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Stabilization in Road Construction with RBI Grade 81 Using Fuzzy Logic

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Abstract

In apparent, the RBI grade 81 of black cotton soil used in road construction and fuzzy model utilized for classification of road. Black cotton soil is generally available in varying ratios of clay minerals such as the Montmorllionite, illite and kaolinite. RBI Grade-81, in turn, is an innate inorganic soil-stabilizer which re-designs and modulates the traits of soil to reinforce it for the roads and pavement. Roads on black cotton soils put several insurmountable roadblocks in choosing appropriate soil adaptation method. The quality of a pavement is invariably dependent on the potency of its sub-grade. In our work the stabilization of RBI grade 81 by addition of black cotton soil for road construction is analyzed by using fuzzy logic. The utilization of fuzzy logic is mentioned for classifying the road as pedestrian walk, light moving vehicles and heavy moving vehicles. By using fuzzy logic in road construction is to classify the output in which level the road has been used. Fuzzy outputs are classifying the road by minimization of error and finally in logic the three significant considerations are the light moving vehicles and heavy moving vehicles.

Keyword: Black cotton soil, RBI grade 81, unconfined compressive strength (UCS), modulus of elasticity (E), California bearing ratio (CBR), fuzzy logic algorithm.

1. INTRODUCTION

Black cotton soil is related with as engineering formation and in occurrence of water resolve demonstrates a property to swell or shrinkage causing the structure to knowledge moments which are mainly distinct to the through result of loading by the composition (Parijat Jain and Goliya 2014). Generally soils are also referred to as “Black cotton soil” in some parts of the world. They are so named because of their fittingness for rising cotton. Black cotton soils have varying colour’s ranging from light grey to dark grey and black (Oriola *et al.* 2010). The soil is more harm to structure, mainly light building and pathway, than any other normal exposure, as well as earthquakes and floods. The forename Black cotton soil (BCS) is plagiaristic from the statement that cotton plant succeeds well on it (Ijimdiyaa *et al.* 2012). It has characteristic which incorporates; low specific gravity, high compressibility and water holding capacity, high natural dampness content, low bearing capacity and medium to low permeability (Kolay *et al.* 2011). The extremely liberal clay (in its untreated and treated conditions) was experienced at two unlike temperatures and three various states of water content and dry density in order to examine the consequence of these aspects (water content, dry density, temperature, pore fluid) on the distension descriptions of the clay (Mohammed Shukri Al-Zoubi 2008). The different industrial wastes like fly ash, pond ash effortlessly obtainable near thermal power plants can be employ for soil stabilization with RBI Grade 81. The RBI Grade 81 is a chemical soil preservative (B M Patil and K A Patil 2013). An exercise is approved to get better the routine of this soil by using substance admixtures RBI Grade 81 and Sodium silicate. Accumulation of admixtures total by weights and remedial is done for 7 days, 14 days and 28 days (Madurwar *et al.* 2013). The 7, 14, 28 days released compressive strength (UCS), on luxury kaolinite deliberate in UCT apparatus as for sodium silicate stabilizer. Sodium silicate was choosing because of its high silicate which is easily soluble in water and fabricating an alkaline solution as well (Hossein Moayedi *et al.* 2011). soil stabilizer can be worn is not the only norm for its suitability, as the toughness, cost, and simplicity of function also needed consideration. RBI Grade 81 assures all these desires (Mamta and Mallikarjun.Honna 2014). The Sub grade Should hold adequate Stability Under Adverse Climatic And Loading Conditions. The formation of Waves, Corrugations, Rutting and Shoving in black top pavements are usually attributed to poor sub grade conditions (Tapas Dasgupta 2014). Geotechnical application is approving physical chemical properties which incorporate stabilization of soil, recovery of low lying areas by construction of structural fills, construction of road embankment, dykes, and dams (Patil *et al.* 2014). Utilizing fine fly ash for enhancing the geotechnical possessions of the black cotton soils under cram and temporarily envelops the experimental assessment accepted out in this observe (Bairwa Ramlakhan *et al.* 2013). Soil can be resistant with Jute fibre and CBR tests were passed out with and without strengthen. The present MORTH requirements needs that the sub grade must be compressed to 100% MDD accomplished by the adapted Proctor Test (Siva Gowri Prasad *et al.* 2014). Fuzzy logic has been used in a number of water possessions applications but in general as a enhancement to predictable optimization methods in which the natural ‘crisp’ intention and some or all of the limitations are restored by the fuzzy constraints [Panigrahi and Mujumdar

2000]. There is a necessitate to centre on getting better assets of black cotton soils by means of cost effective materials like treating with industrial wastes those having cementations properties. The most important intention is to find out optimum amount of additive necessitated for stabilization of black cotton soil (Sanjeev Tanaji Jadhav and Sushma Shekhar Kulkarni 2014). The physical and engineering properties of virgin soils and spoiled soils were established on soil. However, an additional additive along with RBI-81 seems to be a better option especially for expansive soils. By using fuzzy logic model the road has been classified for light moving vehicle and heavy moving vehicles (Arpita V Patel 2011).

2. RELATED WORKS

In 2012 Pankaj Modak *et al* have planned the adjustment of the Black cotton soil (BC soil) are profoundly clayey soils (Montmorillonite mud mineral). The dampness changes in BC soils with fly ash, compressibility and pliancy nature can be incredibly enhanced by the expansion of Lime and fly ash. They incorporate the assessment of soil properties like optimum dampness content, dry density, and quality parameter (California Bearing ratio esteem). Diverse amounts of Lime and fly slag (% by weight) are added to the BC soil and the analyses led to these soil combinations. Through the consequences, the application of lime and fly ash elevates the California Bearing Ratio values. In terms of material cost, the use of less costly fly ash can reduce the required amount of lime.

In 2012 Nabil Ibrahim El Sawalhi have suggested that the building components which impact the parametric expense estimation were reviewed. A poll study and relative index ranking strategy were utilized to show the most five essential variables from the perspective purposes of foremen, customers and specialists. 106 Case studies from true executed development extend in the Gaza Strip were gathered for the most vital five variables to develop Fuzzy logic Model. The outcomes exposed the capacity of Fuzzy Model to anticipate expense appraisal to a worthy level of precision.

