# Ability of Mixed Soil Technique

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**ABSTRACT –** The design of mixed soil model requires determination of appropriate quantities of various component of model, which are soils, gravels, sand and water content to get a model with desirable properties. 31 mixed soil models were developed and effect of moisture, percentage of soils, gravels and sand on unit weight, angle of friction, cohesive and bearing capacity have been evaluated. The results revealed that mixed soil behavior has direct correlation with its composition and it would control soil foundation ability.

Keyword**: Soil Mixing, Cohesive, Angle of friction**

## INTRODUCTION

A method to reduce magnitude of damage caused to the structure due to weak bearing capacity of soil is excavate and replacement of some part or the whole of the soil foundation [1]. It has been reported about the effect of lime on some geotechnical properties of Igumale shale, to ascertain its suitability for use as a modifier or stabilizer in the treatment of the shale [2]. There is an innovative report which, use of soil-cement mixing method using jet grouting technique to improve the bearing capacity of sub-base foundation for road construction. The construction sequences and the basic design example of jet grouting for embankment works on soft clay are also given in that research. The design concept and method of analysis of jet grouting work used finite element technique. It was found that the total settlement is reduced by this technique [3]. The use of deep soil mixing methods for the construction of excavation support systems is often the method of choice based on design requirements, site conditions/restraints and economics [4]. The use of soil mixing for providing stabilization to soft or loose soils is considered a fairly new technology. The design of the soil mix remediation will address the feasibility of soil-mix, slope stability, anchorage of the soil mix walls, alternate failure surfaces, continuity of drainage, and quality assurance [5]. Soil mixing has been successfully applied for liquefaction mitigation, steel reinforced retaining walls, groundwater cutoff walls, and stabilization of contaminated soils. Applications of this technology have recently been expanded. Such applications have included settlement control of soils, slope stabilization and the formation of composite gravity structures. In slope stability applications, soil mixing could improve the overall shear strength of the soil formation to adequately increase the factor of safety [6-13]. Here the author made an attempt to investigate the safe bearing capacity of soil models that have been developed by soil mixing technique. The models were consisted of soils, sand and gravels representing around Mysore.

## METHODOLOGY AND EXPERIMENT

The research has been performed on the bearing capacity of soils with numerically developed soil composition. The objective of investigation is determination of best bearing capacity with natural local material to achieve best and economical soil mixed model, which could be a trustable soil foundation for any type of structures. In this regard 31 different mixed soil models consists of soils-sand-gravels were prepared (table1). The direct shear test has been employed and cohesive, angle of friction and density of the each models under different moisture conditions (0%, 3%, 6%) were measured (table 2.a-b). In calculation of bearing capacity at all models has been assumed of 1.5 m depth and 2.5m* 2.5m widths for square footing.

## RESULT AND DISCUSSION

Evaluation of soil foundation is one of the importance factors in structure stability. The experiment result indicated soils bearing capacity could be predictable and applicable in field of soil and foundation engineering if characteristics of soil behavior accurately have been studied.

The angle of friction has positive correlation with safe bearing capacity (fig 1-2). The mixed soil type 5 at 0% and 3% moisture and under loose conditions has exhibited maximum safe bearing capacity of (1595.69 $KN/m^2$) and (1337.96$KN/m^2$) respectively. It is attributed due to the differential distribution of soils particles and less void ratio, which leads to sufficient increases unit weight and angle of friction. The mixed soil type 3, at 6% moisture has exhibited maximum Safe Bearing Capacity of 622.89 $KN/m^2$; it is due to sufficient percent of the coarse gravel (4.75 mm size), which imported relatively high degree of binding to the soil type and resulted high degree of cohesiveness and angle of friction.

Mixed soil consists of only different types of soil mixtures were exhibited minimum level of SBC. At 0% moisture; mixed soil type 23 has exhibited 136.64$KN/m^2$, at 3% moisture, mixed soil type 24 has exhibited 231.52$KN/m^2$, at 6% moisture; mixed soil type 27 has exhibited 163.88$KN/m^2$. All these SBC values are recorded under loose conditions. All these mixed soils types; 23, 24, 27 and 29 were not mixed with gravel and sand. Hence the binding intensity drastically reduced. The low binding intensity of these soil mixed have resulted of relatively low cohesiveness and angle of friction and hence exhibited low SBC values. Increasing water content in the mixed soil is another factor in decreasing soils bearing capacity, in such situation model with proper mixing of admixture material could be introduced as best options.

