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Scientifically Surveying the Usage of Terrasil Chemical for Soil Stabilization

Nandan A. Patel[1],Prof.C. B. Mishra[2] ,Mr. Vasu V. Pancholi[3]
Student of M. E. (Transportation System Engg.)[1], BVM Engineering College, V. V. Nagar,Anand, India
Associate Professor, Civil Engineering Department[2], BVM Engineering College,V. V. Nagar, Anand, India
I/c in Geotechnical Dept.[3], Institute of Seismological Research,Raison, Gandhinagar, India
Email:nandan9601@gmail.com[1], cbmishra@bvmengineering.ac.in[2],vasupancholi@gmail.com[3]

Abstract - The thriving urban population of India advances development of growth of trade, commerce, service sector which depend on heavy commercial vehicles and individual ascent in income contributing to rise in motorization andexperiencing quick accelerations in urban travel interest putting weight on restricting street space surpassing the heap conveying limit of roads in the steadily changing atmosphere of our nation particularly on road running in clayey soil ranges are known for bed condition and unpredictable conduct of the nature of the soil contributing to failure of roads thereby compelling rise in maintenance cost. It is the responsibility of the road authorities to use the local materialand correct the soil properties using additives enhancing the strength of soil and make the road durable. The examination was completed to focus first soil engineering properties (with and without stabilizer), standard compaction; four days soaked California Bearing Ratio (CBR), permeability test and cyclic loading test according to codal procurement. A concoction named Terrasil was utilized as stabilizer and it was utilized for altered measurement i.e. 0.041% by dry aggregate weight of soil test according to the convention of Zydex Industries, Vadodara. Test outcome demonstrates that designing properties got modified and CBR on stabilized clayey samples increased considerably, which reflects the lower thickness in correlation with natural characteristic soil properties.Additionally the expense is diminishing which advantages the road builders, engineers, policy makers and pavement designers as well.

Index Terms - Terrasil, Soil Stabilization, strength.

1. INTRODUCTION

Subgrade is a vital part to bolster all pavement loads coming on it also to bear the ever changing climate of our country. Natural soil subgrade properties that are not beneficial, for example, CBR (California Bearing Ratio) low and high swell so that when connected to the development of a soil road, the area base will easily damage. For that if utilized as a part of the development of CBR worth ought to be towering so it can withstand a load on it. The swelling will lessen the volume of soil that is stable when it rains he is not swollen, generally when the dry season does not contract too high so that the cracks in the roads can be diminished or eliminated. The motivation behind soil adjustment is to enhance the physical properties of clayey soil, mechanical and build the conveying limit of the area that will be considered in the arrangement of pavement. Consequently, soil adjustment requires the arranging and execution of an exact system for soil improvement of particular designing road venturesand administration life of the asphalt. The key achievement in soil adjustment is soil testing.

2. OBJECTIVES

In the present an endeavor is made to study the change of soil file properties of untreated local soil furthermore contemplate the effect of expansion of 0.041% of Terrasil to untreated soil by dry weight of the soil to be balanced out for subgrade for road development in addition to the diminishment in thickness adding to economy and dependable asphalt advantageous to pavement designers architects and contractors.

3. REVIEW OF EARLIER WORK

A number of researchers have worked in developing different methods of soil stabilization, which are practical and economical.

B M Lekha S Goutham, A U Ravi Shankar – (2013) in his work on “laboratory investigation of soil stabilized with nano chemical” states that the behavior of Black Cotton (BC) soil with and without stabilizationwas studied. A chemical named Terrasil was used as stabilizer and it was used for different dosages and cured for 7-28 days.Due to the chemical reaction, the soil mass densifies by minimizing the voids between particles and itmakethe soil surface impervious. The important geotechnical properties of

soil were determined in the laboratory. It is noted that CBR values increase with the increase in percentage of stabilizer. Permeability is found to be nil for treated soil. It makes the soil impermeable completely. The XRD and SEM analysis conducted for the soil samples were not able to justify the improvement for stabilized soil. [15]

Ibrahaim M.A. Moafaq, A.A. Abdulrahman, H.A. (2011) – in his study on "Long haul Quality and Durability of Clayey Soil stabilized with Lime" passes on that toughness attributes of clayey soil settled with lime were controlled by directing tests contains UCS for tests with the ideal lime percent (4%), and subjected to cycles of the WD, dry-wet and FT toughness tests and additionally, long term soaking and slake tests. [16]

