iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 10 **Issue:** V **Month of publication:** May 2022

DOI: https://doi.org/10.22214/ijraset.2022.43340

www.ijraset.com

Call: 08813907089 | E-mail ID: ijraset@gmail.com

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 10 Issue V May 2022- Available at www.ijraset.com

Experimental Investigation on Black Cotton Soil Mixed with Tyre Waste

Kushappa M Kabade[1], Bhagyashree Shinde[2], Akshata Beerappagol[3] Swarnakavya Rothod[4] Sumalata Desai[5]
[1, 2, 3, 4, 5]*Civil EngineeringDeapartment, Secab Institute of Engineering and Technology*

Abstract: ***Expansive soil or black cotton soil are one of the problematic soil. Settlement of the structure, cracking in the different component of the structure etc. are some major problems caused in the structure constructed over such soil. The Stabilization is process done for improvement of existing soil by using an admixture. Rubber crumbs can be treated as admixture. The potential of using rubber from warm tyres in many civil engineering works has been studied for more than 30 years. Applications where tyres can be used have proven to be effective in protecting the environment and conserving natural resources. Hence in this study attempt is made study to behaviour of black cotton soil using rubber crumbs in terms of stability behaviour.***
Keywords: Black cotton soil, Rubber crumbs.

I. INTRODUCTION

In recent years numerous factors have led to an increase in the number of people migrating to the large cities. Subsequently these cities are getting over populated and quite expectedly the need of residential construction has increased. The construction projects situated in the areas with unsuitable soil is one of the most common problems in many regions of the world. The unsuitable soils can be treated with alternative materials by the usual method of soil stabilization.

Soil stabilization is a technique introduced many years ago to render the soil capability of meeting the requirement of specific engineering projects.

The technique of soil stabilization are often used to obtain desired geotechnical properties by addition of stabilizing agents such as lime, fly ash, river sand, tyre waste, slag, etc.

In the present study an attempt is made to improve the geotechnical properties of black cotton soil by addition of industrial by product tyre waste. The black cotton soil is weak among all the soils because of the rich proportion of the mineral Montmorillonite. This soil possesses swelling and shrinkage characteristics and they are highly compressible. The soil may not possess required strength properties and this makes the soil unsuitable for constructions. Hence for any civil engineering construction on black cotton soil with low bearing capacity requires stabilization. Previous studies have shown that the stabilization of black cotton soil have resulted in improvement of soil strength and reduction in volume changes.

With the ongoing rise in use of motor vehicles, hundreds of millions of tyres are discarded each year throughout the world. Tyre waste is the rapidly increasing waste material in India. As it is a non-biodegradable material and hazardous to the environment, the disposal of this waste (involves incineration) is a huge problem. The replacement of tyre waste materials in the form of stabilizing agent is a modern approach by which waste materials can be advantageously used.

II. LITERATURE REVIEW

A. CH Kusuma Keerthi and Sumanth Doodala

This paper an investigation attempt is made to stabilize black cotton soil using grounded rubber tyre powder. Black cotton is mixed with grounded rubber tyre with 5%, 10%, 15% and 20%. The unconfined and CBR tests were carried out in the laboratory for different mix proportions of rubber powder with black cotton soil. Considerable improvement is found in strength of black cotton and shedi soil for the 5% percent mix of rubber.

Only at a range of 5 % rubber powder may gives effective dry density and will give higher CBR values. Dry density and CBR values goes on decreasing with 10%,15%,20% of rubber powder(as shown in table 1). From this study it is concluded that there is a considerable improvement in California Bearing Ratio (CBR) of black cotton soil with addition of 5% of rubber powder as soil stabilization when compared to only black cotton soil. It has been concluded that economic cost and quality of stabilization improvement, it is clear that this type of stabilization may be applicable in stabilization of black cotton soil in construction of road or in shoulder portion of highways.

Table I
California bearing ratio test results for black cotton soil with different proportions of rubber powder.

