A Laboratory Study on Stabilized Gravel for Road Sub-Base

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Abstract— High quality aggregates that meet the specifications are getting increasingly scarce and expensive in many localities in India. Traditional flexible pavement specifications require high quality aggregates in both base and sub base course. In many cases locally available aggregates are not satisfying the specifications and the aggregates that meet the specifications have to be hauled in long distances. This act significantly increases the cost associated with the construction and subsequent maintenance and rehabilitation of them. Thus, the use of locally available marginal aggregates in flexible pavement construction is one of the possible answers to high pavement construction costs and lack of quality aggregates sources in a vast country like India. A broad definition of a marginal aggregate is "any aggregate not in fully accordance with the specifications used in a country for normal road aggregates but can be used successfully either in special conditions, made possible because of climatic characteristics or recent progress in road techniques or after subjecting to particular treatment". So if through appropriate modification of the materials or structural design the use of local materials can be permitted, the construction can be accelerated and significant monetary benefits can be achieved. So the main objective of the study is to improve the properties of the locally available gravel soil/ marginal aggregate (Moorum) by adding cement and bitumen emulsion. An attempt has been made to use cement for increasing the strength of the gravel and emulsion for increasing the water resisting capacity. The whole work involves increasing strength of gravel soil (Moorum) and expressed in terms of CBR and UCS value.

Key words: Marginal Aggregate, CBR, Bitumen Emulsion, Graval

I. INTRODUCTION

This chapter describes the experimental works carried out in this present investigation. This chapter is divided into two parts. First part deals with the Materials used second part deals with the tests carried out on the mixture.

A. Materials Used

1) Moorum

The primary material used in this study is Moorum which is collected from NIT, Rourkela campus. Moorum which is a fragmented weathered rock naturally occurring with varying proportions of silt and clay. It is considered as a low grade marginal material for road construction. It is widely available in different parts of our country with significant variation in its qualities from one location to another in terms of its crushing and impact value, grain size, clay and deleterious content. It has generally low bearing capacity and high water absorption value in comparison to conventional aggregates. It finds application in the construction of base/sub base course in rural roads of India with suitable stabilization methods. (Source: - Laboratory evaluation for the use of moorum and Ganga sand in wet mix macadam unbound base course, Vol. No 42 No. 4 April 2014, Indian Highways)

2) Bitumen Emulsion

Emulsified Bitumen normally comprises of bitumen beads suspended in water. Most emulsions are utilized for surface medications. On account of low consistency of the Emulsion when contrasted with hot connected Bitumen, The Emulsion has a decent entrance and spreading limit. The kind of emulsifying specialists utilized as a part of the bituminous emulsion figures out if the emulsion will be anionic or cationic. In the event of cationic emulsions there are bituminous beads which convey a positive charge and Anionic emulsions have contrarily charged bituminous drop.

In light of their setting rate or setting time, which shows how rapidly the water isolates from the emulsion or settle down, both anionic and cationic emulsions are further characterized into three unique sorts. Those are fast setting (RS), medium setting (MS), and moderate setting (SS). Among them fast setting emulsion is exceptionally unsafe to work with as there is next to no time stays before setting. The setting time of MS emulsion is almost 6 hours. In this way, work with medium setting emulsion is simple and there is adequate time to place the material in legitimate place before setting. The setting rate is fundamentally controlled by the sort and measure of the emulsifying operators. The chief distinction in the middle of anionic and cationic emulsions is that the cationic emulsion surrenders water speedier than the anionic emulsion.

More than a period of time, which may of years, the black-top stage will over the long haul separate from the water. Black-top is insoluble in water, and breakdown of the emulsion incorporates the mix of drops. The black-top drops in the emulsion have a little charge. The wellspring of the charge is the emulsifier, and ionisable portions in the black-top itself. However when two beads do achieve enough essentialness to annihilation this obstruction and approach about then they hold quick to each other. More than a period of time, the water layer between beads in floccules will thin and the drops will join. Segments which compel the drops together, for instance, settlement under gravity, dispersal of the water, shear or hardening will stimulate the flocculation and blend process. For this situation blending with soil medium setting bitumen emulsion is less successful and quick setting is not simple to work with soil. So here I utilize moderate setting emulsion as primary settling operators.

