Significance of Gravel for Road Sub-Base

Er.Sumeet Bura, Er. Parveen Berwal

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. This study will attempt to define in engineering terms the impact of using marginal aggregates in flexible pavements. Strategies for improving the performance of marginal aggregates to equal that of standard aggregates will be evaluated. The major emphasis will be on marginal aggregates for flexible pavements.

Index Terms— Marginal aggregate, CBR, UCS, Bitumen Emulsion
Sub Area : Transportation Engineering
Broad Area : Civil Engineering

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I. INTRODUCTION

The base course or basecourse in pavements is a layer of material in an asphalt roadway, race track, riding arena, or sporting field that is located directly under the surface layer. If there is a subbase course, the base course is constructed directly above this layer. Otherwise, it is built directly on top of the subgrade. Typical base course thickness ranges from 4 to 6 inches and is governed by underlying layer properties. Generally consisting of a specific type of construction aggregate, it is placed by means of attentive spreading and compacting to a minimum of 95% relative compaction, thus providing the stable foundation needed to support either additional layers of aggregates or the placement of an asphalt concrete wearing course which is applied directly on top of the base course. Aggregate base (AB) is typically made of a recipe of mixing different sizes of crushed rock together forming the aggregate which has certain desirable properties. 3/4 inch Aggregate Base, Class 2, is used in roadways and is an aggregate made of a specific recipe of different sizes and quality of rock inclusive of $^{3}\!/_{4}$ in (19.05 mm) to fine dust. An aggregate is normally made from newly quarried rock, or it is sometimes allowed to be made from recycled asphalt concrete and/or Portland cement concrete.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 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.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 aggreagtes in flexible pavement : Background survey and experimental plan, Final report U.S. Department of Transportation Federal Aviation Administration, 1994). Using local available marginal materials is often very tempting, but the decision to use or reject these materials should only be made after a complete evaluation. The decision should be based on an evaluation of the material characteristics and how these characteristics will

affect the design, performance, and construction of the pavement. Potential problem areas must be clearly identified, or any expected cost savings will be lost. (Source:-Marginal aggreagtes in flexible pavement : Background survey and experimental plan, Final report U.S. Department of Transportation Federal Aviation Administration, 1994)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. Economical 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

Pavement

(Source:-Enabling use of marginal aggregates in road construction, Manuel C.M.Nunes, University of Nottingham, 1994)

A **gravel road** is a type of unpaved road surfaced with gravel that has been brought to the site from a quarry or stream bed. They are common in less-developed nations, and also in the rural areas of developed nations such as Canada and the United States. In New Zealand, and other Commonwealth countries, they may be known as '**metal roads**'.[1][2] They may be referred to as 'dirt roads' in common speech, but that term is used more for unimproved roads with no surface material added. If well constructed and maintained, a gravel road is an all-weather road.

The use of marginal materials in sub base and road base level represents a value added application compared with their frequent waste nature that may represent an important contribution in making these aggregates competitive against conventional materials and reduce the importance of hauling cost over long distances. For this purpose some of the stabilisation may be necessary to improve their performance. *(Source:-Enabling use of marginal aggregates in road construction, Manuel C.M. Nunes, University of Nottingham, 1994)*

Objective and scope of work

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

Out of different marginal aggregates found in India, the marginal aggregates used in this study is 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. Moorum is a locally available marginal aggregates widely present in different parts of our country. It has less productive use as compared to other marginal aggregates. So the purpose of this research is to utilize moorum by focusing on the following features.

- To enable the most appropriate use of moorum in pavement construction (in base/sub base course) by ensuring adequate performance result in the field of strength and shear value.
- To study the characterization of moorum using cement and bitumen emulsion as additives.
- 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.

(Source:-Enabling use of marginal aggregates in road construction, Manuel C.M. Nunes, University of Nottingham, 1994)

Methodology

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

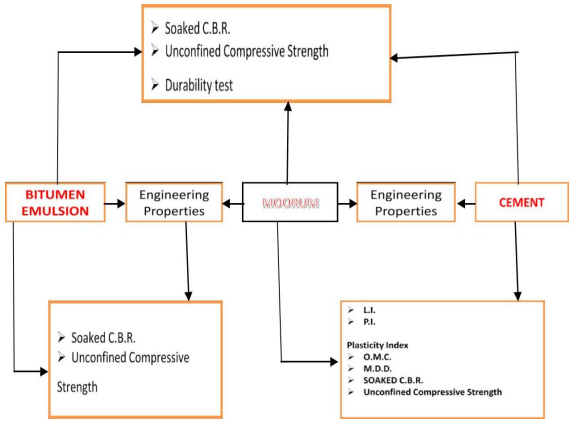

Figure:- Methodology flow chart

METHODOLOGY

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.

