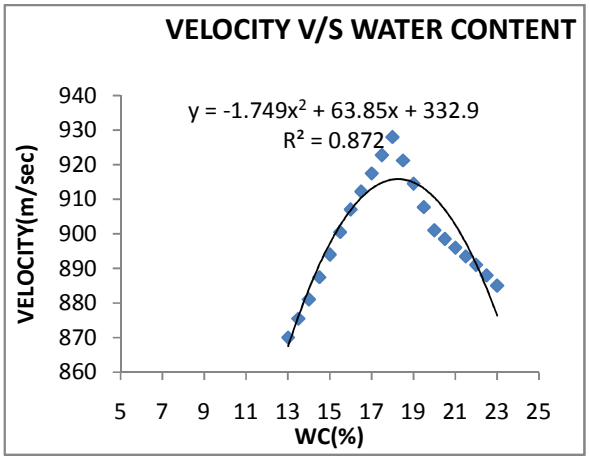

Fig14 Variation of Velocity with water content

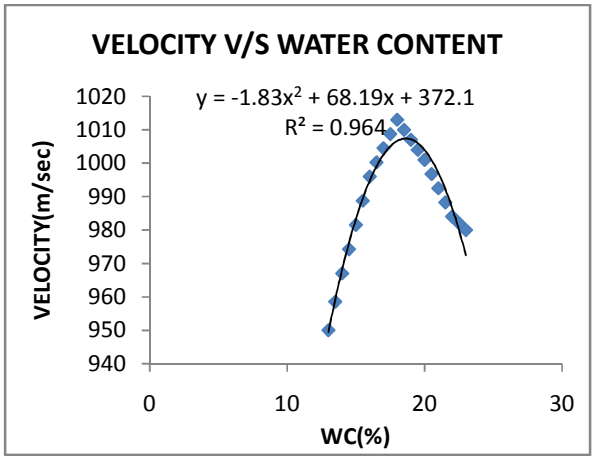

Fig17 Variation of Velocity with water content

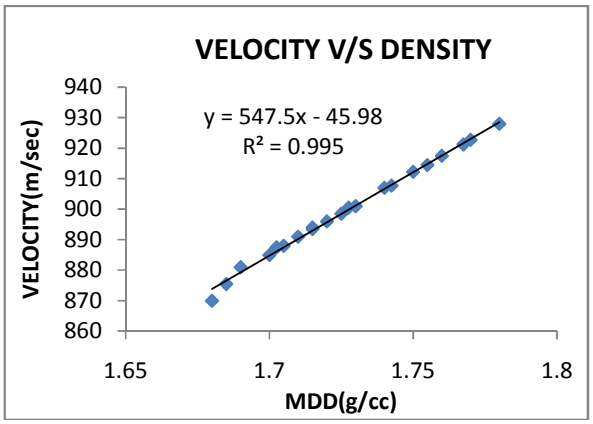

Fig15 Variation of Velocity with Density

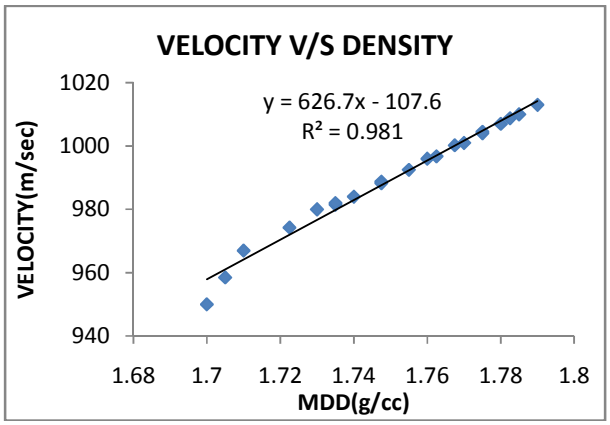

Fig18 Variation of Velocity with Density

5)FOR 20% GGBS:

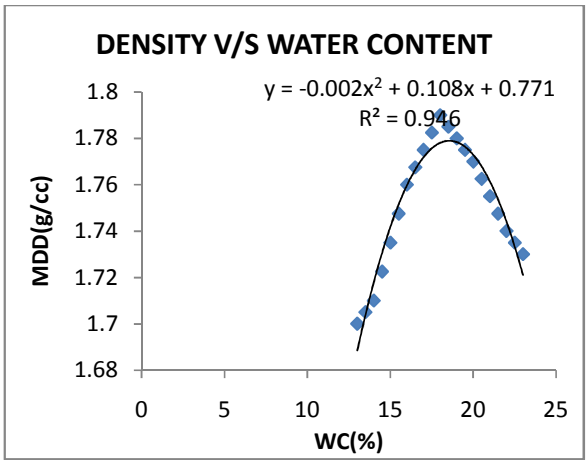

Fig16 Variation of Density with water content

6)FOR 25% GGBS:

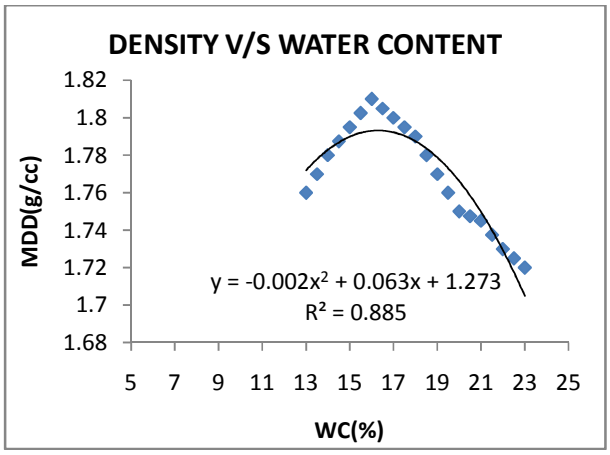

Fig19 Variation of Velocity with water content

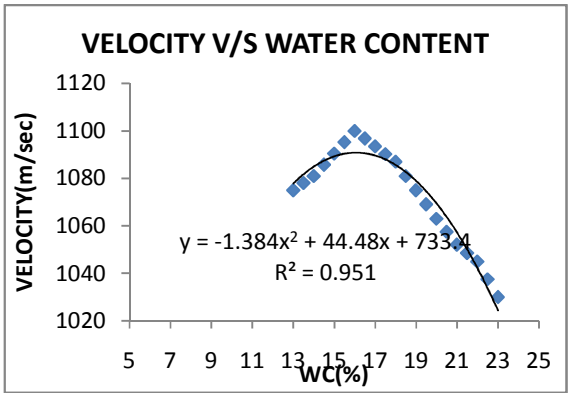

Fig20 Variation of Velocity with water content

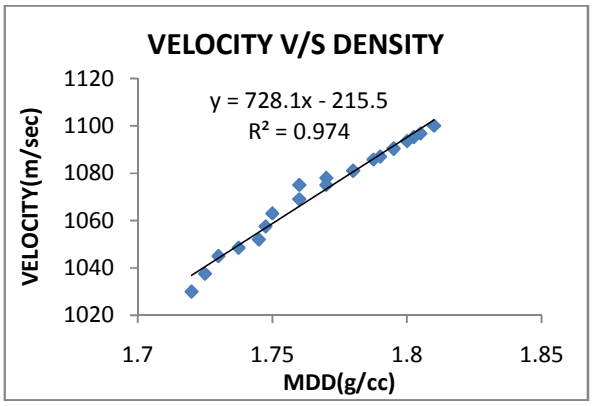

Fig21 Variation of Velocity with Density

V. CONCLUSIONS

The points concluded by this study are as follows:

1. Maximum dry density, Water content, Velocity and time are the various parameters found in this study.
2. The relation between three parameters were analyzed.ie. Relationship between a) Density V/S Water content b) Velocity V/S Water content c) Velocity V/S Density.
3. For the soil used, the velocity increased with increase in density.
4. The velocity increased with increase in water content till optimum moisture content and then decreased.
5. The density increased with increase in water content till optimum moisture content and then decreased.

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