Today the primary usage of bitumen is in the asphalt business for development and upkeep. Bitumen emulsions are a scrambling of bitumen in a watery nonstop stage, settled by the extension of an emulsifier. They are prepared as emulsions at high temperatures, however associated as powerful scatterings at including temperatures. In asphalt designing bitumen things are ordinarily included with total. The strong grip that happens between the bitumen and mineral total enables the bitumen to go about as a cover, with

the mineral total giving mechanical quality to the way. From the audit of present situation bitumen emulsion goes about as a key device for predominantly for street upkeep and development. Anyway, adequately here emulsion is going to use as a dirt settling operators.

3) Cement

Types of cement used here is O.P.C. (Ordinary Portland Cement) grade 43. O.P.C. 43 grades based on the 28 days compressive strength of cement. Different types of ordinary Portland cement available in India like grade 33, grade 43 and grade 53. That all based on their 28 days characteristics strength. Type of cement used in this research is 43 grades OPC

B. Tests carried out on the Materials used and their Mixtures

1) Specific Gravity

The proportion between the mass of any substance of an unequivocal volume partitioned by mass of equivalent volume of water is characterized as Specific Gravity. For soils, it is the quantity of times the dirt solids are heavier in the appraisal to the equivalent volume of water present. So it is fundamentally the quantity of times that dirt is heavier than water. Particular gravities for distinctive sort of soils are not same. In the season of investigation it ought to be thought about the temperature rectification and water ought to be without gas refined water. This particular gravity of soil is indicated by 'G'. Particular gravity is extremely an essential physical property used to figure other soil designing properties like void proportion, thickness, and porosity and immersion condition.

As it is talked about, the proportion between the heaviness of the dirt solids and weight of an equivalent volume of water is termed as Specific Gravity. The estimation is done in a volumetric jar in a test setup where the volume of the dirt is figured out and its weight is then further separated by the heaviness of equivalent volume of water. G is specific gravity

- $G = (M2 – M_1) – ((M_4 - M_1) - (M_3 - M_2))$ M_1 = Weight of bottle
- M_2 = Weight of bottle and dry soil
- M_3 = Weight of bottle, dry soil and water
- M_4 = Weight of bottle and water

Specific gravities for different soil are not same generally, the general range for specific gravity of soil can be categorized are:

Types of Soil	Specific Gravity
Sand	2.63 – 2.67
Silt	2.65 – 2.70
Clay and silt Soil	2.67 – 2.90
Organic Soil	1.00 – 2.67

Table 1: Standard Specific Gravity

2) Particle Size Distribution

The synthesis of soil particles are of a mixed bag of sizes and shapes. The scope of molecule size present in the same soil test is from a couple of microns to a couple penny meters. Numerous physical properties of the dirt, for example, its quality, porousness, thickness and so on are relied on upon distinctive size and state of particles present in the dirt specimen.

Sifter examination which is ruined coarse grained soils just and the other system is sedimentation investigation utilized for fine grained soil test, are the two strategies for discovering Particle size appropriation. Both are trailed by plotting the outcomes on a semi-log diagram where ordinate is the rate better and the abscissa is the molecule distance across i.e. sifter sizes on a logarithmic scale. The strainer investigation for coarse grained soil has been directed.

Very much evaluated or inadequately reviewed are essentially the sorts of soil found. All around reviewed soils have distinctive particles of diverse size and shape in a decent sum. Then again, if soil has particles of a few sizes in overabundance and inadequacy of particles of different sizes then it is said to be ineffectively or consistently evaluated

The outcomes from sifter investigation of the dirt when plotted on a semi-log diagram with molecule width or the strainer estimate in factory meter as the X-hub with logarithmic hub and the rate better as the Y-pivot. This semi-log diagram gives an unmistakable thought regarding the molecule size dispersion. From the assistance of this bend, D10 and D60 are steadfast. This D10 is the measurement of the dirt underneath which 10% of the dirt.

C. Liquid limit and Plastic Limit Test

The fluid furthest reaches of a dirt is the moistness substance or the current dampness, conveyed in rate of the mass of the oven dried soil at the breaking point composed between the fluid and plastic states. The water content at this farthest point condition is self-confidently characterized as far as possible and is the clamminess content at a consistency as controlled by technique for the standard fluid utmost mechanical get together.

As far as possible is the dampness substance comparing to the limit between fluid state and plastic conditions of soil mass. At fluid breaking point the dirt has such a low shear quality (17.6g/cc) which streams to standard measurement for a length of 12mm of a notch when jostled 25 times utilizing the standard fluid utmost gadget or device. Casagrande contraption is one of the mechanical assemblies utilized for deciding the fluid furthest reaches of a dirt material. The water content at which 25 drops of the glass to make the furrow excessively close is called as far as possible.

