

STABILIZATION OF BLACK COTTON SOIL BY USING BIO-ENZYMES FOR PAVEMENT CONSTRUCTION

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Abstract: Bio-enzyme is a natural, non-toxic, non-flammable liquid. It is fermented from vegetable extracts that improves geo-technical properties of black cotton soil. In this thesis work online purchased black cotton soil was mixed with bio-enzyme (terrazyme) with different dosages of 250ml/2m³, 250ml/1.5m³, 250ml/1.0m³ and 250ml/0.5m³ respectively and subjected to various tests after the curing period of 0, 7, 14, 21 and 28 days in order to get idea how much strength is improved. The CBR Test (both in soaked and un-soaked conditions) and Unconfined compression Test were performed for un-treated soil and enzymatic soil and test results were tabulated. The experimental results shows that terrazyme stabilization improves the strength of the black cotton soil upto great extent. With increase in percentage of terrazyme and days of curing, unconfined compression strength values of the soil increased from 40.25% to 73.33% with dosage of 250ml/2m³ to 250ml/0.5m³, respectively for curing period of 28 days. Also with increasing in percentage of terrazyme, the unsoaked CBR value was increased from 5.45 to 8.35 that is 53.21% after curing period of 28 days.

Keywords: CBR, Terrazyme, Stabilization, MDD.

1. Introduction

With the urbanisation of India, construction of Highways on black cotton soils becoming a challenge day by day for civil Engineers. This challenge was initial faced by Engineers after stabilization of soil with lime, jute fibre, cement, bitumen. Stone dust etc. But these traditional soil stabilizers becoming now very expensive. This scenario has led to an urgent need for identification and introducing new materials to improve the roads performance and to keep the cost at an affordable level. In this respect different types of stabilizers ranging from inorganic to organic have now been tried in laboratory and in field to evaluate their suitability as soil stabilizer. Recently bio-enzymes (Terrazyme) have emerged as a new chemical for soil stabilization.

1.1 Properties of Black Cotton Soil:

Characteristics:

- A typical black soil is highly argillaceous [Geology (of rocks or sediment) consisting of or containing clay] with a large clay factor, 62 per cent or more.
- In general, black soils of uplands are of low fertility while those in the valleys are very fertile.
- The black soil is highly retentive of moisture. It swells greatly on accumulating moisture. Strenuous effort is required to work on such soil in rainy season as it gets very sticky.
- In summer, the moisture evaporates, the soil shrinks and is seamed with broad and deep cracks. The lower layers can still retain moisture. The cracks permits oxygenation of the soil to sufficient depths and the soil has extraordinary fertility.

1.2 Objectives of present study

1. To study the experimental outcome by doing various bio-enzymatic soil stabilization tests.
2. To study the effect of bio-enzyme on geotechnical properties of black cotton soil.
3. To optimize the quantity of terra-zyme dozes to be used as stabilizing agent.
4. To develop suitable specifications and recommendations for evolving the proportions for its use in Highway constructions in India.

2. Literature Review

2.1 P Jenith at ol.(2017) have done an examination investigation of bio-catalyst on black cotton soil as a parkway material. In this test study, a preliminary advance must be taken to balance out the dark cotton soil for the development of streets and structures. In this investigation, quality of the Untreated dark cotton soil and Enzymatic soil (Ecozyme + dark cotton soil) are tried after the relieving time of 0days, 7days, 14days, 21days and 28days for different Ecozyme measurements of 200ml/3m³, 200ml/2.5m³, 200ml/2m³, 200ml/1.5m³. The different tests, for example, Preliminary test, Compaction test, Unconfined Compression Test (UCC), Soaked and Unsoaked California Bearing Ratio (CBR) test are performed for both parent soil and Enzymatic soil and furthermore test results are classified.

2.2 Priyanka at ol.(june-2016):- has done research center examination on dark cotton soil and furthermore on red soil with bio-protein as a dirt stabilizer. They have concentrated how to enhance geotechnical properties of soil. The gathered soil tests were treated with the financially accessible Enzyme and were restored for 7, 14 and 21days separately. The aftereffects of Consistency limits, Compaction test, Free swell record (FSI), Unconfined Compressive Strength (UCS and California Bearing Ratio (CBR) of untreated soils are introduced in this work.