The interaction between the coarse and fine grain matrices affects the overall mechanical behavior of the mixture of soils [14]. The existing unusual soil volume change behavior like settlement under effective stress decrease during wetting and massive settlement near saturation [15]. Adding some granular soils to pure plastic clay soil will decreases the differential behavior of any earth structure [16].

## CONCLUSION

In a city with loose sandy saturated soil ground, mixed soil technique could be used for increasing soil strength and make guarantee to stability of structure. To reduce dimension of foundation in construction of any structure on soft soil, soil mixture method strongly could recommend. In mitigation of liquefaction, soil mixing is one of the cost effective and feasible methods. Soil mixing has ability to increase strengthen of soft and wet soils in a very short duration and could be applicable in construction of any engineering projects. It is a very economical process and could be performed at anywhere to increase the strength and stability of the soil.

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Table2.a Experiments Results [1]

| Moisture (%) | γ $KN/m^3$ | Φ D | C $KN/m^2$ | S. B .C $KN/m^2$ | Moisture (%) | γ $KN/m^3$ | Φ D | C $KN/m^2$ | S. B .C $KN/m^2$ |
|---|---|---|---|---|---|---|---|---|---|
| Model 1 | | | | | Model 2 | | | | |
| 0 | 11.80 | 38 | 0 | 701.55 | 0 | 12.54 | 35 | 10 | 699.82 |
| 3 | 10.84 | 30 | 2 | 236.21 | 3 | 11.5 | 35 | 0 | 412.08 |
| 6 | 10.54 | 25 | 6 | 176.81 | 6 | 9.99 | 31 | 0 | 218.20 |
| Model 3 | | | | | Model 4 | | | | |
| 0 | 13.93 | 36.5 | 14 | 1083 | 0 | 12.71 | 42 | 0 | 1522.6 |
| 3 | 13.32 | 36 | 10 | 865.26 | 3 | 12.23 | 38 | 6 | 936.03 |
| 6 | 12.23 | 31 | 20 | 622.89 | 6 | 11.81 | 37 | 0 | 735.23 |
| Model 5 | | | | | Model 6 | | | | |
| 0 | 13.32 | 42 | 0 | 1595.6 | 0 | 11.5 | 37 | 12 | 972.18 |
| 3 | 13.2 | 39.5 | 10 | 1337.9 | 3 | 11.8 | 36 | 4 | 628.87 |
| 6 | 10.29 | 34 | 0 | 318.13 | 6 | 10.29 | 33 | 0 | 287.01 |
| Model 7 | | | | | Model 8 | | | | |
| 0 | 12.11 | 36 | 0 | 529.09 | 0 | 13.26 | 32 | 0 | 329.73 |
| 3 | 10.9 | 34 | 0 | 336.99 | 3 | 11.8 | 32 | 0 | 293.43 |
| 6 | 10.6 | 33 | 0 | 295.65 | 6 | 10.9 | 29 | 0 | 187.15 |
| Model 9 | | | | | Model 10 | | | | |
| 0 | 11.38 | 35 | 0 | 407.78 | 0 | 10.29 | 37 | 4 | 656.88 |
| 3 | 12.23 | 32 | 0 | 304.12 | 3 | 11.38 | 31 | 10 | 426.44 |
| 6 | 10.9 | 31 | 4 | 309.23 | 6 | 10.9 | 29 | 0 | 187.15 |
| Model 11 | | | | | Model 12 | | | | |
| 0 | 10.9 | 36 | 0 | 476.22 | 0 | 12.35 | 33 | 0 | 344.46 |
| 3 | 11.08 | 34 | 0 | 342.56 | 3 | 12.35 | 32 | 0 | 307.10 |
| 6 | 11.5 | 31 | 5 | 340.12 | 6 | 11.63 | 28.5 | 0 | 190.11 |
| Model 13 | | | | | Model 14 | | | | |
| 0 | 11.5 | 35 | 0 | 412.08 | 0 | 12.72 | 36 | 0 | 555.74 |
| 3 | 13.02 | 33 | 6 | 489.90 | 3 | 12.72 | 34 | 0 | 393.26 |
| 6 | 12.11 | 27.5 | 6 | 259.01 | 6 | 11.08 | 32.5 | 4 | 373.44 |
| Model 15 | | | | | | | | | |
| 0 | 11.2 | 37 | 0 | 577.32 | | | | | |
| 3 | 11.38 | 36 | 0 | 497.19 | | | | | |
| 6 | 10.9 | 34 | 0 | 336.99 | | | | | |

