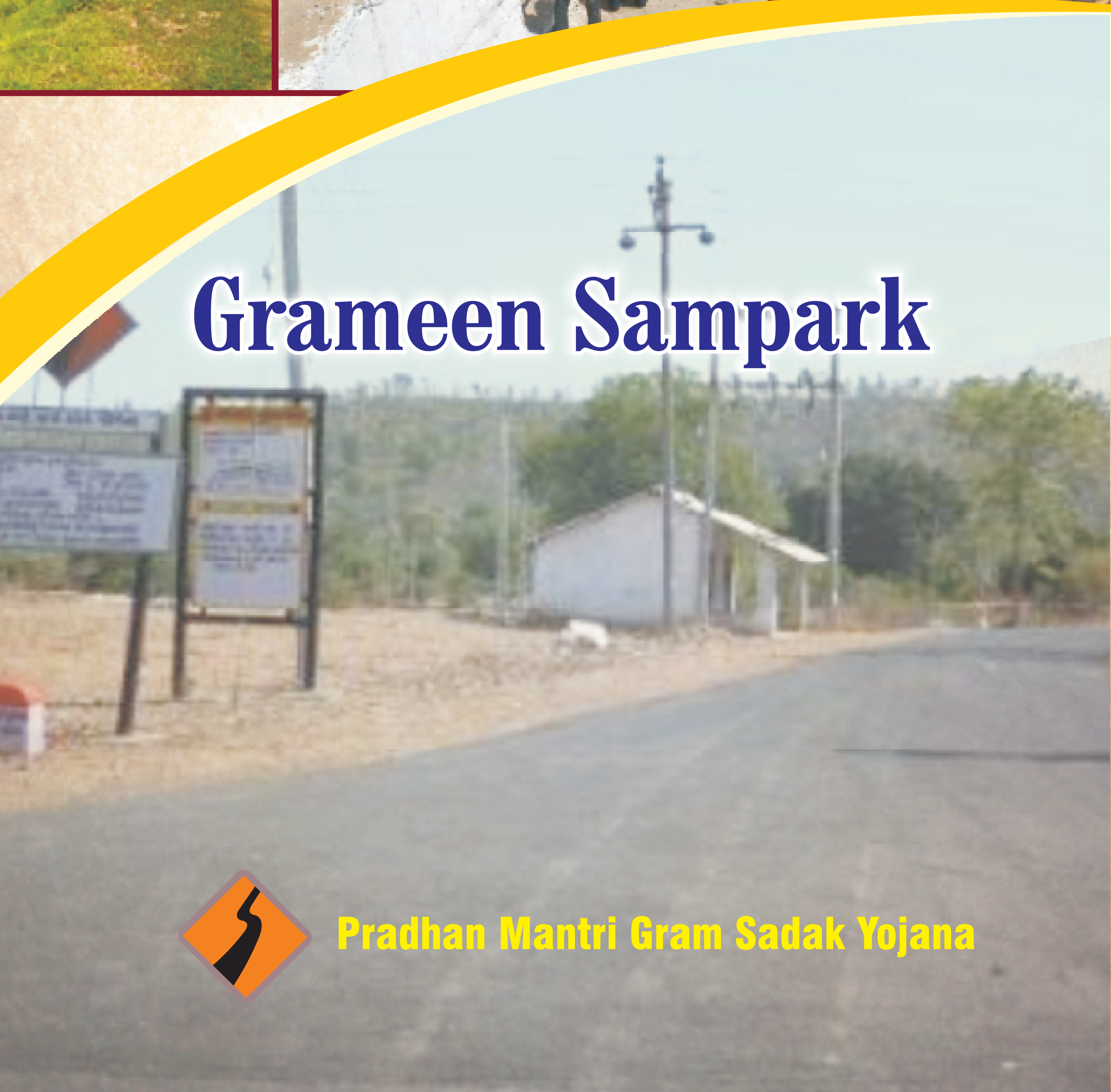


Grameen Sampark



Pradhan Mantri Gram Sadak Yojana

In this Issue

Editorial

Pradhan Mantri Gram Sadak Yojana

(Rajesh Bhushan)

Abstract

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Otta Seals have been adopted in many countries as a low-cost pavement sealing alternative for durable and smooth roads. However, this pavement surfacing option for low volume roads is not yet universally accepted, and its effectiveness is disputed, because of its varied performance. This paper assesses the Otta Seal experience in Nepal for the last ten years, for both local and strategic roads in different geographic terrains covering the hills and plains of Nepal. It addresses aspects of Otta Seal technology in relation to design, construction, cost and in-service performance, as well as its acceptance by the stakeholders, including the beneficiaries. The stakeholder acceptance has been affected by the early deterioration of the road surface in some instances, mainly attributable to inadequate design, poor quality of construction and inexperience with a new road technology. Road geometry, vehicle speed, and axle loads are other factors which have seriously affected durability. However, overall the performance of the pavements has been considered to be acceptable. The factors contributing to early failures require further discussion and research to help build ownership of this low-cost paving technology among road agencies.

INTRODUCTION

Selecting appropriate pavements for low volume roads is an issue for pavement engineers in both the developed and developing countries of the world. Finding an economically viable and sustainable pavement solution has been a longtime endeavor in road building. After the introduction of Otta Seals to Norway in 1965, this low cost sealing has been implemented in European and African countries with satisfactory performance. The Otta seal is essentially a 16mm to 32mm thick bituminous surfacing, constituted of an admixture of graded aggregates ranging from natural gravel to crushed rock in combination with relatively soft (low viscosity) binders with or without a sand seal cover (*1*).

In Nepal, Otta Seals were introduced in 2002 to protect freshly gravelled roads from Monsoon erosion. Gravel surfaces are susceptible to extensive erosion during the wet season in hill roads with steep gradients. During the pilot phase, low cost pavements using various sealing options were tried and Otta Seal was found to be most cost effective and simple in construction. The country has now about 1100 km roads with Otta Seal, which has been applied to both national strategic and district roads, mostly constructed under World Bank funded projects. However, the experience is mixed as pavements have noticeably failed within a short span of time, which has created confusion among the stakeholders regarding usefulness of Otta seals.

This paper addresses various aspects of Otta Seal performance related to factors such as physical terrain and geology, design, cost, method of construction, quality of works, and maintenance. The paper is based on the information recorded by the principal author through periodic field visits and supervision reports during his tenure in the World Bank, a recent assessment carried out by the Nepal Department of Roads (DOR) and official records of the Nepal Department of Local Infrastructure Development and Agricultural Roads (DOLIDAR) *(2)*. All the information available is drawn from the visual inspection of the pavement- no engineering tests, in any form, have been carried out.

About 15% of the pavements treated with Otta Seal have failed at different times after construction. The types of the pavement failure are settlements, scaling, cracking, raveling, stripping, wheel track damages, potholes, washouts, edge breaking, bleeding and washouts. Most premature failures were caused by poor sub grade, inadequate design, and deficiency in quality of works and monsoon floods. Although a substantial length of road is performing fairly well, the stakeholder's acceptance is not encouraging. The reasons are immediate failures, contractor's behavior, and inadequate budget for drainage structures and poor maintenance management.

