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Study on Ground Improvement Technique in Different Construction Work

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Abstract: ***The techniques considered for improving the durability of pavment must be benificial for future generation also.The construction industry is under growing pressure to play a part in sustainable development by minimizing the amount of waste generated and maximizing the quantities of material that are recycled and reused for road construction***

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I. INTRODUCTION

Ground improvement techniques are tailored to enhance the bearing capacity and settlement performance of existing soil condition sufficiently for shallow foundations to be used safely.

In recent times the vibrated stone column has grown in popularity as it may be applied to a wide range of ground conditions and soil strengths and is an environmentally acceptable and cost effective method of treating soft deposites.

II. LITERATURE REVIEW

A. McKelvey et al. advices caution when using recycled material due to the high risk of contamination as construction materials are susceptible to smearing. If used in vibro replacement , this material could affect the integrity of the granular column as well as posing a possible risk to the surrounding environment.

B. The viability of recycled rubber is being explored for many engineering applications including construction.

C. Lewis, R. (2006). “Examination of waste material in Geotechnical Applications” BEng Dissertion , Queen’s University Belfast.

D. Black , J.A & Sivakumar , V. (2005). “Vibrated Stone Column In A Weak Peat Deposite Enhanced by Geogrid – Put A Sock On It” , Proc. 6th International Conference on Ground Improvement Techniques , Coimbra , Portugal , pp. 177-184.

E. Xiaoguang , M., Zeai, H., Dermatas , D. , Wei, W. & Hsui, Y.K (1998).”Immobilization of Mercury (2) in Contaminated Soil with Used Tire Rubber , Journal of Hazardous Materials, Vol. 57 , No. 1 , pp.231-241. Elsevier Science.

F. Baez, J.I. & Martin , G.R. , 1992, “Quantitative Evaluation of Stone Column Techniques for Earthquake Liquefaction ,” X World Conf. on earthquake Engineering Rotterdam,pp.1477-1483.

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III. PROBLEM IDENTIFICATION

The premature deterioration of asphalt pavement is usually due to failure in construction or human error . This can be due to a number of factors including:

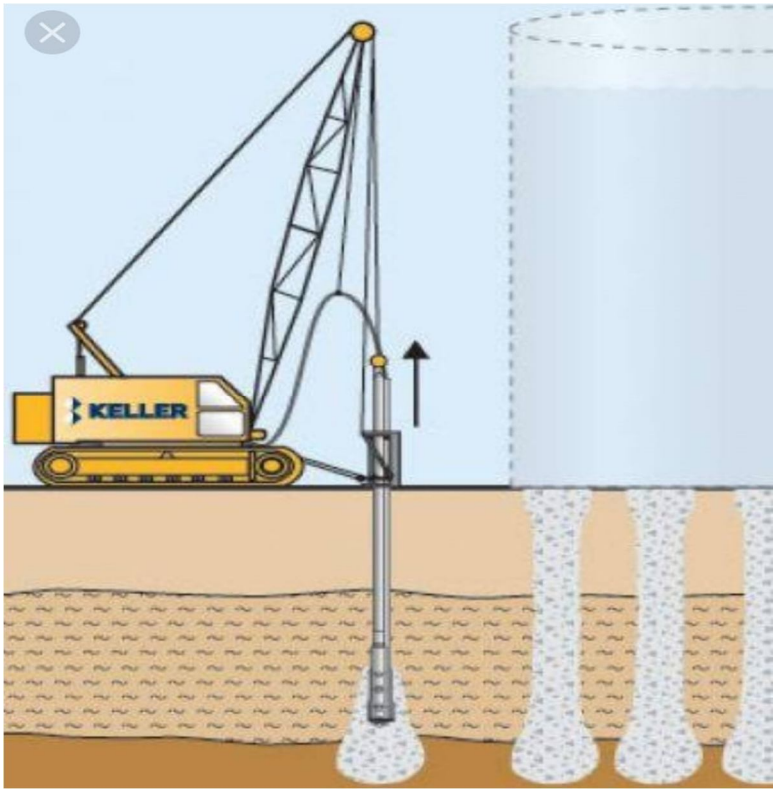
1) Insufficient or improperly compacted base below the asphalt .
2) Over or under compaction of asphalt .
3) Improper temperature of asphalt when applied .

Poor drainage .

IV. METHODOLOGY

A. Vibro Stone Column Technique

1) Vibro stone columns or aggregate piers are an array of crushed stone pillars placed with a vibrating tool into the soil below a proposed structure .
2) This method of ground improvement is also called vibro replacement.
3) Such techniques increases the load bearing capacity and drainage of the soil while reducing settlement and liquefaction potential.
4) Stone columns are made across the area to be improved in a triangular or rectangular grid pattern.
5) They have been used in Europe since the 1950s , and in the United States since the 1970s. Column depth depends on local soil strata, and usually penetrates weak soil
6) During construction , a vibrating tool suspended from a crane penetrates to the design depth by means of its own weight and vibrations.
7) Predrilling may be required in dense soil or may be used to reduce the amount of ground displacement during installation.



8) The vibrating probe breaks down the pores of the surrounding soil , thereby densifying the soil.
9) The stone that is poured in takes the place of the soil and keeps up the pressure on the soil that was created by the vibrating probe.
10) The stone consist of crushed coarse aggregates of various sizes.
11) The ratio in which the stones of different sizes will be mixed is decided by design criteria.
12) Spacing and diameter of columns are also determined by design criteria.