D=Degree, γ=Unit Width, S.B.C= Safe Bearing Capacity and OMC= Optimum Moisture Content

Table 2.b Experiments Results

| Moisture (%) | γ $KN/m^3$ | Φ D | C $KN/m^2$ | S. B .C $KN/m^2$ | Moisture (%) | γ $KN/m^3$ | Φ D | C $KN/m^2$ | S. B .C $KN/m^2$ |
|---|---|---|---|---|---|---|---|---|---|
| Model 16 | | | | | Model 17 | | | | |
| 0 | 11.5 | 35 | 0 | 412 | 0 | 11.93 | 33 | 0 | 332 |
| 3 | 13.02 | 36 | 0 | 568 | 3 | 11.5 | 33 | 0 | 320 |
| 6 | 11.8 | 35 | 0 | 422 | 6 | 11.02 | 32 | 0 | 274 |
| Model 18 | | | | | Model 19 | | | | |
| 0 | 12 | 35 | 0 | 430 | 0 | 12.11 | 37 | 0 | 624 |
| 3 | 11.83 | 33 | 0 | 329 | 3 | 12.11 | 32 | 0 | 301 |
| 6 | 11.58 | 32 | 0 | 287 | 6 | 11.5 | 30 | 0 | 216 |
| Model 20 | | | | | Model 21 | | | | |
| 0 | 11.02 | 35 | 0 | 394 | 0 | 11.51 | 31 | 12 | 464 |
| 3 | 11.38 | 35 | 0 | 407 | 3 | 10.9 | 30 | 12 | 398 |
| 6 | 10.78 | 33.5 | 0 | 317 | 6 | 11.38 | 29 | 12 | 376 |
| Model 22 | | | | | Model 23 | | | | |
| 0 | 12.42 | 35 | 0 | 445 | 0 | 11.81 | 35 | 8 | 623 |
| 3 | 12.59 | 35 | 0 | 451 | 3 | 10.6 | 34 | 10 | 555 |
| 6 | 11.51 | 30 | 4 | 281 | 6 | 11.38 | 35 | 0 | 407 |
| Model 24 | | | | | Model 25 | | | | |
| 0 | 13.32 | 34.5 | 0 | 136 | 0 | 11.51 | 33 | 0 | 321 |
| 3 | 12.53 | 32 | 0 | 311 | 3 | 10.6 | 31 | 0 | 231 |
| 6 | 11.5 | 30.5 | 0 | 233 | 6 | 10.48 | 31 | 0 | 228 |
| Model 26 | | | | | Model 27 | | | | |
| 0 | 12.72 | 34 | 0 | 393 | 0 | 14.05 | 34 | 0 | 434 |
| 3 | 11.93 | 36 | 0 | 521 | 3 | 12.72 | 30 | 0 | 239 |
| 6 | 11.57 | 35 | 0 | 414 | 6 | 12.72 | 30 | 0 | 239 |
| Model 28 | | | | | Model 29 | | | | |
| 0 | 12.11 | 32.5 | 0 | 319 | 0 | 12.72 | 37 | 0 | 655 |
| 3 | 11.81 | 31 | 0 | 257 | 3 | 11.81 | 32 | 0 | 293 |
| 6 | 11.81 | 27 | 0 | 163 | 6 | 12.41 | 31 | 0 | 271 |
| Model 30 | | | | | Model 31 | | | | |
| 0 | 12.72 | 34 | 6 | 530 | 0 | 13.02 | 35.5 | 0 | 517 |
| 3 | 12.41 | 33 | 6 | 472 | 3 | 12.71 | 32 | 0 | 316 |
| 6 | 11.08 | 32 | 0 | 275 | 6 | 12.11 | 30 | 0 | 227 |

