Improvement of Soil Index Properties by Adding Stone Dust Mix

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Abstract

Index properties and strength of such type murrum/Gravel soil is low and does not fulfill the requirements for its use as a road pavement material like GSB. These properties may be improved by adding a suitable admixture of stone dust/river sand. Therefore a detailed experimental study is proposed by adding combination of quarry soil (i. e. murrum/Gravel soil) with stone dust in various percentage, to find suitable proportion of local murrum/ Gravel soil that will suit parameter for granular Sub-base material for low traffic volume roads in rural area.The main object of this study is to find out solution for use of local gravel soil/murrum in construction of road pavement layers by adding suitable percentage of stone dust/river sand. To improve its properties and to make it suitable material for road pavement material like Granular sub-base. Following objects are taken in to consideration during study.
Keywords: Stone Dust Mix, Soil Index Properties

I. INTRODUCTION

Regarding the scope of this investigation in most of the developing Countries like India, there is major scope for development of rural infrastructure. Since only by providing a better infrastructure facilities like fast, easy, and economical conveyance and connectivity of rural areas with district and tehsil places the overall social and economic development of villages can be possible. For the sake of rural development government had launched many schemes like "Prandhan Mantri Gram Sadak Yojana and Mukhaya Mantri Gram Sadak Yojana" for construction of rural roads and link roads. Still there is large numbers of village roads and link roads which remain untouched and proposed for construction in incoming Government schemes of rural development.

As in the construction of such type of village roads and link roads there are two major concepts, which are taken in to consideration. One is maximum use of local resources so that local employment and economy may improve; another is to maintain economical construction cost as well as easy construction procedure. Since maximum village roads are of short length and scattered on different locations, the quantum of work to be executed is also small and scattered in different locations. To execute small work in scattered location by importing good quality material from a long distant approved quarry is uneconomical and difficult in operation. Hence keeping in view the economy of work, difficulty in movement of heavy machineries, non availability of good material and for optimum utilization of natural resources, there is a hard need of this study and there is good scope of getting advantages in construction of rural roads with the help of this study.

II. SCOPE OF STUDY

Regarding the scope of this investigation in most of the developing Countries like India, there is major scope for development of rural infrastructure. Since only by providing a better infrastructure facilities like fast, easy, and economical conveyance and connectivity of rural areas with district and tehsil places the overall social and economic development of villages can be possible. For the sake of rural development government had launched many schemes like "Prandhan Mantri Gram Sadak Yojana and Mukhaya Mantri Gram Sadak Yojana" for construction of rural roads and link roads. Still there is large numbers of village roads and link roads which remain untouched and proposed for construction in incoming Government schemes of rural development.

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Study will also help us, to find the solution of reuse the garbage obtained from dismantling of road pavements. Disposal of material obtained from dismantling of road pavements is a big problem for environment and fertility of land. Their reuse will not only be economical for construction but also save our environmental balance

III. FIELD SURVEY AND CLASSIFICATION OF LOCAL GRAVEL SOIL/MURRUM

The materials available for the construction of earthen embankments, sub grade were fine sandy loam, gravel, clay and basaltic rock. The variable mixtures of the sandy loam and gravel could be successfully used for embankment construction and sub grade work, while the basaltic rock formed excellent material for slope protection. Gravel is suitable for the construction of an embankment. The weight and stability of gravel are both satisfactory, but gravel lacks the essential feature of water tightness, as it often contains as much as from 35 to 40 percent of pore space. Sand/stone dust, on the other hand, while less porous than gravel, is much less stable in compaction at site.

The laterite soil popularly known as murrum can be characterized by a deep weathered layer from which silica has been leached. There is an accumulation of aluminium and iron oxides and hydroxides. The reddish colour of these soils is imparted by the iron compounds. Murrums are residual soils and are formed from weathering of basaltic rock at places, where monsoon is severe. They constitute mixture of weathered rock pieces in varying sizes, sand, silt and clays. They are good material for road construction.

Basically a perfect murrum/gravel soil shall be composed of well graded coarse siliceous and gritty to touch and free from dirt and deleterious matter. Material passing 75 micron shall not exceed 10%. Liquid limit shall not exceed 20% and Plasticity index shall not exceed 6%, but in most of the gravel quarries, murrum obtained from disintegration of rock contains soft aggregate, clayey soil, clayey sand and percentage of coarse aggregate infractions, these materials are of high plasticity index, High plasticity modulus and low strength/CBR value.