In 2013 Madurwar *et al* have proposed the extensive soils were bringing on number of harms to the structures, especially light structures and pavements contrast with other characteristic risks like earthquake, floods, and so on. By means of the same expectation, an endeavor was made to change building properties of black cotton soils from Nagpur locale, Maharashtra, India by employing RBI Grade 81 and sodium silicate. Atterberg's point of confining, Compaction, California Bearing Ratio (C.B.R.), Unconfined Compressive Strength (U.C.S.) tests were done on the specimens of soil and soil with stabilizers. Curing of specimens was done 7 days, 14 days and 28 days. RBI Grade 81 supplemented to the soil in dry state in rate changing from 2% to 6% and sodium silicate 3% to 6% in the solution. Through the consequences, though sodium silicate if connected with lime or cement for adjustment might discovered suitable in light of the fact that sodium silicate has expanded the pH of soil environment for the quality advancements.

In 2013 Tejinder Singh *et al* have proposed the soil can be stabilized with RBI grade

81 and then can be used in Sub grade and also as Sub base and base Layers. The whole Pavement can be constructed by using RBI grade 81 thus reducing energy consumed and placing of unbound granular material (WBM/WMM) without compromising on Strength and durability. Various samples have been made by taking soil with 0% RBI Grade-81 content; 2% RBI Grade-81 content; 4% RBI Grade-81 content; 6% RBI Grade-81 content; 8% RBI Grade-81. The CBR sample is prepared by 7 days curing and 4 days soaked period. The comparison of the strength results with or without RBI Grade 81 has been done. It has been found that RBI Grade 81 is a unique and innovative material which results in saving the extra cost of the pavement.

In 2014 Lekha *et al* have suggested the gathered soil specimens were analyzed with RBI 81 in different combination degrees. Therefore, the treated soil specimens were cured for distinctive periods running from four hours to twenty eight days. The building properties derived for various blend extents of soil and the stabilizer are concentrated on. The consequences of Unconfined Compressive Strength (UCS) test, California Bearing Ratio (CBR) test and Fatigue Life test performed for distinctive blend extents of soil and stabilizer, for various curing periods under drenched and unsoaked setting have been analyzed and examined.

In 2014 Najia Nouf *et al* have made an modify engineering properties of a black cotton soil from Nagpur region, Maharashtra, India by stabilizing it with an eco friendly stabilizer RBI Grade 81 to make it suitable as a sub grade material. Tests such as Atterberg Limits, Modified Proctor Compaction, California Bearing Ratio (C.B.R.), Unconfined Compressive Strength (U.C.S.), Consolidation, were carried out on the untreated and stabilizer treated soil with varying curing period of 7 ,14 and 28 days. The stabilizer was added to the soil in different percentages (by dry weight) varying from 1% to 6%. The results indicate that RBI-81 was effective in improving engineering properties of black cotton

3. PROPOSED METHODOLOGY

The objective of the study is to utilize the unconfined compressive strength (UCS in kN/m²), modulus of elasticity (E in kN/m²) and California bearing ratio (CBR in %) in the black cotton soil with the RBI grade 81 stabilizing percentage by employing the fuzzy logic. In the process, input features embrace the percentage of liquid limit (LL in %), plastic limit (PL in %), plasticity index (PI in %), optimum moisture content (OMC in %), maximum dry density (kN/m^3), and the outputs are unconfined compressive strength, California bearing ratio and modulus of elasticity. It is pertinent to note that the whole experimental process consumes a significant period of time (7days, 14 days, and 28 days) and incurs considerable economic cost, which can be effectively eradicated by the further extension of research work. The proposed fuzzy logic approach is utilized to attain results similar to the ones achieved in the real time experiment. While the known input and output takes in fuzzy logic then creates the membership function and based on the function the rules are generated, according to the process the model has been developed. Where as in case of testing, unknown input and output are feed in the generated fuzzy model to retrieve unconfined compressive strength, California bearing ratio and modulus of elasticity. In this proposed work the model not only produced corresponding output it also laid the platform for the appropriate utilization of output. The two significant considerations are light moving vehicles and heavy moving vehicles. Based on the retrieved result the fuzzy model will produce the area where the feed input combo works.

3.1 Flowchart

The following Figure 1 shows the flow chart for the fuzzy logic controller algorithm and it is explained below.

