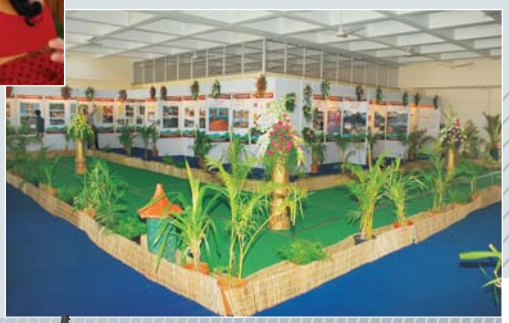
Grameen Sampark



Pradhan Mantri Gram Sadak Yojana

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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

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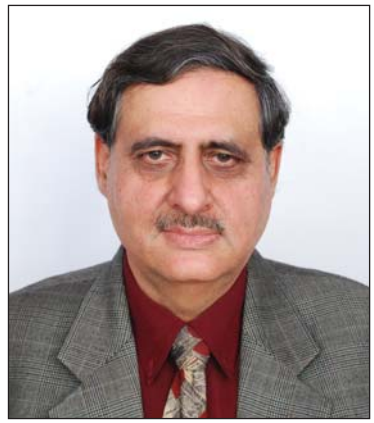


Editorial

The World Road Association (PIARC), a non profit organization established in 1909, envisages improved international co-operation to foster progress in the field of Road and Road Transport. In tune with its objective, PIARC requested NRRDA to organize an International Seminar on **Sustainable Maintenance of Rural Roads**, which was successfully organized during January, 2010, in co-operation with Panchayati Raj Engineering Department (PRED), Government of Andhra Pradesh at Hyderabad.

Delegates from several parts of the globe made their presence useful with excellent presentations on the need, methods, practices and the benefits of **Sustainable Maintenance of Rural Roads - A Step towards Asset Management**. Delegates from India actively contributed and were also benefited from theoretical underpinnings and worldwide practices for effective and sustainable Rural Roads Maintenance.

It is heartening to report that the event was graced by Dr. K Rosaiah, Hon'ble Chief Minister of the host State Andhra Pradesh; Dr. C.P. Joshi, Hon'ble Minister for Rural Development and Panchayat Raj, Government of India; Shri Pradeep Jain, Hon'ble Minister of State for Rural Development, Government of India; Shri B. Satyanarayana, Hon'ble Minister of Panchayat Raj, Government of Andhra Pradesh, besides senior officers from Ministry of Rural Development, NRRDA and other State Governments. The deliberations proved useful, with excellent participation of experts and delegates, who guided with a beacon of recommendations which will surely gear up the Maintenance Management of Rural Roads.

I would like to place on record the excellent work done by the organizers for the successful conduct of the event. I hope that the lessons learnt would be put to optimum use and stakeholders will take Rural Roads Maintenance seriously enough by putting appropriate systems in place.

This issue of Grameen Sampark is dedicated to the PIARC International Conference on **Sustainable Maintenance of Rural Roads -** the need of the hour.

(Dr. Pramod Kumar Anand)
Director General, NRRDA

Seminar on Sustainable Maintenance of Rural Roads

Prabha Kant Katare*

*Director (Projects) & Chief Quality Coordinator, National Rural Roads Development Agency, Ministry of Rural Development, Government of India

A two-day international seminar on 'Sustainable Maintenance of Rural Roads' was jointly orgainsed by Permanent International Association of Road Congress (PIARC), National Rural Roads Development Agency (NRRDA) and the State Government of Andhra Pradesh in Hyderabad from 21st -23rd January 2010.

This seminar was part of the PIARC programme of International Seminars. The overall objective of the programme is to ensure that the roads and road transport related needs of all PIARC member countries are widely recognized with a view to address and tackle outstanding issues and problems. The objective is to achieve, through the exchange of experiences, transfer of information and technology, the work programmes of technical committees and the identification of areas of research to address the remaining gaps in domain knowledge. The programme has been designed to study a wide range of issues particularly related to sustainability and maintenance of rural roads and problems of particular concern to developing and emerging nations.

The Seminar was organized by Technical Committee A.4 dealing with Sustainability of the Road Transport System Rural Roads Systems and Accessibility to Rural Areas together with the

Government of Andhra Pradesh. The Technical Committee gathers members from different countries from around the world to share knowledge and expertise which is disseminated world wide through publications, participation and organization of international conferences and comparison of practices in different countries and regions of the world.

The main objective of the Seminar was to provide a common platform for practitioners to share experiences and deliberate the issues and challenges associated with the planning, provision and maintenance of rural roads in a sustainable way. Innovations with respect to involving local communities throughout the process also form part of the overall objective of the Seminar.

The Seminar in Hyderabad was inaugurated by Shri Pradeep Jain, Hon'ble Union Minister of State for Rural Development and Shri B. Satyanarayana. Hon'ble Minister of Panchayat Raj, Andhra Pradesh with the unveiling of an Exposition on the Achievements of PMGSY. Representatives from 20 countries and 400 participants from various states attended the seminar. Speaking on the occasion, the Minister of State for Rural Development, Shri Pradeep Jain reiterated that the country's development was possible only with the development of rural areas, hence the centre was providing funds for various schemes, ever though the responsibility of construction of Rural Roads lay with the states.

Permanent International Association of Road Congresses (PIARC)

- Non-political, not-for-profit organization established in 1909.
- Held Consultative Status within the United Nations Economic and Social Council since 1970.

Mission

- Organise international forums.
- Disseminate best practices.
- Promote efficient tools for decision making.
- Special emphasis for Developing Countries and Countries with Economies in Transition.

Members

- National Governments
- Regional Authorities
- Collective Members
- Individual Members

The Panchayat Raj Minister, Andhra Pradesh, Shri Bothsa Satyanarayana, expressed his confidence that important decisions and strategies on construction and maintenance of Rural Roads would definitely emerge at the end of the two day seminar. He said that the quality of roads was sure to improve when experts from various countries met at once place to share their thoughts and ideas.

The seminar focused on the Indian experience of dedicated National Programme on Rural Accessibility PMGSY, Sustainable Accessibility and Planning the Development of Rural Road Network, Implementing Sustainable Maintenance, Community Participation and the way forward.

The Valedictory Session was chaired by the Hon'ble Union Minister of Rural Development, Dr. C.P. Joshi and the Hon'ble Chief Minister of Andhra Pradesh, Dr. K. Rosaiah. Dr. C.P. Joshi expressed his disappointment at the indifferent attitude of some states for not budgeting adequate funds for maintenance of roads, even though the Central Government was spending crores of rupees for construction of roads. He explained that maintaining good roads had a cascading effect as adequate transportation facility let to improvement in agricultural production, better medical & education facilities and employment resources.

He assured the Chief Minister of Andhra Pradesh of maximum funding under various schemes.

Dr. K. Rosaiah highlighted the role played by the State Government in removal of poverty in rural areas through various development schemes. Infact, Andhra Pradesh is one of the foremost states in implementing Rural Development Schemes. He said that the economic conditions of the rural population had improved significantly by connecting about 7646 habitations with construction of about 15,484 km of PMGSY roads. Another 3195 habitations would also be connected by PMGSY.

Important Recommendations from PIARC International Seminar on "Sustainable Maintenance of Rural Roads" held from 21st to 23rd January 2010 at Hyderabad, India

- Prime Minister's Rural Roads Programme implemented in India deserves appreciation. The programme has well defined objectives and deliverables, appropriate funding and professional programme management strategies in place. The socio-economic, impact having considerable bearing in alleviation of poverty in the rural India, has been clearly reflected through various independent evaluations. The programme is capable of replication in other parts of the developing world.
- In view of importance of rural road network with special reference to socio-economic development of rural India, there is a need to formulate Rural Roads Act on the lines of Indian National Highway Act of India.
- Asset management culture needs to be introduced for rural roads with appropriate institutional arrangements and dedicated funding mechanism. Capacity building for rural road asset management deserves to be given priority.
- There is a need to develop rural road maintenance and management policy document at different levels of governance.
- While planning and constructing the rural road network, the maintenance and sustainability aspects should be given due consideration.
- For planning sustainable rural road network maintenance and management, the Integrated Rural Accessibility Planning (IRAP) methodology may be adopted.
- GIS based database for rural road network would prove effective not only for development but also for planning and management of the network, therefore; necessary GIS based database and a GIS platform should be created for rural roads in India.
- The rural road network should not be seen in isolation, full road network maintenance should be planned properly with appropriate decision making support for prioritization.
- For rural road maintenance activity, appropriate synergy needs to be developed with other rural development programmes in India.
- There is a need to take up right maintenance by right method at right time for achieving sustainability of rural roads assets in India and other developing countries.
- The States, who are responsible for management of rural road network need to institutionalize rural road maintenance with sufficient dedicated funding, scientific planning and appropriate institutional development.
- For rural roads maintenance, there is a need to explore various options such as Public-Private-Partnership (PPP) model, micro enterprise based maintenance model, etc. It was

recommended that Government of India may take up pilot projects for such models.

- Pilot project on citizen monitoring of PMGSY roads in a limited area has adequately demonstrated the possibility of involvement of citizen and the community in monitoring the development of rural road network. In maintenance, the possibility of the involvement of community is much better. Community and local self government institutions such as PRIs can play vital role in planning execution and oversight of maintenance activities. Therefore, a suitable model for participation of community and PRIs needs to be developed.
- The mode of connectivity should be decided on the basis of technical feasibility. In India habitations of lower population should also be considered for providing basic access with use of appropriate low end technologies and locally available material.
- There is a need to develop appropriate mechanism for channelizing the potential of youth in overall rural development. Local resources need to be harnessed with respect to local skills, human resources and locally sourced material.
- Rural Road Pavement Performance Study results under PMGSY should be used for developing performance model which would help in deciding maintenance management strategies.
- There is a need for concurrent and long term evaluation of rural road maintenance through independent agencies.

Rural Roads: Considering A New Paradigm

Dr. Arvind Mayaram*
(Background research by Subhra Ranjan Mishra)

According to India Infoline's (IIFL) survey, rural India, which houses more than 70% of India's population, now constitutes the "fastest growing mass of consuming households" with 56 million households having an annual income of about Rs. 100,000 comparable to that of urban areas with about 51 million households. The increase in consumption expenditure in rural India (5.5% CAGR during F.Y. 2002-06) has outpaced that of the urban areas (at 5.3% CAGR). Agriculture exports from India have become more competitive, resulting in 20.2% CAGR in agriculture exports during F.Y. 04-08, compared to 11.5% annual growth in the previous decade. Much of this change in the fortunes of rural India has been a result of the strategy of inclusive growth followed by the Government and about Rs. two lakh crore spent on rural infrastructure development under Bharat Nirman. The contribution of Pradhan Mantra Gram Sadak Yojana (PMGSY) is significant in this rural revolution.

The PMGSY is rated as one of the better executed rural development programmes. Under the programme 31,924 unconnected habitations have been connected by constructing 85,405 kms road length since its inception up to March 2009. By the end of 2009-10, this is expected to go up to 66,802 unconnected villages to be connected with the total constructed road length going up to 1,46,200 kms. About 1,55,000 kms existing rural roads have also been upgraded.

However, increasingly, the issue of maintenance has begun to plague the programme. Presently, while the capital expenditure (capex) is being borne by the Central Government, the funds for maintenance are to be

*Author is a member of the Indian Administrative Service. Views expressed herein are personal.

provided by the State Governments. A continuous decline in the resource provision in the State budgets for maintenance of the rural roads is being witnessed. As the impact of the 6th pay commission recommendations is unfolding in the States, it is quite possible that resource crunch and political expediency to spend more on new works would further reduce allocations for operations and maintenance. Central Government's power to leverage sanction of new roads to enforce adequate maintenance funding would also decline as more and more State Governments complete the work on core network. About 60% of the work has been completed by 2009[1]. This core network is a subset of the total network of rural roads which ensures minimum single access to the targeted unconnected habitations, and is funded solely under PMGSY. It includes habitations with 500 and more population in States, except those in tribal areas, hill States and desert areas where the number is 250.

It may therefore be the right time to have a re-look at the programme and experiment with some new ways of constructing and maintaining rural roads. Two areas deserve attention and these could converge well:

First, from the present Engineering Procurement and Construction (EPC) model, rural roads could be constructed and maintained through a variant of Build-Operate-Transfer (BOT - annuity) model that has become popular in the national highways sector. The packages being offered presently are very small and do not excite serious investors. Typically packages are in the range of Rs. 1 crore to Rs. 5 crore, of which maintenance is budgeted at 6% to 8%. Whereas the capex is 100% funded by the Central Government, all PMGSY roads (including associated main rural links / through routes) are covered by 5-yearly maintenance contracts, to be entered into along with the construction contract, with the same contractor, as per the standard bidding document. Operations and Maintenance (O&M) funds to service the contract are to be budgeted by the State Government and placed at the disposal of the State Rural Roads Development Agency (SRRDA) in a separate maintenance account. The maintenance requirement is assessed by the Programme Implementation Unit (PIU) within SRRDA as

part of the preparation of detailed project report (DPR). While the contractor undertaking initial construction is locked into maintenance obligation for 5 years post construction, the funding arrangement leaves much to be desired. States like Orissa and West Bengal have had a track record of not ensuring adequate financial provisioning for the purpose while some other States like Jharkhand, Bihar and Uttar Pradesh have had no concrete planning in this regard. The present mechanism of disbursement of payments to the contractor envisages monthly payments during the first year for the construction works (but in practice it is released over 4-5 instalments). The payments on account of O&M over the 5 years are stipulated to be released on a half yearly basis, but this is not scrupulously followed on account of budgetary shortfalls. The experience is that whereas the quality of construction of roads has improved considerably, the maintenance of these roads is not always of the desired quality. This is not only because of the structure of the contract and the funding arrangements but also because of the quality of contractors undertaking these works.