For the purpose of this standard, the definitions given in IS: 2809-1972 ‘Glossary of terms and symbols relating to soil engineering (first revision)‘ and the following shall apply.

1) Clay - An aggregate of microscopic and submicroscopic particles derived from the chemical decomposition and disintegration of rock constituents. It is plastic within a moderate to wide range of water content.
2) Silt - A fine-grained soil with little or no plasticity. If shaken in the palm of the hand, a part of saturated inorganic silt expels enough water to make its surface appear glossy. If the pat is pressed or squeezed between the fingers, its surface again becomes dull.
3) Sand and Gravel - Cohesion less aggregates of angular, sub-angular, sub-rounded, rounded, flaky or flat fragments of more or less unaltered rocks or minerals. According to this system, gravel is a fraction of the soil material between 80 mm and the 4.75-mm IS Sieve size, and sand is the material between the 4.75mm IS Sieve size and the 75micron IS Sieve size.

IV. CLASSIFICATION AND IDENTIFICATION

A. Division

Soils shall be broadly divided into three divisions as given below.

- Coarse-Grained Soils - In these soils, more than half the total material by weight is larger than 75-micron IS Sieve size.
- Fine-Grained Soils - In these Soil, more than half of the material by weight is smaller than 75-micron IS Sieve size.
- Highly Organic Soils and Other Miscellaneous Soil Materials - These soils contain large percentages of fibrous organic matter, such as peat, and particles of decomposed vegetation. In addition, certain soils containing shells, concretions, cinders, and other non-soil materials in sufficient quantities are also grouped in this division.

B. Subdivision

The first two divisions shall be further divided as given.

1) Coarse-Grained Soils

The coarse grained soils shall be divided into two subdivisions, namely:

- Gravels - In these soils, more than half the coarse fraction (+75 micron) is larger than 4.75-mm IS Sieve size. This subdivision includes gravels and gravelly soils.
- Sands - In these soils, more than half the coarse fraction (+75 micron) is smaller than 4.75-mm IS Sieve size. This subdivision includes sands and sandy soils.

2) Fine-Grained Soils

The fine-grained soils shall be furthir divided into three subdivisions on the basis of the following arbitrarily selected values of liquid limit:

- Silts and clay of low compressibility – having a liquid limit less than 35 (represented by symbol L),

- Silt and clays of medium compressibility -having a liquid limit greater than 35 and less than 50 (represented by symbol I), and
- Silts and clays of high compressibility – having a liquid limit greater than 50 (represented by symbol H).

C. Groups

- The coarse-grained soils shall be further divided into eight basic soil groups. The fine-grained soils shall be further divided into nine basic soil groups.
- Highly organic soils and other miscellaneous soil materials shall be placed in one group. The groups shall be designated by symbols. As per SP 36 table 1 and 2

D. Field Identification and Classification Procedure

The field method is used primarily in the field to classify and describe soils. Visual observations are employed in place of precise laboratory tests to define the basic soil properties. The procedure is, in fact, a process of elimination beginning on the left side of the classification chart and working to the right until the proper group name is obtained. The group name should be supplemented by detailed word descriptions, including the description of the in-place conditions for soils to be used in place as foundations. A representative sample of the soil is selected which is spread on a flat surface or in the palm of the hand. All particles larger than 75 mm are removed from the sample. Only the fraction of the sample smaller than 75 mm is classified. The sample is classified as coarse grained or fine-grained by estimating the percentage by weight of individual particles which can be seen by the unaided eye. Soils containing more than 50 percent visible particles are coarse-grained soils, soils containing less than 50 percent visible particles are fine-grained soils. If it has been determined that the soil is coarse grained,' it is further identified by estimating and recording the percentage of: (a) gravel sized particle, size range from75 mm to 4.75-mm IS Sieve size (or approximately 5 mm size); (b) sand size particles, size range from 4.75 to 75-micron IS Sieve size; and (c) silt and clay size particles, size range smaller than 75-micron IS Sieve.