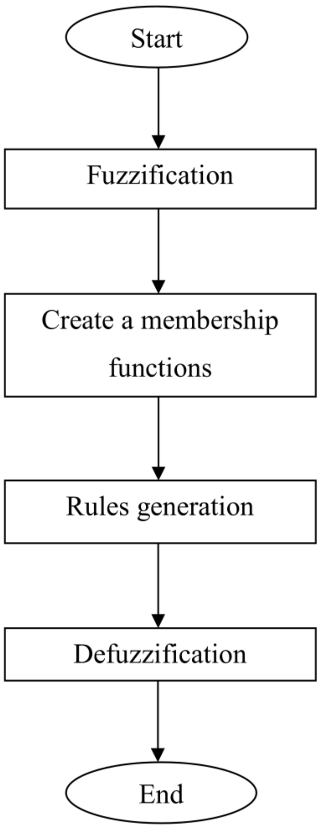


Fig.1: Flow chart for Fuzzy logic algorithm

3.1.1 Techniques Of Fuzzy Logic In Road Construction

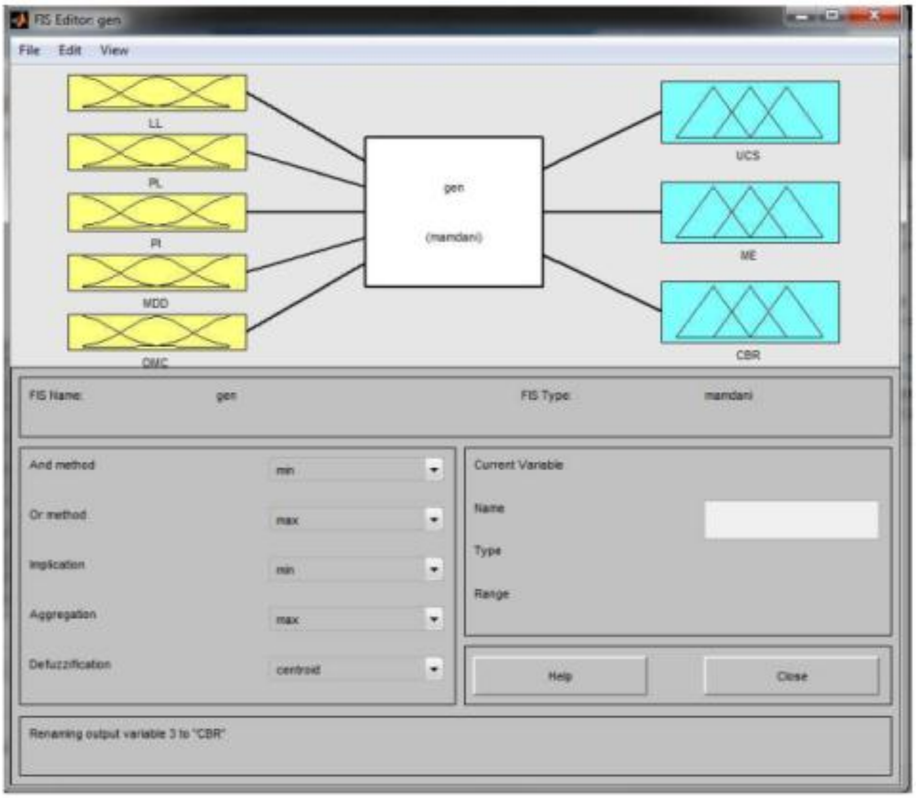
The various processes are initiated in the fuzzy logic for predicting the static outputs. Mainly the steps used in logic are the fuzzification, rule generation and defuzzification. In the fuzzification the membership functions are maintained for process and in our work three membership functions are executed. Based on the membership function the rule generation is produced and the final defuzzification is analyzed based on certain techniques in the fuzzy model.

3.1.1.1 Fuzzification

Fuzzification represents the procedure of describing the degree of membership of a crisp value for each fuzzy set. In other words, it refers to the procedure of modifying the real scalar value into a fuzzy value. There are various kinds of fuzzifier such as singleton fuzzifier, Gaussian fuzzifier and trapezoidal or triangular fuzzifier. A fuzzy subset *A* of a set *X* represents a function $A: X \rightarrow L$, where *L* denotes the interval [0,1]. This function is otherwise known as a membership function. A membership function, in turn, is a simplification of a characteristic function or an indicator function of a subset defined for $L = [0,1]$. Generally, a fuzzification of mathematical conceptions depends on the simplification of such theories from characteristic functions to membership functions. In the procedure of fuzzification, membership functions defined input variables are initiated to their actual values in order that the degree of genuineness for each rule premise can be ascertained. In the work characteristic functions is considered as liquid limit (LL in %), plastic limit (PL in %), plasticity index (PI in %), optimum moisture content (OMC in %), maximum dry density (kN/m^3) and outputs are unconfined compressive strength, California bearing ratio and modulus of elasticity were based on this functions certain intervals are obtained. According to this function the membership is created and by means of set of linguistic values the rule base determines the policy of domain experts. Based on the fuzzification the logic is processed and the advantage of this fuzzy logic is that it provides the stability of the road construction.

Membership functions

A membership function is endowed with various shapes for evaluation in fuzzy logic, the easiest membership functions being formulated by means of employing straight lines. From among them, the easiest is the triangular membership function, whose function name is trimf. It represents more than a set of three points forming part of a triangle. The trapezoidal membership function, trapmf, contains a flat top and is in effect, a truncated triangle curve. With a certain angle the formula is used to calculate the functions. In the membership function the output is obtained and the basis of the input includes (liquid limit (LL in %), plastic limit (PL in %), plasticity index (PI in %), optimum moisture content (OMC in %), maximum dry density (kN/m^3)) and the outputs represent unconfined compressive strength, California bearing ratio and modulus of elasticity and the function is verified in the fuzzy logic. According to each output the membership function is captured in the process. Then the proper membership functions are defined for output variables too. The proper range for each term and the number of membership functions can be defined based on the designer experiments and the system configuratio

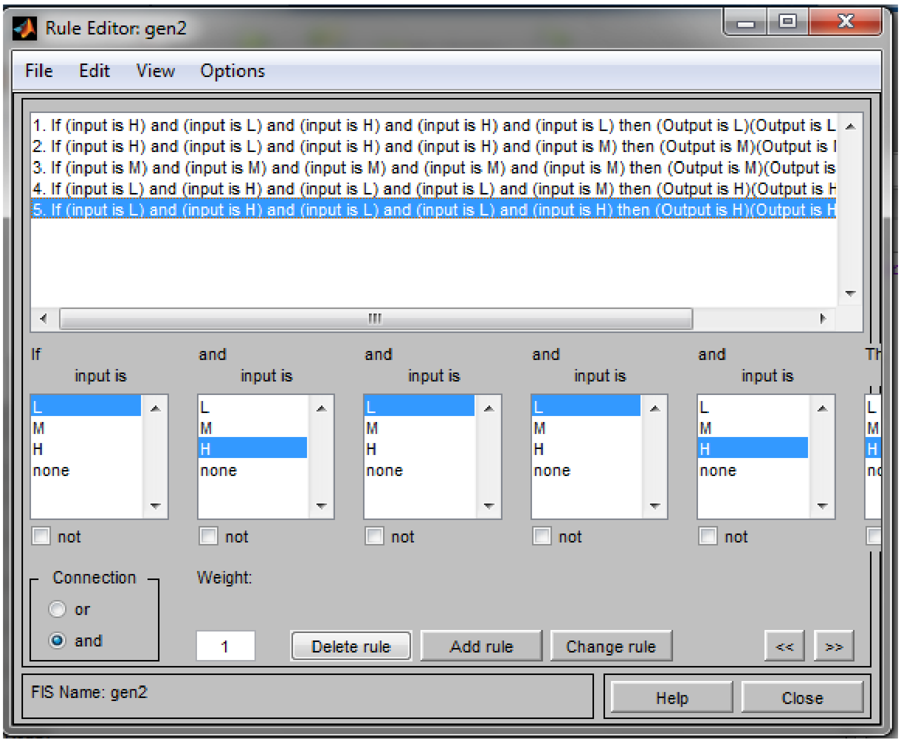


Structure.1 FIS generation

Structure.1 shows the corresponding inputs such as liquid limit (LL in %), plastic limit (PL in %), plasticity index (PI in %), optimum moisture content (OMC in %) and maximum dry density (kN/m^3) are applied and the rule generation and specified outputs like unconfined compressive strength, California bearing ratio and modulus of elasticity.