A. SI NO	B. Rubber powder percentage	C. CBR value for 2.5mm penetration (%)	D. CBR value for 5mm penetration (%)
E. 1	F. 0%	G. 21.57	H. 21.32
I. 2	J. 5%	K. 25.28	L. 24.29
M. 3	N. 10%	O. 23.80	P. 22.80
Q. 4	R. 15%	S. 23.05	T. 21.81
U. 5	V. 20%	W. 22.31	X. 21.81

B. Manjesh Srivastava, Akash Priyadarshee, Vikas Kumar, Sunayana, Ashish Kumar and Vijay Kumar

This paper presents the study series of the model test over the ring footing supported by black cotton soil mixed with the tire chips are performed to understand the strength and stiffness behavior of soil mixed with tyre chips. Impact of the tire content and depth of the tyre chips reinforced soil on the load carrying capacity of the black cotton soil is investigated. Tyre chips content varied in this study was 5-20%. While, depth of the footing was varied from 0.5D to 1.5 D, where D is the diameter of the ring. Results obtained from the model tests have shown that the maximum performance occurred at the 10% tire content and at the depth of 0.5 D. from the study it is concluded that Tyre chips have potential to improve the load carrying capacity of the soil and it also concluded that Performance of the tyre chips was optimum when content of the tyre chips was between 5-10%.

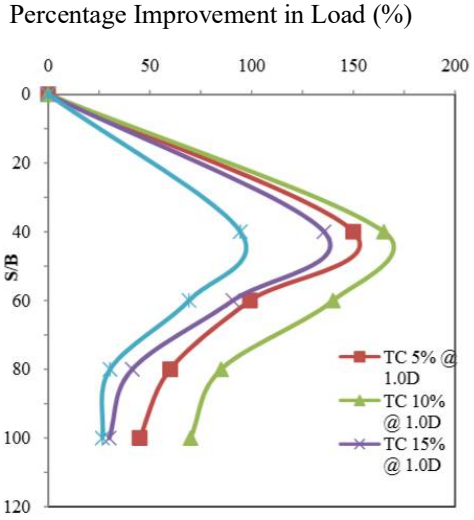


Fig.1 variation of load improvement with tire content

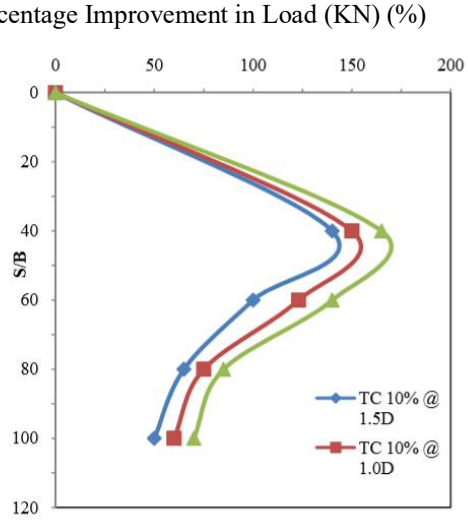


Fig.2 Variation of load improvement with depth of the tire

C. Ganesh S Ingle

This paper presents the strength and swelling behavior of black cotton soil (expansive soil) using a shredded rubber tyre as an additive. Series of unconfined compressive strength and California Bearing Ratio (CBR) tests were carried out on black cotton soil mixed with 0%, 5%, 10%, and 15% of shredded rubber tyres, and the results were compared with untreated soil sample. The study also investigated the influence of shredded rubber on swelling characteristics of black cotton soil by performing the swelling pressure test. From the experimental results, it is inferred that the optimum addition of a 10% shredded rubber tyre can effectively improve the strength behavior of black cotton soil (as shown in fig3). The unconfined compressive strength and California Bearing Ratio (CBR) of soil stabilized with 10% of shredded rubber tyre increased by 32 % and 49.3% respectively as compared to the untreated soil. The present study also investigated the swelling potential of Black cotton soil and it is found to be decreased by 33.33% for the addition of 15% shredded rubber soil as compared to untreated soil. Hence it is concluded that the shredded rubber up to 10% can be effectively used to improve the strength and swelling characteristics of Black cotton soil.

