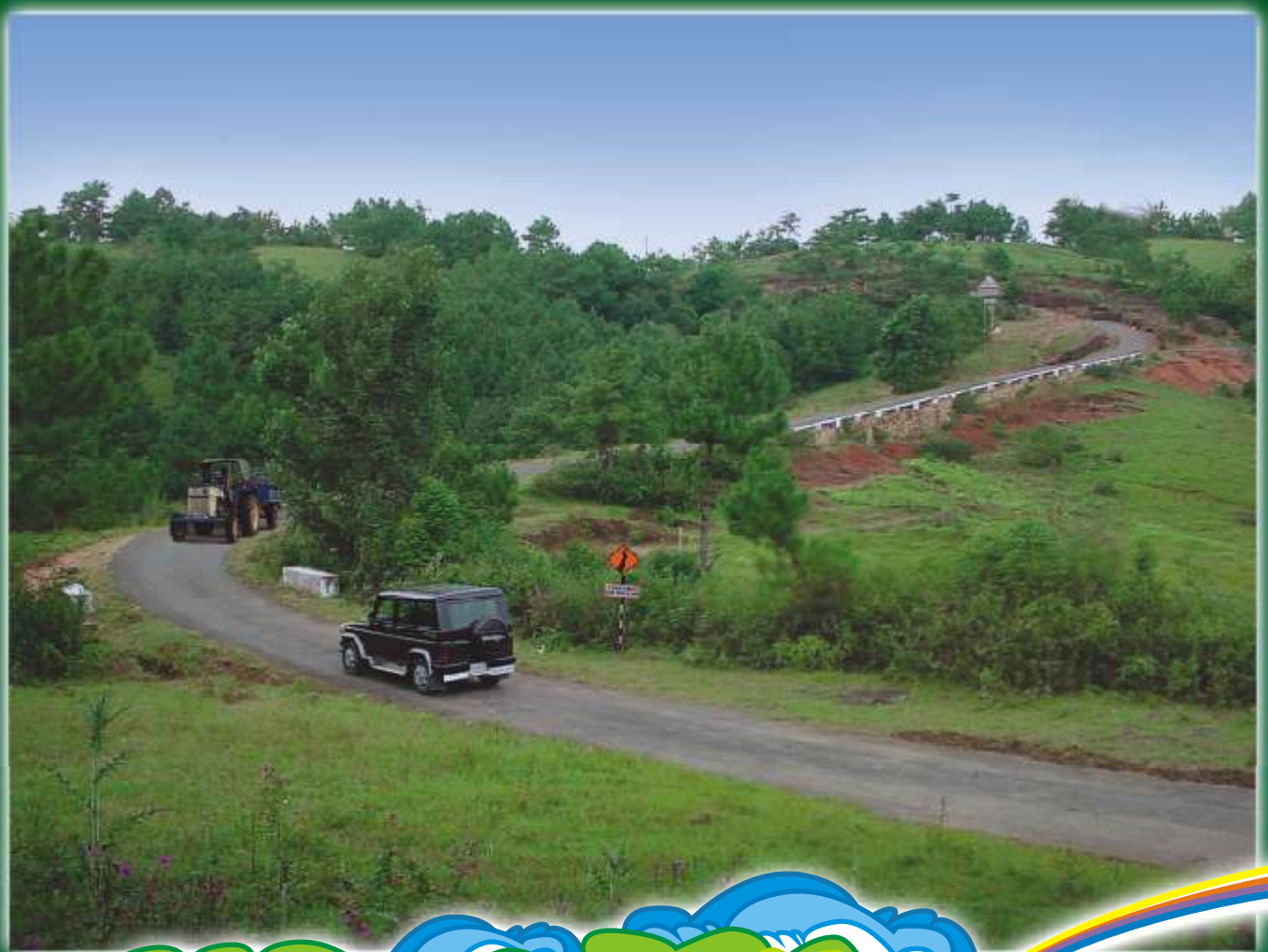
COMMEMORATIVE ISSUE FOR

National Conference on Rural Roads and Exposition

Grameen Sampark



Pradhan Mantri Gram Sadak Yojana

In this Issue

The National Rural Roads Development Agency (NRRDA) was established on 14th January, 2002 as the dedicated agency of the Ministry of Rural Development for the operational management of the rural roads programme PMGSY

Grameen Sampark is a newsletter of the NRRDA containing items of topical interest. For official text or detailed information please contact NRRDA or visit the website.

Published by: National Rural Roads Development Agency (NRRDA), 5th floor, 15, NBCC Tower, Bhikaji Cama Place, New Delhi-110066

e-mail: nrrda@pmgsy.nic.in Website:www.pmgsy.nic.in

Editing, Design & Printing by Akhil Chandra Associates:
N-70/4, South Avenue, Sainik Farm,
New Delhi-110062
Ph.: 65427077, Email: akhilchandraassociates@gmail.com

For article contribution and free subscription contact:
Dr. B.P. Chandrasekhar, Director (Tech.), NRRDA,
(email: bpc@alpha.nic.in).
Note: Accepted articles may be condensed.

Editorial

The National Conference on Rural Roads is being organized at the initiative of National Rural Roads Development Agency (NRRDA) on 23rd -24th May, 2007. All major stakeholders of the rural roads sector, technical experts, programme managers, R&D organizations, construction agencies would share a common platform to deliberate on various issues relating to planning, construction, maintenance, financing and quality control aspects of the rural roads development. The Ministry of Rural Development has prepared a long term perspective plan "Rural Roads Development Plan-Vision -2025", which is being released during this conference. The task of preparing this document was entrusted to the Indian Roads Congress (IRC). Several rounds of consultation were held with the domain specialists and State Governments for finalizing this document. I would like to complement the IRC for coming out with a comprehensive plan, setting out clear mile -stones and implementation strategies for networking the entire rural India with well engineered roads within a definite time frame.

During conference a number of technical sessions would be held to discuss theme specific issues. Papers received for presentation in the technical sessions are being published as a separate compendium. We also thought it appropriate to bring out a Special Issue of the Grameen Sampark to catch up with this National Conference. This issue carries some of the papers which we have received for the conference which are of general interest. We shall carry recommendations of the conference in the next issue of Grameen Sampark. We do hope that the contents of this special issue would be useful to the practicing engineers involved in the rural roads development programmes.

(J.K. Mohapatra)
Director General, NRRDA

Some observations regarding constructions of Roads under PMGSY Scheme in the state of Madhya Pradesh

Dr. S. K. Mittal[1], DR. P. K. Agarwal[2], and Er. Ajay Diwakar[3]

A huge amount is being invested in the Pradhan Mantri Gram Sadak Yojana (PMGSY), with the objective of providing connectivity to all the unconnected habitations with a population of more than 1000/500 and population of more than 500/250 persons in tribal areas. Given the objective and the investment, it is essential that the roads constructed under PMGSY scheme are of the desired quality. Quality control is an essential tool and a prerequisite in this regard. The Madhya Pradesh Rural Roads Development Authority (MPRRDA) has been entrusted with the task of implementing this programme in the state of Madhya Pradesh.

A large number of roads are being constructed under PMGSY scheme of GOI in the state of Madhya Pradesh. The quality of these roads is considered to be quite good. The sincere efforts of MPRRDA in providing road infrastructure in rural India have been appreciated at national level. However, few practices being adopted mainly due to cost considerations have resulted in some shortcomings. Some of the important points observed and reported during the inspections of roads by the Coordinator and members of the STA, MANIT, being constructed under PMGSY scheme in the state of Madhya Pradesh are presented here. This note also presents some suggestions for further improvement.

1. Professor and Coordinator, STA, MANIT, Bhopal
2. Assistant Professor & Member, STA, MANIT, Bhopal
3. Assistant Manager, MPRRDA, PIU, Sehore, Madhya Pradesh

Some Important Observations

Provision of adequate drainage on roads is extremely critical to improve the performance, quality and life of roads. However, this is one area which is not receiving proper attention for various reasons. As a result of this neglect, roads tend to deteriorate faster and in many cases even may fail prematurely.

Granular Sub Base (GSB)

It is desirable to provide a drainage layer in full formation width. However, it is observed that GSB layer is not being provided in full formation width of the road mainly due to cost considerations. Basically there are mainly two functions of the GSB. Firstly, to dispose off the seepage water which is entering from the top surface .(pavement / and shoulder). Secondly, to release the pore pressure from the underlying soil (Fig.1).

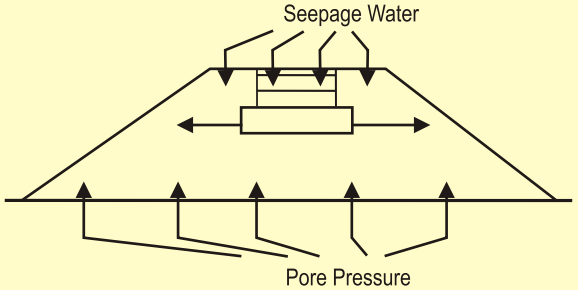


Fig. 1: Release of seepage water and pore pressure through GSB

However, it may adversely affect the performance of the road. This is more important in the state of M.P as the state has large areas with black cotton soil with poor drainage characteristics. Therefore, it is suggested that

GSB layer should be provided in full formation width of the road.

Shoulder Drains

It is observed that rain cuts are being formed at number of places at shoulders. Therefore, shoulder drainage is another important aspect requiring attention of field engineers.

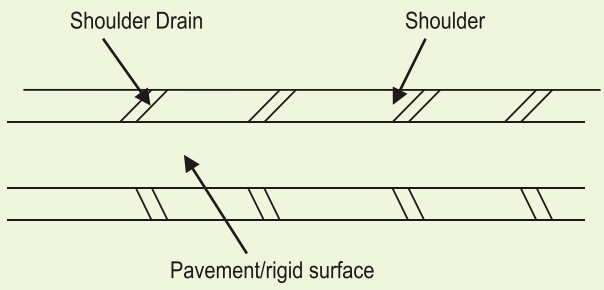


Fig.2. Shoulders with shoulder drains.

Hence, it is suggested that for effective drainage over the paved/shoulder surface, shoulder drains may be provided at the interval of 4 to 10 m centre to centre sloping outward following longitudinal slope.

Stone Pitching near Cross Drainage Structures

It is observed that road embankments are being cut specially during rainy seasons near Cross Drainage structures. Therefore, it is suggested that special provision must be made to provide protection works including stone pitching etc. near Cross Drainage structures.

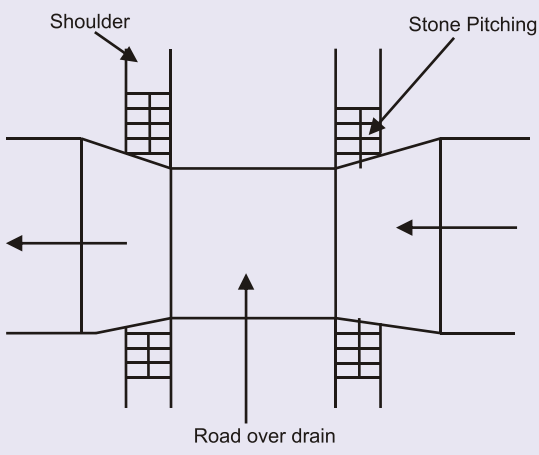


Fig.3. Stone pitching near Cross Drainage Structure

Pavement Evaluation

It is observed that for quality control test of the pavement, pits are being dug on the pavement at regular intervals which may lead to weakening of the pavement. Therefore, it is suggested that some more innovative methods like Non Destructive Testing (NDT) may be adopted.

Premature Failure

Another important observation is that a large numbers of trucks carrying construction material from nearby quarries are using some of the roads constructed under PMGSY scheme. This may lead to premature failure of the roads, if traffic exceeds the design traffic. Therefore, it is suggested that detailed studies (including traffic survey and Benkalman beam studies etc.) may be carried out on these roads to assess the needs for their strengthening to avoid premature failure of these roads. This will protect the huge investments made in constructing these roads.

Maintenance Fund with PIUs

In general, the surface condition of most of the roads visited (even Phase I roads) were found to be very good in the state of M. P. However, minor repair/ improvements like filling of shoulders, filling of joints, rain cuts, cutting of bushes etc. are needed. It is important to highlight here that some maintenance works (such as filling of potholes etc.) are of urgent nature and therefore, need to be repaired immediately as the need arises.

The roads constructed under Phase I are now more then 5 years old and have started showing distress and need timely maintenance. However, it is observed that sometimes it is not possible to carry out the needed maintenance immediately due to various contractual and legal constraints. Therefore, it is suggested that some funds may be allocated to each PIU for maintenance of roads so that timely maintenance can be carried out as and when required.

This will ensure timely maintenance resulting in lesser future maintenance cost and will increase the life of the roads.