1) Gravelly Soils

If the percentage of gravel is greater than that of sand, the soil is a gravel. Gravels are further identified as being clean (containing little or no fines, that is, less than 5 percent) or dirty (containing appreciable fines, that is, more than 12 percent) depending upon the percentage of particles not visible to the unaided eye. Gravels containing 5 to 12 percent fines are given boundary classification. If the soil is obviously clean, the classification shall be either: (a) well-graded gravel (GW), if there is good representation of all particle sizes; or (b) poorly graded gravel (GP), if there is an excess or absence of intermediate particle sizes. A well-graded soil has a reasonably large spread between the largest and the finest particles, and has no marked deficiency in any size. If the soil obviously is dirty, the classification will be either (c) silty gravel (GM), if the fines have little or no plasticity; or (d) clayey gravel (GC), if the fines are of low to medium or high plasticity

2) Sandy Soils

If the percentage of sand is greater than gravel, the soil is sand. The same procedure is applied as for gravels except that the word sand replaces gravel and the symbols S replace G. The group classification for the clean sands will be either: (a) well-graded sand (SW) or (b) poorly-graded sand (SP), and the dirty sands shall be classified as (c) silty sand (SM), if the fines have little or no plasticity; or (d) clayey sand (SC), if the fines are of low to medium or high plasticity.

V. EXPERIMENTAL WORK

The materials available for the construction of earthen embankments and sub grade were fine sandy loam, gravel, clay and basaltic rock. The variable mixtures of the sandy loam and gravel could be successfully used for embankment construction, while the basaltic rock formed excellent material for slope protection. Gravel is suitable for the construction of an embankment and Sub grade work. The weight and stability of gravel are both satisfactory, but gravel lacks the essential feature of water tightness as it often contains as much as from 35 to 40 percent of pore space. Sand, on the other hand, while less porous than gravel, is much less stable and much more seriously affected by moisture as compared to gravel.

The present investigation deals with the mechanical stabilization of murrum with mixtures of stone dust/sand. The work presented in this dissertation consists results of index properties (liquid limit, plastic limit), compaction characteristics (optimum moisture content and maximum dry density) and shear strength parameters (cohesion and angle of shearing resistance) for the murrum blended with varying percentages of stone dust/sand.

A. Sample Preparation (As per IS 2720-I):

Soil sample, as received from the field, shall be dried in the air or in sun. In wet weather, a drying apparatus may be used in that case the temperature of the sample should not exceed 60°C. The clods may be broken with a wooden-mallet to hasten drying. The organic matter, like tree roots and pieces of bark should be removed from the sample. Similarly, matter other than soil, like shells should also be separated from the main soil mass. A noting shall be made of such removals and their percentage of the total soil sample noted. When samples are to be taken for estimation of organic content, lime content, etc, total sample should be taken for estimation without removing shells, roots. etc.

B. Drying of the sample

The amount of drying depends upon the proposed test to be conducted on the particular sample. The type, temperature and duration of drying of soil samples for different tests are given in Table I. When oven is used for drying, the temperature in the oven shall not exceed by 110°C.

C. Degree of pulverization

The big clods may be broken with the help of wooden mallet. Further pulverization may be done in pestle and mortar. The pulverized soil shall be passed through the specified sieve for the particular test and the soil retained on that sieve shall be again pulverized for sieving. This procedure should be repeated until on further attempts at pulverizing very little soil passes through the specified sieve. Care should be taken not to break up the individual soil particles. Quantity of soil sample should be taken as given in table of IS 2720 part –4 .

D. Grain Size Analysis (As per IS 2720 Part - IV):

The portion of the soil sample retained on 4*75-mm IS Sieve, selected as given in 3.2, shall be weighed and the mass recorded as the mass of the sample uncorrected for hygroscopic moisture. The quantity of the soil sample taken shall depend on the maximum particle size contained in the soil. The sample shall be separated into various fractions by sieving through the Indian Standard Sieves specified. Other sieves may be introduced between the sieves depending upon the additional information that may be desired to be obtained from the analysis. While sieving through each sieve, the sieve shall be agitated so that the sample rolls in irregular motion over the Sieve. Any particles may be tested to see if they will fall through but they shall not be pushed through. The material from the sieve may be rubbed, if necessary, with the rubber pestle in the mortar taking care to see that individual soil particles are not broken and re-sieved to make sure that only individual particles are retained. The quantity taken each time for sieving on each sieve shall be such that the maximum weight of material retained on each sieve at the completion of sieving does not exceed the values given in Note 2 of IS 2720 part - IV. The mass of the material retained on each sieve shall be recorded. If the sample appears to contain over 5 percent moisture, the water content of the material shall be determined in accordance with 5 IS m: 2720 (Part 4) – 1985 IS : 2720 (Part 2)-1973" and the masses corrected accordingly. When the sample contains less than 5 percent moisture it is not necessary to determine the water content for dry weight computations and all the determinations may be made on the basis of wet weight only. If the soil contains more than about 20 percent gravel particles and the fines are very cohesive with considerable amounts adhering to the gravel after separation, the gravel shall be washed on 4.75-mm IS Sieve using sodium hexameta phosphate solution, if necessary. For further analysis a fresh