3.1.1.2 Rules Generation

While in the required membership function the rules have been generated, based on the input and output the rules will be generated independently and the process is obtained in the fuzzy logic controller. The technique produces fuzzy if-then rules with non fuzzy singletons (i.e. real numbers) in the resultant segments. From the specified input and output pairs of training data, a resultant genuine number is obtained for each fuzzy if – then rule produced from the fuzzy subspaces is formed on the presumption that the domain interval of every input variable is segregated equally into fuzzy sets.



Structure.2 Rule generation

The logic behind rule can be easily derived. For example,

Rule1: if (LL is high and PL is low and PI is high and MDD is high and OMC is low) then (UCS is low and E is low and CBR is low).

Rule2: if (LL is high and PL is low and PI is high and MDD is high and OMC is medium) then (UCS is medium and E is medium and CBR is medium).

Rule3: if (LL is medium and PL is medium and PI is medium and MDD is medium and OMC is medium) then (UCS is medium and E is medium and CBR is medium).

Rule4: if (LL is low and PL is high and PI is low and MDD is low and OMC is medium then (UCS is high and E is high and CBR is high).

Rule5: if (LL is low and PL is high and PI is low and MDD is low and OMC is high) then (UCS is high and E is high and CBR is high).

According to the rule defuzzification is taken place and it predicts the outputs.

3.1.1.3 Defuzzification

When the rules are generated the found results are as in the case when the classification has taken place. Based on the rule the defuzzification is analyzed by various methods for predicting outputs. There are several methods for defuzzification like the centroid method, maximum method, height method etc. In the centroid method, the crisp value of the output variable is evaluated by locating the variable value of the centre of gravity of the membership function for the fuzzy value. In the maximum method, one of the variable values at which the fuzzy set contains its greatest truth value is taken as the crisp value for the output variable. By using any technique the final classification is tested. In this fuzzy model the road construction stability is verified and classified as low, medium and high for pedestrian walk, light moving vehicles and heavy moving vehicles which belong to the certain range of each parameter occurring in the input and output results mentioned. The logic is that the stabilization of percentage is analyzed and then the model is used in road construction. In the black cotton soil the RBI grade 81 is added and the stability is improved.

4. RESULT AND DISCUSSION

In the paper various inputs like liquid limit (LL in %), plastic limit (PL in %), plasticity index (PI in %), optimum moisture content (OMC in %) and maximum dry density (kN/m^3) are given and the three output values such as unconfined compressive strength, California bearing ratio and modulus of elasticity are obtained. In the road construction, the fuzzy logic is utilized which minimizes the error values by using this algorithm. In spite of formulating with different training techniques, the performance are not up to the level to copeup with , and hence inorder to retain minimized error values, fuzzy logic is used to designe in optimal manner. For developing the stability of road construction the addition of RBI grade 81 in black cotton soil is used in the proposed work. The experiment was conducted in various parameters such as the unconfined compressive strength, modulus of elasticity and California bearing capacity for road construction in black cotton. liquid limit (LL in %), plastic limit (PL in %), plasticity index (PI in %), optimum moisture content (OMC in %), maximum dry density (kN/m^3) and certain datasets are given to analyze and to predict the outputs such as unconfined compressive strength, California bearing ratio and modulus of elasticity and also in which category the road has been utilized in this construction work

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4.1 Liquid limit based on outputs

If black cotton soil is used for road construction, and in this soil the RBI grade 81 is added for stability and easiness to work in the field. The three valid outputs comprise the unconfined compressive strength, modulus of elasticity and California bearing ratio. The variation is analyzed in plastic limit for unconfined compressive strength, modulus of elasticity and California bearing ratio. Figure.1 shows the liquid limit Vs output such as unconfined compressive strength, modulus of elasticity and California bearing ratio. Each output has been varied in a certain range of given datasets. In this graph except liquid limit the other inputs such as plastic limit (PL in %), plasticity index (PI in %), optimum moisture content (OMC in %), and maximum dry density (kN/m^3) are constant. The variation of liquid limits causes change in 48.2 % and the output is verified and mostly the values are same in three parameters in road construction. The California bearing ratio is decreased from 48.2% to 47.5% in the X-axis and in Y-axis from 0.35 to 1.05 then the unknown values are used to test in the ratio. The modulus of elasticity is also decreased from 48.2% to 47.5% in X-axis and in Y-axis from 3.5 to 6.5 then the unknown values is used to check the variation by using liquid limit in modulus of elasticity. The unconfined compressive strength is varied from 48.2% to 47.5% in X-axis and in Y-axis increased 1.5 to 2.5 Y-axis the unknown values are utilized in the performance.