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B. Description of Vibro-Stone Column Technique

1) Vibro stone columns or aggregate piers are an array of crushed stone pillars placed with a vibrating tool into the soil below a proposed structure .
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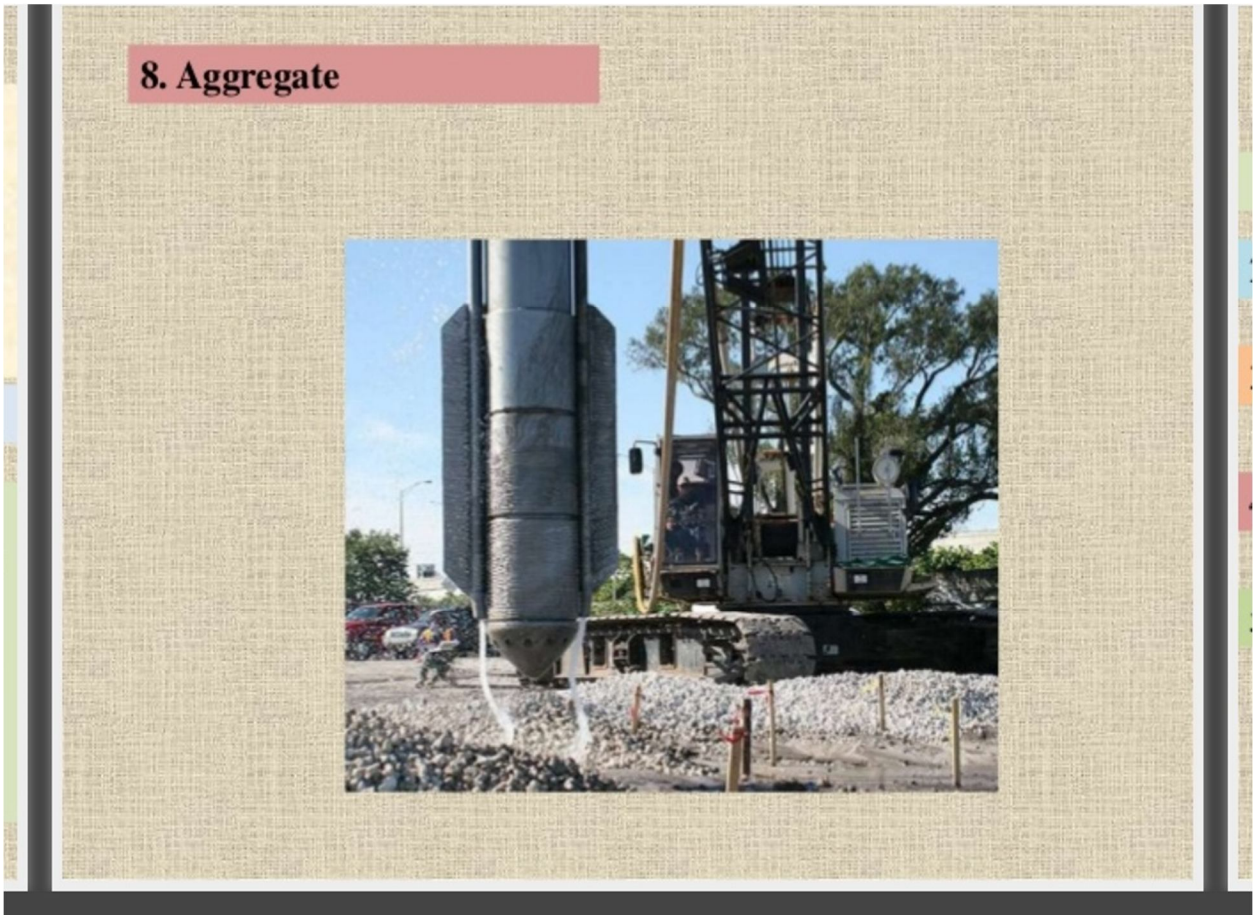
6) During construction , a vibrating tool suspended from a crane penetrates to the design depth by means of its own weight and vibrations.
7) Predrilling may be required in dense soil or may be used to reduce the amount of ground displacement during installation
8) Crushed stone is introduced into the hole by one of two methods.



9) In the dry bottom method a pipe attached to the vibrator supplies stone directly to it.
10) In the wet top method , water jets located in the vibrator's tip create an annualr space around the vibrator through which stone is introduced from the top.

C. What do stone column do?

1) Stone column help to limit the amount and consequences of future liquefaction by : Densifying the soil throuugh vibration and introducing stone into the soil.
2) Reinforcing the soil creating a stiff composite soil mass.

D. What is vibro?

1) Vibro-compaction is a ground improvement technique that can be used to transfer structural loads to suitable levels in poor ground conditions.

2) The effect of vibration consolidates and strengthens the ground, helping to compact non cohesive soil such as sand that would otherwise be unsuitable for construction.

E. How are Stone Columns Made?

1) While some stone columns were carved in one piece , as buildings became bigger , columns began to be constructed from separate drums.

2) These were individually carved and fitted together using a wooden dowel or metal peg in the centre of the drum.

F. Brief Description of vibro stone Column

1) This technique involves the improvement of weak soils by the installation of densely compacted columns made from gravel or similar material with a vibrator.

2) The displacement process reinforces all soils in the treatment zone and densifies surrounding granular soils.

3) It's a technique first developed by KELLER company founder , Johann Keller, which is used on thousands of projects.