Portion of the fraction passing 4.75-mm IS Sieve shall be taken,

Calculations - The percentage of soil retained on each sieve shall be calculated on the basis of the total mass of soil sample taken and from these results the percentage passing through each of the sieves shall be calculated.

E. Atterberg Limit test (Liquid limits and Plastic limit As per IS 2720 PART –V):

1) Test for the determination of liquid limit by Cone penetration method –

The basic principle is to observe depths of penetrations of soils at various initial moisture contents of a metal cone of a certain weight and apex angle with the point barely touching the surface is allowed to drop into the surface. The standardization has been to identify liquid limit water content for a specified depth of penetration.

2) Soil Sample

A soil sample weighing about 150 g from thoroughly mixed portion of the soil passing 425 micron IS Sieve obtained in accordance to IS : 2720 (Part 1)-1983.

3) Procedure

Soil sample obtained as above shall be worked well into a paste with addition of distilled water. In the case of highly clayey soils, to ensure uniform moisture distribution, it is recommended that the soil in the mixed state is left for sufficient time (24 hours) in an air-tight container. The wet soil paste shall then be transferred to the cylindrical cup of cone penetrometer apparatus, ensuring that no air is trapped in this process. Finally the wet soil is leveled up to the top of the cup and placed on the base of the cone penetrometer apparatus. The penetrometer shall be so adjusted that the cone point just touches the surface of the soil paste in the cup clamped in this position. The initial reading is either adjusted to zero or noted down as is shown on the graduated scale. The vertical clamp is then released allowing the cone to penetrate into the soil paste under its own weight. The penetration of the cone after 5 seconds shall be noted to the nearest millimetre. If the difference in penetration lies between 14 and 28 mm the test is repeated with suitable adjustments to moisture either by addition of more water or exposure of the spread paste on a glass plate for reduction in moisture content. The test shall then be repeated at least to have four sets of values of penetration in the range of 14 to 28 mm. The exact moisture content of each trial shall be determined in accordance with IS: 2720 (Part 2)-1973.

4) Determination of Liquid Limit

A graph representing water content on the y-axis and the cone penetration on the x-axis shall be Prepared the best fitting straight line is then drawn. The moisture content corresponding to cone penetration of 20 mm shall be taken as the liquid limit of the soil and shall be expressed to the nearest first decimal place.

a) Plastic Limit:

- Soil Sample - A sample weighing about 20 g from the thoroughly mixed portion of the material passing 425-micron IS Sieve, obtained in accordance with-IS : 2720 (Part 1)-1983" shall be taken. When both the liquid limit and the plastic limit of a soil are to be determined, a quantity of soil sufficient for both the tests shall be taken for preparation of the soil. At a stage in the process of mixing of soil and water at which the mass becomes plastic enough to be easily shaped into a ball, a portion of the soil sample in the plastic state should be taken for the plastic limit test.
- Procedure - The soil sample shall be mixed thoroughly with distilled water in an evaporating dish or on the flat glass plate till the soil mass becomes plastic enough to be easily molded with fingers. In the case of clayey soils the plastic soil mass shall be left to stand for a sufficient time (24 hours) to ensure uniform distribution of moisture throughout the soil. A ball shall be formed with about 8 g of this plastic soil mass and rolled between the fingers and the glass plate with just sufficient pressure to roll the mass into a thread of uniform diameter throughout its length. The rate of rolling shall be between 80 and 90 strokes/min counting a stroke as one complete motion of the hand forward and back to the starting position again. The rolling shall be done till the threads are of 3 mm diameter. The soil shall then be needed together to a uniform mass and rolled again. This process of alternate rolling and kneading shall be continued until the thread crumbles under the pressure required for rolling and the soil can no longer be rolled into a thread. The crumbling may occur when the thread has a diameter greater than 3 mm. This shall be considered a Methods of test for soils : Part 1 Preparation of dry soils samples for various tests satisfactory end point, provided the soil has been rolled into a thread 3 mm in diameter immediately before. At no time shall an attempt be made to produce failure at exactly 3 mm diameter by allowing the thread to reach 3 mm, then reducing the rate of rolling or pressure or both, and continuing the rolling without further deformation until the thread falls apart. The pieces of crumbled soil thread shall be collected in an air-tight container and the moisture content determined as described in IS: 2720 (Part 2)-1973
- Plasticity Index: - The plasticity index is calculated as the difference between its liquid limit and plastic limit:

Plasticity index (Ip) = liquid limit (wl) - plastic limit (wp).

5) Experiments on material used (Gravel soil / murrum):

From above parametric study of murrum of four sources in chapter 3, I have concluded that the most suitable murrum is of Hanotia Alam quarry. Due to its good engineering properties than other quarries murrum, it will be more economical to improve its property. Hence I have chosen Hanotia alam quarry murrum for investigation. The location of gram Hanotia alam is approximately 7 km from Misrod town of Bhopal. Following test is conducted on material obtained from quarry Hanotia Alam;

Name of test – Sieve analysis of murrum

Table – 1
Gradation of natural murrum

Weight of sample (gm.)		*4000*		*Name of quarry*	*Hanotia Alam*	
S. No.	*IS sieve in mm*	*Weight retained gms*	*Cumulative Wt. Rt. gms*	*Cum. Wt. Retain. %*	*% Passing*	*Limit %*
1	*75*	*0*	*0*	*0*	*100*	*100*
2	*26.5*	*1680*	*1680*	*42*	*58*	*55-75*
3	*4.75*	*1960*	*3640*	*91*	*9*	*10-30*
4	*0.075*	*200*	*3840*	*96*	*4*	*0-10*
	Sieve Size	*Upper Limit*	*Achieved*	*Lower Limit*		
	75	*100*	*100.00*	*100*		
	26.5	*75*	*58.00*	*55*		
	4.75	*30*	*9.00*	*10*		
	0.075	*10*	*4.00*	*0*		

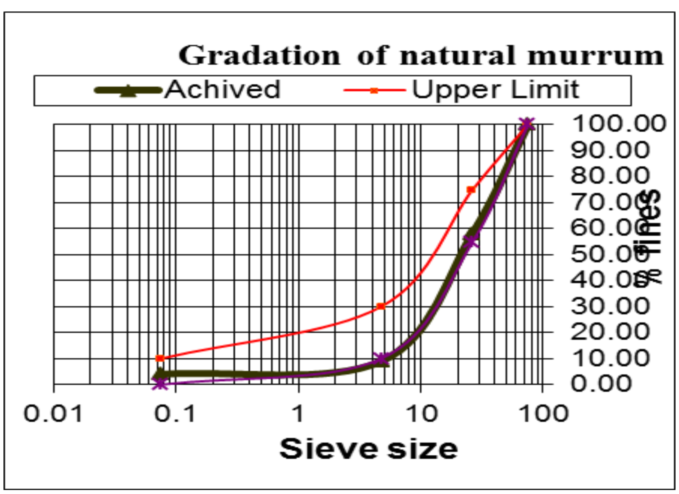


Fig. 1: Gradation curve of natural murrum

- Analysis of test result:-The analyses of results obtained from experiments conducted on murrum mixture with stone dust of different percentage are as below.
- Properties of basic materials:- The characteristics of natural material murrum and stone dust is as below;

Table 2
Summary of results for Natural murrum and stone dust as individual ingredient of admix

S. No.	*Properties*	*Natural Murrum*	*Stone dust*
1	*Liquid limit*	*31.00%*	*0*
2	*Plastic Limit*	*23.24%*	*0*
3	*Plasticity Index*	*7.66%*	*0*
4	*Optimum Moisture content*	*11.00%*	*7.75%*
5	*Maximum Dry Density*	*1.70 gm/cc*	*2.18gm/cc*
6	*Soaked CBR Value*	*14.37%*	*63.04%*
7	*Un soaked CBR Value*	*20.86%*	*---*

- Index Properties of Murrum Mixtures: -The liquid limit and plastic limit tests are conducted on the murrum mixtures for this investigation and the obtained results are presented in the table. The plasticity index is obtained by deducting plastic limit from liquid limit.