Omer, N.M. (2012) – in his examination chip away at "Soil adjustment by chemical agent" the outcomes showed that, the proficiency of the lime in the change of UCS of clayey soil is of negative impact in the long haul strength periods. The WD cycles indicated more noteworthy lessening in UCS than drying-wetting cycles, while the volume change of tests when subjected to drying at first and foremost, and were more prominent than those directed with wetting. Then again, FT cycles cause a reduction in the UCS values, and the decrease proportion was more noteworthy than WD cases. In any case, amid drenching tests it was found that, at ahead of schedule dousing periods, the lime balanced out specimens were constantly picking up quality, however past this, the quality diminished with expanding splashing period. The balanced out test with (4 and 6%) lime turns out to be more solid against the WD cycles. [17]

4. MATERIALS

Following are the materials which are to be used in this study.

4.1 Soil

Soil under examination isbrown in shading made of fine particles (category CL) and is obtained from Nadiad (Latitude 22.70000 N & Longitude 72.87000 E), Gujarat where the street is going to pass, Ahmedabad to Vadodara NH8.

4.2 Terrasil

The substance utilized for the present examination to balance out the clayey soil was terrasil produced by Zydex Industries, Gujarat, possessing ingredients Hydroxyalkyl – alkoxy – alkysilyl compounds (65 – 70 %), Benzyl alcohol (25 – 27 %) and Ethylene glycol (3 – 5 %). It is a nanotechnology based 100 percent organosilane, water solvent, bright and warmth steady, receptive soil modifier to waterproof soil subgrade. It responds with water cherishing silanol gatherings of sand, soil, and totals to change over it to exceptionally stable water repellent alkyl siloxane bonds and structures a breathable in-situ layer. The holding procedure starts inside of 3 hours of the beginning application and the procedure is finished (72 hrs.), terrasil turns into a lasting piece of every soil particle and won't separate or drain into groundwater[15]

In this study dosage of terrasil is 0.041% by dry aggregate weight of soil test according to the convention of Zydex Industries, Vadodara. The soil structures at untreated and treated conditions are exhibited in Figures 1 and 2.

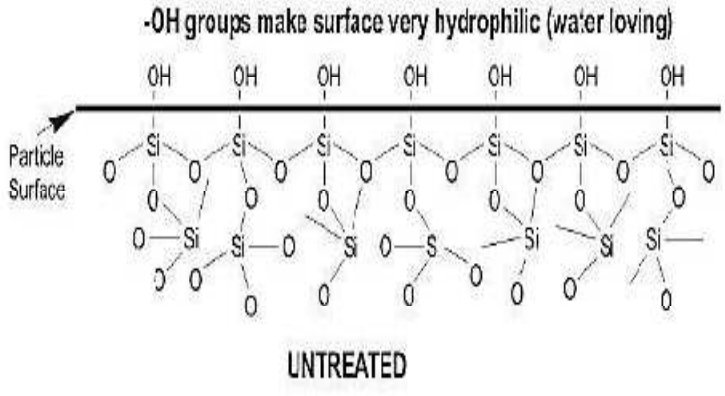

Fig. 1 Untreated soil surface silicate structure

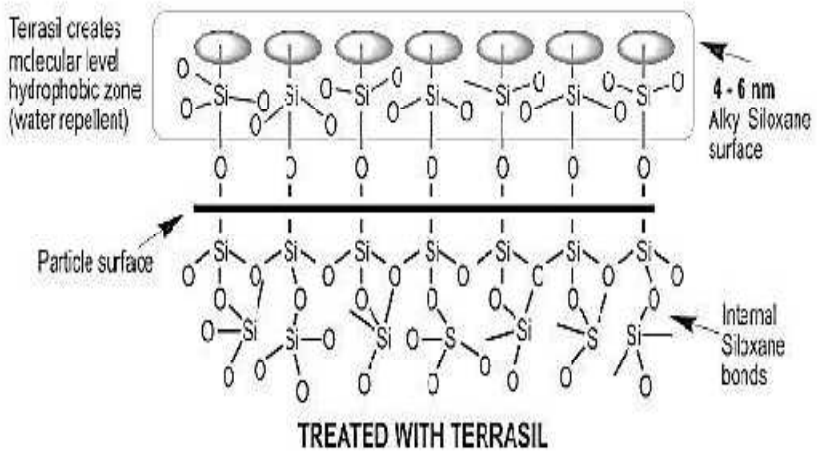

Fig. 2Treated soil surface silicate structure

5. TEST RESULTS

Various tests were performing for identify the Engineering property of soil as per Indian Standard are as below:

5.1.Water Content – Dry Density Relation Using Heavy Compaction for CL soil

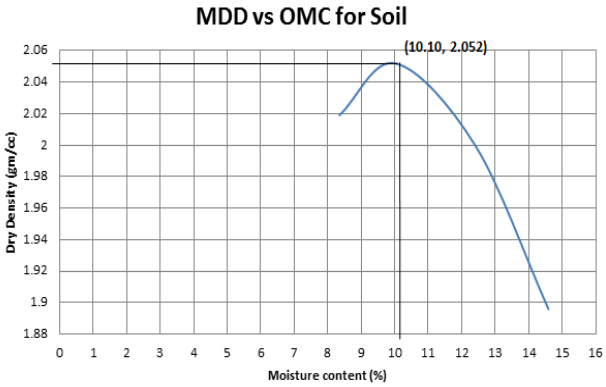

Fig 3 : MDD v/s OMC for soil

The graph shows that MDD & OMC values of soil to determine the optimum dosage of terrasil after carrying out [6] CBR value of soil only as per the protocol of zydus laboratory. Consequently the LL and PL values of treated soil are carried out.[5].

Fig 4 : Sample of Liquid limit & Plastic Limit

5.2 Atterberg limits and FSI

Material	LL	PL	PI	FSI
CL soil	30.23%	18.69%	11.54%	17.5%
Soil + 0.041% Terrasil	30.10%	20.42%	9.68%	17.0%

Table 1 :Atterberg limits and FSI

Thus it is observed from table 5.2 that there is marginal reduction in Atterberg's limits. Amount of clay content plays a major role in the variation of

consistency limits. It is adsorbed water is incredibly lessened for treated soil and these soil particles gain a propensity to agglomerate which may be due to chemical reaction. As a consequence of relative development, the surface range get lessened which thus decreases the swelling limit. This reasons abatement of FSI qualities with expansion in curing period of 24 hours.

The California Bearing Ratio (CBR) tests were performed on soaked specimens for modified proctor densities. The soaked values of CBR are be used for designs generally, the open air cured samples were soaked for four days before testing. The samples were placed for curing below the halogen lights for four days in atmospheric condition as per protocol of zydus laboratory, Vadodara. After the specified curing was over, the CBR molds were taken out and tested and the results are presented.[7].

5.3. CBR value for soil with & without Additive

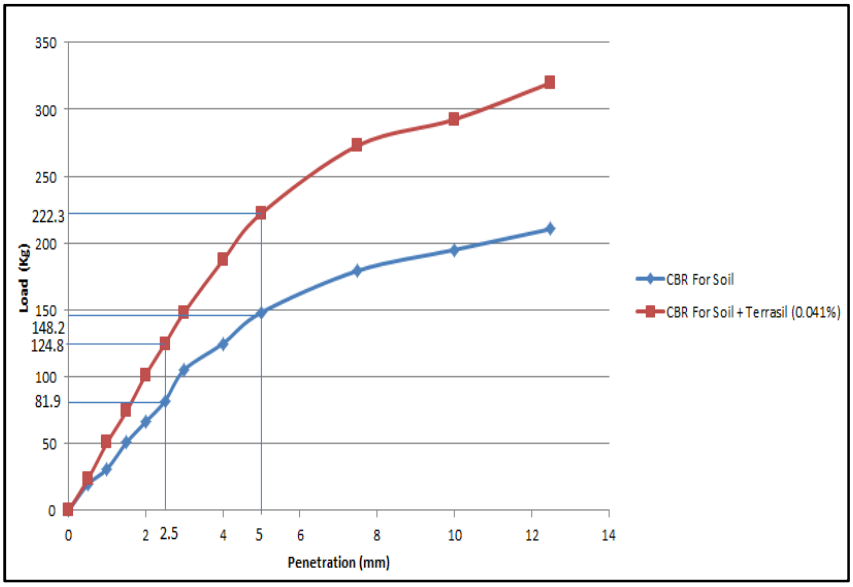

Fig 5 : Penetration v/s Load

CBR Value at St. Penetration 2.5 mm and St. load 1370 Kg		
Sample	CL Soil	Soil + Terrasil (0.041%)
Load at 2.5 mm	81.90	124.8
CBR Value	5.69 %	9.12 %