2.3 Brajesh Mishra (2015):- has done a concise report on building conduct of dark cotton soil (BCS) and adjustment of dark cotton soil with lime as a stabilizer, based on his work and trial examinations it was seen that the record properties of dark cotton

soil successfully improved by utilization of various level of lime substance. In this exploration work he changing rate (3% and 5%) of lime used to balance out the dark cotton soil.

3. Materials and Methodology

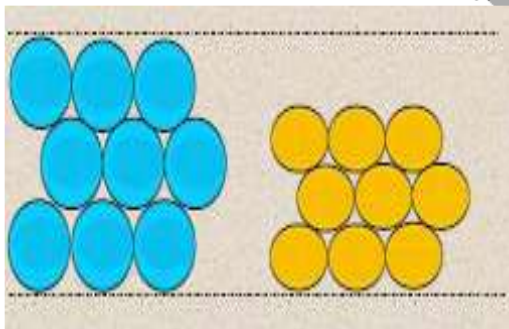
First I have collected black cotton soil which I have purchased online from Madhya Pradesh through Indiamart, as black cotton soil is not easily available in our region. After that I have done sieve analysis of the said soil. Then I have brought some quantity of bio-enzyme (Terrazyme) from market. Then I have made various samples, some samples I had kept untreated and remaining samples I had mixed with different quantities of terrazyme. After that the remaining samples of soil I had mixed with 4 different terrazyme dosages. I had tested all the samples on 0 days, 7, 14, 21 and 28 days respectively. At last I had compare the test results both numerically and graphically.

4. Properties of Black Cotton Soil

Table 1 Properties of black cotton soil

S.NO.	Property	Results
01	Specific gravity	2.61
02	Grain size Distribution	
	Clay (%)	20.40
	Gravel (%)	00.00
	Sand (%)	11.70
	Silt (%)	67.90
03	Atterberg limits	
	Plastic limit(%)	36.20
	Liquid limit(%)	52.35
	Plasticity index (%)	16.15
04	Max. Dry Density (Kn/m ³)	14.74
05	Optimum Moisture content (%)	22.00
06	CBR (%)	
	Un-soaked	5.10
	Soaked	1.25
07	Unconfined compressive strength (KN/m ³)	42.00

5. Properties of Terra-zyme



Reaction with enzyme



Terrazyme

Table 2 Properties of Terra-zyme (purchased from market)

Property	Value (As per manufacturer)
PH value	3.95
Specific Gravity	1.06
Appearance/odour	Dark brown/Non-toxic
Total Dissolved solids(TDS)	19.81 ppm
Cation exchange capacity	3.88%
Hazardous content	None
Melting point	Liquid
Reactivity data	Stable
Solubility in water	Completely
Evaporation rate	Same as water
Boiling point	100 degree celcius

6. Results and Discussions

6.1 Dosage of Terrazyme:

The dosage recommended by the supplier of enzyme, guide and based on literature works, different studies carried out by using enzyme are selected. In the present study the dosages selected are as follows 250ml/2m³, 250ml/1.5m³, 250ml/1.0m³ and 250ml/0.5m³ is carried out with and without the Terra-Zyme to study the variation in the geotechnical properties.

6.2 Dosage Calculation:

For Sample-1: Dosage is 250 ml of terrazyme for 2m³ of soil.= $1.945 \times 2 \times 1000 = 3890$ kg of soil

Therefore, For 1 kg of soil = 0.0642 ml quantity of terra-zyme.

For Sample-2: Dosage is 250 ml of terra-zyme for 1.5 m³ of soil.= $1.945 \times 1.5 \times 1000 = 2917.50$ kg of soil.

Therefore, For 1 kg of soil = 0.0857 ml quantity of terra-zyme.

For Sample-3: Dosage is 250 ml of terra-zyme for 1 m³ of soil.= $1.945 \times 1 \times 1000 = 1945$ kg of soil.

Therefore, For 1 kg of soil= 0.128 ml quantity of terra-zyme.

For Sample-4: Dosage is 250 ml of terra-zyme for 0.5 m³ of soil.= $1.945 \times 0.5 \times 1000 = 972.50$ kg of soil.

Therefore, For 1 kg of soil = 0.257 ml quantity of terra-zyme.

6.3 CBR Test Results

CBR test is performed to determine the CBR value. To ascertain the behaviour of soil under soaked conditions and un-soaked conditions.