Table 3
Relation in between Atterberg limit and % of stone dust

S.No.	**Description of mix**	**LL**	**PL**	**PI**
1	*Natural Murrum*	*31*	*23.24*	*7.66*
2	*N.M. + 10% stone dust*	*29*	*22.93*	*6.07*
3	*N.M. + 15% stone dust*	*28*	*22.34*	*5.66*
4	*N.M. + 20% stone dust*	*26.5*	*21.35*	*5.15*
5	*N.M. + 25% stone dust*	*24*	*20.14*	*3.86*

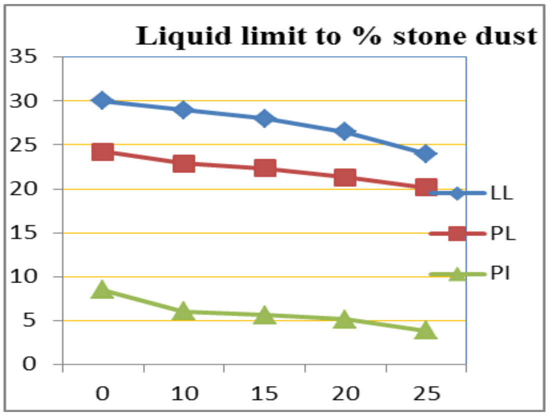


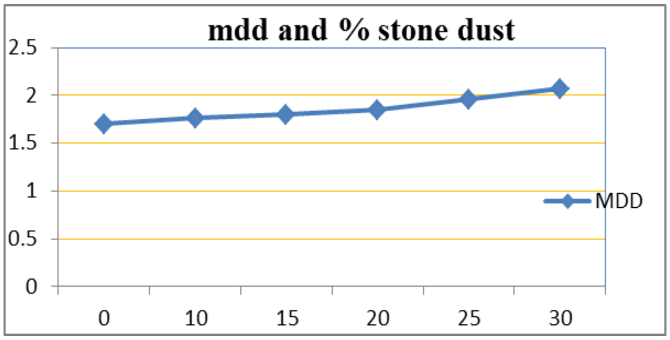
Fig. 2: Graph showing relationship of LL, PL, PI with % of stone dust

It is observed from the table 3 and fig.2, the liquid limit and plastic limit values of murrum-dust mix decreases with increase in percentage of stone dust. The plasticity of the mixes is reduced due to increase in stone dust particles which impart non-plasticity to the mix.

Compaction characteristics of Murrum Mixtures: -Heavy compaction tests were conducted on the murrum mixtures considered for this investigation to determine the maximum dry density (mdd) values and optimum moisture content (omc) values and the results are shown in table 4

Table – 4
Relation in between omc and mdd AND % of stone dust

S.No.	**Description of mix**	**mdd**	**omc**
1	*Natural Murrum*	*1.70gm/cc*	*11%*
2	*N.M. + 10% stone dust*	*1.76rm/cc*	*10.86%*
3	*N.M. + 15% stone dust*	*1.8gm/cc*	*9.96%*
4	*N.M. + 20% stone dust*	*1.85gm/cc*	*8.83%*
5	*N.M. + 25% stone dust*	*1.96gm/cc*	*8.4%*
6	*N.M. + 30% stone dust*	*2.07gm/cc*	*7.95%*



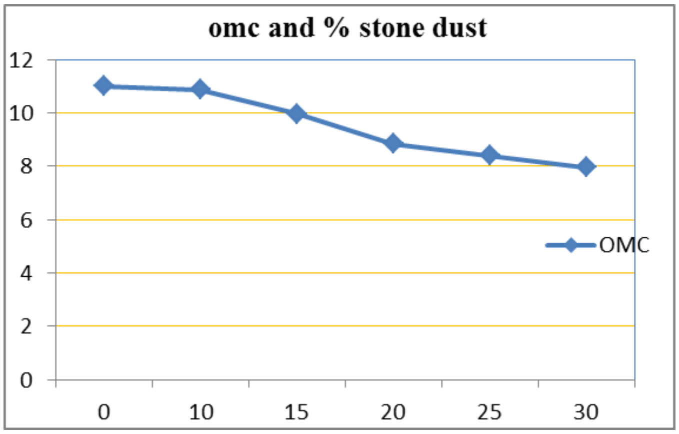


Fig 3: Graph showing relationship of omc and mdd with % of stone dust

The variation of maximum dry densities and the optimum moisture contents for varying percentages of additives are shown in Fig. 4.4. The mdd values are increasing and omc values are decreasing with increasing percentages of stone dust added to murrum. This is due to the fact that stone dust particles fill the voids of the coarse grained particles of murrum.