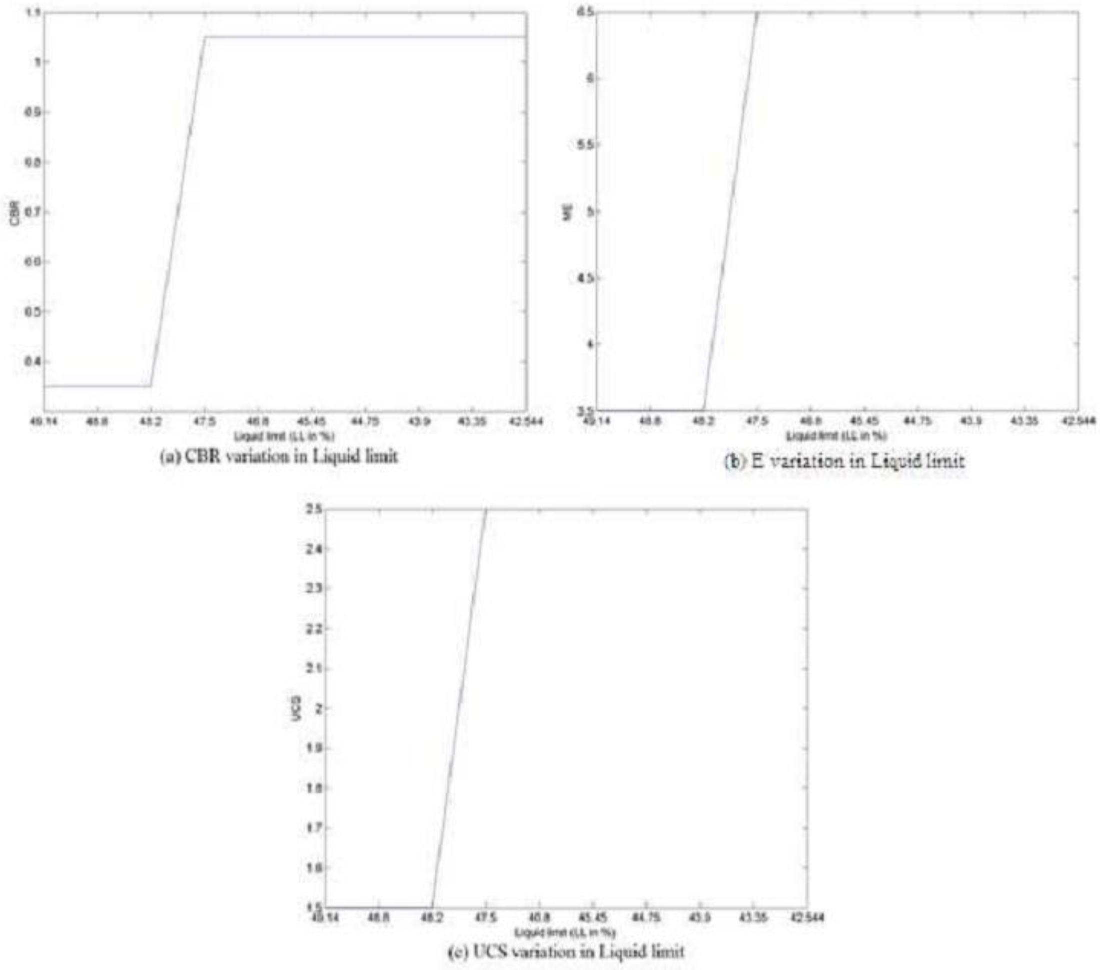
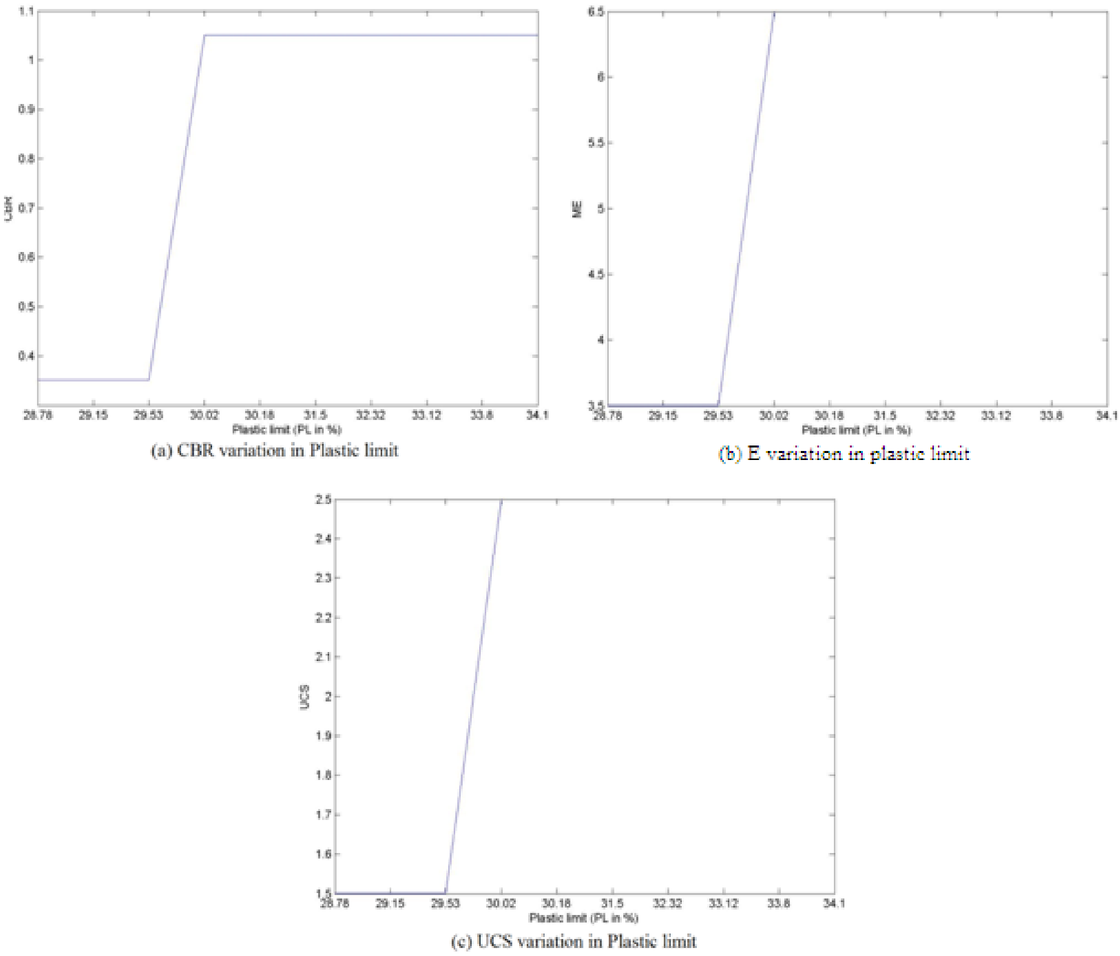


Fig.1: Liquid limit Vs outputs

4.2 Plastic limit based on outputs

In the comparison the variation is assured in the plastic limit for the unconfined compressive strength, modulus of elasticity and California bearing ratio. Figure.2 shows the plastic limit Vs output such as unconfined compressive strength, modulus of elasticity and California bearing ratio. Each output has been varied in a certain range of given datasets. In this graph except plastic limit the other inputs such as liquid limit (LL in %), plastic index (PI in %), optimum moisture content (OMC in %), maximum dry density (kN/m^3) are constant. The variation of limits causes change in 29.53 % and the output is verified and mostly the values are same in three parameters in road construction. The California bearing ratio is increased from 29.53% to 30.02% in the X- axis and Y-axis 0.35 to 1.05 and then the unknown values are used to test the ratio. The modulus of elasticity is also increased from 29.53% to 30.02% X-axis and Y-axis 3.5 to 6.5 and then the unknown values are used to check the variation by using plastic limit in modulus of elasticity. The unconfined compressive strength is varied from 29.53% X-axis and 1.5 Y-axis has increased up to 30.02% X-axis and 2.5 Y-axis and the unknown values are utilized in the performance.



