

STABILISED 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 aggregate 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, UCS, Bitumen Emulsion

INTRODUCTION

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) 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 aggregates in flexible pavement: Background survey and experimental plan, Final report U.S. Department of Transportation Federal Aviation Administration, 1994) 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.

REVIEW OF LITERATURE

Evans and Hicks (1982) tried excellent basalt, two low quality marine basalts, and a fine grained hill sand. The blend properties assessed which incorporate dia. metral versatile modulus and a dia. metral weakness life for both as compacted example and example moulded by dampness introduction. Layered versatile outline standard were utilized with the dynamic test results to create layer equivalencies for emulsion treated negligible total contrasted and hot blend black-top cement. The outcomes show that that beneficiation of minor total with black-top emulsion ought to make satisfactory clearing quiets, especially for low volume streets.

Al-Abdul Wahab and Asi (1997) utilized moderate setting emulsified black-top and medium curing lessening black-top to settle both marl and rise sand. Lime and Portland bond (2% and 4%) were added to the settled soils to quicken the curing procedure and to lessen strength misfortune because of water harm. It was found that balanced out operators enhanced both shear quality and

imperviousness to the broke down soils to water harm. It was watched that Portland concrete was more compelling than lime.

Asi et al. (1999) completed test to explore the practical utilization of frothed black-top innovation in Saudi Arabia to enhance the common ridge sands for conceivable use as a base or sub base material. A few variables were explored to assess the relative change of ridge sand and to allow the improvement of outline methodology for the future utilization of frothed black-top innovation in the cruel climatic states of eastern Saudi Arabia. Measurable examination of the outcomes was utilized to confirm the impacts of emulsified black-top and

frothed black-top treatment, with and without the expansion of Portland concrete, on the

quality attributes of the treated blends, top blends, when contrasted with that of the emulsified black-top blends.

Nageim et al. (2012) led different tests which went for growing new icy bituminous emulsion blends (CBEM) containing fly slag from burned residential and mechanical byitems contrasted and those after effects of customary control frosty containing OPC and hot blend black-top. The principle targets of the analyses were to examine the change in mechanical properties of CBEM's because of consolidating OPC, and recognize the likelihood of supplanting the OPC with waste fly fiery remains materials. The blends mechanical properties explored were; ITSM, creep firmness. Toughness in term of water affectability was examined as well.

Khadijeh Moosavi, Behzad Kalantari (2011) directed examinations to enhance bearing limit of wind-blown sand. The

change in the mechanical quality of settled examples was contemplated by California Bearing Ratio (CBR) test. The curing period utilized are 7, and 28 days for both, un-drenched and splashed specimens. The got results demonstrate that CBR estimations of windblown sand treated with concrete fundamentally increments by rate of bond increments. Imperviousness to disappointment because of forced heaps of this kind of sand treated with concrete increments with time. 1%, 3%, 5%, 7%, 9%, 11%, and 13% of the mounts of concrete was added to the dirt and it was turned out to be clear that if under (100

kg/m³) of customary bond Portland is blended with wind-blown sand and compacted at their ideal dampness content, following 28 days of curing expand the CBR of in-situ wind-passed up more than 23 folds (from 7.2% to 172%) for un doused examples.

Brown and Needham (2000) measured the rate at which mixture of bitumen beads created and stuck to the total particles, since this is the beginning instrument by which mechanical properties of the blend are produced. The study was then stretched out to get a comprehension of the properties of emulsion mixed with OPC, hydrated lime or limestone filler. This was done since it was felt that a commitment to "tying" of the total in blends originated from the hydration of bond and from the blended bitumen. Element Shear Rheometer tests were utilized on different mixes exhibiting the solidifying impacts of both OPC and hydrated lime and that filler had little impact. The emulsifying procedure was additionally indicated to have no impact on the qualities of the base bitumen. Electron microscopy was utilized to study the crystalline structures of

completely cured blends with and without OPC expansion. Master translation considered that a percentage of the qualities of concrete hydration impacts were available in those blends consolidating OPC. The study inferred that the enhancements to key properties of icy blend by the expansion of OPC can be clarified by a scope of components, including enhanced rate of emulsion mixture after compaction, concrete hydration and upgrade of cover thickness. Yan et al. (2010) decided the weakness properties of black-top emulsion and froth black-top frosty reused blends utilizing the Nottingham Asphalt Tester (NAT) (Cooper NU-14 analyzer). In this examination, froth and emulsion cool reused blends were assessed for backhanded rigidity, firmness modulus at three temperatures and four anxiety levels, and exhaustion life at 15 °C and four anxiety levels. Furthermore, the law of dislodging and split improvement was additionally investigated amid the exhaustion testing. The outcomes demonstrated that solidness modulus diminished with expanding temperatures and anxiety levels.

EXPERIMENTAL METHODOLOGY

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)

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.