Table 2 : CBR value at 2.5 mm Penetration

CBR Value at St. Penetration 5 mm and St. load 2055 Kg		
Sample	CL Soil	Soil + Terrasil (0.041%)
Load at 5 mm	148.20	222.30
CBR Value	6.64 %	10.82

Table 3 : CBR value at 5 mm Penetration

HereCBR of 5 mm penetration value of soil is 7.21%and Soil + Terrasil (0.041%) is10.82%.CBR of 5 mm entrance quality is taken for outline as results are rehashed. It is obvious that soil treated with terrasil renders enhanced thickness values by diminishing the void proportions. This propensity may be because of viable caution trade process which by and large takes longer period without such stabilizers. The low CBR of the CL soil (as compared to the soil with 0.041% terrasil) is attributed to its inherent low strength which is due to the dominance of the clay fraction.

Laboratory Determination of Permeability test result for Soil with and without additive(IS: 2720 (part 17)-1986)

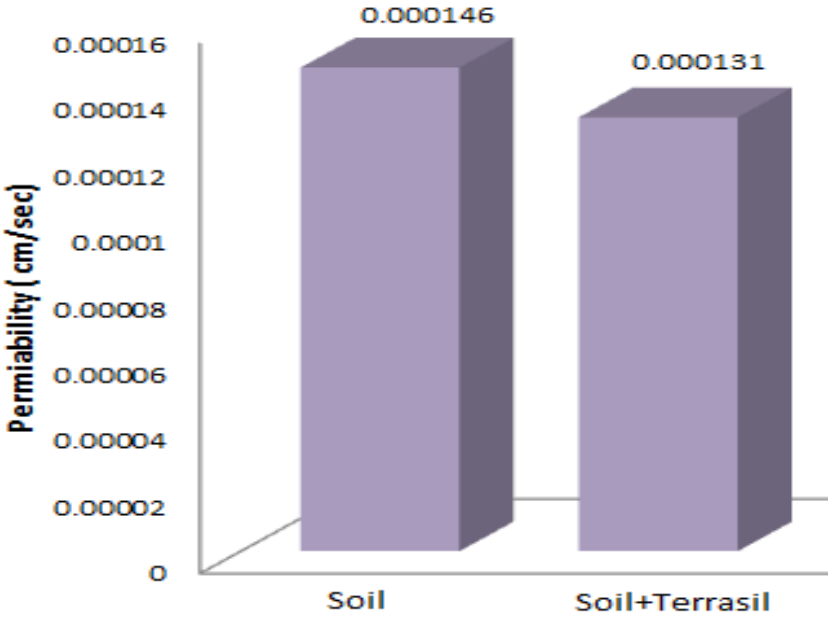

Fig 6 : Permeability test result for soil with and without additive

The test outcomes show that as the measurement 0.041% terrasil is added to soil there is an exceptional decline in porousness. The chemical reaction response between soil + 0.041% terrasil prompts lasting siliconization of the surfaces by changing over the water cherishing silanol gatherings to water repellent siloxane bonds and this made the clayey soil waterproof.

Standard Test Method for Load Controlled Cyclic Triaxial Strength of Soil (ASTM D 5311 – 92 (2004))

This test method covers the determination of the cyclic strength (sometimes called the liquefaction potential) of saturated soils in either disturbed states by the load-controlled Cyclic Triaxial technique to evaluate the dynamic behavior of soil. The size of membrane is 50 diameter and 100 mm height as per codal provision. The cyclic triaxial test with varying number of cycles to corresponding deviator stress indicates average peak cyclic strength in extension and compression. It is clear that, as the number of cycle increases during cyclic loading of clayey soil samples, there is gradual reduction of deviator stress due to the buildup of excess pore water pressure and finally deviator stress reduces to zero when the pore water pressure becomes equals to initially applied confining pressure. Looking to the comparative graph one can say that soil with 0.041% terrasil shows higher values of extension and compression which results in reducing the early period of liquefaction with number of cycles while soil will liquefy early during seismic forces as per the literature.[9]

