

A Review On Stabilization Of Black Cotton Soil By Using Fly Ash, Marble Sludge And Brickdust Waste

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Abstract - In our country, Black cotton soil covers more than one-fifth of the whole land territory. These are for the most part found in and around the Deccan level. The black cotton soil is a far-reaching soil which demonstrates hazardous for the designing work. Black cotton soil has low bearing limit, high compressibility and swelling and shrinkage properties. To defeat on these building issues soil stabilization is the best arrangement. In our exploration we utilized the idea of compound stabilization. We utilized fly fiery debris and rice husk straw slag in various extent with black cotton soil. The present paper quickly portrays the trial examination did by including fly fiery debris and rice husk straw powder to black cotton soil for enhancing its building properties. Nowadays the necessity of soil stabilization in black cotton soil has been expanded by including diverse material. It's an expected to extend the exploration and including conceivable material here has been talked about with this study. Stabilization utilizing strong squanders is one of the diverse strategies for treatment, to enhance the building properties and make it reasonable for development. The gainful impacts of some unmistakable strong squanders as got in research facility examines, in stabilization of extensive soil have been talked about in this study.

Keywords - Black Cotton Soil (BC-Soil), fly ash, brick dust, Engineering property, Stabilization

1. Introduction

Sweeping soils, for example, black cotton soils, are essentially powerless to adverse volumetric changes, with changes in dampness. This character of soil is ascribed to the nearness of mineral montmorillonite, which has an extending cross-section. Understanding the conduct of far-reaching soil and receiving the suitable control measures have been incredible undertaking for the geotechnical engineers. Broad research is going ahead to discover the answers for black cotton soils. There have been numerous techniques accessible to controlling the far-reaching nature of the soils. Treating the far-reaching soil with electrolytes is one of the methods to enhance the conduct of the broad ground. Thus, in the present work, experimentation is done to examine the impact of electrolytes i.e., potassium chloride, calcium chloride and ferric chloride on the properties of extensive soil.

Soil stabilization can be described as upgrading the soil properties. Soils containing basic levels of silt or mud have changing geotechnical characteristics: they swell and advance toward getting to be plastic inside seeing water, shrink when dry, and stretch out right when introduced to ice. Site development is reliably a delicate and troublesome issue when wanders are finished on such soils. In various words, the re-usage of these materials is as often as possible troublesome, if surely attainable. When they have been treated with lime, such soil can be used to make banks or subgrade of structures, in this way evading expensive revealing works and transport. Usage of lime basically changes theascribes of a soil to make whole deal enduring quality and security, particularly with respect to the action of water and ice.

The mineralogical properties of the soil will choose their level of reactivity with lime and a complete quality that the offset layers will are believed to be the extraordinary contender for stabilization. Soils containing important measures of normal material (more imperative than around 1 percent) or sulfates (more conspicuous than 0.3 percent) may require additional lime or unprecedented improvement. The quality and bearing limit of the soil is amazingly upgraded by soil stabilization through controlled compaction, proportioning and the development of sensible admixtures. The swelling soil isn't fitting for the advancement tackle record of its volumetric changes. It swells nonsensically with a change of water content. Such tendency of soil is a direct result of the closeness of fine soil particles which swell, when they communicate with water, realizing trade swelling and contracting of soil on account of which differential settlement of structure happens. In the examination the results are considered of the capacity of lime and consumed block dust as offsetting added substance to the extensive soil is evaluated for the improving outlining properties of soil. The evaluation incorporates the confirmation of the swelling potential, atterberg's points of confinement and compaction preliminary of far-reaching soil in its trademark state and when mixed with changing the degree of block residue and lime. Stabilization of black cotton soil has been done in this wander work by using lime and block dust as admixture.

Using marble dust as a stabilization agent

Shahul Hameed et al (2012) creator examined an expanding alert now that the decision of development materials should likewise be represented by environmental contemplations. In the start of the Twentieth Century, the total populace was 1.5 billion; before the finish of the twentieth century, it had ascended to 6 billion and now, in the year 2011 it is 7 billion.

Maintainability includes that the requirements of the present age are met without squandering, dirtying, destructive, wrecking nature and without trading off the capacity without bounds ages to address their issues. Globally, endeavours are being made to join the idea of supportability in outline and development of infrastructural frameworks. The ASCE (2005) Code of Ethics calls for Civil Engineers to fuse the standards of reasonable improvement in their training. Indeed, even a little decrease of the ecological effect per ton of solid will bring about extensive natural advantages in view of the colossal measure of cement created today. Innovative work to change over these modern squanders to the helpful application, for example, a development material will give more other options to the designer to choose the most reasonable solid trade material for various conditions. Reusing and utilizing waste to deliver an SCC may then be the best alternative to maintain the future economy. Lower porousness can be prompted longer toughness and delayed administration life of the structure. These outcomes are of incredible significance since this sort of inventive cement requires a lot of fine particles. Reusing and utilizing waste to create an SCC may then be the best alternative to manage the future economy. Accordingly, it is suggested that the supplanting of characteristic sand with 85% CRD and 15% MSP, as the substitution in SCC. Blends SCC2, SCC4 and SCC6 with W/P 0.3 are prescribed. Table 7.1 prescribes that material amount per cubic meter of cement for creating SCC utilizing CRD and MSP aggregates.

A. Dhanalakshmi, M. Shahul Hameed(2018) examined the corroborative material and their determination on the properties of specific SCC. Quarry squander limestone powder (QLP) can effectively be utilized as a part of the generation phase of legitimate SCC blends miniaturized scale and nano silica materials enhanced the consistency of the HPSCC and decreased the likelihood of draining and isolation. The investigation of SCC blends was made by supplanting up to 30% of Class C fiery remains with foundry silica-dust Addition of MSP more prominent than 15% makes the solid unsatisfactory for SCC. Consequently, the consequences of this exploration give a solid help to the utilization of MSP as a filler in SCC fabricating. A most extreme of 8% of limestone powder with silica smoulder, 30% of quarry residue and 14 % of clinkers could be utilized as a mineral admixture without influencing the self-smaller capacity. In any case, various clear conclusions have been gotten about the conduct of HSSCC

Gupta and Sharma (2014) had examined the impact of fly fiery debris, sand and marble dust on compaction and CBR estimations of sweeping soil, there was roughly 200% expansion in absorbed CBR the example having soil - 52.36%, and 22.44%, fly cinder - 13.2% and marble dust-12%

Amu et al. (2005) had used (Class- F) fly ash and cement for stabilization of expansive soil. It was found that stabilizing effect of 9% cement and 3% fly ash was better than the stabilizing effect 12% cement.

2. Soil stabilisation with lime-activated-GGBS

The accessibility of soils with the correct designing profile has for since a long time ago hindered the utilization of most floodplains for various land utilize and advancement centred applications, particularly street infrastructural improvement. As of late, the clatter for the diminishment in the worldwide use of rare regular assets has prompted certified endeavours in the use of most floodplains for infrastructural advancement. This by chance will constitute an immense easing on the weight applied on great soils as they are normally arable terrains. One such accentuation is that talked about by this paper, utilizing soil stabilization as a measure of lessening the pernicious impacts occasioned by flooding on the developed street, and street dykes. Where street developments through floodplains experience troublesome materials, one of the accessible established alternatives had dependably been to unearth and import great materials for substitution as they were either frail or extensive sub-levels (Yang and Zheng, 2006). Right now, inferable from enactments and charges forced on specific practices, the procedure of removal and transportation of good quality soil material is winding up more costly. This expanded cost is either on the grounds of expanding carbon film coming about because of consuming petroleum product, or the cost suggestion and harm to the earth. This has brought about the collection of the greenhouse gases in charge of an unnatural weather change. In an offer to diminish this worldwide ecological emergency it is essential that waste generation is decreased or overseen, vitality utilization lessened, practices to lessen common asset wastages actualized and forms bringing about carbon dioxide emanation into the earth likewise lessened. Sadly, this is a hard nut to open as most improvement forms depend on mechanical exercises that creates these gases for their production.

The effectiveness of stabilising weak soil soaked in water to simulate flooding scenarios,

(G.N. Obuzor et al, 2012) The pickup in quality by a lime-balanced out framework is advanced at specific scopes of stabilizer expansion. In any case, after absorbing water for a stretched out time of up to 10 days, the sturdiness record however low was seen to increment with restoring age. The quality of a Lime– GGBS– LOC framework expanded with the diminishment in lime content, and under brutal states of absorbing water for a broadened time of 10 days the quality improvement was not fundamentally bargained. In the interim, as far as its strength, it apparently declined with expanding age. Toughness expanded with increment in compaction dampness substance, and fractional splashing of tests expanded quality and sturdiness file esteems. Consequently, at 4%L– 12%G and 33% cover structure and dampness content the sturdiness was most noteworthy despite the fact that as far as quality, it was seen to diminish with expanding dampness past an ideal. The most noteworthy qualities were conceivable with 4%L– 12%G– LOC balanced out examples after a restoring time of 90 days and unsoaked. The quality diminishment record of Lime– LOC frameworks is colossally dependant on the GGBS segment which builds the density and penetrability of the framework through the expanded creation of cementitious gels.

3. CBR of BC-Soil using Brick Powder & Lime

(Akshatha , 2016) Black cotton soils are profoundly clayey soil dark or blackish in shading. "Black cotton soil is regularly known as Expansive soil due to their shading and their appropriateness for developing cotton. They contain 'montmorillonite' dirt mineral which has high extensive attributes. BC soils have low shrinkage farthest point and high ideal dampness content. It is profoundly delicate to dampness changes, compressible subgrade material. Issues related to asphalt development turn out to be more basic when the subgrade comprises far-reaching soils. In India, far-reaching soils cover around 0.8x106 Km2 regions,

roughly one-fifth of its surface territory. Henceforth the subgrade and its unfortunate attributes can be altered utilizing a reasonable stabilization strategy.

Steadiness adjustment includes the techniques utilized for altering the properties of a soil to enhance its designing execution. In the development of street and landing strip keeps, the primary goal of the stabilization is to expand the quality or steadiness of soil and to lessen the development cost by making best utilization of the locally accessible materials. From the ongoing examinations it is watched that, strong waste materials, for example, stone work squander (Brick powder) are utilized for this planned reason. Transfer of these waste materials is basic as these are causing perilous consequences for nature. This may be observed to be a sparing treatment strategy for soils as these materials are accessible locally and such arrangement will be discovered valuable for the creating nations like India where the economy is the prime worry for receiving any new strategy or system. Lime has been generally utilized either as a modifier for clayey soil or as a folio. At the point when clayey soils with high pliancy are treated with lime, the versatility file is diminished and soil ends up friable and simple to be pummeled, having less liking with water. Lime additionally imports some coupling activity.

The MDD of the chose BC soil increments and the OMC of the soils diminishes with the expansion of lime and also Brick Powder. The Increase in MDD and diminishment in OMC is more with an increment in the extent of admixtures in the soils. The consequences of the examination demonstrate that both lime and Brick Powder are appropriate for upgrading properties of the soils. Black cotton soil after stabilization the required CBR estimation of 8% as indicated by IRC: 37-2012 is accomplished by settling with the substitution of BC soil by half BP, 4% lime and 30% BP + 1.5% lime. From the above talk, it can be presumed that the BP can adequately be used with BC soil in enhancing the soil CBR esteems. The utilization of Brick Powder brought about the usage of decimation squanders and observed to be sparing for a neighbourhood. This will bring about the usage of rejected black cotton soil in development. From the outcomes, it is inferred that the effect of Brick Powder and Lime is sure.

4. Lime-cement stabilized soil-mine tailing for highway construction

(O.O. Ojuri et al, 2016) Lime-cement was utilized as a balancing out cover in a proportion of 1:2 to treat Lateritic Soil-Mine Tailings (LMT) blends. Quality attributes and natural effect of the Lateritic Soil-Mine Tailings Binder Mix in parkway development was assessed utilizing a progression of research centre tests. Results got from the investigation uncovered that the contextual investigation lateritic soil has a place with the SC bunch in the Unified Soil Classification System (USCS) or A-2-7 (4) soil gathering of the AASHTO soil characterization framework with the fluid point of confinement and versatility record estimations of 53.5% and 31.4%, individually.

The expansion of shifting amounts of mine tailings to supplant the soil test diminished the fine division and Atterberg confines values along these lines enhancing the nature of the soil as a subgrade material in thruway development. Maximum dry density (MDD) estimations of the soil expanded while optimum moisture content (OMC) diminished when the lateritic soil blended with mine tailings (LMT) were treated with Lime-Cement cover. The California Bearing Ratio (CBR) estimations of the soil expanded both with the expansion of the mine tailings and cover. LMT90-10 test (which comprise of 90% of lateritic soil and 10% of mine tailings) was the main example out of the shifted LMT tests in this examination which couldn't meet the base 80% CBR esteem for Highway base course soil suggested by the Federal Ministry of Works and Housing in Nigeria.

The Unconfined Compressive Strength simply like the CBR likewise expanded with an increment in their relieving time and expansion of folio. The natural assessment of the LMT tests in this examination was done on the LMT70-30 blend (which comprise of 70% of lateritic soil and 30% of mine tailings). Filtering test uncovered that the substantial metals exhibit in the leachates of LMT70-30 with folio expansion were diminished underneath the administrative level except for chromium and barium. The draining test likewise demonstrated that the impact of the filtering ages in the examples was insignificant. The mineralogical investigation done on the filtered tests demonstrated that mine following minerals were available in the soil grid, the 8% fastener had the most elevated level of immobilized mine tailings mineral.

5. Soil stabilization of BC-soil by inorganic chemicals

Zumrawi Magdi M. E. (2015) demonstrated the execution of asphalt is exceptionally receptive to the attributes of the soil Subgrade. Consequently, powerless Subgrade is improved by embracing the most proficient stabilization technique. In view of the writing survey, stabilization with fly fiery debris enacted with concrete was observed to be an effective choice for development of soil properties. In such manner, a trial program was embraced to study the impact caused by the joined activity of fly cinder and bond stabilization on the geotechnical characteristics of sweeping Subgrade Soils. Broad soil treated with fluctuating rates of fly powder, 0, 5, 10, 15, and 20 percent joined with 5% bond content were examined. Consistency limits, compaction, California Bearing Ratio, swell potential and swell weight tests were directed on treated and untreated soils. The experimental comes about to demonstrate that expansion of bond fly powder admixture to the soil has an incredible impact on its properties. It was discovered that the ideal dose of fly fiery debris is 15% blended with 5% concrete uncovered an inconsequential change in quality and strength and the decrease in swelling and versatility properties of the soil. Based on the outcomes, it is prescribed that bond fly slag admixture be viewed as a suitable alternative for the stabilization of far-reaching subgrades.

Pandey and Rabbani (2017) have introduced an investigation on the stabilization of asphalt Subgrade soil utilizing lime and cement. India is a position of the geological assorted variety having distinctive soil in various regions. So to enhance those areas having poor bearing limit stabilization procedure is utilized. Both mechanical and compound stabilisation methods are utilized for the change of soil quality. In the mechanical technique, a few machines are utilized for digging the soil and some other sort of soil blended with poor soil in the required amount. After legitimately blending of the soil, spread it by machine and compacted with machine up to required quality. In substance strategies soil mixed with synthetic mixes like lime, bond, fly slag and enzyme. In spite of the fact that bond is skilled of stabilising an extensive variety of soil writes, it is best in sandy soil, sand with residue soil, and dirt soil having plasticity go low to medium. Lime is basically used for mud soil having high pliancy.

(JitendraNayak, 2017) In this investigation, an attempt has been made to study the effect of the chemicals like Sodium Carbonate (Na_2CO_3), Calcium Carbonate (CaCO_3), on the geotechnical properties of an expansive soil. Maximum improvement found in CBR value when 1.00% of the chemical used in case of Sodium Carbonate (Na_2CO_3) and Calcium Carbonate (CaCO_3) and after all calculations it is found that Calcium Carbonate (CaCO_3) is more effective in improving the CBR values of the admixed soil when compared to Sodium carbonate. Previously mentioned properties of soil utilized the substance organization of synthetic concoctions, the strategy received for blending and the tests directed are presented in this Chapter. The blending has been done in the lab. The properties considered in this study are versatility, pH, and swelling. The soil test kept prepared is blended with concoction arrangement of varying percentages. The compound arrangement is set up by dissolving concoction powder in refined water. The rates of the chemical are changed from 0.00, 0.25, 0.50, 0.75, 1.00 And 1.25 percent by weight of the soil. The soil and the chemical are blended all together and utilized for the tests. The California bearing proportion test is entrance test meant for the assessment of sub level quality of streets and asphalt. The outcomes acquired by these tests are used with the observational bends to decide the thickness of asphalt and its segment layers. This is the most widely utilized technique for the plan of adaptable asphalt.

1. The CBR values of the admixed soil corresponding to 2.50mm as well as 5.0mm penetrations are higher than that of the untreated soil.
2. The maximum improvement in CBR value corresponding to 2.50mm penetration is found to be 38.46% and 130.60%, when the soil is admixed with Sodium Carbonate (Na_2CO_3) and Calcium Carbonate (CaCO_3) respectively.
3. The maximum improvement in CBR value corresponding to 5.00mm penetration is 29.40% and 141.20%, when the soil admixed with Sodium Carbonate (Na_2CO_3), Calcium Carbonate (CaCO_3), respectively.
4. The maximum improvement in CBR value occurs at 1.00% of the chemical in case of Sodium Carbonate (Na_2CO_3) and Calcium Carbonate (CaCO_3).
5. The Calcium Carbonate (CaCO_3) is more effective in improving the CBR values of the admixed soil when compared to Sodium carbonate.

6. Construction and demolition waste (CDW)

(Javier Tavira et al, 2018) The development area contributes essentially to ozone-depleting substance emanations on account of the utilization of overwhelming hardware and as a result of bond creation; these outflows contribute incredibly to environmental change (UE Directive 2010/31/EC). Also, development exercises devour a vast amount of non-sustainable characteristic assets, for example, aggregates, which are rare in numerous nations. To lessen these negative impacts and add to the maintainability of the segment, it is important to advance the utilization of reused aggregates (RA) from development and destruction squander (CDW). This will give a second life cycle to crude materials **(G.A. Blengini, 2009)**.

Because of the high amount of excavated soil obtained from construction sites **(S. Mudgal et al, 2014)**, it is very imperative to discover new applications for these squanders. To the best of the creators' information, there are no past examinations researching RA blended with exhumed soils and utilized as unbound layers in streets. RMA with soil (RMAS) could likewise be a decent material for lessening versatility of the unearthed squanders, since RA has no extensive properties **(J.R. Jiménez, 2013)**. To test the suitability of RA utilized as a part of unbound layers in street asphalts, it is basic to recreate genuine scale models. It is central to perform centre and long-haul assessments to confirm the consistency of RA in these employments. In view of the term of the present investigation, this objective has been accomplished. It likewise fills a hole in the accessibility of long-term execution thinks about on reused materials utilized as a part of streets open to movement.

7. BC-Soil stabilized by subbase material (brick powder and lime)

In the course of recent decades, stabilization is observed to be the best procedure for decreasing the swelling and shrinkage nature of the black cotton soil. Different researchers had a go at settling black cotton soil utilizing lime, bond, fly fiery remains, rich husk cinder, and so on. **(Mohanty, 2015)**. Of these, the lime stabilization is one of the systems which is being used for balancing out black cotton soil from a previous couple of decades. Utilization of lime lessens the high versatility of black cotton and makes it useful. Also reaction amongst lime and soil influences the soil-to lime blend more quality resistant **(B. Mishra, 2015)**. Be that as it may, as of late, the cost of lime has expanded and brought about an increment of the cost of lime stabilization of soil. Additionally, in the present examination, an endeavour is made in settling the black cotton soil with lime which ended up being unsatisfactory as subbase material. Consequently, the need for option and practical materials has stirred.

Brick block powder, a waste material accessible in wealth at block furnaces, is wealthy in silica and is accessible free of cost. Compound investigation of block powder demonstrated rich arrangement of silica of around 55% alongside minor pieces of iron oxide (8%), aluminum oxide (15%), calcium oxide (7%), magnesium oxide (2%), and sulfur trioxide (1%) **(A. Ali Aliabdo et al, 2014)**. Block powder is by and large effectively utilized as a part of the mortar and solid making from a previous couple of decades. It is accounted for that use of 25% block powder in solid making brought about satisfactory quality and warm obstruction and furthermore tended to cost adequacy and natural issues. Incomplete supplanting of concrete with block powder in mortar has demonstrated that with the utilization of block powder the reused total mortar appeared to be prevalent as far as mortar-brick block security quality chiefly due to its rheological properties. Utilization of block powder as an incomplete substitute for sand in concrete demonstrated a decrease in unit weight of cement and had enhanced the quality of cement adequately **(D. Tavakoli et al, 2014)**. Likewise, utilization of block powder in bond mortar lessens the weakening impact of soluble base silica responses.

Ongoing examinations prompted advantageous utilization of block powder in asphalt. Block powder when utilized as an elective filler in black-top blend brought about enhanced mechanical properties of the wearing course of adaptable pavements **(S. Wu et al, 2011)**. Concentrates on the utilization of black brick powder as a stabilizer for black cotton soil demonstrated that when around half block brick powder is blended with black cotton soil there has been a noteworthy increment in quality parts of the soil. Be that as it may, utilization of block powder alone for stabilization of black cotton soil requires it in enormous sums.

Blending different materials alongside block powder for balancing out black cotton soil lessens the issue of getting the material. Block aggregate when utilized as a part of fly cinder lime-settled black cotton soil enhanced the quality attributes of black cotton soil for use as a base course in asphalts. Block dust alongside bagasse fiery remains utilized for balancing out black cotton soil enhanced the unconfined compressive quality of the soil essentially (K. Sudharani, 2017).

8. Conclusion

From the investigation did on block powder and lime stabilized black cotton soil blend, the conclusion is Lime stabilization of black cotton soil under study improved the quality attributes of the soil, but not to the degree of reasonableness as subbase material. Blending 20% block powder and 80% lime-stabilized black cotton soil enhanced the most extreme dry density and diminished the ideal dampness content in comparison to 4% lime settled the soil.

80% lime-balanced out black cotton soil and 20% brick powder blend brought about the increment in the soaked CBR esteem by around 135%, when contrasted with 4% lime-settled soil, making it acceptable for utilize subbase material. Use of block powder decreases the substance of lime which thus lessens the cost of the task as the brick powder is unreservedly accessible. Likewise, utilization of block powder reduces the issue of waste disposal. Hence block powder and lime-balanced out black cotton soil mixture can be viably utilized as sub base material in flexible pavements of country territories where block powder is accessible in good sums and furthermore in regions with less accessibility of good quality material.

Stabilization of sweeping soil utilizing strong squanders enhances the geotechnical properties of broad soil. The greater part of the analysts has examined the impacts of stabilization on list properties, compaction properties, UCS, CBR and swelling properties of far-reaching soil. The impacts of stabilization on, combination properties, sheer quality, part elasticity, firmness and pressure have driven conductivity of broad soil have not been contemplated by a large portion of the scientists. Examinations on, impacts of contaminants on geotechnical properties of settled soil, mineralogical studies, solidness and financial part of stabilization are constrained in writing. Conduct of the balanced out soil subjected to cyclic stacking is additionally constrained in writing. The techniques for development using the strong squanders are not really found in writing. Consequences of field examine are additionally observed to be irrelevant in writing. Not very many examinations have been made with respect to, stabilization of sweeping soil utilizing Fly fiery debris, marble ooze, and block dust squander. Immaterial investigations have likewise been done on stabilization of sulphate rich extensive soils.

Reference

- [1] M. Shahul Hameed, A. S. S. Sekar, L. Balamuruganand V. Saraswathy, Self-Compacting Concrete Using Marble Sludge Powder and Crushed Rock Dust, *KSCE Journal of Civil Engineering* (2012) 16(6):980-988, DOI 10.1007/s12205-012-1171-y.
- [2] Logaraja, R., Shahul Hameed, M., presented a paper entitled "Thermal Resistant Concrete Under Elevated Temperature" in the 2nd International Conference on recent Trends in Civil Engineering, Technology and Management (ICRTCETM-2017) on 12th & 13th April 2017 organized by PSR Engineering College, Sivakasi, Tamil Nadu in association with Seventh Sense Research Group, Chennai Division, (www.internationaljournalsr.org), Tamil Nadu, India
- [3] Shahul Hameed, M. Kathirvel, P. and Sekar, A.S.S., "Production of SCC using crusher rock and marble sludge dusts", *Journal of National Building Materials and Construction World*, ISSN 0973- 0591, Vol.16, No.4, pp.222-232, October 2010.
- [4] A. Dhanalakshmi, M. Shahul Hameed, Review Study on High Strength Self Compacting Concrete, *IJSTE - International Journal of Science Technology & Engineering | Volume 4 | Issue 12 | June 2018*.
- [5] Shahul Hameed, M., Kannan Paulraj and Dr.Saravanan, R "Five "I" model: Measuring quality of Banks in rural Marke", *PSNA journal of business and system*, ISSN 2319-2909, RNI No. TNENG/2011/36418, Vol.II, Issue II, pp.23-44, June-Dec 2012.
- [6] Akshatha R, Bharath H M, Improvement in CBR of Black Cotton Soil Using Brick Powder (Demolition Brick Masonry Waste) and Lime, *International Journal of Innovative Research in Science, Engineering and Technology* (An ISO 3297: 2007 Certified Organization), Vol. 5, Issue 9, September 2016.
- [7] Ali Aliabdo A, M. Abd-Elmoaty, and H. Hani Hassan, "Utilization of crushed clay brick in cellular concrete production," *Alexandria Engineering Journal*, vol. 53, no. 1, pp. 119–130, 2014.
- [8] Amu, O. O., Fajobi, A.B. and Afekhuai, S.O. (2005) "Stabilizing Potential of Cement and Fly Ash Mixture on Expansive Clay Soil," *Journal of Applied Sciences*, 5(9), 1669-1673.
- [9] Anil Pandey, AhsanRabbani "Stabilisation of pavement subgrade soil using lime and cement: review" *International Research Journal of Engineering and Technology* (IRJET) e-ISSN: 2395 -0056 Volume: 04 Issue: 06 | June -2017 www.irjet.net p-ISSN: 2395-0072.
- [10] B. Mishra, "A study on engineering behavior of black cotton soil and its stabilization by use of lime," *International Journal of Science and Research*, vol. 4, no. 11, pp. 290–294, 2015.
- [11] D. Tavakoli, A. Heidari, and S. H. Pilehrood, "Properties of concrete made with waste clay brick as sand incorporating SiO₂," *Indian Journal of Science and Technology*, vol. 7, no. 12, pp. 1899–1905, 2014.
- [12] G.A. Blengini, Life cycle of buildings, demolition and recycling potential: a case study in Turin, Italy, *Build. Environ.* 44 (2009) 319–330, <https://doi.org/10.1016/j.buildenv.2008.03.007>.
- [13] G.N. Obuzor, J.M. Kinuthia, R.B. Robinson, Soil stabilisation with lime-activated-GGBS—A mitigation to flooding effects on road structural layers/embankments constructed on floodplains, *Engineering Geology*, *Engineering Geology* 151 (2012) 112–119.
- [14] Gupta, C. and Sharma, R.K. (2014) "Influence of Marble Dust, Fly Ash and Beach Sand on Sub-Grade Characteristics of Expansive Soils," *International Conference on Advances in Engineering and Technology -2014(ICAET-2014)* Spl. Publication of IOSR Journal of Mechanical and Civil Engineering, 13-18.

- [15] J.R. Jiménez, Recycled aggregates (RAs) for roads, in: *Handb. Recycl. Concr. Demolition Waste*, 2013, pp. 351–377. doi:10.1533/9780857096906.3.351.
- [16] Javier Tavira, José Ramón Jiménez, Jesús Ayuso, María José Sierra, Enrique Fernández Ledesma, Functional and structural parameters of a paved road section constructed with mixed recycled aggregates from non-selected construction and demolition waste with excavation soil, *Construction and Building Materials*, Elsevier - Construction and Building Materials 164 (2018) 57–69.
- [17] Jitendra Nayak, Tapas Singh, An experimental investigation on soil stabilization of expansive soil by using inorganic chemicals, *International Journal of Engineering Sciences & Research Technology*, December, 2017, ISSN: 2277-9655, Volume 6(12).
- [18] K. Sudharani, S. K. Abhishek, N. Adarsh, and Manjunath, “Stabilization of black cotton soil using brick dust and bagasse ash,” *International Journal for Scientific Research and Development*, vol. 5, no. 5, pp. 140–144, 2017.
- [19] M. K. Mohanty, *Stabilization of Expansive Soil Using Fly Ash*, Department of Civil Engineering, National Institute of Technology, Rourkela, Odisha, India, 2015.
- [20] Magdi M. E. Zumrawi “Stabilization of Pavement Subgrade by Using Fly Ash Activated by Cement” *American Journal of Civil Engineering and Architecture*, 2015, Vol. 3, No. 6, 218-224 Available online at <http://pubs.sciepub.com/ajcea/3/6/5> © Science and Education Publishing DOI:10.12691/ajcea-3-6-5.
- [21] O.O. Ojuri, A.A. Adavi, O.E. Oluwatuyi, Geotechnical and Environmental Evaluation of Lime-cement Stabilized Soil-mine Tailing Mixtures for Highway Construction, *Transportation Geotechnics* (2016), doi: <http://dx.doi.org/10.1016/j.trgeo.2016.10.001>.
- [22] S. Mudgal, M. Hestin, M. Trarieux, S. Mimid, Contacts BIO Intelligence Service Véronique Monier Service Contract on Management of Construction and Demolition Waste – SR1 European Commission (DG ENV) In association with, 2011.
- [23] S. Wu, J. Zhu, J. Zhong, and D. Wang, “Experimental investigation on related properties of asphalt mastic containing recycled red brick powder,” *Construction and Building Materials*, vol. 25, no. 6, pp. 2883–2887, 2011.