Information given to Villagers

Villagers were contacted during the visit and their problems and benefits of the roads were discussed with them. In general, villagers were very happy with the quality of the road works in the state of M.P. Persons of some villages have also informed that their income have increased after completion of roads. However, in some villages, people were not having sufficient information regarding other various schemes of GOI. Therefore, it is suggested that more information needs to be provided to villagers how to get benefit from various schemes of GOI and how to increase their income.

Further during discussions with officers of MPRRDA on the site, the authors felt that they have sound technical



knowledge of road construction and they are trying to maintain good quality of work in spite of the fact that they are working under very adverse conditions. Some of the roads are being constructed in very sensitive areas in the state of M.P.

Adopting Innovative Methods and Technique

With the advent of new techniques such as GIS etc, it is desirable that they be incorporated in PMGSY/ Bharat Nirman project for efficient data management, optimizing construction cost and time. This will help the executing agency in better planing, construction and maintenance management for vast rural road network in the state.

Material of desired specification is sometimes not available within economical reach. But the locally available material with some process can be brought to required specification. For example local sand of small rivers can be brought to required specification by back washing on tractor mounted pipe network similar to washing done in rapid sand filter. This may lead to cost effective technique resulting in lowering tender rates and improving quality of work. Therefore it is suggested that more resources should be allocated for conducting such studies / pilot projects in various states.

Conclusions

Some of the important findings observed in the state of M.P can be summarized as follows:

- It is desirable to provide a drainage layer in full formation width.
- Shoulder drainage is another aspect requiring attention of field engineers.
- Special precautions must be observed to provide protection works including stone pitching etc. near CD structures where ever required and cost should not be the limitation for such cases.
- Detailed studies including traffic survey and Benkalman beam studies etc. may be carried out on roads to assess the needs for their strengthening to avoid premature failure of these roads. This will protect the huge investments made in constructing these roads.
- Some funds must be allocated to each PIU for maintenance of roads so that timely maintenance can be carried out as and when required. This will ensure timely maintenance and will reduce additional future maintenance as the proverb is " stitch in time and save nine."
- Various innovative techniques such as GIS and some pilot project studies for achieving better quality from locally available material may be promoted.

Experience in Implementation of PMGSY in hills of Sikkim*

In the midst of the Great Himalayan ranges and under the perpetual gaze of Kanchenzonga, Sikkim is nestled to the north of West Bengal with its snow bound mountains, deep gorges, perennial rivers, valleys and paddy fields. The state with its lush green cover and crisp fresh mountain air is an example of pristine environment evincing peace, tranquility and serenity. The remoteness of this far flung State coupled with rugged snow capped mountains and dense forest interspersed by golden paddy fields deep gorged rivers and springs potrays a sense of time having passed the land by. Devoid of rampant industrialization, the State still boasts of unpolluted clean air, natural spings and cause ways, remote villages and a hale and hearty population.

The geological features of the State are amazing as they vary from mixed soil to Class I type of rock while the extreme Northern, Western and Eastern regions comprise of hard rocks. The rocks in other areas are generally still undergoing metamorphosis. In addition to un-framed topography and weak geological formations, it has massive sliding zones and seepage prone areas. Obviously, formulation of road construction process in such terrain is a tricky game in respect of selection of alignments, survey of the same, even with modern equipment assessment of type of soil to be encountered during execution and bridging of gorges of varying spans often more then 25 mtrs.

Unlike the plain areas, the habitations in Sikkim are scattered and as a result, to take the road into the habitation becomes often problematic because of obligatory points coming in the alignment and the length of road that is actually required to provide accessobilty to the habitations becomes long the elements of the execution are still more problematic.

In a terrain where visibility is restricted on account of hilly topography as well as forests and accessibility is interrupted by the streams/fords/gorges, it is very difficult to select alignments maintaining all codal norms and stipulations. Primarily, the selection depends on local information, existing foot tracks and accessible control and obligatory points. But often technically appropriate alignments cannot be adopted as the small landowners quite logically, do not agree to part with

* From the Office of the Addl. Chief Engineer, Rural Management & Development Department, Govt. of Sikkim, Gangtok

whatever land they own, for the sake of having only a pucca road. They rather prefer toiling up and down the hill as their ancestors have done from time immemorial. Therefore, the alignments are seldom satisfactory as they do not conform to the specified norms of gradient and curvature.

Sikkim is a State where rainfall is quite high and it rains anytime during the year. With all these impediments and because of inadequate capacity of the nodal agency, some components of the programme implementation process have been outsourced. The result of which has been quite encouraging in terms of achievement of targets and improvement in quality standards.

Community Participation, Social and Environmental Issues

Community participation, involvement of the local community, either directly or indirectly, through their elected representatives and the PRIs is vitally important in the planning and implementation process of any development activity. During the construction process, the State has encouraged the involvement and active participation of locals and adopted the demand-based approach through PRIs, primarily to create awareness as well as to help solve problems during road construction. Intrusion into numerous private land holdings, which normally trigger sentimental and compensation issues, objections arising owing to degradation of hills slopes during construction, felling of trees, relocation of displaced habitations etc., were sorted out amicably.

Having identified these key issues, road projects were selected as in the core network plan in Phases covering the +1000 habitations first in a descending order of habitations. Since in Sikkim land is scarce and limited and land issues being very touchy, final survey works were carried out only after obtaining no objection certificates from land owners, after disseminating adequate information on the rate of the compensation payable to the owners.

Sikkim has been declared a Green State, thus environmental issues involving felling of trees and degradation of land takes front stage. Keeping the Forest Department in confidence and working in tandem with

the guardians of the green is a prioritized activity of the field officials. All construction activities are geared keeping in tune with procedures and norms of the Indian Forest Act and works taken taken up only after the necessary clearances and compensatory amounts paid.

Hill roads cannot be constructed without cutting the hills. Often, in cutting of very hard rocks explosives are used causing extensive harm to the environment. All forest and vegetation cover lost by cutting of hills require planned and promt replenishment. An action plan has been formulated incorporating appropriate site specific arboriculture work along the rural roads. In slip prone areas and scarred hill faces arboriculture has already been taken up after the completion of cutting works, in some of the roads. To the extent possible the muck and debris from hill cutting are not disposed off on the valley side but are carried to some suitable debris dumping areas. This practice is carried out in close conjunction of the State Forest Department.

Construction Process

Habitations in Sikkim are scattered along mountain slopes either in clusters or as in many cases individually located along higher ridges or lower valleys. Rural roads

thus need to either snake up or down from existing through roads so as to provide connectivity to the habitations there.

The roads mostly have been laid on hill faces within very restricted areas owing to sharp ridges and deep gorges on either side. Zigzagging of the alignment is the common methodology adopted to reach the targeted habitations. Long drawn alignments are normally avoided if road stretches pass through uninhabited areas making the project uneconomical. Selection of layout routes involving the shortest length of road is chosen, keeping the grades and geometrics within permissible limits of IRC specifications.

During the course of the layouts, take off points from through roads are very carefully chosen and mainly from strategic locations. Alignments with too many sturnings and zigzags are discouraged to save agricultural lands. Road alignments running parallel to each other on the same hill face are avoided but in many cases it is not possible to do so. The ruling grade of the road alignments are targeted to be in 1:20 but in many isolated cases owing to terrain constraints 1:10-12 grades have also been adopted compensating the steepness with extra formation widths.

The normal practice of half cutting and half filling to attain formation width except in exceptional cases is not followed for reasons of economy. Hence the outer hill edge reference markings denoting alignment and grade are sought from the surveyors and not the centre line alignment points before cutting into the mountain to attain formation width.

Where connectivity to any habitation is of great distance, the same is taken up in phases, limiting each proposal, as much as possible, to below 6. kms. This method has to be adopted since in hills, works can only be executed in a single direction requiring more gestation period. Thus, to ensure timely completion shorter distance proposals are made which will also allow slope stabilization of the earlier executed road before cutting works can be taken further up and beyond.

The Hill Roads Manual, issued by NRRDA and Special Publication 20 of IRC, is heavily relied upon by the field functionaries, for all technical matters related to PMGSY road projects. The publications thoroughly deal with all activities of hill roads construction from laying out road alignments to formation cutting, sub-base and base course specifications in upgradation works and black topping and for quality control of materials. However, in some cases it has been experienced that there are some areas left vacant and not addressed to specifically in construction specifications for works at altitudes of 8000 feet and above where the temperatures are perpetually low and wet. Further, geometric specifications of curves and alignments should be further detailed in 10 degree segments since the natural slope of hill faces determines the road geometrics to be adopted.

Field experience shows that where U-turns are required to be laid, the inner minimum radius of 14.0mtrs. is very difficult to achieve in natural slope levels of more than 30 degrees. If implemented the economics is not practical, so in most of the cases the specification is considered as the outer radius.

The formation development process in hill road construction is usually beset with slope stability problems. Cut mountain rocky slopes, which at times stretches out in several kilometers pose several confusing phenomena. Some undergo hardening after cutting and exposure and some differential weathering. It is observed that a proper investigation before execution of the cut roads should be undertaken to formulate a possible and economic construction procedure.

We have encountered a number of rocky belts with the cross slope almost 50 to 60 degrees through which the roads have been aligned. The height of cutting to achieve the specified formation width is as much as 54 ft on an average. In such situation it is practically not possible to prevent the debris from rolling down hill, and as a result, impact on environment becomes colossal, despite our best effort to collect them and dispose at designated place.

Wherever the slope is little wider, we have been trying to prevent the damage by way of collecting them manually, utilizing useful materials for the road and disposing off the not useful one at suitable location.

In such rocky stretches blasting operations constitute one of the important constituents. The contractor's tendency to achieve fast progress by using heavier charges has been causing severe sacking of hill slopes forming cracks and fissures. It is also adding to reactivation of geological faults, triggering of land slides, inducing unpredictable behavior on the rock etc.

We are of the opinion that control blasting or use of suitable machinery should be resorted to. Also use of special equipments like pneumatic picks, rock saws, plugs and feathers, electrically operated rock cutters, hydraulic blasters and any other suitable equipment and use of liquid detonators should be encouraged. It appears that the dose of explosive as specified in the data book needs to be reviewed. However, the controlled use of explosives or the procedure mentioned above may contribute to delayed progress.

Drainage System

Our experience on drainage system is that instead of following conventional drainage system, the approach should be area or site specific. Realistic assessment of drainage system is possible only after hill cutting and



formation development work is completed. In most of the works the provision of drainage is found insufficient. The State should be allowed to submit proposal on account of additional works of drainage, for funding under this programme.

The catch water drains should be provided at suitable locations for intercepting gush of water on hill slopes and the discharge from the catch water drain should be integrated with the other drainage system. Unplanned disposal of water from cross drainage structure is responsible for extensive damages to environment and properties. A suitably designed outfall disposal arrangement is found to be very effective in avoiding the damages.

Since drainage system is most critical to stability of hill roads, it is imperative that the drainage system should be devised in a very realistic manner and without any restrictions on the cost.

Aligning Breast Walls and Soil Stability

The retaining walls are mainly constructed in hill roads for retaining earth on valley side, to improve curve geometrics and to achieve formation width. Breast walls are constructed for slope stabilization. We have observed the failure pattern of different types of walls and it is seen that suitably designed dry stone masonry wall and gabion walls have many advantages over other higher type of walls. The optimal use of dry walls and gabion walls has helped in reducing the cost of construction to get a great extent. Fuller application of reinforced earth wall needs to be encouraged such that the earth obtained from the hill cutting is effectively utilized for slope stabilization.

One of the causes of the failure of breast walls is water seeping into the back of wall. Suitable arrangement for the fast draining of runoff should be designed and provided. A proper examination of foundation on which the walls are to be constructed is imperative and preferably wall should be provided with a mat foundation of lean concrete as a foundation treatment.

The storm water runoff should be let out to the L drain only and integrated with the cross drain and the storm water should not be allowed to drain off towards the valley side, specially where the retaining structures have been provided. We opine that cross fall for hill roads should be a straight line towards the hill side so that surface water is drained out into the L drains.

The failure of walls in many cases is because of improperly constructed clogged weep holes. Due attention should be given to see that the weep holes are constructed properly and checked from time to time. The stepping back of the walls towards the hill slope has been observed to be very effective in preventing failure of the walls, which should invariably be insisted on.

For slope stabilization with plants it is preferable that instead of planting species of trees which grow tell and big we go in for turning of slopes with dwarf bushy undergrowth. Additionally, avoiding big trees with dense foliages will help prevent sight obstructions.

Bench cutting wherever possible in the tall hill slope, which we have provided in some of the road stretches has helped slope stability to a large extent. The open jointed fragile rock faces on the hill roads can also be stabilized to some extent by way of rock bolting and shortcreting where necessary. Many of the roads in the State have been treated with rock bolting and partial success is seen.

Quality Management

Despite fervent effort the change in the mind set of the implementing agencies and contractors as well, appears very gradual. However, there has been a marked improvement over the years, it is perceived from the experiences we have had after having conducted a few orientation programmes at PIU and State Level that the training on Quality Parameters should be more frequent and preferably prior to the commencement of works of any phase. The positive impact of the strong quality underpinning provided by NRRDA has immensely contributed to enriching quality culture not only in road construction but also in other engineering assignments in the State. However, the test frequencies specified in the quality control handbook/registers need to be perhaps moderated and made more compatible to suit the hill road construction process.

