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List of Annexures

Measures proposed to achieve economy in Construction of rural roads under the PMGSY

1. Introduction

1.1 Cost of construction of rural roads has been showing an unusually upward trend in several States under the PMGSY. Accordingly, as decided by the Hon'ble Minister for Rural Development, a Committee (Expert Group) was constituted vide P-10018/1/ 2015-P-III dated 02.03.2015 (**Annexure 'A')** to deliberate over the issue and propose measures that can be adopted for achieving economy in construction of rural roads.

1.2 The Expert Group held its first meeting on 12.03.2015 and second meeting on 18.05.2015 to deliberate over the various measures that can help in addressing the issue. Sequel to the deliberations, draft report was prepared in consultation with the Chairman and as directed by Hon'ble Minister for Rural Development, a presentation was made before him in Hyderabad on 18.11.2015, where a few Hon'ble Members of Parliament also joined the presentation. The report has been further refined and finalized in the light of deliberations at that meeting and discussions within the Expert Group held on 27.11.2015.

1.3 The Group was of the unanimous view that there is positive scope for reduction of costs in construction of rural roads. However, any such reduction should not be at the cost of quality and compromise on proper engineering standards and safety considerations of PMGSY roads. The PMGSY has made a name for itself for reasons of all round quality management systems. These roads are being constructed as well engineered roads. This hallmark must continue and in fact should apply to all rural roads, not merely to PMGSY. At the same time, there is need to resist the temptation to over specify and over design as the available resources are to be utilised in achievement of all-round connectivity to all

habitations throughout the country as early as possible. Statement of average cost of construction in different states over the last 10 years is given in **Annexure 'B'.** In general, non utilisation of locally available / non-conventional materials including industrial wastes, new technologies, inadequate investigations, non-adherence to provisions of IRC guidelines, excess provision of protection and CD structures and use of bituminous layers are some of the reasons for increase in average cost of construction. Major reasons for increase in average cost of construction in different states are given in **Annexure 'C'.**

1.4 Safety aspects have also to be duly embedded into the design of rural roads - a factor which requires increased attention in view of increased motorization and vibrant rural economy as a result of poverty reduction through creation of rural infrastructure including roads under other programmes. Similarly, timely and adequate maintenance of rural roads is equally critical so that access is available on a sustained basis.

1.5 The key to achieve economy in road construction is preparation of quality and cost effective Detailed Project Reports(DPRs), which should be location specific and based on extensive surveys and investigations. Quality cum Cost Based System (QCBS) for engagement of consultants for DPR preparation, which has already been prescribed under PMGSY, should be strictly mandated where the SRRDAs decide to outsource this task. This might involve some more cost for preparation of proper DPRs and necessary approval of the Competent Authority concerned.

1.6 The various measures that can contribute to achieving economy in construction of rural roads and value for money from investments in rural roads are divided into the following groups:

(i) Pavement Design

(ii) Geometric Design

(iii) Maximising use of local and non conventional materials and industrial wastes

(iv) Special engineering measures in hill areas

(v) Special engineering measures in flood prone areas

(vi) Bridges, Culverts and Side Drains

(vii) Protection works

(viii) Special measures at Entry to Habitations/ Villages

(ix) Timely and adequate maintenance.

(x) Knowledge and technology development to enhance resource efficiency

(xi) Awareness raising among quarry and mine owners and coordination among various organizations, including public representatives

(xii) Awareness raising among community

(xiii) General Measures

(xiv) Capacity Building of Programme Implementation Units (PIUs)and Contractors

Measures proposed under each group are brought out in the succeeding sections.

1.7 It needs to be recognized that for implementation of these measures it will be necessary to seek additional support of STAs, NQMs, SQMs and strengthen the NRRDA to exercise adequate oversight during implementation.

2. Pavement Design

2.1 Pavements are basically of two types – flexible and rigid. Flexible pavements are mostly black-topped with bituminous surface except following where even Gravel roads can serve the purpose.

(i) In arid / desert areas with annual rainfall less than 500 mm and traffic up to 150 motorized vehicles per day excluding two-wheelers

(ii) In other areas with annual rainfall less than 1000mm and traffic up to 50 motorized vehicles per day excluding two-wheelers where gravel surface can be provided.