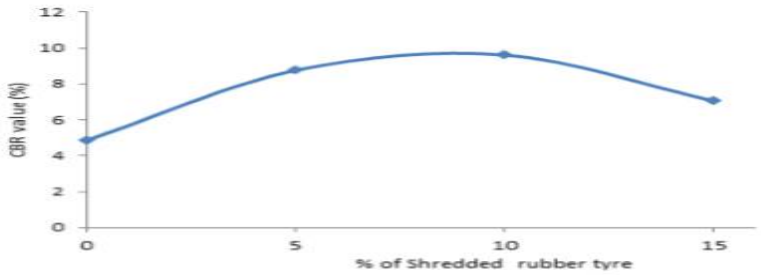


Fig.3 Variation of CBR value with different percentage of shredded rubber content in soil.

D. G. Ravi Kumar and K. Gayathri [2018]

This paper presents the stabilization of soils using crumb rubber powder with various proportions of 5%, 10% and 15%. The soil properties, compaction, CBR test and direct shear test were used to gauge the behavior and performance of the stabilized soil. The shear strength of the black cotton soil is increased with the addition of 10% crumb rubber powder (as shown in fig1). The shear strength of the red soil is decreased with the addition of crumb rubber powder (as shown fig2). From this investigation, it has been concluded that addition of 10% of crumb rubber powder to the soil increases CBR value. If the percentage of rubber powder increases more than 10%, the soil strength gradually decreases. Hence is has been concluded that 10% is the optimum rubber powder for the stabilization of black cotton soil. The investigation evaluates the use of rubber for stabilization of red soil is not adoptable.

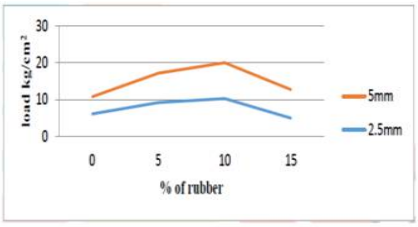


Fig.4 California Bearing Ratio for black cotton soil

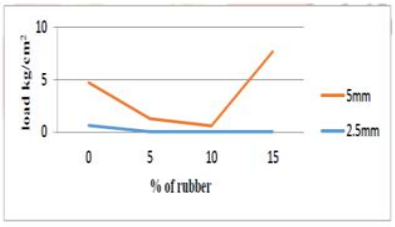


Fig.5 California Bearing Ratio for red soil

E. Piyush V. Kolhe, Rushikesh V. Langote

This paper present the effect of rubber tyre shred (0 - 10%) on engineering as well as index properties of black cotton soil. It was found that the optimum moisture content and maximum dry density decreases with increase in the percentage of rubber tyre shread. The CBR value increases with increase in the percentage of rubber tyre shread. The effect on shear strength parameters was also checked by performing various laboratory tests. Hence it has been concluded that the CBR values increases with increase in percentage of rubber tyre shread and found to be maximum for 8% rubber tyre(as shown in the fig4).It was found that the rubber tyre can be effectively used in road construction and pavement design as the CBR value can be improve.

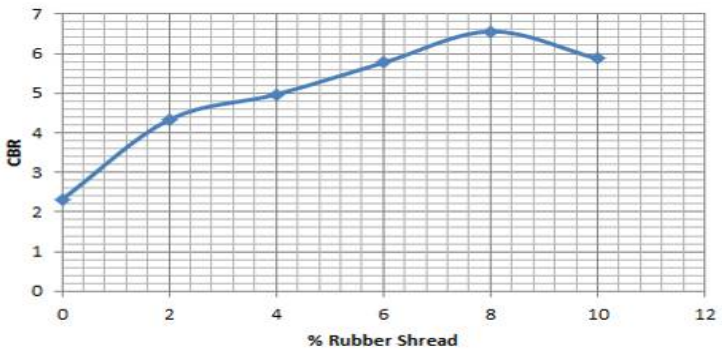


Fig.6 Variation of CBR Value with Different Percentage of Rubber Tyre shread.