By introducing the investor-developer category, the small contractor would not be phased out of the game but would

[1]Source: National Rural Roads Development Agency - NRRDA

become a player as a sub-contractor in most cases. However, the supervision of the prime contractor driven by higher performance risk would be more efficient than the Public Works Department type of supervision presently being followed. And with a focus on outputs, or performance by the prime contractor as well as sub-contractors, the cost and administrative burden to Government for monitoring shall reduce. Presently the monitoring is done through in-house quality control by the PIU and independent monitors appointed by the Government, while the contractor is expected to furnish a performance guarantee of 10% of the amount put to tender that is retired in phases. However, for attracting investor-developers, the packages on offer will have to be of a higher quantum. This would entail bundling of several contiguous rural roads into one package of Rs. 50-100 crore, thereby attracting some of the reputed and large investor-developers into this sector. The contribution of the State Governments and that of the Central Government would have to be structured in the form of one-time transfer to the SRRDA's annuity fund instead of the present arrangement that puts the responsibility of funding the capital expenditure on the Central Government while the responsibility of funding the maintenance is that of the State Government.

In a typical BOT (annuity) model, the concessionaire (private sector developer) is required to meet the entire construction cost upfront (no grant is paid by the Government) and also the expenditure on annual maintenance or the concession period. The concessionaire recovers the entire investment and cost of return determined by the market out of the annuities payable by the Government every year, for which a budget provision is made. However, to avoid lengthy and cumbersome accounting and budgeting issues, the annuity in this variant model can be determined by way of an up-front one time grant. The annuity payments along with periodic increases on account of indexing to inflation can be taken as cash flows for the period of the concession, discounted at specified rate to arrive at net present value (NPV). This can be paid to the developer up-front after the construction is over against a credible and adequate performance guarantee. The concession for the BOT in rural roads can be for a period of 20-25 years which will substantially improve the quality of maintenance besides offering the flexibility to Government of undertaking a larger number of road clusters for development. Also, the long-term maintenance obligation will provide opportunities for a large number of local sub-contractors to spawn and grow.

Secondly, with BOT (annuity) mode, construction of rigid pavement (cement concrete pavement laid on a well prepared granular sub-base) should be considered, because of the fact that the life-cycle cost (LCC) of these pavements is estimated to be less than that of the currently preferred flexible pavement (topped with bitumen). Flexible pavements have traditionally been the preferred choice because of low capex as compared to the rigid pavements as the initial cost of the former is about 28% higher than the latter[2]. However the LCC analysis takes into account the initial investment cost and also the maintenance and rehabilitation cost over the design life of the pavement structure. The LCC of a concrete pavement works out less (approximately 27%) compared to flexible pavement, if fly-ash is added to reduce the quantity of cement used[3]. Ministry of Rural Development (MoRD) has already decided to do a pilot for construction of rigid pavement in EPC mode. However, as only the initial project cost is being considered, the cost of concrete

[2] Source: Cement Manufacturers' Association
[3] Reference: Grameen Sampark

pavement will be higher than the cost of flexible pavement. But, construction of concrete pavement would be best suited for long term Public Private Partnerships (PPP - BOTs) as the concession period, i.e. 20 years would synchronise with the design life and would cover LCC of the project, thereby incentivising the private partner to construct high quality roads for reducing maintenance cost and maximising profit. Rural habitations would, in turn, get good quality connectivity over a much longer period of time.

Model financial projection

The key assumptions for a rigid pavement design are:

- Project based on a 100 kilometre package
- Rs. 42 lakh per kilometre is taken as the cost of construction for rigid pavement design. Annual maintenance cost of rigid pavement is taken at Rs. 12,000 per kilometre for a single lane rural road (ref: NRRDA). There is no further periodic maintenance
- Cost of debt is 12%, cost of equity 16% and inflation at the rate of 5%
- Period of analysis is considered as 20 years, being the design life of concrete pavement in rural areas
- Rate of return for calculating annuity stream is 15%
- The discounting rate for arriving at NPVs is 12%
- Two years' period for construction

The upfront grant payable to the developer is estimated at Rs. 54.35 crore, say Rs. 55 crore, of which only Rs. 1.78 crore is accounted towards operations and maintenance over the period of 20 years.

In the present approach adopting flexible pavement design (having technical life of 10 years), the NPV of project cost of a 100 kilometre new construction over a 20 years' period is estimated at approximately Rs. 56.30 crore, of which Rs. 26.30 crore is accounted towards annual maintenance, renewal in each 5 years and new re-laying after the 10th year. Here, the key assumptions include:

- Rs. 30 lakh per kilometre is taken as the cost of construction for flexible pavement design
- 8% of project cost for routine maintenance over a 5-year period
- Renewal at the rate of Rs. 5 lakh per kilometre once in 5 years
- Relaying of new road at the end of 10 years

While the theoretical construct looks simple, the implementation of PPPs for rural road projects would be complex. The private sector shall be required to absorb the risks associated with bridge financing, construction, O&M and project completion risk. Risk identification, changing user profile over long term concession, management of partnership, including enforcement of performance, etc. would be difficult to structure. The configuration of viable packages for the private sector to invest in is a challenge too. However these are not insurmountable problems. Being State projects, these would also not be subject to the existing PPP approval process for Central sector projects, including documentation, resulting in quicker roll out. Besides, the approach holds promise for adoption if a similar model could be successfully utilised to attract private finance for the highways development when more traditional project finance structures were considered risky. The experiment will also pave the way for replication in other infrastructure sectors, such as drinking water supply and solid waste management, in rural areas.

Indian Rural Roads Maintenance: A Crying Need

Dr. Pramod Kumar Anand*

Rural roads have a pride of place in India, being over 2.65 million km of the 3.3 million km total road length[1]. One need not resist the temptation to proclaim that rural roads cover 80% of road length in India. True as it may be - of length, it can't be claimed so for road surface area, as other roads are wider. But then on the front of importance, the rural roads again literally prove to be, 'Last but not the least' crucial link- being the very embodiment of the last mile connectivity. A revisit to rural road length in India reveals that these are almost 7 times of distance between the Earth and the Moon[2]. A more earthly comparison places these at over 66 times of equatorial circumference.

Ensuring rural India access to urban India, these prove to be the link for proverbial Bharat to India; a manifestation of multi-headed 'Dualism', that captures rural urban divergence. Remarkably the government policy of inclusive growth aims to fill this chasm among many others.

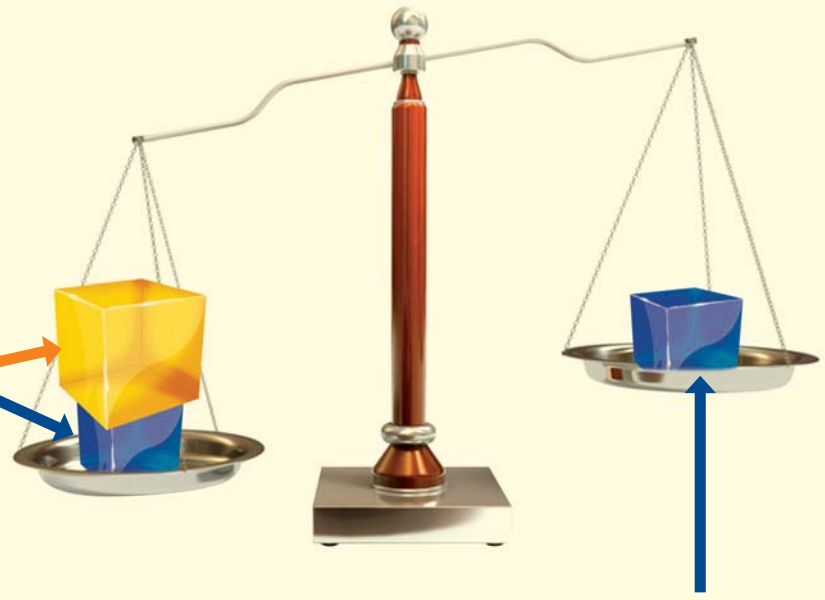
*Author is a civil servant. Views expressed are personal.

It is a difficult task to assess the value of this vast rural asset, due to classical problems faced in any aggregation. For instance, one can't compare cost of a rural road in steep hills of Arunachal Pradesh with one in plains of Uttar Pradesh; of a road laid a few decades back with one laid recently (due to inflation, if nominal costs are compared); of one punctuated by multiple cross drainage works in rainy Assam with one in low rainfall location and so on. An easier assessment may however be made, of current replacement cost of the colossal asset that surely it is. Obviously, any reasonable replacement can be with the provision of some modest cross drainage works to make even fair weather among these as broadly all-weather. though to cut down replacement cost, for links to very small habitations, a reasonable compromise can be made on width, type of surface etc. Let us make a crude estimate that for such roads current average replacement cost is Rs. 2 million per km. broadly keeping in view that road population distribution is skewed towards lower value end. This puts a price tag of Rs. 5,300 billion[3] on the replacement value of Indian rural roads with at least modest cross drainage. If one is permitted to commit the cardinal sin of comparing a stock variable (like this value) with a flow variable (like annual expenditure), this asset is worth 3.5 times of Govt. of India's total capital expenditure[4] for 2010-11. And if not permitted so, the replacement value is over 78 times of the $ 1.5 billion towering 'Burj Dubai' cost[5].

2. PLETHORA OF COSTS ASSOCIATED WITH MAINTENANCE:

The numerous burdens invited by poor maintenance[6] outweigh the regular cost of maintenance as manifested in the diagram below:

A Stitch in Time Saves Nine (and Many More)



Avoidable Burdens

i. Additional Maintenance cost
ii. Additional Vehicle Operating Costs
iii. Higher Depreciation of vehicles
iv. Utility forgone in discomfort
v. Opportunity cost of extra travel time
vi. Inaccessibility to medical aid
vii. Area cut-off during disasters
viii. Additional carbon footprint
ix. Accident related incalculable costs …

3. PREVALENT GENERIC MODEL NEED FOR IMPROVEMENT:

Poor maintenance leads to a plethora of additional economic and social costs, of which the most talked about one, by a typical road user is the Vehicle Operating Cost (VOC). Literature is surfeit with a number of models which internalize the stylised fact that if maintenance of a road is overlooked its rate of deterioration shoots up. To capture increasing rate of deterioration, an exponential relationship is assumed. Logarithms come to rescue, by facilitating conversion of such a relationship to a linear one- an econometrician's delight, as the easier to apply, Ordinary Least Squares (OLS) method, can be used. Assuming a normal distribution, the requisite 'sufficiently large' sample size exceeding 30 can be easily taken, road population being so high[7].

For instance a representative generic model used is:

$VOC = a * e^{*RG} * e^{*RF}$

Where, VOC = Vehicle Operating Cost (say in Rs./km./vehicle)

RG = Roughness (say in mm/km)

RF = Rise and Fall (say in m/km)

a, and are parametric constants (though would vary for different road types)

On 'a priori' basis the three constants are expected to be positive

as VOC is positive and increasing in RG and RF. More variables (like cracking, ravelling and dummy variables like rainy day can be added so long as results explain better and the problem of multicollinearity does not creep in.

On taking logarithm (say, natural) the equation is simplified as:

$\text{Log}_e VOC = a' + \ *RG + \ *RF$ (here, a' is $\log_e a$)

For fine tuning, VOC can be differently subscripted to indicate different vehicle categories, like VOC_{bus} and evolve a family of equations.

A million[9] dollar question arises, whether such a model duly captures adverse impact of poor maintenance? If not, in which direction is it biased? And what are the precautions needed to use such a model? Firstly, the road is not a homogenous product but a vibrant symphony in three dimensions. In its depth are in harmony layers like subgrade, sub base, base etc. under the surface layer. Its breadth constitutes of earthen and hard shoulders with its centre crowned with camber and longitudinally it flows with varying features like curves, gradients, cross drainage

works and so on. This non-homogeneity comes in the way of devising any theoretical model aimed to fully capture the true (unknown) relationship. For instance, a small pothole on one road may cause little immediate damage to its value; compared to traffic density caused higher damage to a similar road. However, within a few days the value of damage caused to the first one may become much larger due to chain reaction triggered by the innocuous looking pothole. Such nuances, that too stochastic in nature are not that easy to model.

