Revised Project Proposal

On

FEASIBILITY STUDIES ON USE OF NON STANDARD LOCAL MATERIALS IN RURAL ROADS AT BISHNUPUR DISTRICT OF MANIPUR

Submitted To:

National Rural Roads Development Agency

By:

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&

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Research Project Proposal (Revised)

(Funding in the field of Rural Roads under NRRDA/MoRD)

1.0 Project Title: Feasibility Studies on Use of Non Standard Local Materials in Rural Roads at Bishnupur District of Manipur.

Broad Subject : Road materials

Sub Area **:** Alternative/ New materials for rural roads.

Duration in Months : **1 year.**

Total Cost : **Rs. 8.125 Lcs. (Original proposal of Rs. 10.0 Lcs)**

1.1. (a) Name and details of lead organization : National Institute of Technology Silchar.

(b) Name and details of Collaborative Organization : Nil.

1.2 Principal Investigator : Dr. Pabitra Rajbongshi

Designation : Associate Professor & Coordinator, STA, NIT Silchar
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1.3 Co-Principal Investigator (s) (Full Name(s)) (Mr./ Mrs./ Ms./ Dr.) : Nil.

Designation :
Department :
Institute Name :
Address :
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2.0 Project Details (in 1000 to 1500 words)

2.1 Introduction:

There is a growing awareness of the socio-economic and technical reasons for developing rural infrastructures into low volume roads. The use of locally available low standard/ alternate materials is a vital aspect for low cost roads. However, appropriate guidelines are lacking. Significant challenges are to be met, not only technically but also in convincing governments and/ or funding agencies. The technical issues may be dealt by taking the concept of appropriation and cost optimal procedures over the traditional/ standard design methods. Also, the standard road design considerations, their applicability, theory and performances in rural roads is not fully ensured or developed and is questionable. It is expected to explore alternative possibilities/ opportunities for application of locally available non standard road materials, especially in low cost roads like PMGSY scheme.

Any material not fully in accordance with the specifications in force of a country or region for normal road materials, but can be adopted successfully either in special conditions or treatments, may be defined as non standard road materials. Marginal material also falls under the non standard product. The utilization of locally available and task-suited road materials is a fundamental aspect within the scope of appropriate design and cost effective methodology. Local materials may be out of specifications in respect of approved specifications for rural roads (MoRD, 2014). However, the concept of fitness for the purpose within a specific road environment may allow many of such non standard materials to be designated acceptable and suitable. Of course, one needs to justify its feasibility in terms of cost and technical aspects. Therefore, site specific details investigation is required on the non standard materials, which can be opted as one of the possible alternative source for construction materials, and save cost and environment as well, without quality compromise. The Bishnupur district of Manipur is proposed as site for investigation in the present project works.

2.2 Problem Statement:

Prior to application of any non standards materials, details study needs to be performed on the specified location/ materials, and shall explore the feasibility. Insufficient research has been carried out to justify the changes in the current standards and specifications. They are associated with lots of empiricisms and approximations. There are opportunities to transfer technology towards the use of non standard/ sub standard local materials, especially in low cost roads. Contractors or departments are reluctance to utilize non standard approaches (materials/ design/ construction technology etc) because of risk factor, lack of technicality or expected failure. Such weakness is further accelerated due to maintenance free conditions and quality assurance. As a result, funding agencies require supporting the relatively high cost, without search of alternative solutions that may help in terms of environment and cost effectiveness. To overcome such practical problems, one needs to perform details investigations on the site specific sub standard available materials and justify the applicability/ feasibility - technically and financially. Bishnupur district of Manipur is one of such location, where plenty of unused non standard local materials are available which possibly would find useful as road materials in rural roads.

The soils in many positions of Bishnupur area is very poor, in the form of moorum, silt and clay, and laterized red soils in nature, and unsuitable to use in road construction/ subgrade without treatment or improvement. This results excessive cost in earthwork preparation. Also, a large amount of sand stone, conglomerates, shales type of soft/ low graded aggregates are derived while cutting the hills during road alignment. These may possibly be useful in road construction, specifically in base/ sub base layer with certain improvement/ modification. In other words, due to transportation of road aggregates from the queries with long lead significantly increases the cost/km. Normally, contractors/ departments ignore to adopt these materials due to inadequate technical information, quality issues, risk factor etc. These issues form the scope and problem statement of the project proposal.

2.3 Objectives:

The objectives of the present study are:

a. To evaluate existing practices in preparation of DPRs and road constructions in two Blocks of Bishnupur district at Manipur.
b. To collect and transport locally available non standard soils and stones from the selected locations to NIT Silchar for laboratory investigations.
c. To evaluate engineering properties of locally available non standard soils and stones materials.
d. To study treatments on the non standard materials using suitable stabilization techniques for possible improvement in materials characteristics.
e. To compare and justify the feasibility for use of treated/ new materials in PMGSY roads.

2.4 Literature Review (Maximum 500 words)

2.4.1 International status:

Soil stabilization is the permanent physical and chemical alteration of soils to enhance their physical properties. Stabilization can increase the shear strength of a soil and/or control the shrink-swell properties of a soil, thus improving the load bearing capacity of a sub-grade to support pavements and foundations.A recent interstate project in design using lime stabilization, consistent with AASHTO mechanistic-empirical designs, cost only $21.6 million—more than 25 percent savings. (Qubain et al., Transportation Research Board Meeting, January 2000).

Muhmed and Wanatowski (2013) in a case studyindicated that the addition of lime resulted in a reduction in the plasticity of kaolin and an improvement in compaction properties. The unconfined compressive strength (UCS) of stabilized clay experienced an increase with lime addition. Two variables influencing the amount of strength developed were studied. These variables included curing time and water content. Curing time contributed to an increase in the UCS, from 183 kPa to 390 kPa, that is approximately twice of the strength of untreated kaolin. In general, all lime treated fine-grained soils exhibit decreased plasticity, improved workability and reduced volume change characteristics. However, not all soils exhibit improved strength characteristics. It should be emphasized that the properties of soil lime mixtures are dependent on many variables. Soil type, lime type, lime percentage and curing conditions (time, temperature, and moisture) are the most important (Joint Departments of the Army and Air Force, 1994).