Comparative Graph Load Controlled Cyclic Triaxial Strength of Soil with and without additive:

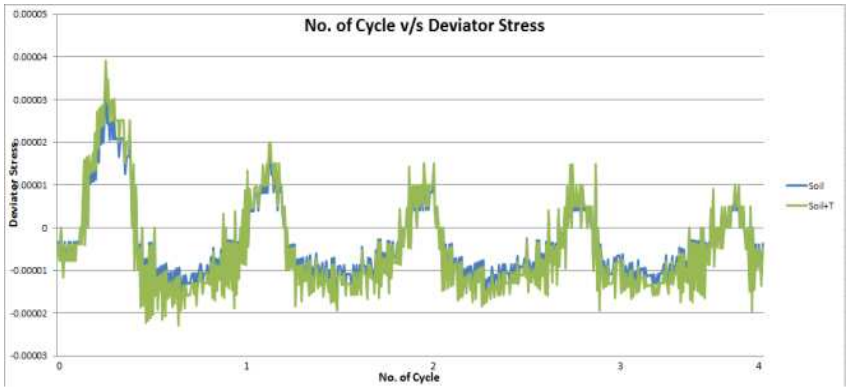

Fig7: No. of Cycle V/S Deviator Stress

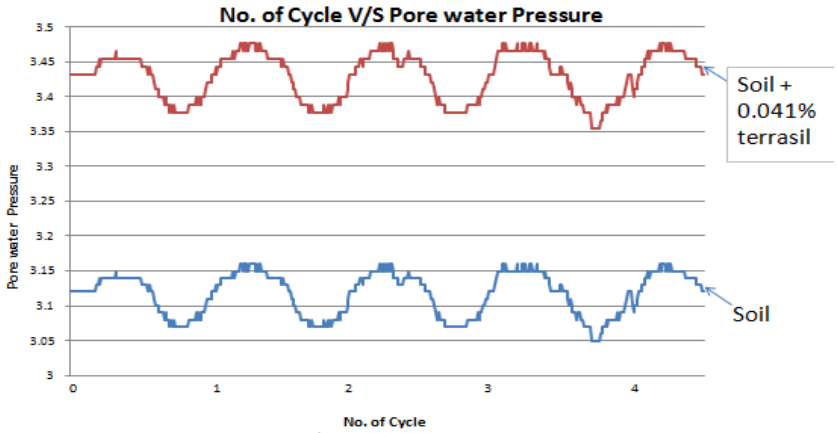

Fig8: No. of Cycle V/S Pore Water Stress

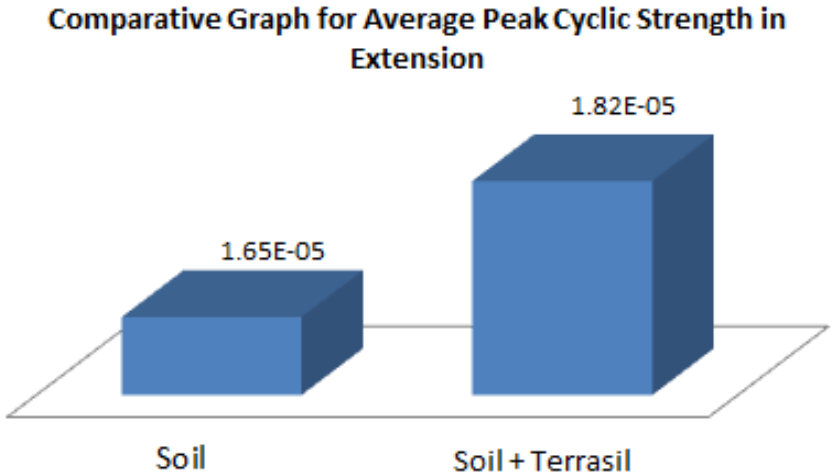

Fig : 9 Comparative graph for average Peak Cyclic Strength in Extension

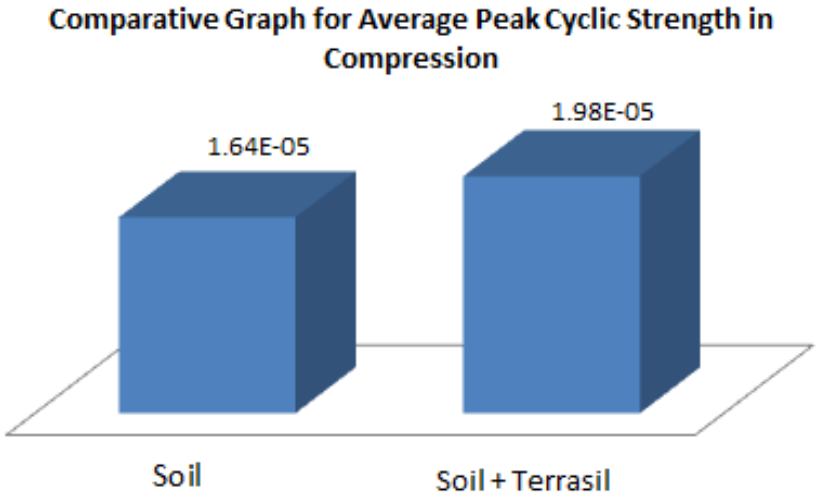

Fig : 10 Comparative graph for average Peak Cyclic Strength in Compression

THICKNESS DESIGN OF FLEXIBLE PAVEMENT AS PER IRC: 37 – 2001 & IRC: 37 – 2012 FOR CL SOIL& CL SOIL + 0.041% TERRASIL

The traffic taken into consideration is 7 msa (Million Standard Axle) accordingly the thickness design is calculated as per IRC: 37 – 2012 for materials. Generally the construction cost is based on tender pricing. It is assumed that the initial cost reflects correct design and the best workmanship of required quality. Here the rate is taken from NH Standard Data Book (Road & Bridge) 29/01/2013 for calculating the total cost of construction.[10].

Material	CBR at 5 mm penetration	Total Thickness (mm)	Cost (Rs)
CL Soil	6.64%	547 mm	9271686
CL Soil + 0.041% Terrasil	10.82%	405 mm	8708166

Table 4 :thickness design is calculated as per IRC: 37 – 2012.

6. CONCLUSION

Performance of CL soil and 0.041% terrasil stabilized soil has been investigated in this work. Based on the tests conducted in the laboratory, the following conclusions have been drawn:

- The liquid limit and plastic limit of the soils decrease with the addition of 0.041% terrasil in soil. FSI value of treated soil reduces because the film of adsorbed water is greatly reduced for treated soil and the surface area reduces, resulting in decreased swelling capacity.
- It is observed that the treated soaked CBR values are increased which is because soil treated with 0.041% terrasil renders improved density values by reducing the void ratios.