Tests carried out on the Materials used and their Mixtures

- Specific Gravity
- Particle Size Distribution
- Liquid limit and Plastic Limit Test
- Residue Test for Emulsion
- Compaction Test (Modified Proctor Test)
- California Bearing Ratio Test
- Unconfined Compressive Strength
- Durability Test

RESULTS AND DISCUSSIONS

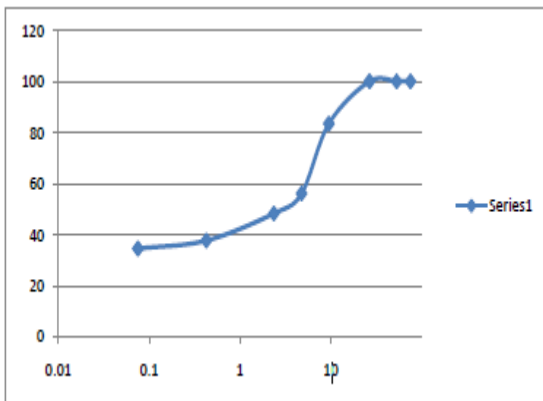
The basic physical properties of gravel (moorum) used in this study have been

determined and are presented in Table below

Table: Basic Properties of Moorum

| Sl. No. | Property | Test result |
|---------|---------------------------|-------------|
| 1 | Specific gravity | 2.73 |
| 2 | Liquid Limit, % | 30.10 |
| 3 | Plastic Limit, % | 21.17 |
| 4 | Plasticity Index, % | 8.93 |
| 5 | O.M.C. % | 10.12 |
| 6 | M.D.D. gm/cm ³ | 2.02 |

Grain size distribution (sieve analysis)



Grain size distribution graph

C.B.R. Test

The CBR is the measure of resistance of a material to infiltration of a standard plunger under controlled thickness and dampness conditions. This is a to a great degree typical test to appreciate the sub-level quality before development of roadways. The test has been comprehensively explored for the field association of adaptable asphalt thickness need. In a far-reaching way testing is done taking after IS: 2720 (Part 16). The test includes bringing on a round and barrel shaped plunger of 50mm distance across to enter an asphalt part material at 1.25mm/moment. The heaps, for 0.5mm, 1mm, 1.5mm, 2mm, 2.5mm... 5mm, 5.5mm, 6mm... up to 12mm to 13 mm are recorded in every 0.5mm of expanding. Infiltration in mm are plotted in X pivot and burden communicated in kg with comparing focuses are plotted in Y hub

and plan diagram for diverse example. For the most part the CBR esteem at 2.5mm infiltration is higher and this worth is adopted. CBR is characterized as the proportion of the test burden to the standard burden, communicated as rate for a given entrance of the plunger. This worth is communicated in rate. Standard heap of diverse infiltration is talked about some time.



C.B.R. Testing Apparatus

U.C.S. Test

The unconfined compression test for remoulded sample of Moorum is conducted and load applied uni-axially until failure of specimen occurs. This test provides a good assessment to the shear strength of cohesive soils. Test is conducted as IS 4332 – part (v) for gravel soils.

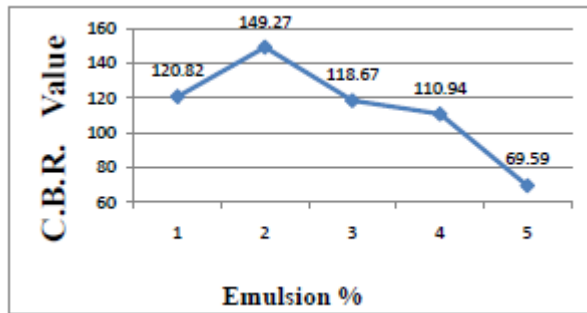
100 mm dia. and 200 mm height sample is prepared using the UCS mould and the sample is then tested in the U.C.S. Testing machine .O.M.C. and M.D.D. data obtained in the modified proctor test are used to take the amount of soils and mount of water needed for preparing the sample.



U.C.S. testing apparatus

Change in properties of Moorum after addition of 5% Cement and varying % of emulsion

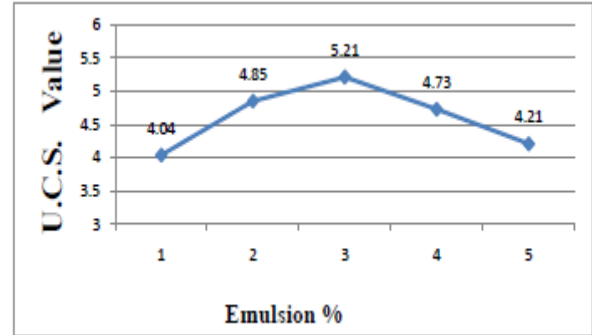
Change in C.B.R.



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 5 % of cement.

Change in U.C.S.



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 5 % of cement.

Durability Test

Durability test is conducted as per IRC: SP: 89 – 2010. Two identical set of UCS specimen is prepared for the best combination .One is kept in oven at 27 + 2 degree centigrade for 14 days for normal curing after coating with paraffin to avoid any type of Moisture lost during curing period. Another one kept in oven at the same temperature for 7 days and after 7 days it was kept in water and after 14 days U.C.S. of both the samples is measured.



Testing of durability sample after 14 days dry curing

CONCLUSIONS

Sub-level may be characterized as a compacted soil layer, for the most part of normally happening neighborhood 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.

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