BACKGROUND

The road density in Nepal is one of the lowest in South Asia. The country has about 53,500 km as strategic (10,800 km) and local roads (42,700 km). The strategic roads, which include national highways, feeder roads and other roads of national importance, are managed by DOR. The local roads are managed by district entities under the technical umbrella of DOLIDAR and urban roads are administered by municipalities under the Ministry of Local Development (MOLD). These roads are situated in different geographical terrains from plains of the Terai to the steep mountains. The total length of paved including gravel surface is about 17,000 km. Of the seventy five political districts, eighteen are yet to be connected by all weather paved roads. Only 51% of the population enjoys the access to all weather roads within walking distance. Providing cost effective and sustainable all weather access in the country is a great challenge and is equally important for the improvement in social benefits-better access to health and services and participation in the nation economy.

PILOTING OF SEALING OPTIONS (WHY OTTA SEAL WAS ADOPTED)

Because of the low traffic/volume in nature, fully blacktop roads are neither viable nor affordable. The existing 7,000 km of gravel roads are not in satisfactory condition due to the lack of timely maintenance. Moreover, gravel surface disappears within 2 to 4 years in the hills and mountainous region.

Treatment-DBST, Semi grouted Bituminous Pavement, 20mm thick Premix Asphalt and Otta Seal) were piloted on the Tansen-Tamghas road in hilly terrain. (Figure 1). After the observation of the pavements for one year, the Otta Seal was considered as the suitable option in consideration of ease of construction, low-cost and long life. The DOR adopted the Otta Seal for all gravel roads under the World Bank project. This option was not only economically justifiable due to saving of vehicle operating costs and travel time, but also provided comfort and dust free environment to road users. DOR has upgraded about 800 km of gravel and earthen roads to Otta Seal standard so far. The modality is further implemented by DOLIDAR in upgrading about 300 km of local roads in twenty districts. Sharing the experience of Nepal, the neighboring country Bhutan also piloted two roads with Otta Seal.

FIGURE 1. Freshly-laid Otta Seal

DESIGN OF PAVEMENTS

The Norwegian guideline (1) was used for the design of Otta Seal surface for both district and strategic roads, even though the existing pavement details and surfacing are different. In general, the upgrading of earthen tracks is carried out with a layer of gravel of thickness 150mm to 250mm for low volume roads in Nepal. The Average Annual Daily Traffic (AADT) ranged from 50-500 vehicles per day.

Design adopted by DOR:

In the DOR design the Otta Seal comprises of 6.5mm sand layer over 16mm medium graded river aggregates. No prime coat is considered and the first layer of bitumen is MC3000 sprayed at the rate 1.7 21 liter/m2. The bitumen content for the sand sealing is 0.8 liter/ m^2. In the initial years of the introduction of Otta Seal, the structural pavement was comprised of medium graded 100mm thick crusher run material over 150mm thick river gravel based on international practices for gravel roads, as an improvement to the 150mm gravelling practice of DOR. After the poor results for some roads, DOR is now complying with TRL Overseas Road Note 31 for the design of the pavement thickness. (3). The pavement contains two layers with different specifications of material. The lower layer is 150-300mm thick natural gravel meeting minimum requirement of DOR standard specifications (CBR value not less than 30) and upper layer is 125mm crusher run granular material with higher strength (CBR value not less than 60).

The general design criteria are:

- Ten years life for full pavement
- Width of carriageway is 3.5 m (single lane)
- Single layer Otta Seal and Sand Seal
- Sealed shoulder in hill side for better drainage management
- Double Otta Seal in steep gradient (over 7% gradient) and in narrow curves (radius less than 10m)

All the roads constructed by DOR with Otta Seal are in hills.

Design adopted by DOLIDAR for District Roads:

Since the traffic in local district roads are generally low (AADT 50-100), DOLIDAR used only single layer Otta Seal directly over 150-200mm graded river gravel surface following Norwegian guidelines. The thickness of the sub-base considered was on the basis of the general practice. In some roads, the Otta Seal performance was satisfactory even with 150-200mm sub-base. But higher traffic roads faced premature deterioration in the pavement due to poor sub grade and inadequate thickness of sub-base. From the lessons learned, DOLIDAR is now using graded gravel for design thickness based on the DCP related CBR value of the sub grade.

The design criteria adopted are

- Ten years life for full pavement
- Width of carriageway is 3.5 m (single lane)
- Single layer Otta Seal
- 100mm x 200mm concrete edging for roads in plain area
- Additional layer of Sand Seal in hills.

The district roads with Otta Seal are both in hills and plains of the Terai.

CONSTRUCTION MATERIALS AND METHODS

The sub-base materials used by both the agencies are graded natural gravel. The surfacing chips used for the Otta Seal is also screened and graded river singles. MC 3000 bitumen is used with necessary cutbacks. Experience showed that Otta Seal performance is closely associated with the bonding of the underlying layer. DOLIDAR is now blending sub-base material with 10% additional clay material in river gravel to enhance bonding, limiting the PI value (<6) as per the specification. With these changes the pavements are having better results.

FIGURE 2. Otta Seal Laying Process cleaning, bitumen spray and chips spreading.

The construction operations are mechanized for grading of the sub grade, sub-base lying with compaction, bitumen spraying, chips spreading and rolling (Figure2). Where proper construction equipment was not available on time for some district roads, bitumen and chips spreading were being done manually. However, compaction was done with pneumatic rollers and steel rollers. Brushing and cleaning of the finished sub-base are carried out through labor. These manual operations did not result in much difference in the end product.

PAVEMENT COSTS

DOR managed Strategic Roads:

The construction cost is one of the prime factors in selecting the type of surfacing for the low volume roads in Nepal. At the beginning of Otta Sealing in the country, the cost comparison was made for the full pavement construction cost with that of DBST, semi grouted surface and premix asphalt layer including base course. No base course (GB1-GB2) was provided in case of Otta Seal surfaced pavements and the pavement base for Otta Seal was determined on the basis minimum sub-base (GB3+GS) thickness practices. This led to the substantial cost saving Otta Seal pavements. However, due to subsequent failure of Otta Seal for weak sub-base DOR is designing the roads with full structural pavement including base course as determined by TRL OSRN 31 (3). In this scenario there is no significant saving (about 5% only) in Otta Seal pavement as compare to DBST pavement for the strategic roads managed by DOR. The cost of various surfacing means in Nepal as follows:

TABLE 1. Cost of Various Pavement Options for DOR Managed Roads

A. Cost of Otta Seal Pavement for 3.5 m wide road per km				
S.No.	**Particulars**	**US$/m^2**	**Total US$/km**	**Remarks**
1	Structural Pavement (sub-base and base course)	6.14	21,490.00	For thickness required by TRL OSRN 31
2	Otta Seal 16mm	2.42	8,470.00	
3	Sand Seal	0.97	2,546.00	On 75% of the length
4	Double Otta Seal	1.78	1,558.00	On 25% of the length for gradient >7% and turnings.
5	Total cost per km		34,064.00	
B.	**Cost of DBST pavement for 3.5 m wide road per km**			
S.No.	**Particulars**	**US$/m^2**	**Total US$/km**	**Remarks**
1	Structural Pavement	6.14	21,490.00	For thickness required by TRL ORN 31
2	1st layer 19mm	2.72	9,520.00	
3	2nd layer 10mm	1.36	4,760.00	
4	Total cost per km		35,770.00	
5	Increase in DBST Cost to Otta Seal	5%		
C.	**Cost of 30mm premix asphalt pavement for 3.5 m wide road per km**			
S.No.	**Particulars**	**US$/m^2**	**Total US$/km**	**Remarks**
1	Structural Pavement	6.14	21,490.00	For thickness required by TRL ORN 31
2	Premix Asphalt	7.06	24,710.00	
3	Total cost per km		46,200.00	
4	Increase in premix asphalt Cost to Otta Seal	36%		

Note: The original design did not include an aggregate base course, and the estimated cost of Otta Seal was significantly lower than the DBST option.