F. M. Neeraja [2016]

This paper presents the experiments are conducted on BCS and shredded tyres mixed in different percentages (5 and 25%) and sizes (15 and 30mm) to find out the relative strength gain. Compacted dry densities of black-cotton soil and shredded tyre mixture were found to be around 90% of that the soil alone. The CBR value of soil-tyre mixture also increased compared to that of the soil alone. But, as the size of tyre increases, CBR value may get decreased (as shown in the below table). Hence from the study it has been concluded that the compacted dry density reduced solely due to the lighter weight of the tyre, Permeability of the mixture increased, bearing ratio was maximum when 5% of 15mm shredded tyres are added to the soil.

Table II
Variation of CBR Value with Respect to Percentage of Shredded Tyres for 1.5 cm and 3.0 cm Size.

Material	% OF Shredded Tyre	CBR Value (%)
Black cotton	0	5.24
Black cotton and shredded tyre(1.5cm)	5	11.27
Black cotton and shredded tyre(1.5cm)	25	10.28
Black cotton and shredded tyre(3.0cm)	5	11.51
Black cotton and shredded tyre(3.0cm)	25	10.26

G. P. T. Ravichandran, A. Shiva Prasad, K. Divya Krishnan and P. R. Kannan Rajkumar

This paper presents the investigation on possibility of using crumb rubber powder was an additive to improve the strength of soft soil, with the various percentages of crumb rubber (5, 10, 15 and 20%).In addition to strength development, the influences of this stabilizer type and different quantities on drainage characteristics are also studied. Hence from this study it has been concluded that the addition of crumb rubber of 10% shows the improvement in CBR value of soil is 161% and 130% in soil A1 and A2 (as shown in the below fig).And it also concluded that the crumb rubber powder mixed with both the soil showed improvement in CBR value with its addition up to 10% and there onwards decreased with further increase in crumb rubber powder.

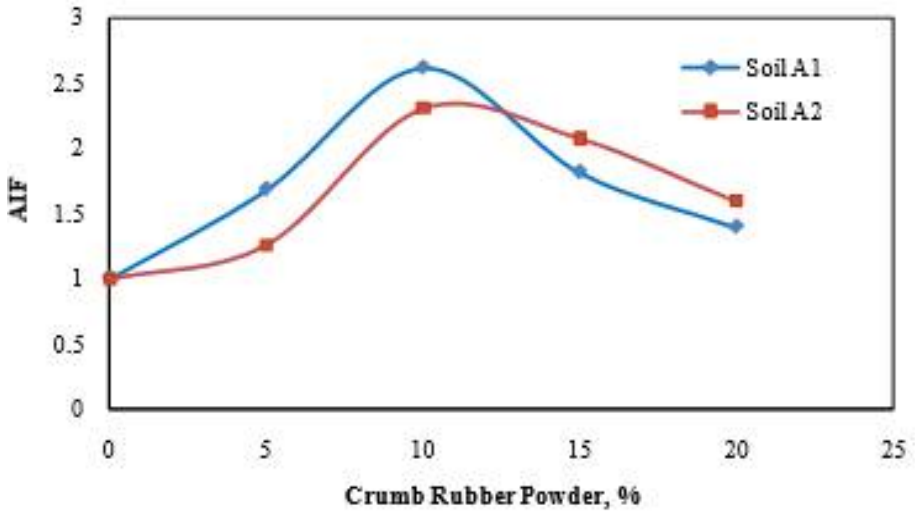


Fig.7 Variation of admixture inluence factor on CBR values with the addition of CRP.