Conclusion

- In order to attain optimal economic construction cost of the rural roads, we are afraid that we have made compromises with respect to some of the essential requirements of the road. By doing so the cost of construction has initially been moderated but in the long run this may have pronounced effects on stability and sustainability of the roads.
- The water crossings and gorges, which are encountered across the alignments in many cases exceed 25mtrs span. The guidelines for the bridges exceeding 25mtrs, requires to be reviewed and the bench mark on span limit may be increased to 40mtrs. in lieu of 25mtrs.
- Landslide hazards and snow fall effects being a recurrent phenomenon in hilly states, many of the road benches get dislodged as a result the habitation once connected gets reverted back to unconnected status. In such cases relocation of the road should be allowed from the fund under this programme.
- The code of practices for road construction in hills should be made specific to hilly condition and with the system approach and management suitably interlinked.
- We feel that there is an absolute need to contain road construction activities within what is actually and absolutely necessary.
- There is a need for a more pragmatic and integrated approach to deal with environmental consideration, as this aspect is mostly tackled in isolation.
- Most of the habitations in the hills are located in far flun remote areas and although the total population count may be less than 250, providing accessibility to such habitation is a felt need. Hence the bench mark on population for hilly States should be suitably modified.

Research Work in West Bengal under PMGSY

Bikram Das*.

Folded Plate Retaining Wall (A cost effective innovative protective structure)

The lower reach of the river Ganga (called Hooghly river) in its delta stage, gives birth to many tributaries such as Damodar, Mundeswari and many other rivulets also join. Farakka Barrage and other Headworks form a network of irrigation canals. The average rainfall in the Gangetic plain being more than 1600 mm., a good number of drainage channels exist in the vicinity. The soil being alluvium in nature the phenomenon of scouring is predominant. Thus the embankments are always threatened during every monsoon. Requirement of retaining structures become imminent along the road to protect the road from erosion particularly in village road, which passes along the innumerable ponds and low land ditches. A huge cost on account of retaining / protective structure shoot up the estimated cost of road works. Construction of masonry or concrete retaining walls of permanent nature is found to be expensive, very often this component becomes 20-30% of the entire cost of the project.

In case of rural roads, this phenomenon is more pronounced since the demand of the protective measures is more along the embankment due to existence of ponds/water bodies. In order to control cost, in many cases the embankments are being protected by eucalyptus *Ballah* / Bamboo pilling. It is a kind of structure where the earth is retained by flattened bitumen drum sheets fixed on about 5 m. long eucalyptus tree trunks of average diameter 100mm.150mm. (girth) driven up to ?rd of its length by driving by monkey along the line of protection. After a couple of years either the drum sheets get corroded or the tree trunks get rotten. If the retained earth by such time is settled to natural slope then it works fine, otherwise cracks appear and slippage starts taking place very soon. In major cases the pilling works are being done very close to the edge of formation because of convenience of work or due to non-availability of land.

Objective

To develop a kind of retaining structure, which shall be structurally sound, and at the same time economically compatible.

* Superintending Engineer & S.Q.C., WBSRDA

Research Experience

Keeping in view the additional rigidity achieved by a folding plate, a slender wall of 250 mm, thick even bonded in Rattrap bond had been constructed in jig-jag manner, i.e. folded in plan. The base of the wall i.e. the foundation was a 100 mm. thick plate M15 plain cement concrete of width approximately 0.6 of height of retention. The foundation had been placed on virgin soil having bearing capacity of 10 MT/Sq M.

Some length of such wall will be provided with 5 numbers corbelled offsets coming out along the countryside or a pre-cast R.C.C. slab of M15 cement concrete of 100 mm thick. This forms a relieving shelf in each segment of the retaining wall. The load of earth on this shelf gives rise to a restoring moment .by producing cantilever moment. Hence effect of overturning moment is reduced.

Such members were physically executed in some districts as experimental basis and its efficiency tested at site.

An earth compactor was successively passed with full vibration with an intention to record the failure parameters. It was amazing to see that the structure could not be made. Fine cracks appeared at the junctions of stretches where relieving shelves were not provided. The stretches with reliving shelves remained intact.

This type of retaining walls was constructed in Nadia, South 24 Parganas and Dakshin Dinajpur districts in more than 30 places and all are performing well.

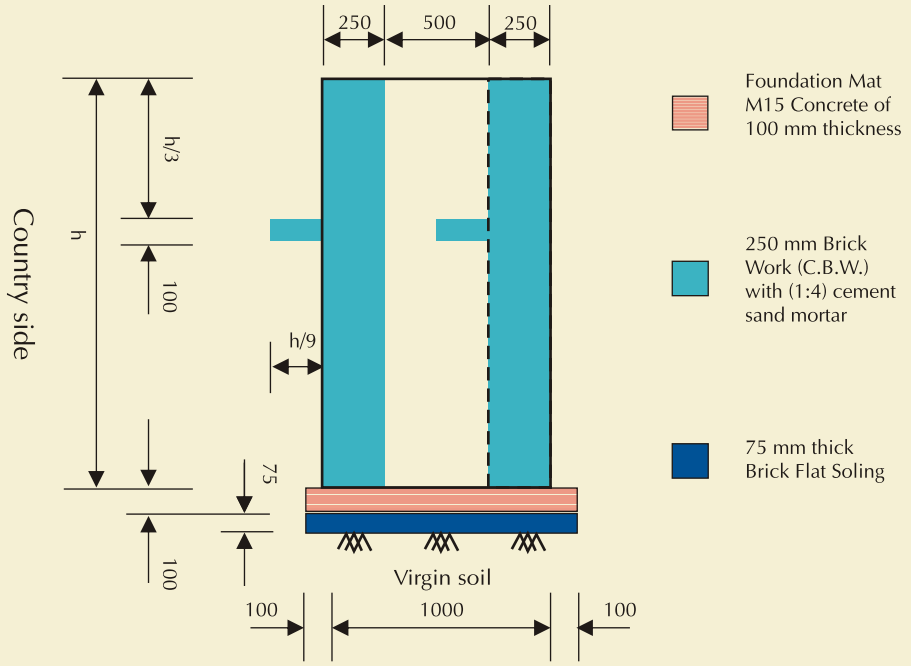
Inference

This kind of protective work (Retaining wall) is proved structurally sound and being very cost effective .The illustrated structure is permanent in nature and they may be accepted. The technology may be transferred to facilitate further research work.

Comparative Analysis

A comparison of costs with other types of retaining wall / structure may be tabulated as under: -

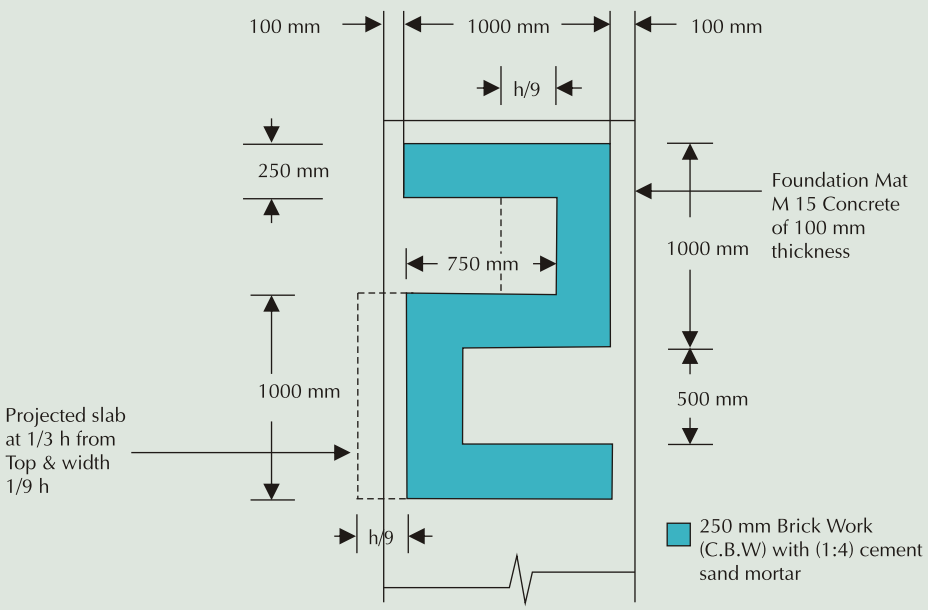
Comparison of the rate per meter-run between various type of guard walls (Cost in Rs. / meter)				
Folded plate retaining wall		Conventional Masonry Retaining Wall	Conventional Guard wall made of cement concrete	Conventional Eucalyptus ballah with drum sheet walling
With Rat-Trap Bonded Brick Work	With 250th Conventional Brick Work			
Rs. 1407.20 / m.	**Rs. 1659.39 / m.**	**Rs. 4090.50 / m.**	**Rs. 7376.81 / m.**	**Rs 1400.00/m**



Sectional Elevation of the Folded Plate Masonry Wall

All dimensions are in mm
h should not be more than 1800 mm. For greater value of h the width of CBW and Foundation Slab should be increased.

Plan of Folded Plate Masonary Retaining Wall



All dimensions are in mm
h should not be more than 1800 mm. For greater value of h the width of CBW and Foundation Slab should be increased.

Roller Compacted Dry Lean Concrete used as Base Course

One of the most important factors for the life of pavement structure is the drainage. Since the water is treated as enemy to bitumen, any accumulation of water disintegrates the bituminous surface. As a result potholes are developed. In rural roads, especially in the built up area this problem becomes acute. In the built up area generally 7.5 M. roadway width is not available. We have to restrict it to 6.00 M. Now for crossing the traffic at least 5.50 M. width is necessary. As a result there is hardly any space to construct side drain.

Now in this situation rigid pavement with raised kerb is the best solution, because the rigid pavement will permit flow of water over its surface. But as per IRC, the PQC for rigid pavement should be of high-grade concrete M30 or more. For such high-grade concrete, batching plant is essential. Now for rural roads especially under PMGSY, installation of batching plant is not economical viable. Moreover, the cost of the high-grade concrete is also very high.

Considering the above aspects the use of low grade concrete for the construction of rural roads is the only choice left. That's why the Roller compacted Dry Lean Concrete is the best answer in such case.

IRC recommends using Dry Lean Concrete as sub base for the rigid pavement. But attempt has been made to use DLC as base course for rural roads. In SP 20 Roller compacted DLC has been recommended and a design curve has been given showing the thickness of DLC against the CBR of sub grade. It is recommended to provide a drainage layer below the DLC and a bituminous wearing course on top.

Since due to poor drainage facility in the built up area we are adopting DLC and hence no question of providing bituminous W.C. arises.

Now a comparative statement is furnished below regarding the pavement thickness required both for flexible pavement & DLC: -

CBR	A Curve		B curve		C curve	
	Flexible Pavement	DLC	Flexible Pavement	DLC	Flexible Pavement	DLC
2%	425 mm.	288 mm.	515 mm.	307 mm.	505 mm.	338 mm.
3%	350 mm.	265 mm.	415 mm.	288 mm.	480 mm.	325 mm.
4%	275 mm.	260 mm.	350 mm.	275 mm.	410 mm.	310 mm.
5%	250 mm.	250 mm.	315 mm.	260 mm.	360 mm.	290 mm.
6%	210 mm.	240 mm.	265 mm.	252 mm.	300 mm.	275 mm.
7%	180 mm.	225 mm.	270 mm.	240 mm.	275 mm.	265 mm.

But for DLC a drainage layer of 100 mm. should be provided. So for the sub grade having CBR value 4% or more DLC will be costlier.

DLC may be treated as semi rigid pavement. Hence with the increase in sub grade reaction the requirement of thickness of DLC will decrease.

Several test cases have been carried out in the district of Birbhum, Purulia, Nadia & Bankura. The sites were so chosen to cover both for extreme climate (e.g. Bankura, Birbhum & Purulia) and moderate climate (Nadia). The CBR of the sub grade of these chosen sites is around 3% to 4%. The extreme climate was chosen to evaluate the quantum of temperature crack.

100-mm. thick GSB grade I was provided as drainage layer. DLC was cast with zero slump concrete of M-10 concrete and roller compacted. 3.00 M. panel was made by cutting the concrete to 1/3rd of its depth within 24 hours. The gap was filled in with sealant material, then a wearing course of 75 mm. thick by M25cc was laid. The wearing course was also laid in panel 56. The panel was made longitudinally with interval of 3.0 M, to reduce the warping stress. The thickness of DLC may be reduced by 100 mm. since 75 mm. M25 W.C.is provided to be cast within 3 days and below DLC a sub base course of 75 mm. thick is provided.

If the road is designed for rigid pavement, the thickness of M30 concrete will be around 200mm for 3% CBR and a panel of 3.5M. If R.C.C.P. is considered , the thickness of M30 grade concrete with zero slump will also be around 200mm.