District roads supported by DOLIDAR:

Because of the low volume nature, DOLIDAR is using single layer of graded river gravel (GB3) as the pavement structure with Otta Seal cover for district roads. The option is cost effective relative to saving vehicle operating costs, travel, time and other social benefits. The cost per km of district road for gravel base pavement with Otta Seal in hills and Terai are:

TABLE 2. Cost of Otta Seal Pavement for District Roads Supported by DOLIDAR

A. For 3.5 m wide road in plains of the Terai			
S.No.	**Particulars**	**US$/m^2**	**Total US$/km**
1	Structural Pavement	2.73	9,555.00
2	Otta Seal 16mm	2.33	8,155.00
3	Concrete edge	-	3,000.00
4	Total cost per km		20,710.00
A. For 3.5 m wide road in hills			
S. No.	**Particulars**	**US$/m^2**	**Total US$/km**
1	Structural Pavement	3.64	12,740.00
2	Otta Seal 16mm	2.42	8,470.00
3	Sand Seal	0.97	3,395.00
4	Total cost per km		24,605.00

PERFORMANCE OTTA SEAL PAVEMENTS

For both the strategic roads and districts roads the overall performance does not seem to be unacceptable, although not encouraging. In the seven years Otta Seal pavement history, about 15% of the road length has failed for various reasons cited below. On DOR managed road about 11% (about 90 km in 15 roads) and on district roads about 22% (about 70 km in 36 roads) failures have been observed for the roads upgraded to all weather standard. District roads faced more failures as the unit upgrading cost was limited for economic reasons and, road and pavement structures, in particular drainage were insufficient.

Some roads failed immediately after one monsoon due to poor sub grade, subsurface water and inadequate thickness of pavement (Figure 3). Monsoon landslides are common in the hills of Nepal and there should not be any surprise at the damaged pavements in such areas, which could happen to any type of pavement. Unstable geology was another factor, when exposed after a fresh cut for road widening, caused severe pavement damages. In the hills, shady areas in general are damp and Otta Seal is susceptible to damage due to continuous exposure to water/moisture.

FIGURE 3. Structural failure of base

Some premature failures of raveling, stripping, rutting were also observed for poor quality of works. Proper grading of chips, quantity and quality of bitumen are important factors for better performance. Scaling and stripping of Otta Seal are associated with the bleeding of sealed surface. Such problem occurred only at few locations. Inadequate preparation and compaction of the sub grade or fill material are other causes of failure of pavement (Figure 4).

FIGURE 4. Rutting, potholes and scaling.

Road geometry is another reason observed for the failure of Otta Seal. Raveling is quite common in the steep gradient, sharp turnings and braking zones (Figure 5). The damage is more in the early days of Otta Seal, when the vehicular speed is not controlled. Since all the roads upgraded were single lane, edge breaking is significant in the plain area because of high speed vehicle driven at while crossing the vehicles coming from opposite direction.

FIGURE 5. Edge breaking and ravelling on curves.

Another critical factor responsible for the early damage is due to the unanticipated traffic development of heavy axle load vehicles on some roads. In particular, at the upgrading of the district roads in Terai connected to the Indian border heavy axle vehicles are diverted to district roads for its short distance in crossing the border. The pavement was not meant for heavy vehicular traffic.

The institutional factors are also very critical in getting unwanted results in the pavement. The frequent change of the project staff after some training and experience also influence the performance. The contractors are equally responsible in delivering the quality outputs. The trained contractors are often a sleeping partner of a weak joint-venture local partner, who will be executing the job. The whole Otta Seal pavement works were carried out in post conflict situation in the country. In addition to the capacity constraints of the executing agencies, site supervision and quality control were not an easy job. In addition, lack of proper maintenance (Figure 6) has resulted in further premature deterioration of the roads.

FIGURE 6. Otta Seal maintenance

The causes of failure and their contribution on Otta Seal pavement performance in the District Roads as recorded by DOLIDAR are presented in Figure 7.

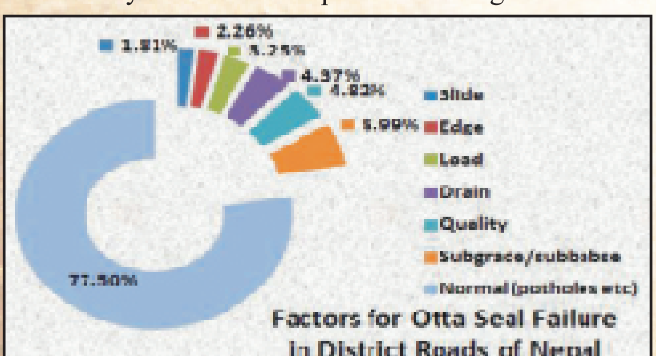

FIGURE 7 Different failure types by percentage occurrence.

Overall Otta Seal is performing well, especially where roads have been stabilized in terms of water management and geology. Some roads are still in fair condition after 7 years of construction without any maintenance attention (Figure 8). Anecdotally, about 1/4 of the roads have severe damage between 1-2 years (rutting, bleeding, scaling, washouts, cracks, subsidence), 1/4 length medium damage in 2-4 years (edge breaking, raveling, stripping, potholes) and about half of the roads normal damage in 4-7 years (potholes, stripping etc). Otta Seal has worked well where re-gravelling was done on existing gravel surface. The performance is relatively better in plain and dry area.

FIGURE 8 Otta Seal after Seven Years

LEARNING BY DOING PROTECTIVE MEASURES INITIATED.

The implementation of Otta Seal pavement roads is moving on through the learning by doing approach. Protective and remedial measures are initiated to address the problem in the performance. As a result, DOR is now following ORN 31 for the pavement design. Now, more contractors, consultants and DOR officials are exposed to the construction technique of the Otta Seal and are capable of making modification in the execution to suit the site conditions.

In case of the districts, there is no luxury on construction cost to fulfill all the engineering requirements including adequate water and pavement structures for their roads. Based on the lesson learned, the districts are allowed to use Otta Seal only for upgrading existing gravel road. That too is governed by anticipated traffic volume and sub grade strength. Sand seal is now made mandatory in hill roads and concrete edging in the plain of Terai. (Figure 9) .These provisions have improved the performance.

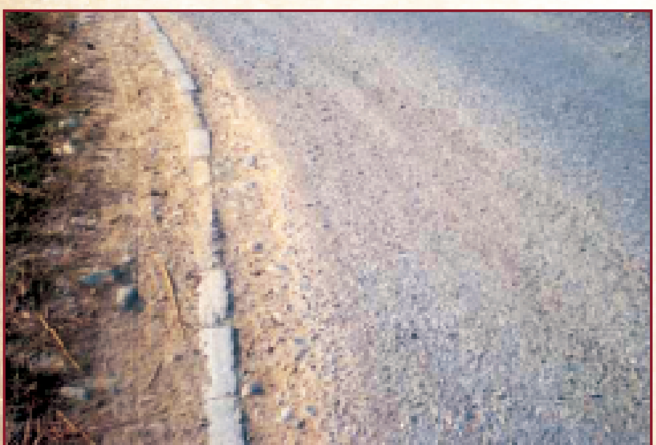

FIGURE 9 Concrete edging

STAKEHOLDER'S VIEW.