G. Common Uses

1) Reduce foundation settlement

2) Increase bearing capacity , allowing reduction in footing size

3) Increase stiffness

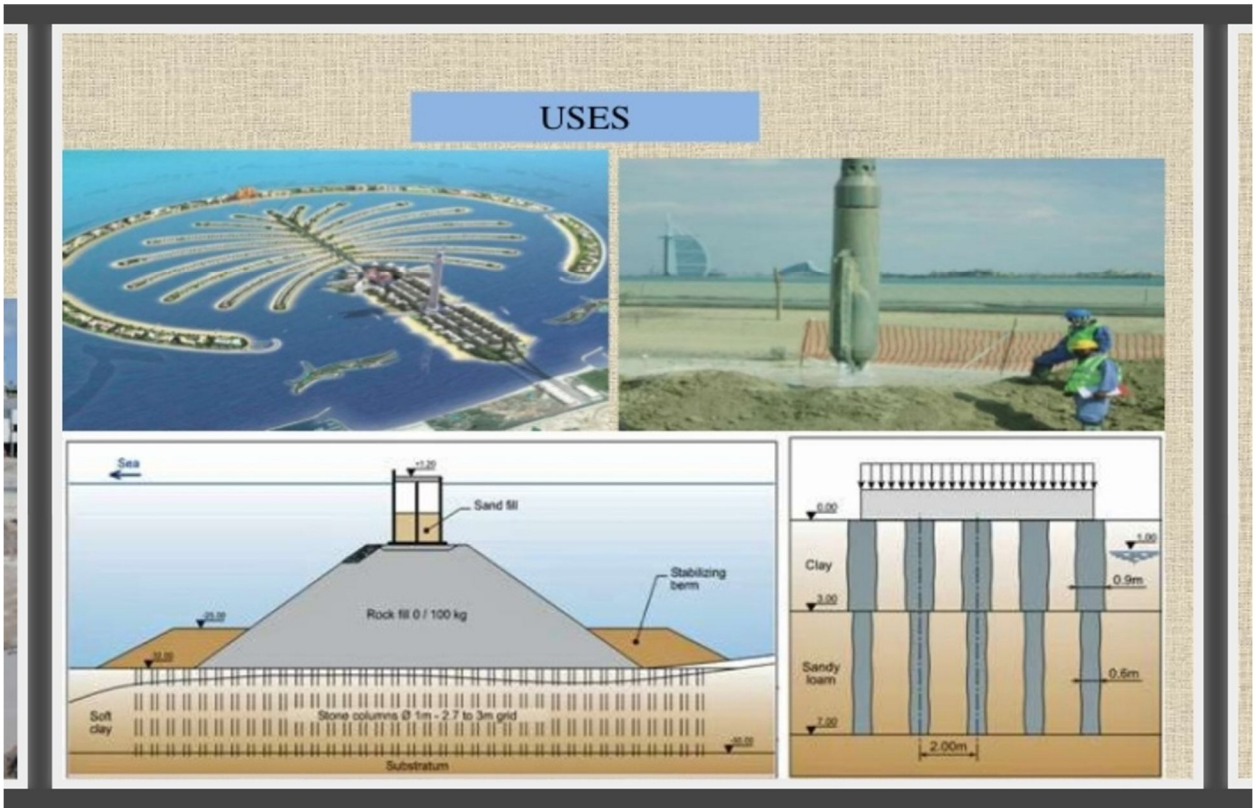
4) Increase shear strength

5) Reduce permeability

6) Mitigate potential for liquefaction

7) Permits shallow footing construction in treated fills

8) Very effective for sand compaction and land reclamation**.**



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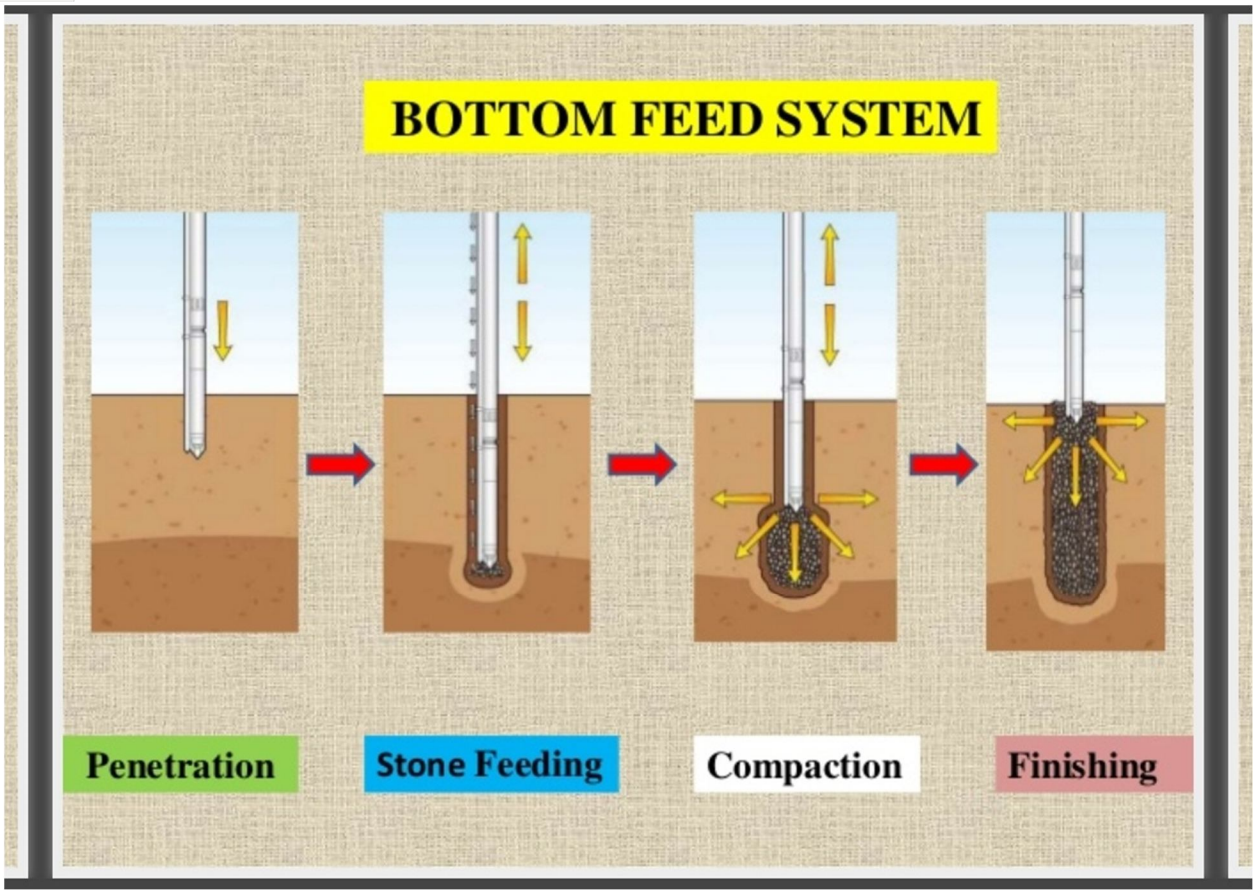
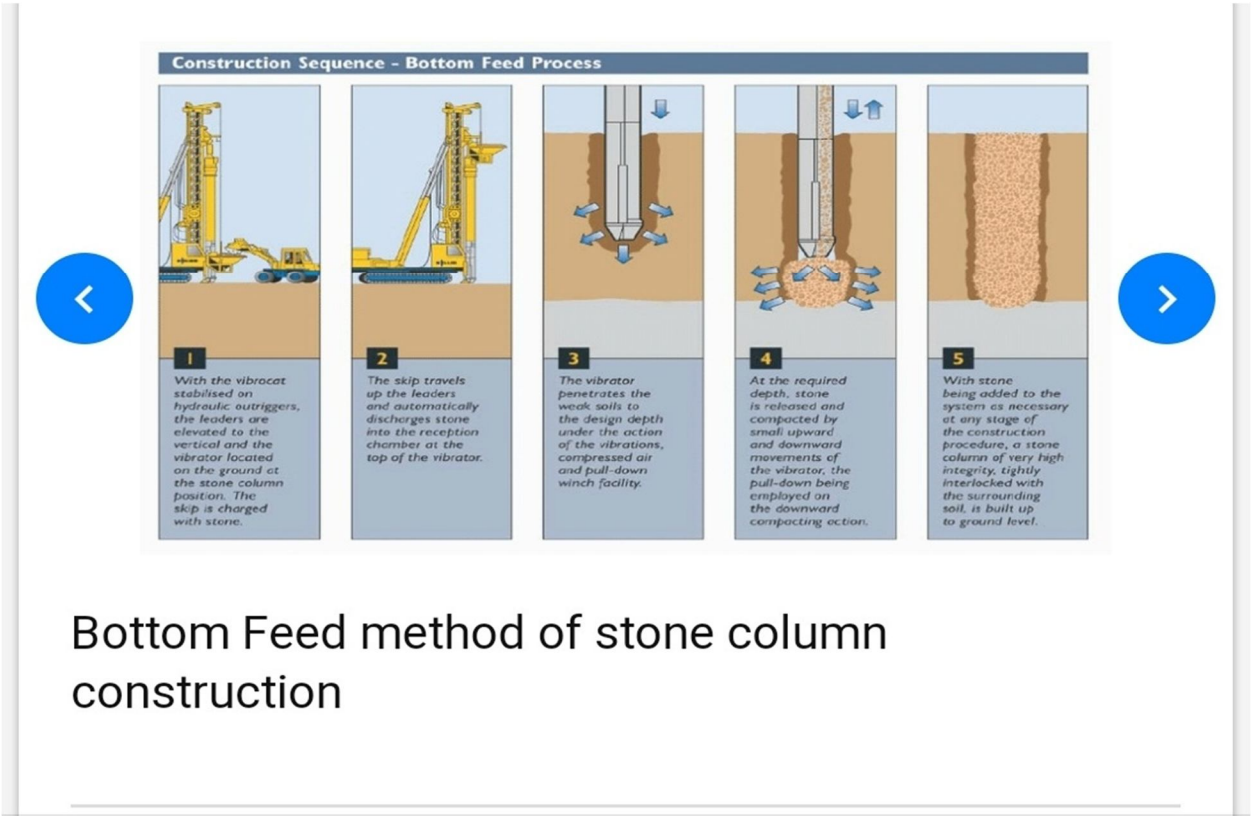
H. Process Of Vibro- Stone Column