H. Ms. Rajvinder Kaur, Er. Dalvir Sing

This paper presents the influence of tire waste on shear strength and bearing capacity of soil, experimental has been performed on soil sample with different tire ratio powder of waste have been used in this study. Various crumb rubber powder having 0%, 5%, 10%, 15% were choose. To find the effect of tire waste on shear strength direct shear test device has been used and CBR test apparatus has been utilized to study the effect of tire waste on the bearing capacity of the stabilized soil. It was found that shear strength of black cotton soil is increased with addition of 10% of CRP (as shown in the table).Hence it has been concluded that addition of 10% of CBR to the soil increases CBR value but if the percentage of CRP increase more than 10%, the soil strength gradually decreases.

Table III
California bearing ratio for black cotton soil.

Penetration (mm)	Load (kg/cm square)			
	0% of rubber powder	5 % of rubber powder	10% of rubber powder	15% of rubber powder
2.5	6.109	9.175	10.233	4.963
5	4.649	7.978	9.759	7.715

I. Shubha M and Pavan Kumar Balichakra [October 2018]

In this study an attempt is made to stabilize the soil using tyre waste of percentage (i.e. 4%, 6%, 8%, 10%, 12%). The soil is generally weak and has less stability against the application of load. Results of the study reveal that the engineering properties of soil can be improved by the addition of tyre waste and also solves the problem of disposal of waste. From the results it can be concluded that the tyre waste in the form of rubber crumb can be effectively utilized as a stabilizer in the pavement construction. From the standard compaction test results, it can be observed that the maximum dry density reduces with increase in percentage of rubber crumbs and this could be due to the light weight of rubber crumbs. From the CBR test it is observed that CBR value increases with the percentage increase in rubber crumbs, this increment in CBR value can be observed up to the addition of 12% of rubber crumb to the black cotton soil, reduces the CBR value [as shown in the below the fig]. Hence it can be concluded that 12% is the optimum value of rubber crumb that can be added to the soil for stabilization. The problem of disposal of tyre waste can also be addressed by the intelligent utilization of waste as a stabilizing material in the road construction.

Table IV
California bearing test value

Description	CBR
Black cotton Soil	0.76%
Soil+4% rubber crumb	0.94%
Soil+6% rubber crumb	0.99%
Soil+8% rubber crumb	1.26%
Soil+10% rubber crumb	1.28%
Soil+12% rubber crumb	1.30%
Soil+14% rubber crumb	1.16%

J. I Juliana, A R Fatin, R Rozaini, M N Masyitah, A H Khairul and A Nur Shafieza

In this study, soil stabilization using crumb rubber with 2%, 4%,6%,8%. A series of laboratory testing of unsoaked and soaked (4 days) California Bearing Ratio (CBR) test have been performed to evaluate the best percentage of CR which fulfilled the JKR specification for subgrade. The results show that all mixtures; M2 (2% CR), M3 (4% CR), M4 (6% CR), and M5 (8% CR)(as shown in fig) are fulfilled the subgrade requirement according to the Public Works Department Malaysia (JKR) standard specification for road works where the CBR value must achieve more than 5%. The mixture with 4% CR (M3) shows the highest unsoaked and soaked CBR value. Hence from the it has been concluded that the 4% CR is recommended to be implemented for subgrade soil stabilization.

Table V
The percentage mixture of soil and crumb rubber.

Mixture	Percentage Mixture (%)	
	Soil	Crumb Rubber(CR)
M1(control sample)	100	0
M2	98	2
M3	96	4
M4	94	6
M5	92	8