Fikiri Fredrick Magafu, & Wu Li reported (2010) the native soil behavior of unpaved low volume roads and their mode of failure were studied to establish proper method of stabilizing native soils using local available materials. The use of lime and its positive effect to modify and stabilize Ngara soil in Tanzania. As per Lambe, (1962), soil cement has been made with cement varying from 5 to 20% for satisfactory stabilization. Due to development of strength of subgrade layer there must be some reduction of thickness of base & sub base layers. Cement also has been used to controls the erosion of inorganic soils, Oswell, and Joshi, (1986). Oswell and Joshi (1986) found a good correlation between unconfined compressive strength and erosion resistance.

Oyediran & Kalejaiye (2011) reported that Maximum Dry Density (MDD), Optimum Moisture Content (OMC), California Bearing Ratio, CBR (Soaked and Un soaked) and Unconfined Compressive Strength, UCS (Cured and Uncured) of three bulk soil samples obtained from a test pit at depths of 0.5m, 1.0m and 2.0m were determined prior to and after stabilization at the West African level of compaction with 2%, 4%, 8%, 10% and 20% by weight of cement. Results show that stabilization of the soils with cement increased the MDD, CBR and UCS while there was a reduction in OMC as cement was increasingly added. Furthermore addition of more than 10% by weight of cement was observed to cause reduction in MDD, UCS and CBR but increase in the OMC. As per Kansas Department of Transportation report (2004), performance of soil stabilization agents by cement kiln dust has been used as a soil additive to improve the texture, increase strength and reduce swell characteristics.

Cement can be applied to stabilize any type of soil, except soils with organic content greater than 2% or having pH lower than 5.3 (ACI 230.1R-90, 1990). Kezdi (1979) report that cement treatment slightly increases the maximum dry density of sand and highly plastic clays but it decreases the maximum dry density of silt. In contrast studies by Tabatabi (1997) shows that cement increases the optimum water content but decreases the maximum dry density of sandy soils. Cement increases plastic limit and reduces liquid limit, which mainly reduces plasticity index, Kezdi (1979). Portland cement can be used either to modify and improve the quality of the soil or to transform the soil into a cemented mass with increased strength and durability. The amount of cement used will depend upon whether the soil is to be modified or stabilized (Joint Departments of the Army and Air Force, 1994). (Kowalski et al., 2007). As per "Portland Cement Association" (PCA) typical cement contents range from 3 – 10% cement, resulting in 7-day unconfined compressive strengths from 300 – 800 psi (2.1 – 5.5 MPa) of pavement base layer. Again as per PCA rutting will not occur in a cement treated base.

As per office of Geotechnical Engineering (2008) to enhance the effectiveness of lime, cement or fly ash modification or stabilization combinations, the subsequent guidelines shall be used. An increase of 50 to 100 psi over the natural soil is required for the stabilization and an increase of 30 psi over the natural soils is required for modification. Aydilek (2009), addition of LKD and curing of specimens generally increased CBR and resilient modulus and lowered plastic strains, whereas fly ash addition alone decreased the strength and stiffness due to the non-cementitious nature of the ash.

Brooks (2009) investigated the soil stabilization with fly ash and rice husk ash. This study reports; stress strain behavior of unconfined compressive strength showed that failure stress and strains increased by 106% and 50% respectively when the fly ash content was increased from 0 to 25%. When the rice husk ash (RHA) content was increased from 0 to 12%, Unconfined Compressive Stress increased by 97% while California Bearing Ratio (CBR) improved by 47%. Therefore, an RHA content of 12% and a fly ash content of 25% are recommended for strengthening the expansive subgrade soil. A flyash content of 15% is recommended for blending into RHA for forming a swell reduction layer because of its satisfactory performance in the laboratory tests.

Akbulut et al. (2007) investigated modification of clayey soils using scrap tire rubber and synthetic fibers. This result showed that the unreinforced and reinforced samples were subjected to unconfined compression, shear box, and resonant frequency tests to determine their strength and dynamic properties. These waste fibers improve the strength properties and dynamic behavior of clayey soils. The scrap tire rubber, polyethylene, and polypropylene fibers can be successfully used as reinforcement materials for the modification of clayey soils. Bernal et al. (1996) reported; it has been found that the use of tire shreds and rubber-sand (with a tire shred to mix ratio of about 40%) in highway construction offers technical, economic, and environmental benefits. The salient benefits of using tire shreds and rubber -sand include reduced weight of fill, adequate stability, low settlements, good drainage separation of underlying weak or problem soils from subbase or base materials, conservation of energy and natural resources, and usage of large quantities of local waste tires, which would have a positive impact on the environment.

Tire wastes can be used as lightweight material either in the form of whole tires, shredded or chips, or in mix with soil. Many studies regarding the use of scrap tires in geotechnical applications have been done especially as embankment materials (Ghani et al., 2002). There have also been reports that describe construction related applications for waste tires such as crumb rubber modifiers for highway pavement and shredded tires as fill material. The reuse application for tires is dependent on how the tires are processed. Processing basically includes shredding, removing of metal reinforcing, and further shredding until the desired material is achieved (Carreon, 2006).

White (2005) reported; Soil compaction characteristics, compressive strength, wet/dry durability, freeze/thaw durability, hydration characteristics, rate of strength gain, and plasticity characteristics are all affected by the addition of fly ash. Ingle and Bhosale,

(2013) reported that based on stiffness characteristics of geosynthetics it greatly reduces the thickness of flexible pavement, an illustration presented shows typically saving of 40% in base course thickness. Jones, Rahim, Saadeh, & Harvey (ITS, 2010) Asphalt stabilization is not commonly used in California since it is usually less effective than lime or cement stabilization on soils with high fines contents(i.e., more than 12 percent passing the #200 [0.075 mm] sieve) and higher plasticity indices (i.e., plasticity index higher than six), which are common throughout the state. However, asphalt stabilization can be used effectively on coarser-grained sandy soils, which do occur in some areas of the state. It can also be compared with cementitious stabilizers on soils with fines contents up to 20 percent and/or plasticity indices up to 10 to determine which stabilization method achieves the best results at lowest cost.