Depending on the performance of the roads, the stakeholder's opinions vary. Where the substantial pavement has failed within a short span of time (one-two years) the stakeholders, in particular road users are strongly against the Otta Seal. Even the officials of the executing agencies (DOR and DOLIDAR) have divided views. Those who are not supporting the pavement modality opine that their reputation is not only at stake, the investigation and enquiries are painful journeys in the event of failures. Moreover, in the lack of proper maintenance management and qualified small contractors in the country, their preference is to go for thin (20-30mm) maintenance free pre-mix asphalt surfacing.

On the other hand, the users are quite satisfied, where the pavement is providing fair ride after three years of construction. The road has changed their life style through saving in transportation cost and time and dust free environment. Moreover, the women and girl children are getting more benefits from the quick access to medical and after school education facilities. The technical people, who are in support of the pavement mechanism realize the cost efficiency, benefits and need of improvement technical aspects in the longer run. In a study carried out by DOR, 87% of the technical personnel interviewed, directly or indirectly involved in the Otta Seal works expressed that Otta Seal is the right choice (Figure 10).

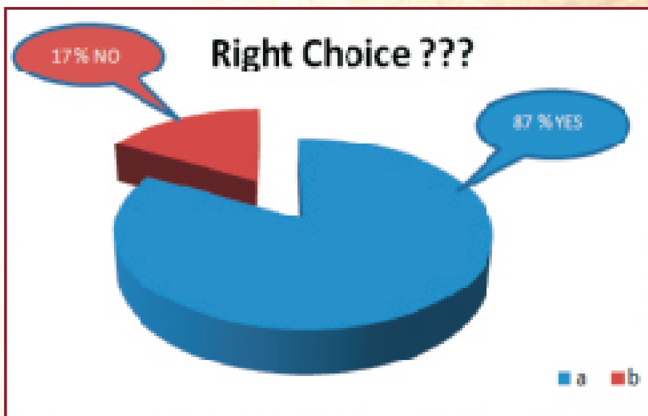

FIGURE 10. Stakeholder opinions

CONCLUSION AND WAY FORWARD.

Despite the varying views of the stakeholders in Nepal regarding the performance of the Otta Seal, its use for low volume roads in Nepal cannot be ruled out. It has brought economic and social changes in the rural communities of Nepal. It is evident that most of the failure occurred not due to the surfacing itself but inadequate design and quality issues. Quality of surfacing could be enhanced through prior training of the contractors and supervising engineers. Rigorous and close construction supervision is equally important in a country where self regulating systems are not adequate.

Above all the performance is closely associated with the nature of the sub grade and sub-base. The 1 thickness and nature of sub-base are critical factors in the better performance of the pavement. Bitumen penetration and bonding of aggregates (PI value) in sub-base appear to play significant role in the durability of Otta Seals. The whole cost-benefit of Otta Seal is linked with the design thickness of the sub-base course and type of material used for granular base (GB1 to GB3). The contractors are using crushed quarry stone material at higher price, where specified natural gravel is not available in the vicinity. If crusher run material (natural gravel or quarry stone) is to be used as the base there is no substantial saving in Otta Seal pavement cost compared to DBST pavements. Other surfacing options (DBST etc) could perform better than Otta Seal with a marginal cost increase on cost of the chips. Otta Seal is vulnerable to raveling on slopes and steep gradient during the early days following paving so proper traffic management is essential. Any overlook in paving material could easily lead to a pothole. On single lane roads edge breaking is rampant. Against this background, further research work is advisable for the determination of i) optimum characteristics and thickness of sub-base material suitable for Otta Seal on low volume roads and ii) advantage of Otta Seal over DBST for pavement with crusher run material base course in consideration of the lifecycle costs.

Of the two roads piloted in Bhutan, one contract was terminated after completion of trial for chips not meeting abrasion test, and specified chips was not available in the nearby area. Another road was successfully completed. There was some construction errors in overlapping bitumen spray due to the width of the Bitumen Distributor to the road width. Bhutan engineers were exposed to training on Otta Seal in Nepal before the pilot. The road authorities were happy with the saving in cost as compared to the thin premix asphalt as pavement surfacing. This was a useful technology transfer spin-off resulting from the introduction of Otta seals in Nepal and permitted the transfer and application of this paving technology under the World Bank funded Bhutan: Second Rural Access Roads Project.

It is a common tendency that new technology is not adopted easily due to the risk associated in case of failure. Some road authorities remain skeptical about the performance of the Otta Seal compared to other bituminous surfacing technology. In this regard, confidence building of the stakeholders is equally important. This will be possible only with better performance results with Otta Seal.

REFERENCES

1. Overby, C. *A Guide to the Use of Otta Seals. Publication No. 93* Norwegian Public Roads Administration, August 1999.
2. ITECO-North Star Engineering Consultant. *Sustainability of Otta Seal*, Department of Roads, 31 Nepal, 2012.
3. Transport Research Laboratory. *Overseas Road Note 31, Fourth Edition,* Overseas Development Administration, London, 1993.

Studies On The Effect of Admixtures AND INTERFACIAL BONDING LAYER on Bond Strength of ULTRA THIN White topping OVERLAYS

By

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SUMMARY: Traditionally, Cement concrete has been perceived as a material for new pavement construction, in particular for streets with heavy axle loads. However, with respect to pavement rehabilitation, agencies many a times consider bituminous overlays as the first option, regardless of the condition of the existing pavement structure. It is in this environment that Ultra Thin White Topping (UTW) overlays are gaining popularity.

Although Ultra Thin White Topping overlays have been constructed for decades, the bond between the new concrete and existing bituminous pavement is not only assumed during design but specific measures are taken to ensure such bond during construction. Ultra Thin White Topping (UTW) is a pavement rehabilitation technique that involves the placement of a thin Portland Cement Concrete (PCC) overlay, 50 mm to 100 mm thick, over a distressed Bituminous pavement. The bond between the two layers promotes composite action of the pavement section and as a result has a direct impact on the performance of the UTW Pavement. This paper highlights the effect of various admixtures to cement concrete on the bond strength of composite section.

The bond strength results indicated that the ROFF cement interface improved the bond strength in all combinations considered in this study. Plain cement concrete developed lowest bond strength when compared to all other combinations. The data obtained from bond strength test after 7 days and 28 days curing clearly indicated that bond strength in all combinations with ROFF cement interface developed higher bond strength when compared to bond strength of similar combinations without ROFF cement interface.

1. INTRODUCTION

Although Thin White Topping (TWT) and Ultra Thin White Topping (UTW) overlays have been constructed for decades, their recent popularity is largely the result of a renewed demand for longer-lasting but cost-effective solutions for Bituminous pavement rehabilitation. A White Topping overlay is constructed when a new portland cement concrete layer is placed on top of an existing Bituminous pavement system. The concrete thickness for a UTW is equal to or less than 100 mm and in TWT concrete thickness is greater than 100 mm but less than 200 mm. Conventional White Topping is an overlay of 200 mm or more. In most cases, a bond between the new concrete and existing bituminous layers is not only assumed during design, but specific measures are taken to ensure such bond during construction. The success of this bond, leading to composite action, has been found to be critical factor for the successful performance of this pavement-resurfacing alternative [1].

1.1 Fundamental Behavior of Ultra Thin White Topping (UTW)

UTW overlays provide a unique pavement structure that is fundamentally different from other pavement types. UTW overlays are designed and constructed with consideration of a sound bond between the PCC and bituminous materials. The result is a composite structure that distributes traffic and environmental loading differently than more conventional PCC or bituminous pavement structures.