Secondly, the very exponential nature of the model would dictate that if VOC on a road, that is not at all maintained becomes say, 1.3 times in 4 years[10]; it would become 1.3*1.3 i.e. 1.69 times in another 4 years[11]. But stylized facts speak loudly that a road entailing 30% cost rise in the first 4 years[12] would be in such a pathetic condition, which left to itself for 4 more years is not likely to be fit for any use.

Thirdly, here one has considered only VOC, but implications of the other serious concerns like time wasted and so on covered in tilted balance diagram and their interactive terms are not included in the model.

Thus, the model needs some improvement to capture ground realities, especially, for such contingencies when maintenance is totally overlooked and therefore, even minimal maintenance of shoulders and patch work is not undertaken, what to talk of more prudent interventions like thin overlay etc.

In a nutshell, the existing models are not geared to fully capture gravity of poor maintenance led problems.

4. LOW MAINTENANCE CAPITAL EATEN UP:

To have a feel of the level of costs entailed for normal maintenance, one can draw some broad conclusions by rule of thumb calculations, which can certainly be fine tuned using better field data. Beforehand, the issue of aggregation of costs over a panel of data needs to be resolved. Instead of falling into the questionable trap of first estimating inflation blown future costs and then discounting these to current value by assigning an arbitrary discount rate, let us just simply stick to express all future costs in terms of real base year prices. In this backdrop, reverting to the context of Indian roads, let us assume a situation of regular normal maintenance called as Scenario 1, covering the following ideal interventions over an upgradation cycle:

i. Normal maintenance @ 10% cost[13] for block of first 7 years[14]

ii. Renewal @ 10% of cost in year 8

iii. Normal maintenance @ 10% cost for block of 7 years in years 9 to 15

iv. Renewal @ 10% of cost in year 16

v. Normal maintenance @ 10% cost for block of 7 years in years 17 to 23

vi. Upgradation @ 50% of cost , in say, only 1/3rd roads where traffic flow was excessive (as regular maintenance was assured), so around 17% cost per road, in year 24

Therefore, the weighted average annual maintenance cost for a representative road comes to (67%/24) or say, 2.8% of its cost, in real base year price terms.

On the other hand, let us assume a situation in which even preventive costs are overlooked, called Scenario 2, under which, upgradation would be needed every 7th-8th year. Under this Scenario, in a block of 24 years around 3 upgrdations totalling 150% of the cost would be needed (for each road) which boils down to an annual around 6% of road cost, which is over double of the cost in Scenario 1.

Thus for a 2.65 million km asset, under Scenario 1, it is as if losing 0.0742 or say, 0.074 million km a year and under Scenario 2 a high 0.159 or say, 0.16 million km a year.

In this background let us look at the fully Govt. of India funded intervention of PMGSY (Pradhan Mantri Gramin Sadak Yojana). Under the new connectivity component of this programme about 0.05 million km i.e. 50,000 km is being added a year. Notably this annual addition itself exceeds road network length in (each of) over 100 countries ranked 80th and below in the world. Remarkably PMGSY targets at new connectivity to over 1,36,000 habitations by a total of over 3,65,000 km additional length. This addition itself would be so large that only 16 countries of the world have total road length exceeding it. Moreover, this one time intervention by the Central government is coupled with certain upgradation component targets.

States/UTs are also adding some new roads, especially to connect such habitations that are not eligible under PMGSY coverage and also undertaking varying degrees of maintenance. Since these additions by the Central Government and States/UTs are to connect such habitations which have above average population, so are these roads of above average road value. But on the question whether the 0.05 million km plus annual addition and maintenance surpass in value terms the annual attrition rate of 0.074 million km plus (Scenario 1), one has to keep one's fingers crossed. It also needs to be borne in mind that while new additions initially add to the capital stock, once complete these too push annual attrition upwards.

On the maintenance front, situation varies across the States which (obviously) fall between the Scenarios 1 and 2 above. They, on their part are also renewing /upgrading a number of roads besides maintaining many though at a level that falls short of Scenario 1. Thus existing attrition costs are phenomenal and need to be immediately addressed to by the States/UTs. This is inspite the fact that under PMGSY initial contract is a composite one (with the

same contractor) under which capex is borne by the Central government and annual maintenance costs for first 5 years supposedly by the States/UTs. However, performance of the latter on maintenance front is varied and on an average below par. The good news for them is that the 13th Finance Commission has devolved Rs. 200 billion to States/UTs for road maintenance over 4-year period 2011-12 to 2014-15. Part of over a quarter of cess on Petrol and half the cess on High Speed Diesel[15] is also assigned to them for development and maintenance of roads other than National Highways. These just need to be supplemented by appropriate allocations from State/UT budgets for these very arteries of India. To supplement these channels certain revenue models need to be evolved, though it is not advisable to have recourse to toll barrier stoppages on each rural road as that would hamper flow of traffic and invite leakages.

As an aside, it may appear that most of the expenses for new connectivity and maintenance are borne out of 'public money'[16] while benefits largely accrue to private individuals and entities - the 'free riders'. But the stark reality is that it is not so because only the very taxes paid by these beneficiaries become 'public money'.

But one lesson, hopefully not learnt the hard way, is that, unless the issue of maintenance is handled squarely, the value of this rural road asset may even diminish and any delayed corrective action would certainly warrant awful avoidable economic and social costs.

1 Source: http://www.nhai.org/roadnetwork.htm website of National Highway Authority of India.

2 To be precise 6.89 times of mean lunar distance of 3,84,403 km.

3Or Rs. 5,30,000 crore.

4 Source: http://indiabudget.nic.in placing it at Rs. 1,50,025 crore.

5 @ Rs. 45 a $.

6 Instead of the 'Regular Maintenance cost' say, x; the total financial cost to the maintenance agency in future, is discounted to present value and then split into x plus say, y. The latter is termed as 'Additional Maintenance cost' in the diagram

7 Koutsoyiannis, A (1996 reprint), 'Theory of Econometrics', Macmillan Press Ltd., pp 83 and 86 discusses. Otherwise alternatives like Student's 't' test needs to be applied..

8 Many manifestations of this generic model exist. A number of other generic models in vogue also suffer from some of the infirmities pointed out here.

9 May be multi billion.

10 Accounting for fuel cost and depreciation.

11 At constant prices.

12 In simpler terms implying that average of a vehicle run on such a road would have fallen from 10 km / litre to 7 km /litre ignoring depreciation.

13 All at real prices of base period.

14 Further fine tuning can be done by assigning traffic density or through route/ link route categorisation of roads.

15 Part of the other half assigned to PMGSY.

16 Government spending.

Maintenance Management for Rural Roads

H.K. Srivastava*

NECESSITY

PMGSY roads are designed for a 10 year life. If quality of construction, proper maintenance and periodic renewals are ensured, subject to traffic constraints, PMGSY roads can give continued service even beyond their 10 years design life. PMGSY guidelines stipulate that the State government shall undertake maintenance of the entire core network, particularly road works constructed or upgraded under PMGSY. From the year 2004 onwards, 5 year maintenance is contracted out alongwith construction contract itself in respect of roads constructed or upgraded under the program. In respect of roads constructed through PMGSY investments, further maintenance beyond initial 5 years is also required.

Interaction during the review meetings, meeting of the Empowered Committee as well as sample checks carried out under the maintenance audit in 15 States and regular inspection by the National Quality Monitors indicate that sufficient funds are not being placed at the disposal of the SRRDAs and regular maintenance of roads, already completed under the program, is not being carried out. The institutional arrangements require to oversee the

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maintenance planning and implementation also requires substantial improvement. Maintenance of rural roads which are not funded through PMGSY or where the initial 5 year maintenance is over is another grey area where there is a need to have Annual Maintenance Plans derived out of a formalized Maintenance Management System. The prevailing maintenance scenario in the country calls for a basic management approach to the maintenance issue rather than an engineering approach and as such, it is very essential that a Maintenance Management System for the rural road core network is put in place by the respective State governments at the earliest possible. If timely maintenance is ensured, the huge investments made in construction of new roads or upgradation of roads gives the desired level of service throughout its design life and beyond. Absence of timely maintenance results in severe damages. Restoration works are very expensive and time consuming. Under PMGSY, upto March 2010 approximately 2.6 lakhs km of roads have been completed. This has resulted in increased social and economic benefits all around. Usefulness of the programme would reduce substantially due to poor maintenance. As such, it is all the more essential that created assets and infrastructure provide the required level of service.

KEY ELEMENTS

The key elements to ensure required maintenance would be:

a) **Strengthening the institutional measures:** This could be achieved by designating a nodal person in each PIU and in the office of Chief Engineer or SRRDA who should keep a track of the maintenance activities and list out areas where no action is being taken or only partial action is being taken.

b) **Providing the required level of funding for maintenance of rural roads by the respective States governments:** For this purpose, an assessment of fund required would be necessary, so that the demand for the same could be incorporated in the annual budgets. Also, grants available through the respective Finance Commissions need to be channelised for maintenance of such roads. Usually, the Finance Commission links their grants to certain conditions, mainly relating to the levels to the institutional arrangements, as well as funding at the state level. Then only the grants of the Finance Commission become available as an additionality.

c) **Rational use of available resources:** It is also necessary that the scarcely available maintenance funds are not utilized for works of capital nature. The upgradation or strengthening of roads, repair of roads damage by natural calamities such as floods, land slides etc are not part of the maintenance activities and as such should not be carried out from the available maintenance funds. These are to be funded out of the capital budget heads for which estimates are required to be prepared separately and sanction obtained. In case of repair of damage through natural calamities, usually funds available at the state level for these purposes need to be utilized.

d) **Supplementing maintenance funds:** It would also become necessary to raise additional resources by way of levying a cess at the State government or at the Panchayat level, who soever are authorized to do so, to meet partially the cost of maintenance. However, the collection of additional resources should be channelised for maintenance purposes through inbuilt provisions in such enactments.

Enabling Requirements

Having made provisions for institutional development, the maintenance plan prepared through the adopted system, needs to be translated into action. Essential enabling requirements are:

a) **The standard contract document:** The work of maintenance could broadly be categorized as work of routine nature, work of renewal and special repairs. Depending on the volume of work and the availability of contractors, the size of the contracts should be decided. It could include works in all three categories within a reach or it could be segregated out. The work of renewal is primarily equipment based (hot mix plant and paver). Works of routine nature do not require heavy equipment. The nature of work under the special pair would again depend upon the items of work proposed to be covered. As such, the contract document for these three categories could be simple but specific to the need. However, the basic features should cover the timely completion (or penalty for delayed performance), the performance of the road (from the view point of the road user) after the maintenance activities have been completed. That is to say that there should be a provision for performance guarantee in the bid document particularly in case of renewals, repairs to CD works and retaining walls, patch repairs etc.

b) **Institutional arrangements:** The dedicated planning cell in SRRDA, preferably headed by officer of the rank not below the Superintending Engineer, should oversee the follow up actions required for data collection, assessment of funds, development of contract document, timely call of tenders and award of work followed by implementation monitoring and timely release of funds to the PIUs. These cells could also be entrusted with the work of preparation of Annual Maintenance Plan, dovetailing it with the availability of funds vis-à-vis the physical requirements.

c) **Monitoring:** Monitoring is an essential part of any management activity so that the status of activities being implemented or otherwise is available. The works entrusted to this unit should include the

projected requirement of funds and its availability, checking out the physical and financial progress of works as per the Annual Maintenance Plan as well as quality of work carried out by the field units through maintenance contractors. A set of performance indicators could also be prepared so as to ensure that essential features of the maintenance are not lost sight of.

d) **Capacity building:** This exercise would involve interaction and also training to the officers and staff entrusted with maintenance responsibility. The contractors would also need to be encouraged to take up the maintenance works. Same set of facilities, as is provided to the Contractors carrying out original works, need to be extended to these contractors as well. One example of such facilities is providing plant and machinery advance, if need be.

e) **Financial management:** This would also be an integral part of the maintenance activity and as such the units should be equipped for the same.

f) **Developing Training modules:** The feedback received from the field units, through interactions, should help in developing a training module and course material for planning and implementing the maintenance activities.

CONCLUSION

Maintenance is an essential activity sequent to construction activity in order to reap the benefits of created assets. Emphasis has to be on prevention of deterioration of the road structure through proper design and maintenance rather than having repairs. This would reduce the vehicle operating cost, delays and public criticism. Need for reconstruction adds to burden on national economy. It would be necessary that prioritization of maintenance activity is carried out so as to make use of available maintenance funds in an optimal manner. Necessary institutional mechanism needs to be put in place and built where deficient for deriving sustained benefits from the roads constructed under the Programme. It is necessary to make a beginning.