Sherwood, (1993) pozzolanas are siliceous and aluminous materials, which in itself possess little or no cementitious value, but will, in finely divided form and in the presence of moisture, chemically react with calcium hydroxide at ordinary temperature to form compounds possessing cementitious properties (ASTM 595). Clay minerals such as kaolinite, montmorillonite, mica and illite are pozzolanic in nature. Artificial pozzolanas such as ashes are products obtained by heat treatment of natural materials containing pozzolanas such as clays, shales and certain silicious rocks. Plants when burnt, silica taken from soils as nutrients remains behind in the ashes contributing to pozzolanic element. Rice husk ash and rice straw are rich in silica and make an excellent pozzolana. Non pozzolonic chemical stabilisers mostly take the form of strongly acidic, ionic, sulphonated, oil-based products. A cementitious reaction does not usually occur, but due to many factors including ionic exchange, the absorbed water can be reduced leading to better compaction and increased strength. The material must have appropriate clay content for the stabilizer to have a beneficial effect. When correctly utilized, these products can be very cost effective (Paige-Green, 1998).

The use of by-product materials for stabilization has environmental and economic benefits. Ground granulated blast furnace slag (GGBS), a by-product material in Egypt, and lime are used to stabilize samples of a clay soil similar to a typical Egyptian clay soil. This test soil comprises 80% River Aire soil and 20% calcium montmorillonite. The main objectives of this research were to investigate the effect of GGBS, with and without lime, on the engineering behavior (plasticity characteristics, compaction, unconfined compressive strength (UCS) and swelling potential) of the test soil and to identify the reaction products of the stabilized materials to determine the mechanisms by which changes in engineering properties are obtained.(M.S Ouf, 2012)

Al-Azzawi, Daud, Abdul Sattar (2012) investigated the effect of silica fume addition on the behavior of soil subgrades which has inadequate natural stability. Natural silty-clay soil and silty-clayey soil-silica fume mixtures were compacted at the optimum moisture content and subjected to various laboratory tests. The test results showed a significant improvement on swelling pressure and compressive strength of composite samples with silica fume. The swelling pressure decreased by 87% with increasing silica fume contents from 5% to 15% for all samples and the compressive strength of clay samples increased by 4% with increasing silica fume contents from 5% to 10% and after that it decreased. It is observed that the permeability of soil increased with increasing silica fume content. The coefficient of permeability is increased by 100% with increasing silica fume content to 15%. Also, the results show that the silica fume decreases the development of cracks on the surface of compacted clay samples through reducing crack width by 75%.

The test results lignin-based co products are effective in stabilizing for the silt. The UCS of lignin-treated soil samples increase with the increase in content of additives. A high increase in UCS occurred with 12% of additives in all cases. (Zhang, Cai, Liu & Puppala, 2014). Purushothama Raj (2013) reported that aggregants & Dispersant are materials that at low treatment levels make relatively modest changes in the properties of fine grained soils. The function of it is alteration of electrical force between soil particles, like Portland cement. These chemicals have high potentials for use in situations where only a modest improvement in soil behavior is needed. Since these chemicals are relatively cheap are effective at low treatment levels & can be relatively easily incorporated, they can permit comparatively low cost soil stabilization. (Lambe, 1962)

Wood ashes have soil binding properties (binding of water due to hydration of CaO, coagulation of soil particles caused by Ca citation) similar to burnt lime. The substitution of burnt lime as a binder for stabilization silt and clay soils seems to be a reasonable way of wood utilization. Obernberger (2012). Tingle et al. (2003) performed unconfined compressive strength testing on lean clay and fat clay treated with various natural and synthetic polymers. For the lean clay, the greatest increase in strength compared to untreated samples was obtained from treatment with lignosulfonate. Gow et al. (1960) also demonstrated that lignosulfonate could be an effective stabilizer. The lignosulfonate was used to treat a soil-aggregate mixture, and then California Bearing Ratio (CBR) tests were performed on compacted samples. Unsoaked specimens showed the greatest increases in CBR value after curing for a week. Soaked specimens still showed an increase in strength after curing for a week, but the strength increase was markedly less than that seen with unsoaked specimens.

2.4.2 National status:

Niroj Kumar Mishra & Sudhira Rath (2011) reported that the roads of Western Orissa (India) are in very poor condition & there are many big power plants coming up in these regions, fly ash utilization in road construction has a very good potential here. Using locally available weak clayey soil from Burla nearer to Sambalpur (India), fly ash from nearby Hindalco, Hirakud locally available lime manufactured at Katni, moorum (late rite) from “Godbhaga” moorum quarry, sand from Jharsuguda region, various tests were carried out to determine the CBR & other criteria like Liquid limit, Plastic limit, Sieve analysis etc. The intention was to determine the mix giving the maximum CBR value, satisfying the requirement of IRC. Here the cost effectiveness study of utilizing fly ash & lime for low volume roads with special emphasis on roads of Western Orissa (India) over weak clayey soil was carried out. The main aim of the study was to maximize the fly ash utilization in sub-grade & sub-base layers. It was observed that the maximum saving was possible for sub-grade in 70% soil + 30% fly ash + 2% lime combination i.e. Rs 6.85 lakhs may be saved per km (as per 2007 schedule of rate) of road as compared to road using only virgin soil as sub-grade.

Kumar et al. (2005) conducted studies on Roorkee soil, the CBR value of poorly graded sand increased from 11.42% to 18.57% for 75% fly ash + 25% soil mix & to 22.85% for fly ash + 4% lime mix. Another study was conducted by NIT Tiruchirapalli (2003), shows that stabilized fly ash with optimum lime content shows maximum economy. Three combinations were tried, stabilized fly ash with 50% sand, optimum lime content & activators (optimum lime content + 20 % sand). The saving was 6 %, 25.3 % & 20.3 % respectively. Malhotra & Naval (2013) show that the stabilized clay (lime stabilization) has lesser swelling potential whereas increase in optimum moisture content has been observed.

