



## A REVIEW OF INNOVATIVE RURAL ROAD CONSTRUCTION TECHNIQUES

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### Abstract

**Rural Roads Connectivity is one of the key for rural development, as it promotes access to economic and social services, generating increased agricultural income and employment. While building rural roads, the provisions based on the parameters that affect the sustainability at a minimum cost. The conventional methods and specifications tend to recommend technology and materials, however difficult and distance away they may be, which normally result in higher cost of construction. This call for introduction innovative approaches in rural roads building for achieving cost-effectiveness. Though such methods and technologies were tried world over, they could not become popular in India, due to procedural constraints and lack of awareness. An attempt is made to bring in together innovative technologies and discuss their positive impacts so as to convince the field engineers in adopting such technologies at places found effective.**

### INTRODUCTION

About 800 million people of India live in nearly 3 lakh villages scattered all over the country. Roads provide the means to bring the rural population on to the main stream. The State and Central level, through different programs, about 50% of habitations in the country are still not connected by all-weather roads. As a Poverty reduction strategy, PMGY was launched as a 100% centrally funded programme for Rural

Roads Development in India. The rural connectivity is expected to have many positive impacts on economy, agricultural, employment and social services to rural masses. India is distinguished for its geographical diversities with mountains, hills, rivers terrains, forest, wet lands, deserts and scattered habitations in remote areas. Also, there exists a wide range in the sub-grade soil types, rainfall, traffic pattern and availability of construction materials. These natural barriers create problems for developing a standard uniform technique to serve the requirements at all the sites. This requires adoption of different technologies based on site specific conditions. For the construction of Rural Roads, Indian Roads Congress has brought out Rural Road Manual IRC SP: 20-2002 for design and construction. The design is based on the CBR value of the soil sub-grade and the 10 years projected cumulative traffic with an assumed 8% traffic growth per year. Based on this concept, normally two layers of WBM with 75 mm thickness is laid over the granular sub-base with suitable material having minimum 16% CBR. However, there are situations in many states where the prescribed standards are not available at normal leads resulting in longer haulage and higher costs. If the locally available materials, including marginal and industrial waste materials are utilized, it could be possible to reduce the cost of road construction. Several types of new materials are tried to establish the efficacy of new materials in road construction.

However, the use of new materials and technologies is not becoming popular owing to certain procedural constraints as well as lack of awareness and therefore appropriate steps may have to be taken for popularizing the new technologies for building better rural roads with less cost. Adoption of such technique may also result in the conservation of natural resources, energy environment

## 2. SOIL IMPROVEMENT TECHNIQUE

One of the proven technologies for the use of local soil and marginal aggregates is stabilization. The stabilization can be mechanical or chemical and several types of stabilizing agents have proved to be suitable under different conditions of soil and environment. The soil stabilization techniques include:

- Stabilization with lime.
- Stabilization with cement.
- Stabilization with a combination of lime and cement

Specifications for soil stabilization are included in both MoRT&H and MoRD book of specifications their adoption is not getting popular, due to problems associated in attaining homogeneity of soil-stabilizer mix in the field and achieving the desired results. The only constraint in the use of the above techniques lies on the procedures adopted in the field. It is possible to popularize the use of stabilization techniques through appropriate training and capacity building of the field engineers. Further, development of low end technology equipment, for use in the rural roads also facilitates wider use of these methods.

In addition to the above, several methods are being tried with the use of industrial waste by products in road building. The following are some of the important materials which have proved good.

- Fly Ash for the construction of the embankments and stabilization of sub-base and base-courses.
- Steel and copper slag for the construction of sub-base and base course
- Marble dust in sub-grade and sub base.

Though the construction of different elements of the road with Fly Ash has been successfully

implemented, the use of other materials is not so widely adopted except for in-plant roads. However, construction technologies with the use of such materials can also be successfully adopted, if the field engineers are properly trained.

Studies were carried out on the use of waste materials like rice husk ash and lime sludge. These materials, if left un-used, may affect the surroundings and also create problem for their disposal. Use of those waste materials in road construction can alleviate the problem of their disposal to great extent. In India, studies were conducted at CRRI, IIT Roorkee and several other places for their use in stabilizing the soil. The results indicated that their usage has great impact on the improvement of soil properties. The studies suggested that they are very useful for stabilizing clayey soils. The summary of the results indicate the following.

- Improve Atterberg limits to make soil suitable for road building.
- Increase the unconfined compressive strength of soil as well as CBR

## 3. Innovation in Soil Improvement

Recently several environmental friendly enzymes have come into the market such Fujibeton, Terrazyme and Renolith. These product indicates minimization, elimination of the use of aggregate. Such materials can also be tried in the rural roads construction after proving their efficacy in the Indian conditions.

## 4. Soil Stabilizing Agent

The Fujibeton material is climatically stable material and suitable for stabilization of all types of soils. The product is an inorganic polymer that chemically binds with all compounds, where blended with ordinary Portland cement in 1 to 5% by weight of OPC. The blended mix which is used for stabilization of soil that improves the properties of soil.

The design concept is based on the optimization of agent mix for stabilization based on unconfined compressive strength results, determined on the given soil for different proportions of soil-Fujibeton mix and calculation of the thickness of the stabilization layer based on design CBR test, wheel load and volume of traffic. The top layer of the pavement

should be covered with 4 to 6 cm asphalt concrete.

Soil agent improves CBR of the sub-grade and does not create shrinkage cracks and is highly effective for clayey/soils. With Fujibeton, a high dry density is obtained with minor compaction. Small equipment like tractor mounted equipment are sufficient. Also, this technology does not require skilled manpower for road construction. This technology is efficient and economical for construction of embankment and sub-grade & sub-base course.

### **3.1 Terrazyme is a natural, non-toxic; environmentally safe, bio-enzyme product that**

#### **Technologies in Rural Roads Construction**

There are several other techniques that can be adopted in conditions of low bearing capacity soils, marshy lands and location with drainage problems such as the use of geo- textiles. Several types of geo-textiles including synthetic, jute coir etc. are proved to give good results and provide cost effectiveness for rural roads.

#### **Use of Jute Geo-textile**

Jute Geo-textile is a kind of natural technical textile laid in or on soil to improve its engineering properties. It is made out of yarns obtained from the jute plant. Jute Geo Textiles have high moisture absorption, high initial tensile strength, bio- degradable and improved soil structure on degradation. The basic functions of JGT are separation, filtration, drainage and initial. improves engineering qualities of soil reduces ruts and potholes resulting in more durable and longer lasting roads. The function of agent is to minimize absorbed water in the soil for maximum compaction, which decreases the swelling capacity of the soil particles and reduces permeability. The application of agent enhances weather resistance and increases load-bearing capacity of soils especially in clayey/soils. This will provide cost effectiveness both in the initial construction cost and maintenance cost.

#### **Advantages of Terrazyme Technology**

Improvement in soil CBR.

Minimum loss of gravel due to erosion or abrasion by the traffic preserving original

transverse section of slopes.

This technology is used in strengthening of layers of un-surfaced roads, in base layers and sub-base layers covered with asphalt material. Among the soil materials stabilized by Terrazyme are sandy clay, silty clay, sandy silt, plastic and non-plastic clay, sandy loam, fine loam, loam mixed with clay.

### **3.2 Soil Cement Renolith Stabilization Technique:**

Renolith is polymer based chemical, which is environmentally friendly and which facilitates the bonding of soil particles Soil-cement with agent has a high modulus of elasticity and can disperse the wheel loads very effectively. It is a semi-rigid material. A feature of this technology is that it requires very little amount of aggregate, which is useful at places where the material haulage is more. The use of agent, when used in soil stabilization with cement, gives strong and durable base. This type of construction does not require surfacing for low volume roads, since the base course is stabilized.

reinforcement. It is environment friendly. Jute Geo- textiles can be more effective, eco-friendly and economical if used judiciously and jointly with other measures. Based on the experiences of the use of Jute Geo Textiles, MoRD in collaboration with JMDC is implementing a pilot project in five States covering a length of about 58 Km under different soil and environmental conditions

This project is taken up with different types of Jute Geo –Textile and placement at different levels. The post construction performance monitoring is expected to give valuable data for arriving at standards and specifications of this technique which helps for wider application. The project is in progress and the results are expected shortly.

**4.1 Flexible-Concrete Pavement Technology**  
IIT has developed a new technology for low cost cement concrete road construction, which has proved to be suitable in place of conventional Cement concrete roads for low volume traffic. Even though the initial cost of flexible-concrete road is high compared to cost of conventional flexible pavement, the life cycle

cost with maintenance costs over a period of 15-25 years is less compared to the conventional one. The technology consists of placing a form work of plastic cells 150 x 150mm and 100mm deep over the prepared foundation of road and placing zero slump concrete in the cells and compacting with road roller/ plate compactor / earth rammer. On curing, a flexible-concrete pavement is obtained which will not wear even under iron tired carts if aggregates of good quality are used. A model road has already been constructed in a village close to Kharagpur using the technology IITGP-Road. Experimentation through pilot project for the IITGP-Road technology is being tried in the construction of the rural roads under PMGSY, so as to enable standardization and popularization of this cost effective solution.