6.3.1 Soaked CBR Test results

Table 3 Soaked CBR test values

Soil terrazyme dosage	Curing time period (Days)				
	0	7	14	21	28
Untreated soil	1.15				
250ml/2m ³	1.35	1.46	1.87	2.35	5.1
250ml/1.5m ³	1.41	1.57	1.91	2.37	5.25
250ml/1.0m ³	1.47	1.61	1.92	2.50	5.42
250ml/0.5m ³	1.51	1.69	1.99	2.78	5.54

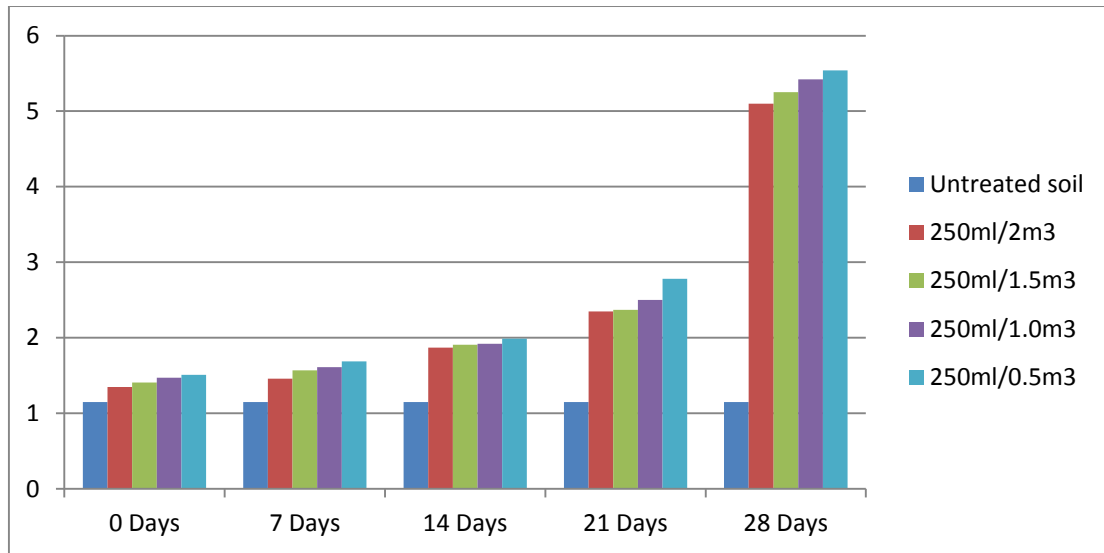
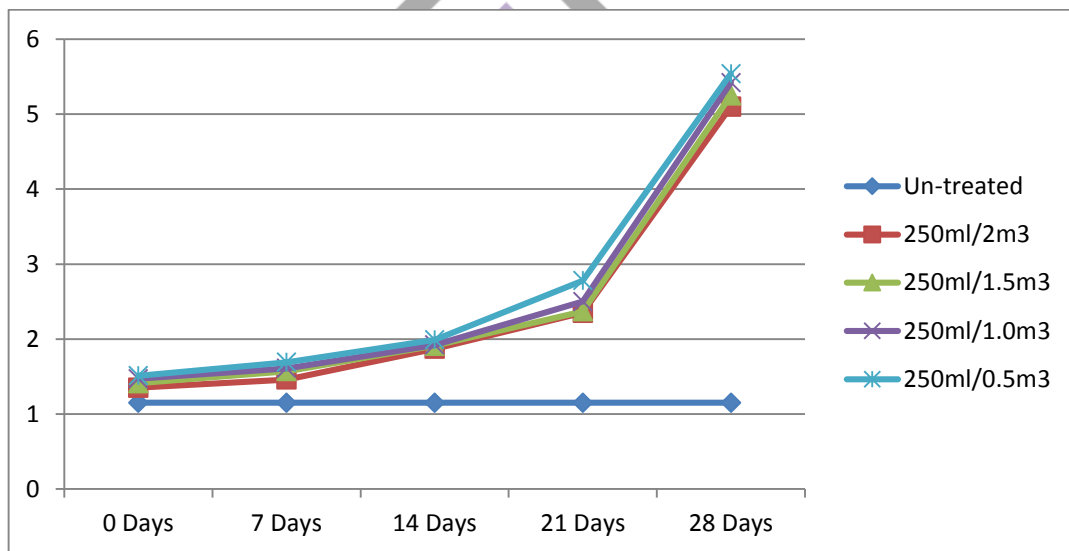