Rigid pavements are of cement concrete.

2.2 Under the PMGSY, most rural roads are being constructed as black-topped flexible pavements. Consideration may be given to provision of gravel pavements instead of black-top on such Link Roads of the Core Network (CN) as would conform to the criteria indicated in para 2.1 above. The Indian Roads Congress (IRC) has brought out a Manual for Design, Construction and Maintenance of Gravel Roads, IRC:SP:77-2008. Relevant design standards for gravel roads are available in this Manual and are also included in the recently revised 'Guidelines for the Design of Flexible Pavements for Low Volume Rural Roads', IRC:SP:72-2015. The PIUs and the DPR Consultants need to refer to these Manuals and Guidelines. Experience and feedback of the states on roads built as gravel roads under state programmes may be useful for further updating this Manual and promoting construction of gravel roads. Practically, many of the PMGSY roads can be designed as gravel/ unsealed roads for very low traffic volumes as in Para 2.1 above. However, use of low cost sealing options such as surface dressing, mix seal surfacing, otta seal, chip sealing etc. may be allowed in high annual rainfall areas of more than 1000 mm.

2.3 Where conditions for providing a gravel road are not appropriate, brick pavement or stone-set pavement or fly ash block pavement can be considered. Brick aggregates are already in use as sub-base in Tripura and some parts of Bihar and Uttar Pradesh and roads constructed using brick aggregates have performed well.

Though some introductory reference is already available in IRC: SP : 20: 2002, these technologies are not widely used. The IRC may be requested to come up with suitable guidelines for these types of pavements also.

2.4 It is noticed that sometimes Katcha (non –paved) rural roads (Non PMGSY)are being constructed without proper engineering standards and even without adequate compaction of earthwork and sub-base. It needs hardly any emphasis that even katcha roads should be well engineered with attention to compaction, camber/ superelevation, drainage structures so that connectivity objective is served and at the same time, when those are paved later, not much investment are involved in rectification measures. IRC has already published Gravel Roads Manual in 2008 (IRC SP: 77-2008) which should always be referred for such roads.

2.5 For design of flexible pavement, three parameters are basic

(i) Selection of design period

For rural roads, a design period of ten years has been adopted under the PMGSY. This is considered appropriate. This is neither too long as to entail prohibitively huge cost of initial construction nor too short as to require expensive upgradation at frequent intervals.

(ii) Assessment of sub-grade strength

The IRC, on the initiation of NRRDA, has recently revised the Guidelines on Design of Flexible Pavements for Low Volume Rural Roads, IRC: SP: 72-2015. The Guidelines stipulate inter alia that

(a) For evaluation of sub grade strength for new roads, the moisture content need not be for a 4-day soaked CBR value in all situations, rather it should be based on average annual rainfall, local ponding and flooding.

(b) All rural roads should be designed for a minimum sub grade CBR of 5 percent

(c) Where the sub grade strength is less than CBR 5 percent, measures of subgrade soil stabilization be adopted to improve the subgrade strength to 5 percent or more.

These guidelines need to be strictly followed in assessment of sub grade strength and preparation of DPRs by PIUs and consultants and enforced by the State Technical Agencies (STAs) at the time of DPR scrutiny.

(iii) Estimation of traffic

The procedure for estimation of traffic is fully explained in the IRC Guidelines referred to above. However, this needs to be followed strictly. The Rural Roads for smaller habitations (population below 500) shall be designed for a traffic not exceeding 100,000 ESAL (traffic category T_3), unless site situation warrants otherwise, for which a full justification needs to be provided.

2.6 Recently revised guidelines for the Design of Flexible Pavements for Low Volume Rural Roads, IRC: SP : 72- 2015 provides detailed process for design of new pavements and separately for upgradation of deficient existing roads, which should be strictly adhered to. This also includes use of recycled granular material for upgradation of roads.

2.7 There is need to exercise site audit by way of ground verification for assessment of subgrade strength and project estimates at Executive Engineer level. This applies to both situations where the DPR work is outsourced to consultants as well as that carried out in-house by the AE in the PIU. The STA must make a site visit and furnish his report in the following cases:

(a) Average Cost per km is abnormally higher than the average cost of similar works in the district/ region.