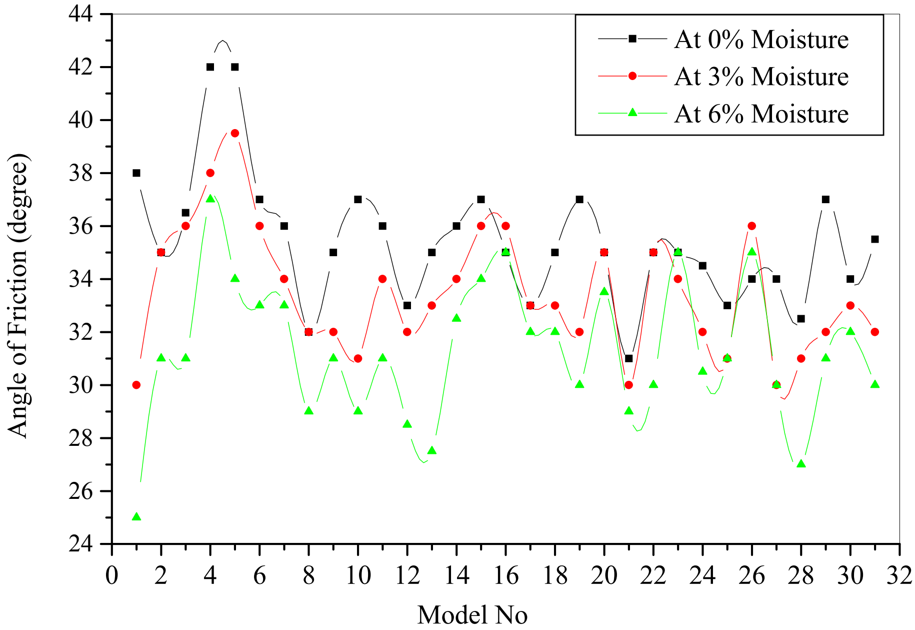


Fig . 1 . Angle of Friction (KN/m$^2$) vs Model

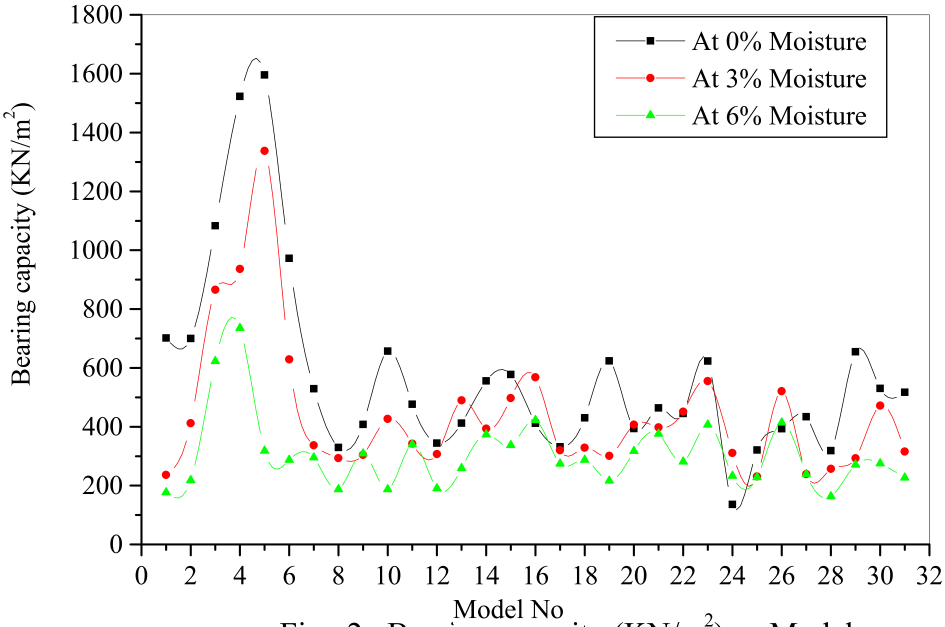


Fig . 2 . Bearing capacity (KN/m$^2$) vs Model