1) In the top feed process , the vibrator penetrates to the design depth using the vibrator's weight and vibrations, as well as air jets located in the tip.
2) The stone is then added at ground level to the space created around the vibrator.
3) The stone falls through the space to the vibrator tip , and fills the void created as the vibrated is lifted a few hundred millimetres.
4) The vibrator is then lowered , densifying and displacing the underlying stone .
5) This vibro replacement process is repeated in lifts untill a dense stone column is constructed to the ground surface.
6) The bottom feed - process is similar , except that the stone is fed to the vibrator tip through an attached feed pipe.
7) Pre – drilling of dense strata may be required for the vibrator to penetrate to the design depth .
8) Vibro rigs can be fully instrumented with an on – board data acquisition system.
9) Data from the system , such as amperage and lift rate , can then be recorded and displayed in real – time alongside specified target values on an in-cab monitor.
10) This monitoring allows the operator to correct any deviations in real – time during the construction process to keep the vibro compaction within project specifications.
11) Variations on the product include vibro concrete columns where concrete is pumped into the ground through the vibrator , and environmental stone columns where a plug of cement – based grout or weak concrete is placed at the base of the column.

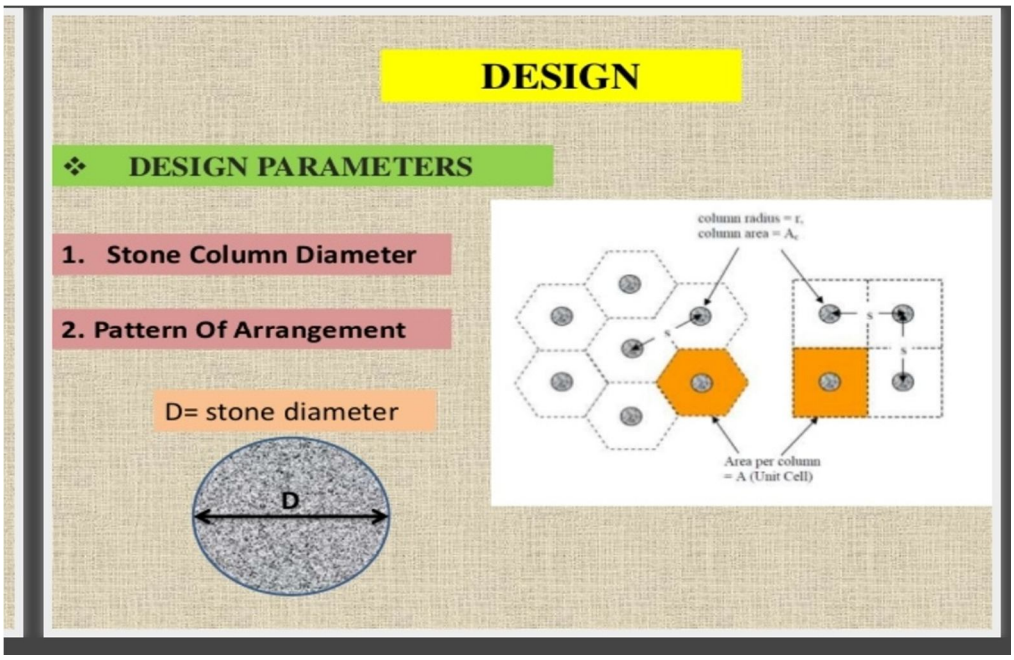




Bottom Feed method of stone column construction

I. Advantages

1) Offers an economical alternative to pilling .
2) A versatile ground – improvement method that can be adjusted to a wide variety of soil conditions and foundation requirements.
3) Can be carried out to depths of up to 15 metres.
4) Relatively quick execution so subsequent structural works can follow very quickly.
5) Enables standard shallow foundations which can lead to savings.
6) Environmentally – friendly as recycled materials can be used.
7) Extremely quiet with low vibration.