Figure 1 Graphical representation of soaked CBR test results



6.3.2 Un-soaked CBR Test results

Table 4 Un-soaked CBR Test results

Soil terra-zyme dosage	Curing time period (Days)				
	0	7	14	21	28
Untreated soil	5.45				
250ml/2m ³	5.52	6.30	7.19	7.82	8.02
250ml/1.5m ³	5.61	6.42	7.22	7.89	8.09
250ml/1.0m ³	5.88	6.71	7.37	7.94	8.15
250ml/0.5m ³	5.97	6.99	7.62	8.07	8.35

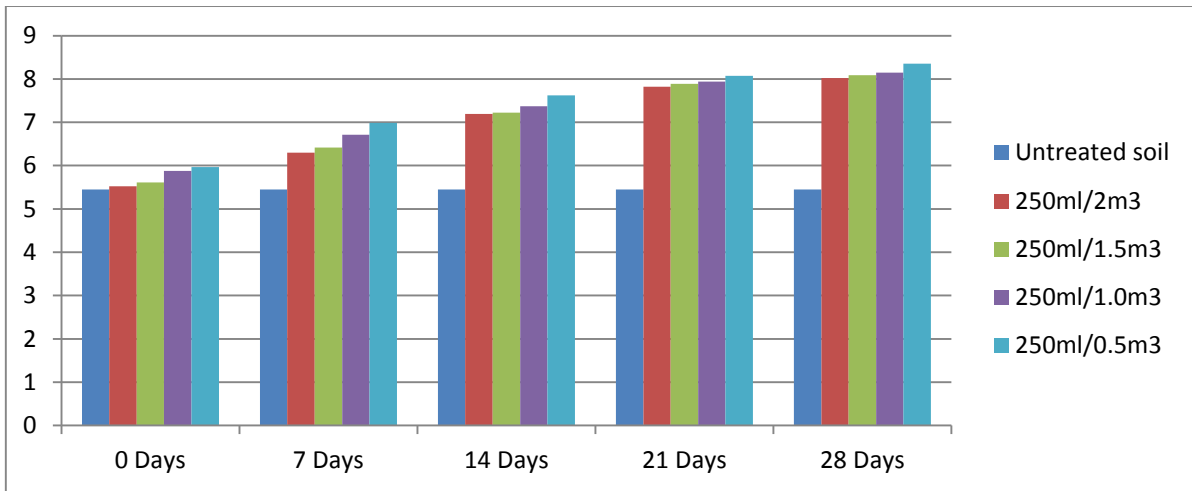
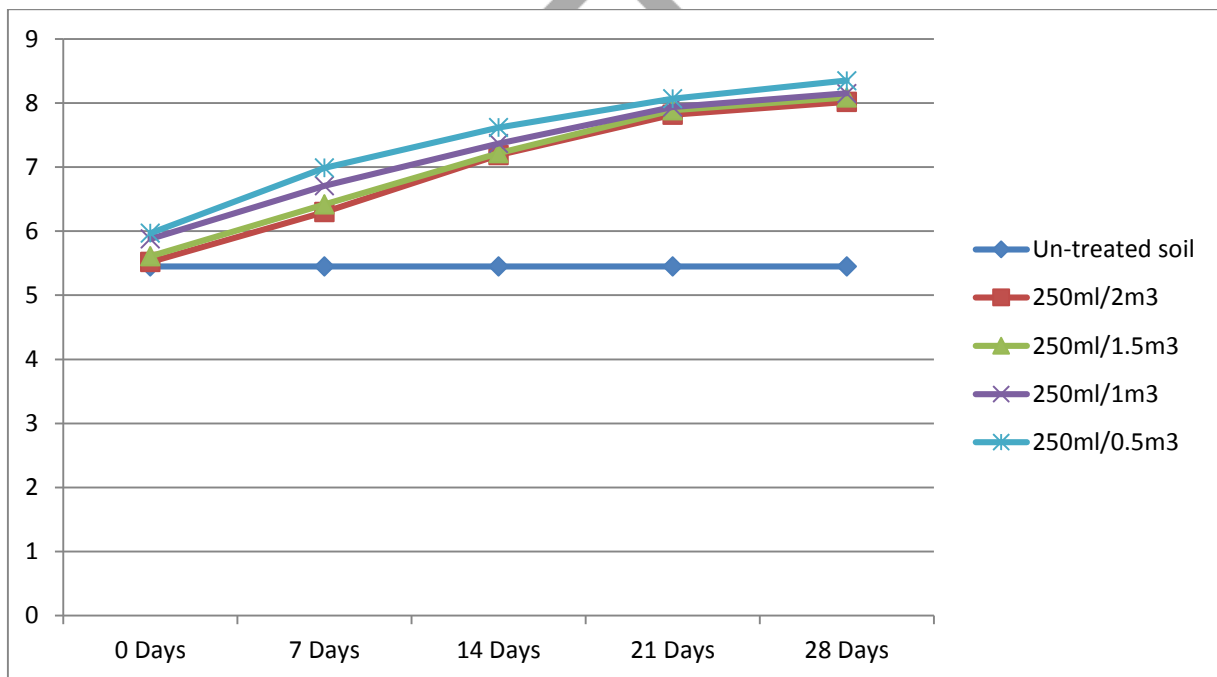