(a) CBR variation in Plastic limit

(b) E variation in plastic limit

(c) UCS variation in Plastic limit

Fig.2: Plastic limit Vs output

4.3 Plasticity index based on outputs

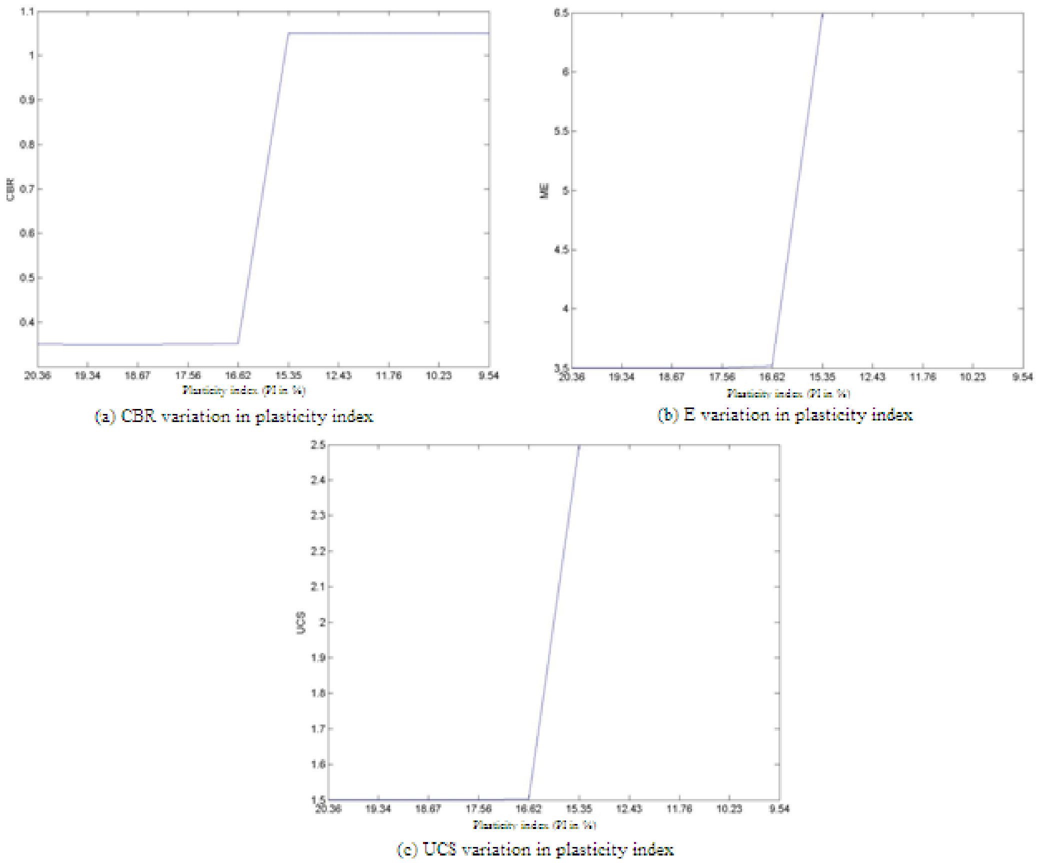
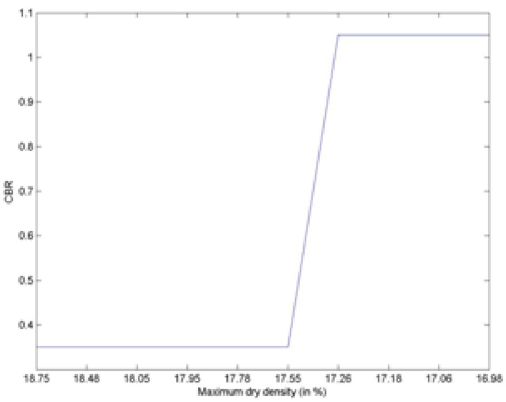


Fig.3: Plasticity index Vs outputs

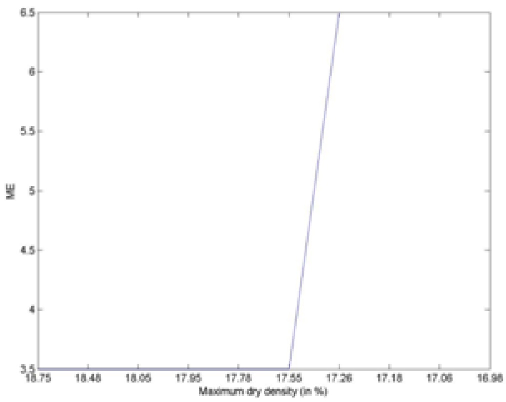
In the comparison the variation is assured in the plasticity index for the unconfined compressive strength, modulus of elasticity and California bearing ratio. Figure.3 illustrates the plasticity index Vs output such as unconfined compressive strength, modulus of elasticity and California bearing ratio. Each output has been varied to certain range in given datasets. In this graph except plasticity index the other inputs such as liquid limit (LL in %), plastic limit (PL in %), optimum moisture content (OMC in %), maximum dry density (kN/m^3) are constant. The variation of limits causes change in 16.62 % and the output is verified and mostly the values are same in three parameters in road construction. The California bearing ratio is varying from 16.62% to 15.35% in the X- axis and Y-axis 0.35 to 1.05 then the unknown values are used to test the ratio. The modulus of elasticity is also varied from 16.62% to 15.35% X-axis and Y-axis 3.5 to 6.5 then the unknown values are used to check the variation by using plasticity index in modulus of elasticity. The unconfined compressive strength is varied from 16.62% to 15.35% in X-axis and Y-axis 1.5 to 2.5 and the unknown values are utilized in the performance.

4.4 Maximum dry density based on outputs

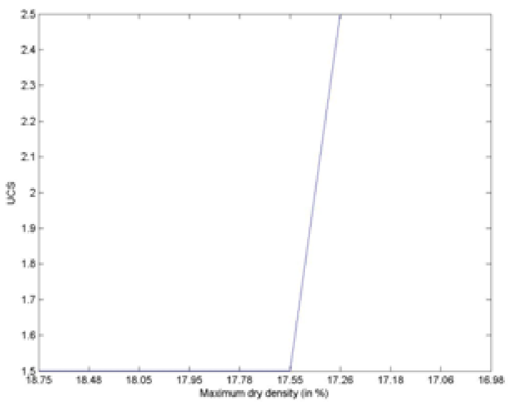
The variation is assured in the maximum dry density for the unconfined compressive strength, modulus of elasticity and California bearing ratio. Figure.3 shows the plastic index Vs output such as unconfined compressive strength, modulus of elasticity and California bearing ratio. Each output has been varied to a certain range in the given datasets. In this graph, except maximum dry density, the other inputs such as liquid limit (LL in %), plastic limit (PL in %), plasticity index (PI in %), optimum moisture content (OMC in %) are constant. The variation of limits causes change in 17.55 % and the output is verified and mostly the values are same in three parameters in road construction. The California bearing ratio is varied from 17.55% to 17.26% in the X-axis and Y-axis 0.35 to 1.05 then the unknown values are used to test the ratio. The modulus of elasticity is also varied from 17.55% to 17.26% X-axis and Y-axis 3.5 to 6.5 then the unknown values are used to check the variation by using plasticity index in modulus of elasticity. The unconfined compressive strength is varied from 17.55% to 17.26% X-axis and Y-axis 1.5 to 2.5 the unknown values are utilized in the performance.