J. Quality Assurance

1) The vibro equipment we use is designed and manufactured by our in – house equipment manufacturer exclusively for use by keller companies.
2) In – house quality production management software enables us to capture and analyse data in real time and valid the performance of the ground improvement being carried out .
3) A variety of production parameters are generally logged during execution including depth , current pull down force , uplift/pull down sequence, time and date and element number.
4) Field trials can also be used to verify column production parameters , along with static load tests , single or group , column material compressive strength tests , single or group , column material compressive strength tests and column diameter verification.

K. Laboratory Experiment

1) Vibro - replacement is primarily used for settlement control . Load test are therefore the best indicator of the settlement characteristics of the treated ground under load.
2) A number of reduced scale plate loading tests were performed to assess the load settlement performance of isolated granular columns in a sand deposite using the top-feed method .
3) The overall column performance is largely dependent on the amount of lateral support provided by the surrounding soil . In the laboratory experiments loosely compacted sand was used to form the test bed as it would model a soft deposite typically found in-situ.
4) The diameter , length and particle size of each stone column was selected to replicate a realistic field condition at approximately 8 times the scale of the prototype , based on a typical column with diameter 600mm , length 6-10m and particle size of 40-75mm.

L. Experimental Programme

Test 1 column type	Test 2 column type	Test 3 column type
Standard Aggregate (Half – Length)	Standard aggregate	Standard aggregate
Crushed concrete(Half-length)	Crushed concrete	Crushed Paste
No column	No column	No column

Test 4 column type	Test 5 column type	Test 6 column type
Standard aggregate	Standard aggregate	Standard aggregate
50% rubber 50% aggregate	Rubber	100% Polystyrene
No column	No column	50% polystyrene 50% aggregate

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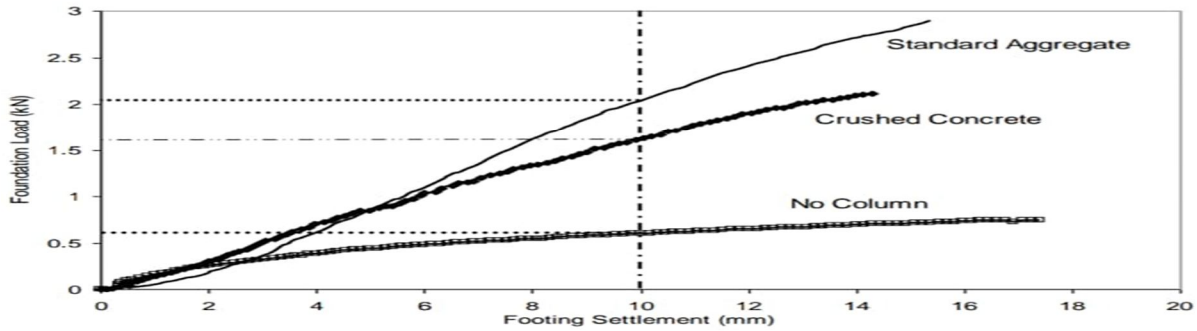