(b) Excess provision of CD works, protection works, CC road length or CC drains as indicated by cost component break up.

(c) Higher traffic volumes projected for design.

(d) Height of embankment proposed is 1 m or more (the HFL must be shown on the drawings and the DPR)

2.8 For achieving economy in construction of wearing coat for flexible pavements, surface dressing needs to be promoted for traffic categories T_1 to T_5. Further, closely graded Premix Carpet Surfacing or Mixed Seal Surfacing may be adopted in place of Open Graded Premix Carpet (OGPC).

2.9 As indicated in para 2.1 above, wherever average annual rainfall is less than 1000 mm and the subgrade is not expected to remain submerged for 4 days based on High Flood Level (HFL), pavements can be designed on the basis of unsoaked CBR.

2.10 Cement Concrete roads are designed for 20 years. They are usually costlier than black-topped roads in initial construction. As such their use is not common in rural roads, except for stretches passing through the village/habitation posing drainage problem. Cement Concrete Roads be provided only in habitation area where houses are existing on both sides of roads and construction of embankment is not possible due to land constraints and also effective drainage is difficult. Where CC roads are proposed, the following measures may be adopted to achieve economy:

1. Use of improved stabilized subgrade in all situations where CBR is less than 5 percent.
2. Use of fly ash / pond ash (wherever available) within economical leads.
3. Use of Cell filled Concrete, Roller Compacted Concrete, Panelled Cement Concrete, Silica Fume Concrete pavements, Self Compacting Concrete etc. including that in habitation area with adequate quality control measures .

Details of proposed low cost panelled cement concrete roads are given in **Annexure 'D'** and details of cement flyash block Khadanza pavement are given in **Annexure 'E'.**

3. Geometric Design

3.1 The geometric design standards for rural roads under the PMGSY as laid down by the IRC were reviewed earlier by the NRRDA (refer NRRDA Circular dated 30.09.2010). They have been further reviewed in the light of experience gained on application of the revised standards. These are given in **Annexure 'F'** in respect of hill areas and in **Annexure 'G'** in respect of plain areas.

3.2 The roadway width for Link Road in plains may be allowed to be 7.5m instead of 6m even when the paved carriageway is 3.0m, wherever the land use along the link warrants wider roadway with likely higher levels of traffic and availability of land. The carriageway for link roads may be 3.75 m with road way width of 7.5 m, where projected traffic is more than 100 motorized vehicles per day (excluding 2 wheelers). This will improve safety.

3.3 For Bridges (in plains) on through routes, the width may be 7.5 m. For link roads, the width may be 5.5 m. However, where traffic in the long term say 15-20 years is expected to be higher than traffic category T_7, width may be 7.5 m. Prior approval of NRRDA may be mandated for such cases in respect of PMGSY roads.

4. Maximising use of locally available marginal materials and industrial wastes

4.1 Many types of locally available / marginal materials like mining and quarrying wastes (over burden material, low grade ore which is not useful for metal extraction, weathered rock, moorum, etc), industrial wastes (fly ash, slag, etc), flaky or soft aggregates (laterites, phyllites, shales, brickbats, slate, etc), excavation / tunnelling or river dredging material (rock powder, marble slurry or dust, rock pieces, fine sand, gravel) from other infrastructure projects are available in different parts of the country. Using such materials in road works would be a 'win-win' situation for all

concerned - road construction agencies would get construction materials at lower cost, mining agencies and industries would be able to dispose of unwanted by-products (which they consider as 'Waste') and save precious land being used for disposal. In coastal areas, sea shells may be another potential product for use in road works that could be explored.