As far as possible is the dampness content at which the dirt stays in plastic state. It is the water content at which the dirt just starts to disintegrate when moved into a string of 3mm breadth.

Plasticity Index (P.I.) = Liquid Limit (L.L.) – Plastic Limit (P.L.)

Fig. 1: Liquid limit apparatus

High quality aggregates are becoming increasingly scarce and expensive in many localities. Traditional flexible pavement specifications require high quality aggregates in the flexible pavement base course materials and asphalt concrete mixtures. In an increasing number of cases, locally available

aggregates are not meeting applicable specifications, and aggregates that meet the specifications must be imported to the site at considerable expense.

The use of marginal aggregates in flexible pavement construction is one of the best answers to high pavement construction costs and a lack of quality aggregate sources. A broad definition of a marginal aggregate is "any aggregate that is not normally usable because it does not have the characteristics required by the specification, but could be used successfully by modifying normal pavement design and construction procedures"'. (Source:-Marginal aggregates in flexible pavement: Background survey and experimental plan, Final report U.S. Department of Transportation Federal Aviation Administration, 1994)

D. Need for present research

In order to decide whether to use marginal materials in both advantages and disadvantages should be weighed. This is not simple judgement since some aspects involved can"t be quantified in monetary terms. An evaluation of marginal materials for use should be based on technical. Economic and environmental factor, and due consideration should be given to them. (Source:-Enabling use of marginal aggregates in road construction, Manuel C.M. Nunes, University of Nottingham, 1994)

- Availability and economic acceptability: - marginal materials need to be available in adequate quantities and at convenient locations (or to be economically transported to the sites) to justify the development.
- Technical adequacy: - suitable physical, mechanical and chemical properties are required in order to maintain appropriate standard of quality and performance in road construction.
- Environmental acceptability: - all the materials used in pavement must not be potentially harmful during the construction and throughout the life time of the

E. Objective and scope of work

This research focused essentially on the lacunae discussed above. The overall aim is to develop a stabilized gravel to enable the use of marginal aggregates in road construction

(Source: - U.K. Guru Vittal (Use of Marginal Materials and Fly ash in Road Works))

Fig. 2: Different types of Marginal Aggregates available in India

F. Importance and benefits

The main benefits from this study are expected to be twofold. First of all this result will contribute to broaden the existing knowledge in the field of marginal aggregates, especially concerning their laboratory performance under C.B.R. and U.C.S. test. In due course, this knowledge should contribute to future changes in the Indian specifications for rural road construction and as a result it will likely to widen the market for marginal aggregates. (Source:-Enabling use of marginal aggregates in road construction, Manuel C.M. Nunes, University of Nottingham, 1994)

Secondly, from a more general use of materials further benefits will result, such as

The reduction of demand for conventional aggregates, allowing preservation of finite resources.

The reduction of energy cost related to extraction and transportation of conventional aggregates.

The reduction in environmental cost related to conventional aggregates quarrying.

The reduction in environmental and economic problem associated with waste storage and dumping.

Conservation of conventional aggregates by releasing land that would otherwise be used for quarrying aggregates.

II. METHODOLOGY

Methodology to be followed during the course of experimental work is as follows.

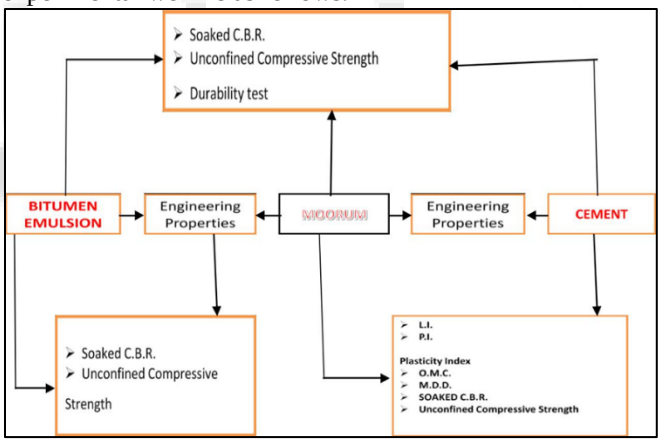

Fig. 3: Methodology

III. FUTURE SCOPE OF WORKS

- Analysis the strength of Moorum using any other soil test like I.T.S. or modulus of elasticity.
- Same Experiments can be performed with SS-1 or MS emulsion.
- Same experiments can be performed with adding mixture of lime and emulsion to see the variation in result.
- Same experiments can be done using cut back bitumen and cement or lime.

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