Figure 3: Load-Settlement graph of Test 1 – Half Length Columns

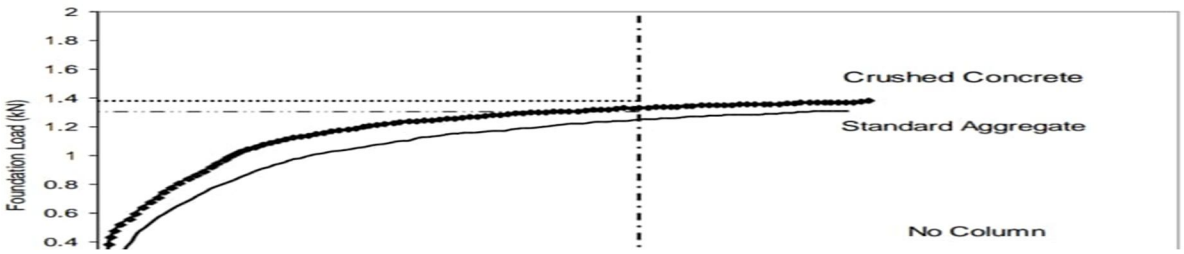

Figure 3: Load-Settlement graph of Test 1 – Half Length Columns

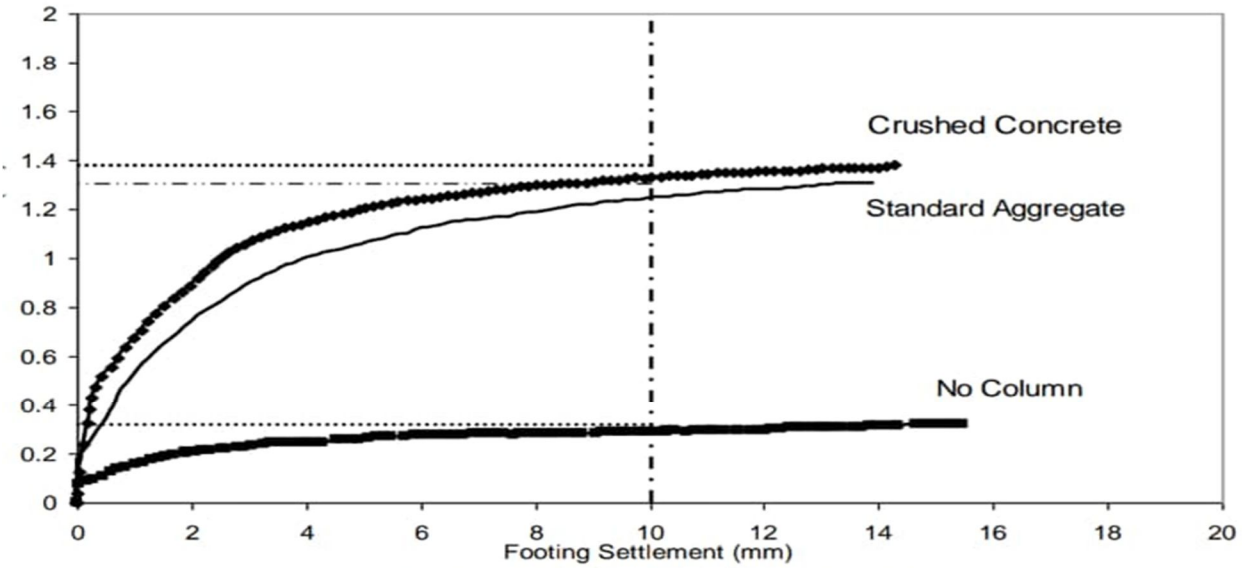

Figure 4: Load-Settlement graph of Test 2

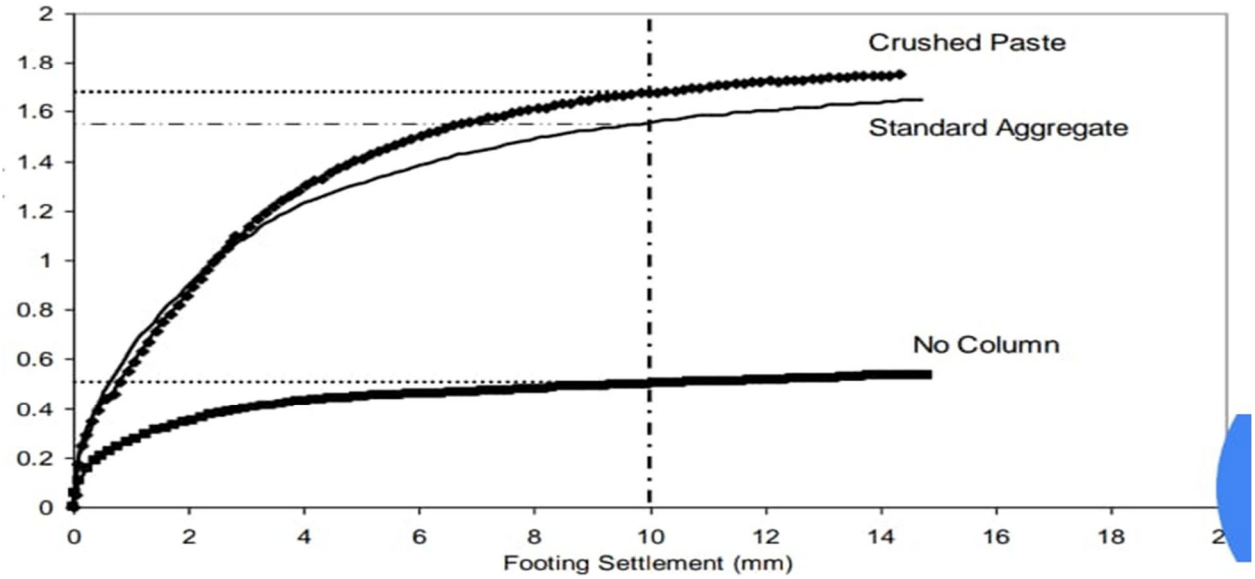

Figure 5: Load-Settlement graph of Test 3

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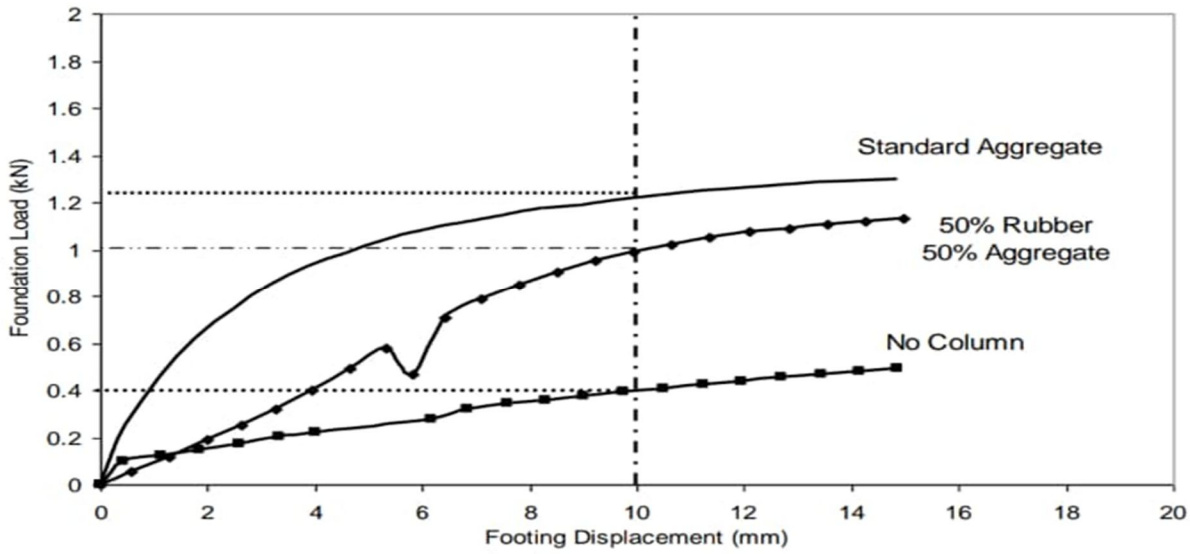