4.2 Accordingly, it is proposed that maximum lead for carriage of road aggregates (road construction base/ sub-base materials) except bitumen, emulsion, cement and steel shall be 50 km. It needs to be borne in mind that road construction materials are required to comply with specification requirements with regard to gradation, plasticity and strength / density criteria. Locally available / marginal materials within this permissible lead may not have all the attributes of conventional good quality road construction materials To promote usage of locally available / marginal materials, it is required to prepare a nationwide data-base of geographic availability (location defined by latitude and longitude) and physical and engineering properties of such materials (properties of materials as available and also after stabilization to improve its properties). Some of these materials may perform better with higher compaction efforts and in such cases compaction to refusal should be mandated. Test track studies would be essential to establish feasibility of usage of stabilised marginal/locally available materials in different layers of road pavement. Test track construction and performance monitoring are required as next step to establish their utilisation in this field. In the mean time, senior officers of the State road agencies should approve utilization of local materials keeping in view important properties of materials. For provision of bitumen surfaces, use of stone chips would be involved for which lead beyond 50 km may be permitted subject to certificate by the Executive Engineer of the PIU that suitable stone chips are not available within the permissible lead.

4.3. NRRDA in consultation with CRRI, PTAs and Standing Advisory Committee may formulate specifications for use of local materials. These

specifications may also include the variations in properties that can be tolerated if local materials are proposed to be used.

4.4. It is equally essential to characterise such materials from environmental safety / acceptability point also (heavy metal content, leachate analysis, etc). Even though wastes like fly ash have been classified as 'Non hazardous' by environmental regulatory bodies, the same may need to be applicable for other mining / industrial wastes. All such materials would have to be characterised to establish their 'Non hazardous and safe for use in road works' aspect.

4.5 The MoRD Specifications already provide relaxation in respect of grading of materials for granular sub base (GSB) layer. This is not being utilized in practice for provision of GSB layer with locally available materials. This needs to be enforced at the time of preparing DPR by the PIU and scrutiny by the STA.

4.6 Strength properties of locally available / marginal materials can be improved in some cases by enhancing compaction standards. Adoption of modified proctor compaction test and use of vibratory rollers can be incorporated in specifications and contract documents, especially when such materials are planned to be used in road works. This measure needs to be mandated where subgrade strength (CBR) is marginally less than 5 percent and also sub-base materials, where strength is marginally less than 20 percent.

4.7 Stabilization techniques - mechanical as well as chemical admixture stabilization can be widely adopted to enhance strength properties of locally available / marginal materials within the permissible lead of 50 km referred to in para 4.2. Portland cement which is available everywhere can be used as admixture for stabilization in most of the cases. While use of stabilised material in subgrade / sub-base can be achieved even when strength improvement is lower, use of stabilised material in base course would rely upon adequate gain in strength. This, in turn, depends on

quantum of coarse aggregate size particles and cement percentage in the mix. The recently revised IRC: SP:72:2015 has design templates for road pavement cross section using stabilised base / sub-base, which can be referred to. Lime stabilization may be adopted for clayey soil and PI more than 10. Cement stabilization is to be resorted to for silty and sandy soil when clay content is high; two stage stabilization; first with lime and then with cement is to be used. Where stabilization technique is adopted and provision of aggregate relief layer is made, as per IRC SP : 72: 2015, the exception could be made for the permissible lead beyond 50 km subject to certification by the Executive Engineer of the PIU that suitable aggregates for the relief layer are not available within the permissible lead. This will promote use of stabilization technology, conserve natural resources and preserve the existing road network from damage due to vehicles carrying construction material.

4.8 With support of NRRDA, the CRRI has now completed a Pilot project for Data-base preparation of conventional and locally available materials for 4 districts (Gwalior and Jabalpur in Madhya Pradesh; Darbhanga and Bhagalpur in Bihar). Results of this study need to be enforced for modification of design of ongoing and upcoming projects of PMGSY in these districts/ regions. This study needs to be extended to all other states in India. However, priority may be given to regions/ districts where the average cost/ unit length of construction is higher due to longer leads of standard traditional construction materials. This will help in harnessing the fruits of such study and data base at an early date. The data on soil classification and soil strength for all roads/ locations can be indicated for each block on GIS platform. STAs with support of PIUs may be entrusted with this task and CRRI may coordinate / guide STAs in this endeavour. Districts which have similar types of soil, materials, climate, industrial activities and are adjoining can be clubbed to represent a region. For example, Darbhanga District in Bihar and other surrounding districts have

many similarities with regard to soil and material availability and they can be clubbed to form a 'region'. The availability of marginal and conventional materials would be similar in such a region with few exceptions like thermal power plants/ steel plants, etc which may not be located in every district of that region. A time bound action plan needs to be prepared by the NRRDA to accomplish the task with well defined role of CRRI, STAs, PIUs. The investment in this study would help in evolving stabilization strategies to achieve positive reduction in cost of road construction.