Roads in Assam have mostly the problems like formation of potholes, ruts, cracks and localized depression and settlement especially during rainy season. These are mainly due to insufficient bearing capacity of the subgrade in water saturated condition. The subgrade soil mostly yields low CBR value 2-5%. Applications of coir mat can improve sufficient CBR value. In the CBR method of pavement design (IRC 37-2001) total thickness of pavement increases exponentially with decrease in the CBR value of subgrade soil which in turn increases the cost of construction. (Baruah, Saikia & Bora, 2010). Mittal & Agarwal; (2013) it is expected that with the inclusion of coir geotextile layer below Granular Subbase (GSB) layer would be helpful in restricting the movement of upper pavement layers due to seasonal moisture variation in subgrade expansive, shrinkable soil. An experimental study, Singh & Bagra (2013) was, conducted on locally available (Doimukh, Itanagar, Arunachal Pradesh, India) soil reinforced with Jute fiber. In this study the soil samples were prepared at its maximum dry density corresponding to its optimum moisture content in the CBR mould with and without reinforcement. The percentage of Jute fiber by dry weight of soil was taken as 0.25%, 0.5%, 0.75% and 1%. Finally it was shown CBR value greatly improved with % of natural fiber.

Sivakumar Babu and Vasudevan (2008), Singh et al. (2011), Singh (2011) and Singh (2012) reported the soil testing result, with the natural and geosynthetic fiber reinforced soil and fly ash. The fiber reinforcement works as frictional and tension resistance element. Due to addition of Jute fiber makes the soil a composite material whose strength and stiffness is greater than that of unreinforced soil. The strength and stiffness of reinforced soil increases with the increase in fiber content and may be due to this reason also the CBR value of reinforced soil was observed to be greater than that of unreinforced soil. The optimum fiber content corresponding to maximum improvement in CBR value is found to be 1 %. It was difficult to prepare the identical samples (at constant dry density) of reinforced soil beyond 1 % of fiber content and hence in that study the maximum fiber content was considered to be 1 % by dry weight of soil.

The CBR value and UCS of soil are considerably improved with the RHA (Rice Husk Ash) content (Roy, 2014). From the observation of maximum improvement in strength, 10% RHA content with 6% cement is recommended as optimum amount for practical purposes. Observing the tremendous improvement of CBR value of soil, this soil stabilization technique may be recommended for construction of pavement also.Kumar & Rajasekhar (2009) reported Un-Confined Compressive test are carried out on 38 mm diameter and 75 mm height samples of the soil mix proportions. The results show that there is continuous increase in UCC value with the increase in coir content in the mix for 1 day and 7 days samples. The addition of pond ash improves strength by one percent after curing one day and 1.4 percent after seven days curing. The UCC strength of the blended soil (soil + pond ash + coir) increases with increase in percentage of coir and keeping pond ash content (i.e. 15%) constant. The UCC increases from 251.04 kN/m^2 to 372.39 kN/m^2 with the addition of 0.8% coir for mix of 82.4% soil and 15% pond ash for one day UCC test in light compaction. The CBR increases from 20.54% to 44.64% at 0.6% of coir and at 0.8% of coir, the CBR decreases to 38.44% at un-soaked condition and the CBR increases from 4.71% to 10.17% at 0.6% of coir and at 0.8% of coir the CBR decreases to 8.93% under light compaction.

2.5 Importance of the proposed project in the context of the current status:

- Supporting information/ data towards the inadequate guidelines/ directions for use of site specific non standard materials in rural roads.
- Details engineering investigations/ evaluations and report preparation on non standard local materials at Manipur (North East zone).
- Relatively high construction cost of PMGSY roads due to lead factor.
- Possible use of residual soil/ stones in low cost roads.
- Reduction in construction cost in PMGSY roads, as expected.
- Environmental protection.

2.6 Expertise available with the proposed investigating group/ institutions in the subject of the project:

Refer to *clause* 6.0(B) regarding laboratory facilities in the institution and *clause* 9.0 of the proposal, including the list of publications authored by the principal investigator.

2.8 Expected outcome of the research:

The expected outcome may be enumerated as under:

a. Use of locally available non standards materials in rural roads.
b. Reduction in cost/km of PMGSY roads at Manipur.
c. Technology transfer for low cost roads in North East state- as case study.
d. Save environmental hazards.

3.0 Work plan:

3.1 Methodology (Maximum 1000 words):

i. Data collection and site survey/ visit.
ii. Materials collection.
iii. Technical evaluation of collected materials.
iv. Material treatments – stabilizations, and evaluation of treated materials.
v. WBM/ GSB mix design.
vi. Pavement analysis and design using new/ treated materials.
vii. Rate analysis and cost evaluations/ comparison.

3.2 Time schedule of activities giving milestones (in Bar diagram):

Month ------→

1	2	3	4	5	6	7	8	9	10	11	12
Site survey & data collection											
	Materials collection										
		Materials evaluation									
			Materials treatment & investigations								
						GSB/ GB mix design					
								Pavement design & cost analysis			
										Report preparation	

Study matrix and Time lines of project execution

Sl no.	Events	Actions	Time line (month wise)
1	Site survey & data collection, and RA engagement	• Field visit to Manipur and site survey. • Data collection regarding quarry site, SOR etc. • RA engagement following institute norms.	First month
2	Materials collection	• Local soil & aggregates collection from 3/4 locations at Manipur to NIT Silchar. • Aggregates collection from nearby quarry sites of Bishnupur district. • Procurement of stabilizers.	2nd month
3	Materials evaluation	• Evaluation of original site soils viz. grain size distribution, soil classification, LL, PI, Sp. Gr., organic matter, MDD, OMC, CBR, shear parameter etc. • Evaluation of local stone aggregates viz. gradation, ACV, AIV, LAAV, Sp.Gr., FI & EI, water absorption etc. • Similar evaluation of stone aggregates collected from nearby quarry site of Bishnupur district.	3rd and 4th months
4	Materials treatment & investigations	• Testing of stabilizing materials viz. lime and cement (others have locational disadvantage). • Testing on stabilized soils viz. grain size distribution, soil classification,	4th to 7th months