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Rural Road System and Accessib
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MINISTRY OF RURAL DEVELOPMENT
GOVERNMENT OF INDIA
STATE RURAL ROAD DEVELOPMENT AGENCY
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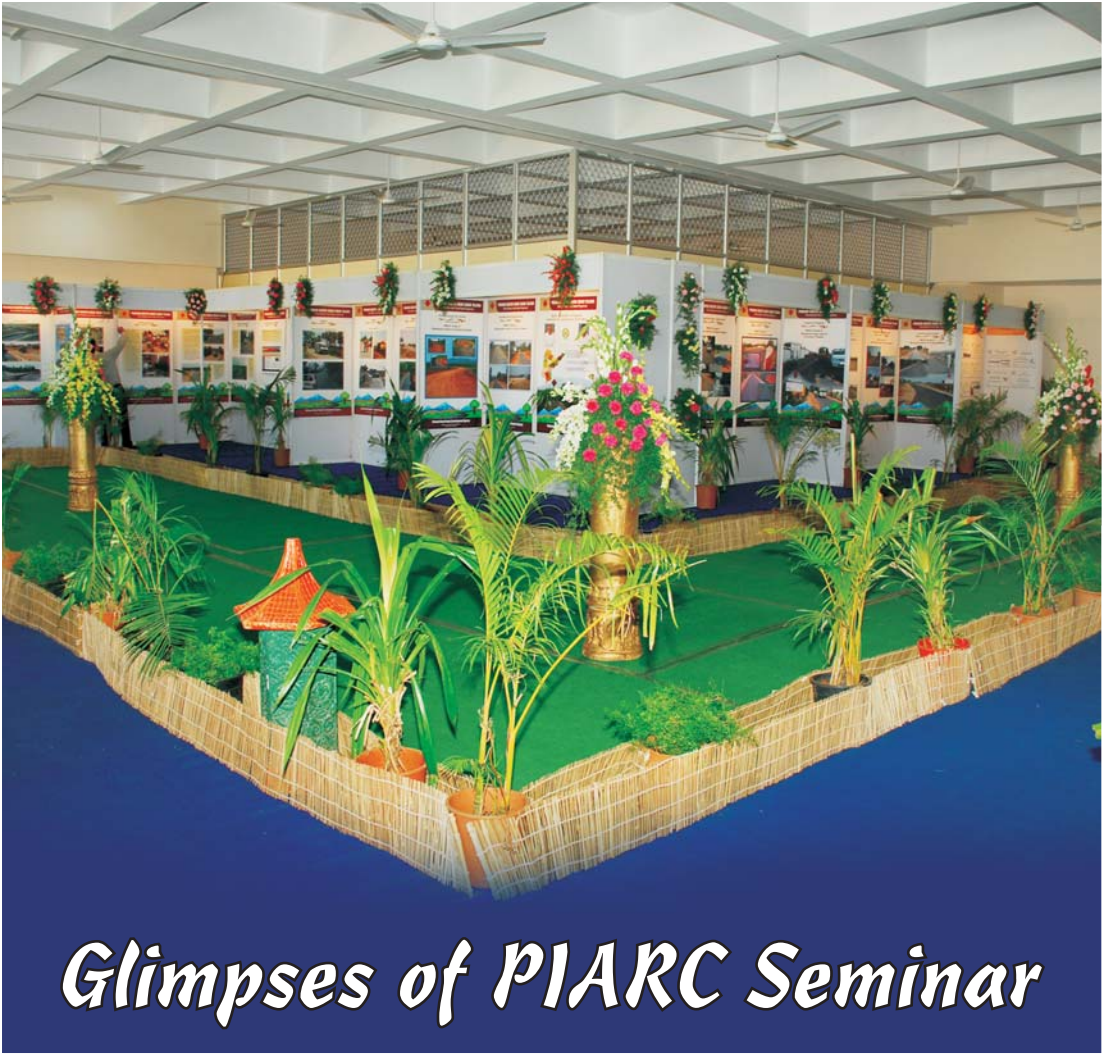
Sustainable Maintenance of Rural Roads
Rural Road System and Accessibility to Rural Areas
Hyderabad 21st - 23rd January, 2010.
National Rural Roads Development Agency

Glimpses of PIARC Seminar



Performance Based Maintenance Contract in Rural Roads: Experience from Nepal

Indu Sharma Dhakal*

In the last two decades, Nepalese road network expanded rapidly. Department of Roads is committed for effective, efficient, safe and reliable road connectivity. Its objective is to reduce the costs of vehicle operation and passenger time by effectively and efficiently. Department of Roads regularly carries out road condition surveys such as, roughness index, surface distress and traffic volume in its network and these data are used to prioritize the rehabilitation and maintenance of the existing road network. Routine maintenance is required at all times because of traffic movement as well as environment degradation. Recurrent maintenance is done at varying intervals during the year with a frequency that depends mostly on volume of traffic. Similarly, bio-engineering work is carried out to stabilize road side slopes where low-cost techniques are suitable.

To encourage private sector participation in maintenance of roads a recent innovation of performance based maintenance contracts has been introduced where the contractor is paid a fixed sum to maintain all or part of the road infrastructure to a specified level. The contract comprises initial rehabilitation of a road in poor condition followed by routine maintenance for a period of three to five years. In the case of external funding, the agencies normally have a time limit on the duration of a loan and are unwilling to fund recurrent expenditure. In this case, the external funding is applied to the initial major works and the government counterpart funding being applied to the subsequent routine works. Such contract includes performance and operational indicators. The performance indicators are surface distress index, roughness and axle load control. The operational

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indicators comprise of specific items relating to pavement, right-of-way, structures, drains and road signs. Approach to monitoring requires a high degree of trust in the honesty of the contractor because the unrepaired defects lead to financial penalties for the contractor. The present specification for such contracts should be simplified and improved to make them more practical and realistic in terms of the monitoring required to assess compliance. The paper deals with a case study of performance based maintenance contract on 76 km road section to illustrate the best practices and challenges to use this in the rural roads.

BACKGROUND

Roads have been constructed in Nepal over the past 50 years since the opening of the first road link to Kathmandu from India in 1956. Most of the roads were constructed from donor's assistance. Now the Strategic Road Network (SRN) has reached to a length of more than 10,000 kilometers. The SRN is a fundamental contributor to the improvement of accessibility in the remote areas of Nepal and allows the development of local networks within individual Districts. A considerable expansion of the local rural road network has occurred over the past 10 years with a large number of local participation.

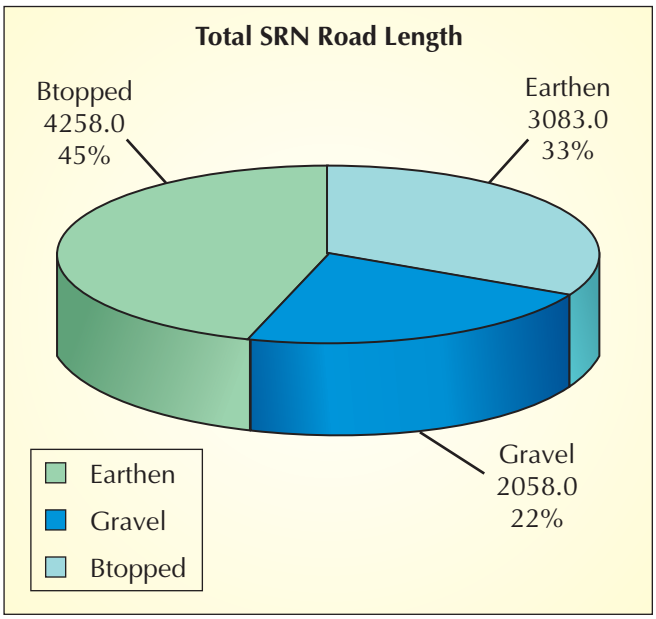

Fig 1. Present SRN Status

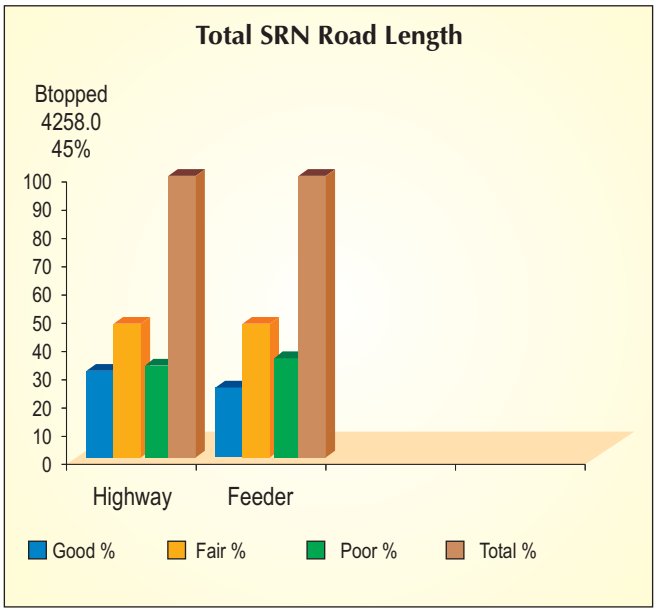

Fig 2. Road Condition as per SDI

Department of Roads (DoR) has carried out systematic network-wide surveys of traffic and road condition since 1993. The scope of these surveys has been roughness, surface distress and traffic volume. In recent years the surveys were made biannually. Fig.1 shows the present status of strategic road networks in terms of black topped, Graveled and earthen. Fig.2 gives the idea of highway and feeder road condition as per surface distress index survey. In addition to these, there is a record about the year of construction, reconstruction and resurfacing of pavements. The SDI and traffic data has been used to prioritise periodic maintenance works.

PLANNED MAINTENANCE SYSTEM

In the last 30 years DoR has encouraged to contract out road maintenance. Such contracts include routine, recurrent or periodic maintenance and were awarded annually reflecting the annual budgets. In traditional maintenance contracts, the Contractor is responsible for the execution of defined works and is paid on the basis of unit prices for different work items. This modality often brings improvement over force-account maintenance practices but the problem is that the Contractor tries to carry out the maximum amount of works, in order to maximize its turnover and profits. The execution of routine, recurrent and periodic activities in a systematic manner is planned maintenance. The combined methods

used to prepare, optimize and implement the activities constitute the maintenance management system. This provides a high level of management control in maintenance operations and makes the best use of available resources. Planned maintenance can only be carried out on roads brought in maintainable condition by rehabilitation or reconstruction.

The Department of Roads has introduced planned maintenance system since 1993. This approach makes the best use of available resources and provides a high level of management control over maintenance operations. The aim is to provide an agreed level of serviceability such that total road transport costs are kept to a minimum. Routine and recurrent maintenance consists of many different tasks frequently necessary to maintain the function of the road, such as, pothole repairs, cleaning drains, sealing cracks, cutting vegetation, etc. Periodic maintenance consists of predictable and more costly measures of a less frequent nature designed to avoid road degradation, such as, resurfacing, overlays, etc. Intelligent management, the timeliness of interventions and the adequacy of technical solutions are critical. Routine maintenance is carried out by the length worker system and Contractors are used for implementing periodic maintenance and rehabilitation of roads. Department of Roads has defined the categories of maintenance and related activities under two categories.

On Road Maintenance

It is work on the carriageway, side drains and cross drainage structures. Routine Maintenance is required continually on every road as a result of environmental degradation as shown in Fig 3. Recurrent Maintenance is required at varying intervals throughout the year depending mostly on the volume of traffic. Similarly, Periodic Maintenance is required at intervals of several years. Emergency Maintenance is needed to deal with emergencies for immediate action when a road is threatened or closed.

Fig 3. On Road Routine Maintenance

Fig 4. Road side Bio-engineering

Roadside Support Maintenance

It covers remedial and preventive works to improve slope stability and water and river management. Routine maintenance is cleaning off-road drains, repairing roadside support structures, repairing slope support structures. Preventative maintenance is trimming slopes, slope netting, masonry walls, gabion walls and revetments for slope, prop walls, check dams, river training works, bio-engineering including operating nurseries, collecting plant materials and seeds and planting out to support slopes. Bio-engineering is broadly defined as the use of vegetation, in conjunction with engineering structures, to reduce slope instability. Other use of bio-engineering is to improve the appearance of the slope (Fig 4). Emergency maintenance is covering cracks in slides and urgent protection measures such as river training works to minimise the threat of further damage to the road or its structures.

PERFORMANCE BASED MAINTENANCE CONTRACTS

Performance based maintenance contracts in road networks is a new concept designed to increase the efficiency and effectiveness of road maintenance operations. This type of contract significantly expands the role of the private sector, from the simple execution of works to the management and conservation of road assets. It should ensure the need of road users, over the entire period of the contract, which is normally several years. Three types of PBM Contracts might be mentioned and the choice depends on the funding source

I. The contract comprises initial rehabilitation of a road in poor condition followed by routine maintenance for a period of 3 5 years. This option might be the most appropriate with the external funding being applied to the initial major works and the government counterpart funding being applied to the subsequent routine works.

II. The contract only covers routine maintenance works such as patching, drain cleaning and vegetation control. Such a contract might be for a year or less if funded out of a recurrent budget. If funded from a recurrent road maintenance budget, this might be the only possibility. This option might be appropriate in rural road maintenance with the toll fund raised by the community being applied to the subsequent routine works

III. The contract is for an extended period and the contractor is free to decide on his own options and timing of periodic maintenance works required to maintain the road so a specified service level (for example roughness, cracking rut depth). To adopt this with a contract period of 10 years requires guaranteed funding for the contract period. For a country like Nepal this can be problematic until such time as the Road Fund provides sufficient income for both periodic and routine maintenance works.