4.9 If the strategy to use the locally available marginal materials is adopted whole heartedly, duly supported by the STAs and research efforts, substantial economies in construction and maintenance of rural roads would accrue. Booklets in various local languages need to be prepared to provide guidance to the PIUs and the local contractors. NRRDA may extend help to SRRDAs in this initiative.

5. Special engineering measures in hill areas

5.1 In many cases, it is observed that the central line and formation level for roads in hill area is being fixed without adequate regard for balancing the amount of cut and fill required along the road stretch during construction. This places an unnecessary burden on disposal of excess excavated material/soil. This involves not only additional cost in transportation but may also be prone to environment degradation. The PIUs and the DPR Consultants need to exercise due diligence on this important aspect in the interest of achieving economy as also protection to environment.

5.2 It is necessary to indicate the type of soil viz hard rock, soft rock and ordinary soil at the time of preparing the DPR, duly indicating the chainages of such category and estimated percentage of quantities of each soil type.

5.3 It has been observed that the hill cut material is normally being discharged either on the valley side or at some identified location with lead. In hilly

areas, the traffic volumes are normally very low and use of hill cut material with appropriate methods of stabilization can be very effective for achieving economy. This will reduce the use of standard traditional construction materials from long distances with very high cost. Where the road passes through rocky strata, consideration may be given to reducing the amount of blasting and utilising the exposed surface as sub-base with profile correction. The strength characteristics and suitability of the rocky strata should, however, be evaluated for this purpose.

5.4 Major expenditure is also incurred on clearance of slips and disposal of materials from slips. First, attempt should be made to use the same in construction of roads. Dumping yards are required to be provided for roads passing through forest areas as per extant instructions/ guidelines of the Ministry of Environment and Forests. Such dumping yards should be planned and provided across the motorable roads. They can be used as slip disposal places, resulting in reduction of cost of disposal.

5.5 Side slopes of roads in hill areas are prone to landslides and slips due to saturation during monsoons and times of heavy rains. Stone pitching and Bio-engineering measures need to be undertaken in conjunction with engineering solutions for stabilization and protection of hill slopes. Reference may be made to Clause 1612 of MoRD Specifications (First Revision) 2014. These measures would help in saving avoidable costs on landslide removal that may occur due to heavy rains.

5.6 For construction of retaining walls and breast walls, use of gabions need to be promoted to effect economy, as per site specific requirements and availability of boulders. For retaining and breast walls, use of dry masonry up to wall height of 3 m and bonded in cement mortar for wall height between 3m and 6m and stone masonry in RR 1:5 for height beyond 6 m is to be provided. Provision of retaining walls/ breast walls should always be supported with adequate investigations, designs and cross sectional drawings. Advantages of gabions over Plain Cement Concrete Wall and

their typical cost comparison for protection structures of different heights, are given in **Annexure' H'.**

6. Special engineering measures in flood prone areas

6.1 Cost-effective engineering solutions are to be thought of for keeping the roads safe and traffic worthy during and after the floods. Depth and duration of submergence will be critical in deciding the type of pavement, shoulders and side slopes treatment. Techno-economic viability of alternatives available should be examined before taking a final decision. The following measures are recommended towards minimizing the potential damages to roads in flood prone areas:

(i) Examine the possibility of locating the alignment on higher contour.

(ii) Heavy compaction of earthwork in embankment and sub-grade construction. The embankment shall be compacted to 95% of the maximum dry density (MDD) obtained by heavy compaction as per IS:2720-Part 8, and the sub-grade to 97% of the MDD.

(iii) Besides Interlocked Cement Concrete Block Pavement (ICCBP) or CC Block Pavement, panelled concrete pavement may be provided in the road stretch likely to be overtopped. This type of pavement is likely to suffer relatively less damage due to overtopping and can be easily repaired and restored. This strategy would be cost effective. In other sections, which are not prone to overtopping, the choice of pavement type shall be governed by the construction cost.