		LL, PI, Sp. Gr., organic matter, MDD, OMC, CBR, shear parameter etc using different stabilizers and different doses of stabilizer. • Testing on mechanical mixtures of site stone and quarry aggregates viz. gradation, ACV, AIV, LAAV, Sp.Gr., FI & EI, water absorption etc in different proportions. • Data interpretation and analysis.	
5	GSB/ GB mix design	• Design and analysis of granular sub-base/ base course materials, with and without low graded site stones. • CBR tests on granular sub-base/ base course materials, with and without low graded site stones.	7th and 8th months
6	Road design & cost evaluation	• Road sections design for rural roads as per usual practices and using stabilizing materials. • Cost evaluation and comparisons for different example cases.	9th and 10th months
7	Report preparation	• Research report writing • Paper works • Presentation	Last two months

3.3 Suggested plan of action for utilization of expected research outcome:

This project aims to characterize the locally available non standards materials at Manipur, towards best possible application in rural roads construction, through suitable techniques. It would also focus on the cost effective use of material/ mix design in PMGSY roads, as case study. Depending upon the outcome of the study and being the project investigator is also the Coordinator of STA, the necessary will be forwarded to the state department for appropriate and effective actions. Suitable suggestions will also be initiated to the sanctioning authority for implementations of the outcomes. A national level publication (in acknowledgement of funding agency) is also expected for such site specific research work at Manipur area.

4.0 Budget Estimates: (Year-wise)

	Items	Description of items	Budget			Total in INR
			1st Yr.	2nd Yr.	3rd Yr.	
A	Recurring					
	Salaries/wages/ manpower	Project Assistant (1)@Rs.18000/- per month + 10% house rent.	237600/-			237600/-
	Consumables	Various necessary consumable items.	45000/-			45000/-
	Travel (TA & DA)	Site visit & site survey	200000/-			200000/-
	Other Research Expenditures including contingencies	Transportation of materials from Manipur to Silchar	40000/-			40000/-
		Labour/ helper for Lab. works.	50000/-			50000/-
		Contingency	40000/-			40000/-
		Miscellaneous	37400/-			37400/-
	Total:					**6,50,000/-**
	Institute overhead	20% of Total project value				1,62,500/-
Total (A)						**8,12,500/-**
B	Equipment	Nil				**0/-**
Grand Total (A + B)						**8,12,500/-**

5.0 Justification for permanent equipment/ software (indicating future use and maint.**).**

N/A.

6.0 List of facilities being extended by the Institution(s) for the project implementation

A) Infrastructural Facilities :

Transportation Engineering Laboratory and Geotechnical Engineering Laboratory at NIT Silchar, along with their available infrastructures.

B) Equipment Available with the Institute/ Department for the project:

Sl no.	Geotechnical Engg. Lab.	Sl no.	Transportation Egg. Lab.
1.	Core Cutter and Sand Replacement apparatus	1	Los Angeles Abrasion Test
2.	Specific Gravity Test.	2	Aggregate Impact Test

3.	L.L. & P.L. Test.	3	F.I & E.I Apparatus
4.	Cone penetration Test.	4	Aggregates crushing test.
5.	Proctor Compaction Test.	5	Pycnometer
6.	CBR Test.	6	Triaxial Test (GSB)
7.	Permeability Test.	7	Bitumen Penetration Test
8.	Unconfined Compression Test.	8	Softening Point Test
9.	Triaxial Test.	9	Ductility Test
10.	Direct Shear Test.	10	Specific Gravity of Bitumen
11.	Vane Shear Test.	11	Flash Point and Fire Point
12.	Consolidation Test.	12	Skid Resistance and Stone Polishing
13.	Hydrometer Test.	13	Benkelman Beam Apparatus
14.	Shrinkage Limit Test.	14	Marshal Test Apparatus
15.	Field Vane Shear Test.	15	Bitumen extractor
16.	SPT Test.	16	Pavement core cutter
17.	Plate Load Test.	17	Thin Film Oven Test
18.	Cyclic Triaxial Test	18	Sybolt viscometer
		19	Bohlin Viscometer
		20	Capillary viscometer
		21	Ground Penetrating Radar (GPR)
		22	LWD

7.0 Deliverables (Reports, Guidelines, etc) and Payment Schedule:

i. Submission of project report to sponsoring organization.
ii. Possible paper publication.

Since the project period is only 12 months, the release of fund by the sponsoring department may be in single installments for smooth completion of project.

8.0 Any other relevant information:

Manipur has a total geographical area of 22 thousand Sq.Km out of which 90% are hilly regions with around 38.5% of the total population. It is largely characterized by dense forests and inaccessible terrains. Bishnupur district at Manipur has about 53000 hectare area with 20 thousand hectare of wetland (marshy land) along with about 50% agricultural coverage. The principal agriculture crops at Bishnupur are paddy, maize, potato, pea, mustard, chilly, cabbage, etc. Sugarcane is also one main crop of the district. Loktak lake, the largest freshwater lake in the North East is situated in this district. The soil in the district is transported type of soils - alluvial and organic. The area covered by plains and hillocks are mainly characterized by alluvial soils. These soils have in general clayey texture and grey/ pale brown in colour with organic matter.

9.0 Detailed Bio-data of the Principal Investigator(s)/~~Co-Investigator(s)~~

[*including: Name, Address, Date of Birth, Institution's Address etc. Academic Qualifications (University/College from where attained, year of passing, class, Thesis title etc.); Publications list (Title of paper, authors, Journal details, pages, year, etc.) Patent list, if any, List of Projects implemented etc.*]

Dr. Pabitra Rajbongshi
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A). Academic Qualification:

Degree	Year	Subject	Institution/Board	Class
HSLC	1986	10th level	SEBA, Assam	1st
HSSLC	1988	10+2 level (Sc)	AHSEB, Assam	1st
B.E.	1992	Civil Engg.	Dibrugarh Univ.	1st
M.Tech.	2001	Transportation Engg.	IIT Roorkee	1st
Ph.D.	2009	Pavement Engg.	IIT Kanpur	N/A

Ph.D thesis: A Comprehensive Design Approach for Asphalt Pavements using Mechanistic-Empirical Framework.

B). Work experience:

S.No.	Positions held	Name of the Institute	From	To
1	Associate Professor (Civil)	National Institute of Technology Silchar, Assam	05 – 04 –10	Till date
2	Assistant Professor (Civil)	National Institute of Technology Silchar, Assam	01 – 01 – 06	04 – 04 – 10
3	Lecturer (Senior Scale)	National Institute of Technology Silchar, Assam	17 – 01 – 04	31 -12 - 05
4	Lecturer (Civil)	Regional Engineering College (Now, NIT) Silchar, Assam	03 – 06 – 97	16 – 01 - 04
5	Lecturer (Civil)	Assam Engineering College, Guwahati, Assam	04 – 10 –94	02 – 06 – 97

C). Sponsored Projects:

Sl. No.	Title	Organization	Amount
1	Up-gradation of Highway Engg Lab.	AICTE	Rs.13.5 Lacs
2	Evaluation of Nonlinear Fatigue Damage in Asphalt Materials	DST (SERB)	Rs.41.8 Lacs

D). PhD guidance:

Currently 3 PhD students are working under my sole guidance.

E). Workshops / Short-Term Courses Organized:

Sl. No.	Title	From	To
1	Advances in Transportation Engineering.	16-4-2012	18-4-2012
2	Awareness on Hostel Management.	22-5-2012	28-5-2012
3	Management Capacity Enhancement Programme on Spiritual Intelligence for Managerial Excellence.	31-8-2012	1-9-2012
4	Outcome Based Curriculum Framework – as per NBA Requirement.	30-05-2013	30-05-2013
5	STTP *on* Civil Engineering Materials and Its Quality Control	20-12-2013	24-12-2013
6	National FDP on Pedagogy: A Framework for Effective Teaching and Learning Strategies	07-05-2014	11-05-2014
7	Skill development workshop on Paving block technology and masonry works.	07-06-2015	08-06-2015

F). Professional Responsibility:

S.No	Responsibility	Organization
1	Coordinator, STA, PMGSY, Manipur State	NRRDA
2	Nominated Member, PWD Reform committee, Govt. of Mizoram	PWD, Govt. of Mizoram
3	Coordinator, TEQIP-II	NIT Silchar
4	Nodal Officer (Academic), TEQIP-II	NIT Silchar
5	Associate Dean (Student's Welfare)	NIT Silchar
6	Hostel Warden	NIT Silchar
7	LM of IRC (No. 37766)	IRC
8	AMIE	IE(I), Kolkatta
9	Reviewer of journals like IRC, IEI(I), ASCE, RMPD, IJP, IJPRT, ICE-Transport etc.	Edito-in-Chief
10	Co-Chair for Int. Conference NIT Rourkela	NIT Rourkela
11	Delivered Invited Lectures at IIT Guwahati	IIT Guwahati
12	Nominated as Resource Person at Assam Road Research Tanning Institute, Guwahati.	ARRT&I, Guwahati
13	Member of Performance Evaluation Committee for SQC, Manipur.	MSSRD, Manipur

G). List of Publications of P.I.:

(a) Journals (International):

1. Kalita K. and **Rajbongshi P.,** "Variability characterization of input parameters in pavement performance evaluation.", *Jr. of Road Materials and Pavement Design*, ISSN: 2164-7402. DOI: 10.1080/14680629.2014.988171.
2. **Rajbongshi P.,** "Reliability Based Cost Effective Design of Asphalt Pavements Considering Fatigue and Rutting", *Int. Jr. of Pavement Research and Technology*,

7(2), pp.153-158, March, 2014, ISSN: 1997-1400. DOI：10.6135/ijprt.org.tw/2014.7(2).153.

3. **Rajbongshi P.,** “Critical Temperature Stress Evaluation in Asphalt Pavements.”, *Proceedings of the ICE-Transport,*, 165(3), pp.167-173, August, 2012, ISSN: 0965-092X. DOI: 10.1680/tran.10.00069.
4. **Rajbongshi P.**, Kunal Kachru and Das A., “Sampling Strategy for Road Distress Survey: A Case Study.”, *Transport,* Institution of Civil Engineers (ICE), 165(2), pp.131-138, May, 2012, ISSN: 0965-092X. DOI: 10.1680/tran.2012.165.2.131.
5. **Rajbongshi P.,** “A Comparative Study on Temperature Stresses in Asphalt Material using Nonlinear Viscoelastic Approach.”, *Jr. of Transportation Engineering,* ASCE, 137(10), pp.717-722, October, 2011, ISSN: 0733-947X. DOI: 10.1061/(ASCE)TE.1943-5436.0000261.
6. **Rajbongshi P**., “Reliability Calculation Considering Non-Linear Fatigue Damage in Asphalt Pavements.”, *Int. Jr. of Pavement Research and Technology,* 4(3), pp. 162-167, May, 2011,ISSN: 1996-6814. DOI: 10.6135/ijprt.org.tw/2011.4(3).162.
7. **Rajbongshi P.,** “Discussion of Development of Fatigue Cracking Prediction Models Using Long-Term Pavement Performance Database.” by Hsiang-Wei Ker, Ying-Haur Lee and Pei-Hwa Wu, Discussion, *Jr. of Transportation Engineering,* ASCE, 136(3), pp.276-277, March, 2010, ISSN: 0733-947X. DOI: 10.1061/(ASCE)TE.1943-5436.131.
8. **Rajbongshi P**. and Das A., “Estimation of Temperature Stress and Low-Temperature Crack Spacing in Asphalt Pavements.”, *Jr. of Transportation Engineering,* ASCE, 135(10), pp.745-752, April, 2009, ISSN: 0733-947X. DOI: 10.1061/(ASCE)TE.1943-5436.0000050.
9. **Rajbongshi P.,** “A Critical Discussion on Mechanistic-Empirical Fatigue Evaluation of Asphalt Pavements.”, Technical note, *Int. Jr. of Pavement Research and Technology,* 2(5), pp.223-226, September, 2009, ISSN: 1996-6814. DOI: 10.6135/ijprt.org.tw/2009.2(5).223.
10. **Rajbongshi P.** and Das A., “A Systematic Approach of Field Calibration of Fatigue Equation for Asphalt Pavements.”, *Jr. of Road Materials and Pavement Design,* Taylor & Francis, 10(1), pp.109-124, 2009. ISSN: 2164-7402. DOI: **10.3166/rmpd.10.109-124.**
11. **Rajbongshi P.** and Das A., “Thermal Fatigue Considerations in Asphalt Pavement Design.”, *Int. Jr. of Pavement Research and Technology,* 1(4), pp.129-134, October, 2008, ISSN: 1996-6814.
12. **Rajbongshi P.** and Das A., “Optimal Asphalt Pavement Design Considering Cost and Reliability.”, *Jr. of Transportation Engineering,* ASCE, 134(6), pp.255-261, June, 2008, ISSN: 0733-947X. DOI: 10.1061/(ASCE)0733-947X(2008)134:6(255).