Observation: Two year have already been passed & till date the performance of the road is good.

Inference: Though DLC is a bit costlier than Flexible pavement; it is much cheaper than rigid pavement with high grade of concrete. This type of road is an ideal one, especially in built up area where drainage facility is inadequate. Moreover its maintenance cost is negligible and hence it is economical in the long run.

Auto Project Management System

In West Bengal, like all other states, numerous small projects are under way at the same time under PMGSY scheme. All of these projects do not progress at the same pace as expected. So often it is necessary to monitor the progress of these projects very closely which is a very tedious job. The projects that lag behind the target set need special attention. Hence the project manager needs the exact data about the targets set and the progress report of these projects both in terms of finance as well as the physical progress as fast as possible. For these if he needs to search paper or files to get data time required will be very high. By the time he gets ready to take any action other problems are likely to come. That's why we need to go for an automatic system to monitor these projects. The manager should be able to get data about any project just by one click.

Keeping in view of the above aspects software called Auto Project Management System (APMS) has been developed. It allows the manager to view the requisite data about the projects just by one click. APMS also checks and finds out the projects that are lagging behind the schedule.

System Requirements

- P3 or P4 processor
- 256 Mb Ram
- A database management system (RDBMS) preferably Oracle
- 20 GB hard disk
- Windows platform (can be any i.e. Windows 98, ME, XP or Vista)
- A network card if it needs to be deployed over a network i.e. LAN (optional)
- A modem if network is distributed over different geographical locations. (Optional)

Description

Auto Project Management System (APMS) has security provisions. It has two level access systems. The user of APMS is categorized in two i.e.

i. Administrator (has all privileges)

ii. General employees (has restricted access and privileges)

An administrator has privileges to create accounts and even create another administrator account. Thus administrator of APMS can control the number of users and their privileges.

The startup or login screen of APMS

When administrator creates a user he defines the type of account after verifying his password.

Password required for entering user creation screen.

User creation screen

Now browsing screen is there to access different functions of APMS.

1. Insert : to enter new projects data
2. Show all : to display all projects data
3. Update : to update projects data
4. Defaulters : to display all the lagging projects i.e. the projects that did not meet the target

Both administrator and general employee account can access all these functions

5. Administrative rights: to access special privileges like delete and edit entire project data.

All projects are assigned a package number. Incase of update, delete and edit user can easily access that project details only by giving the package number. This saves a lot of time in searching that particular project.

Incase of update only the progress of the particular project can be entered for previous two months and current month. Thus it keeps a control over late entries.

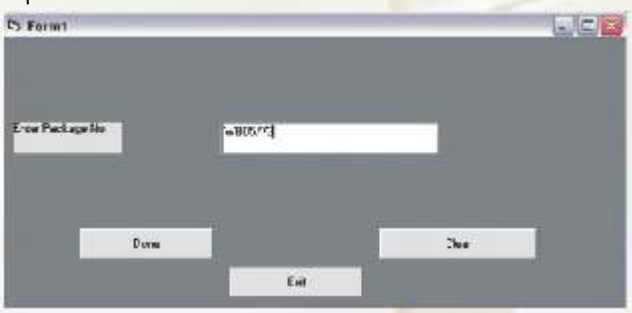
Incase of errors only an administrator can edit the data or delete the data about that project. Hence with out the information of higher officials the data regarding the projects cannot be manipulated or adulterated.

Browser screen

Insert screen

After entering data it asks for confirmation then finally enters the data into database.

Update Screen



Asking for package number for update

Update screen where only achieved fields of 3 months can be edited.

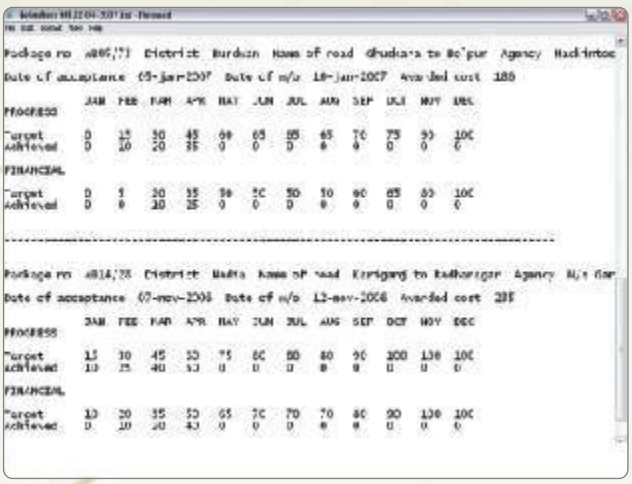
Similarly Edit and Delete screens work. Only difference is all fields can be edited and only administrator can access.

Defaulter Screen

On clicking defaulter button it shows all the projects that did not meet the target. Other than displaying all the defaulting projects it also creates a text file in the hard disk with the name defaulters and current date e.g. "defaulters till 22-04-2007 ". It gives a print option too.

Show all Screen

It works in similar fashion as defaulter screen except it displays all the projects including defaulters. It also creates a text file in the hard disk with the name all records till current date e.g. "all records until 22-04-2007.txt". It also gives the print option.



Defaulter screen

Back up

Incase of computer breakdown there is a possibility to lose data. Hence APMS provide a facility to take back up all the information entered. It can be done a week or a month depending on frequency of change of data. Thus it provides security against data losses even if Windows crashes.

Networking

In case of local area network APMS keeps the database server in a single computer and rest of the connected user access the same database through clients of server. Thus duplication of data is prevented. Many users can login at the same time and can view and edit information. If the users are located at different geographical locations and are not connected through LAN then APMS can create xml files and send it over Internet. Thus complete and updated information can be stored at headquarters.

Thus all these features make Auto Project Management system a perfect tool for managing projects. Using APMS will help in saving time and effort.

Durable Pavements for Village Roads with Sand-cement

B.B.Pandey

There are many regions in India and other countries where good quality aggregates are not available. The imported aggregates for the construction of water Bound Macadam are costly. In such cases, locally available sand can be used for making durable pavements by using innovative technology. The short technical article describes how sand-cement mixture can be made use of for making a flexible -rigid pavement.

In continuation with a pilot project on construction of a low cost concrete road in a village (reported in Grameen Sampark, Jan-June 2006), author carried out another model study on pavements made up of cast in situ cement-sand blocks on the perimeter road in side the IIT campus. The existing road consisted of 150mm of compacted moorum over a subgarde soil of Plastiticity Index of 8 and a liquid limit of 30. The percent compaction was only 90% and it had a moisture content of about 18% at the time of construction. The laboratory CBR under standard compaction was 5 at a moisture content of 12%. In situ CBR is not expected to be higher than 3 because of low compaction level.

The moorum subbase was covered with a formwork of cells of recycled plastic(Fig.1)

Fig.1: Formwork of Recycled plastic

Fig.2: Cement-sand mixture being filled into cell the cells at OMC

A mixture of cement and sand is prepared at optimum moisture content and the mix is placed into the cells whose sides are 150mm x 150mm and the depth is 100mm. The mix was designed to have 28-day compressive strength of 20MPa since the blocks are not subjected to flexure. The cement-sand placed into the cells is compacted with a 8-10 ton roller(Fig.3). Fig. 4 shows a view of the finished surface. Curing was done for two weeks with wet gunny bags.

Fig.3: Rolling of cement-sand filled into cells

Emeritus Professor of Civil Engineering, I.I.T. Kharagpur

Fig.4: A view of finished surface

Cement-Sand surface can not resist abrasion action of wheels of commercial vehicles for a long time. A wearing course of single coat or double coat bituminous surface dressing should be provided. Good quality aggregates are needed only for the wearing course. The thin bituminous wearing course has a life of about five to six years and resurfacing may be needed after that. For a long life wearing course, the cells should be filled up with cement-sand to a depth of about 75mm (75%) of the total depth of the cells and the remaining depth of 25mm should be filled with zero slump concrete and the rolling should be done with a road roller.

Figs.5 and 6 show cores taken from compacted cement - sand with a wearing coat of zero slump cement concrete and the cement-sand layer on which bituminous surface dressing is required to be done

To evaluate the strength of the pavements, a two axle truck loaded with laterite boulder with a gross weight of 22 tons was made to move to and fro for about 500 repetitions. The front left wheel and the rear left dual wheel weighed 4 tons and 7tons respectively. Each applied about 500 passes over the model pavements. There was no sign of any deterioration in spite of high wheel loads normally not encountered on village roads. FWD tests gave an elastic modulus of about 1100MPa for the cemented layer while the subgrade modulus was 20Mpa because of poor compaction and high moisture content. A typical pavement can have cement-stabilized subbase, cell filled cement -sand base with a wearing course. The construction is labour intensive and can generate employment. About 30 to 40 percent of sand can be replaced with brick or other soft aggregates to bring down the requirement of cement. Cushion of cement-sand around the soft aggregates would prevent large-scale degradation of soft aggregates during rolling.

Fig. 5: A core of cement-sand mix with a concrete wearing course

Fig. 6: A core of cement-sand mix

PMGSY Connecting Rural Bharat to Urban India

Challenges Faced in Checking DPRs and Remedies

Mishra R.C*., Chhangani O.P**. and Kaushik N.P***.Dr.P.Agarwal

Pradhan Mantri Gram Sadak Yojna (PMGSY) was aimed at providing the quality road connectivity to rural India to provide service facilities to rural population trough road network and to boost the rural economy. Detailed project reports (DPR's) are instrumental in assessing the the coast of construction, quality of work and basic requirements and needs like Cross Drainage works (CD works), Protection works in a comprehensive manner. The DPRs are prepared on the basis of topographical investigation, traffic survey (present and projected) design of pavement and choice of technology to enable the execution of the work.

The state technical agencies (STA) were entrusted with a task of scrutinizing the DPRs prepared by the field engineers to point out technical deficiencies and achieve optimality as per the guidelines provided by Ministry of Rural Development (MoRD) and as well as operation manual of National Rural Road Development Agency (NRRDA). These agencies provided the STAs with good literature and other supporting documents which were a real help in assessing and scrutinizing the DPRs.

Structure of DPR

The field engineers were asked to prepare the DPRs right from the Core Network, decide district wise judicious allocation of roads, CNCPL/CUPL. DPR preparation includes the proper investigations for traffic survey, engineering survey of the selected routes, proper alignment, hydrological survey for design of CD works, soil investigations, analysis of rates etc. Once the PIU is satisfied, the DPRs are further processed as per procedure laid down by NRRDA.

STA at UCE RTU, Kota

Department of Civil Engineering, University College of Engineering, Rajasthan Technical University, Kota (erstwhile Engineering College, Kota) was selected as State technical Agency for facilitating and scrutinizing the DPRs of Kota region (Bundi, Baran Jhalawar, Kota , Karoli and Sawaimadhopur) and Udaipur (Chittor, Udaipur, Banswara and Dungarpur). As STA so far more than 1500 DPRs belonging to phase V,VI, VII and Desert and Tribal Area development phase VIII amounting to nearly rupees nine thousand millions have been processed.

* Chief Co-ordinator STA and HOD Civil Raj. Tech. Univ. Kota
** Co-ordinator STA, Deptt. of Civil Engg. Raj. Tech. Univ. Kota
*** Co-ordinator STA, Deptt. of Civil Engg. Raj. Tech. Univ. Kota

Challenges Faced in Scrutinizing DPRs

As indicated above the two regions under scrutiny represent a vast variation in topographical conditions, soil type, hydrological and terrain type. The conditions prevailing in these areas vary from black cotton area to rocky area (*Pathary* area), ravines of Chambal to hilly terrain. The rainfall is maximum in Haroti region of Rajasthan where the river are notorious as can be gauged by the name of one of the river in the area "*Ghoda Pachhad*", i.e. one which can defeat even the horse who gets mistaken by the low level of the water in the river and tries to cross the river, suddenly the flood comes and the horse is also carried away by the strong current of water. The flood water comes suddenly and due to rocky terrain resulting into large quantities of surface runoff sufficient cross drainage provisions are needed for providing the round the year connectivity. The black cotton soil is another problem area in the region with CBR value less than 2.5 and soil swelling pressure posing threats to the pavement design. Some salient points to be referred are as follows:

Parameter	Variation
Soil Type	Black cotton soil (clay) to Big boulders(Rocky strata)
CBR Value	2.0 in the clay to 10 in Hilly terrain
Rain fall	500 mm to 1000 mm
Terrain Type	Ravines of Chambal to Hilly Terrain
Natural Gradient	Very mild in the plains to 1 in 12 in ravine and hilly areas
Population Density	Scarce to normal

Alignment

There has been no provision for acquisition of land by central government and it is left to the state government to arrange for the same. As the state government is not willing to put any funds for the said purpose the alignment of the road is along the existing revenue track. This has resulted into longer route in most of the cases as the route being zigzag, rendering the project cost to be very high. The economical solution could have been to acquire the land and straighten the path, reducing the cost of construction and fuel cost for the vehicles. In certain cases the route could not be completed as the revenue track passes through the forest land. Being the disputed case the road constructed on either side without being properly connected and thereby defeating the very purpose of the project.