Case Studies in India:

- length of roads around 1000 m in various stretches were constructed using waste plastic as an additive in bituminous mix under the scheme “1500 km Plastic Tar Road”, and found that, the performance of all the road stretches are satisfactory.
- The performance of the road stretches constructed using waste plastic in Karnataka is also found to be satisfactory.

The construction of roads using Waste Plastic in the above states is based on the guidelines developed by Bangalore University. standard specifications are not available on the use of waste Plastic in Bituminous road Construction. In this regard, IRC was specially requested by NRRDA for the preparation of such Guidelines for enabling the construction of Rural Roads under PMGSY using Waste Plastic. In order to facilitate the development of Guidelines on this, an Expert Group has been appointed by NRRDA for preparation of interim guidelines for the use of Waste plastic which will be sent to IRC for approval and releasing as IRC guidelines.

Impacts of Innovative Technologies

The stabilization of soil with Enzyme based stabilizers like Fujibeton, Terrazyme and Renolith, can eliminate the need for the use of aggregate material in base course resulting in

conservation of material. This results in reduction .

The noteworthy feature of soil-Cement-Renolith Stabilization that it requires very little

#### 4.2 Use of waster plastic Blended Bitumen

To improve the performance of bituminous mixed used in the surfacing course of roads, the used of re-cycled plastic, mainly polyethylene, in the manufacture of blended indicated reduced permanent deformation in the form of rutting and reduced low temperature cracking of the pavement surfacing. Laboratory studies were carried out at the Centre for Transportation Engineering of Bangalore University, in which the plastic was used as an additive with heated bitumen in different proportions (ranging from zero to 15% by weight of bitumen) The results of the laboratory investigations indicated that, the addition of processed plastic of about 7.8% by weight of bitumen, helps in substantially improving the stability, strength, and other desirable properties of bituminous concrete mix, even under adverse water-logging conditions. The additions of 9.0% by weight of processed plastic for the preparation of modified bitumen results in a saving of 0.5% bitumen by weight of the mix or about 8.5% bitumen per cubic meter of BC mix in the cost of construction. A typical analysis for saving of cost in terms of material, machinery and labor for two layers of WBM (75 mm each) and 3.75 m carriageway indicate a saving of about Rs. 8.0 lakhs with medium lead.

It Is not only the reduction of cost, but the real interesting part of this is the conservation of natural resources and energy along with preservation of the environment, which gives long way, if such aggregate free construction of rural roads are encouraged and popularized

#### CONCLUSION

From the above discussions, the following conclusions can be drawn:

Fujibeton can used to improve CBR for the sub-grades by about 2.6 times. Simple tractor mounted agriculture equipment can be employed for construction and Economy in construction when aggregates are to be brought

from far off distance as well as due to reduced thickness of sub base / base course.

Terrazyme increases CBR of soil sub-grade by more than 100%. Impedes widespread occurrence of dust from loose fine material in the surface of the soil roadways and reduces cost of construction by 15-20%. The roads constructed using Terrazyme minimizes the material loss of gravel from erosion or abrasion by the traffic on the soil roadways preserving original transverse section and slopes and impedes widespread occurrence of dust from loose fine material in the surface of the soil roadways.

amount of aggregate, performs with increased life and reduced maintenance cost provide a good base for the field Engineers to experiment the construction of unsealed roads in rural areas and also in localities where aggregate are not available in normal leads. The Jute Geo-textile strengthens the soil sub-grade by preventing intermixing of sub-grade and sub-base by acting as a separation layer and further it prevents migration of fines of a sub-grade by acting as a filtration materials. By the pilot project taken up under PMGSY, it is found that there is cost saving of about 18% in road construction. The IITGP-ROAD technology needs to be studied further the initial cost of Cement Concrete Pavement is at par with the conventional pavement, it is lower than the conventional flexible pavement if maintenance cost is also considered whose bitumen top is to be renewed every 10 years at a cost of over 8 lakhs. The use of modified bitumen with the addition of processed waste plastic of about 10.0% by weight of bitumen helps in substantially improving the stability, strength, fatigue life and other desirable properties of bituminous concrete mix, resulting which improves the longevity and pavement performance with marginal saving in bitumen usage.

The use of new materials and technologies is not becoming popular in our country mainly due to lack of awareness. Failure to instill confidence in the field engineers by addressing their problems can be another reasons, the third being non-

availability of suitable standard equipment.

During the implementation of such Projects the field engineers are to be taken into confidence and need to be involved eight form Project Preparation. All technical and implementation processes are to be meticulously documented which become handy in the disseminations process for exposing more field engineers to the technologies. This will instill confidence among them and large scale adoption of these technologies would become possible. These projects also brings out the cost effectiveness and conservation of natural resources that may lead to environmental preservation in the long run.

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