As Fig.1 illustrates, the stress distribution in a bonded system versus that of an unbonded system can be significantly different. As a result of the composite section, the stresses in the top PCC layer are significantly lower in the bonded than those in the unbonded case. Furthermore, because much of the slab is in compression and because concrete is much stronger in compression than in tension, the design of the slab can be thinner for a bonded case than for an unbonded case.

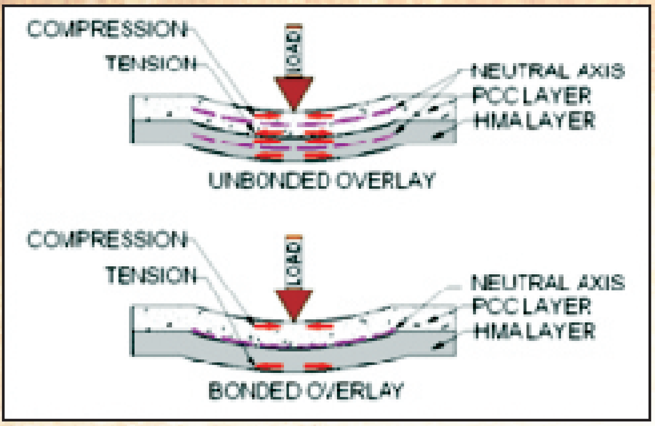


Fig.1 Effect of composite action on UTW and TWT under loading

Although a fully bonded system would be ideal, it has been shown that partial bond is usually realized as a result of a number of factors. In such case, the neutral axis will lie somewhere very much near to the interface of PCC layer and bituminous layer, as illustrated in Fig.1. It has been reported that a key to the success of UTW overlay, is a uniform and stable support system. In such a case, the support is provided by an existing bituminous pavement. Therefore, it should be recognized that any contributing factor to the failure of the bituminous pavement might similarly lead to a failure of the overlay.

2. PRESENT STUDY

It is evident that the performance of UTW depends on the bond strength between the existing Bituminous layer and the PCC overlay. To attain the required compressive strength and to improve the concrete characteristics certain additives like fly ash, micro silica, polypropylene fibers are used as admixtures to concrete. These admixtures can alter the bond strength of concrete overlay on an existing bituminous layer. Hence it is necessary to evaluate the bond strength and study the performance of concrete with admixtures when used as UTW.

2.1 Experimental Work

The main aim of this experimental work was to study the effect of admixture and interfacial bonding layer on the bond strength of UTW. As there are no standard testing equipment and procedure available to evaluate this property suitable instrumentation was developed and fabricated to suite the requirement for conducting direct tensile test on composite specimens. To evaluate the effect of admixtures and interfacial bonding layer on the bond strength of the composite section, the following combinations were selected for the study.

- Plain cement concrete (M40)
- Plain cement concrete (M40) with ROFF cement interface
- Cement concrete + Fly Ash
- Cement concrete + Fly Ash with ROFF cement interface
- Cement concrete + Micro silica
- Cement concrete+Micro Silica with ROFF cement interface
- Cement concrete + Polypropylene Fiber
- Cement concrete+Polypropylene Fiber with ROFF cement interface

2.2 Materials and Experimental Procedure

Portland cement (53 Grade) and locally available coarse and fine aggregates were used to prepare the concrete layer over a bituminous concrete layer. 60/70 grade bitumen and locally available aggregates were used to prepare a bituminous concrete base. The specific gravity of fine, coarse aggregates and fillers was found to be 2.66, 2.68 and 2.7 respectively. Micro silica is a by-product of the electric arc furnaces used in the production of ferro silicon and silicon industries. Micro silica is in the amorphous state with the chemical composition of > 90 % silica and the grain size of < 0.1 microns. It is very fine active artificial pozzolanic and cementitous material. Fly ash (also called pulverized fuel ash) is the most widely used pozzolanic waste material and one that has largest potential for use in concrete. It is a waste product of the coal-based power plants. ROFF cement is a cementitious polymer modified tile adhesive and usually known as ROFF cement. It resembles Portland cement to a great extent but has a longer pot life and longer initial setting time. It is ideal for surfaces which are constantly in contact with water e.g., swimming pools, bathrooms, kitchens, shower floors, etc. This polymer modified tile adhesive is used to improve bonding for granite, marble etc on concrete layers.

The different sizes of aggregates i.e. 20mm, 12.5mm, 10mm, 6mm and dust samples were collected and sieve analysis was done to obtain the individual gradation of these aggregates. The desired aggregate gradation for bituminous concrete (BC) has been obtained to match the midpoint gradation by Rothfutchs method (20 mm down 28%, 12.5mm down 20%, 6mm down 22% and quarry dust 30%). Plain bitumen of grade 60/70 was used for the study and the physical properties of bitumen were tested as per IS codes and found satisfactory. The optimum bitumen required was obtained as 5.9%.

The bituminous concrete was prepared as per the standard procedure and was placed in the pre heated cylindrical moulds and were well compacted initially using tamping rod and later by applying repeated compressive load from a universal testing machine. The moulds were left to cool down for 24 hrs. The cement concrete mix proportion adopted in the experimentation was 1:2.02:3.05(coarse aggregate 1142kg/cum, fine aggregate 756kg/cum, cement 375kg/cum and water cement ratio of 0.4% which is 150lit/cum) which corresponds to M40 grade concrete. The mix design was carried out according to IS: 10262-1982. Homogeneous concrete mass was prepared as per the mix design. This mass was gently placed on the Bituminous base in layers and consolidated by using just the required vibration for good compaction. After consolidation the surface was finished smooth and was covered with wet gunny bags. After 3 days the specimen was demoulded and transferred to the curing tank. After curing for 7 days and 28 days the specimens were tested for their respective bond strengths. The dimensional details of the composite cylinder specimen and the picture of the mould are shown in Fig.2. A picture of composite cylindrical specimen in curing tank is shown in Photograph 1. The cylindrical composite specimens having 75mm thick concrete layer over 75mm thick bituminous layer were subjected to direct tensile test by clamping the specimens with specially designed clamps, which could hold the specimen and could be clamped on to UTM for conducting the test. The clamping arrangement for conducting direct tensile test is shown in Photograph 2.

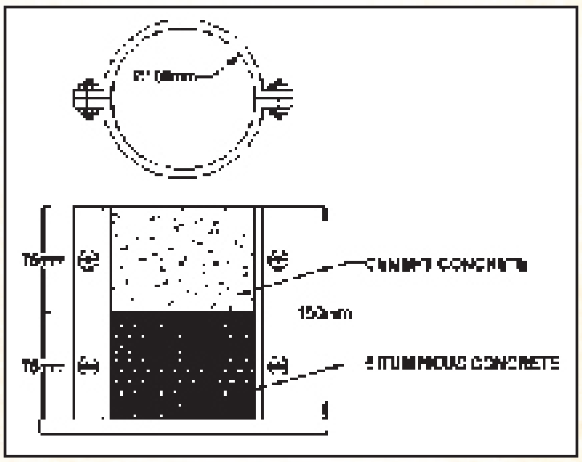


Fig.2 Dimensions of Composite Cylinder

Photograph 1 Curing of Composite Cylinder

Photograph 2 Clamping Arrangement

3. Test Results

To determine the effect of these admixtures on the bond strength between Bituminous Concrete and cement concrete layer, the specimens were subjected to direct tensile test by fixing the specimen onto the UTM with a specifically designed clamp set. The results of direct tensile test on composite cylinders with plain cement concrete (PCC) and composite cylinders with plain cement concrete with ROFF cement interface (PCC + ROFF I/F) are presented in the Table 1 and Fig.3.