(b) Journals (National):

13. **Rajbongshi P.,** “Modified Design Method of Dowel Bar.”, *Jr. of Institution of Engineers* (India), Kolkata, Vol.87, pp.67-72, 2006.
14. **Rajbongshi P.,** “Computer Oriented Bituminous Mix Design by Marshall Method.”, *Jr. of Institution of Engineers* (India), Kolkata, Vol.83, pp.14-16, 2002.

(c) Conferences (International):

15. Mukharjee, D and Rajbongshi, P. (2015). Studies on elastic behavior and strain characteristics in asphalt pavement due to soil stabilization, *Int. conf. on Sustainable Energy & Built Environment*, School of Mechanical and Biulding Sc. (in association with ASCE, Indian section), VIT Unv., ISBN-978-81-923320-6-2.
16. Madhumita Paul and Rajbongshi P (2015). Descriptive analysis of age difference in gap selection by pedistraian at uncontrolled road sections, *Int. Conf. on Current Researches in Management, Technology and Social Sc*., March 2015, IARA Lonavala.
17. Mrinmoy K Gautam and Rajbongshi P. (2015). Prediction of fatigue life of asphalt pavement, *Int. Conf. on Latest Trend and Practices in management, Technology and Social Sc*., April 2015, IARA Manali.
18. Shankaregowda and Rajbongshi P. Design Gradation of Surface Layer for Porous Asphalt Pavements", *Int. Conf. on Innovative Strategies being Adopted in Management Technology & Social Sciences*, Indian Academicians and Researchers Association, Kohima, Feb. 14, 2015. (Published in Int. Jr. of Advance and Innovative Research, 1(2), pp.50-54. ISSN:2394-7780).
19. Prabhakar Kumar and Rajbongshi P (2015). Assessment of skid resistance value on bituminous mix sample, *Int. Conf. on Current Researches in Management, Technology and Social Sc.*, March 2015, IARA Lonavala.
20. Jimli Das and Rajbongshi P. (2015). Laboratory studies of bituminous mixes using reclaimed asphalt materials, , *Int. Conf. on Current Researches in Management, Technology and Social Sc.*, March 2015, IARA Lonavala.
21. Rajbongshi P. "Probability Distribution of Temperature Stresses in Asphalt Pavements", *Proceedings of the Int. Conference on Developments in Road Transportation* (DRT-2010), NIT Rourkela, Orissa, October 8-10, 2010, pp.487-491.
22. Rajbongshi P. and Das A., "A Systematic Approach for Development of Field Rutting Equation.", *Int. Conference on Pavement Engineering* (ICPE-09), College of Engineering and Technology, B.P.U.T., Bhubaneswar, February 14-15, 2009, pp.184-190.
23. Rajbongshi P. and Vasan R.M., "Rubberized Mastic Asphalt Using Soft Bitumen.", *Int. Conference on Transportation Planning and Implementation Methodologies for Developing Countries* (TPMDC 2008), CD-ROM, IIT Bombay, December 3-6, 2008.
24. Rajbongshi P. and Das A., "Estimation of Structural Reliability of Asphalt Pavement for Mixed Axle Loading Conditions.", *Proc. of the* 6th *Int. Conference of Roads and Airfield Pavement Technology* (ICPT), Sapporo, Japan, July 20-23, 2008, pp.35-42.
25. Rajbongshi P. and Das A., "Reliability Based Automated Design of Flexible Pavements.", *Presented at the Annual Meeting of TRB 2008*, Transportation Researchers Board, Washington, D.C., January, 2008.
26. Rajbongshi P. and Das A., "Temperature Stresses in Concrete Pavement – A Review.", *Int. Conference, CENeM 2007*, CD-ROM, Bengal Engineering and Science University, Shibpur, January, 2007.

(d) Conferences (National):

27. Madhumita Paul and Rajbongshi, P. (2015).Pedestrian demographic behavior on gap acceptance at uncontrolled road sections, National Conf. on Technological Innovations for Sustainable Infrastructure, NIT Calicut, (paper no. T0060), March, 2015, pp.504-508.
28. Prabhakar Kumar and Rajbongshi P (2015). Surface characteristics of bituminous mixes based on aggregate textures, National Conf. on Technological Innovations for Sustainable Infrastructure, NIT Calicut, March, 2015.
29. Mukharjee, D and Rajbongshi, P. (2015). Determination of elastic modulus of subgrade layer due to application of soil lime stabilization, Civil Engg. Asso., Civil Engg. Dept., NIT Calicut (paper no. T0105) March, 2015.
30. Jimli Das and Rajbongshi P. (2015). Bituminous mix design using reclaimed asphalt materials, National Conf. on Technological Innovation for Sustainable Infrastructure, NIT Calicut, March, 2015, pp.465-469.
31. Rajbonghsi P., "Rutting Analysis of Flexible Pavements.", *Proc. of National Conference on Advances in Road Transportation* (ART-2005), NIT Rourkela, 2005, pp.414-422.
32. Rajbonghsi P., "Rutting Progression Models of Flexible Pavements: A Review.", *Proc. of National Conference on Recent Trends in Highways & Bridges* (RTHB-2005), TIET, Patiala, 2005, pp.194-206.
33. Rajbongshi P., "Studies on Mastic Asphalt: A Review.", *Proc. of National Conference on Improvement, Rehabilitation and Maintenance of Roads* (IRAM-2003), Govt. College of Engineering, Aurangabad, August, 2003, pp.85-90.
34. Rajbonghsi P., "Comparative Studies on Mastic Asphalt and Conventional Bituminous Mixes.", *Proc. of National Conference on Modern Cement Concrete and Bituminous Roads*, College of Engineering, GITAM, Visakhapatnam, December, 2003, pp.173-185.