(a) CBR variation in MDD



(b) E variation in MDD

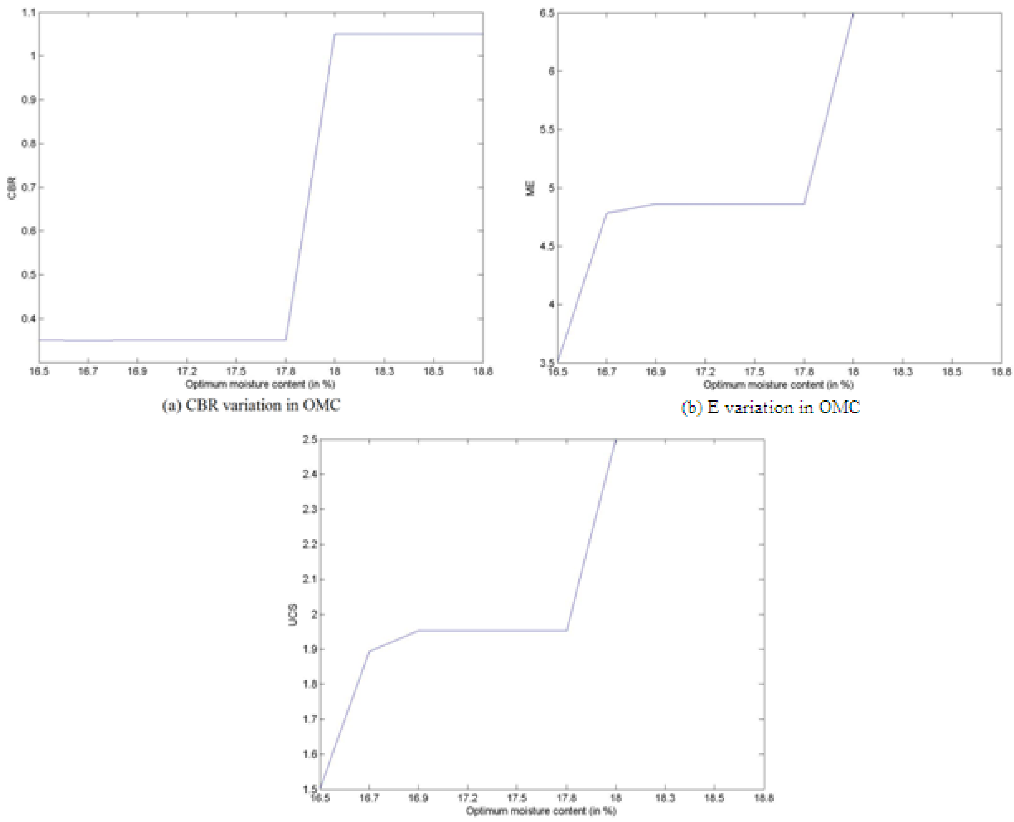


(c) UCS variation in MDD

Fig.4: Maximum dry density Vs outputs

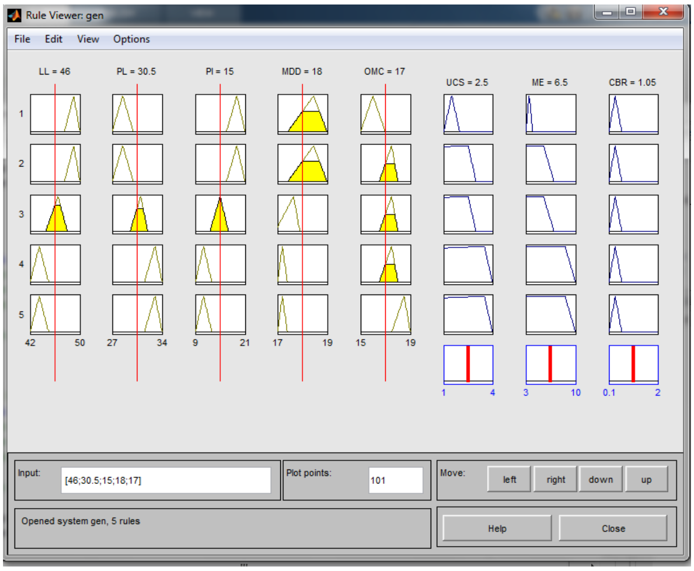
4.5 Optimum moisture content based on outputs

In the comparison, the variation is assured in the optimum moisture content for unconfined compressive strength, modulus of elasticity and California bearing ratio. In figure.5 it is shown that the optimum moisture content Vs outputs such as unconfined compressive strength, modulus of elasticity and California bearing ratio. Each output has been varied to certain range in the given datasets. In this graph, except optimum moisture content, the other inputs such as liquid limit (LL in %), plastic limit (PL in %), plasticity index (PI in %), maximum dry density (kN/m^3) are constant. The variation of limits causes change in 17.8 % and the output is verified and mostly the values are same in three parameters in road construction. The California bearing ratio is varied from 17.8% to 18% in the X- axis and Y-axis 0.35 to 1.05 then the unknown values are used to test in the ratio. The modulus of elasticity is varied from 16.5% to 16.7% X-axis then up to 16.9% level which is medium and varied from 17.8% to 18% and Y-axis 3.5 to 4.8 finally ends in 6.5 then the unknown values are used to check the variation by using plasticity index in modulus of elasticity. The unconfined compressive strength is varied from 16.5% to 16.7% X-axis then up to 16.9% level is getting slop and medium up to 17.8% to 18% and 1.5 to 1.9 Y-axis has increased and slop in 1.95 then increased to 2.5 Y-axis the unknown values are utilized in the performance