- Strength parameters of murrum mixtures: From the each murrum-stone dusty mix, Six identical soil samples are prepared (Three for soaked CBR and Three for un soaked CBR test) with water contents of optimum moisture contents values of 10.86%, 9.96%, 8.83%, 8.40%, and 7.95% and compacted to corresponding densities of maximum dry densities values of 1.76, 1.80, 1.85, 1.96 and 2.07gm/cc. It was observed from table 4.6 and fig. 4.5, as the percentage of stone dust increases the soaked and unsoaked CBR value of murrum mixture increases.

Table 5
Relation in between Soaked and Un soaked CBR and % of stone

S.No.	*Description of Mix*	*CBR soaked*	*CBR Unsoaked*
1	*Natural Murrum*	*14.37%*	*20.86%*
2	*N.M. + 10% stone dust*	*16.22%*	*22.25%*
3	*N.M. + 15% stone dust*	*17.61%*	*24.11%*
4	*N.M. + 20% stone dust*	*20.40%*	*26.42%*
5	*N.M. + 25% stone dust*	*24.10%*	*30.13%*
6	*N.M. + 30% stone dust*	*28.74%*	*34.77%*

VI. CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE WORK

A. Conclusion:

Based on the laboratory test results, the following conclusions are drawn;

- As the percentage of stone dust additive increases from 10% to 25% the plasticity of the murrum stone dust mixture decreases from 23.2% to 20.14%.
- As the percentage of stone dust additive increases from 10% to 30% the mdd values of the murrum stone dust mixture increases from 1.70 gm/cc to 2.07 gm/cc and the corresponding omc values decreases from 11% to 7.95%.
- As the percentage of stone dust additive increases the CBR values of the murrum stone dust mixture increases from 14.37% to 28.74%.

As the percentage of stone dust additive increases from 10% to 30% the Gradation of the murrum stone dust mixture moves towards upper limits of gradation value and at maximum of 30% stone dust it just touches the upper limit of gradation.

It is observed that the mixture of the murrum mixed with 25% of stone dust full fill the requirement for granular sub base material recommended by Ministry of rural development (MORD). The values at 30% stone dust are also full fill the requirement of granular sub base material but when we are getting our suitability of admixes on lower % of stone dust i. e. 25% then seeing to economy of construction the 25% stone dust is recommended as additive.

The detail comparisons of parameter recommended and of result obtained on 25% stone dust are as given in table 6.

Table – 6
Comparison of recommended parameters with laboratory results

S. No.	*Properties*	*Values Recommended by MORD*	*Values analyzed on mixture of murrum with 25% stone dust as additive*
1	*Liquid limit*	*Not more than 25*	*24 % (less than 25%)*
2	*Plasticity Index*	*Not more than 6*	*3.86% (Less than 6%)*
3	*MDD*	*Not less than 1.70 gm/cc*	*1.96gm/cc (More than 1.70gm/cc)*
4	*CBR*	*Not less than 20% after 72 hours soaked condition*	*24.10% after 72 hour soaked condition (More than 20%)*
5	*Gradation as per table 400.1*	*Should lies within prescribed range of table 400.1*	*Gradation curve lies in between Upper limit and lower limit of required gradation.*

Hence we concluded that the 25% stone dust as additive by weight of murrum is more suitable and recommended for execution in the work of road pavement as granular sub base material for rural road works.

B. Recommendation for Future Work:

Following recommendation are recommended for future studies and researches.

1) The similar nature of investigation are also recommended for finding out use of existing plastic soil for other road construction material like embankment, sub grade and hard shoulder by adding suitable good engineering property material.
2) The similar nature of investigation are also recommended for finding out best use of existing plastic soil with additive of aggregate for base course material, soil with lime as additive in soil for embankment/sub grade purpose.
3) The similar nature of investigation are also recommended for the garbage obtained from dismantling of absolute existing road pavement or damaged layer of pavement, which can be used as sub grade or base course by adding stone dust/sand as additive or more than one additive like stone dust and clay or sand with clay and lime.

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