(iv) Shoulders shall be treated effectively by providing brick paving, quarry rubbish or stone set pavement, depending upon locally available materials.

(v) Adequate number of waterway openings to act as balancing culverts shall be provided in flat areas.

(vi) The causeway bed and its approaches covering the portion likely to be submerged and the approaches to submersible bridges covering the

portion likely to be submerged shall be provided with CC Pavement. The design of causeways and submersible bridges shall conform to the relevant IRC publications. Useful guidelines are available in IRC SP 13: Guidelines for the Design of Small Bridges and Culverts and IRC SP: 82 Design of Causeways and Submersible Bridges.

(vii) Where the height of the embankment (approaches to cross drainage works) is 2.5 m or more, side slopes should be protected by stone/cement concrete block pitching particularly if there is water ponding. The use of erosion control blankets like bio-degradable concrete fibers which are cheaper than stone/ concrete block pitching should be explored. Other measures like kerb drains, chutes, toe protection on downstream side should be provided where required depending on the height of embankment, rainfall and longitudinal gradient. In other cases, where embankment height is less than 2.5 m, local grass cover may be adequate.

(viii) Launching apron of suitable length should be provided on the Down Stream side (D/S Side) for protection against scouring in stretches where overtopping is expected. Borrow pits on the downstream side are to be avoided.

(ix) For guidance and safety of road users, 1 m high posts, made of locally available material, and warning signs should be fixed on shoulders at either end and at the lowest point of the road stretch likely to be overtopped. Such posts would be painted and marked to indicate the depth of water, if any, flowing above the road surface during floods.

(x) Roads in flood prone areas shall be closely monitored during and immediately after the floods for any damages to the road or the structures and they need to be restored as soon as practicable in order to ensure that the damages do not aggravate the road condition resulting in avoidable higher cost of rehabilitation later.

6.2 The stretches of road prone to floods shall be identified by the PIU and certified by the CE(PMGSY)/CEO of the SRRDA. High Flood Level (HFL) and proposed road top levels for such stretches of roads should be mandatorily mentioned in drawings/ DPRs.

7 Bridges, Culverts and Side Drains

7.1 Except for bridges, for length above 30m, Guidelines for Design of Small Bridges and Culverts IRC SP:13 shall be followed. The number of cross-drainage structures should be specific to location of each road and characteristic of the catchment served by the road.

7.2 There is need to revive the old system of arch (semi-circular) bridges and culverts to save on costs. For example, flyash blocks (M-10) can be used to construct 1.4 m dia arch culverts. This can result in saving in cost to the extent of 20 to 40 percent. About 80 percent of our streams have flood depth less than 3m. The State of Maharashtra has successfully practiced 2m semi-circle arch supported on raft foundation having short pier height of just 1.5m. This is an example worthy of reciprocating and upscaling by other States as well. Modular construction of culverts/ arch culverts if adopted can achieve substantial savings. Details of concrete block and semi- circular arch bridges and culverts are given in **Annexure 'I'.** Reference may also be made to Rural Roads Manual (IRC SP:20:2002)

7.3 Another strategy towards reducing cost of cross-drainage structures is to go in for submersible bridges and causeways wherever conditions so warrant, Refer IRC:SP:82: Design of Causeways and Submersible Bridges. There should be no need for high level bridge at least on Link Roads. Proper justification should be given if a high level bridge is proposed on a Link Road. In hill areas, even for Through Roads, it may be possible in some cases to provide a causeway with cement concrete bed. Keeping the bridge unnecessarily high would also entail higher cost of approaches, protection works besides additional land for the right of way.

7.4 In majority of cases, hume pipe culverts can serve the purpose of cross drainage in rural roads. In hill areas, where corbelling stones are not available, the NP-2 RCC Hume pipes may be provided for culverts. The requirement of the slab and box culverts should be minimized. However, some of the states are providing costly box culverts which should not be agreed to, without justification on the basis of hydraulic and geometric features. This will require special centering to ensure good quality and fast construction. Where box culverts are required to be adopted small spans of 4 m to 6 m may be adopted which can contribute to 25 to 30 percent cost saving.