Formation level and gradient of the road

The formation level has been also kept at the existing revenue track in most of the cases as the optimum formation level may involve filling which need lots of soil from the barrow pits. The availability of the soil is very scare and therefore the existing levels were preserved, leaving high gradient in some cases.

District boundaries and Rural Roads

The execution work is carried out by the PWD and the decision about the connectivity is taken by the District Administration, including Panchayat Samitees, the two have divergent opinions and the integrated approach for finalizing the optimal use of proper road network is lost, which results in high cost. The border villages are sometime deprived of the due consideration.

Inflated DPR estimates

The general tendency amongst the field engineers is to prepare the estimate on the higher side with the

presumption that at the successive stages of the scrutiny the cost will be slashed. This in some cases results in unrealistic and higher estimates.

Hydrological Data

In the given span of time and limited resources it was very difficult to carry out the hydrological survey. The flood calculations were based on G T Sheets and use of empirical formulas, which in cases were not realistic as the G T sheet has undergone many changes due to the process of urbanization and other factors. Another problem in the design and provision of cross drainage works (CD Works) is capping of the cost restricted to 25% uniformly. However, in exceptional cases the STA can take a decision to increase in this percentage. The problem is encountered when large streams/rivers cross the road, particularly in hilly and ravine areas.

Traffic Survey

The same is the fate of traffic survey which are based on some particular days' record. However, in this case the inflated data used by field engineers mostly proves to be correct, since the growth rate of the traffic is high due to increased use of vehicles by a common man. With the facility of roads the sale of the vehicles even in rural area has gone up.

Damage to the bitumen road in the water logged areas and village portion due to poor drainage

The bitumen roads are most susceptible to the ingress of water and deteriorate very fast in the presence of the water. As in almost all the villages the drainage conditions are very poor the damage to the road is almost instantaneous. Proper drainage and anti clogging measures are required to allow proper drainage and in particular near all hand pump locations.

Variation in cost due CC portion

Since there is a provision of CC road in the village portion, which is very costly as compared to BT road, the average cost per kilometer is sensitive to the relative length of CC portion to total length. There is a large variation in this ratio causing cost per kilometer out of bound. Also the quality of CC roads are not as per standards and construction practices are leading to cracking also cases of early damage are being reported in some cases.

Remedies/corrective measures

Alignment

The DPR's should be thoroughly checked in the light of change in the existing track. If by providing straight alignment the gain in the cost of the construction is more than the cost of acquiring the land, due consideration will be given. Either the Central or the State government should have the provision for the same. This will also result into national saving by reduced fuel consumption.

Formation level and gradient of the road

The formulation level be fixed properly and wherever filling is needed fly ash/ pond ash, if available in the vicinity, be used for the purpose. This will not only save

the soil needed for vegetation but also environmental pollution is controlled by utilizing the ash. As per the specification of the National Highway Authority of India the Typical Geotechnical Properties of fly ash are as per the Table below:

Fly ash to be used as fill material should not have soluble sulphate (expressed as SO2) content exceeding 1.9 gm/lt when tested according to BS:1377-1975 Test 10 using a water-soil ratio of 2:1.

Parameter	Normal Range
Specific Gravity	1.90 - 2.55
Plasticity	Non-plastic
Maximum Dry Density	0.9 - 1.60
Optimum Moisture Content (Percent)	18.0 -38.0
Cohesion(kN/m^2)	Negligible
Angle of Internal Friction (Phi)	30^0 -40^0
Coefficient of Consolidation (C in cm^2/s)	1.7×10^{-5} - 2.0×10^{-3}
Compression Index C_C	0.05-0.40
Permeability (cm/s)	8.0×10^{-6} - 7.0×10^{-4}
Particle Size Distribution(percent of material)	
Clay size fraction (Less than 0.002 mm)	1 -10
Silt size fraction (0.002 mm to 0.075 mm)	8 -85
Sand size fraction (0.075 mm to 4.75 mm)	7 -90
Gravel size fraction (4.75mm to 80 mm)	0 -10
Coefficient of Uniformity	3 -11

The fly ash fill should be provided with proper soil cover to prevent erosion. It should be spread in layers not exceeding 400 mm and compacted using vibratory rollers of dead weight 80-100 kN. Moisture content of the fill material shall be checked at the site of placement prior to commencement of compaction.

Specification for compaction

Maximum dry density after compaction as percentage of MDD	97 %
Maximum dry density after compaction when used in bridge abutments for embankment length equal to 1.5 times the height of the embankment	100%

CC pavement and alternatives

In place of concrete pavement precast concrete blocks of size 450x300x150 mm may be laid over the PCC 150 to 200 mm thick, while the base is still green. The joints may be filled with mortar.

District boundaries and Rural Roads

Though the NRRDA has taken all possible measures to create an integrated rural network, the critical cases be scrutinized again. Mostly the thrust has been to connect the villages to the district headquarter, but, it may be economical to provide connectivity through other districts/state roads. A National Policy in this regard will be helpful.

Inflated DPR Estimates

The field engineers be given the confidence that unnecessary curtailing of the cost will not be affected by the scrutinizing authority. The estimates should be realistic as far as possible without any artificial inflation.

Hydrological Data

The hydrological data collection should be made realistic and keeping in view the topographical changes occurred after the date of preparation of GT sheet. In hilly and ravine areas higher percentage on CD works be allowed. Mostly in the protection works the majority of DPRs includes retaining walls irrespective of water being flowing or in still condition. In case of still water embankment with stable side slopes may be more economical and easy to construct.

Traffic Survey

The traffic survey must be made properly, however the inflated value to some extent does help in the design of the pavement in the light of increased traffic intensity and use of heavy vehicles on the paved roads even in the rural areas.

Disputed Cases with Forest Land

There should be a national policy on the use of forest land to achieve the desired connectivity in the remote areas. The forest officers should be taken into confidence before finalizing the alignment of the rural roads.

Quality Measures

The provision made by NRRDA to award the works with a condition to maintain the road for a period of 5 years has resulted in general a good quality of road construction as compared to ODRs and MDRs. The role of the STA is limited to scrutinizing the DPRs only. The involvement may be extended to quality control measures during execution of the work at least on few roads on random basis. Also the remuneration be made attractive to encourage the technical person associated with scrutiny.

Conclusion

PMGSY is a boon to the nation and the Prime Minister's office needs to be congratulated on this account. The rural roads are proving to be beneficial to the villagers who were deprived of the basic facility needed. As a result of this project the villagers can reach the nearest medical centre in an emergency, in the shortest possible time and their economy has got a big boost.

The authors have tried to study the variation in DPRs, and the queries arising during the scrutinizing process of the DPRs. Some possible reasons and their remedies are suggested herewith. The authors heartily thank all the agencies associated with the project to provide this opportunity for presenting this paper.

Reinforced Flyash in Highway Embankments of India

Praveen Kumar*

There are about 95 million tonnes of flyash [1] per annum as a waste material in coal based thermal power stations in the country. Because of pozzolanic property of flyash, it can be converted in to meaningful wealth as an alternate cementing material in civil engineering works. Use of flyash in roads, airfields and embankments are some of the areas that have attracted the attention and use in large quantities. In context of roads and embankments, it can be said that flyash is a good material for geotechnical application and can replace soil in most of the applications [1].

The existing 130 thermal power plants [1] alone need about 60,000 acres of precious land for disposal of flyash in their life span of 30 years. About Rs. 700 crores has been invested to get rid of flyash where as a similar investment would have been sufficient to convert all flyash in to useful products. In addition to the disposal problem, air pollution gets increased in the ambient air.

Table 1 shows various flyash producing thermal power plants in India. The concept of reinforcing poor soil has continued for a long time. Different types of material are being increasingly employed in various civil engineering activities and especially in highway engineering to facilitate construction , ensure better performance of the structure and reduce maintenance. Over the last few decades, the use of geotextile has recorded a tremendous increase. They have found wide acceptance in the construction industry all over. They are now looked upon as cost effective solutions to many foundations and stability problems. Coal based thermal power stations produce flyash, depending on the quality of coal used and modes of burning and collection, flyash have varied pozzolanic properties. Nearly 50% saving in the cost of road construction can be achieved if locally available flyash is used instead of costly stone aggregates [1].

Associate Professor, Department of Civil Engineering, Indian Institute of Technology, Roorkee-247 667, India, pkaerfce@iitr.ernet.in

Table - 1. Some Major Thermal Power Stations in India

Western Region	Eastern Region	Northern Region	Southern Region	North Eastern Region
Amarkantak	Bandel	Badarpur	Basin Bridge	Bonogoigoan
Ballershah	Barauni	Bhatinda	Ennore	Chanderpur
Bhusawal	Bokaro	Faridabad	Kathaugdem	Kathalguri
Chola	C.E.S.C.	Harduaganj	Nellore	Lakwa
Dhuvaran	Chandrapura	Indraprastha	Neyveli	Namrup
Ghadhinagar	Durgapur	Kalakote	Ramagundam	
Khaperkheda	D.P.L	Kota	Raichur	
Koradi	Gouripur	Obra	Tuticorin	
Korba	Kolaghat	Panki	Vijayawada	
Nasik	Mulajore	Panipat		
Paras	Muzzaffarpur	Paricha		
Parli	New Cossipore	Renusagar		
Rajghat	Patratu	Ropar		
Sabarmati	Santhaldih	Singrauli		
Satpura	Talcher	Ghaziabad		
Trombay	Titagarh			
Ukai				
Uram				
Utran				
Wanakbari				

Properties of Flyash

The chemical, physical and engineering properties of ash depends on the type and source of coal used, method and degree of coal preparation, cleaning and pulverization, type and operation of power generation unit, ash collection, handling and storage methods etc. So the properties of flyash vary from plant to plant and even within the same plant [3]. The mineral group present in coal such as hydrated silicate group (kaolinite and montmorillonite etc.), sulphate group (quartz, feldspar, apatite etc.) and their varying composition play a major role in determining the chemical composition of ash. During combustion the above minerals gets transformed. So the overall composition varies from particle to particle and from one sample to another. The principle constituents of ash are silica, alumina and iron-oxide with smaller amounts of calcium oxide, magnesium oxide, sulphur and unburnt carbon [4].

Table 2 shows average composition of flyash from various power plants in India. It is observed that Indian fly ash generally tends to be more siliceous and also contains higher concentration of unburnt coal than the flyash from foreign countries and therefore is less reactive. Unburnt carbon acts as diluent of the pozzolanic matter in flyash. Based on the amount of calcium oxide present, flyash is divided into two categories as per ASTM. Type F (Cao less than 5%) and type C (Cao more than 5 %). The type F fly ash is derived from burning of anthracite or bituminous coal and type C fly ash is obtained from burning lignite coal. Type C fly ash may contain lime content higher as well as pozzolanic properties [5].

Table - 2 Composition of Flyash from Various Thermal Power Plants [5]

Location	SiO_2	Al_2O_3	Fe_2O_3	CaO	MgO	SO_3	Loss on Ignition
Delhi	59.00	28.10	4.30	2.50	0.30	0.10	4.40
Singrauli	56.80	28.80	7.80	2.70	0.60	0.10	0.40
Obra	64.40	23.00	6.50	0.70	0.20	0.21	3.40
Panki	58.00	25.10	10.00	1.10	0.40	0.30	4.30
Harduaganj	61.00	16.10	5.60	3.10	0.40	0.40	11.80
Korba	66.53	18.90	8.90	3.60	2.60	0.20	0.53
MPEB	58.30	24.60	4.40	5.40	3.90	--	3.30
Durgapur	49.30	20.05	19.60	2.28	1.53	Trace	6.13
Barauni	60.28	22.68	8.45	1.10	0.31	1.40	6.0
Bokaro	51.60	22.00	4.70	0.86	0.85	2.10	19.40
Chandrapur	60.30	26.80	5.30	1.18	0.51	1.60	5.20
Phulpur	59.77	23.92	9.56	2.51	1.28	--	--
Indraprastha	60.10	18.60	6.40	6.30	3.60	--	4.90
Neyveli	45.59	23.33	0.64	5.16	1.50	Trace	1.20