Table 1 Direct Tensile Test Results of Composite Cylinders (PCC and PCC + ROFF I/F)

Type of Composite Specimen	Curing period	Thickness in mm		Average Yield Load in KN	Average Bond Strength N/mm^2
		Bituminous Concrete	Cement Concrete		
PCC	7 days	75	75	0.40	0.051
	28 days	74	76	0.82	0.104
PCC + ROFF I/F	7 days	74	76	1.07	0.136
	28 days	75	75	1.32	0.168

To illustrate the effect of Fly Ash as admixture to cement concrete on the bond strength of the composite sections, several composite cylinders with different percentages of Fly Ash were casted and tested for their bond strength. The results of direct tensile test on composite cylinders with Fly Ash admixture (FA) and composite cylinders with Fly Ash admixture and ROFF cement interface (FA + ROFF I/F) are presented in the Table 2 and Fig.4.

Table 2 Direct Tensile Test Results of Composite Cylinders (FA and FA + ROFF I/F)

Type of Composite Specimen	Curing period	Thickness in mm		Average Yield Load in KN	Average Bond Strength N/mm^2
		Bituminous Concrete	Cement Concrete		
20% FA	7 days	74	76	0.86	0.110
	28 days	75	75	1.56	0.199
20% FA + ROFF I/F	7 days	75	75	1.08	0.138
	28 days	75	75	1.59	0.203
25% FA	7 days	75	75	0.90	0.114
	28 days	76	74	1.67	0.212
25% FA + ROFF I/F	7 days	74	76	1.13	0.144
	28 days	75	75	1.56	0.199
30% FA	7 days	74	76	0.85	0.108
	28 days	74	76	1.67	0.212
30% FA + ROFF I/F	7 days	76	74	1.15	0.146
	28 days	75	75	1.58	0.201

To illustrate the effect of Micro Silica admixture on the bond strength of the composite sections, several composite cylinders with different percentages of Micro Silica were casted and tested for their bond strength. The results of direct tensile test on composite cylinders with Micro Silica admixture (MS) and composite cylinders with Micro Silica admixture and ROFF cement interface (MS + ROFF I/F) are presented in the Table 3 and Fig. 5.

Table 3 Direct Tensile Test Results of Composite Cylinders (MS and MS + ROFF I/F)

Type of Composite Specimen	Curing period	Thickness in mm		Average Yield Load in KN	Average Bond Strength N/mm^2
		Bituminous Concrete	Cement Concrete		
2% MS	7 days	75	75	0.94	0.119
	28 days	75	75	1.62	0.206
2% MS + ROFF I/F	7 days	74	76	1.13	0.143
	28 days	75	75	1.57	0.200
4% MS	7 days	74	76	1.03	0.131
	28 days	74	76	1.68	0.214
4% MS + ROFF I/F	7 days	74	76	1.19	0.152
	28 days	75	75	1.60	0.203
6% MS	7 days	74	76	1.13	0.143
	28 days	74	76	1.79	0.228
6% MS + ROFF I/F	7 days	74	76	1.22	0.155
	28 days	75	75	1.62	0.206

To illustrate the effect of Polypropylene Fiber as admixture on the bond strength of the composite sections, several composite cylinders with different percentages of Polypropylene Fiber were casted and tested for their bond strength. The results of direct tensile test on composite cylinders with Polypropylene Fiber admixture (PPF) and composite cylinders with Polypropylene Fiber admixture and ROFF cement interface (PPF + ROFF I/F) are presented in the Table 4 and Fig.6.

Table 4 Direct Tensile Test Results of Composite Cylinders (PPF and PPF + ROFF I/F)

Type of Composite Specimen	Curing period	Thickness in mm		Average Yield Load in KN	Average Bond Strength N/mm^2
		Bituminous Concrete	Cement Concrete		
0.1% PPF	7 days	75	75	0.39	0.050
	28 days	74	76	0.79	0.100
0.1% PPF + ROFF I/F	7 days	74	76	1.00	0.127
	28 days	75	75	1.44	0.183
0.2% PPF	7 days	75	75	0.35	0.044
	28 days	76	74	0.74	0.094
0.2% PPF + ROFF I/F	7 days	74	76	0.83	0.106
	28 days	75	75	1.30	0.165
0.3% PPF	7 days	74	76	0.28	0.035
	28 days	76	74	0.58	0.074
0.3% PPF + ROFF I/F	7 days	74	76	0.78	0.099
	28 days	75	75	1.23	0.156

4. CONCLUSIONS

The bond strength results indicated that the ROFF cement interface improved the bond strength in all combinations considered in this study. Plain cement concrete developed lowest bond strength when compared to all other combinations. The data obtained from bond strength test after 7 days curing clearly indicated that bond strength in all combinations with ROFF cement interface developed higher bond strength when compared to bond strength of similar combinations without ROFF cement interface.

The results of bond strength obtained after 28 days curing clearly indicated that uniform bond strength (0.2 N/mm2) was achieved in specimens with ROFF cement interface along with Fly Ash and Micro Silica admixture. Whereas marginally higher bond strength was observed in specimens with 25% and 30% Fly Ash admixture without ROFF cement interface. The specimens with 2%, 4% and 6% Micro Silica without ROFF cement interface also developed marginally higher (> 0.2 N/mm2) bond strength. The bond strengths of specimens with Polypropylene fiber admixture developed lesser bond strength (< 0.2 N/mm2). Increase in percentage of Polypropylene fiber admixture will reduce the bond strength considerably, however a marginal increase in bond strength was observed in specimens with ROFF cement interface.

Proper and uniform bonding of UTW with Bituminous layer is necessary for the composite action of pavement system. It is this composite action which leads to the reduction in the required thickness of UTW. Hence from the above study it can be concluded that use of Polypropylene fiber as admixture is not advisable in UTW. The results also substantiates the application of ROFF cement interface as it helps in developing uniform bond strength when applied along with Micro Silica or Fly Ash admixture. However ROFF cement interface can be eliminated if proper surface cleaning is carried out before placing UTW with Micro Silica or Fly Ash admixture, as the UTW with Fly Ash or Micro Silica admixture develops higher bond strengths.

REFERENCES

1. National Cooperative Highway Research Program (NCHRP 338) Thin and Ultra-Thin Whitetopping- A synthesis of highway practice.

KR 04-63, Changala gate - Peruva road - the road to success in record time

Authors: ....

With the objective of providing rural connectivity, Government of India had launched the Pradhan Mantri Gram Sadak Yojna on 25th December , 2000 to provide all weather access to eligible unconnected habitations as a strategy for poverty alleviation. The scheme was launched during 2000-2001 in the Kerala state. The Changala gate -Peruva road was completed in record period of 9 months. The details of the success story is present in the following paragraphs.

The Changala gate Peruva Road in Kolayad Grama Panchayath, Peravoor Block, Kannur District was included in the Pradhan Manthri Gram Sadak Yojna (PMGSY) Phase VIII, Batch I for the State of Kerala in 2013 and the Package No is KR 04-63. The work was tendered on 04/07/2013 and awarded to K.K.Builders, Civil Engineering contractors, Peravoor at 0.30% below Estimate rate as per Agreement No: 07/SE-KSRRDA/2013-14 dated 24.9.2013. The total length of the road is 8.910 km and the total cost of construction is 385 lakhs. The work included construction of new 8 nos 1.00m span slab culverts, 1 No 3.00 m span slab and extension of 2.50 m span slab culvert, 1.00 m span slab culvert and 2 Nos 1.50 m span slab culverts. The site was handed over to the contractor on 30/09/2013 but since the entire length of the road was passing through forest area (Kannavam Reserve Forest), the clearance from the Forest Department was needed and the clearance from the forest department was obtained only on 13/12/2013. After that the initial levels were taken and reported to Chief Technical Examiner on 31/12/2013.