7.5 In hill states, where problems of availability or transportation of NP3 pipes are noticed, the NP 2 type pipes, with appropriate cushion over it, if available within economical leads may be allowed to be provided.

7.6 The PMGSY works also provide for construction of dual purpose bridge-cum-bandhara for enabling storage for irrigation and drinking water apart from crossing the stream. Type designs are being worked out and would be soon available to the SRRDAs for suitable adoption depending upon location specific requirements.

7.7 For cross drainage structure, splayed wing walls may be provided in rural roads in place of return / head walls . Refer **Annexure 'J'** for typical details and drawings.

7.8 Reinforced Cement Concrete (RCC) flared type structure can prove to be a good economic alternative. Details of RCC flared wall are given in **Annexure 'K'**.

7.9 Rural Roads Manual IRC:SP20: 2002 provides for the headwalls of culverts to be placed away from the road way width, thus reducing the height of head walls. However, this is not being practiced by most of the states, adding to the cost of construction of culverts.

7.10 The types of CD structures proposed in **Annexure I, J and K** are as per Rural Roads Manual IRC SP : 20: 2002 with minor modifications and need

to be practiced. Special training may be provided to STAs, PIUs and Contractors in this regard.

7.11 For drains on stretches passing through habitations along CC pavement or bituminous pavement, normally uniform section is provided in DPR and the same is constructed at site. Suppose a bed width of 450 mm and height of 450 mm is provided, whatever is length, varying from say 50 m to 100 m, the same cross-section of drain is constructed. Actually cross-section should be need-based depending upon situation of drain and its length. Cross-section need not be same at the start point and at the other end which is the outfall point. At starting point, depth of drain may be reduced by half say 225 mm. There will be no harm to the drainage system. But cost of the drain will be reduced by about 10%.

Besides cost reduction, along with natural slope of ground, additional slope of 225 mm will be available which will add to the efficiency of the drain. If bed of drain is made self cleansing, by giving it a semi circular or N type or V type shape, its efficiency will further increase and it will become more maintenance free.

So at the time of DPR preparation and actual execution the drain should have at least two cross-sections, one for starting point and the other for outfall point separately. Thus, besides cost reduction as above, a self cleansing and efficient drain will be achieved.

8. Protection Works

8.1 In PMGSY works, protection works are sometimes provided in excess of actual requirement. For protection work, either it is pitching with filter or a retaining wall. In both the cases, height of protection work is normally being taken as height of embankment and flush with outer edge of roadway.

Regarding height of retaining wall or pitching, following points should be considered.

(i) The possibility of placing the wall farther from the edge of roadway i.e. in the slope, should be considered. Depending upon its distance from roadway edge, the height of wall will be reduced according to height of slope. So there will be reduction in cross –section also. With reduced height and cross-section, substantial saving in the cost of protection work will be achieved.

(ii) Height of protection work should depend on the height of submergence of embankment i.e. HFL. Normally the HFL will be lower than the embankment height. If this aspect is taken into consideration, the height and cross-section will be reduced. Thus construction cost will be reduced.

(iii) If there is standing water like pond, slope of earth work up to HFL from 1V : 1.5 H or 1V : 2.0 H, may be changed to 1 V to 4.0 H. This will suffice and may cost lower than any structural work.

8.2 Providing protection structures for restricting the required right of way and avoiding costly land acquisition thus compromising with safety is a common practice in some of the States. Such protection structures add to the cost of road works. These should not be permitted.

8.3 Gabion Structures in place of costly retaining walls may be proposed as per site requirements for achieving economy, as indicated in para 5.6 above.

8.4 If above points are taken into consideration, in several cases, there will be no need of protection work or else the height and cross-section will be reduced. This will lead to substantial saving in construction cost.

9. Creating hygienic conditions and achieving sustained performance at entry to villages.

9.1 It has been observed that streets are being paved in the villages and open side drains are provided to drain off rain water from the habitation area. PMGSY guidelines provide for allowing construction of CC roads and adequate side drains within the habitation. Now a days, many such habitations are being provided with piped water supply under various schemes. As a result, substantial quantity of waste water is discharged from houses into these side drains, from where it is finally drained off on the periphery of habitation along the road side. This water gets accumulated along the road and the adjoining area just at the entry of the habitation in absence of designated disposal and construction of drains without holistic planning, creating unhygienic conditions and also damaging the constructed roads.