Case Studies of Flyash Utilisation in Embankments of India

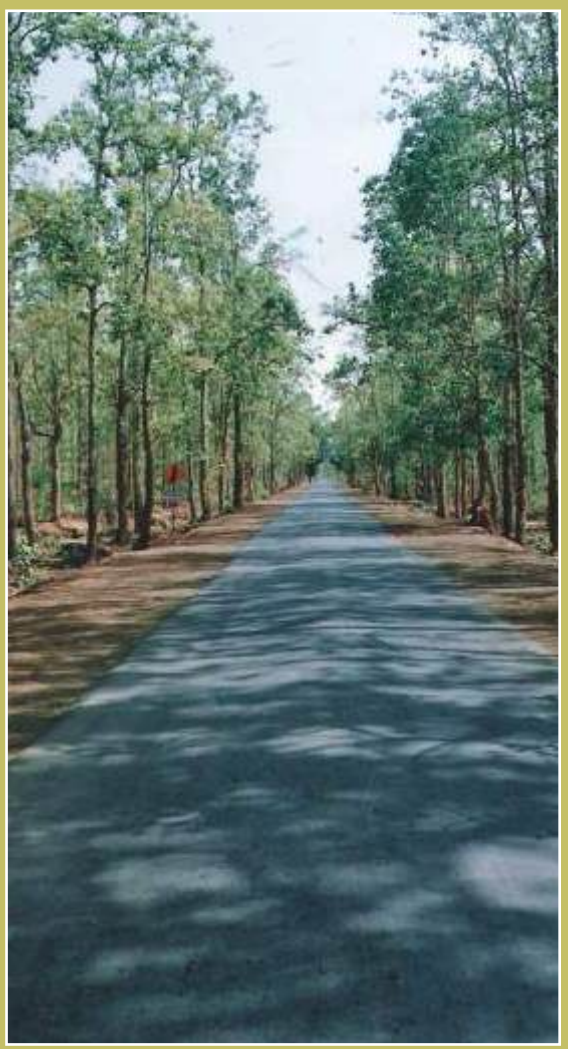
Visvesvarya Setu Project

Delhi PWD in association with CRRI and Flyash Mission constructed the first reinforced flyash retaining wall on one side of the slip roads adjoining NH-2 in the above mentioned project [3]. The length of approach embankment is 59.0 m while the height varied from 7.3 m to 5.3 m. The substructure was reinforced with bi-oriented geogrids using bottom ash as a filler material. For constructing the super structure cast in situ facing panels were placed over previously laid RCC foundation block. Mono-oriented geogrids were laid and anchored to facing panels. Construction of conventional retaining wall would have resulted in acquirement of private property as its foundation would have encroached into adjoining lands. A total quantity of about 2700 cubic metre (compacted) of pond ash was used for filling. The flyover was opened to traffic in Jan.' 96 and has been performing well.

Second Nizamuddin Bridge Project at Delhi

A new four lane bridge is constructed across the river Yamuna, a little down stream of the existing Nizamuddin Bridge along NH-24 [1]. For construction of embankment for approach road flyash (pondash) was used. Flyash from the ponds of Indraprastha thermal power plant Delhi was used as fill material. It is the major flyash utilisation project in India till date. Approximately 0.15 million tonnes of flyash was utilised in the construction along with soil and gravel. The total length of the eastern approach is 1.826 km and the height of embankment ranges from 6 m to 9 m and it consists of two or three flyash cells surrounded by soil cover made up of low permeability soil. The reason for providing 0.40 m thick intermediate barrier is to separate the flyash into several individual cells, this has the advantage in controlling any built up of hydrostatic pressure within the confined flyash cell over a period of time. Each individual cell is constructed with a clear height of 2.0 to 2.3 m approximately.

Specifications adopted for the materials are pond ash compacted to 95% of MDD and it should be 1.2 gm/c.c.



The moisture variation for compaction was OMC± 2%. Soil was compacted to a dry density not less than 1.65 gm/cc and PI value in the range of 8 to 10%. Design of embankment was carried out on the basis of slope stability analysis. The analysis of flyash embankment was evaluated by using the simplified Bishop's method of slices and arrived the side slopes 1V : 2 H.

Embankment with Geogrid and Anchor Reinforcement.

The newly developed combined system technique using anchor and geogrids is found to be suitable for a wide range of fill material [7]. Varuna bridge approach structure proposed to be constructed consists of 10.5 m height. The construction work is to be done in three stages of 3.5 m of flyash each. The retaining structure is reinforced with anchors and geogrids in alternate layers. Construction of embankment is proposed with the obvious advantage that it would allow access for inspection maintenance and construction purpose.

Lime Treated Flyash as Embankment Material [8]

Lime treated flyash was used in the construction of embankment over soft clay at a site near north Madras thermal power plant to carry ash slurry pipe line near Attipattu at Madras. An experimental work has been carried out to know the stability and settlement characteristics. The flyash samples were collected from Ennore thermal power station, Madras. The lime used in this embankment was of reagent calcium oxide (CaO) of 95% purity, optimum lime content was found to be 1.6%.

Details of Experimental Programme

Soil

The soil used in the study was locally available Roorkee Soil. It is a cohesionless soil which is classified as A-3 as per revised PRA (Public Roads Administration) classification and (SP) as per IS classification. The various properties of Roorkee soil are given in Table.3.

Flyash

The flyash used in the study was brought from National Thermal Power Station situated at Ghaziabad which

was available free of cost. Flyash is classified as silts of low compressiblity (ML). The physical and chemical properties of flyash are given in Table 4 .

Lime

The Lime used in the study was commercial lime available in Roorkee market. Intentionally, scientific lime was not used because in actual only commercial lime will be used.

Table -3. Properties of Soil

Property	Value
Classification as per Revised PRA	A-3
OMC (%)	13.5
Maximum Dry Density (gm/cc)	1.8
Specific Gravity	2.65
Uniformity Coefficient, Cu	2.19
Coefficient of Curvature, Cc	0.90
Liquid Limit (%)	Non Plastic
Plastic Limit (%)	Non Plastic
Plasticity Index (%)	Non Plastic

Table -4 Physical and Chemical Properties of Flyash

Properties	Test Value
1. Physical Properties	
(a) Specific Gravity (G)	2.16
(b) Fineness by Sieving	
Sand particles (%)	3.5
Silt particles (%)	95.5
Clay particles (%)	1.0
(c) Proctor OMC (%)	22.0
(d) Maximum dry density (gm/cc)	1.4
2. Chemical Properties	
(a) Silica (SiO_2) (%)	58.78
(b) Iron oxide (Fe_2O_3) (%)	9.31
(c) Alumina (Al_2O_3) (%)	26.92
(d) Calcium Oxide (CaO) (%)	1.77
(e) Magnesium Oxide (MgO) (%)	0.68
(f) Total sulphur (%)	0.1
(g) Sodium Oxide (N_2O) (%)	0.28
(h) Potassium Oxide (K_2O) (%)	1.44
(i) Loss on Ignition (%) by weight	0.72

Geotextile

Only one Type of the Geotextile was used which was of non-woven type in the present study. The properties of this material is given in Table 5.

Table -5 Properties of Geotextile

Fabric Construction	Needle punched non-woven
Material composition	100% Polypropylene
Weight per sq. metre	309 gms
Thickness	2.97 mm
Resistance to Chemicals	Excellent
Resistance to bio-degradation	Excellent
Roll available	4.5 m wide and 25-30 m long

Test Pit Preparation

Test pits of size 1.5m x 1.5m x 1.0m were dug in the pavement test hall of Transportation Engineering Section of IIT, Roorkee. The pits were prepared with following materials:

a. Soil

b. Flyash

c. Flyash + 4% Lime

d. 75% Flyash + 25% Soil

e. Two such pits were prepared at a time, one unreinforced and the other reinforced with geotextile at varying depth of 50cm (H/2), 30cm (H/3) and 10cm (H/10) from top. Where H is the total depth of the pit for each of the above materials. Compaction was done at OMC in five layers of 20 cm each with the help of tamping rod. Densities were measured using aluminum cups

and compaction was carried out till at least 95% of laboratory maximum dry density was achieved. Vibratory roller was also used on the surface to ensure uniformity in compaction. When lime was used in combinations with flyash the compacted surface was left for 3 days of air curing. This was done to ensure the reactivity of lime with other materials.

Analysis of Laboratory Test Results

Compaction Tests

Standard proctor tests were conducted to determine the optimum moisture content (OMC) and maximum dry density (MDD) of various materials. The results of proctor test carried on soil , flyash, flyash + 4% lime, 75% flyash + 25% soil are given in Table 6. It is seen that the compacted dry density of flyash is well below that of most conventional fill materials. This is advantageous if the fill or embankment has to be placed on ground of low bearing capacity or where long term settlement is possible. Moreover it is seen in case of flyash that for greater variation in water content there is little variation in maximum dry density.

Table–6: Maximum Dry Density and OMC of Various Materials

S.No.	Type of Material	Optimum Moisture Content (%)	Maximum Dry Density (gm/cc)
1	Soil	14.0	1.85
2	Flyash	22.0	1.43
3	Flyash + 4% Lime	23.5	1.64
4	75% Flyash + 25% Soil	18.5	1.59

Field CBR Test

Results obtained from field CBR test on soil (SP) , flyash, flyash + 4% lime and 75% flyash + 25% soil (SP) are given in Table 7. These tests were conducted without geotextile reinforcement and with reinforcement placed in the materials at 50 cm, 30cm and 10cm from the surface in order to study the effect of position of geotextile on CBR and eventually to find the position which gives maximum benefit.

Table-7 CBR Values for Various Types of Materials Including Soil

S. No.	CBR without geotextile (%)		CBR with geotextile at 50 cm from surface (%)		CBR with geotextile at 30 cm from surface (%)		CBR with geotextile at 10 cm from surface (%)	
	at 2.5 mm	at 5.0 mm	at 2.5 mm	at 5.0 mm	at 2.5 mm	at 5.0 mm	at 2.5 mm	at 5.0 mm
Soil (SP)	11.42	10.95	12.85	12.38	17.14	16.66	22.14	21.42
Flyash	15.71	14.28	17.85	17.14	23.57	21.90	28.57	26.66
Flyash + 4% Lime	22.85	20.00	27.85	26.19	35.0	30.95	40.71	34.76
75% Flyash + 25% Soil (SP)	18.57	14.76	22.14	18.57	27.85	24.28	34.28	30.00

It may be observed that introduction of geotextile in soil has an effect on its CBR value. CBR value depends on type of soil, amount of compaction and position of geotextile in soil. It is observed that the CBR values show an increasing trend with the introduction of geotextile placed in the materials at 50cm, 30 cm and 10 cm from surface.

The CBR values in case of soil (SP) is nearly doubled when geotextile was kept in it at 10 cm from surface to that when geotextile was not used as reinforcement. From Table 4.2 it is seen that there is a gradual increase in CBR values when geotextile used at 50cm, 30cm and 10cm from surface to that when geotextile was not used. Maximum values of CBR were obtained when geotextile was kept at 10cm from top, which shows that for maximum benefit the geotextile should be kept near the surface. Lime showed very good affinity with flyash and CBR values were greatly enhanced for both with and without geotextile.. Similarly the mixture of flyash with soil showed improved results both with and without geotextile.

Plate Load Tests

From the values of the modulus of subgrade reaction and modulus of elasticity of various materials with and without reinforcement it shows that the inclusion of geotextile adds to the strength of the subgrade. Table 8 reveals that the modulus of subgrade reaction increases as the geotextile layer moves towards the surface of material. Table 9 gives the values of modulus of elasticity for various types of materials. Modulus of elasticity increases as the geotextile is nearer to the surface.

Table-8 Modulus of Subgrade Reaction (K) for Various Materials

	K value without geotextile (kg / cm3)	K value with Geotextile at 50 cm from surface (kg /cm3)	K value with geotextile at 30cm from surface (kg/cm3)	K value with geotextile at 10 cm from surface (kg /cm3)
Soil (SP)	2.464	3.040	4.352	4.736
Flyash	4.160	4.608	5.056	5.880
Flyash+4% Lime	5.568	5.952	7.072	8.032
75%Flyash +25% Soil (SP)	4.416	5.120	5.792	6.720

Table-9 Modulus of Elasticity (E) for Various Materials

	E value without geotextile (kg / cm2)	E value with geotextile at 50 cm from surface (kg /cm2)	E value with geotextile at 30cm from surface (kg/cm2)	E value with geotextile at 10 cm from surface (kg /cm2)
Soil (SP)	120.6	130.7	155.7	160.3
Flyash	140.4	147.6	194.4	221.4
Flyash+4% Lime	196.2	223.2	248.4	264.6
75%Flyash +25% Soil (SP)	151.2	180.0	199.8	216.0

Table10-12 shows the percentage increase in field CBR, Modulus of Subgrade Reaction and Modulus of Elasticity values after use of Geotextile.