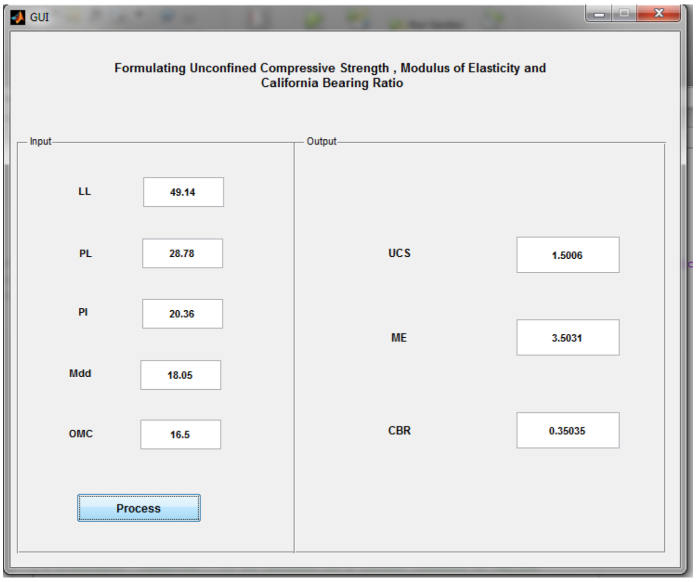
(a) CBR variation in OMC (b) E variation in OMC (c) UCS variation in OMC

Fig.5: Optimum moisture content Vs outputs



Structure.3 Rule viewer

At the end of the result, testing takes place and for anlyzing the result, the inputs are used in fuzzy logic algorithm. The snap shows that the input datas like liquid limit at 46% which is medium, plastic limit at 30.5% which is medium, plasticity index at 15% which is medium, maximum dry density at 18% which is high and optimum moisture content at 17% which is medium based on these inputs the outputs are unconfined compressive strength which is varied as 2.5 which is medium level, the modulus of elasticity is varied as 6.5 which is medium level and finally california bearing ratio is varied as 1.05 which is medium level and the result is predicted in a clear manner.



Structure.4 GUI

Structure.4 illustrates the inputs such as liquid limit, 49.14%, plastic limit, 28.78%, plasticity index, 20.36%, maximum dry density, 18.05% and optimum moisture content, 16.5% and based on this the outputs formulate the unconfined compressive strength 1.50, modulus of elasticity 3.50 and california bearing ratio 0.35 which have been predicted.

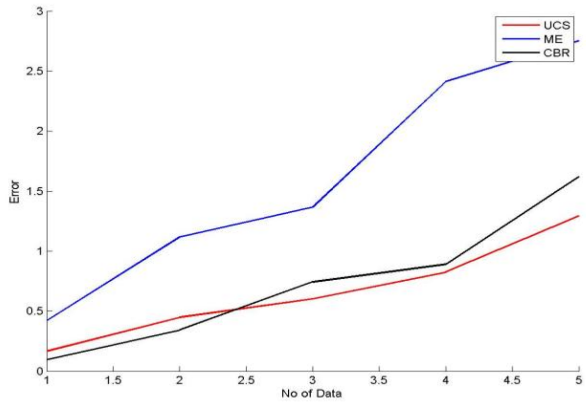
Table.2 The outputs of fuzzy logic in road construction

SL. No	Unconfined compressive strength	Modulus of Elasticity	California bearing ratio
1.	150.06	3503.12	3.50
2.	228.66	5286.41	8.57
3.	227.26	5273.49	8.54
4.	327.00	8269.69	15.53
5.	328.52	8285.12	15.56

Table.2 shows the output which has been predicted from certain inputs like liquid limit (LL in %), plastic limit (PL in %), plasticity index (PI in %), optimum moisture content (OMC in %), maximum dry density (kN/m^3) and while used in fuzzy logic algorithm the nearer value of output is performed. The unknown values are used in fuzzy logic to predict the outputs as valuable and nearer specified outputs in unconfined compressive strength, modulus of elasticity and California bearing ratio.

4.6 Minimization of error in outputs

For minimization of error value the fuzzy logic is utilized and three outputs were causing an error in the performance of classification. In the X axis the number of data values is 1 to 5 and the modulus of elasticity is blue line which has been distracted in 2, 3 and 4.



The California bearing ratio is detected as black line which is distracted in 2, 3 and 4 then the unconfined compressive strength is detected as red line in the error graph which also causes a distraction in 2, 3 and 4. In the Y axis the error value starts from down 0.5 and the modulus of elasticity is high which are compared to California bearing ratio and unconfined compressive strength. Modulus of elasticity is varied from 0.4 to 1.1 and the slight slope from 1.1 to 1.4 then increased up to 2.4 and 3 in error of Y –axis, and in X-axis 1 to 2, 2 to 3, 3 to 4, and 4 to 5 numbers of data. California bearing ratio is varied from 0.1 to 0.4 which is increased up to 0.7 and raise to 0.8 and up to 1.5 in error value of Y-axis and in X-axis the variation is caused from 1 to 2, 2 to 3, 3 to 4, 4 to 5 number of data. Unconfined compressive strength is varied from 0.1 to 0.4 and increased from 0.5 to 0.6 and raised to 1 in error value of Y-axis and in X-axis the variation is caused from 1 to 2, 2 to 3, 3 to 4, 4 to 5 number of data. Comparing the three outputs the error is minimized and it is used for construction. Based on this error graph the minimization is presented in the road construction work

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5. CONCLUSION

From the results, the outputs such as unconfined compressive strength, modulus of elasticity and California bearing ratio are predicted by using fuzzy logic algorithm in the road construction. The inputs like liquid limit (LL in %), plastic limit (PL in %), plasticity index (PI in %), optimum moisture content (OMC in %) and maximum dry density (kN/m^3) are the parameters to find the classification of road. For the process using fuzzy logic the given inputs are utilized and the following graph shows the variation of each input in certain outputs and analyzes them. Then finally the outputs found with an error are compared with each output such as (unconfined compressive strength, modulus of elasticity and California bearing ratio) and the classification is presented as light moving vehicle and heavy moving vehicle in road. By the utilization of fuzzy logic, the error value is minimized in the outputs and by analyzing the classification, the road is used. Based on the retrieved result the fuzzy model produces the area where the feed input combo works. It is worth-mentioning that the entire procedure gets well-implemented in the working platform of MATLAB software. In future the software techniques are used like ANN algorithm and utilized for better performance and the time is reduced and cost has been minimized.

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