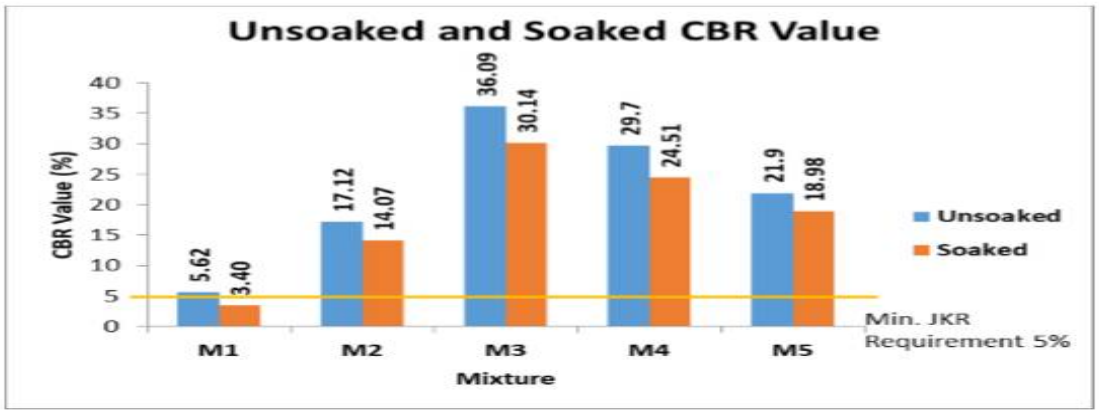


Fig.8 Graph of un soaked and soaked CBR values with 0%, 2%, 4%, 6% and 8% of crumb rubber.

III.COMMENT

1) The soil stabilization of black cotton soil can be done at some extent.
2) Tyre waste can be used as soil stabilizing material.
3) For stabilization rubber crumbs are more effective than the rubber chips.
4) Comparing treated and untreated soil, the untreated soil gives more result.

IV.CONCLUSIONS

A. From the investigations, addition of 2 to 10% of crumb rubber powder to the soil increases CBR value.
B. Tire chips also improve the stiffness behavior of the soil.
C. In addition, the introduction of crumb rubber as soil stabilizer also will reduce the road construction cost and significantly also will solve the waste tires disposal and pollution problems.
D. This investigation evaluates the use of rubber for stabilization of red soil is not adoptable.
E. It was found that the rubber tyre can be effectively used in road construction and pavement design as the CBR value can be improved.

F. Tyre chips have potential to improve the load carrying capacity of the soil.

G. Observing its economic cost and quality of stabilization improvement, it is clear that this type of stabilization may be applicable in stabilization of black cotton soil in construction of road or in shoulder portion of highways.