The Contractors compete among each other during the bidding process, by proposing a fixed monthly lump-sum fee per km of road to be paid to them. It is important to understand that contractors are not paid directly for physical works but for outputs, i.e., the initial rehabilitation of the road to pre-defined standards, the maintenance service of ensuring certain quality levels on the roads under contract and specific improvements. The monthly lump-sum remuneration paid to the Contractor will cover all physical and non-physical maintenance services provided by the Contractor, except for unforeseen emergency works which would be remunerated separately.

Preventive and Catch-Up Maintenance Works

The Initial Road Condition Survey is done to establish baseline road condition data and to determine the amounts and locations of Preventive and Catch-Up Maintenance Works. This type of contract makes it necessary for the Contactor to have a good management capacity. Management means the capability to define, optimize and carry out in a timely basis the physical interventions which are needed in the short, medium and long term, in order to guarantee that the roads remain above the agreed service quality levels. In other words, within the contract limitations and those required to comply with local legislation, technical and performance specifications and environmental and social regulations, the Contractor is entitled to independently define: (i) what to do, (ii) where to do it, (iii) how to do it, and (iv) when to do it.

The initial works comprise an overlay and routine maintenance backlog. The initial overlay is to a design given by the client; the contractor does not have the option to provide any needed strengthening that he considers necessary to meet the performance specification in terms of roughness progression. The PBMC starts after this work is complete and runs for a period of about 5 years. The performance indicators are Surface Distress Index (SDI), International Roughness Index (IRI) and Axle Load control. The operational indicators comprise specific items relating to pavement, right-of-way, structures, drainage and road signs and marking.

Emergency Works

If damages clearly caused by natural phenomena with imponderable consequences result in a reduction of service quality levels below the normal threshold values or are considered likely to do so in the near future, or are

considered likely to put at risk the safety of individuals, works, services or equipment, the Contractor makes a formal request to carry out emergency works. Emergency works are remunerated based on measurement of the actual work completed and the unit prices for such work items. If road traffic has been interrupted because of an emergency, the Contractor takes the measures necessary to reopen the road to traffic in the shortest time possible, and maintain the road open during emergency works.

Operational Indicators

The Contractor is responsible for the continuous monitoring and control of road conditions and service levels. This will not only be necessary to fulfill the contract requirements, but it is an activity which will provide him with the information needed in order to be able (i) to know the degree of his own compliance with service level requirements, and (ii) to define and plan, in a timely fashion, all physical interventions required to assure that service quality indicators never fall below the indicated thresholds. All initiative is given to the Contractor who should do whatever is necessary and efficient to achieve the quality levels required. This concept is expected to lead not only to significant efficiency gains, but also to technological innovation. The PBM works requirements are given in Table 1 below.

Performance Indicators

Surface Distress Index is an assessment of the condition of the surface based on visual ratings of the major and minor defects. The surface is assessed visually on 100m of surface every kilometer and individual ratings for each defect per 100m test section are assessed. Ratings are scored from zero (no defect) to 5 (very poor condition). An average rating for each kilometer and for the road link as a whole can be produced from the individual ratings. Shoulders are rated separately, scored from 0 to 4. An SDI survey is carried out immediately following the completion of preventive and catch-up maintenance works. SDI ratings shall be determined in the above defect categories for each 100m section of each kilometer or part kilometer of each road link included in the Contract. A second SDI survey, matching the first, will be undertaken immediately before contract completion. The average SDI for each kilometer and part kilometer of each road link determined in the final survey shall not be less than the value determined for the corresponding kilometer or part kilometer at contract inception. The score for the shoulders for each kilometer and part kilometer of each road link shall not be less than the initial value for the corresponding kilometer or part kilometer at contract inception.

Table 1. Requirements of Performance Based Maintenance Work Item

Item Feature	Requirements of PBM
Pavement maintenance	Provide safe, smooth driving conditions, minimise rate of pavement deterioration by maintaining integrity of seal.
Operational Servicing	Provide timely emergency response and minimise disruption caused by temporary loss of use of the road.
Drainage Maintenance	Provide full capacity of drains at all times to ensure storm water is rapidly and efficiently conducted away from road pavement and structures.
Roadside maintenance Structures	Ensure all roadside structures are structurally sound and acting in the manner intended.
Drainage	Provide full capacity of drains at all times to ensure storm water is diverted or conducted away from the road and its structures.
Vegetation	Provide safe driving conditions, maintain visibility, and keep tidy.
Road Marking	Provide clear markings for safety of road users.
Road Furniture	Provide clear information for road users and be structurally soundProvide guidance to drivers and help prevent vehicles running off the road.Provide clear information about distances and to be structurally sound.
Operational Servicing	Provide prompt response to repair/rectify damage.Provide safe travel, minimise pollution, keep tidy.
Bridge Maintenance	Provide full capacity of drains to ensure water is conducted away.
	Provide safe smooth driving over deck and expansion jointsMaintain structural integrity by painting, cleaning, minor repairs etcProvide accurate and timely reports of structural conditions

Road Roughness is a measure of the roughness of the road and is an indicator of surface condition, pavement condition and the quality of repairs carried out. Measurements of road roughness can be made in a variety of ways, but they are usually carried out using a bump integrator fitted to a vehicle. The bump integrator is calibrated against a reference section of road whose roughness has been measured by more direct means. The vehicle is driven over the road and the bump integrator reading, which is a measure of the number and severity of the bumps in the road, is converted to an internationally recognised road roughness measure, usually IRI.

The axle load control indicator requires that no vehicle shall have an axle load exceeding 10.2 tons. The contractor needs to operate permanent weigh stations at each end of the road section and at any intermediate access points used by heavy vehicles. Monitoring of this indicator would require operating additional mobile weigh stations. The Department will designate the Contractor as the agent of the Department charged with the enforcement of load limits throughout the contract section. This designation will be made in writing, copied to all relevant authorities, after contract signature. The Contractor should keep full and accurate records of all vehicle weighing and the complete results are reported at weekly intervals.

Performance Monitoring

The Contractor should conduct an additional road condition survey following the completion of preventive and catch-up maintenance works. The conditions to be surveyed shall be surface distress Index, road roughness using the bump integrator and pavement deflection using the deflection beam. Monitoring requires a high degree of trust in the honesty of the contractor. Without full parallel monitoring by the client it is impossible to determine how honest the self control unit is in reporting. To assess these requires a high frequency of road inspections while joint formal inspections are only monthly. Tolerances regarding surface distress and roughness indicators are listed in Table 2.

The Client may carry out informal inspections of service quality levels at any time and anywhere on the roads included in the contract. If he detects any road sections where the service quality criteria are not met, he shall inform the Contractor of the non-compliance within 24 hours in writing, in order to enable him to take remedial action as soon as possible. The results of informal inspections may be used for purposes of correcting the Contractor's monthly statements or applying penalties or liquidated damages, particularly in cases in which the road has been completely interrupted and the criterion of road usability has not been met.

Table 3. Weight Factor for Calculating Non-Compliance

S No	Aspect	Weight Factor
1	Pavement/shoulders/road side	36
2	Structures	20
3	Drainage System	16
4	Signaling and Road Safety	18
5	Provision of maintenance services	10
	Total	**100**

The overall coefficient of compliance for the road in a particular month is determined by using the weight factors as shown in Table 3 and calculating the simple average of the coefficients of compliance of all one kilometer test sections of that month for the road.

Table 2. Adjustments to Performance Indicators

Service Quality Level	Annual Adjustment	Tolerance
Surface Distress	None	Average SDI score for each road link shall be the same as or less than the baseline SDI score for that link. No SDI score shall differ by more than one point from the baseline SDI scores for that kilometer (to allow for normal variations in readings – SDI scores for individual kilometers are in whole numbers.).
Road Roughness	Increase by ten percent (10%) for each kilometer	Average roughness for each kilometer or part kilometer shall be not more than 10% greater than the average roughness measured the previous year for the same section.

Payment Reductions

Payment Reductions are applied in case of non-compliance with Service Quality Level requirements and Liquidated Damages are applied in the case of non-compliance with required Preventive and Catch-up Maintenance Works as per the Condition of Contract. Payments for each kilometer of road each month will be the rate in the Bill of Quantities multiplied by the coefficient of compliance. Payment Reductions for non-compliance with service quality level criteria on certain PBM items as determined through informal inspections. If any road section fails to meet the performance criterion for SDI, a sum equal to10% of the relevant pay item is deducted from each payment for the length of road which does not meet the performance criterion for as long as the failure exists. These amounts are cumulative, thus the length of road which fails both performance criteria will be subject to a 20% deduction. In the event that any road section fails to meet the performance criteria for SDI or road roughness during the surveys carried out at the end of the contract period, the Contractor shall forfeit his retention in the proportion that the length of road which is deficient bears to the total length of road in the contract. The lengths of road are cumulative. Thus for the purposes of determining the deduction, the total length of road which fails the SDI performance criterion will be added to the total length of road which fails the road roughness criterion.

PBMC IN HETAUDA-NARAYANGHAT ROAD

Road Network Development Project under the financial assistance of Asian Development Bank (Loan 1876-NEP) initiated Performance Based Maintenance Contract (RNDP/ICB/PBM/HN) in Hetauda-Narayanghat Road (76 km). The Works to be covered under this contract comprised of Preventive and Catch-up Maintenance, Improvement Works, Emergency Works and Routine Maintenance of 76 km followed by 3 years of Performance Based Maintenance and Emergency Works. Department of Roads is the Executing Agency whereas Roughton International in association with ITECO Nepal / Full Bright /ICGS is the Consultants. Contractor is CTCE Kalika JV. Summary of contract items, standard jobs and amounts is tabulated in Table 4.

Preventive and Catch-up Maintenance and Improvements were completed during the initial eighteen months funded by ADB and the government counterpart funding being applied to the subsequent performance based maintenance for the next 3 years. The total contract period is 4 years and 6 months. Two performance indicators SDI and IRI are used to monitor the service quality level. Preventive and improvement works have been completed smoothly and PBM is in progress.

Table 4. Bill of Quantities and Standard Jobs in PBMC

S. No.	Maintenance Component	Standard Jobs	Amount (NRs)
1	General Items	Site Establishment, Establishment and maintenance of facilities for Initial Road Inventory, Initial Road Condition Survey,SDI Survey, Road Roughness Survey, Pavement deflection survey, Axle Load Control, Set up and Operate Axle Load Control Station etc	8095020
2	Routine Maintenance and PBM Works	Routine maintenance on roads after repair and resealing etc	8863569
3	Preventive and Catch-Up Maintenance Works	Pavement surface repairs, Slurry seal, Prime coat and 50 mm premix carpeting, Resealing Drainage, Road furniture, Marking etc.	72852909
4	Emergency Works	Earthworks, Pavement, Structures	9897327
5	Bio-Engineering Works	Grass cutting, Vegetation control, Tree and shrub management etc	2687018
6	Improvement Works	Earthworks, Structures, Pavement works, Bio-engineering works etc	48031384
7	Day work	Labour, Material, Equipment	5038906
	Total		**155466135**

OPPORTUNITIES AND CHALLENGES

The Department of Roads should benefit by obtaining better overall road conditions at the same level of expenditures. Future generations will benefit most from PBMC, because they do not have to pay for the reconstruction of roads destroyed because of a lack of maintenance today. For contractors and other private sector enterprises, such contracts should open up new business opportunities, in which longer contract periods provide a more stable business environment. The contractors have a financial incentive to carry out the works at the least cost. It is easy to enhance the development of mechanism for axle load control on road pavement in PBM contracts. It will also help to promote good governance because of the transparency in contracts. Length workers are highly motivated in their work due to the regular income provided by the job in rural areas where such opportunities are rare. They are often road neighbours, too, and their employment is a positive benefit to the care of the road as a whole.

In the other hand, for the execution of PBMC, a good preparation on engineering work is required on the actual conditions of the road to cover preventive and catch-up maintenance works. Length workers do not have fixed kilometer to work and they are often exploited by the contractor. There is also a danger of poor workmanship and a tendency on the part of the contractor to concentrate his efforts on work items he considers to be the most profitable. The use of contractors does not leave the client free of responsibility; the contractors completed work must be checked for quality and measured for payment. Approach to monitoring requires a high degree of trust in the honesty of the contractor because the unrepaired defects lead to financial penalties for the contractor. Because of PBMC the client may be left with a pool of idle staff and equipment with associated workshop facilities.

CONCLUSION

The use of performance based maintenance contracts will unleash significant efficiency gains, and stimulate innovation in comparison with traditional road administration practices. The PBMC specifications could be simplified and revised in scope to make them more practical to use in the maintenance of rural roads. Road users will be able to know the service level they can expect in return for the payments they make for the use of the infrastructure. The road neighbours are interested for slope protection in road corridor area by organising themselves in groups if they are given legal authority for the use of these trees and grasses. The possibilities of assigning simple on-road routine maintenance tasks to local communities also need to be explored.

It is recommended that post evaluation be carried out after completion of contract in Hetauda-Narayanghat Road for evaluating the effectiveness of the PBMC. It is necessary for the donor and the executing agency to review its policy to use PBMC in rural roads. Public accountability and transparency in contracts should be increased because access to information reduces corruption, and transparent institutions earn the public's trust.