The contractor started the work as soon as the clearance from the Forest Department was obtained. The work was planned after the rainy season of October November and finished before the start of the next rainy season of June - July. The collective effort from Engineers along with Grama Panchayath President and Members handled the work related problems such as utility shifting in close coordination with the utility departments. Accredited Engineer, Assistant Executive Engineer and Executive Engineer had routinely conducted the necessary tests at the site for the timely stage clearance. The National Quality Monitor also visited the site on 15-02-2014 and reported satisfactorily. All mandatory tests were also carried out during the construction. The compaction of the subgrade, gradation of different layers, and the crust thickness were above satisfactory level.

Through meticulous planning and concerted efforts the work was completed on 20.05.2014 by availing 232 days. The social impact of the work is that the road is beneficial for the 3 habitations namely Peruva, Thettumma and Chembukavu. A total of 2050 people are directly benefitted by the road work which includes 510 Scheduled Tribe families and 105 other families.

The project completion within time is special since the hurdles like Forest Department clearance, work management during rainy season, timely stage passing, quality ensuring mechanisms, timely shifting of utilities by the utility department were to be tackled. The Changala gate-Peruva road success story is a morale booster to all the stake holders of the PMGSY in the Kerala State and efforts are being taken to replicate the methodology elsewhere in the state.

Good Practice for Construction of Cement Concrete Pavement in Chattisgarh

Sh. Sudhir Agarwal, CEO, CGRRDA, Chattisgarh
Sh. S.K.Gupta, SQC, CGRRDA, Chattisgarh

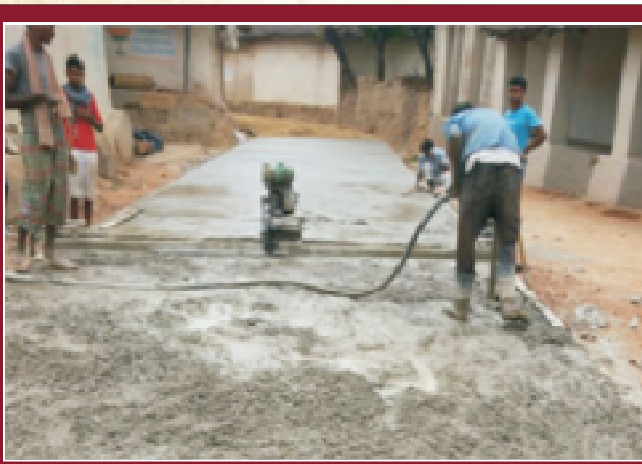
Instructions have been given in respect of qualitative construction of concrete roads to ascertain whether construction work has been done according to set specification or not. To examine this after completion of 28 days of construction, the executive engineer should get these core samples examined in the district / departmental / central laboratory in his presence. If tests are found to be within the prescribed criterion, the test report should be detailed in the measurement book and payment for construction work may be made accordingly.

Earlier 8 core cutters were made available in all the Superintending Engineer's head quarters. Core cutter with the rest 18 mobile vans were not provided earlier. Hence, for the rest of mobile vans one core cutter and diesel generator were made available.

In Chhattisgarh State, where Pradhan Mantri Gram Sadak Yojna and Chief Minister Gram Sadak and Vikas Yojna cement concrete roads are being constructed and Gram Gaurav Path Yojna's works are also in progress. To maintain the progress of cement concrete work, it is necessary to carry out tests after taking core samples from time to time and payment should not be delayed in any condition. As soon as the core samples are received tests are carried out on priority basis, by Executive Engineer in the Govt. Laboratories. The test reports to be entered in measurement book immediately.

It is ensured by the superintending engineer that payment is made by the executive engineer after getting the tests carried out & entered inmeasurement book as per Govt. Instructions. All this information is collected under project circle and presented to the Chhattisgarh Rural Road Development Agency, Raipur.

In today perspective, the cement concrete road construction works are carried out in all other plans such as Gram Panchayat, Rural Engineering Services/Chief Minister Gram Sadak Yojna with PMGSY and big improvement has been seen in this work.



Pradhan Mantri Gram Sadak Yojana EXPERIENCE

Mahendra D. Patel, Contractor, Gujarat

Experiencing huge success of PMGSY-I in past decade, GOI has now launched PMGSY-II. This shows the importance of this Project. It is the only scheme of government which is implemented on such huge scale throughout the country and works thereof are successfully completed with quality satisfaction to the beneficiary. The results are quite encouraging and as envisaged at planning stage of the scheme.

The firm M/s Shantilal B Patel, Vadodara, registered as **'AA' Class** and also registered in **Special Category-I (Road, Bridge & Building works)** by Govt. of Gujarat is associated with PMGSY programme since Phase-III. The firm undertook construction of PMGSY roads mostly in backward District of Panchmahal, Dahod, Naswadi, Dediapada etc. and has with technical expertise, guidance, supervision, inspiration and motivation of Shri Mahendra D. Patel, A Civil Engineer and partner of the firm, completed nearly 2000 km interior / scattered roads including the CD works ranging from 0.60 to 3.00 km length, within prescribed time limit and quality followed by three tier quality check by National Quality Monitors from time to time. This is about 1/4th length of all roads constructed under PMGSY in the entire state of Gujarat. **IT IS A RECORD IN ITSELF AS NO AGENCY IN INDIA WOULD HAVE SUCCESSFULLY COMPLETED THIS QUANTUM OF PMGSY WORKS ON SUCH A LARGE SCALE.**

The experience of the firm to complete this mammoth task is tabulated below for reference to Clients, other Contractors, Policy Makers, Officials of Planning Commission, etc.

Any PMGSY package consists of scattered roads ranging up to 20 nos. and length of each road varying from 0.5 to 7.0 km. Roads may be located anywhere within the sphere of 40 Km and away from each other. Thus to complete any package, it requires micro planning of work, man power & machinery. Also the tender condition necessitates provision of Field Laboratory for testing of materials as first tier quality control for each package. The time allowed for completing the package work is generally nine working months and 18 months including adverse weather conditions viz. monsoon etc. for package costing more than 10 Crore and the time limit is treated as an essence of contract.

1. Our planning for PMGSY works starts right from tendering stage. We depute our staff for site survey and collect various data which prove very much useful during execution. We prepare a list of information to be obtained from site as per attached Annexure-I and compile the same on its receipt. The information so compiled in office helps us to judge the quantum of work and probable difficulties to be faced as the proposed roads are always located in interior and remote areas. It is always difficult for planning the work without complete data based on site visit and we decide the priority of the roads to be constructed depending on anticipated difficulties. We prefer to execute the most difficult road first and plan to commence work difficult road subsequently.

2. Having decided the priority, we form teams (consisting of one Degree Engineer & two Diploma Engineers, a Laboratory Technician, Surveyor & two Supervisors) entrusted with maximum 4 roads each provided with a set of Laboratory equipments.

3. We also form an equipment bank at District level comprising of equipments owned by us and on hire. We also keep some equipments as stand by to cope up the requirement in case of emergency.

4. Sometimes it happens that many roads come under forest area. Where in acquisition area is less than a hectare we use to get clearance in no time at local level. So such roads are cleared by this procedure as soon as we get order to start the work from department.