H). M. Tech Project guidance:

1. Dowel Bar Analysis and Parametric Studies on Dowel Behaviour, by Satarupa Majumder (09-21-301), May 2011.
2. Parametric Studies on Multi-Layer Flexible Pavements, by Gobin Engleng (09-21-302), May 2011.
3. Studies on Block Pavement, by Geetimukh Mahapatra (10-21-307), May 2012.
4. Effect of Mix Characterstics on Layer Thickness of Flexible Pavements, by Aparna Reang (11-21-307), May 2013.
5. Effect of Aggregates Gradation on the Mix Parameters, by Hindola Saha (11-21-304), May 2013.
6. Subgrade Behaviour and Its Impact on Pavement Structure, by Chinmoy Rudra Roy (12-21-308), May 2014.

7. Traffic Flow Characterization at C-Class Indian City – A Case Study, by Saikat Deb (12-21-307), May 2014.
8. Simulation Studies on Pavement Performance Parameters Used in Probabilistic Design Approach, by Kuldeep Kalita (12-21-306), May 2014.
9. Life Cycle Cost Analysis of a Two Lane plain Jointed Cement Concrete Pavement, by Sushen Kr. Roy, (12-21-310), May 2014.
10. Subgrade Stabilization and Its Cost Effectiveness, by Dipanjan Mukharjee, (13-21-313), May 2015.
11. Pedestrian Gap Analysis at Uncontrolled Road Sections, by Madhumita Paul (13-21-317), May 2015.
12. Development of Fatigue Prediction Models in Asphalt Pavement Using ANN, by Mrinmoy Kr. Gautam, (13-21-308), May 2015.
13. Surface Characteristics of Bituminous Mixed based on Aggregate Textures, by Prabhakar Kumar, (13-21-309), May 2015.
14. Porous Asphalt Pavement Design for Storm Water Management, by Shankaregowda, (13-21-310), May 2015.
15. Bituminous Mix Design using Reclaimed Asphalt Materials, by Jimli Das, (13-21-316), May 2015.
16. Characterization of Traffic Flow at Silchar City, by Kankana Hazarika, (13-21-303), May 2015.

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6. Bernal, A., C.W. Lovell and R. Salgado, 1996. Laboratory Study on the Use of tire Shreds and Rubber-Sand in Backfilled and Reinforced Soil Applications. Publication FHWA/IN/JHRP-96/12. Joint Highway Research Project, Indiana Department of Transportation and Purdue University, West Lafayette, Indiana. doi: 10.5703/1288284313259.
7. Brooks, R.M., 2009. Soil stabilization with flayash and rice husk ash. International Journal of Research and Reviews in Applied Sciences, 1(3): 209-217.
8. Carraro, J.A.H., J. Dunham-Friel and M. Smidt, 2008. Beneficial Use of Scrap Tire Rubber in Low Volume Road and Bridge Construction with Expansive Soils. (USDOT-MPC/274 INTERIM REPORT), Department of Civil and Environmental Engineering, Colorado State University.
9. Carreon, G.D., 2006. Stabilization of marginal soils using recycled materials. Theses and Dissertations. Paper 2473. http://scholarcommons.usf.edu/etd/2473.
10. Cokça, E., " Effect of Fly Ash on Swell Pressure of an Expansive Soil", Electronic Journal of Geotechnical Engineering, Paper 9904. Oklahoma State University, USA, 1999, www.ejge.com/1999/Ppr9910.htm
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22. IRC :63- 1976 – Tentative Guidelines for the Use of Low Grade Aggregates and Soil Aggregates Mixtures in Road Pavement Construction.
23. IRC :SP- 89-2010 – Guidelines for Soil and Granular Material Stabilization using Cement Lime and Fly Ash.
24. IRC: 50-1973 – Recommended Design Criteria for the Use of Cement Modified Soil in Road Construction.
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35. Mittal & Agarwal; (MNIT Bhopal, 2013) Application of Coir Geotextile in Rural Roads Construction on BC Soil Subgrade; International Journal of Engineering and Innovative Technology (IJEIT) Volume 3, Issue 4, October 2013; ISSN: 2277-3754

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Endorsement from the Head of Institution
(*To be given on official letter head*)

राष्ट्रीय प्रौद्योगिकी संस्थान सिलचर
National Institute of Technology Silchar
(राष्ट्रीय महत्व का संस्थान)
(An Institute of National Importance)
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फैक्स/Fax (03842) 224797 ई पी ए बी एक्स/EPABX 233841 - 5100/5101

Project Title: Feasibility Studies on Use of Non Standard Local Materials in Rural Roads at Bishnupur District of Manipur.

1 Certify that the institute / University agrees to participation of Dr/Prof **Pabitra Rajbongshi** as the Principal Investigator and Dr/Prof. nil as the Co- Principal Investigator for the project and that in the unforeseen event of discontinuance by the Principal Investigator, the Principal Co-Investigator will be appointed for fruitful completion of the project

2. Certified that the equipment and other basic facilities as enumerated in and such other administrative facilities as per terms and conditions of the grant will be extended to the investigator(s) throughout the duration of the project.

3. Institute assumes to undertake the financial and other management responsibilities of the project.

4. Certified that the responsibility of maintenance / upgrade of equipments / software's procured or developed from the grants of the research proposal will be with this institute and no funds in future will be requested from the Ministry of Rural Development, Government of India for this purpose. These equipments/ software's will become the property of the institute after completion of the project and these will always be made available to SRRDAs for conducting any tests / analysis, on request.

Director

Director
NIT Silchar

Place: Silchar
Date:

Certificate from Investigator

Title of the Proposal: Feasibility Studies on Use of Non Standard Local Materials in Rural Roads at Bishnupur District of Manipur.

1. I/ ~~We~~ agree to abide by the terms and conditions of the NRRDA research grant.

2. I/ ~~We~~ did not submit the project proposal elsewhere for financial support.

3. I/ ~~We~~ have explored and ensured that following important equipments/ software and other basic facilities will actually be available as and when required for the purpose of the project, from the institute.

   (i) Equipments listed in 6.0 (B) of the project proposal.

   and shall not request for financial support under this project, for procurement of these items.

Yours sincerely,

Dr. Pabitra Rajbongshi

(Name and Signature of the Principal Investigator)

Place: Silchar
Date: 19/6/2015.