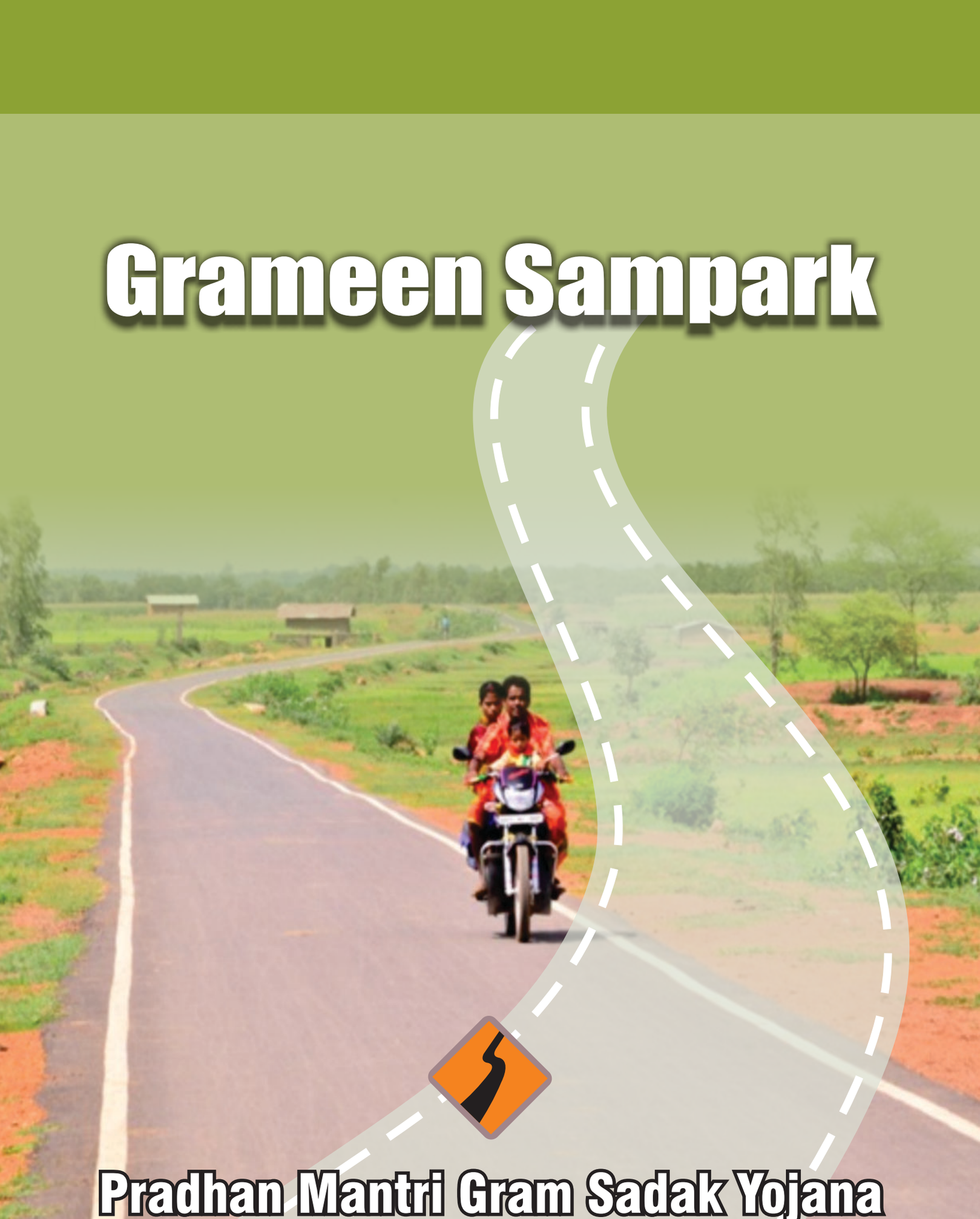
Grameen Sampark



Pradhan Mantri Gram Sadak Yojana

In this Issue

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

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

Published by: National Rural Roads Development Agency

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Note: Accepted articles may be condensed.

Editorial

Rural roads comprise over 80% of the total road network in India. Hence, keeping them in a serviceable condition is crucial to rural and agricultural growth. Rural roads, particularly, good quality all-weather PMGSY roads provide access to millions of rural people to social and economic facilities i.e. hospitals, schools, colleges, markets, administrative centers etc. In last 16 years, PMGSY has constructed well-engineered, good quality network of about 5,10,000 kms of rural roads. As this network increases, so do the concerns regarding rural road safety in India.

2. The World Health Organization (WHO) has predicted that by 2020, road accidents will be third most important cause of death or disability worldwide, and if nothing is done, road accidents will kill more people than Malaria and Tuberculosis. Existing records seriously under-report the number of road accidents and casualty caused therein. This is even more acute in the context of rural roads network. In India, road safety becomes a critical issue when new or improved and upgraded rural roads under PMGSY-I and PMGSY-II open up isolated areas. This is particularly due to the increased interaction between motorized and non-motorized traffic. This interaction causes more accidents on rural roads, but most of these accidents generally go under-reported. This problem is made more acute because of the fact that no special initiative has been taken to educate communities about basic traffic rules before, during or after the construction of new roads. Various studies in India have indicated that risk on rural roads is higher for pedestrians and cyclists in comparison to users of motorized vehicles. A study on PMGSY programme in Rajasthan has showed that there are higher risks for school going children travelling by bicycle. The rural road safety strategies in India therefore have to focus on 5 Es – engineering, education and enforcement with due consideration to environment and evaluation as well as other comprehensive actions.

4. Apart from the 5 Es, there is a need to focus on Road Safety Reviews (RSR) and Road Safety Audits (RSA). While Safety Reviews are reactive, Safety Audits are pro-active. The attempt should be to train road engineers in conducting such Reviews and Audits.

5. Road safety is everybody's concern, but is not receiving the due attention it deserves. This issue of "Grameen Sampark" covers some of the important themes on road safety. We hope that all stakeholders will commit and discharge their responsibilities for promoting road safety.

(Rajesh Bhushan)
Director General, NRRDA

Characterization of River Bed Materials for Rural Road Construction

P.P Biswas* M.K.Sahis** S. Sarkar***

1.0 Introduction

The rural road connection in India may be considered as a neural network of the economy of the country. In this context, road pavement structure with sustainable materials has become the need of the hour where cost effective and durable pavement construction materials are gaining priority increasingly.

India is a river based country. River bed materials particularly in the downstream stretch of a river can be obtained in vast quantity and with a cheaper cost, which can be used in different types of construction including road pavement. Few research projects have been undertaken in India for characterization of river bed materials of different rivers originating from different mountain sources and rolling through different terrains and terminating at different sources. Present paper primarily deals with characterization of river bed materials (RBM) for use in flexible pavement either in base or sub base layer to make the pavement durable and cost effective.

The River bed materials is an accumulation or deposit of material derived naturally from the disintegration of rocks. Different rivers having various types of bed materials. This various forms include, Stone, Boulder, Gravel, Coarse aggregates, different types of sand, Silt and clay.

In spite of some legal difficulties, the application of RBM in flexible pavement construction, particularly as granular base and granular sub base are gaining popularity in rural road construction due to reduction in project cost. Presently, emphasis need to be laid to fix up appropriate specification for use of such RBM materials to make the pavement structure durable on different types of subgrade soil. In this backdrop, suitable mix design of soils and granular materials need to be formulated for optimal utilisation of fine and coarse aggregates. Moreover, collection, transportation and segregation of RBM may be considered as a potential source of income of local people, who otherwise are considered as community participant and stakeholders of such rural road projects.

2.0 Objective and Scope

The main objective of the research work reported in present paper is to characterize the locally available river bed materials in line with the relevant Indian Roads Congress specification, under laboratory investigation. To fulfil the objectives, two rivers from North Bengal and two rivers from South Bengal have been considered in present study and river bed material samples were collected from three different locations of each river.

3.0 River details with Sample Classification

Table 1. Name and Location of River Selected for Sample Collection

Sl. No.	Name of River	Location of Sample Collection	Sample number
1	Teesta River. (North Bengal)	1) Kalijhora (Near Hydel Power project) 2) Sevok (Near Sevok Corronation Bridge) 3) Down stream end of NJP-Assam Railway Bridge.	T1 T2 T3
2	Balasone River (North Bengal)	1) Matigara. 2) Matigara Road bridge 3) Siliguri. (Near Rail Bridge)	B1 B2 B3

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Sl. No.	Name of River	Location of Sample Collection	Sample number
3	Damodar River (South Bengal)	1) 1)Arambag Road Bridge, Burdwan 2) Amta,Howrah, (Near Bridge) 3) Mahisrekha, Howrah, (Near Bombay road Bridge)	D1 D2 D3
4	Ajay River (South Bengal)	1) 1)Bolpur (Near Railway Bridge) 2) Natunhat (Mongolkort), Burdwan 3) Katwa, Burdwan	A1 A2 A3

4.0 Laboratory Investigation

The following laboratory tests were conducted following standard guidelines of relevant IS codes. (i) Sieve Analysis (ii) standard Proctor test (iii) Flakiness and Elongation. (iv)Specific Gravity (v) Water Absorption (vi) Aggregate Impact Test (vii) Los Angles abrasion test (viii) CBR Test.

Three test samples from each locations of each river were considered for distribution (GDC) is one of the most important and useful test of coarse and fine aggregates to be used in the Flexible pavement with unbound granular base and sub base. The results obtained for grain size distribution of the RBM materials are presented in Table2. Other test results obtained from laboratory investigation are presented in Table3 and Table4.

Table2. Grain size characteristics of River bed materials

River sample	D_{10}	D_{30}	D_{60}	C_u	C_c
Ajay	0.20	0.45	0.75	3.1	1.2
Damodar	0.27	0.40	0.55	1.9	1.0
Teesta	0.50	1.80	15.8	32.1	0.45
Balason	0.55	2.60	12.2	21.6	1.0

Where Cu = Uniformity Coefficent Cc = Coefficient of curvature, D10, D30 and D60 is the effective size corresponding to 10% , 30% and 60% of the sample finer in weight on the Grain size distribution curve.

Moreover, MDD= Maximum Dry Density, OMC = Optimum Moisture Content, AIV = Aggregate Impact Value CBR = California Bearing Ratio.

Table 3. Laboratory test results of River bed aggregates

Property	Test Value of RBM of		Maximum. requirement as per IRC	
	Teesta	Balasone	Sub-Base Course	Base Course
Aggregate Impact Value (%)	14.9	17.2	50	40
Los Angles Abrasion Value (%)	35.6	40.28*	40	40
Flakiness Index (%)	41*	28	40	30
Water Absorption (%)	0.60	0.58	1.0	1.0
Specific gravity	2.69	2.67	2.67-2.9	2.5-3.0
CBR (%)	33.65	35.9	Grade-I 30% (Minimum) Grade-II 25% (Minimum) Grage-III 20 % Minimum	

*Marginally out-of specification.

Table 4. CBR and Standard Proctor test results for RBM

Sample No	Light Compaction		Heavy Compaction		CBR (%)	
	MDD (gm/cm^3)	OMC (%)	MDD (gm/cm^3)	OMC (%)	Unsoaked	Soaked
Damodar	1.58	12.3	1.76	10.4	28	25
Ajay	1.58	13.7	1.76	12.5	29	24
Teesta	2.05	9.90	2.13	9.70	38	34
Balason	2.13	8.60	2.18	7.50	42	38

5.0. Discussion and Concluding Remarks

Based on the investigation carried during present scope of work, the following conclusion may be drawn.

1. Gradation of riverbed materials of river Ajay and river Damodar were found to be medium sand. Grading of river Teesta and Balasone mostly satisfied requirement Grading zone I & II of IRC specification for sub-base construction and mostly tends to follow Grading A of IRC SP:77 2008 for construction of base course. To achieve 100% grading requirement of specification on tested virgin samples some fine contents may be required to be added.
2. The test result, presented in Table 3 conducted on river bed materials show that the RBM considered under present investigation may be used as a sub-base and base layer in low volume rural roads.
3. Specific gravity of collected river bed materials of river bed sand and aggregates were found in the range of 2.61 to 2.68 and 2.65 to 2.7 respectively. It is within the range 2.50 to 3.0 and hence may be used as highway construction material.
4. Bulk density of sand particles of river Ajay at loose and dense state were found 1.36gm/cc to 1.46 gm/cc and 1.68 gm/cc to 1.75 gm/cc respectively. Damodar were found at loose and dense state are 1.30 gm/cc to 1.45gm/cc and 1.60 gm/cc to 1.75 gm/cc respectively.
5. Dry density of sand particles of river Ajay by light compaction and heavy compaction were found as 1.58 gm/cc and 1.76 gm/cc respectively. Light compaction and heavy compaction result on Damodar sand were found 1.58 gm/cc and 1.76 gm/cc respectively. Similarly, dry density of river bed aggregates of river Teesta at light compaction and heavy compaction were found 2.05 gm / cc and.13gm/cc respectively. Moreover, light compaction and heavy compaction test results of Balasone RBM were found 2.13gm/cc and 2.18gm/cc respectively and therefore may be considered for use in road construction.
6. It is evident from Table 4 that the CBR of RBM materials under soaked and unsoaked conditions comply the requirement of granular sub base for rural roads even with comparatively higher design load.

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Some Basic Concepts to Enhance Safety On PMGSY Roads

Dr. P. K. Agarwal*, Dr. *Rakesh Mehar*and Er. *Himanshu Jaisawal******

Abstract

PMGSY roads are generally single lane roads with low design speeds and with low volumes of traffic both motorized and non-motorized. The sudden influx of high speed motorized vehicles to the PMGSY roads can seriously affect the safety of road users, particularly of vulnerable road users like children, women carrying head loads of agricultural produce, cyclists etc. The problem gets serious because all the road users use the same narrow road width of a single lane, where crossing and overtaking becomes very difficult. Moreover, drivers and road users are not always given any significance to attention for the awareness of driving rules and regulations in rural areas. Further, at the time of accidents, trauma care facilities are not easily and instantly available for victims on PMGSY roads in rural areas. Under these conditions, remedial safety measures, both engineering and social, must be taken. Road safety on PMGSY roads needs increasing attention in planning, design and implementation process. . It is thus expected that as the PMGSY roads get constructed and upgraded, road safety will be an issue requiring serious consideration. Therefore, this study highlights some safety issues and also some remedial measures to enhance safety on PMGSY roads. Various road safety measures like improvement of geometrical deficiencies of roads, enforcing road safety policies, conducting road safety audit, organizing human awareness programme etc. can be very effective and helpful in reducing the road accidents. It is expected that this study will be useful to enhance safety on PMGSY roads.

Introduction

Road safety problem in rural roads is more acute with developing countries as they contribute to around 90% of deaths arising out of road fatalities. While the number of accidents was rising in India (up by 13% from 2004 to 2009) it was decreasing in China (down by 54%). In India, PMGSY roads Safety is a very serious issue of concern because rural areas are far from development and accidents trauma care facilities are not easily available. Road safety attains higher importance especially with programs like PMGSY. The road accidents cause huge economic and social losses hence it is necessary to reduce road accidents. It can be said that many accidents on PMGSY roads may go unreported/ unrecorded and any clear statistics regarding the number of accidents on PMGSY roads in India is not available. Therefore, the issues concern with road safety are to be properly understood and attended to for minimizing the accidents on PMGSY roads, though it is not possible to eliminate them. Accidents involving vulnerable road users were higher on PMGSY roads than on state highways. Although speeds were lower on PMGSY roads, the proportion of vulnerable road user was higher and fatalities in this group were likely to be serious. Hit and run cases were more frequent on PMGSY roads.

According to the MORTH, 61% of the RTI fatalities occur in rural areas and it is possible that a larger number of cases go unreported on PMGSY roads. Number of accidents in rural areas (2, 66,231) larger being 53.5% compared to urban areas (2, 31,455) at 46.5%. In fact the percentage of injured persons (59.4%) is also higher. Similarly rate of fatalities (63.4%) being even higher. The percentage share of accidents in rural areas and urban areas were 53.7 and 46.3 respectively. Figure 1 presents the comparison of number of accidents in rural and urban areas in the year of 2014 in India.

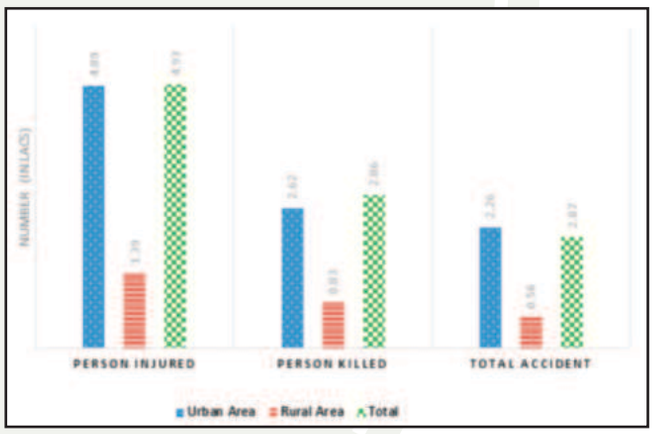

Fig 1-Comparison of Road Accidents in Urban and Rural Area of India (in the Year 2014) (MORTH,2014)

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This study contains three sections. First section presents the introduction of the study, second section presents major safety issues on PMGSY roads. The third section of the study presents remedial safety measures to reduce the road accidents on PMGSY roads. The last section presents the important conclusions drawn from this study.

Specific Safety Problems on PMGSY Roads

This study identifies some specific safety problems that occur specifically on PMGSY roads. These problems can be associated with various factors like narrow lanes, obstruction to traffic, awareness, literacy etc. Some of the specific safety problems on PMGSY roads are summarized as follows.

- Habitation, schools, market etc. near PMGSY roads creates road safety hazards and make accidents prone locations. Photograph 1 illustrates the habitations near road creates safety hazards condition.

Photograph 1- Habitation along PMGSY Roads creates Hazards to Road Safety

- Over loading of passenger vehicles, Poor Vehicle Condition, over speeding, are also road user behavioral problems which may cause the road accidents. Photograph 2 illustrates the overloading that can cause the serious road accident.

Photograph 2 - Overloading of Passenger Vehicles is another Safety Issue on PMGSY Roads

- Cattle and animals crossing roads, especially during nights may suddenly obstruct the road and can cause the severe accidents.
- Narrow culverts, bridges and absence of railings increase the probability of vehicles to fall in culverts.
- In PMGSY Roads, users use same narrow road of single lane width with mixed traffic condition, which makes the overtaking operation phenomena more unsafe. Also overtaking whenever carriage way is blocked by animal drawn vehicles / herds of cattle is dangerous and can provoke the accidents. Photograph3 shows the mixed traffic condition at single lane may provoke accidents while overtaking.

Photograph 3 – Narrow road width may provoke accidents during overtaking-A Safety Issue on PMGSY Roads

- Due to the lack of education in rural areas, human awareness about traffic rules and regulations are not at desire level.
- Drunken driving and pedestrian's carelessness are some safety issues that should be considered seriously through various human awareness programme.
- In the rural areas where literacy and awareness are at low level, accidents are considered as acts of God. Accidents are not being taken seriously for preventing them. There is no unified authority to address the problem of road safety.

Safety Issues on PMGSY Roads

The problem associated with safety particularly on PMGSY roads is multifold. Safety at rural roads can also be influenced by various factors like geometrical deficiencies of roads, traffic operation related issues, road user behavior issues, planning and design related issues etc. Some of the safety issues at PMGSY roads are discussed briefly as follows:

- Lack of Super-Elevation at sharp curves possibly creates safety hazards conditions. Photograph 4 illustrates the safety hazards condition due to sharp curves at PMGSY roads.

Photograph 4 - Road Safety Hazards due to Sharp Curves on PMGSY Road

- Improper sight distance at sharp curves due to trees, vegetation and other obstruction creates accident prone locations and increases the road safety hazards condition at PMGSY roads. Photograph 5 illustrates the improper sight distance due to obstruction at PMGSY roads which creates the safety hazards condition.

Photograph 5 - Improper Sight Distance- A Safety Hazardous Condition at PMGSY Roads

- Insufficient shoulder width and shoulder drops don't give space vehicle to stop and provoke accidents by narrow lane width.
- Poorly designed intersections create the accidents prone junctions, Drivers and road user in the rural areas are not always given to enough attention of driving rules and traffic signs.
- Abrupt changes in rural roads also make vehicles to change its direction very rapidly and endanger to accidents.
- Pooling of water due to deteriorating roads, especially during rainy season cause the failure of roads and hence make it more prone to the accidents.
- The sudden entry of high speed motorized vehicles to the PMGSY roads can seriously endanger the safety of road users, particularly of vulnerable road users like children (going to the schools), women, cyclists etc.
- Un-manned railway crossings can make the more chance of collision of vehicles with trains due to the absence of any control.
- Pooling of water due to deteriorating roads, especially during rainy season also creates safety hazards conditions.
- In Rural areas, Tar roads are being constructed and there is sudden plight of vehicles on these roads with higher speeds, which creates hazards condition.

Remedial Safety Measures on PMGSY Roads

There are various serious issues concerning road safety on PMGSY roads as discussed in earlier section. Hence there is need to identify some remedial safety measures to enhance safety at PMGSY roads. Some of the remedial safety measures are summarized as follows:

- Geometrical deficiencies on PMGSY roads needs to be improved. Transition curves, adequate super elevation, extra widening need to be provided accurately.
- The vertical profile of the PMGSY roads needs to be designed to ensure that minimum stopping sight distance is available at every point. Also Suitable summit and valley curves need to be provided for comfort of passenger.
- Guard Stones should be provided on the sharp

horizontal curves. Further, proper super elevations, cautionary boards and extra widening should also be provided at curves to enhance safety. Photograph 6 illustrates the provision of guard stones at sharp curves to enhance safety at PMGSY roads.

Photograph 6- Guard Stone provided at Sharp Curves enhances safety on PMGSY Roads

- Junctions of PMGSY roads with main road needs be designed by providing minimum turning radius, flaring of the side road, acceleration/deceleration lanes and adequate sight distances etc.
- Safety near habitation and schools can be enhanced by providing adequately designed road humps, rumble strips, warning signs, habitation sign boards etc. Photograph 7 illustrates that provision of speed humps near habitations may enhance safety at PMGAY

Photograph 7 –Provision of Road Humps near schools, Habitations etc. Enhances Safety

- Roadway markers and delineators on the roads needs to be provided to guide the road users about the horizontal road alignment.
- Provision of traffic signage, warning and regulatory signs etc. may enhance road safety, especially near habitations and school zones, sharp curves, narrow bridges, junctions, submersible bridges and causeways.
- Road Markings at edges needs to be provided to alert the drivers in the night time about the carriage way lines to enhance safety.
- For ordinary wires and lines carrying very low voltage up to and including 110 volts, e.g., telecommunication lines, vertical clearance is 5.5 meter, clearance needs to be provided as per guidelines of IRC: 32-1969.
- Trees and electric poles on the shoulders should be painted in black and white layers to increase the visibility at night.
- Wells at critical locations should be protected with proper protection walls.
- Properly designed bus-bays must be provided at bus stop to ensure that the buses do not hamper the normal traffic.
- Road safety can be enhanced by conducting road safety audit through which we examine an existing or future road or intersection and identify the road safety hazards by an independent, multidisciplinary team.
- A Road Safety Audit (RSA) is a formal procedure for assessing safety performance examination of an existing or future road or intersection by an independent audit team. Road safety audits can be used in any phase of project development from planning and preliminary engineering, design and construction.
- School children must be made aware of simple precautions to be taken while moving along or crossing the roads. Help of Gram Sabha /NGOs may be sought for awareness campaigns for road safety. Suitable educational materials should be developed and aimed at risk groups identified by specialists. Awareness sessions about road safety aspects and signage should be conducted to obtain the behavior change and thus helps in reduction of accidents. Photograph 8 illustrates awareness sessions with the school children and also with the community to enhance the awareness about road safety

aspects.

Photograph 8 – Organizing Safety Awareness Programme at Schools Enhance Road Safety in Rural Areas

Conclusions

Safety on PMGSY roads has become a serious concern, with the increasing road network in scattered and remote areas in India. Various safety issues on PMGSY roads are discussed in this study which includes geometrical deficiencies, traffic regulation related issues, road user behavior related issues and planning and design issues, etc. Remedial measures to enhance safety on PMGSY roads are also identified in this study like improvement of geometrical deficiencies, improvement in traffic operations, enforcement and policing, appropriate planning and design of rural roads, organizing awareness sessions etc. Thus, it is expected that this study will be useful in enhancing safety at PMGSY roads and will help to decrease road accident in rural areas.

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Road Construction In Hilly Regions: Need For Exploration, Study of Best Practices And Adoption of Suitable Technique For Construction.

G.T. Dhungel Roshan Raj Pandey***

Introduction

Road construction in Hilly regions is a challenging task due to number of factors which renders construction costly and at the same time the cost of maintenance, which is on the higher side than maintenance of road in plain areas. The issue of sustainability of the road in fragile region like Sikkim is even more pronounced. The experience gained over the past many years of the authors is thus tried to put forth in this article along with the present method of construction adopted and the best methods that could be adopted for making roads more sustainable and environment friendly.

Cut and Throw method:

It is seen that most of the construction that is taking place entails obtaining the entire formation of the road in cutting thus calling for large scale cutting in fragile hill slopes which in turn renders the slope vulnerable to slides and slope failures due to:

1. Slope modification: As it is the natural cross slope of the hills that is encountered in the state of Sikkim is in the range of 30 to 45 degrees and any further modification of the cross slope, which is inevitable during obtaining entire formation in cut and throw, renders the slope vulnerable to slides and failure of the entire slope sections.

2. High precipitation: Sikkim receives an average annual rainfall of about 2000-3000mm which is usually concentrated during the season of April-September and thus the soil remains in a completely saturated state during the aforementioned season causing:

i. Increase in weight of the soil thus increasing the shear stress causing slopes to fail

ii. Wetting/Saturation of soil also causes increase in pore pressure thus reducing the shear strength of the soil causing the slopes to fail.

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This holds equally good for construction along the cultivable area (mostly paddy).As is known, paddy cultivation is done by impounding water in the terraces and the soil remains in a saturated condition during the entire gestation period of the paddy. Therefore excavation along such stretches calls for putting up protective works immediately after excavation to prevent landslides and further hill slope failure.

3. **Soil and Rock Classification:** The type of soil encountered greatly varies from one region to other in a very short span of length of road but usually the type of soil encountered during construction of roads in Sikkim is of soil mixed boulder type which is of non cohesive type thus offering very little or no resistance against sliding. The rock encountered in most of the places is of fractured strata with thick overburden of soil.

Therefore it is felt that the technique of cut and throw with a minimum of or no slope protective measures be best restricted to places where the cross slope is below 30 degrees or places where rock is encountered.

4. **Land:** It is a well known fact that almost 48% of the land in Sikkim is a Forest Land thus making available very little land for everything else. Therefore construction of road or other infrastructures has to be done very judiciously and all the infrastructures that are created have to be sustainable from every angle including the environment.

<u>Reproduced below is an extract of Sikkim Human Development Report 2014:</u>

Land is a highly scarce resource in Sikkim. Only 11 per cent of the total geographical area, at an altitude of a little less than 2,000 metres, is available for cultivation. Furthermore, the mountainous terrain and the highly dispersed population The mountainous terrain poses special challenges for human development in Sikkim. Being a small mountainous state compounds the problems of ensuring universal access to essential goods and services. overview xxiv greatly add to the costs of providing social services and

infrastructure. Again, because of its small size, the state enjoys practically no economies of scale. ***Almost all types of construction material need to be brought in from outside the state. Transportation is not only difficult and hazardous, but also adds substantially to costs of production of goods and services.*** *Similarly, establishing systems of support, supervision and performance monitoring become complicated and expensive as people need additional resources and time to travel for many days to visit remote areas. It is also difficult to attract qualified people to serve in these remote and hostile areas.* ***(Source: Sikkim Human Development report 2014)***

5. **Seismic activity:** The state falling in the Zone-V experiences frequent seismic activities which coupled with the high precipitation triggers slides every now and then especially during the monsoon season thus jeopardizing the safety of traffic plying along the routes during such times. Thus the need of the hour is to have a very systemic planning and execution of road construction works so as to ensure safety of the users as well as having roads that are resilient to all the above mentioned parameters.

Reproduced below is an extract of Sikkim Human Development Report 2014:

The biggest challenges for public administration are posed by the state's geo-physical characteristics. Sikkim's physiographic structure makes the lives of people extremely vulnerable to earthquakes and landslides. The region has experienced relatively moderate seismicity, with 18 earthquakes of magnitude 5 or greater over the past 35 years. The seismic activities cause frequent landslides and rockfalls, especially in the epicentre. The earthquake of 18th September 2011, with a magnitude of 6.8 and the epicentre located near the India–Nepal border, caused the worst damage and destruction in recent years. Three aftershocks of magnitude 5.7, 5.1 and 4.6 followed within 30 minutes. The tremors were felt across a wide region including India, Nepal, China, Bhutan and Bangladesh. Close to a hundred people were reported dead with more than 60 in Sikkim alone. The earthquake, the aftershocks and the heavy seasonal rains triggered more than 300 landslides which caused serious fatalities and also damage to infrastructure. ***Roads were the worst affected by the landslides. Many of them were either severely breached or suffered total washout. This disrupted communication and relief supplies and delayed reaching disaster victims in time.***

BEST CONSTRUCTION PRACTICES:

It is hoped that the above mentioned facts have definitely thrown some light on the enormity of the situation faced during construction as well as maintenance of the hill roads.

While there is no denying that that the road geometrics and gradient are an important factor to be considered in construction of roads but it is felt that the Guiding principle while constructing roads in the hills, the Governing factor, to be considered should be the stability of hill over all other parameters. The stability

of the hill slope needs to be ensured by adopting the **"Cut and Fill"** technique along with adequate provision slope treatment wherever soil is encountered, rather than going for cut and throw as elaborated earlier. The formation without protective structures may best only be attempted where rock is encountered or where the cross slopes of the hill does not exceed 30 degrees. Even in such cases it is best to prevent scouring or erosion of soil by way of putting up lining/skin walls in Masonry or RCC.

Of course, the cost of construction of such roads will be much more on the higher side than the roads constructed using conventional techniques, but in places with fragile terrain compounded by scarcity of land altogether, it will be much more economical and beneficial for the society at large in the long run to have such roads.

Special emphasis should also be given while construction of longitudinal drainage and cross drainage structures so as to tame and drain off the surface runoff intercepted by the road. Longitudinal drains are best constructed in steps so as to reduce scouring of the lining of the drain surface by taming the velocity of the water flowing through it. Accordingly sufficient drops with cover should also be provided at the outlets of cross drainage structures.

Further, there will be ample number of trouble spots all along the mountainous reaches/steep hills which warrants special treatment and thus every possible way of stabilizing/new construction techniques should be explored considering not the cost factor but the roads which will be stable, safe and environmentally sustainable.

Few such methods/type of structures/techniques are:

a) Green panel walls/retaining structures/ Geosynthetic Reinforced Slopes and Walls with Wire Mesh Facing.

A wire mesh is erected for containing/retaining the earth which in turn is drawn towards the hill by high tensioned wire cables and is bolted. The filling is done with reinforced soil in layers and compacted.

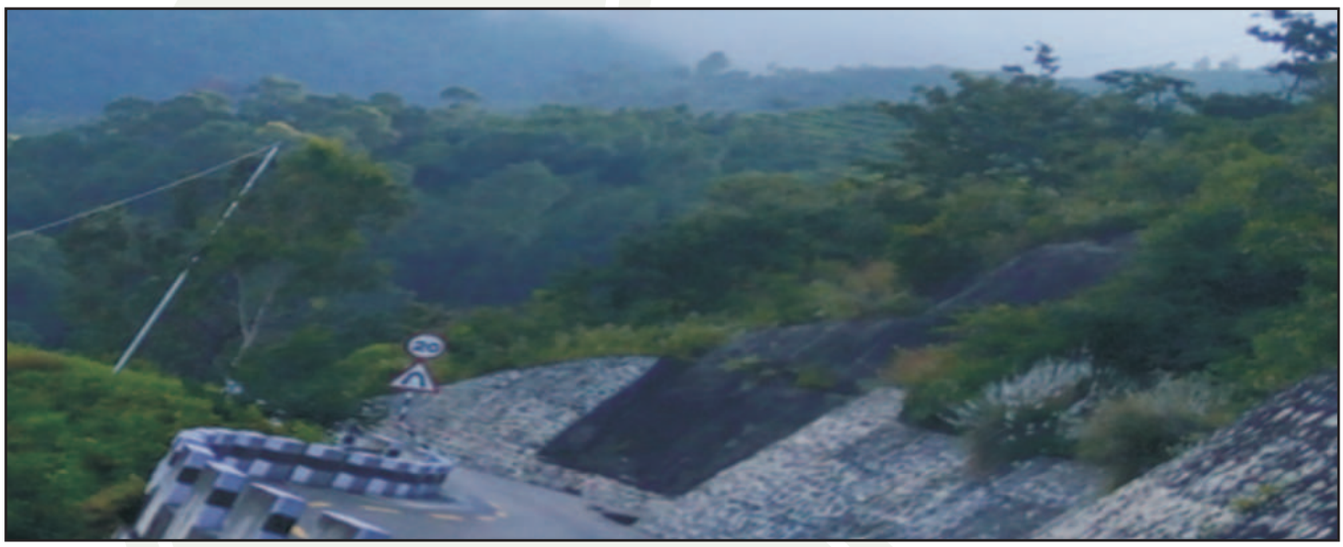
b) Gabion retaining walls with or without the use of Geo-synthetics,

In the above picture it can be seen that gabion structure has been put up for retaining the earth used for filling for achieving the desired road formation

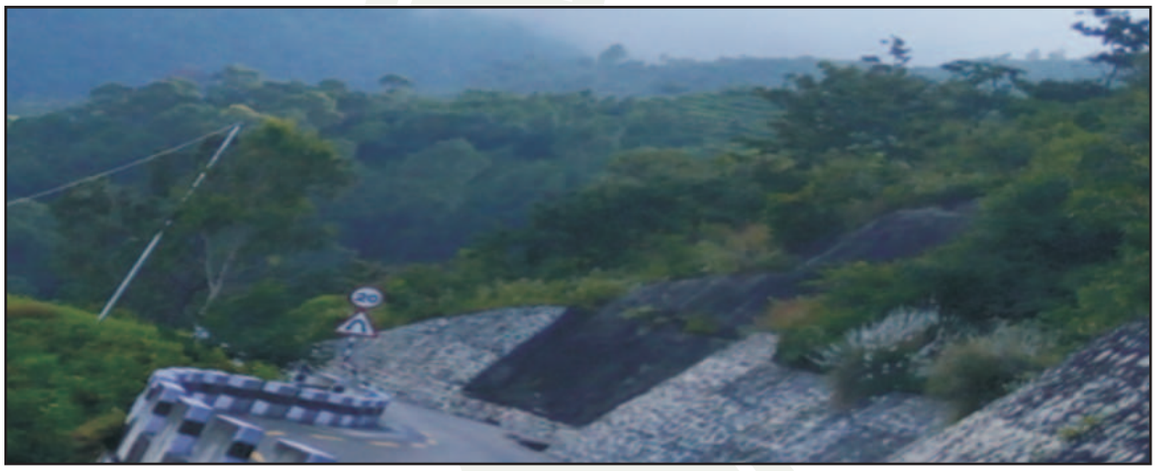
c) RCC walls(Counter fort/Cantilever/Graviloft),

RCC walls of all types are found used extensively in the road projects and their performance is well established beyond any doubt.

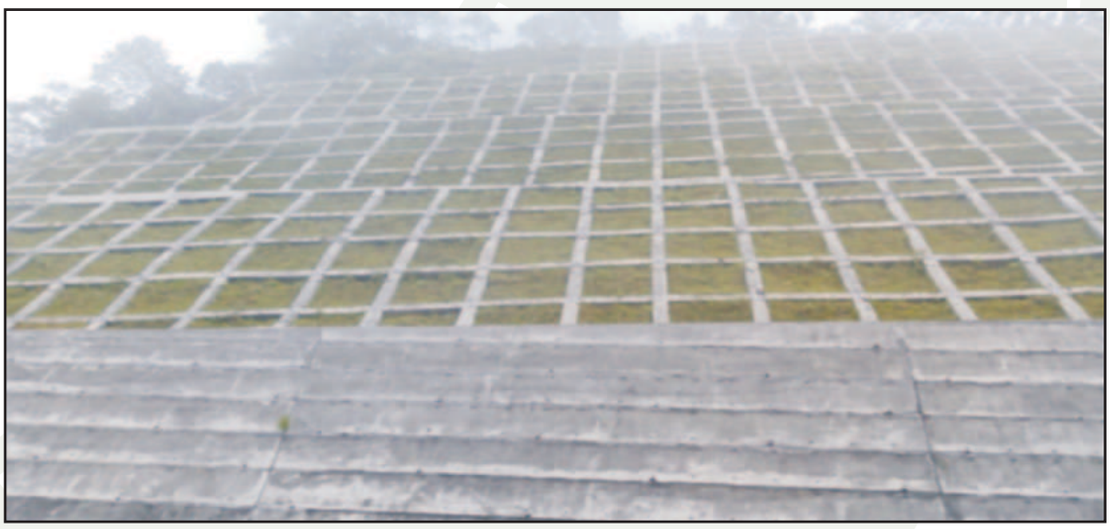
d) Shotcreting,



A section of the hill side is stabilized by shotcreting.It was found used in many stretches.



e) Rock bolting/Stabilization of slopes/fractured rocks by construction of RCC bands bolted with high tension steel cables



f) Masonry/RCC skin walls

This particular type of wall was found used extensively all along the route for stabilization/prevention of erosion of the hill side slope. This particular wall does not retains or take any kind of load. This is laid as a lining and thus follows the slope of the hill. The section of the wall is usually about 0.6m thick throughout. As shown in the picture above it has also been used to prevent erosion of embankment along the valley side.

g) Use of vertiver plants/bamboos/Geo textiles for preventing scouring/erosion of soil.

The use of the above has shown some promising results in many of the roads and can be further explored in upcoming construction works too. Apart from being cost effective the use of the above requires minimum skill and can be thus used extensively and studied for their effectiveness.

Apart from the above listed techniques there are other emerging technologies which can be explored and used as per their effectiveness. The best suitable construction material/technique can only be arrived at if we first make a start by being open to trying new technologies

Below illustrated are few of the photographs of one of the route that was selected for study that had made use of all the above mentioned techniques for construction:

It was found that the proper geometry was maintained along the routes with proper gradient and radius of curvature along major circular curves/hair pin bends. The minor curves were not found improved and they followed the natural profile of the hills as it is.

The gradient along the straight reaches were found to be that of limiting and exceptional gradient thus avoiding mass scale cutting of hills. For that matter it was also observed that the hill cutting along the entire stretch was kept to bare minimum and the road formation was found achieved by way of construction of walls of different types, thus restricting the damage to the environment/hills to the minimum. The road is found to be constructed adopting cut and fill technique with skin walls, Breast walls and Retaining walls throughout the stretch.

The said tour of the route was undertaken during the monsoon and surprisingly there wasn't a single slide or blocked drains anywhere all along the route of length of about 100Km.

The said route is in the country of Nepal and is reported to have constructed by Japan. The route bifurcates from the highway connecting Kathmandu with Eastern part of Nepal at "Bardibaas" and traverses through steep mountainous terrain before connecting the valley of Kathmandu, reducing the travel distance by almost 150Km than the usual route.

It is sincerely hoped that in the coming days the construction practices adopted in our country too will come at par with the construction practices adopted by the developed countries and our roads too will be safer/stable and sustainable in all the aspects. Till such time it is felt that it is the duty of all the Engineers to bring forward their experiences and sensitize all the stakeholders involved in the construction of hill roads in every possible way.

Reference

1. ***Source: Sikkim Human Development report 2014***

2. ***Hill Road manual, Indian Road Congress (IRC:SP:48-1998)***

3. ***Do it your self, Gabion Retaining Walls for Rural Roads, National Rural Roads Development Agency, New Delhi***






Road Safety in Rural Roads in Madhya Pradesh (PMGSY–ADB Funded Projects)

*M.K. Gupta**

1.1 Road Safety at the Design Stage

1. Road safety aspects have to be incorporated as part of the design criteria during the development of Detailed Project Report (DPR) for the Rural Road Project. Application of the PMGSY standard in rural roads development should be accompanied with sufficient knowledge of road safety requirements. Sufficient budget to allow adequate provision of road safety features in the project should be provided. This could then be fully utilized by the State Governments during construction and maintenance of rural roads4. These are some of the key imperatives, which became clear to the Implementing Agencies during ADB supported component of PMGSY in Madhya Pradesh.

2. During the project design of PMGSY roads in Madhya Pradesh , a 'transect walk' is invariably carried out to engage with local communities in order to identify hazards, local black spots effectively and most importantly to identify the possible and locally acceptable countermeasures. Inputs from this exercise is registered and addressed during the development of the DPR. The PIU ensure that this exercise is carried out and the recommended actions to deal with the road safety issues is incorporated in the design, specifically mentioned in the DPR and the BOQ of the bidding documents.

1.2 Road Safety Hazards

3. Road safety in rural road operations of motorized vehicles primarily deals with physical hazards, traffic operations at intersections, traffic operations passing through habitations or center of activities such as schools and markets.

a) Physical hazards. A roadside hazard is any roadside object or feature that is located on or near the roadway and which is likely to create a danger to the occupants or riders of any vehicle leaving the carriageway. Collisions with roadside objects are a concern not only because of the numbers of accidents occurring but also because of their severity. The likelihood of this type of collision resulting in a fatality or serious injury is generally greater than most of other types of accident.

b) Road intersections. Road safety issues at intersections is primarily caused by poor sight towards oncoming traffic, for example by high fences, and sometimes combined by high speed of the vehicles so that collision cannot be avoided.

c) Habitations or other center of activities. Road safety issues related to habitations usually involve pedestrians, school children, non-motorized vehicle users, or cattle belonging to the inhabitants.

A few common such hazards are listed below:

1. Start point and End Point Junctions
2. Sharp Curves
3. Trees and Electric Poles on the shoulders
4. Functional or even unusual Wells abutting the road structure
5. High Embankments
6. Schools / habitations on the alignment
7. Electric Line Crossings

Various innovations and countermeasures including installation and use of appropriate signages on

* Engineer-in-Chief, MPRRDA, Madhya Pradesh

PMGSY roads in Madhya Pradesh, have been done to minimize the risk of accident caused by these hazards. The following pictures illustrate various road safety issues in rural area, and actual treatment at design and post-construction stage adopted in PMGSY roads, in the State

S. No.	Issue	Images	Remarks
1.	Flare at the start point of the road		When the rural road meets higher category road, proper flare for increasing visibility have been provided. Further, Speed Breaker and Cautionary Boards have also been provided as mitigation measures on PMGSY roads.
2.	Speed Breakers		Speed Breakers are provided with information boards at locations near school and start of habitations on all PMGSY roads.

S. No.	Issue	Images	Remarks
3.	Measures relating to Trees on the roadside		Trees and Electric Poles on the shoulders are regularly painted in black and white layers to increase the visibility at night.
5.	Wells situated adjacent to roads		Wells at critical locations are protected with proper protection walls.

S. No.	Issue	Images	Remarks
6.	Guard stones		Guard Stones are provided on the sharp horizontal curves. Further, proper super elevations, cautionary boards and Extra widening has also been provided at curves to prevent any kind of accidents.
7.	Road Markings		Road Markings at edges have been provided to alert the drivers in the night time about the carriage way lines on all PMGSY roads.

S. No.	Issue	Images	Remarks
8.	Speed Control near Schools and Habitations		Proper sign boards and Speed breakers have been provided before schools and Habitation to ensure safety of foot traffic and to ensure speed regulation.
9.	Warning Boards		Warning boards on Cross Drainage (CD) works, to alert the drivers not to cross the paved under water during rainy season/ floods.

S. No.	Issue	Images	Remarks
10.	Electronic Line Crossings (ELC)		Increasing the height of ELC to provide proper vertical clearance done, wherever required
11.	Habitation Name Board		Habitation Name Boards before the Habitation erected all PMGSY roads.

In Rural areas, bituminous (BT) roads are constructed more quickly due to which there is sudden increase of motorized vehicles with high speeds. As the rural population historically, has not been exposed to such intense motorized traffic, conducting Awareness sessions about road safety aspects and signages helps in bringing about the behaviour change and thus helps in reduction of accidents. With this realization in mind, MPRRDA has taken proactive steps.

PIUs are organizing awareness sessions with the school children and also with the local community to enhance the awareness about road safety aspects. These sessions focus particularly on how to use and cross the roads, particularly by non-motorized vehicles (cycles, bullock carts etc.) as well as by pedestrians traffic. The DOs and DON'T's are emphasized in such sessions.

1.	School Session on correct road usage and road safety.	
2.	Community Consultation	

A flex as below has been prepared and regularly used by PIUs for making aware the school children and Community about the common type of signages used on roads and the need to comply with these signages.

Innovative Bridges: An Initiative Taken In Uttarakhand

*AK Dinkar**

World is witnessing the era of innovations where concept of bridges is also getting modernized. Great attentions are being paid across the globe to enhance the structural behavior, geometry, durability, riding quality and aesthetics of the bridges. Performance of bridges in high seismic zones is one of the key concerns of bridge professionals across the world.

An initiative, in this regard, has been taken by URRDA while proposing 65m and 45m span bridges under PMGSY Scheme in Uttarakhand. The bridges which are going to become landmark structures of the country will probably depict the extent till which modernization of bridges can be done (Fig.1 & 2). The bridges, which have got altogether a different elegant look, have also got two excellent behavior merging into them i.e. arch action and frame (integral) action. Arch bridges are well known for their superior behavior since ages and integral bridges, where substructure in monolithically connected to superstructure, are recent trends across the world due to their many inherent features i.e. superior structural behavior under stringent seismic/flood conditions, enhanced durability, no maintenance requirements, improved riding quality and distinct graceful look. Provision of integral bridges is recommended internationally including IRC specifications.

The bridges, which will be constructed in next one year, are proposed in reinforcement cement concrete and bearings, which are known to be weakest link in any bridge, have been completely eliminated from the bridges. Bridge across Gori nadi is a straight bridges having unique irregular shape and bridge across Ram Ganga river is curved in plan to improve the geometry of the road at bridge location.

Fig 1: Proposed 65m span bridge across Gori nadi

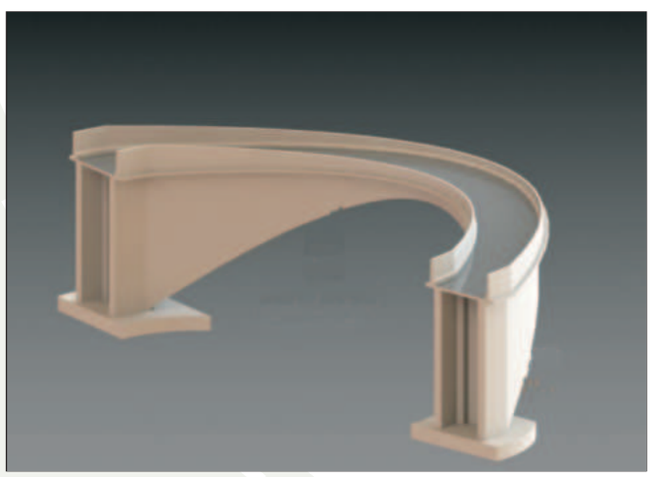


Fig 2: Proposed 45m span bridge across Ram Ganga river

* Chief Engineer URRDA, Uttrakhand

All Women Community Contracting Initiative in PMGSY Rural Roads in Uttarakhand

*AK Dinkar**

1. Introduction:

As per census 2011 there are about 1.01 Crore population residing in 13 districts of Uttarakhand. Agriculture is one of the most significant sectors of the economy of Uttarakhand. Economies of Uttarakhand known as "Money Order Economy", as the most of men are working in the Armed Forces of India. Women in Uttarakhand are well known as the backbone of hill economy and ecology. Due to the gender-based division of labour, they have been assigned the responsibilities of diverse activities related to land, water, forest and livestock. They are the main food producers and do almost 90% of agricultural work but have not been recognized as farmers. Their tremendous contribution to the socio-economic development of the family, community and nation at large, is remarkable.

2. All Women Community Contracting as Tool for Women Empowerment:

The Community Contracting has no involvement of formal contracting firms and role of Contractor is replaced by the Community, which takes charge of works relying on local labours. The only prerequisite is that there is a demand for employment in the local community. The community under contract is assumed to exist in a village or group of villages which demonstrate a common interest in their own development. The women constitute 49 % in total population of Uttarakhand. Women are the main bread winner and actual farmer in the villages as most of the male counterparts have migrated to plains for earning cash. Women in Uttarakhand have associated formerly or informally into MMDs, SHGs and Federations for their economical security. Women are however; most vulnerable in terms of Health, food, and economical security. The share of women workers as cultivators in rural areas is 57 %.Therefore; it was thought that a pilot project of all Women Community Contracting routine maintenance should be initiated in Uttarakhand, so that conditions of Women folks could be improved.

The Ministry of Rural Development GoI, has taken up Community Contracting as tool for women empowerment, in rural road projects. The URRDA under guidance of NRRDA initiated Community Contracting on pilot basis for "Off-Carriageway Maintenance". in the 9 rural roads covering length of 62.406 Km through the registered all Women Mahila Mangal Dal (MMD)/ Self Help Groups(SHGs) in the State of Uttarakhand.

3. Community Contracting Options:

There are several options in practice nationally or internationally for community contracting likewise Govt. Deptt. signs a Contract directly with the community representatives (The Community is the Contractor), a registered Contractor receives a Contract from the Deptt. in which he is obliged to Sub-Contract, the more labour intensive parts of the work to the local Community (Himanchal Pradesh, South Africa), Deptt. appoints a Management Agency (NGO, Consultant or Contractor) who administrate the contract with village labour force (Indonesia), the Govt. Deptt. signs an agreement with the community where the community at as a joint client with the Deptt. to and signs Contracts with groups within the community i.e. either Community leadership a MoU with the Deptt. to manage the contract or they can either directly employ and manage the labour or issue the Sub-Contract to Groups or Enterprise within the Community.(Cambodia, Indonesia, Laos, Myanmar, The Philippines, Thailand, Vietnam, Afghanistan etc.) and in Uttarakhand, Small Enterprise (SE)- in the form of Mahila Mangal Dals (MMDs) are already formed and these Enterprises are registered as society with the

* Chief Engineer, URRDA, Uttarakhand

Registrar of Societies. In this option the Govt. Deptt. signs a Contract with a Small Enterprise (SE)- existing or newly created from within the community. The Small Enterprise is the Contractor and which is used successfully in several Latin America Countries and Nepal for Routine Road Maintenance. Uttarakhand has also adopted this option/module for Community Contracting.

4. Process of initiating All Women Community Contracting:

One day workshop at URRDA was organized to discuss the possibilities of initiating Community Contracting in Rural Roads and identifications of Mahila Mangal Dals (MMDs). The participants of workshop were Members of All Women MMDs, ILO representatives and Engineers of PMGSY. After workshop road selection process was done by visiting each road and subsequently trainings was given to MMD members. Roads which were have completed 5 year maintenance and had good conditions were identified for off–carriageway routine maintenance through Community Contracting including identification of MMDs. After identifications of road BoQ were called from concerned PIUs and Contractor profit was deducted from the BoQ. The MoU/ Agreement was prepared and vetted from the ILO/NRRDA. MoU was signed and work started from September,2016.

Workshop at URRDA

ILO Representative guiding MMD Members

Training to MMD Members

MMD Member breaking Coconut to Inaugurate the Community Contracting in the Rural Roads under PMGSY

4. Performance Indicators: Table: 2

Maintenance Activity		Performance Indicator
RM-01.00	Clearing minor landslides	There are no landslides or other obstacles on the road surface, road shoulders, or side drains.
RM-02.00	Clearing side drains	The side drains are clear and at least 20 centimetres (cm) wide and 15 cm below the road surface, and there is no stemming of water.
RM-03.00	Clearing CD works (Culverts etc.)	The culvers and their inlets and outlets are clear, and water can flow freely.
RM-04.00	Clearing bridges	The area under the bridges is clear, and water can flow freely.
RM-05.00	Clearing Vegetation	The vegetation does not impede visibility or normal vehicle transit, not does it restrict the flow of water away from the road.
RM-06.00	Repair the road Shoulder	There is no depression or cuts in the road shoulder, and where necessary water has been directed away and the shoulder has been stabilized with vegetation or retaining walls.
RM-07.00	Repairing the drainage system.	Scour checks have been placed in eroded side drains, and undermined structures are protected by stones.
RM-08.00	Repairing retaining wall / breast walls	There are no loose stones in the retaining walls/ breast walls and weep holes are clear.
RM-09.00	Repairing edge stones	Proper re-fixing of edge stones along the road shoulders at defined intervals
RM-10.00	Planting Vegetation	The slopes and road shoulders prone to erosion are protected by vegetation material.

5. Progress under Community Contracting at a Glance: Table: 3

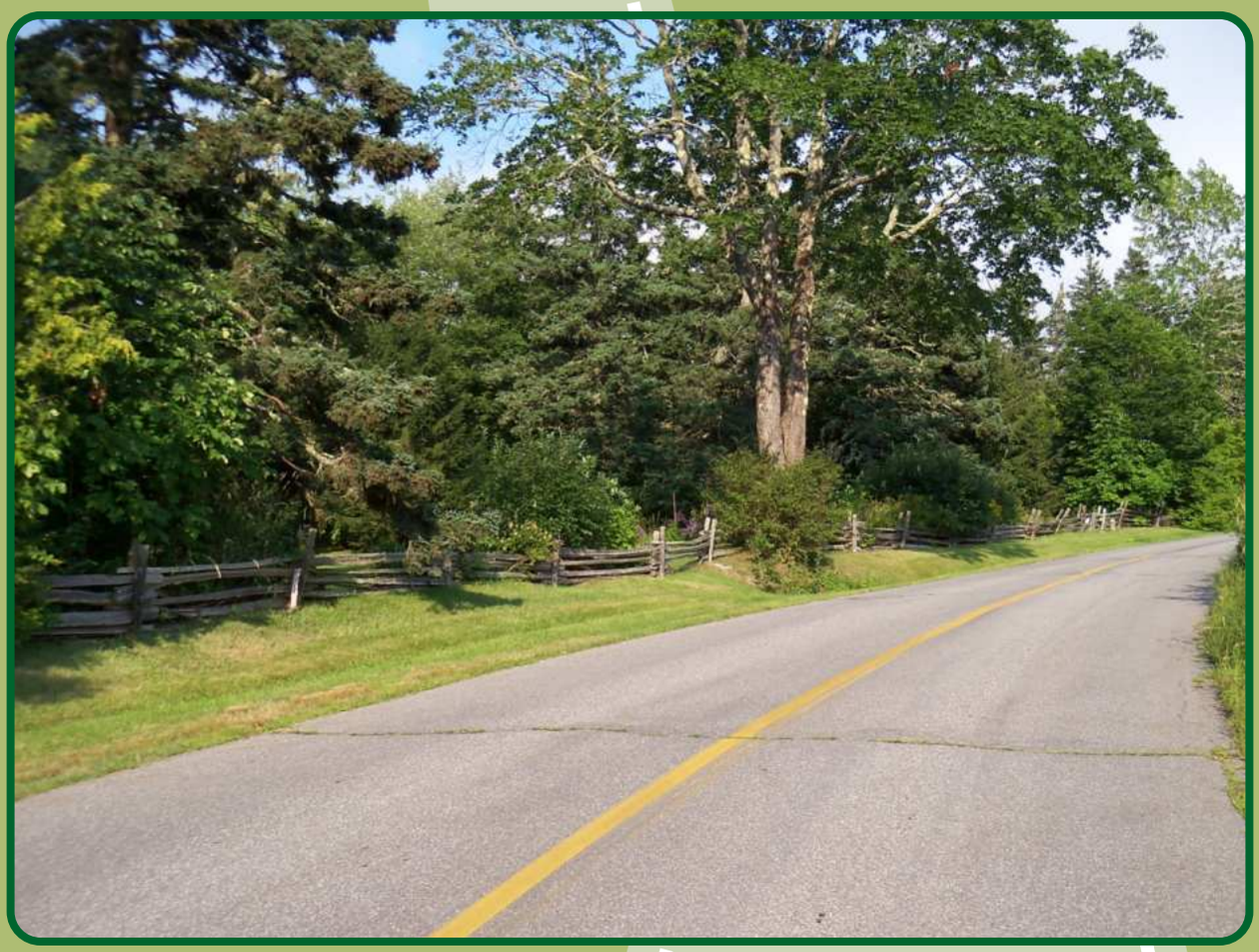
S. No	Name of Road	District	Target Length (km)	Annual Maintenance Cost Rs. Amount released Rs.		Total No. of MMD Members	Date of Agreement	Month	No. of MMD Members	benefitted Amount paid to MMD till date	Length maintained till date Km.
1	Rayri Arkhund M Road	Rudra-prayag	5.63	3.13	1.775	50	30/8/16	Sept.	20	36949.00	2.00
2	Tilwara Tehri km 06 to Kot Launga M Road		4.86	2.73	1.525	45	29/8/16	Sept.	20	40102.00	2.00
3	Gulabrai Tuna M Road		10.50	5.87	3.485	233	22/8/16	Sept. / Oct.	200	84000.00	10.50
4	Kolubend to Swari Gwans M Road		8.50	4.68	2.790	105	20/8/16	Sept. / Oct.	90	100000.00	8.50
5	Milay to Kuai M Road	Pauri	2.10	1.45	1.045	28	30/9/16	Sept.	16	20000.00	1.00
6	Simli to Sankot M Road	Chamoli	8.38	5.17	2.661	105	1/9/16	Sept. / Oct.	105	129718.00	8.38
7	Tharali-Dungari to Ruisain M Road		7.43	4.429	2.297	210	1/9/16	Sept. / Oct.	210	132509.00	7.43
	Dungari Ratgaon M Road		6.01	3.58	1.845	220	1/9/16	Sept. / Oct.	220	108745.00	6.01
8	Kothiyal Sain Saveri Sain to Nandprayag Devkhal M Road		4.00	2.12	1.245	40	1/9/16	Sept. / Oct.	40	40000.00	4.00
9	*Dinni Talli - Dinni Malli to Dobal M Road	Nainital	5.00								
Total			**62.41**	**33.16**	**18.67**	**1036**			**921**	**692023.00**	**49.82**

* This road project is dropped from Community Contracting due to unwillingness of local community women

6. Findings of Community Contracting

1. Women/ Rural Community Empowerment.
2. Creation of Employment and Income generation opportunities at community level
3. Reduction in maintenance cost of rural roads
4. Creation of sense of ownership for road maintenance
5. Better control over funds at community level
6. Development of skills in administration and work management for community members
7. Development of skills in construction work which could be applied for other purposes

MMD Members at work under Community Contracting in the Rural Roads of PMGSY



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