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Rational Design Criteria for Sustainable Rural Roads

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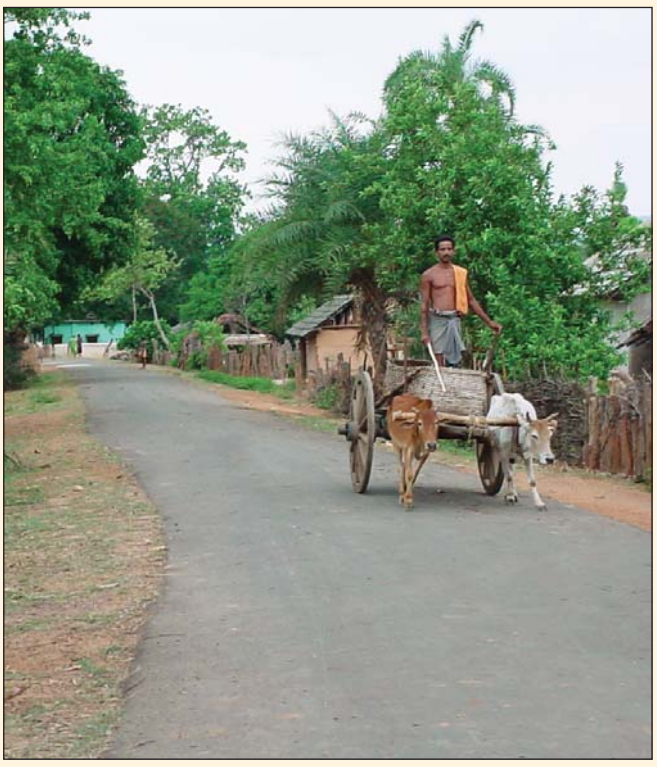
Rural road connectivity is an important element of rural development as it provides access to education, medical and economic services and provides opportunities for increased agricultural income and employment. Other district roads (ODR) and village roads (VR) comprise the rural roads in India covering about 80% of the total road length of the country. A large number of roads are being constructed under the Prime Minister's rural connectivity programme (PMGSY) with the objective of providing all-weather road connectivity to all the habitations with population more than 500. Rural transport sector is generally deprived of funds and in the absence of rational and practical guidelines and specifications for the design, construction and maintenance, rural roads have generally not been able to provide satisfactory service. Considering the vast network of existing rural roads, rationalization of the design approach can result in significant reduction in life cycle cost. Hence, a study was carried out on selected rural road test sections in the eastern part of India to develop a more rational design criterion for low volume rural roads. This paper presents the development of a design criterion using the performance data collected during the study.

KEYWORDS: Rural Road, Design Criteria, Pavement Performance



INTRODUCTION

Rural roads play a key role in poverty alleviation in rural areas by providing access to education, medical and economic services and opportunities for increased agricultural incomes and employment. Other district roads (ODR) and village roads (VR) comprise the rural roads in India. About 80% of the total road length in India comes under the category of low volume roads. A large number of roads are being constructed under the Prime Minister's rural connectivity programme (PMGSY) with the objective of providing all-weather road connectivity to all the habitations with population more than 500. The

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roads being built under this programme are mostly granular pavements with thin bituminous surfacing. These roads are currently designed as per the guidelines given in IRC: SP: 20 (2002) and IRC: SP:72 (2007). However, these documents do not refer to any mechanistic principles and there is also no reference to any documented performance data that formed the basis for these documents.

Rural transport sector is generally deprived of funds and in the absence of rational and practical guidelines and specifications for the design, construction and maintenance, rural roads have generally not been able to provide satisfactory service. Considering the vast network of existing rural roads, rationalization of the design approach can result in significant reduction in life cycle cost. Hence, there is a need to optimize the design of pavements by developing more rational design criterion for low volume rural roads.

For development of a rational criterion, evaluation of performance of in-service pavements is essential. Very few studies have been conducted on rural roads in India. Keeping this in view, a study has been initiated for performance evaluation of rural roads constructed under the Prime Minister's rural connectivity programme (PMGSY), sponsored by National Rural Roads Development Agency (NRRDA). An attempt has been made here to develop a mechanistic-empirical performance criterion for rural roads using the performance data collected from the ongoing study.

PERFORMANCE CRITERIA FOR PAVEMENT DESIGN

In mechanistic design methods, the limiting values of stresses and/or strains at which a given degree of distress will occur are commonly known as the performance criteria. Performance criterion is generally developed considering a failure condition, which may be either structural or functional. While most of the mechanistic-empirical flexible pavement design methods consider the cracking of bound layers and rutting along the wheel paths as main distresses to be addressed, some design methods have different functional parameters such as Present Serviceability Index (PSI), roughness or other such indices that reflect the user's perspective.

In the case of low volume roads, the bituminous surfacing (for paved roads) is usually thin (less than 40 mm) and is not expected to contribute significantly to the structural capacity of the pavement (Pidwerbesky et al., 1997). Hence cracking of bituminous surfacing can not be considered as a main mode of failure in such pavements. Rutting is the major mode of structural failure in granular pavements with thin bituminous surfacing. The permanent deformation in the subgrade and granular layers caused by repeated applications of wheel loads, manifests at the surface of pavement as rutting. The concept of measuring serviceability of pavement in terms of PSI, adopted by AASHTO (1993) is also used by some agencies as performance criterion for design of rural roads. PSI is estimated using structural distress parameters as well as surface profile characteristics. Another simple parameter used to evaluate pavement performance is roughness, which reflects the user perspective. The roughness of the road can be measured by different techniques and equipments resulting in different roughness indices; hence it is to be expressed in terms of International Roughness Index (IRI). Rutting and roughness have been identified as two major distresses in case of thin surfaced granular pavements.

PERFORMANCE EVALUATION OF RURAL ROAD SECTIONS

Site Selection

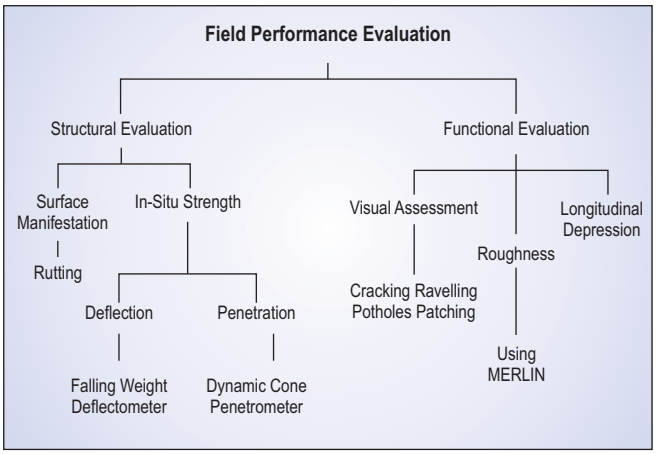
Nineteen test sections with different traffic intensities and subgrade strengths were selected in the West Medinipur

district of West Bengal, India. These roads were constructed under PMGSY and the main reason for considering the PMGSY roads is the greater degree of quality control exercised in a systematic manner at different stages of construction of roads under this scheme. As test sections with smaller length are convenient to monitor, a length of 200 m was considered for this study.

Field Investigations

The field performance evaluation was carried out as per the programme given in Fig. 1.

Fig. 1: Programme for Field Investigations



Six rounds of data have been collected during different periods of the investigation between 2005 and 2009. This includes evaluation of pavements using FWD and DCP, measurement of rut depth, roughness, longitudinal depression, pot holes, raveling and patching etc. The soil collected from the site during the first round of investigation, were tested in the laboratory to determine different properties.

Evaluation of Pavements using FWD and DCP

With the development of nondestructive evaluation techniques, it has become more convenient to assess the strength of pavement layers without disturbing the pavement. Evaluation of pavement condition under dynamic loading is considered to be more rational as load pulses can be applied to simulate practical traffic loading conditions. Falling Weight Deflectometer (FWD) is commonly used for application of impulse load for pavement evaluation. The FWD developed at Indian Institute of Technology Kharagpur (Reddy 2003) was used for the deflection studies. This is an in-vehicle model and the manoeuvrability of the equipment on heavily trafficked highways and narrow width roads is better compared to trailer mounted models. Fig. 2 shows a view of the in-vehicle FWD.

Fig. 2: A General View of the In-Vehicle FWD

A genetic algorithm based backcalculation program called 'BACKGA' developed at IIT, Kharagpur (Reddy 2003) was used in this study for estimating the pavement layer moduli from FWD test results. But it is not affordable for many road organizations to go for the FWD evaluation due to the high initial cost associated with the equipment.

Strength of the pavement layers can also be assessed using Dynamic Cone Penetrometer (DCP). DCP is a portable low cost equipment, which can be used for rapid characterization of the layers in a granular pavement with or without a thin bituminous surfacing. Hence, it is possible to introduce this instrument to local road authorities that deal with rural road construction and maintenance work.

Measurement of Rutting

Rut depth was measured using a 1.5 m long straight edge. The 200 m long test sections were divided into 10 sub-sections of 20 m each. Rut depth measurements were made at the center of each subsection on both wheel paths.

Measurement of Roughness

Different equipment such as fifth wheel bump integrator, profilograph, dip stick and MERLIN, etc are used for measurement of surface roughness. MERLIN (A Machine for Evaluating Roughness using Low-cost Instrumentation) was developed by the Transport Road Research Laboratory (TRRL), UK (Cundill, 1996) for measurement of road roughness in developing countries. The machine is robust and straightforward to use. Its ease of use has led to its widespread acceptance. Being inexpensive, this can be easily procured by the rural road agencies for evaluation of low volume roads.

Measurement of Longitudinal Depression

Longitudinal depression is the longitudinal unevenness measured along the wheel path. Formation of longitudinal depression can be attributed to poor compaction and uneven settlement in any of the layers of the pavement. Longitudinal depressions also lead to intermittent loss of contact between tyres and pavement, reducing the effectiveness of steering and braking. Longitudinal depressions were measured at the same locations where rutting was measured i.e. in the centre of each subsection with the same straight edge placed in longitudinal direction, along both the wheel paths.

Laboratory Investigations

Different laboratory tests such as liquid limit and plastic limit, percentage passing IS 75µm sieve, Proctor compaction test, CBR test, unconsolidated undrained triaxial compression test and resilient modulus test were conducted to characterize the subgrade soils collected from site.

Terminal Condition

To develop a performance criterion, the terminal condition of the pavements needs to be established. In order to identify the terminal condition in terms of different performance indicators for thin surfaced low volume roads, a survey was conducted for measuring the riding quality of the pavement surfaces by a panel of experts, who travelled over the selected road sections (including twelve additional sections) at a speed of 50 km/h in a passenger car. The panel members were asked to assess the riding condition of the pavement sections on a scale of 0 to 5 (0 for very poor to 5 for very good). Correlations were developed between riding quality, roughness and rutting. Many other studies (QDMR, 2000, Ahlin and Granlund, 2002 and Yu et al., 2006) have also reported the threshold limits in terms of roughness for different riding qualities. On the basis of the available literature and using the results of the riding quality survey conducted in this study, the threshold limits given in Table 1are proposed for different riding qualities for thin surfaced low volume roads.

Table 1: Threshold Limits of Performance Indicators for Low volume Roads

Riding Quality	Roughness IRI (m/km)	Average Depth (mm)	Rut Average Longitudinal Depression (mm)
Very Good	< 4.5	< 2	<3
Good	4.5 – 5.5	2-5	3-4
Fair	5.5-6.7	5-13	4-5.5
Poor	6.7-8.5	13-25	5.5-7.3
Very Poor	> 8.5	>25	>7.3

From Table 1, it may be observed that roughness more than 8.5 (IRI) gives uncomfortable ride on low volume roads. The corresponding values of rut depth and longitudinal depression are 25 mm and 7.3 mm respectively. Qiu et al. (2000) also established allowable rut depth for low volume rural roads by conducting a geometric analysis with the principle of avoiding excessive water back-up in the wheel path that could cause water-planing. For rural roads, with a cross slope of 4%, they recommended the allowable rut depth to be 25 mm. Hence a rut depth of 25 mm may be considered as terminal condition for rural roads.

TRAFFIC

Characteristics of commercial vehicles influence the performance of pavements and should be considered in the analysis in a rational manner. Traffic volume, growth rate and spectrum of axle loads are some features to be considered in converting the expected traffic to be carried by the pavement into equivalent number of standard axles.

Classified traffic volume counts were conducted on all the pavement sections during the study period to assess the intensity and nature of traffic plying on rural roads. The

loading pattern on these roads is highly seasonal and cannot be captured by an axle load survey conducted in a particular season. Hence, a different methodology was adopted here to calculate the average daily traffic in terms of standard axle repetitions plying on each test section. Details of goods carried by the commercial vehicles were separately surveyed for this purpose. Typical axle load characteristics were obtained for different combinations of vehicle type and loading conditions from previously collected axle load data, which commonly ply on rural roads.

Pavement Life

Pavement life was computed in terms of standard axle load repetitions. For the nineteen test sections considered in this study, the rutting and roughness trends were extrapolated to estimate the life of pavement for reaching the terminal conditions of 25 mm rut depth and IRI of 8.5 respectively as identified earlier.

MECHANISTIC EVALUATION OF PAVEMENT SECTIONS

Accurate modelling of the granular material during analysis is essential for better correlation of the identified mechanistic responses with the performance of thin sealed granular pavements. Material property expressed in terms of resilient modulus (MR) is an essential input for mechanistic analysis of pavement structures. As resilient modulus is a stress dependent property, appropriate value is selected as the basis of average stress condition expected to be prevalent in the layer. 3-D finite element models can better incorporate the complex behavior of the composite pavement materials.

The test sections were analysed as two layer systems consisting of a granular layer and subgrade using 3-D finite element modeling. The nonlinear k- relationship (Hicks and Monismith, 1971) developed by Pandey and Naidu (1994) for resilient modulus of granular materials as given by Eq. 1, was used in the finite element modeling.

$$M_R = 347(\ )^{0.7375} \quad \ldots (1)$$

where,

M_R = Resilient modulus in MPa

= Sum of principal stresses (1+ 2+ 3), in kPa

DEVELOPMENT OF PERFORMANCE CRITERIA

The mechanistic-empirical approach for design of flexible pavements consists of two parts: calculating the response of the pavement materials to the applied loading and predicting the pavement performance from these responses. For low volume roads with thin bituminous surfacing, most of the rutting will occur in the subgrade (Qiu et al., 2000). An attempt has been made in this study to identify the mechanistic response that best correlates with pavement life in rutting mode (expressed as number of standard axle load repetitions required to cause a specified rut depth of 25 mm).

Subgrade strain criteria developed by considering nonlinearity in granular layer is given as Eq. 2.

$$_z = 0.029N\text{-}0.272 \quad \ldots (2)$$

Where,

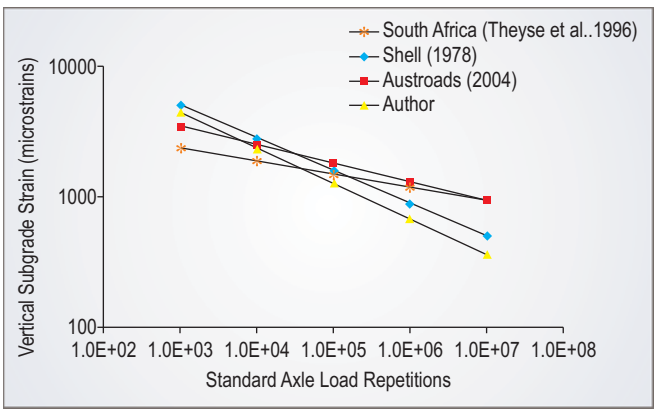
z = Vertical compressive strain over subgrade

N = Number of standard axle load repetitions leading to failure

The R2 value of the performance criteria given by Eq. 2 is 0.70. The t-stat value for parameter estimate is 6.21 indicating that the correlation is statistically significant.

Comparison of the subgrade strain performance criteria developed by Shell (1978), Austroads (2004) and South African procedure (Theyse et al., 1996) for low volume roads along with that developed in the present study (Eq. 2) is given by Fig. 3.

Fig. 3: Comparison of Performance Criteria



CONCLUSION

It is understood that to make the roads sustainable, design should be accurate and economical. In the absence of rational and practical guidelines and specifications for the design, construction and maintenance, rural roads have generally not been able to provide satisfactory service. Performance criterion is the most important aspect considered in the design of pavements and hence it should be rational. An effort has been made in this study to develop a performance criterion for rural roads based on critical subgrade strain. The nonlinear material property of the granular layer along with the properties of the subgrade soils were used in the finite element modeling for mechanistic evaluation of the pavements. Threshold limits for different riding qualities were proposes and the terminal condition was identified for thin surfaced low volume roads. Expected pavement lives in terms of standard axle load repetitions were correlated with the subgrade strain values for different test sections, obtained from the mechanistic evaluation to develop the performance criterion, which has been compared with the similar criteria developed in other countries.

Acknowledgements

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Improved Asset Management Climbing Out of the Road Sector Pothole!

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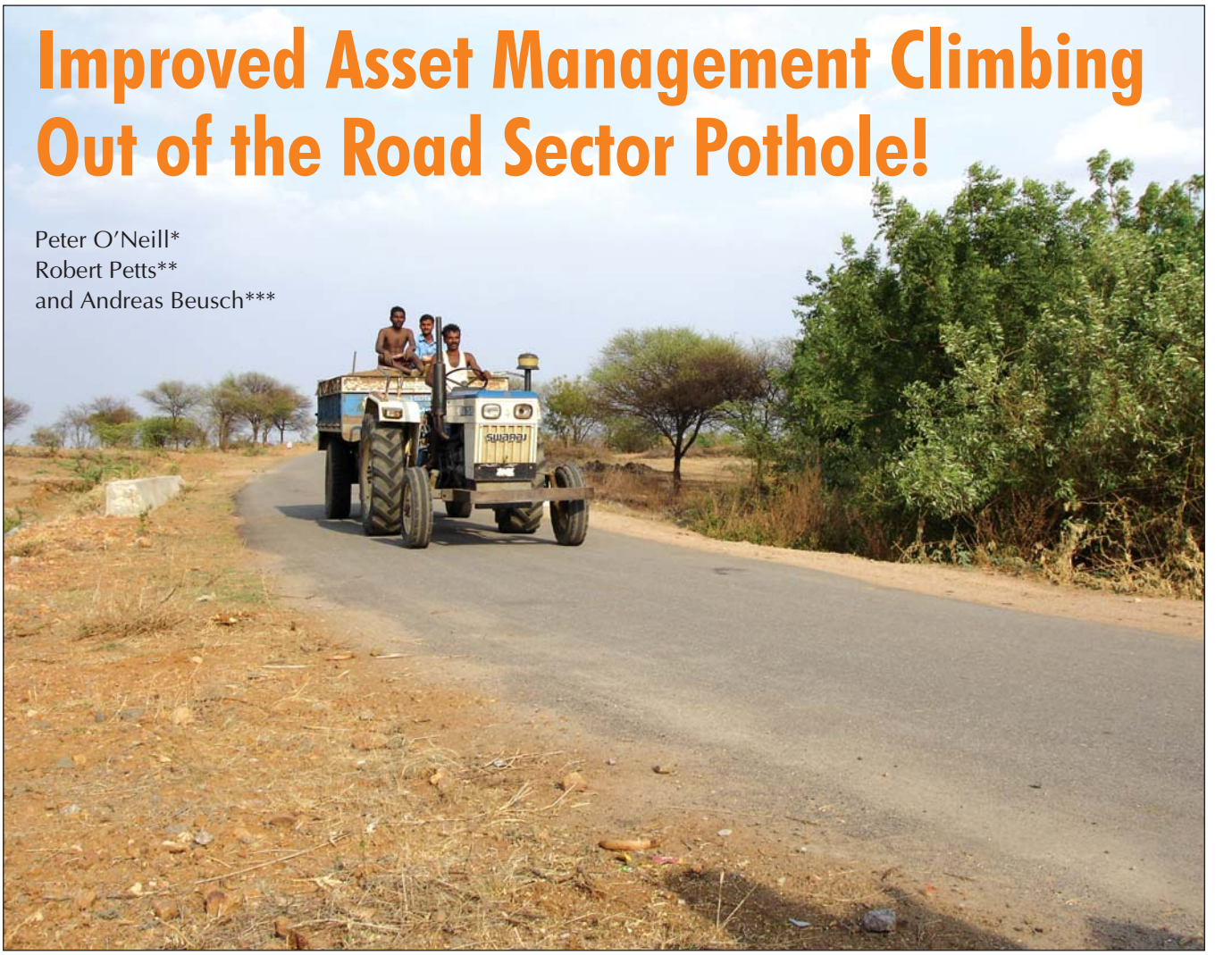

Despite decades of development aid assistance and publication of numerous 'Good Practice' guidelines, the rural road networks of many developing countries are still generally in a lamentable state of repair. This seriously constrains most development and poverty alleviation initiatives due to poor access and un-necessarily high transport costs. In many regions the rural road networks are predominantly unpaved (earth or gravel)[1]. With the likely future levels of investment and high costs of upgrading, this situation is unlikely to change significantly in the near future. Unfortunately earth and gravel roads require regular and ongoing maintenance that is costly in comparison to the initial investment cost[2]. Note that costs quoted in this paper are indicative only. Costs vary enormously between regions and even within countries due to the wide range of influential factors.

1 World Bank estimates that less than 15% of the classified networks are paved in Sub Saharan Africa and Latin America (Reference 1).

2 An engineered earth road may only cost about US$5,000/km to construct, but may require more than US$500/km/year to maintain (>10% of capital cost per annum). A gravel road may require the equivalent of >10% of its investment value to be deployed each year for periodic maintenance re-gravelling alone.

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For road asset owners the cost of rehabilitation is usually far higher than the relatively low cost of regular and appropriate maintenance, yet it is common practice to postpone or cancel timely maintenance with the inevitable adverse economic and social consequences. The main looser is the rural population that bears the costs and consequences of consistently unreliable access and very high transport costs from sub-standard road surfaces.

How can the industry move to a position of responsible and effective rural road asset management, taking advantage of full life costing and the advantages of regular maintenance?

The paper reviews the sector experiences of improving road network management and maintenance performance. It concludes that most road asset management initiatives have not clearly identified the full range of challenges to be addressed, and have had neither the duration nor comprehensive range of interventions needed to improve performance sustainably to acceptable levels.

The paper draws on experiences of institutional and operational performance reviews that indicate that the road sector network management technical problems are of a minor, though still crucial, nature. Improved sector performance also requires that the various constraining financial, institutional, operational and governance issues be identified and that comprehensive solutions need to be developed with the full support of the key sector stakeholders, over an extended timescale. In 1981, the World Bank[3] concluded that "The evidence is abundant that satisfactory basic (maintenance) systems can seldom be established in less than fifteen or twenty years..."

The authors believe that this period can be reduced with a thorough assessment and identification of all of the challenges to be addressed, and the development of comprehensive solutions with the active participation of the key stakeholders.

The Economics and Funding of Maintenance

The justification for proper maintenance of the rural road infrastructure asset is well documented [for example 4, 5]. Rational maintenance expenditure usually provides economic rates of return far in excess of road construction, upgrading or rehabilitation investment.

Proper road maintenance contributes to reliable transport at reduced cost, as there is a direct link between road condition and vehicle operating costs (VOC). An improperly maintained road can also represent an increased safety hazard to the user, leading to more accidents, with their associated human and property costs. In general, road maintenance activities can be broken into four categories; these are often funded from separate road agency budgets:

i. **Routine works.** These are works that are undertaken each year that are funded from the recurrent budget. Activities can be grouped into cyclic and reactive works types. Cyclic works are those undertaken where the maintenance standard indicates the frequency at which activities should be undertaken. Examples are verge cutting and culvert cleaning, both of which are dependent on environmental effects rather than on traffic levels. Routine unsealed road grading works are ideally carried out when there is sufficient moisture in the surface to avoid expensive watering and compaction. Reactive works are those where intervention levels, defined in the maintenance standard, are used to determine when maintenance is needed. An example is patching, which is carried out in response to the appearance of local deformation or pot-holes.

ii. **Periodic works.** These include activities undertaken at intervals of several years to preserve the structural integrity of the road. For rural roads this normally consists of major rebuilding of the earth road section and drainage system. For gravel roads the principal

3 World Bank, The RoadMaintenance Problem and International Assistance, 1981.

4 World Bank, Sally Burningham and Natalya Stankevic,Why road maintenance is important and how to get it done, Transport Note No. TRN-4, June 2005, et. al.

5 PIARC (World Road Association), Save Your Country's Roads.

periodic maintenance activity is re-gravelling to replace the surface material losses caused by traffic and weather. As such, they can be budgeted for on a regular basis and can be included in the recurrent budget. However, many countries consider these activities as discrete projects and fund them from the capital budget. Failure to plan and implement these works in a timely manner cause additional rehabilitation costs and of course great inconvenience and added VOCs to road users.

iii. **Special works.** These are activities whose need cannot be estimated with any certainty in advance. The activities include emergency works to repair landslides and washouts that result in the road being cut or made impassable. Winter maintenance works of snow removal or salting are also included under this heading. A contingency allowance is normally included within the recurrent budget to fund these works, although separate special contingency funds may also be provided.

iv. **Development.** These are construction works that are identified as part of the development planning activity. As such, they are usually funded from the capital budget or external assistance. Examples are the paving of unpaved roads in and to villages.

CHOICE OF TECHNOLOGY

For decades there has been a discussion about the appropriate technology for rural road works in developing countries. The basic resource costs in developing countries are very different from the economically advanced nations. Labour wage rates are usually in excess of US$100/day equivalent and market credit rates <10% per annum in the developed world. In stark contrast, developing country wage rates are usually much less than US$10/day. Furthermore the private sector generally has difficulty in accessing credit, and interest rates are usually in excess of 20% per annum. This extreme difference in resource availability and costs suggests that labour-based and low-capital technologies should predominate. However, the experience is that policies, prejudices, ignorance, unprofessional practices, lack of experience, inappropriate standards, specifications and contract framework etc. can combine to prevent widespread uptake of what would generally be a more socio-economically attractive strategy for developing countries. Some regions in Asia have not suffered from these shortcomings and have reaped the benefits.