- Permeability is found to be decreasing in the case of soil treated with 0.041% terrasil, this is due to the material becoming dense as changes over the water cherishing silanol gatherings to water repellent siloxane bonds takes place.
- Load controlled cyclic triaxial strength of soil indicates there is gradual reduction of deviator stress due to the buildup of excess pore water pressure in CL soil but the soil treated with 0.041% terrasil performance is good as it shows higher values of extension and compression which results in reducing the early period of liquefaction with number of cycles while soil will liquefy early during seismic forces as per the literature study.
- The study reveals the change in thickness owing to reactions of soil treated with 0.041% terrasil is about 25% lower than the thickness obtained for CL soil
- The cost of construction of CL soil works out to be Rs. 9271686 per km while as for soil treated with 0.041% terrasil works out to be lower i.e. Rs. 8708166/- per km. The difference is Rs. 5,63,520/- per km.

From economy point of view benefit associated with the utilization of 0.041% Terrasil is attractive and supports the sustainable development in road construction. The road builders, engineers, policy makers and pavement designers can avail the benefit of it.

7. FUTURE SCOPE OF WORK

This study identified and raises number of questionsrelatedtonumber of topics on which further research would be beneficial:

1) Liquefaction potential analysis needs to be carried out to determine the material susceptible to liquefaction during earthquake of high magnitudes.
2) The XRD and SEM analysis needs to be conducted for the soil samples to justify the improvement for stabilized soil.
3) Fatigue analysis and triaxial tests for untreated and treated soil samples for better idea about the use of the soil in pavement construction can be carried out.

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