Figure 6: Load-Settlement graph of Test 4

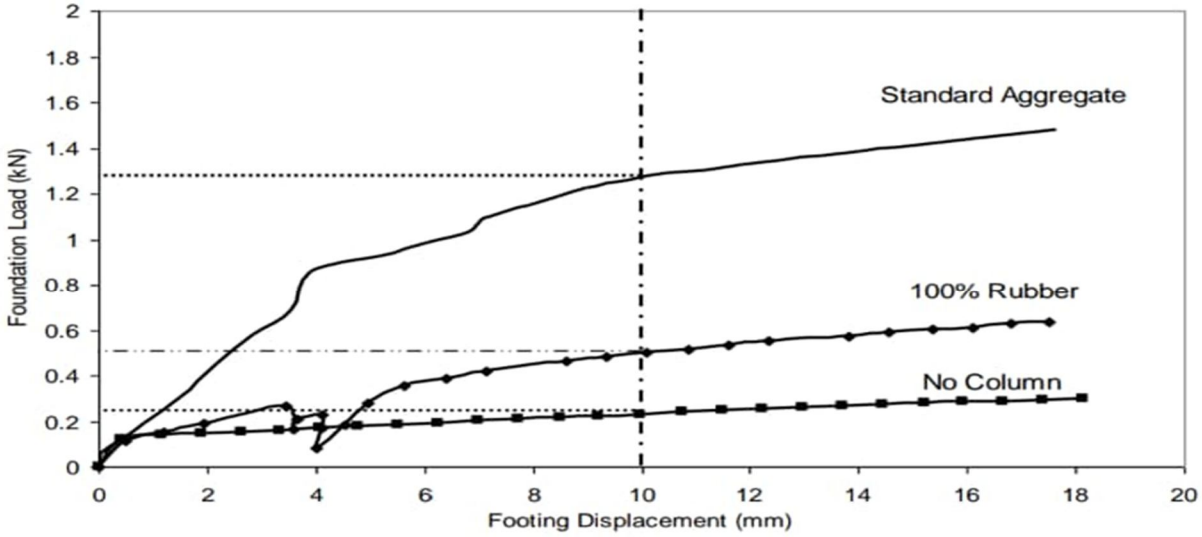

Figure 7: Load-Settlement graph of Test 5

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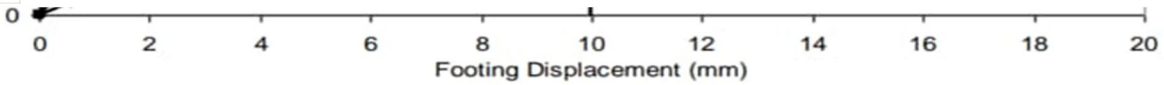

Figure 6: Load-Settlement graph of Test 4

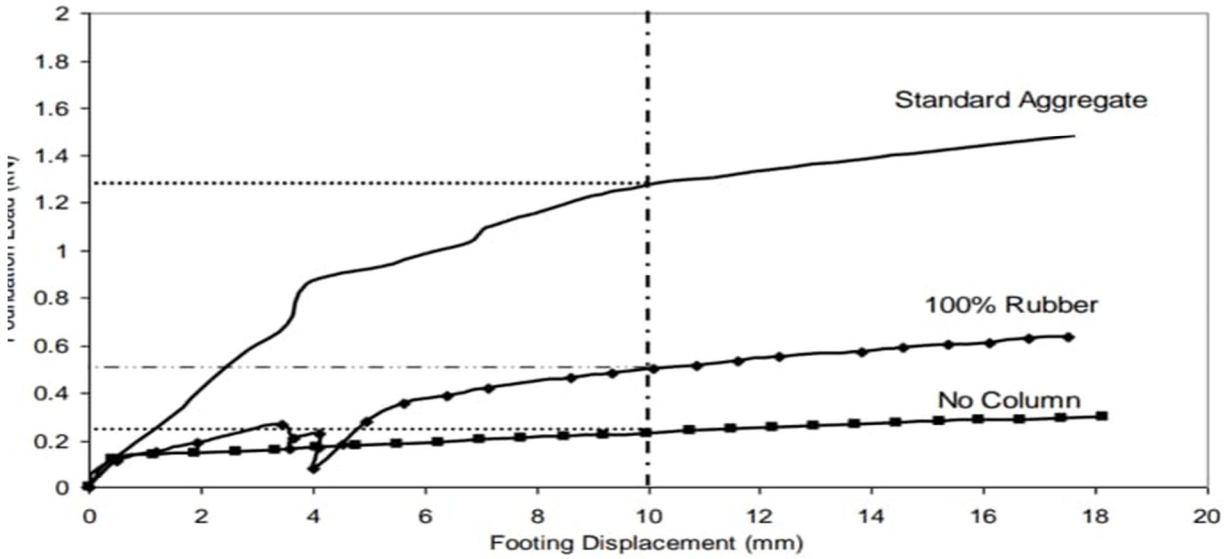

Figure 7: Load-Settlement graph of Test 5

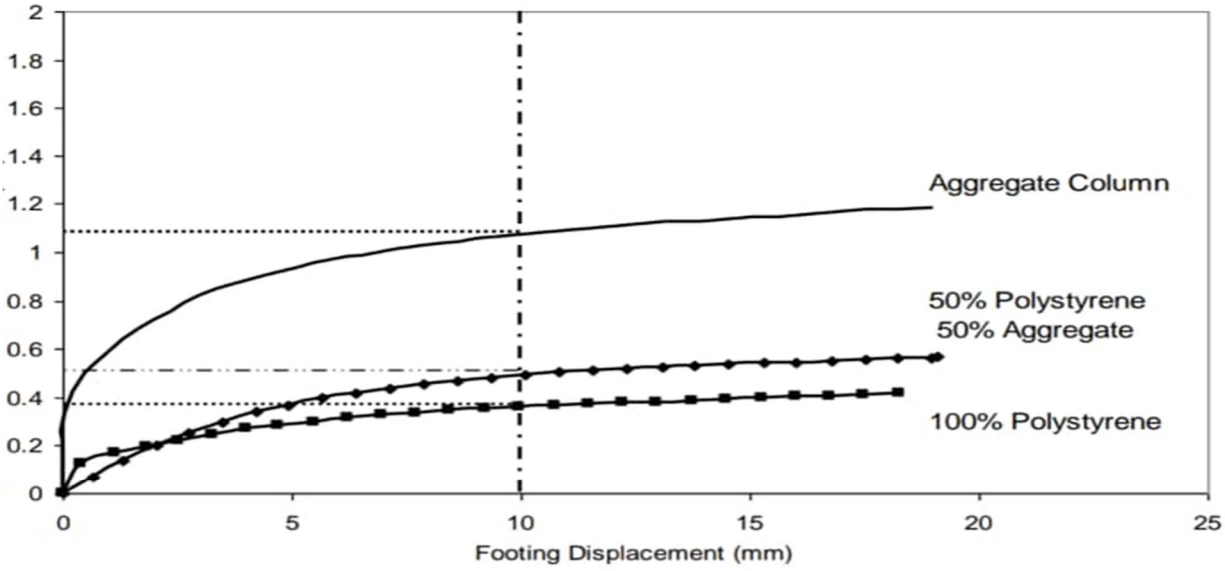

Figure 8: Load-Settlement graph of Test 6

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V. RESULT AND DISCUSSION

By the overall stuudy of the vibro stone column technique I come to know that there are two principlal methods of construction of vibro stone columns are :

A. The Conventional top feed Process

In this process , a hole is formed by a built base machine with a vibrator which is mounted on the mast of a built excavator.After removing the vibrator the hole remains open and the stone infill is added and compacted by the vibrator in stages , assisted by compressed air.