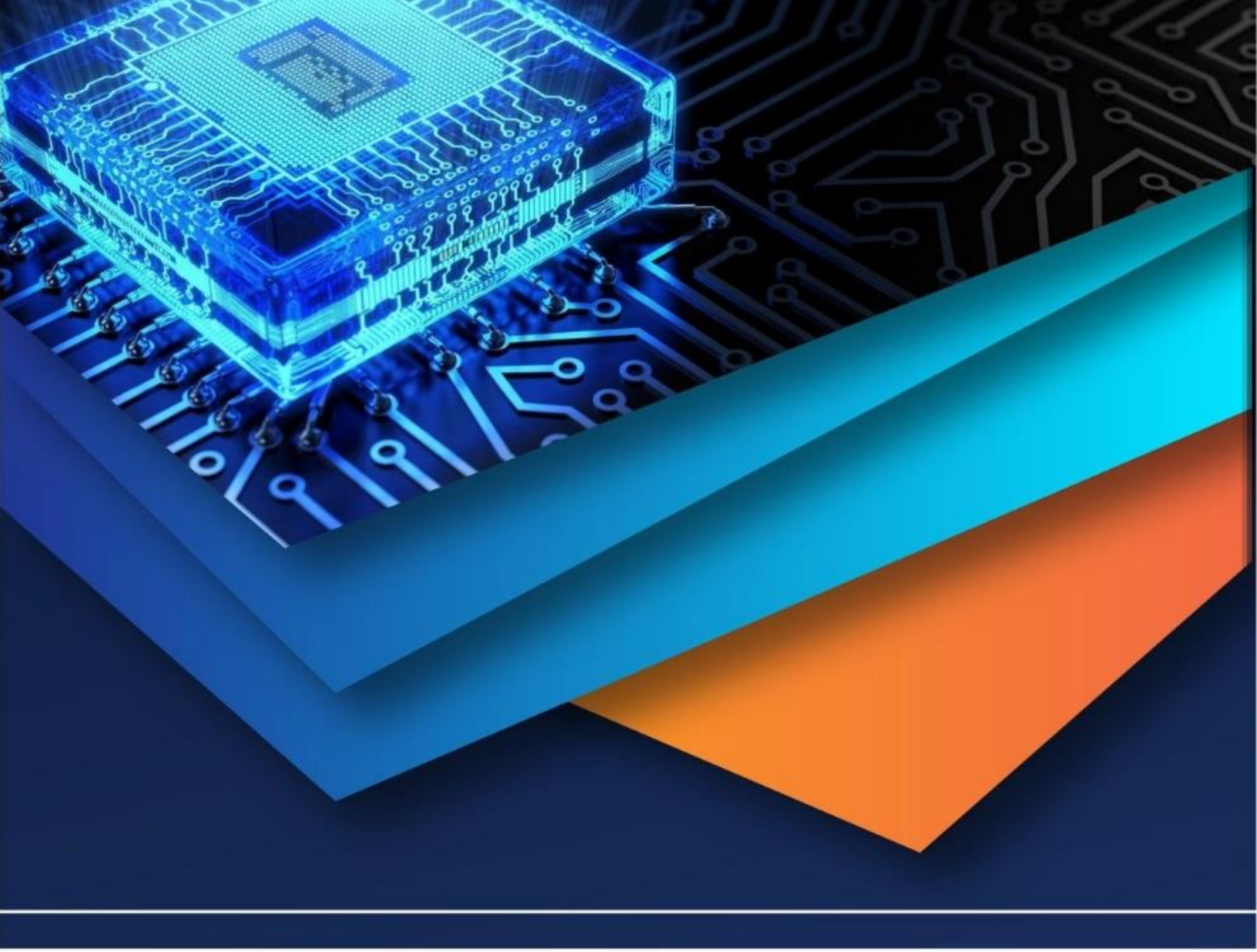
H. The utilization of industrial wastes is an alternative to reduce the construction cost of roads particularly in the rural areas of developing countries.

I. The soil stabilization method is economical as it reduces the disposal problem by recycling of tyre waste.

J. The unsoaked soil more effective than the soaked soil.

REFERENCES

[1] Piyush V. Kolhe, Rushikesh V. Langote – "Performance of Black Cotton Soil Stabilized with Rubber Tyre Shreds"
[2] M. Neeraja – "A Study on black cotton soil- shredded tyres mixture properties"
[3] P. T. Ravichandran*, A. Shiva Prasad, K. Divya Krishnan and P. R. Kannan Rajkumar "Effect of addition of waste tyre crumbs rubber on weak soil stabilization "
[4] Shubha M and Pavan Kumar Balichakra –"Stabilization of Black cotton soil with Tyre Waste''
[5] I Juliana, A R Fatin, R Rozaini, M N Masyitah, A H Khairul and A Nur Shafieza – "Effectiveness of crumb rubber for subgrade soil stabilization"
[6] Ms. Rajvinder Kaur, Er. Dalvir Singh – "Tyre rubber powder as soil stabilization"
[7] CH Kusuma Keerthi and Sumanth Doodala – "Stabilization of black cotton soil by using grounded rubber powder''
[8] Ganesh S Ingle – "Strength and swelling Behavior of Black cotton soil stabilization with waste rubber tyre"
[9] G. Ravi Kumar and K. Gayathri: Performance evaluation of crumb rubber powder as soil stabilizer.
[10] Manjesh Srivastava, Akash Priyadarshee, Vikas Kumar, Sunayana, Ashish Kumar and Vijay Kumar: Strength and stiffness behavior of the black cotton soil reinforced with tire chips under Ring Footing.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY