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# An Experimental Study of Natural Soil Subgrade Stabilized With Wheat Husk Ash and Polypropylene

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***Abstract:** Quality of a pavement depends on the strength of its sub-grade soil. The strength of sub-grade is the major parameter for determining the thickness of pavement. In case of pavement the sub-grade must be uniform in terms of geotechnical properties like shear strength, compressibility etc. Pavement construction may be on natural soil which may be Expansive soil, Black cotton soil, clayey soil, organic soil etc. Natural soils, suffer volume change due to moisture content, which causes heaving, cracking and the break-up of the road pavement. Due to this reason Stabilization of these types of soil is necessary, to suppress swelling and increase the strength of the soil.*

*The growing cost of traditional stabilizing agents and the need for the economical utilization of industrial and agricultural wastes for beneficial engineering purposes has prompted an investigation into the stabilizing potential of Wheat Husk Ash (WH) and Polypropylene (PP) in subgrde soil. The objective of this work is to utilize the effectiveness of Wheat Husk Ash and Polypropylene material to enhance the properties of natural soil used for subgrade material in pavement. The soil was stabilized different percentages of (5, 10, 15, 20, 25 & 30) of WH and after getting optimum percentage of WH, PP with percentage of 0.25%, 0.50%, 0.75%, 1.00%, is added along with WH individually, for the construction of sub grade soil and test like Liquid Limit, Plastic Limit, Plasticity Index, Specific Gravity, Optimum Moisture Content, Maximum Dry Density, Swelling Pressure and CBR is performed.*

***Keywords:** Wheat Husk Ash (WH), Polypropylene (PP), Swelling, OMC, MDD, CBR*

## I. INTRODUCTION

Soil is basic and important element in civil engineering field. Stability of every structure depends on the type and characteristics of foundation which in turn depends on the type of soil. Many problems irrupt if expansive soil, Natural soil is to be used in foundation, because of its shrinkage and swelling properties. There are many methods to make natural soil stable for various constructions. Natural soil is comfortable for road work, compared to other types of soil. There are two ways to enhance the quality of subgrade soil -"Replacement of soil" or "Soil stabilization". Soil stabilization can be done chemically or mechanically. Chemical stabilization is carried out by adding different chemicals in suitable proportion, while mechanical stabilization is achieved by addition of admixtures which helps to improve the properties of soil.The present entire practice of major road construction over deep layer of natural soil subgrade appears to be conservative lacking technical and financial optimization. It is therefore, realized that for the major road construction in natural soil subgrade areas, an alternative approach needs to be made to evolve a pavement subgrade system, that will ensure its effectiveness with respect to both no traffic load condition and maximum traffic load condition along with its simple, easy, economic and durable construction. Wheat is the most common and important human food grain and ranks second in total production as a cereal crop. Wheat grain is a staple food used to make flour for leavened, flat and steamed breads etc., Wheat Husk Ash fiber is waste of crop of wheat, which is escaped out while getting grain from crop. Wheat straw ash is a agricultural waste which obtained from burning wheat straw. When crops of wheat is cut then straw is remain in the ground it self, this straw is a complete waste. But now a days by burning these straw its ash can replace by cement. Much literature is not available on wheat straw ash but it completely shows that it posses pozzolanic properties. Polypropylene (PP) also known as polypropene, is a thermoplastic polymer used in a wide variety of applications including packing, etc. Polypropylene (PP) is a lightweight fiber, it has density of 0.91gm/cm$^3$.It does not absorb water. It presents that it has good resistance towards water abosorb. Polypropylene has excellent chemical resistance. PP fibres are very resistant to most acids and alkalis. The thermal conductivity of this fiber is lower than that of other fibers. PP also has low melting temperature and has high creeping rate. The use of Polypropylene and Wheat Husk Ash as stabilizing material for natural soil can be checked under various tests such as grain size distribution, liquid limit, plastic limit, Plasticity index, Specific gravity, OMC, MDD, Swelling pressure and California bearing ratio (CBR) for soaked and unsoaked conditions. In present study use of Polypropylene and Wheat Husk Ash are used as admixtures for mechanical stabilization of soil subgrade. Polypropylene(PP) and Wheat Husk Ash (WH) help to improve important properties like plasticity, swelling and CBR by addition of these admixtures upto 30%. admixtures used in powder form, mixed with soil in various ratios to modify the properties and to study the change in soil properties. Today, world faces a serious problem of disposal of large quantities of agricultural and industrial waste like Rice husk ash, Wheat Husk Ash etc. The disposal of these wastes without proper attention creates hazardous impact on environmental health. So Polypropylene and Wheat Husk Ash used in this project because these waste materials are also low cost.

## II. OBJECTIVE OF THE STUDY

The work is undertaken with the following sub objectives are;

*A.* To determine the Geotechnical properties of Natural Soil, PP, WH individually, for the construction of sub grade soil.
*B.* To study the suitability of stabilized soil for sub grade soil.
*C.* To use Agriculture waste and Industrial waste (Polypropylene and Wheat Husk Ash) as a stabilized material.
*D.* To determine the Geotechnical properties of Natural soil (Black Cotton Soil), Stabilized with different percentages of (5, 10, 15, 20, 25 & 30) of WH and after getting optimum percentage of WH, PP with percentage of 0.25%, 0.50%, 0.75%, 1.00%, is added along with WH individually, for the construction of sub grade soil.
*E.* To find the optimum value of Polypropylene and Wheat Husk Ash for use as a stabilized material.
*F.* To study the variation of Grain size distribution, Liquid Limit, Plastic Limit, Plasticity Index, Specific Gravity, Optimum Moisture Content, Maximum Dry Density, Swelling Pressure and CBR for both conditions of natural soil with and without PP and WH with above percentage.
*G.* To study and compare the increases percentages of CBR value of natural soil, PP and WH with stabilized soil.

## III. LITERATURE RIVIEW

Geotechnical properties of natural soil such as soft fine grained and expansive soils are improved by various methods. The problematic soil is removed and replaced by a good quality material or treated using mechanical and/or chemical stabilization. Any of the above method can be used to improve and treat the geotechnical properties of the natural soil(such as strength and the stiffness) by treating it in situ. During the past few decades it has been reported that the use of cement or lime for the stabilization of pavement bases was investigated and developed into practical construction procedures. These practical procedures have been improved and covered periodically by the technical standards for road and traffic. These natural soil do not possess enough strength either in construction or during the service life of the pavement. One of the strategies to achieve this is soil stabilization. Generally, the role of the stabilizing (binding) agent in the treatment process is either reinforcing of the bounds between the particles or filling of the pore spaces. Soil stabilization technique is an open-field of research with the potential for its use in the near future.

Cement contains calcium required for the pozzolanic reactions to occur. Further cement already contains silica thus stabilization with cement is fairly independent of soil properties. The only thing required is water for hydration process to begin and attributes to the improvement of strength and compressibility characteristics of soil. It has a long history of use as an engineering material and has been successfully employed in geotechnical applications. Strength gain in soils using cement stabilization occurs through the same type of pozzolanic reactions found using lime stabilization. Both lime and cement contain the calcium required for the pozzolanic reactions to occur; however, the origin of the silica required for the pozzolanic reactions to occur differs. With lime stabilization the silica is provided when the clay particle is broken down. With cement stabilization, the cement already contains the silica without needing to break down the clay mineral. Thus, unlike lime stabilization, cement stabilization is fairly independent of the soil properties; the only requirement is that the soil contains some water for the hydration process to begin.Many engineer and scientist work on stabilization of soil, some work on stabilization of the soil is given below:

### *A. Leonard and Bailey (1982)*

Effect of fine Rice husk ash and coarse Rice husk ash on natural soil was studied. The various test conducted for this project like Atterberg's Limit, Compaction, Triaxial Compression test, Chemical Analysis, Consolidation. The Attempt was made to proposed use of Rice husk ash, from the compaction test results it was observed that the variation of dry density was irregular at higher moisture contents. Bleeding was initiated at moisture contents resulted in erratic 40% and the bleeding moisture content corresponded to optimum moisture content. From the findings it was proposed that finer ash samples exhibited higher strength as compared to the coarser samples.

*B. Martin et al. (1990)*

The effect of Rice husk ash on expansive soil was studied, and different experimental programmers were carried out such as Particle size distribution, Compaction test, Permeability, Consolidation. They investigated that Rice husk ash in partially saturated state displayed an apparent cohesion due to tensile stresses of retained capillary water. Hence, the effective friction angle, Φ', was considered as the major factor for long term stability analysis. The results of the standard extraction procedure toxicity tests showed low metal leaching characteristics of Rice husk ash.

*C. Raza& Chandra (1995)*

The effect of (Rice husk ash + geo-fabric) on soil was studied, They carried various test such as Compaction, Swelling, CBR & UCS. These Studies carried out for use of Rice husk ashes to stabilized alluvial soils, so as to use them as sub grade and base course in airfield and road pavements. The tests conducted on Rice husk ash, soil and their mixtures having various Rice husk ashes: soil ratio. This study indicates that soil treated with Rice husk ash gives considerable improvement in CBR value of soil. With incorporation of geofabric CBR value further increased.

*D. Boominathan and Ratnea (1996)*

The effect of (Rice husk ash + Sugarcane bagasse ash) on soil was investigated, There were various tests conducted for this research work such as Atterberg's Limit, Compaction and UCS**.** These studies have been carried out to proposed use of Rice husk ash for stabilization of soil with and without Sugarcane bagasse ash incorporate. Addition of Sugarcane bagasse ash to Rice husk ash resulted in flocculation and particle aggregation. It was observed that WL and WP were reduced with the Sugarcane bagasse ash treatment whereas UCS increased by about 25 %. The compressibility of Rice husk ash reduced to almost one fourth of the original value due to Sugarcane bagasse ash treatment. It was concluded that Sugarcane bagasse ash treated Rice husk ash could be effectively used for embankment over soft clays.

*E. Singh et al. (1996)*

studied the effect of Rice husk ash and Sugarcane bagasse ash on soil. There were various test programmed conducted for this research work such as Atterberg's Limits, Compaction, CBR, UCS. The Effects of different proportions mixes of Sugarcane bagasse ash and Rice husk ash on local soil of Varanasi evaluated to propose suitability of Rice husk ash-soil Sugarcane bagasse ash as a base and sub base material for the roads. From this study, it can be concluded that good results were obtained when soil was stabilized with 15 % of Sugarcane bagasse ash and Rice husk ash in the proportion of 1:3. Different proportions enabled an increase in the CBR value from 4.00 % to 20.70 % and the unconfined compressive strength from 134 $KN/m^2$ to 680 $KN/m^2$.

*F. Pandian (2002)*

The effect of two types of Rice husk ashes Raichur Rice husk ash (Class F) and Neyveli Rice husk ash (Class C) on the CBR characteristics of the black cotton soil was studied. The Rice husk ash content was increased from 0 to 100%. Generally the CBR/strength is contributed by its cohesion and friction. The CBR of BC soil, which consists of predominantly of finer particles, is contributed by cohesion. The CBR of Rice husk ash consists of predominantly coarser particles which contributed its frictional components. The low CBR of Natural soilis attributed to the inherent low strength, which is due to the dominance of clay fraction. The addition of Rice husk ash to Natural soil increases the CBR of the mix up to the first optimum level due to the frictional resistance from Rice husk ash in addition to the cohesion from BC soil. Further addition of Rice husk ash beyond the optimum level causes a decrease up to 60% and then these is an increase up to the second optimum level. Thus the variation of CBR of Rice husk ash-Natural soil mixes can be attributed to the relative contribution of frictional or cohesive resistance from Rice husk ash or BC soil, respectively. There is an increase of strength with the increase in the Rice husk ash content. Here there will be additional puzzolonic reaction forming cementitious compounds resulting in good binding between Natural soil and Rice husk ash particles.

*G. Kanirajand and Gayathri (2003)*

Effect of Rice husk ash & cement analysis was carried out, UCS test Experiments used to evaluate the factors influencing strength of cement Rice husk ash base courses. Stabilizer content was determined by conducting UCS test on stabilized Rice husk ash specimens cured at different curing conditions. It included Six different curing conditions and adopted controlled and ambient conditions in the study. It was reported that, UCS of stabilized Rice husk ash specimens depends on curing, unit weight, and water content in addition to cement content and curing period.

*H. Phanikumar and Sharma (2004)*

A study of Rice husk ash on Engineering of soil was carried out through an experimental programme. The effect on parameters like free swell index (FSI), swell potential, swelling pressure, plasticity, compaction, strength and hydraulic conductivity of expansive soil were studied. The ash blended expansive soil with Rice husk ash contents of 0, 5, 10, 15 and 20% on a dry weight basis and they inferred that increase in Rice husk ash content .reduces plasticity characteristics and the FSI was reduced about 50% by the addition of 20% Rice husk ash. The hydraulic conductivity of expansive soils mixed with Rice husk ash decreases with an increase in Rice husk ash content. Due to the increase in Rice husk ash content increases in maximum dry unit weight. When the Rice husk ash content increases there is a decrease in the optimum moisture content and as a result the maximum dry unit weight increases. Hence the expansive soil is rendered more stable. The undrained shear strength of the expansive soil blended with Rice husk ash increases with the increase in the ash content.

*I. S. Bhuveneshwariet. al (2005)*

The effect of Rice husk ash on soil was studied, The experimental programmed was carried out by Atterberg's Limits, Compaction, UCS, and Core Cutter. Reported improvements in properties of expansive soil treated with Rice husk ash at varying percentages. Both laboratory trials and field tests have been carried out. It was observed that field application is done through mixing of the two materials (expansive soil and Rice husk ash) in required proportion to form a homogenous mixture there. Trial embankment of 30 m length by 6m width by 0.6m thickness constructed and in-situ tests were carried out.

*J. J.N. Jha (2006)*

Effect of (RHA +Sugarcane bagasse ash) on soil was studied, The tests like Compaction, CBR and UCS test were conducted .Evaluates the effectiveness of using rice husk ash as a puzzuolanae to enhance the Sugarcane bagasse ash treatment of soil. The Studies carried out to study the influence of different mixed proportions of Sugarcane bagasse ash and RHA on various properties of the soil. The result shows that addition of RHA enhances not only strength developments but also it increases durability of Sugarcane bagasse ash stabilized soils.

*K. Edil et al (2006)*

The effect of Rice husk ash on soil was investigated; the tests were conducted like Atterberg's Limits, CBR test. He was evaluated the effectiveness of self cementing Rice husk ashes from combustion of sub-bituminous coal at electric power plants for stabilization of soft fine grained soils. Tests were conducted on soil and soil-Rice husk ash mixtures prepared at different water contents. The results indicated that, addition of Rice husk ash appreciably increased CBR and resilient modulus of soils.

*L. Purbi Sen. et al (2011)*

The Effects of various locally available stabilizing agents like OPC, Sugarcane bagasse ash and Rice husk ash have been studied for strength improvement. They have used Compaction, Atterberg's limit, UCS tests for these purposes. Specimens were prepared by mixing varying proportions stabilizers with clayey soils separately. UCS and Atterberg limits of the soils were determined separately after curing specimens for 7 days. 7.5%-8% of Portland cement gives UCS strength is around 28 kg/cm2 which is satisfactory for road use under Indian climatic condition. 7 days peak strength of soil-Sugarcane bagasse ash specimen was found at 7.5% Sugarcane bagasse ash content.

*M. BahaiLouafi and Ramdane Baharin (2013)*

experimental work have studied the effect on performance by addition of sand as stabilizer on swelling soil. Based on the study undertaken, they found that the addition of sand reduces consistency limits. They have also worked on introducing sand layer into two different configurations and found that these layers effectively reduce the swelling of soil.

*N. Saad Ali Aiban (1994)*

has done an attempt to assess the strength properties of stabilized granular soils and to evaluate the behaviour of cement- treated soil. Two types of cementing agents were used: Portland cement and calcium carbonate. The effects of some of the variables encountered in the field such as curing type and time, confining pressure, cementing agent content, density, saturation and reconstitution on the behaviour of stabilized soils, were studied. Test results show that the addition of a cementing agent to a wind-blown sand (cohesion less material) with uniform size distribution produces a material with two strength components, that due to cementation or "true" cohesion and that due to friction. The angle of internal friction for the treated sands is not much different from that of the untreated sand. The results also show that the drying process is essential in the development of cementation, especially when calcium carbonate is used as the cementing agent. Peak strength as well as initial tangent modulus values, increase with an increase in curing period, confining pressure, cement content and density. Residual strength values seem to be independent of all parameters other than the confinement and density; behaviour commonly observed for un-cemented sands.

*O. Kowalski et al. (2007*

Portland cement is hydraulic cement made by heating limestone and clay mixture in a kiln and pulverizing the resulting material which can be used either to modify or to improve the quality of the soil or to transform the soil into a cemented mass with increased strength and durability. The amount of cement used will depend upon whether the soil is to be modified or stabilized.

*P. Kent Newman and Jeb S.Tingle (2004)*

in their study of previous research efforts. Portland cement was used as the stabilizer control for comparison of properties to the polymers and was used at concentration of 2.75%, 6% and 9%. Previous research work have shown that the addition of inert material (sand) to swelling soil can be a method of stabilization of soil. Roads constructed on poor subgrade soil also require larger thickness of pavement which can be reduced by inclusion of geogrid. Which increases the bearing capacity of the subgrade, reduce the differential settlement of the pavement, increases the life of the pavement and also reduces the cost due to saving incurred in the reduction of the special fill material? Geogrid can be placed in one or more layers in subgrade soil. Geogrid reinforcement can be used to prevent or reduce rutting caused by bearing capacity failure of the base or subgrade and by the lateral movement of base course or subgrade material.

*Q. SarikaDhule et.al (2011)*

according to her, weaker soils are generally clayey and expansive in nature which is having lesser strength characteristics. Technique of improving the soil with geogrid increase the stiffness and load carrying capacity of the soil through fractional interaction between the soil and geogrid material improving black cotton soil. In her experimental work she tries to modify the properties of weak subgrade soil by addition of geogrid in different percentage i.e 1%, 2%, 2.5% and 3% separately. Simillarly she also studied improvement in properties of soft murum by adding geogrid. Also geogrid was used in mix of soil and 2% cement in different proportions to study its effect. With all these attempts she finds, optimum mixes which are to be used for further construction to achieve desired stability and economy in construction. For this purpose different tests were performed i.e sieve analysis, liquid limit, Plastic limit, Standard proctor test to find its maximum water content and maximum dry density, specific gravity, Laboratory Unsoaked California Bearing Ratio (CBR) and Laboratory soaked CBR test to find it resistance to penetration. For different percentage of geogrid with soil, murum and cement economical cost analysis was carried out. Most economical mix with geogrid is suggested by her. She further found that the CBR value increases with addition of geogrid. Again with addition of this work she also found the effect on CBR value of murrum with 2% cement and different percentage of geogrid . According to the experimental work CBR value found by addition of 2.5% geogrid is more than any other.

*R. A.K.Choudhary et.al (2011)*

placed multiple layers of reinforcement horizontally at specified vertical spacing within the subgrade and thereby determining their relative positions for two different types of reinforcement namely geogrid and jute geotextile. The number of reinforcing layers was varied from 1 to 4. He found that the expansion ratio decreases when the soil is reinforced with single layer and goes on decreasing with increase in number of reinforcing layer but this decrease is significant in case of jute geotextile and marginal in case of geogrid which means insertion of reinforcement controls swelling of soil. The CBR tests were conducted with both unreinforced as well as reinforced specimens with varying number of reinforcing layers and reinforcement types and found that the CBR value of the soil also increases with increase in number of reinforcing layers. Further it was found that geogrid offer better reinforcing efficiency than jute geotextile but it can be gainfully exploited in low cost road project.

*S. S.A. Naeini& R. Ziaie Moayed(2009)*

in their study they prepared three types of soil samples with different percentage of bentonite on which CBR tests were carried with or without geogrid reinforcement in one or multilayer. Result shows that increase in plasticity index decreases the CBR value in both soaked and unsoaked condition. CBR can be considerably increased by using geogrid reinforcement in two layers when compared with unreinforced, but less value when compared with single layered reinforcement. By placing geogrid at layer 2 there is a considerable increase in CBR value compared with unreinforced soil in both soaked and unsoaked conditions. By using two layers of geogrid at layer 1 and 3, unsoaked CBR value increases compared with unreinforced soil. However this increment is much less when compared to the case when geogrid is placed at layer 2. Further, the soaked CBR value is higher than the value obtained for both single and no layer of geogrid.

*T. Dr. P Senthilkumar& R. Rajkumar (2012)*

Successful use of geosynthetics is ensured in a given geotechnical application, as it is not only compatible but effective in improving the soil properties when appropriately placed. In his study the performance of woven and nonwoven geotextile, interfaced between soft subgrade and unbound gravel in an unpaved flexible pavement system, is carried out experimentally, utilising the California Bearing Ratio (CBR) testing arrangement. In order to evaluate the performance, the reinforcement ratio is obtained based on the CBR load – penetration relation of both soft subgrade-gravel and soft subgrade-geotextile-gravel, separately, for woven and nonwoven geotextile. The effect of introducing geotextile layer between subgrade soil and base course layer and found that the resistance to penetration increases with the introduction of geotextile layer. He used the equation given by (Koerner, 2005) for calculating the reinforcement ratio i.e. loads with geotextile to load without geotextile and found that the reinforcement ratio is more than one throughout the test. Hence concluded that the use of geotextile is most advantages in road with soft subgrade at higher penetration. But the author had performed the test essentially on soil of class CH having an MDD of 1.562 moreover he has mentioned the woven and non-woven geotextile but he has not mentioned the percentage of geotextile reinforcement neither its aperture size and its thickness. Hence the results are not validated.

*U. Hossein Moayedi (2009)*

Provides geogrid reinforcement into paved road to improve the performance of the transportation. He in his experimental work provide a series of two-dimensional finite element simulations are carried out to evaluate the benefits of integrating a high modulus geogrid for reinforcement at three different position (i.e. at a distance of 0.5m ,0.25m and at 0.05 from the bottom of the model . Analytical results for three different most possibilities of geogrid reinforcement in the paved road layers have been evaluated. He found that maximum shear stress and normal stress increases when the geogrid is placed at a distance of 0.5 m from the bottom. The optimum position was decided based upon the tension stress absorption value, deformation reduce rate and tension cut-off point location. Three types of reinforcing model and one type of unreinforced model of paved road were selected. He also observed that the vertical deflection under the centre of the load reduces with the use of geogrid just under the asphalt layer and hence concluded that the effectiveness of geogrid is more pronounced when it is placed at the bottom of the asphalt concrete improved if an effective bending is maintained between the asphalt concrete and geogrid.

*V. Dr .D. S. V. Prasad (2010)*

in his study prepared a model of flexible pavement consisting of expansive soil subgrade of 0.5m at bottom compacted in 10 layer and gravel subbase laid in two layers each of 0.07m compacted thickness using a layer of different reinforcing material like geogrid, bitumen coated chicken mesh, bitumen coated bamboo mesh for reinforcement with waste plastic and waste tier rubber was mixed uniformly throughout. The sub base material on which two layers of WBM-II each of 0.075 m compacted thickness was laid. To find the best alternative reinforcement in flexible pavement, cyclic plate load test where carried out. It was found that the total and elastic deformation values of the flexible pavement system are decreased by the provision of providing different reinforcing material. The maximum load carrying capacity followed by less value of rebound deflection obtained for geogrid reinforcement is more than any other reinforcement provided.

*W. Omid Azadegan and Gh. R. Pourebrahim (2010)*

studied the effect of geogrids on compressive strength and Elastic Modulus of Lime/ Cement treated soil in order to find out the effect of geogrid applications, on the geotechnical behavior of lime /cement treated soil used as base, sub-base or structural foundation materials. Study has been performed on compressive treated soil sample with or without geogrid layers and found that when there is an increment in modulus of elasticity and the cohesion, produced by pozzolanic reaction of lime and cement, side deformation of the cylinder decreases and therefore the tension produced in reinforcement and the confinement forces would decrease too. To have appropriate interaction the mix design should comprise enough ductility and side deformation for which, L/C ratio should be greater must be selected and total amount of applied cement must be lower than 5 percent. The author has used UCS using cylindrical sample and not correlate with CBR. Moreover the author fails to mention about specific mix design of pavement which is the governing factor for the interaction between used of geogrid and stabilized soil.

*X. Dr Sujatha Evangelin Ramani (2012)*

provide geogrid reinforcement to improve the strength of subgrade and reduce the thickness of the pavement .The author conducted CBR tests on soil with geogrid introduced at different depths within the sample, in single , double and triple layer and found that the best performance in the single layer occurs when geogrid is placed at 2/3 distance from the base. And found that the CBR value of 3 layer of geogrid is lesser than 2 layer but higher than single layer and hence concluded that geogrid increases the strength of subgrade soil in both soaked and unsoaked condition and proved that geogrid reinforcement provided in a single or multilayer to the sub grad increases the strength of the soil and thus reduces the thickness of the pavement.

*Y. Pradeep Singh and K.S. Gill (2012)*

Reinforced soils are often treated as composite materials in with reinforcement resisting tensile stress and interacting with soil through friction. Although there is lot of information and experience with geo-synthetic reinforcement of sub-grade soils, many pavement failures still occur. These failures may be due to lack of understanding of how these materials influence the engineering properties of sub-grade soils and what is the optimum position of reinforcement. Therefore a compressive laboratory program is required to study strength characteristics of both reinforced and un-reinforced sub-grade soils also to investigate their behaviors under cycle leading. The author in his work describes the beneficial effects of reinforcing the sub-grade layer with a single layer of geo-grid at different positions and thereby determination of optimum position of reinforcement layer. The optimum position was determined based on California Bearing Ratio (CBR value) and unconfined compression tests were conducted to decide the optimum position of geo-grid. Through his experimental work he found that by providing geogrid reinforcement at 0.2H from top give considerable improvement in CBR value and stress strain behavior of subgrade soil.

*Z. Mihai Iliescu and IoanRatiu (2012)*

for subsoil with insufficient bearing capacity, stabilization and improvement of subsoil characteristics are necessary. The bearing capacity can be increased by excavation and replacement of the soft material, chemical stabilization by using chalk or by using geosynthetics. Placed between the subgrade and base course, or within the base course, the geosynthetic improves the performance of unpaved roads carrying channelized traffic and unpaved areas subjected to random traffic. They in their paper devised a new design methodology for stabilizing a road subgrade using geogrid reinforcement. In their experiments, they found out that geogrids can improve the performance of the Subgrade soil. They carried out extensive static and dynamic plate bearing tests on different conditions based on the results of trial and the membrane theory of Giroud&Noiray, they developed design graphs for multifunctional geogrids in unpaved and temporary road.

*AA. Rakesh Kumar and P.K. Jain (2013),*

Different ground improvement techniques have been proposed in the literature to work with this soil and are found to be successful to some degree. The construction of granular piles has been proved successful in improving soft marine clays, which are very poor from strength and compressibility criteria. The technique of granular pile may be applied in expansive soil too. The granular piles derive their load carrying capacity from the confinement offered by the surrounding soil. In very soft soils this lateral confinement may not be adequate and the formation of the granular pile itself may be doubtful. Wrapping the granular pile with suitable geogrid is one of the techniques to improve the performance of granular piles.

The encasement by geogrid makes the granular piles stiffer and stronger. The behavior and the mechanism of the granular pile and geogrid encased granular piles are not investigated for expansive soil. The author made an attempt to investigate the improvement of load carrying capacity of granular pile with and without geogrid encasement through laboratory model tests conducted on single granular pile installed in expansive clay bed prepared in controlled condition in small testing tanks. The load tests were performed on single granular pile. Tests were performed with different diameter of granular piles with and without geogrid encasement. The results from the load tests indicated a clear improvement in the load carrying capacity of clay, with granular pile and with encased granular pile. The increase in the load carrying capacity also increases as the diameter of the granular pile increases. Thus concluded in their study of ground improvement techniques that the construction of granular piles in expansive soil improves the load carrying capacity of the soil.

*BB. Prof MayuraYeole and Dr. J.R. Patil (2013),*

carried out a laboratory CBR test on granular soil with or without geotextile which was placed in one or two layer in the mould. The single layer of geotextile was placed at the depth of (25, 50, 100 mm) from the top of the mould, the maximum CBR obtained was at 25mm and when the geotextile was placed in two layers at {(25 &75 mm),(50 &75 mm), (50 &100 mm)} CBR was increased and it was maximum at 25 & 75mm geotextile layer by 38.21% when compared with the CBR of no geotextile.

*CC. Jesna Varghese, Remya.U. R (2009) ,*

et al Indicated that reinforced soil with fiber has following properties- The relationship between optimum moisture content and maximum dry density of soil significantly affected by the addition of polypropylene fiber. During the study, MDD increases with decreasing OMC. From unconfined compressive test, it was observed that the unconfined compressive strength value of untreated soil was found to be 15.1 KN/m2 and the strength value increased with increase in addition of polypropylene fiber up to 0.05% and then decreases. There is an increase of strength of about 454.37%.That may be due to increase in interfacial shear strength at 0.05 %.For higher amount of polypropylene fibre it shows reverse trend. The strength is increased in low percentage of PPF addition, it ensures more economical in construction. So finally it was concluded that the polypropylene fiber can potentially stabilize the clayey soil.

*DD. Vijaya Kumar et al (2010),*

reported that Wear loss and coefficient of friction of slag composites decreases with the increase in normal loads. Wear loss and coefficient of friction increases with the increase in sliding velocities. The stick-on disc wear testing machine has been used to study the friction and wear behavior of the polymer composites. The wear loss and coefficient of friction are plotted against the normal loads and sliding speeds. It is noted from the graphical representation of the result that with the increase in load weight loss decreases and increase in sliding velocity weight loss also increases.

*EE. Andrzej K. Bledzki*

Reported that the feasibility of utilizing of grain by-products such as Wheat Husk Ash and rye husk as alternative fillers for soft wood fibre as reinforcement in for composites material. Following conclusions are drawn from their study.Wheat Husk Ash thermally stable as low as 235 degree celcius. Structural proportions (cellulose, starch) contained by Wheat Husk Ash are 45% on the other hand 42% contained by soft wood. More carbon rich surface was observed for Wheat Husk Ash compared to soft wood fibre.Wheat Husk Ash contained more surface silicon than soft wood fibre. Wheat Husk Ash composites showed 15% better Charpy impact strength than soft wood composites.

*FF. Mona Malekzadeh and HuriyeBilsel:*

Reported that optimum water content is not influenced by polypropylene fiber inclusion, whereas maximum dry density has been reduced. This can be attributed to the reduction of average unit weight of solids in the soil-fiber mixture. Studying the influence of polypropylene fiber on swell characteristics, the overall conclusion is that one-dimensional swell decreases considerably with 1% fiber addition. Unconfined compressive strength increases with polypropylene fiber inclusions. Maximum value of cohesion can be observed with 1% fiber content which is approximately 1.5 times of the unreinforced soil. From the analysis of split tensile strength test, it is observed that the maximum value of the tensile strength obtained for 1% fiber inclusion is 2.7 times of the unreinforced soil. Increase in the ratio of tensile strength to compressive strength indicates that polypropylene fiber reinforcement is more effective in improving tensile than the compressive strength. Thus fiber enhances the ductile behavior of soils, reducing shrinkage settlements during desiccation, hence detrimental damages to structures, such as roads and pavements may be prevented.

*GG. Pramod S. Patl (2009),*

Disposal of plastic waste in an environment is considered to be a big problem due to its very low biodegradability and presence in large quantities, In recent time use of such, Industrial wastes from polypropylene (PP) and polyethylene terephthalate (PET) were studied as alternative replacements of a part of the conventional aggregates of concrete. Plastic recycling was taking position on a significant scale in an India, The test conducted on material like Cement, Sand, Conventional aggregate having all the results within permissible limit as per IS codes. The modified concrete mix, with addition of plastic aggregate replacing conventional aggregate up to certain 20% gives strength with in permissible limit. Modified concrete casted using plastic aggregate as a partial replacement to coarse aggregate shows 10 % it could be satisfy as per IS codes. Density of concrete is reducing after 20% replacement of coarse aggregates in a concrete.

*HH.S. Soganc (2010)*
The inclusion of fiber within unreinforced and reinforced soil caused an increase in the unconfined compressive strength of expansive soil. Increasing fiber content had increased the peak axial stress and decrease the loss of post-peak strength. For example, unconfined compression strength increased from 202 MPa to 285 MPa for samples reinforced with 1% fiber. The fiber reinforced soil exhibits more ductile behavior than unreinforced soil. Swell percent was reduced as the fiber increased. One dimensional swell decreased considerably with 1% fiber addition. For example it decreased from 11.60% for unreinforced samples to about 5.3% for reinforced samples with 1% fiber.

*II. Mr. Santosh and Prof. Vishwanath C.S. (2012) ,*
Reported that Addition of different % of Wheat Husk Ash Ash (WHA) the water content decrease up to a limit afterwards again it increases. This is more effective for addition of 9% (optimum) WHA. Addition of different % of WHA the dry density increases up to a limit afterwards again it decreases. This is more effective for addition of 9% (optimum) WHA. The stress against different days for varying % WHA, for varying % of WHA, as number of day's increases stress also increases. This is more effective for 7days.

## IV. METHODOLOGY

*Material Used in Research Work*

### *A. Natural Soil*
The Natural soil sample is used in this project were taken from local area from depth of 2.5 m from ground level. It contains deleterious substances and of various sizes. The soil was air dried and pulverized manually. This natural soil is grey and black in color.

### *B. Wheat Husk Ash (WH)*
Wheat husk is collected locally, these husk is burnt and collected ash is used un this project.

### *C. Polypropylene (PP)*
Polypropylene is collected locally, length of the fiber used in this project is 40mm and thickness is 2mm.

### *D. Water*
Throughout the investigation tap water is used in this project, which is supplied by municipal co-operation.

### *E. B.Experimental Program*
There are various test performed in laboratory as per IS code standards like test Grain size distribution, liquid limit, plastic limit, plasticity index, specific gravity, compaction, optimum moisture content (OMC), maximam dry density (MDD), swelling and California bearing ratio (CBR) test were conducted.

## V. RESULT & DISCUSSION

### *A. Natural Soil*

Table 1**:** Summary for Index Properties of N sample

| S.N. | Parameters | Value |
|---|---|---|
| 1 | Grain Size Distribution | |
| | Gravel (%) | 18.40 |
| | Coarse Sand (%) | 7.20 |
| | Medium Sand (%) | 52.60 |
| | Fine Sand (%) | 20.30 |
| | Silt and Clay (%) | 1.50 |

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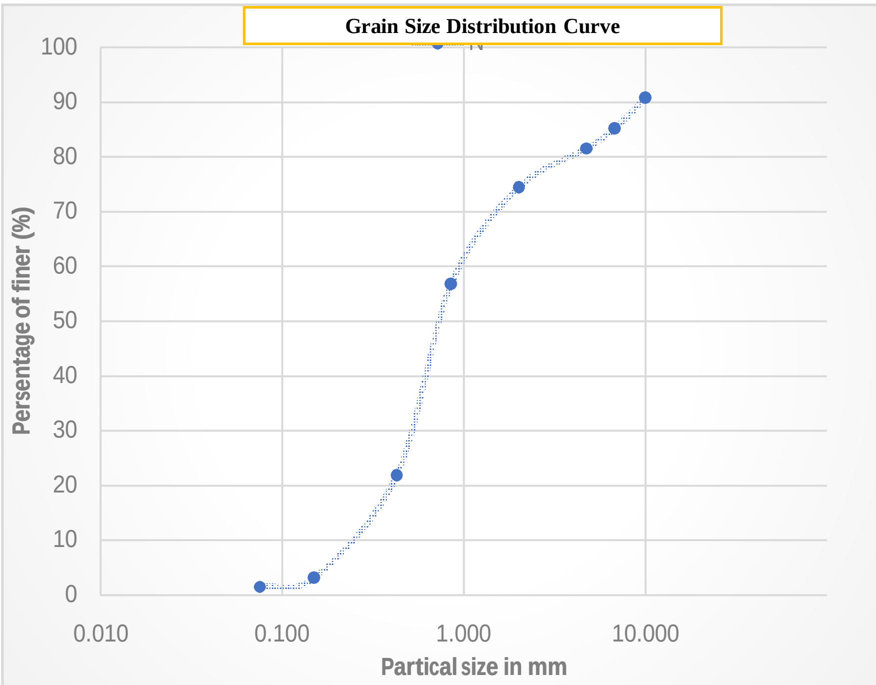
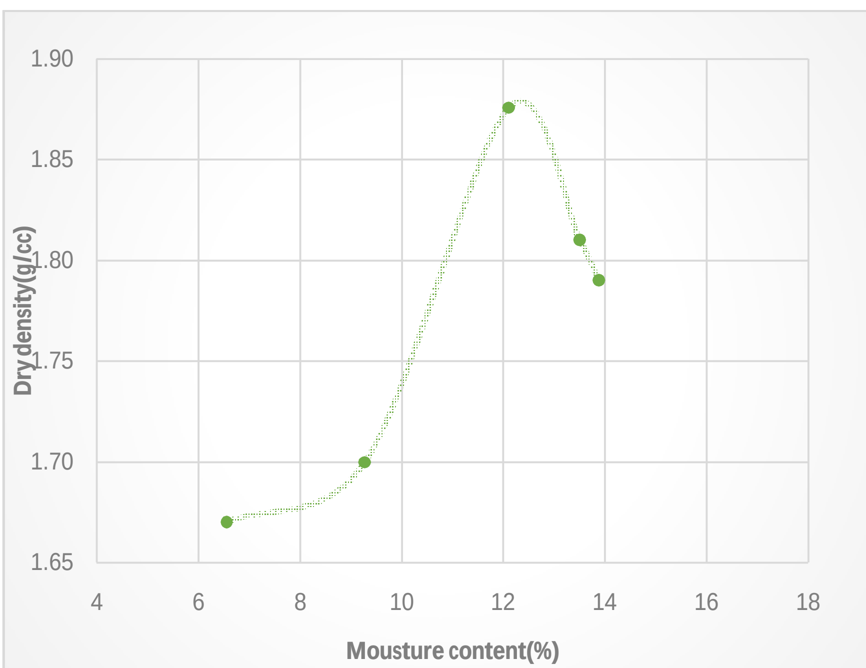
| | | |
|---|---|---|
| 2 | IS Soil Classification | CL |
| 3 | AASHTO Classification | A-6 |
| 4 | Liquid Limit (%) | 26.00 |
| 5 | Plastic Limit (%) | 17.40 |
| 6 | Plasticity Index (%) | 8.60 |
| 7 | Specific Gravity | 2.63 |



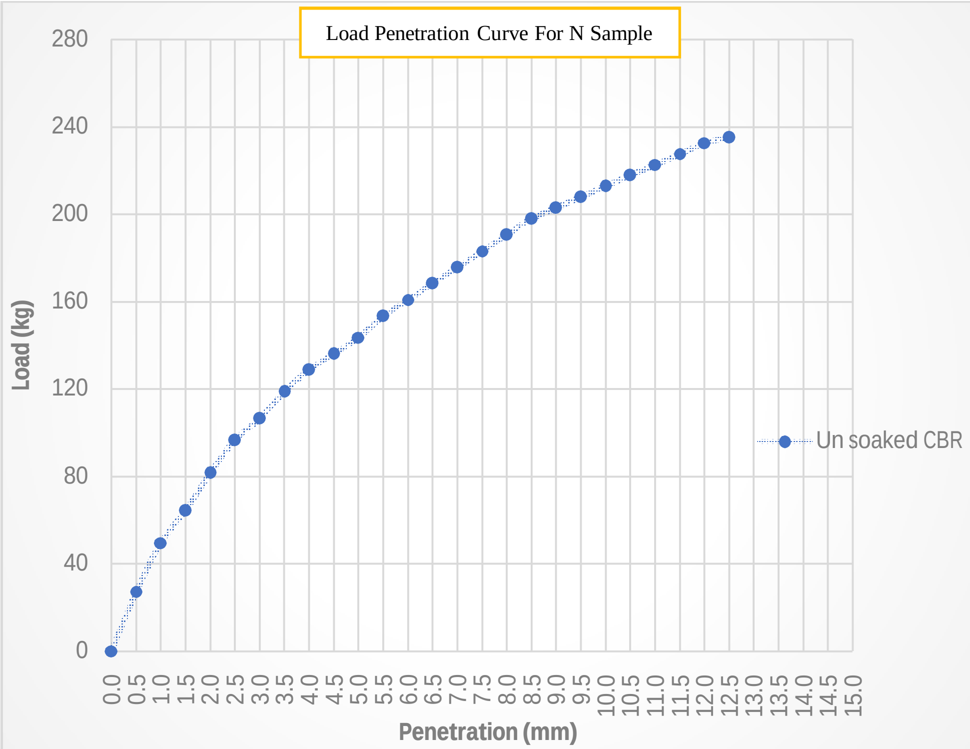

Graph 1: Grain Size Distribution of Natural Soil

Compaction factor parameters are MDD=1.88 KN/m$^3$ and OMC =12.18%.

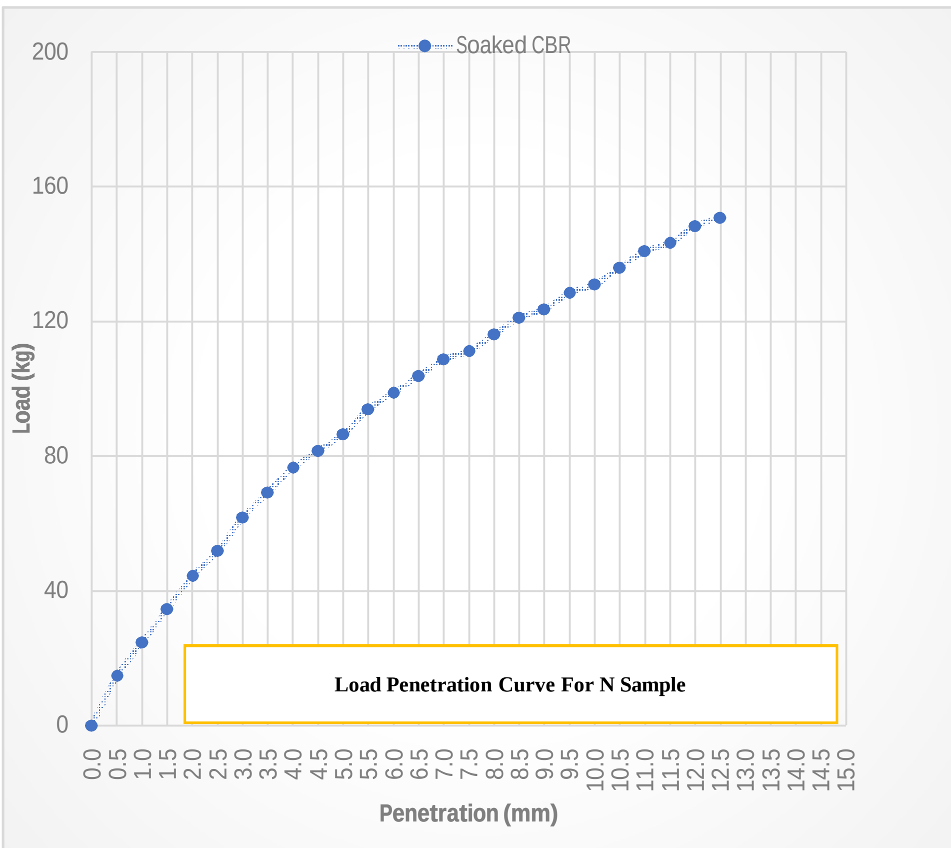


Graph 2: OMC/MDD of Natural Soil (N) SampleGraph 4**:** Soaked CBR of N Sample

Soaked CBR Value for Natural soil Sample is 3.79 % and Unsoaked CBR Value for Natural soil Sample is 7.04 %

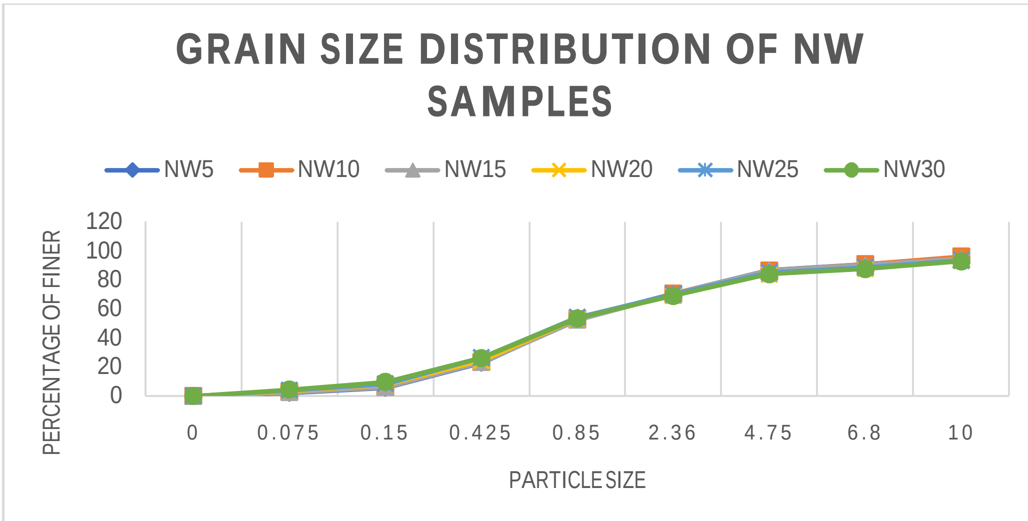



Graph 3: Unsoakesd CBR of N Sample



*B. Tests Results of Natural & Wheat Husk Ash Samples (NW)*

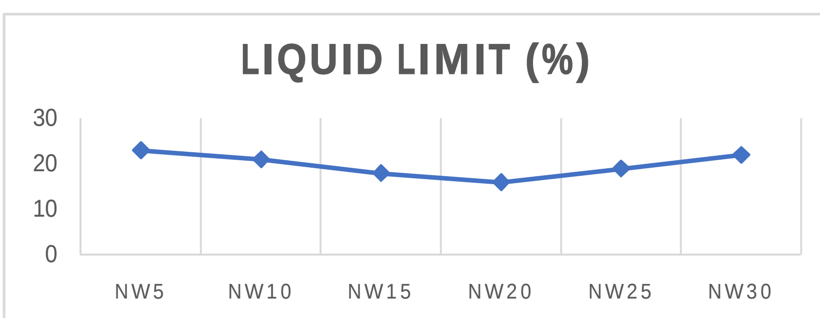
1) *Index Properties of NW Sample:* The tests are conducted on Artificial Mix Samples (NW) type samples i.e. when wheat husk ash is added in the soil upto 30%. and Grain Size Distribution, Liquid Limit, Plastic Limit, Plasticity Index, Specific Gravity have performed.



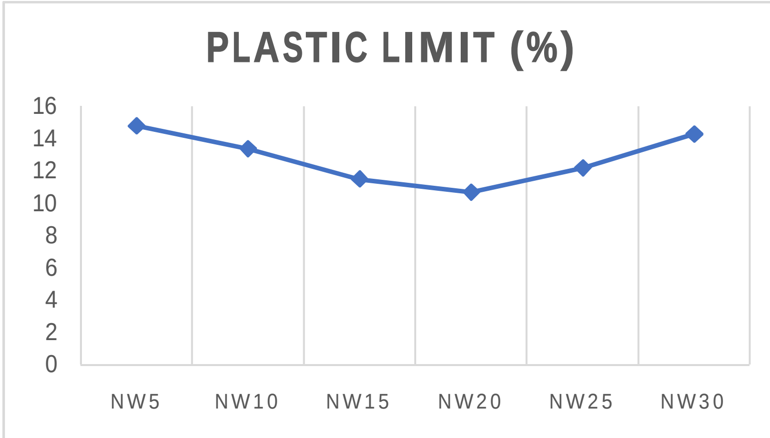

Graph V.1: Grain Size Distribution Curve of NW Sample

Table V.1: Summary of Test Results for Index Properties of NS Samples

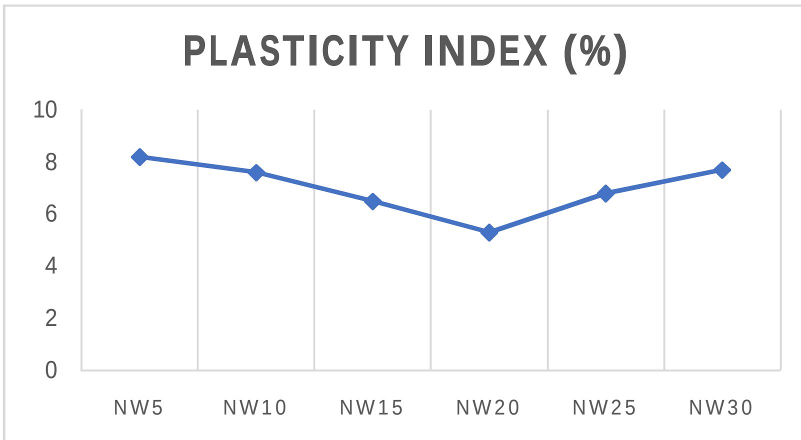
| S.N. | Index Properties of NS Sample | Name of Artificial Mix NW Samples | | | | | |
|---|---|---|---|---|---|---|---|
| | | NW5 | NW10 | NW15 | NW20 | NW25 | NW30 |
| 1 | Grain Size Distribution | | | | | | |
| | Gravel (%) | 13.04 | 13.53 | 13.40 | 16.00 | 15.00 | 15.70 |
| | Coarse Sand (%) | 16.30 | 15.80 | 16.60 | 45.00 | 14.80 | 15.20 |
| | Medium Sand (%) | 47.70 | 47.50 | 46.70 | 45.00 | 43.90 | 42.80 |
| | Fine Sand (%) | 20.80 | 20.70 | 20.40 | 21.10 | 22.40 | 21.90 |
| | Silt And Clay (%) | 2.16 | 2.47 | 2.90 | 3.40 | 3.90 | 4.40 |
| 2 | IS Soil Classification | CL | CL | CL | CL | CL | CL |
| 3 | AASHTO Classification | A-6 | A-6 | A-6 | A-6 | A-6 | A-6 |
| 4 | Liquid Limit (%) | 23.00 | 21.00 | 18.00 | 16.00 | 19.00 | 22.00 |
| 5 | Plastic Limit (%) | 14.80 | 13.40 | 11.50 | 10.70 | 12.20 | 14.30 |
| 6 | Plasticity Index (%) | 8.20 | 7.60 | 6.50 | 5.30 | 6.80 | 7.70 |
| 7 | Specific Gravity | 2.61 | 2.57 | 2.54 | 2.49 | 2.45 | 2.39 |



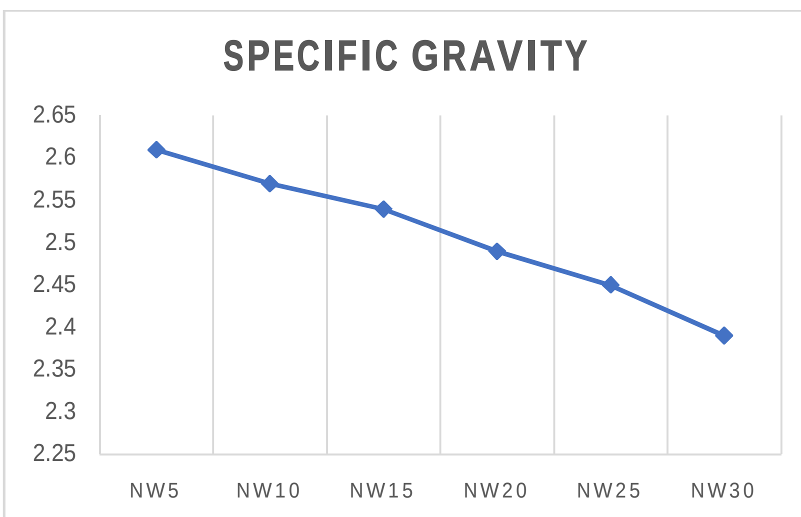

Graph V.2: Variation in Liquid limit of NW samples




Graph V.3: Variation in Plastic limit of NW samples




Graph V.4: Variation in Plastic Index of NW samples




Graph V.5: Variation in Specific Gravity of NW samples

The results of Liquid Limit tests Clay with Low Compressibility (CL) treated with different percentage of Wheat Straw Ash (WHA)can be seen that with increase in percentage of ash the Liquid Limit of CL soil goes on decreasing from 26 to 16%, when WHA waste is increased from 0 to 20% is effective beyond also there is a increase in liquid limit from 16% to 22% when WHA waste is increased from 20 to 30% and further the value for 100% WHA, the sample shows non plastic behavior.

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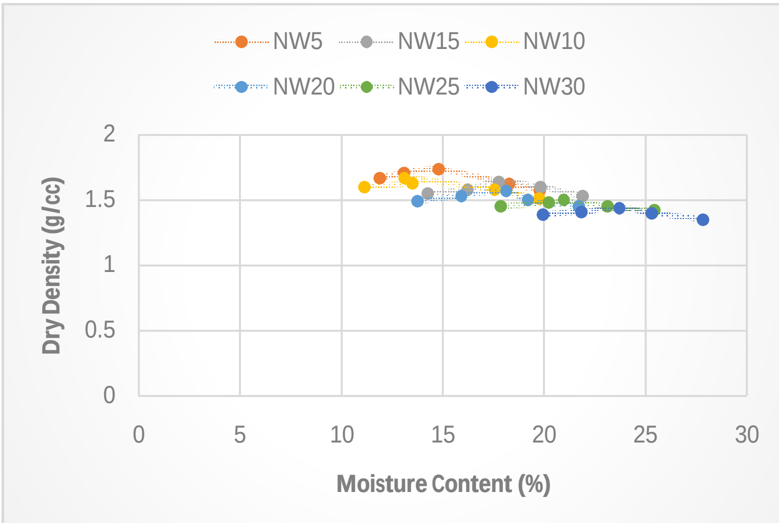
The results of Plastic Limit tests CL soil treated with different percentage of WHA can be seen that with increase in percentage of ash the Plastic Limit of CL soil goes on decreasing from 17.40% to 10.70%, when WHA waste is increased from 0 to 20% is effective beyond also there is a increase in Plastic Limit from 10.70 to 14.30% when WHA waste is increased from 20% to 30%.
The results of Plasticity Index tests CL soil treated with different percentage of WHA can be seen that with increase in percentage of ash the Plasticity Index of CL soil goes on decreasing from 8.60% to 5.30%, when WHA waste is increased from 0 to 20 % is effective beyond also there is a increase in Plasticity Index from 5.30 to 7.70% when WHA waste is increased from 20% to 30%.
The results of Specific Gravity tests on CL soil treated with different percentage of WHA i.e. NS Sample shows that there is a decrease in specific gravity from 2.63 to 2.39 with increase in percentage of ash from 0 to 30% and 1.87 for 100% WHA.

*C. Proctor Compaction Test*

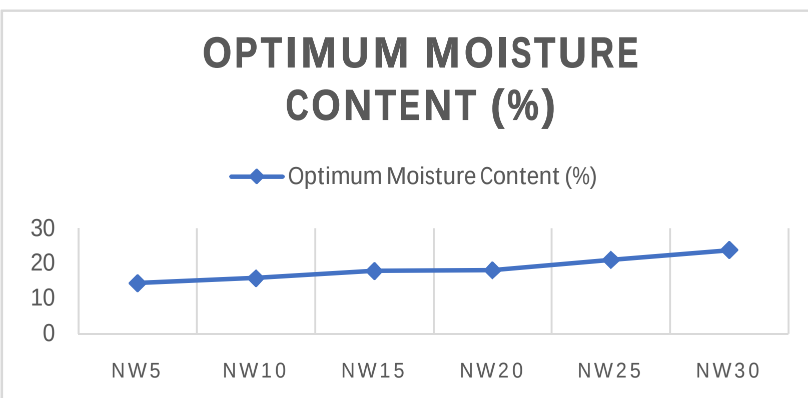
The tests on these Artificial Mix Samples were conducted as on N samples and curve for OMC and MDD were plotted for NW Samples. This curve showing variation of Compaction Curve (OMD and OMC) of Sample NW-5 to NW-30 and the desired NW Samples.



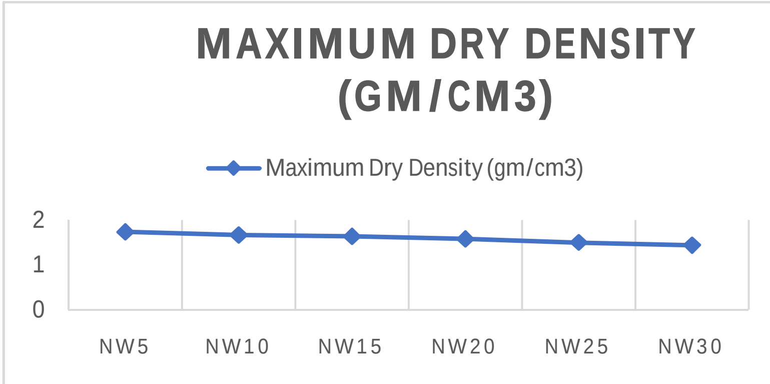

Graph V.6: Compaction Curve of NW Sample

Table V.2: Summary of Test Results for Compaction Properties of Artificial NW Samples

| S.N. | Compaction Properties of NS Sample | Name of Artificial NS Samples | | | | | |
|---|---|---|---|---|---|---|---|
| | | NW5 | NW10 | NW15 | NW20 | NW25 | NW30 |
| 1 | Optimum Moisture Content (%) | 14.42 | 15.80 | 17.85 | 18.05 | 21.00 | 23.80 |
| 2 | Maximum Dry Density (gm/cm3) | 1.74 | 1.67 | 1.64 | 1.58 | 1.50 | 1.44 |




Graph V.7: Variation in Optimum Moisture Content of NW samples

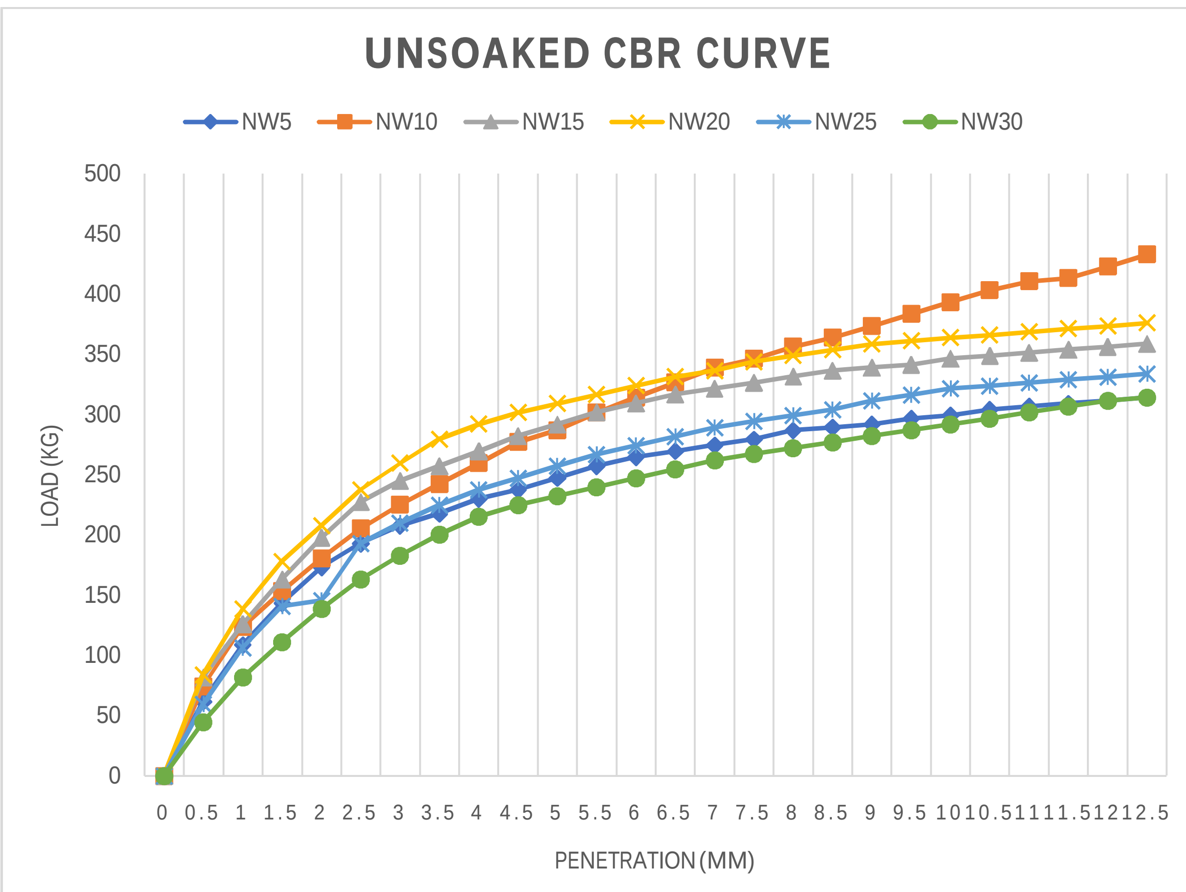



Graph V.8: Variation in Maximum Dry Density of NW samples

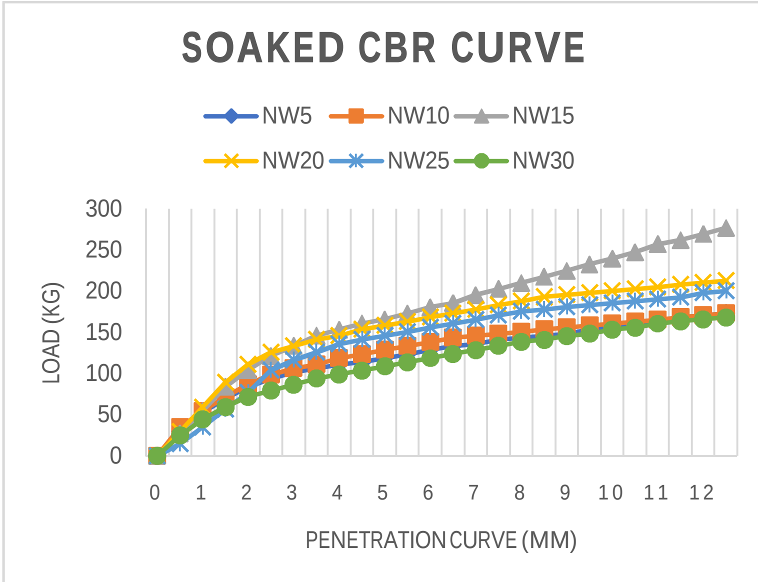
Natural Soil is mixed with varying percentages of Wheat Straw Ash (WHA) waste material by weight. From the test results Moisture Content continuously increases 12.18 to 23.80% and for 100% WHA value of water content is 47.22%. However The Maximum Dry Density decreases from 1.88 g/cc to 1.44 g/cc from 0 to 30% of WHA and the value are 0.98 g/cc for 100% WHA.

*D. California Bearing Ratio*

The tests on these Artificial Mix Samples were conducted as on NW Samples. CBR test were conduct on Samples containing wheat straw ash and evaluate these values and load presentation curve was plotted. NW Samples are showing Compaction Curve shown in graph below and also for Unsoaked and Soaked CBR Curve.



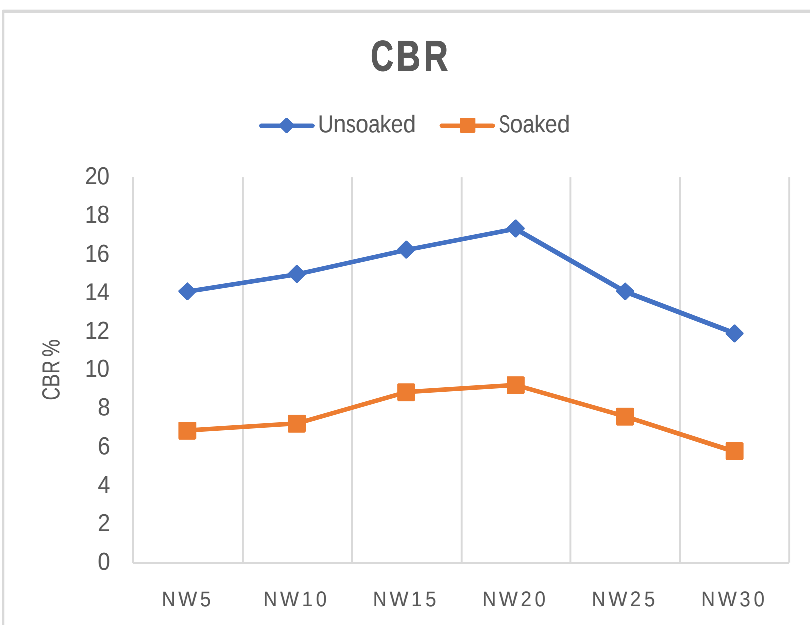

Graph V.9: Unsoakesd CBR of NW Sample




Graph V.10: Soaked CBR of NW Sample

Table V.3: Summary of Test Results for Strength Properties of Artificial NW Samples

| S.N. | Strength Properties of NW Sample | | Name of Artificial NS Samples | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | | NW5 | NW10 | NW15 | NW20 | NW25 | NW30 |
| 1 | CBR (%) | Unsoaked | 14.08 | 14.98 | 16.24 | 17.33 | 14.08 | 11.91 |
| | | Soaked | 6.86 | 7.22 | 8.84 | 9.21 | 7.58 | 5.78 |




Graph V.11: Variation in CBR of NW samples

The results of Unsoaked CBR tests on CL Soil treated with different percentage of WHA and from the results it can be seen that with increase in percentage of ash waste, the Unsoaked CBR of soil goes on increasing from 7.04 to 17.33% when WHA is increased from 0 to 20% is effective beyond also there is a decrease in CBR of soil from 17.33 to 11.91% when WHA waste is increased from 20% to 30% and further the value for 100% WHA is 7.95%.

The results of Soaked CBR tests on CL Soil treated with different percentage of WHA and from the results it can be seen that with increase in percentage of ash waste, the soaked CBR of soil goes on increasing from 4.21 to 9.21% when WHA is increased from 0 to 20% is effective beyond also there is a decrease in CBR of soil from 9.21 to 5.78% when WHA waste is increased from 20% to 30% and further the value for 100% WHA is 5.41%.

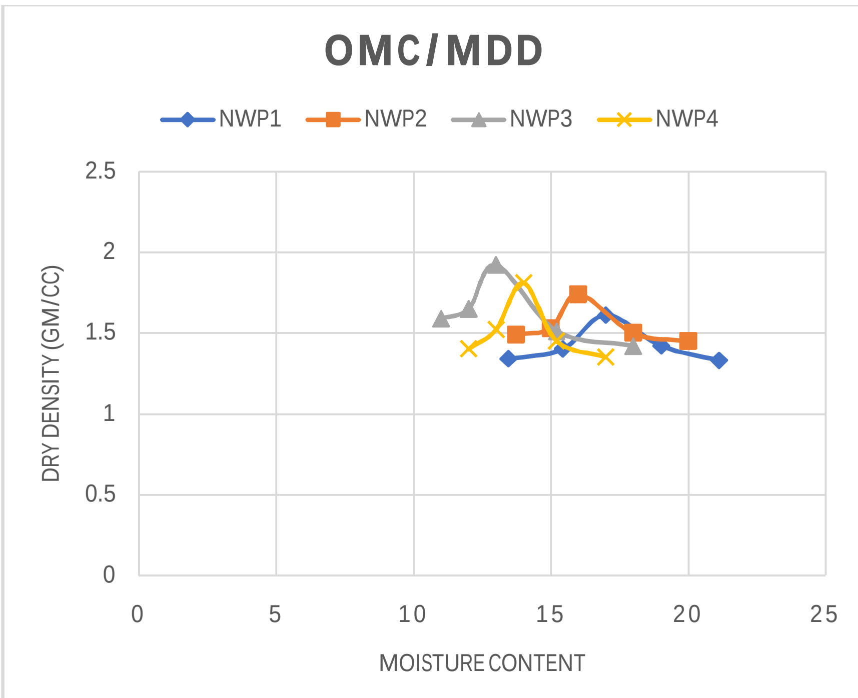
The results of Swelling Pressure tests on CL Soil treated with different percentage of WHA and from the results it can be seen that with increase in percentage of ash waste, the Swelling Pressure of soil goes on decreasing from 2.15 to 0.67 when WHA is increased from 0 to 20% is effective beyond also there is a increase in Swelling Pressure of soil from 0.67 to 1.42 when WHA waste is increased from 20% to 30% and further the value for 100% WHA is 1.95

.