The experimental test was conducted on moorum with adding two additives OPC 43 grade cement and bitumen emulsion. SS-2 emulsion is used in this to study to observe the changing properties of moorum after adding the additives

Change in C.B.R.

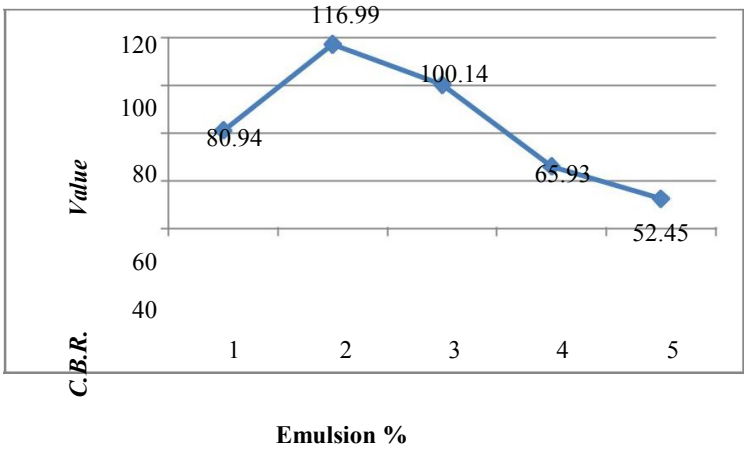

Fig 4.13: C.B.R. test comparison graph

Increase in C.B.R. value with increase in emulsion percentage from 1 to 2, and then Gradual decrease in the value of C.B.R. with more percentage of emulsion. C.B.R. value at 2 % is slightly more than the C.B.R. value of normal Moorum with 3 % of cement.

Change in U.C.S.

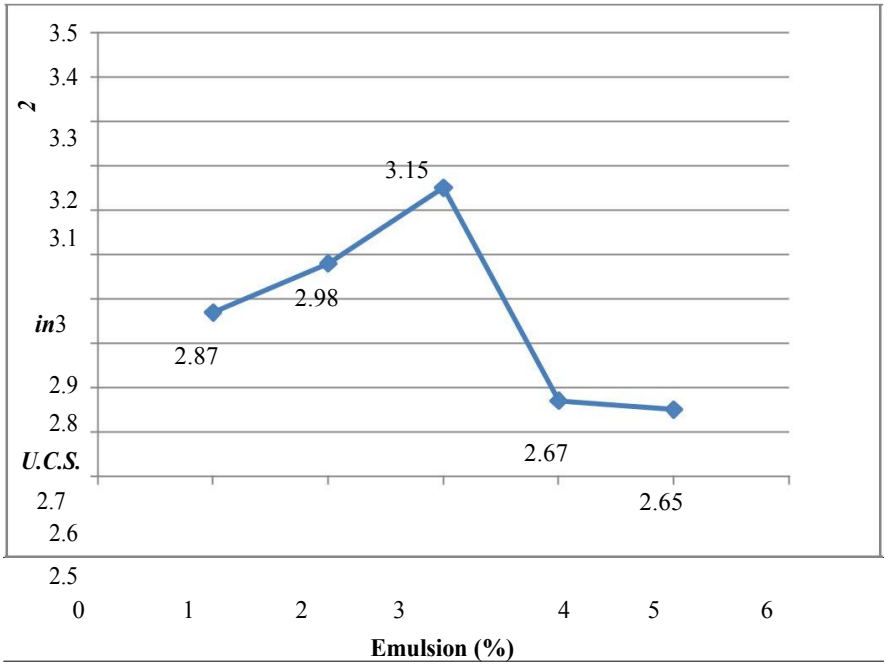

Fig 4.14: U.C.S. test comparison graph

Increase in U.C.S. value with increase in emulsion percentage from 1 to 3, and then Gradual decrease in the value of U.C.S. with more percentage of emulsion. U.C.S. value at 3 % is slightly more than the U.C.S. value of normal Moorum with 3 % of cement.