Table-10 Percentage Increase in Field CBR Values with Geotextile

	% increase in field CBR values when geotextile at 50cm from surface	% increase in field CBR values when geotextile at 30cm from surface	% increase in field CBR values when geotextile at 10cm from surface
Soil (SP)	12.52	50.08	93.87
Flyash	13.62	50.03	81.85
Flyash+ 4% Lime	21.88	53.17	78.16
75% Flyash +25% Soil (SP)	19.22	49.97	84.59

Table-11 Percentage Increase in Modulus of Subgrade Reaction (K) with Geotextile

	% increase in K values when geotextile at 50cm from surface	% increase in K values when geotextile at 30cm from surface	% increase in K values when geotextile at 10cm from surface
Soil (SP)	23.37	76.62	92.20
Flyash	10.76	21.53	41.34
Flyash+ 4% Lime	6.89	27.01	44.25
75% Flyash +25% Soil (SP)	15.94	31.15	52.17

Table -12 Percentage increase in Modulus of Elasticity (E) with Geotextile

	% increase in E values when geotextile at 50cm from surface	% increase in E values when geotextile at 30cm from surface	% increase in E values when geotextile at 10cm from surface
Soil (SP)	8.37	29.10	32.91
Flyash	5.12	38.46	57.69
Flyash+ 4% Lime	13.76	26.60	34.86
75% Flyash +25% Soil (SP)	19.04	32.14	42.85

Conclusions

- The geotextile reinforcement improves the CBR value considerably.
- The field CBR value at optimum moisture content of Roorkee soil (SP), flyash, flyash + 4% lime and 75% flyash + 25% soil (SP) increased by 93.87%, 81.85%, 78.16%,and 84.59% respectively when geotextile was kept at 10 cm from the surface.
- The field CBR values at optimum moisture content showed an increasing trend when calculated without geotextile reinforcement ,with geotextile at 50cm, 30cm and 10cm respectively.
- The position of geotextile reinforcement affects the field CBR value tremendously and maximum field CBR values were achieved when geotextile was kept at 10cm from the surface. Thus for maximum benefit the geotextile should be placed near the surface.
- Lime mixed with soil (SP) showed very good affinity with flyash and their mixture of flyash + 4% lime and 75% flyash +25% soil (SP) gave higher field CBR values.
- The values of modulus of subgrade reaction as well as modulus of elasticity for all the four materials of soil (SP), flyash, flyash + 4% lime and 75% flyash + 25% soil (SP) increase when position of geotextile shifts from 50 cm to 10 cm. Further, the inclusion of geotextile adds to the strength of the subgrade.
- Out of the four different materials taken in the present study, flyash with 4% lime gave the highest strength values in both plate load test and field CBR test.

The values of modulus of elasticity also showed increasing trends with the addition of geotextile layer.

REFERENCES

1. Kumar Praveen, Report on Use of Flyash in Eastern Approach Embankment Second Nizamuddin Bridge CRRI, New Delhi, February, 1999.
2. A. Hilmi Lav and M. Aysen Lav, Microstructural Development of Stabilised Fly ash as Pavement Base Material, Journal of Materials in Civil engineering ASCE Vol. 13-1, May 2000, pp 157-162.
3. Murty AVSR, Utilisation of Flyash For Embankment Construction" Experience Sharing Meet on Use of Flyash in Roads and Embankments, CRRI, New Delhi, 1988, pp 15-23.
4. Trivedi. A and Sood V.K., Coal Ash as Embankment and Structural Fill Material, Dept. of Civil Engineering TIET, Patiala, pp 130-137.
5. Swami R.K., Dhawan P.K., AVSR Murty, Stabilisation of Flyash for Road Construction, SSRR Division, CRRI, New Delhi, pp 161-169.
6. Karri Srinivas Rao, Design of Highway Embankments Using Flyash in Alternate Layers, M.E., Thesis, Civil Engineering Dept., UOR, Roorkee, 2001.
7. Srinivas S., Studies on Shear Strength Behaviour of Coal Ashes, Proc. of the National Seminar on Flyash Characterization and its Geotechnical Application, IISC Bangalore, 1999.
8. Rokade Siddhartha, A Parametric Study on Reinforced Flyash in Highway Embankments, M.E.Thesis, Indian Institute of Technology, Roorkee, 2002.
9. Indian Roads Congress, Rural Roads Manual, SP:20-2002, New Delhi.

Low Cost Soil Stabilization Techniques for Rural Road Construction

Madhavi Vedula* and G. Pavan Nath**

Soil stabilization is the alteration of one or more soil properties, by mechanical or chemical means to create an improved soil material possessing the desired engineering properties. Soils may be stabilized to increase strength and durability or to prevent erosion and dust generation. Regardless of the purpose for stabilization, the desired result is the creation of a soil material or soil system that will remain in place under the design use conditions for the design life of the project. Engineers are responsible for selecting or specifying the correct stabilizing method, technique, and quantity of material required. This paper is aimed at helping to make the correct decisions while selecting the suitable stabilization technique for a particular type of soil. Many of the procedures outlined are not precise; they are giving only the rough idea not the exact solution. In India, soils vary from place to place, and the engineering properties of soils are equally variable. The key to success in soil stabilization is soil testing. The method of soil stabilization selected should be verified in the laboratory before construction and preferably before specifying or ordering materials.

Why Stabilization is required?

Pavements are vulnerable to soil performance because the foundation of the pavement is a road's most important element.

For road engineers, finding a way to balance road performance, limited budgets and tightening environmental regulations is an increasing challenge. Treatments that improve the long-term performance of conventional pavements are becoming less and less cost-effective. Road budgets - especially for maintenance, seem to shrink annually, relative to the task at hand. Environmental regulations mandating dust control and sediment control for road shoulders and unpaved surfaces continue to tighten. Moreover, common amendments such as gravel and well-graded soil for upgrading road structures are becoming less available and increasingly expensive.

Principles of Stabilization

Stabilization can reduce maintenance, improve soil properties and provide an all-weather surface. Stabilization can provide an improved surface condition through less dust, rutting, potholes and corrugating. Factors to be considered when selecting the most suitable method of stabilization are as follows:

- Type of soil to be stabilized.
- Proposed use of the stabilized material.
- The capabilities and experience of the construction
- Personnel.
- The availability of suitable equipment.
- Relative costs.

Stabilization provides increased strength and stiffness and thus enables a reduction in pavement thickness with respect to that used for unbound materials. Mixture designs should include strength criteria for evaluation of the optimum binder content. When a paving material is unsurfaced (i.e. no wearing course), it should have resistance to abrasion and raveling caused by vehicular traffic. Stabilization may be used to reduce raveling, increase skid resistance, or reduce dust. However, pavements that are stabilized by a cementing action cannot be maintained by routine grading and periodic reshaping. Where maintenance of the wearing surface is

* Technical Officer, National Rural Roads Development Agency, New Delhi
** Former Technical Officer, National Rural Roads Development Agency, New Delhi

to be accomplished in this manner, the soil should be modified and not stabilized. Modification should only be used in situations such as that given above and it involves only using lower amounts of stabilizing material than would normally be used with the given soil.

Methods of Soil Stabilization

The most common methods of stabilization include:

- Mechanical stabilization.
- Lime stabilization.
- Cement stabilization.
- Lime-Fly Ash (with or without cement) stabilization.
- Bituminous stabilization.
- Chemical stabilization.
- Geotextiles, fibers, prefabricated materials, etc.

Extreme climatic conditions can have an influence on the correct choice of stabilizer, inhibiting the use of some, and encouraging the use of other, irrespective of cost. In general, the hot arid and cold wet regions require special consideration.

Mechanical Stabilization

Mechanical stabilization is the development of natural forces of cohesion and internal friction within the existing soil. In some instances, the soil can be stabilized sufficiently by compaction alone. Usually, the local soil can be stabilized only with the addition of a reasonable amount of soil or gravel materials. Mechanical stabilization is used when soil or gravel materials with suitable grading and/or plasticity are unavailable locally. Mechanical stabilization involves mixing or blending two or more selected materials in the proportions required to modify particle size distribution and/or plasticity. Mixing can be carried out on site prior to final shaping and compaction. The alternative is to use grid rollers or rock crushers on site to arrive at an appropriate mix. Generally, mechanical stabilization requires the blending of soil and aggregates together in a well-graded (i.e., a complete range of particle sizes) mixture and compacting these to a high density.

A common application of mechanical stabilization is the blending of a granular material lacking in fines with a sand-clay. This blending of the materials has the potential to improve strength, abrasion resistance, imperviousness, and compatibility. The following points should be observed in proportioning and blending mixtures:

- Avoid complicated ratios, difficult for field control.
- Impossible to correct for grading below 0.075 mm (No. 200) sieve.
- Assure adequacy of pulverization and mixing operations.

Lime Stabilization

Lime stabilization is more suitable for hot wet regions. Stabilization with lime will reduce the plasticity of the soil, increase its workability, reduce swell, and modify the material to provide optimum strength. For each type of soil there is an optimum lime content and the addition of further quantities in excess of the amount will adversely affect the properties of the mixture. The amount of lime necessary (percent by mass) to stabilize a material depends on the amount and type of clay mineral in the soil. The use of small amounts of lime (1 to 3 percent) may reduce the plasticity index and be sufficient to stabilize some soils such as clayey gravel with good grading but moderately high plasticity. The use of lime contents of 3 to 6 percent may result in considerable change in the material constitution.

Suitability for a Type of Soil

Lime, generally, reacts well with most plastic materials such as clayey sands (SC) and silty clays (ML). However, materials with plasticity indices lower than 10 may not react readily. Testing is necessary to determine the reactivity of the material to lime. The stabilized soil should retain some cohesion poorly graded clayey sand and gravels, when treated with small percentages of lime. If too much is added they can become friable (easily crumbled or pulverized) and become completely non-cohesive, causing failures. Consequently, base material treated with lime should conform to the grading requirements normally specified for untreated material.

The basic steps in using lime stabilization construction are:

- Spread.
- Slake if quick lime is used.
- Mix and add water of compaction as necessary.
- Lightly compact to seal off.
- Cure.
- Remix.
- Compact.
- Complete curing.

For getting optimum results, the following aspects need close control:

- Pulverization.
- Lime content.
- Moisture content.
- Mixing.
- Compaction.
- Finishing.
- Curing

The general observations listed below are made for those using or contemplating using lime stabilization to improve soil properties:

- Stabilization of sub grades with lime is not recommended for the reduction of heaving where freeze-thaw cycles occur.
- Organic matter will decrease Lime's effectiveness.
- Normal range of lime is 1-1/2 to 8 percent. Application rates can be determined using criteria

provided through trial and error with a trial section.

- Construction should be completed before winter, to allow for complete strength development.
- Drainage must be adequate before stabilizing commences. Compact and shape to a tight finish.

Cement Stabilization

Cement stabilization has been widely used in pavement construction. However, cement is usually not an appropriate stabilizing agent for the wearing course of a pavement. The cementitious bonds formed are not strong enough to resist the action of traffic without being protected by some kind of wearing surface. Also, because of the cementation, cement, unlike lime, cannot be reworked following initial mixing and subsequent setting and are not amenable to being reworked with maintenance equipment, such as graders. It can, however, be used as a sub-base stabilizing agent.

Suitability for a Type of Soil

Cement maybe used to stabilize a wide range of soils, from fine-grained clays and silts to sandy materials. Generally, for fine grained materials, cement is used with clays or silts when the plasticity index (PI) is relatively low (less the 20). Cement stabilization should be avoided in soils where the sulfate exceeds about 1 percent. Construction: Construction practices for cement.

Lime-Fly Ash (with or without cement) stabilization

Fly ash in combination with lime or lime-cement can be used to stabilize coarse-grained soils containing little or no fines. Fly ash is a mineral residual from the combustion of pulverized coal. It contains silicon and aluminum compounds that provide an agent with which the lime can react and form a hardened cementitious.

Suitability for a Type of Soil

All sand, gravel, and combination sand/gravel soils can be stabilized with lime-fly ash or lime-cement-fly ash combinations. The amount of fines in these soils should not exceed 12 percent and the Plasticity Index should not exceed 25.

Bituminous Stabilization

Bituminous stabilization is more suitable for hot dry areas. The addition of bituminous binder is intended to provide cohesion for non-plastic materials and to reduce water penetration through the soil. Bituminous stabilization is best suited to granular materials, and material that can be readily granulated. Bitumen stabilized material has limitations when used as the wearing course for pavement. Unless substantial quantities of bitumen are added, its binding action will be insufficient to prevent ravelling from traffic and weathering. Such higher bitumen content will usually be uneconomical.

Suitability for a Type of Soil

Gravels, sandy loam (SM), sand-clays (SC) and crushed rock have been successfully treated using bituminous stabilization. Fine-grained soils with increasing amounts of material passing a 0.075 mm (No. 200) sieve can be stabilized with bitumen; however, they will require increasing quantities of asphalt material and

increasing costs accordingly. Materials with a PI of less than 10 are most suited to this form of stabilization.

Chemical stabilization

Various chemical compounds, including those listed below, have also been used, often on an experimental basis, as stabilizers.

- Calcium chloride.
- Magnesium chloride.

The use of chemicals may possibly provide short-term advantages by acting as a dust suppressant and providing binding action to form a hard running surface. However, the long-term advantages appear to be limited as a result of leaching of the stabilizer from the pavement. Because of the life expectancy, and possible adverse effects from using some chemicals, their use in the treatment of pavement materials is not recommended as a long-term solution to materials instability. The benefits and costs of using chemicals compared to a bituminous seal or stabilization by mechanical means or using lime or cement needs to be analyzed in the light of relevant experience. This experience to date appears to indicate that the benefits from using chemical stabilization may be short-lived due to the effects of leaching of the chemical from the treated material.