B. The Bottom feed Process

This is a dry process which is used to treat unstable soils or soils with a high ground water level . The Vibrator perforates the weak soil under the influence of vibrations and compressed aie jetting medium and creates a hole to design which is usually a competent bearing stratum , After being held at depth for a short time , the vibrator is withdrawn and a charge of stone is placed into the hole.

VI. CONCLUSION

This study has examined the viability of incorporating reused and recycled waste materials to the technique of vibrated stone columns. It may be concluded that of the materials tested , recycled crushed concrete and 50 % rubber 50 % aggregate columns performed as well as or even better than the commonly used standard aggregate columns performed as well as or even better than the commonly used standard aggregate columns in relation to their load– settlement characteristics. It may be noted that further research into degradation of crushed concrete under sustained loading may be needed in order to validate its use as a suitable stone column material.

A. Future Scope

I would like to perform several test on vibro stone column technique . All tests are performed in a large rectangular steel framed wooden box , 1500x750x750mm,in sixe.

1) Equipment

a) The triaxial machine mentioned can generate a load which is transferred through the foundation loading apparatus to the soil surface .

2) Test Material

a) Sand
b) Polystyrene
c) Granular material
d) Crushed basalt
e) Crushed concrete

VII. ACKNOWLEDGEMENT

I express my sincere gratitude to many people who have helped me and supported during synopsis work. Without them I could not have completed the project on time . I am thankful to my guide , Mr. Piyush Das for valuable guidance , encouragement and patience.
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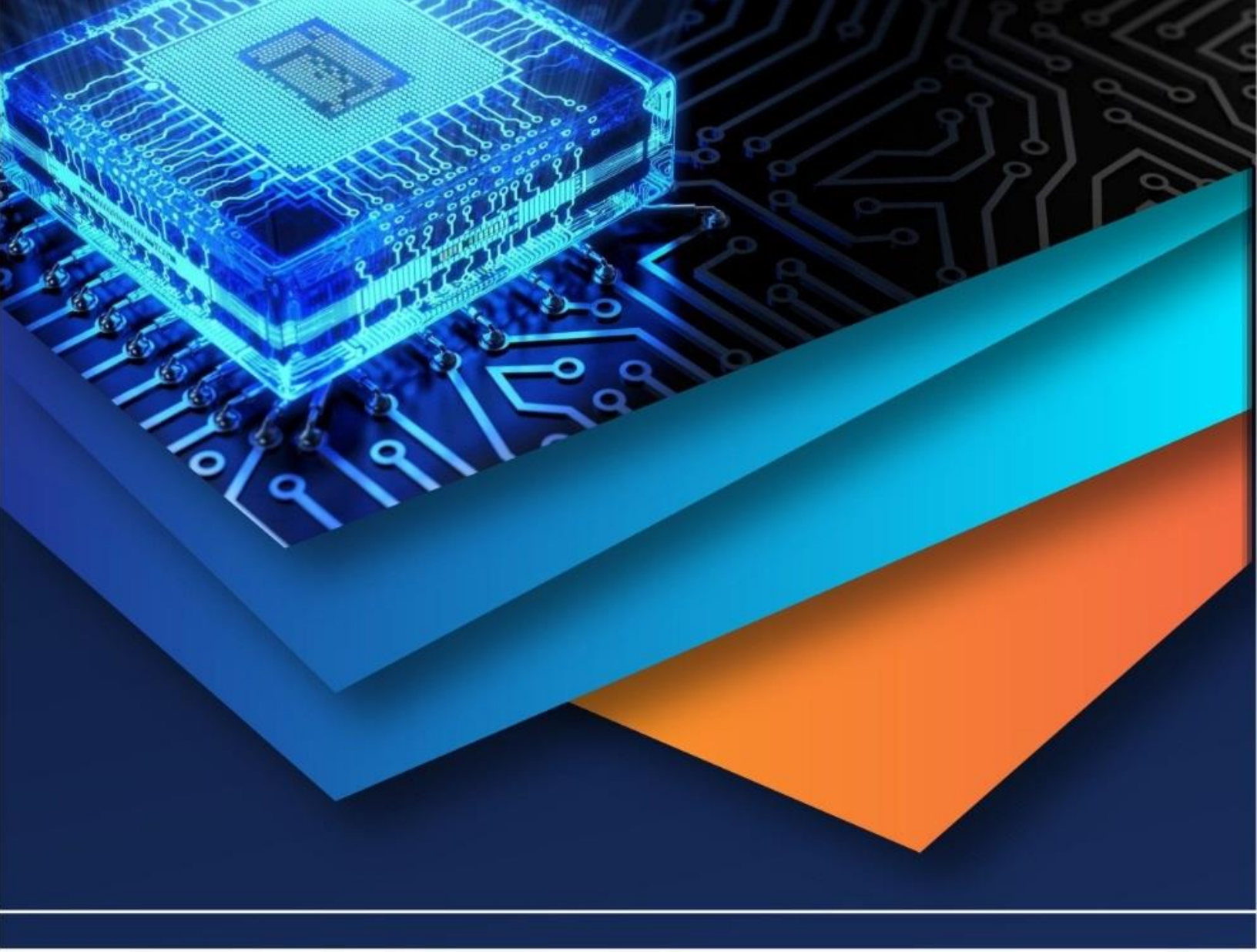

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