*E. Test Result of Natural Soil with Polypropylene & Wheat Husk Ash*

Natural soil with 20% of Wheat Straw Ash i.e. WH20 mix give optimum value of CBR in both soaked and unsoaked condition, now polypropylene is added upto 1% with an interval of 0.25%.

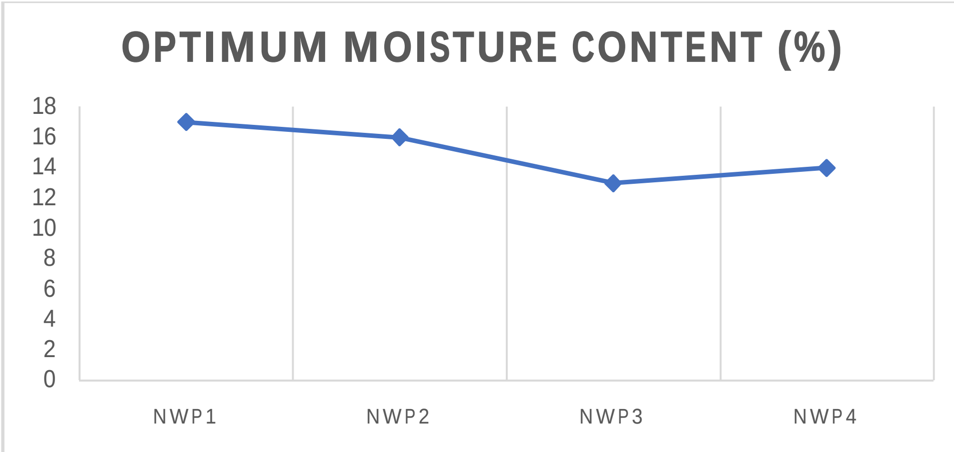
*1) Proctor Compaction test*



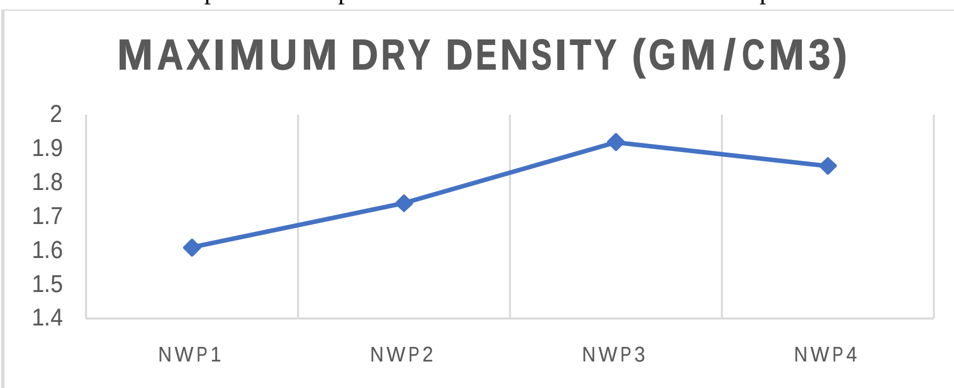

Graph V.12: OMC/MDD of NWP samples

Table V.4: Compaction Properties of NWP samples

| S.N. | Compaction Properties of NWP Sample | Name of Artificial NWP Samples | | | |
|---|---|---|---|---|---|
| | | NWP1 | NWP2 | NWP3 | NWP4 |
| 1 | Optimum Moisture Content (%) | 17 | 16 | 13 | 14 |
| 2 | Maximum Dry Density (gm/cm$^3$) | 1.61 | 1.74 | 1.92 | 1.81 |

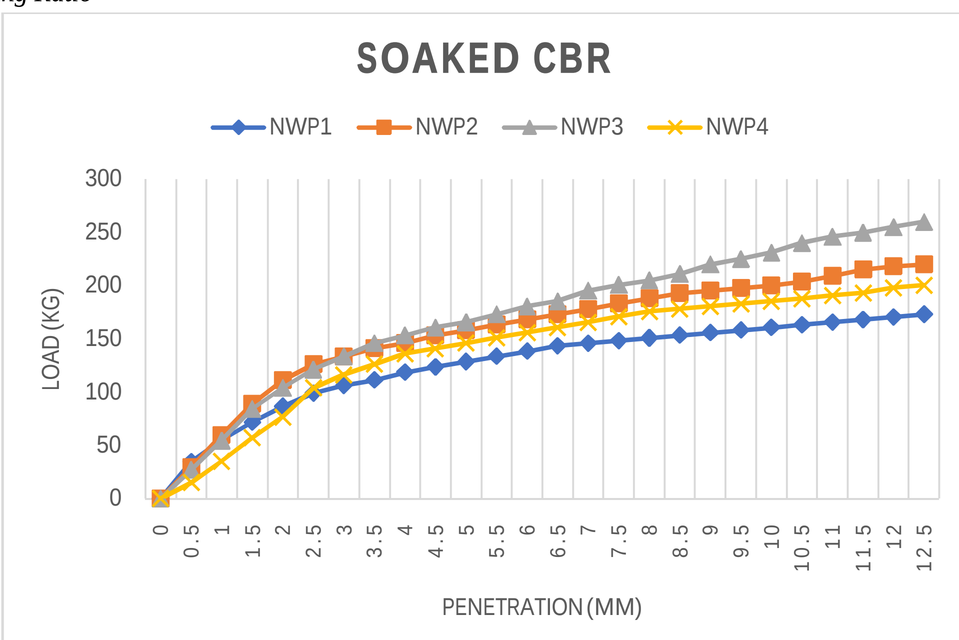



Graph V.13: : Optimum Moisture Content of NWP samples

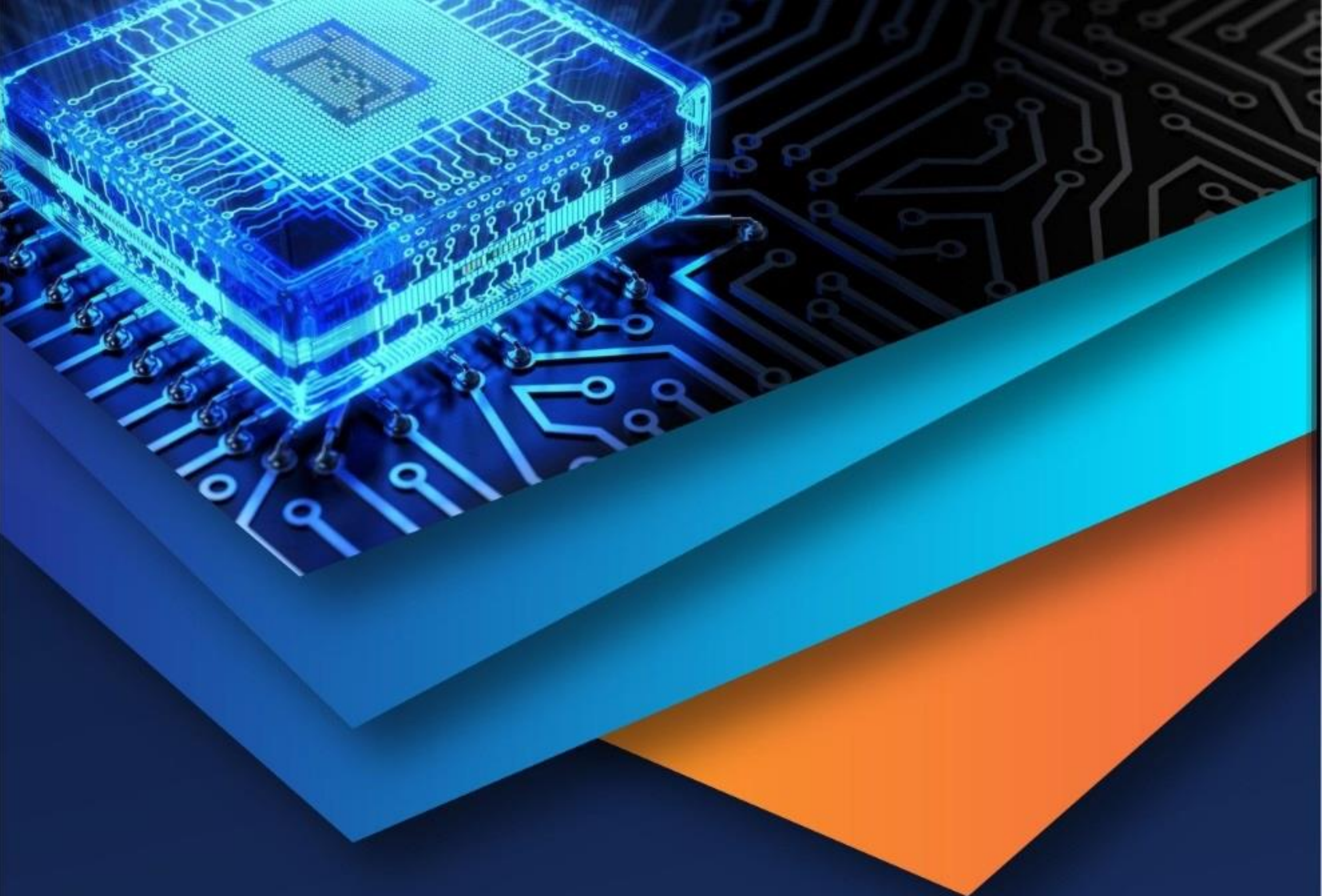



Graph V.14: Maximum Dry Density of NWP samples

2) *California Bearing Ratio*




Graph V.15: Soaked CBR of NWP samples



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