Figure 2 Graphical representation of Un-soaked CBR test results



6.4 UNCONFINED COMPRESSION TEST RESULTS

Unconfined Compression is performed to determine the shear strength of the soil. Unconfined Compression samples are placed kept for a curing period of 0, 7, 14, 21 and 28 days.

Table 5 Unconfined compressive strength Test results

Soil terrazyme Dosage	Curing Time Period (Days)				
	0	7	14	21	28
Untreated soil	39	39	39	39	39
250ml/2m ³	41	43.50	47.60	48.10	54.70
250ml/1.5m ³	43.20	44.05	49.35	56.30	59.10
250ml/1.0m ³	48.80	52.00	57.65	59.75	61.25
250ml/0.5m ³	51.05	54.70	59.80	62.00	67.60

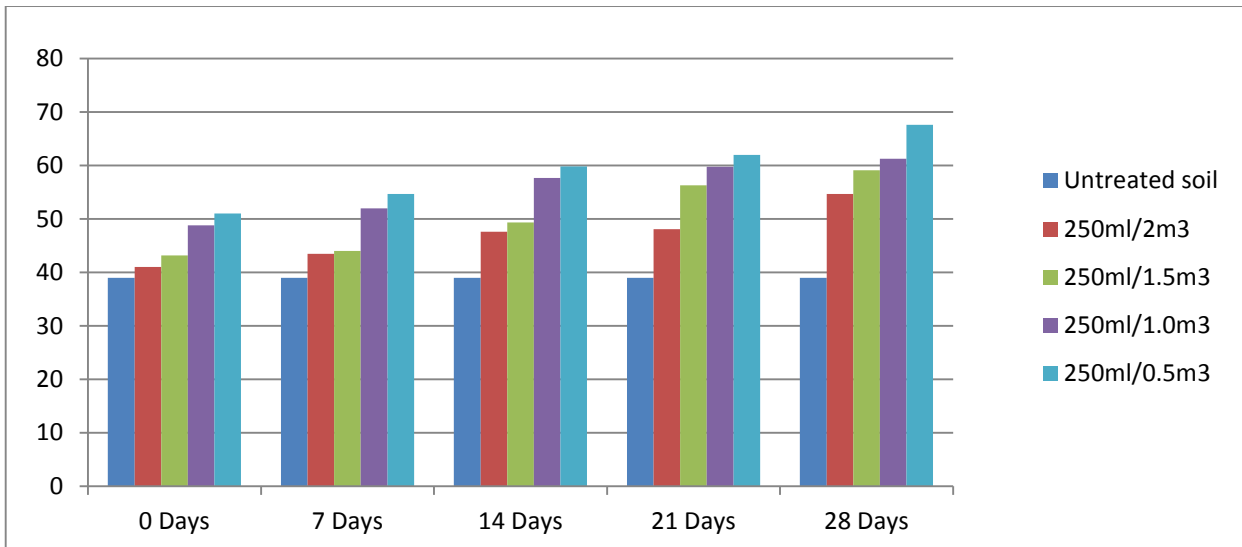
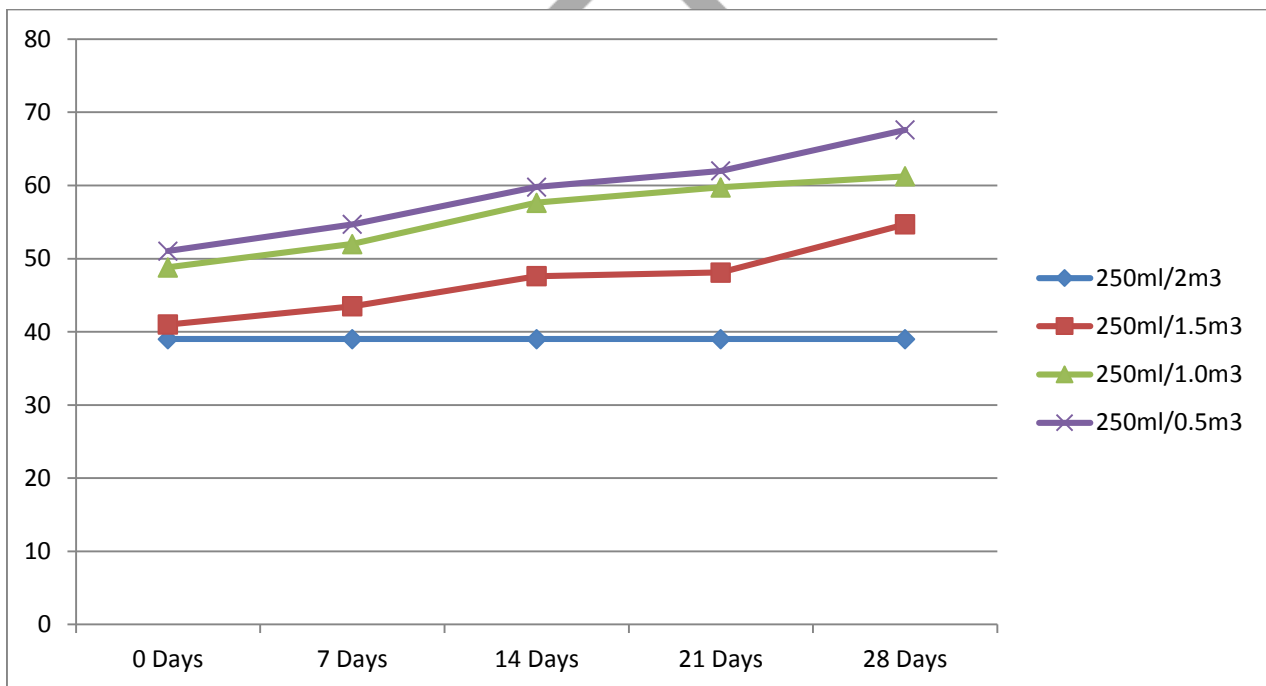


Figure 3 Graphical representation of Unconfined compressive strength test results



7. CONCLUSIONS

On the basis of my thesis work and experimental investigations, it was observed that the geotechnical properties of online purchased black cotton soil was effectively improved by using different dosages of terra-zyme that is 250ml/2m³, 250ml/1.5m³, 250ml/1.0m³ and 250ml/0.5m³ respectively. In this thesis work, terrazyme was used as a stabilizer. I have drawn following points from my research work, these are:-

1. The soaked CBR values of black cotton soil was improved considerably upto 382% for dosage of 250ml/0.5m³ with 28 days curing period.
2. Best result for un-soaked CBR value was observed for dosage of 250ml/0.5m³ that is 0.257 ml of terrazyme for 1 kg of black cotton soil, for which the CBR values increased upto 53.20% respectively.
3. With the application of terrazyme, the best result for Unconfined Compression test was observed with dosage of 250ml/0.5m³ at curing time period of 28 days.
4. With increase in percentages of terrazyme and days of curing, unconfined compression test values of the black cotton soil increased from 40.25% to 73.33% with dosage of 250ml/2m³ to 250ml/0.5m³ respectively for curing period of 28 days.
5. With increasing in percentage of terrazyme, the unsoaked CBR values was increased from 5.45 to 8.35 that is 53.21%.

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