In addition to the chemicals listed above, several proprietary brands of stabilizers are available. These products are generally byproducts of manufacturing processes such as pulp and wood processing, and to date appear to perform similarly to the chemical discussed above, particularly with respect to their life span and effectiveness. Nevertheless, authorities have used such products with varying degrees of success depending on the function to be performed or the problem to be overcome. The following is a listing of typical construction.

Stabilization with Geotextiles, fibers, prefabricated materials, etc

Geotextiles can be used over very soft soils to help spread loads through their tensile strength properties and thereby increase the locations load bearing capacity. Geotextiles can also act as a separator to prevent excess fines from penetrating a granular material placed over it or as a water barrier to prevent moisture from entering the pavement, whenever any cover aggregate is to be added to a soil containing more than 10 percent fines; a geotextile is required as a separation layer. Geotextiles can be used to construct various drainage layers within and next to the pavement to control and remove excess moisture. The use of geotextiles, especially for expedient applications, will facilitate trafficking over low bearing capacity soils. Geotextiles can reduce or eliminate the need for more conventional stabilization materials. When used for separation the geotextile should meet drainage or filter requirements for the local soil conditions. The geotextile openings should be sized to prevent soil particle movement. The geotextile must have the strength to meet survivability requirements related to the sub grade conditions and cover arterials. Design procedures exist where the geotextile is to be used as either as a water barrier or for reinforcement. To operate as a water barrier the geotextile must normally be coated with a bitumen material. Seams between geotextile sheets may be field seamed together by different methods; however, in the field, they are usually just overlapped a given distance to eliminate fastening problems.

Stabilization using fibers involves mixing hair-like fibers into the moist soil using a pulvermixer.

Suitability for a Type of Soil

Fiber stabilization is most applicable for sands and silty sands that are classified as SW, SP, SM, and some SM-SC types of soils. The use of fibers in high-plasticity soils has

had inconsistent results; therefore, their use should normally be limited to the coarse grained soil types as mentioned above.

The fabricated materials referred to for soil stabilization include Uni-Mat, Hex-Mats, and any other fabricated material that can be used as a trafficking surface to support loads on a soft soil.

Stabilization of Soil with Rice Husk Ash and Lime Sludge

The substantial amounts of waste materials like rice husk ash and lime sludge are being produced by various industries throughout the country as a by-product. These materials are causing hazardous effects to the lands and surroundings and a great problem for their disposal. Use of this waste material in road construction can alleviate the problem of their disposal to great extent.

In India, studies were conducted at IIT Roorkee for its use in stabilizing the soil mass, the results indicated that its usage having great impact on the improvement of soil properties. The study suggested that it is very useful for stabilizing the clayey soils. The results of the study are given below;

- It increases the liquid limit and plastic limit thereby decreasing the PI value of soil
- It increases the unconfined compressive strength of soil.
- It increases the soaked CBR of the soil.
- The optimum proportioning of lime sludge and rice husk ash for maximum unconfined compressive strength and lowest plasticity index is 16% and 10% respectively. The soaked CBR however kept on increasing at 15% and 20% rice husk ash.

Recommendations

In the light of the fact that efficacy of Stabilization Techniques was established in several case studies taken under varied field conditions, time has come to initiate the construction of 'Technology Demonstration Projects'. During the implementation of such Projects the field engineers shall be taken into confidence and who need to be involved right from Project Preparation. All technical and implementation processes in these 'Technology Demonstration Projects' are to be meticulously documented which become handy in the disseminations process for exposing more field engineers to such technologies. This will inculcate confidence among them and large scale adoption of these technologies would become possible. The successful demo of these projects also brings out the cost effectiveness and conservation of natural resources that may lead to environmental preservation in the long run.

PMGSY in Naxalite Affected Areas

S.S. Tekade*

PMGSY launched in 2000 has envisayed village connectivity upto 250 + population of habitants in Tribal area. The connectivity status before core network in Gadchiroli and Gondia Distt. (Naxalite Affected Disstt.) was as under.

	Unconnected Village			
	+1000	+500	+250	<250
Gondia	10	7	19	63
Gadchirili	5	20	62	399

It was targeted to achieve 100% connectivity by 2007.

Naxalite Problem

In Naxal affected areas there is strong opposition of taking up the work of village connection as well as upgradation, as these organizations are against road network particularly, B.T. of roads and construction of bridges as otherwise they it difficult to hide themselves.

Same work sanctioned under Phase- II, III & IV required to be terminated or detected due to naxalite menace.

Role of P.W.D.

The P.W.D. has undertaken a massive programme of construction of road network with substantial budget allocation. However the work could not be tackled or completed because of naxalite problem and as a result P.W.D. invited B.R.O. (Border Road Organisation) for undertaking this work in 1996 and signed an M.O.U. (Memo of Understanding) that the expenditure incurred on completion of these projects will be reimbursed to B.R.O. and they will work under police protection. The probable expenditure on completion was found to be 3 to 4 times higher than estimated cost (Estimate prepared as per S.O.R.)

PMGSY Progress

When the work under Phase- II, III & IV were sanctioned by N.R.R.D.A. and entrusted to Z.P. (Zilla Parishad) the contractors were reluctant to take the work because of the Naxalite problem. Anyhow an agreement was reached. However, the same work was terminated because the Naxalites not allow B.T. work. There were bomb blasts and incidents of firing at the machinery and threatening the contractors and labourers.

In Maharashtra provision of M.P.M. 50 m.m. thick was made in the estimate followed by 20 m.m. P.M.C. and seal coat.

As soon as the metal was collected at site for M.P.M. there was strong opposition for starting the work of M.P.M. Some agencies have carried out M.P.M. by mixing the material at the plant and laying the mix by paver.

PMGSY Phase- V Proposals

Considering the experience of execution of PMGSY work in these areas it was discussed with S.T.A. to consider the item of B.M. in place of M.P.M. in order to quickly complete the work using hot mix plant and undertake the work in the available spell period. The S.T.A. took the practical approach in view of the Naxalite problem in these districts and approved the D.P.R.

Execution of PMGSY Phase-V

The approved programme for PMGSY Phase-V was as under:

	Length (K.m.)	Cost (Lakhs)
Gondia	212-95	2740.80
Gadchiroli	159-87	2789.08

*S.E. (PMGSY), Nagpur

Tenders were called by PIU and response to bidding was there but they quoted high rates. There was problem in accepting the tenders at higher rates and the contractors were not ready to reduce the offer because they would have to spend more money in working in this area because of Naxalite threats and higher wages to labour, and longer transportation of mix and poor road network available in transporting the materials. Negotiations were carried out and the agencies were fixed. They have started the work with good speed so as to complete the work in the shortest period.

Sizable work was done in Gondia District. The PIU could complete 30 % work upto March 2007 and is expecting completion of the entire programme by June 2007.

Similarly in Gadchiroli District the work is in full swing and is expected to be 80% complete by June 2007.

Conclusion

There are guidelines given in the Operations Manual and in S.P. 20 PIUs are expected to carry out the work as per guide lines, but if the same problems are met with we can overcome them by adopting new specifications etc. in order to achieve the target.

For new connectivity of villages 250 to 500 population the work can be taken up at G.S.B. level without surfacing and B.T. For new connectivity, Naxals will not allow any machinery to enter the villages. Accordingly proposals for Phase- VI are under preparation and this will be cleared by S.T.A. after due discussion on problems faced to get desired results.

NEWS IN BRIEF

Workshop to discuss Draft Quality Assurance Handbook for Rural Roads

The Quality Control Handbook and Registers are being used for road works under PMGSY for more than 4 years now and it was felt that the revision of the Handbook with inclusion of the provisions for CD works and drainage will be helpful. Therefore, the work of revision of Quality Control Handbook was entrusted to Indian Roads Congress (IRC).

A Workshop on Quality Assurance Handbook on Rural Roads was organized on 16th and 17th April 2007, at Central Roads Research Institute (CRRI), Mathura Road, New Delhi. Senior field officers, selected PTAs/STAs, NQMs and members of Peer Review Group took part in the same to finalize the draft for the Handbook.

The Quality Assurance Handbook for Rural Roads is in two volumes, which cover not only the section on pavement construction but a wide coverage for CD works, hill roads, maintenance has also been made. In addition, details about equipments and procedures for tests have also been covered.

Training Programme for National Quality Monitors (NQMs) and State Quality Coordinators (SQCs) of PMGSY at NITHE

Approximately 120 NQMs and SQCs of PMGSY were provided training in four different batches at NITHE between April-May 2007.

With a view to ensure uniform and objective reporting by NQMs, 4 rounds of Orientation Programme have been completed at NITHE. The orientation programmes were conducted by Shri S. C. Sharma, Former DG, MoRTH and officers of NITHE & NRRDA.

Appointments

Shri A. D. Kapale, Chief Engineer Rural Engineering Services, Government of Madhya Pradesh, joined the National Rural Roads Development Agency, Ministry of Rural Development, Government of India as Director Projects II from 12th April 2007.

General Body Meeting

The 7th Meeting of the General Body of National Rural Roads Development Agency was held on 16th April 2007. The meeting was chaired by Dr. Raghuvansh Prasad Singh, the Hon'ble Union Minister for Rural Development and President, NRRDA.

The Director General informed the GB of main issues. The General Body was informed about the National Conference on Rural Roads scheduled to be held on 23rd to 24th May 2007.

The Hon'ble Minister observed that good participation should be ensured in the Conference so that the field officers

etc. contribute their ideas for comprehensive development of the sector. He also suggested that impact assessment studies should be carried out by NRRDA through reputed institutions to systematically document the socio-economic impact of PMGSY. He was of the view that benefits of the programme need to be quantified and shared with the citizens, keeping in view the huge investment being made on PMGSY. Such studies should bring out the impact of rural roads, inter alia, on migration, access to education and health care, on cost of agricultural inputs and on price realization by the farmers on their produce. Employment generation potential of rural roads, both direct and indirect, also need to be quantified through these field studies,

The Budget Estimates for the year 2007-2008 were approved by the General Body

Training Programme on Rural Road Maintenance in UK

A batch of six officers from different states underwent a training programme on Road Maintenance Management at University of Birmingham, UK from 6th May 2007 to 11th May 2007. Another batch of six officers went for similar training at the same venue from 29th April to 4th May 2007.

Study Tour to Melbourne, Australia

A group of officers led by Shri H. K. Srivastava, Director National Rural Roads Development Agency visited Melbourne, Australia from 27th October to 12th November 2006.

Another group of officers visited Melbourne, Australia from 18th November to 26th November 2006. This group was headed by Shri C. S. Rajan, Principal Secretary of Rajasthan. Thirteen officers were part of this study group delegation.

Shri Pradip Bhargava, Development Commissioner and Additional Chief Secretary, Department of Rural Development Government of Madhya Pradesh, led a group of ten officials for a study tour to Melbourne, Australia from 28th April to 6th May 2007.

Shri A. D. Kapaley, Director (P II), National Rural Development Agency, led a group of seventeen officials from different states to Melbourne in Australia on a study tour from 12th May to 26th May 2007

Pradhan Mantri Gram Sadak Yojana Under Bharat Nirman

"Urban amenities should be available to people living in villages. If villages are provided with the facility of well-built good roads, nobody can stop India from moving towards top-ranking nations of the world."

Dr. Raghuvansh Prasad Singh
Minister of Rural Development, Govt. of India

- Over 62,000 habitations covered requiring construction/ upgradation of over 2,20,900 Kms of roads with an investment of over Rs.44,580 Crores.
- So far 1,20,000 Km roads completed benefiting about 37,500 habitations.
- Over 16,000 engineers and personnel provided training for capacity development under the technical assistance programme of World Bank.
- Since July, 2004, more than 19,000 inspections carried out by independent quality monitors.
- Transparency in Programme Implementation :- All the details of the Programme and the road works are available in the citizens' domain in the website www.pmgsy.nic.in and www.pmgsyonline.nic.in.
- The impact of PMGSY roads is already visible on the ground through better prices for agricultural produce, more employment opportunities, better access to health and educational facilities, improved market access for the rural housholds of quality consumer durables etc.

Pradhan Mantri Gram Sadak Yojana Under Bharat Nirman

Task Ahead

- Providing all weather connectivity to habitations of population of over 1000 (500 in Hills and Tribal Areas) by 2009. 66802 habitations will be provided connectivity under Bharat Nirman.
- Construction of over 1,46,000 km of new roads and upgradation of 1,94,000 km of existing Rural Roads.
- Estimated investment Rs.48,000 crores during 2005-2009.

PMGSY - BRIDGING THE RURAL-URBAN DIVIDE

NATIONAL RURAL ROADS DEVELOPMENT AGENCY
MINISTRY OF RURAL DEVELOPMENT, GOVERNMENT OF INDIA
www.pmgsyonline.nic.in www.pmgsy.nic.in