Change in properties of Moorum after addition of 4% Cement and

varying % of emulsion

4.5.3.1 Change in C.B.R.

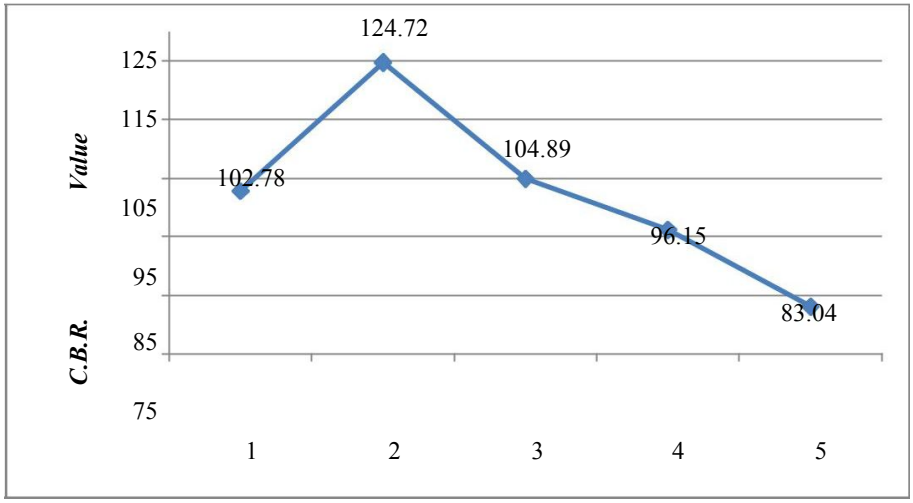

Fig 4.15: C.B.R. test comparison graph

Increase in C.B.R. value with increase in emulsion percentage from 1 to 2, and then Gradual decrease in the value of C.B.R. with more percentage of emulsion. C.B.R. value at 2 % is slightly more than the C.B.R. value of normal Moorum with 4 % of cement.

4.5.3.2 Change in U.C.S.

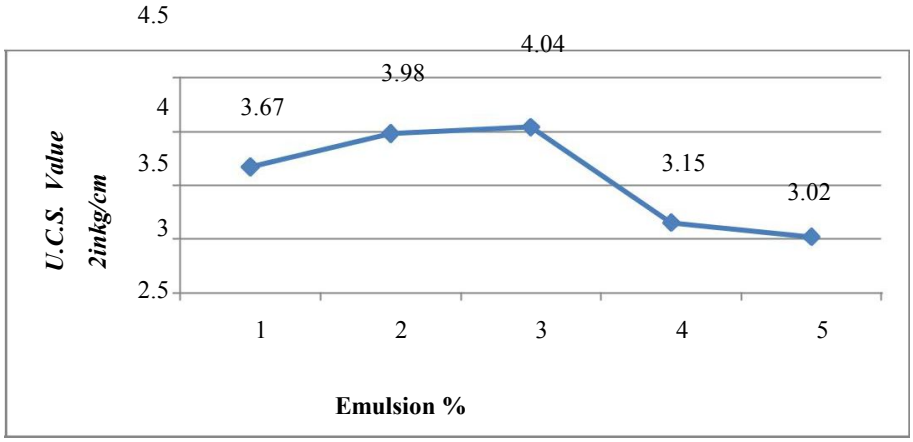

Fig 4.16: U.C.S. test comparison graph

Increase in U.C.S. value with increase in emulsion percentage from 1 to 3, and then Gradual decrease in the value of U.C.S. with more percentage of emulsion. U.C.S. value at 3 % is slightly more than the U.C.S. value of normal Moorum with 4 % of cement.

OBSERVATIONS

Sub-level may be characterized as a compacted soil layer, for the most part of normally happening neighbourhood soil, thought to be 300 mm in thickness, only underneath of the asphalt hull. It gives a suitable establishment to the asphalt. So it is imperative to enhance quality of sub-evaluation soil, it might be by supplanting great soil or by adjustment of existing soil. So a study has been done to enhance the quality of Moorum by adding cement and bitumen emulsion to it to make it suitable for utilization in sub-base course of low volume roads. The accompanying conclusion has been drawn from the above studies.

Adjustment utilizing cement and bitumen emulsion builds the bearing limit of Moorum adequately. This reasons extensive increment in number of suitable proportionate standard axle load (ESAL) and therefore, the lifetime of the road will increment separately. Thus, it is clear that this kind of adjustment may be relevant in low volume road for enhancing its quality. This adjustment is able for high point of confinement of stacking in the area with absence of conventional material.

CONCLUSIONS

- 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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