5. We are having a **Contractor Quality Monitor (CQM)** Team since March, 2009 having Sr. Engineer as its head and other experienced

Engineers with laboratory staff to help him. His duty is to visit 2 to 3 roads every day- perform tests as per SBD Clause 32 of PMGSY Works, keep records and guide site engineers for correction in quality and issue quality guidance,. He is accompanied by a full fledged Mobile Field Test Laboratory having total facility for Material Testing. The main intension of starting this system is to improve quality of work particularly in interior site where quality monitoring is not possible up to sufficient level. The test result so carried out is kept on record. This unit also impart necessary guidance to all Supervisor/Engineer by conducting various seminar time to time.

6. We also form Team of Local Sub Contractors / Labour Contractors for Concrete work / C.D. Works for any PMGSY to be successful. It depends on completion of C.D. works. We provide all logistics to the local Sub Contractors / Labour Contractors for completion of C.D. Works timely as full fledge work of Sub base / WBM / Bitumen work can only be taken up subsequently. We procure NP3 Pipes for C.D. works on their behalf and supply them so as not to suffer quality and procurement time.

Generally all the Roads under PMGSY are on Cart track Roads. Before we start construction, we make line out of the road with the boundary fixed by line, so that any problem with the local people/authorities have to arise can be attracted at an earliest.

As soon as C.D. works for a particular road is over, we start with earth work. Keeping in mind gradient, super elevation and slope with required moisture to be added and achieving compaction as per norms, the base is prepared to receive the WBM layer. Special care is taken at C.D. work location where carriage width is from wall to wall and at curve where additional width is done to facilitate proper negotiation of curve by vehicle.

We prefer to do bitumen work of MPM by adding local HB metal for good bonding, OGC & SC by drum mix plant having good percentage of bitumen as it saves lot of time, minimize wastage and good quality of surface is obtained. The MPM by paver machine and plant is costlier but overall it is in the interest of work and minimizes routine maintenance cost subsequently.

After completion of bitumen road, the work of fixing road furniture / white wash / remaining side shoulder from WBM to top of B.T. etc. completed as per specification by a team specially formed for this with vehicles etc.

So with such rigorous advance planning, follow up, providing logistic support to the team involved, we could complete the road length of 2000 Km is various districts of Gujarat State within stipulated time.

Last but not least, routine maintenance of roads for five years subsequent to completion of work to be carried out by the same agency as a part of contract. We have prepared 'Action Plan for RMS', which has been appreciated by State authorities as well as by various NQMs in past. This Action Plan for RMS facilitate our site supervisors to carry out RMS activities during specified period under intimation of departmental officials and department to supervise such activity, offer corrective steps to be taken and timely asking for funds for RMS work. We intimate the department well in advance for RMS work that would be carried out by us with a copy to our site supervisors. A copy of 'Action Plan for RMS' is appended. Some of photographs of PMGSY works completed by us are appended herewith.

Based on our experience for the forthcoming phases of PMGSY-II, we would like to offer our suggestions for better execution of the work.

a) The execution of item of seal coat having thickness of 6 mm by paver machine is very difficult but due to richer percentage of asphalt we get good surface and though difficult we execute this item. But the thickness of seal coat is required to be enhanced.

b) The Rate Analysis for the various items are based on the methodology framed by NRRDA. It is formed and experienced that the following items are not having rates comparable to market rate due to poor output of manpower/machinery factors in Rate Analysis.

- Cement Concrete
- 20mm OG Carpet
- Seal Coat

a) For pre qualification criteria, the Contractors preferably have completed PMGSY work only as nearly all the State Contractors, executing other roads with different technology and they may not adhere to the requisite quality and achieve targeted progress.

b) It is observed that many in experienced contractors quote the tenders and not execute the same so if such contract is found lowest in many packages, he may be offered just one or two package only.

Incentive scheme for completion of work before stipulated time with quality consciousness was proposed in past but not implemented. This scheme is required to be implemented now.

ANNEXURE - I

ROAD MAINTENANCE SYSTEM

Indent No. : Date :

1. Name of Road :
2. Sub-section : Km to
3. Location (left / right of centerline)
4. Details

Sr. no.	Observing Engineer	Nature of Defect Observed	Remedial measures suggested	Approx qty / area / amount	Remarks
1	2	3	4	5	6
1.					

5. Safety measures to be adopted along with diversion, if necessary
6. Date of commencement / completion

SECTION OFFICER DY. EXECUTIVE ENGINEER EXECUTIVE ENGINEER

ACKNOWLEDGEMENT OF CONTRACTING AGENCY

1. I have received the indent no. dated I undertake to carry out the Repair work within the period of twenty days.
2. Due payment not received on specified date hence repair work as stated above shall only be taken up on receipt of payment.

Place **Date** **Contractor**

RMS Action Plan for PMGSY works in Dahod District :

Sr No	Name of work:	Construction & Maintenance of various roads under PMGSY (Phase-VI)				
1	District :	Dahod				
2	Division :	Panchayat (R&B) Division, Dahod				
3	Block :	Devgadh baria				
4	Pkg. No. GJ	GJ - 07 - 101				
	Total length in Kms.	12.00				
6	Actual date of completion of work / Previous RMS period	07/01/2011	08/01/2011	22/07/2013	22/01/2014	22/07/2014
7	Period	3rd Yr. 2nd Hlf.	4th Yr. 1st. Hlf.	4th Yr. 2nd Hlf.	5th Yr. 1st. Hlf.	5th Yr. 2nd Hlf.
	Start date of RMS	08/01/2011	23/01/2013	23/07/2013	23/01/2014	23/07/2014
8	End date of RMS	07/07/2011	22/07/2013	22/01/2014	22/07/2014	22/01/2015
9	Due date for demanding funds for RMS	07/02/2011	22/02/2013	22/08/2013	22/02/2014	22/08/2014
10	Tentative date for releasing funds for RMS by Department.	09/03/2011	24/03/2013	21/09/2013	24/03/2014	21/09/2014
11	Due Date of intimation to Deptt.	09/12/2010	24/12/2012	23/06/2013	24/12/2013	23/06/2014
12	Dates of carrying out RMS activities *					
13	From :	01/05/2011	15/02/2013	31/10/2011	30/04/2012	29/10/2012
	To :	10/05/2011	24/02/2013	09/11/2011	09/05/2012	07/11/2012
14	Due Date of observations of RMS activities by the department	20/05/2011	06/03/2013	19/11/2011	19/05/2012	17/11/2012
15	Due Date of rectification & submitting reports by Agency	04/06/2011	21/03/2013	04/12/2011	03/06/2012	02/12/2012
16	Due Date of Inspection by Deptt. For rectification done by Agency	09/06/2011	26/03/2013	[illegible]	[illegible]	07/12/2012
17	Due Date of submission of Inspection Report by Deptt. on (14) above.	11/06/2011	28/03/2013	11/12/2011	10/06/2012	09/12/2012
18	Due Date of submission of RMS bill to Department.	02/07/2011	17/07/2013	17/01/2014	17/07/2014	17/01/2015
19	Tender rate / Km.	21600.00	23670.00		25200.00	
20	Amount of RMS bill	129600.00	142020.00	142020.00	151200.00	151200.00
21	Due Date of Payment of RMS Bill by Department	7/17/2011	8/1/2013	01/07/2014	01/08/2014	01/02/2015
22	Submission of delay report of above activities to Circle office.	8/1/2011	8/16/2013	16/02/2014	16/08/2014	15/02/2015
23	Remarks if any.					

* Subject to modification with prior intimation.

for M/s. Shantilal B. Fetal

Signing authority

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Ministry of Rural Development Government of India
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