THE LURCH FROM FORCE ACCOUNT TO PRIVATE SECTOR

Since the 1970s, there have been concerted efforts to introduce labour-based road construction and maintenance into many developing countries where it was not already established. This was principally for reasons of employment creation and poverty reduction, as well as infrastructure provision. The techniques have also been successfully utilised in post-crisis emergency programmes. Initially most projects were under force account or direct labour arrangements, however the focus moved to private sector approaches through initiatives to develop small scale labour based contractors. There was anyway a long established culture of labour-based road works in China, India and some other Asian countries.

Recently the experiences of the labour based road works initiatives have been reviewed in a number of developing countries. There are vital lessons to be learned from the experiences of the last 30 years. These must be absorbed

into future initiatives to ensure that these legitimate strategies for creating rural infrastructure, providing universal access, facilitating rural development and alleviating poverty become cost-effective and sustainable.

WHAT HAS BEEN POSITIVE?

Besides the construction of substantial road infrastructure and considerable project employment in poor communities in many developing countries, considerable technical, institutional, management and social knowledge has been accumulated regarding:-

- Incorporating labour based methods as part of a wider Local Resource Based (LRB) strategy to cost-effectively mobilise all relevant local resources (labour: skilled and unskilled, materials: including marginal, simple equipment, enterprises, within appropriate financing, management and community structures)
- Feasibility, justification and scope for substituting LRB for existing capital intensive, high carbon footprint road works techniques
- Understanding of the social, gender, employment creation potential, local resource based benefits and development facilitation potential of LRB road works
- Effective inclusion of cross-cutting issues in work planning and implementation process and beyond-road activities
- Establishment and documentation of the components of good technical practice for LRB road works methods
- Development of planning tools that are target community inclusive and can prioritise interventions in rural transport infrastructure OR other more appropriate development initiatives/services (for example Integrated Rural Accessibility Planning IRAP)
- Development of high quality training curricula and material suitable for practice-orientated and academic purposes
- Development of productivity norms, standards, specifications, hand tool and support equipment requirements for successful LRB road works
- Development of appropriate quality assurance approaches for rural road works
- International cadre of LRB expertise

WHY HAVE PAST INITIATIVES NOT BEEN SUSTAINED?

In the 1990s, the DFID funded MART initiative and Intech-Zimbabwe Government international workshops on Labour Based Contracting development set out the framework for a facilitating environment for the establishment of cost-effective and sustainable rural road works using private sector, local-resource-based (LRB) approaches. However, many of the essential pre-requisites identified by these initiatives have not been incorporated in the projects and programmes, so that a sustainable 'enabling environment' has not been created.

The experience has identified the following typical shortcomings:-

- Focus on gravel roads, which are initially cheap to build, however maintenance is extremely problematic and rarely properly resourced unsustainable technique (It is anyway difficult to

show LRB advantages over heavy equipment approaches as the operation is essentially a materials transportation exercise)

- Lack of local high level and policy support for local resource based methods
- Lack of effective implementation strategies to mainstream local resource based approaches into planning and design, social impact assessment, approval, bidding, work implementation, quality assurance and auditing.
- Focus on central Road Authority management and failure to effectively capacitate and develop key stakeholders for decentralisation policies: e.g. rural communities, politicians, planners, NGOs, local government, other rural development agencies and sector expertise
- Lack of sufficient understanding of the private construction sector, particularly in the rural environment, and the need and potential for enterprises to have a diversified and robust client base
- Lack of workload continuity for trained contractors and local consultants after project closure
- Lack of appropriate national contract framework for small scale contractors
- Lack of affordable finance for contractor development and failure to make consistently timely contract certificate payments
- Local resource based approaches not included in most civil engineering education and training curricula
- Lack of institutionalised training capacity for local resource based and rural engineering
- Lack of accreditation, certification and recognition of LRB training and expertise
- Lack of effective and sustainable training and demonstration arrangements for LRB good practice
- Lack of forums for contractor representation to counteract the natural contractual imbalance towards clients in a developing country environment
- Weak appreciation of the real and variable costs of works options, economic and social dimensions and benefits, particularly regarding issues of local cost factors, logistics, overheads, credit, delayed payments, employment generation etc.
- National standards, norms and specifications unchanged and do not encourage local resource based approaches
- Failure to adopt durable surfacing and paving techniques which are inherently labour and local materials orientated
- Neglect of the core technical issues that must be fully understood and integrated with the equally important socio-economic dimensions to ensure viable and sustainable outcomes
- Failure to effectively engage with and share knowledge from major LRB road works practitioners

in regions such as China and India

- Failure to support development and mentoring of the next generation of national and regional experts to continue mainstreaming sustainable LRB road works
- Lack of transparency in road sector activities that allows opaque management practices. This prevents effective performance monitoring and audit, and allows fraudulent practices to operate.

WHAT NEEDS TO BE DONE?

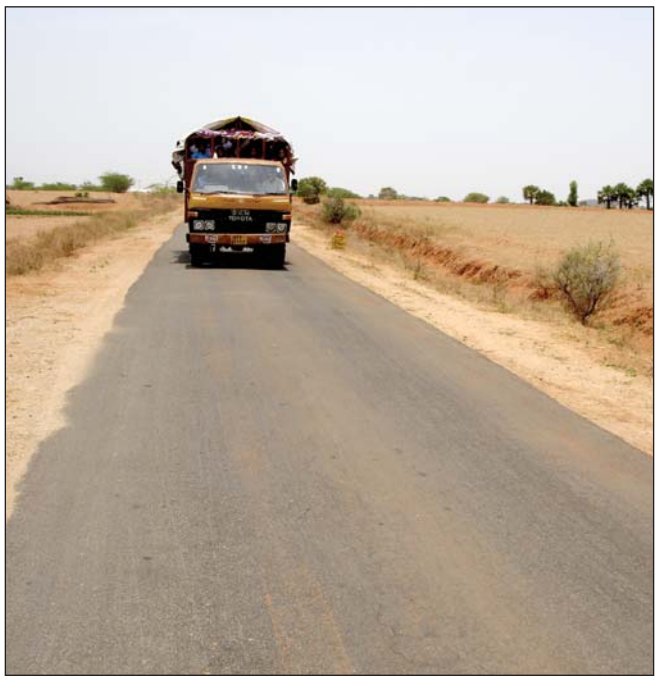
Interested stakeholders in the rural road sector should engage and collectively critically review the past experiences and form a concerted effort to reform the strategies for achieving sustainable local-resource-based solutions for effective rural transport services and infrastructure, and provision of universal basic access. The process could include the following specific initiatives:-

- Commission an objective and constructive sub-sector review by a team of acknowledged leading experts
- Organise LRB road works strategy workshops to include key resourcing agencies, practitioners and stakeholders
- Commission the compilation of a web-posted up to date Knowledge Base as a 'good practice' benchmark
- Develop a concerted programme of effective support for mainstreaming LRB road works methods

THE WAY AHEAD

The review of the experiences of the recent decades suggests that a new approach is required which is more comprehensive and inclusive, and incorporates recognition and adoption of the following key principles and objectives:

- ❖ The national rural road infrastructure is a vital, expensive and extensive asset that requires pro-active, professional management.
- ❖ Identify a strategic 'core' network that can be properly maintained with the available recurrent resources. The rest of the network must necessarily suffer lower levels of service in the short term (this is anyway the status quo on many networks).
- ❖ If parts of the 'core' network are not maintainable, investigate ways and costs to tackle the problematic 'spots', that if tackled will provide year round access.
- ❖ Some sections of the 'core' network will justify complete upgrading to paved standard. This is likely to be justifiable if the traffic levels are in the region of 50 100 vehicles per day equivalent.
- ❖ Carry out a thorough review of the network management. It is likely that at least some of the following issues will require and justify improvement:-
- A National Policy on Rural Transport in place developed to optimise local resource based approaches, after stakeholder consultation.
- Regular critical and constructive policy review by stakeholders.
- An appropriate institutional framework and agreed responsibilities for Rural Transport policy implementation.



- Appropriate classification of the road network according to the road task. Including categories of Low Volume Rural Roads (LVRR). LVRR have low volumes of traffic, as defined by four wheel, two and more axle traffic, but may have very high volumes of alternative traffic modes, such as foot, bicycle, motorcycle, ox-cart etc.
- Appropriate and affordable Standards, Specifications and Guidelines for each category of road, which will enable the application of Rural Road Engineering good practice, including:
  - provision of Low Cost Structures (gTKP Guideline being finalised)
  - improvement of the natural road surface (Engineered Natural Surfaces) where appropriate, and drainage
  - appropriate use of gravel surface, within rational limitations on application of this 'wasting' surface
  - provision of more durable surface options in Spot Improvement - locations or more extensive route lengths where affordable and justifiable (gTKP Guideline being prepared)
  - environment and sustainability issues accommodated
- Pragmatic partnerships between communities, government and other stakeholders developed to realise improvements in Rural Transport.
- Realistic strategies for improving Rural Transport Services in place.
- Potentials for both motorised and non-motorized transport services recognised and issues of commercial viability, affordability, reliability and safety addressed.
- Good practice guidelines on planning, design, construction and maintenance in place, using Rural Accessibility Planning tools where appropriate to determine optimal transport and other rural infrastructure investment priorities.
- RealisticWhole Life Costing methods used to support investment and fund allocation decisions.
- Environmentally Optimised Design (EOD) strategies in place to include investment options from Basic Access and Spot Improvements through to Whole Link upgrades.
- Policies, guidelines and implementation making best use of local resources (materials, labour, skills, enterprises, communities, intermediate equipment, etc.)
- Appropriate and affordable levels of road maintenance established and sustainable financing secured in cooperation with the Finance Ministry.
- Appropriate contract documentation in use that facilitates local enterprise involvement and use of local resource based methods supported where appropriate by low cost equipment.
- Pragmatic Supervision and Quality Control arrangements in place.
- Access by potentially damaging vehicles controlled.

- Awareness Creation and Training of operatives, decision makers and other key stakeholders funded, available and widely used.
- Traditional and potential social resources and practices recognised and the role of women and disadvantaged groups satisfactorily accommodated to realise improved performance potential.
- Monitoring public Rural Transport investments and expenditures carried out routinely and transparently to ensure value for money.
- Appropriate Human Resource Development policies and dedicated resources for the implementation.

CONCLUSIONS

It is clear that the management of rural roads is unusually challenging, with scarce financial and skilled/experienced human resources. It can be argued that it requires a greater level of skill, understanding and commitment than for main roads! However the complexities can be broken down into issues that can be addressed with carefully targeted interventions. However the task is substantial and it is essential to create awareness with all stakeholders from political level to 'grass roots', and to work together to achieve improvements in sector performance. This should start with a comprehensive and critical detailed review of the status quo. With concerted efforts and comprehensive programmes of interventions developed with and supported by all key stakeholders, it is possible to substantially reduce the timescales for radical improvement previously thought to be necessary.

If this is not done, then rural isolation, poor health, poor education, poverty and underdevelopment will continue to blight the rural communities in developing countries.

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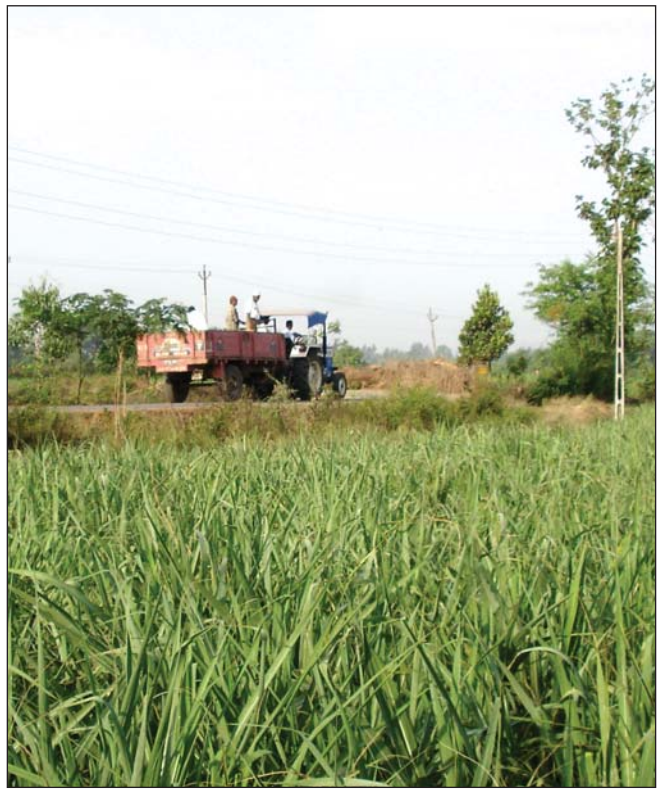

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