9.2 Further, in some of the habitations, small plots have been allotted at the outskirts for dumping their solid waste and cattle dung, the heaps of which can be seen at either end of the habitation. Part of the solid waste with cow dung can be used for making compost which is not being done. This remains scattered on the roads creating unhygienic conditions. To some extent cow dung is used for making dung cakes, which are source of fuel for villagers, but creating unpleasant look along the road.

9.3 There is a need for holistic planning of the rural development schemes within the habitation with rural road to create clean and hygienic conditions. Following suggestions are made for improving the scenario. These measures will be helpful not only in creating hygienic conditions but also in reducing the cost of maintenance and thus achieving sustainable performance of rural roads.

1. PMGSY roads are required to end at a prominent place within the habitation such as Gram Panchayat, Government School, Public heath centre, community facility etc. This is as per the PMGSY guidelines and will help in improving hygienic conditions within the habitation.

2. Side drains should always be provided within the habitation area irrespective of the type of pavement (whether bituminous or cement concrete). These drains should be adequately designed as is also indicated in para 7.11 above based on expected flow of rain water, with varying sectional dimensions increasing in the direction of flow.
3. In most of the cases, while the toilets are being constructed in the houses, provision for soak pit should also be made mandatory, so that the side drains along the roads will carry only the rain water during rains. Such rain water may be allowed through continuity of earthen side drains, to be discharged in natural streams.
4. In case of smaller habitations where piped water systems are not expected, quantity of waste water coming out through side drains will be smaller, which can be discharged in specially constructed common soak pits filled with brick bats leading to percolation of water in the ground.
5. If waste water discharge is significant, Sewage Treatment Plant (STP) can be provided and treated water can be utilized for irrigation purposes.
6. The bio-gas plant including community biogas plant by gram panchayats may be promoted through Rural Development Schemes, leading to safe and hygienic disposal of cattle dung and also providing non conventional energy by creating public awareness.
7. Cleanliness drive may be taken up in villages in big way by involving village level government machinery and moreover creating awareness about public hygiene under Swatchh Bharat Abhiyan of the Government of India.

10 Timely and Adequate Maintenance

10.1 It needs to be recognized that a well engineered road is not only more durable but it also reduces the burden of maintenance. Also, if timely and

adequate maintenance of rural roads is not undertaken, it would result in much higher cost of rehabilitation and accelerated need for surface renewal besides increased vehicle operation cost and wear and tear of vehicles. We would then be depriving the benefits of access especially for medical aid, education centres and agriculture markets (mandis). The Ministry of Rural Development has separately requested the States to formulate maintenance policy for rural roads. Several states have already notified the rural road maintenance policy. The State Governments need to declare that rural roads would receive dependable and adequate allocation of funds for maintenance on continuous and regular basis. This would enable the road agencies to effectively plan and implement the maintenance programmes for the rural road network- not just the PMGSY rural roads but other rural roads as well.

10.2 Several States have taken the laudable initiatives of constructing rural roads under their own programmes on the lines of PMGSY guidelines so that they are also well engineered and quality execution is assured. For ensuring flow of funds for maintenance, the States may consider setting up dedicated funds for rural roads maintenance (a few states have already done so) by transfer of funds from various sources such as grants to the Gram Panchayats (GPs) by the 14th Finance Commission, State Government budget, grants recommended by the State Finance Commissions, additional levies like cess on agricultural produce (market committee fee), additional sales tax on petrol and diesel.

10.3 The Ministry of Rural Development has separately written to the State Governments on the action plan for accelerated execution of PMGSY and to complete the works by March, 2019, so as to provide connectivity to the target habitations. Separately, the Ministry is also considering to financially incentivise the States who achieve the targets allotted to them within the prescribed time frame and that this incentive could be used for periodic maintenance expenditure by the States. The States could avail

themselves of such incentives also for meeting the expenditure on maintenance of rural roads

11. Knowledge and technology development to enhance resource efficiency

11.1 The NRRDA has issued guidelines to the States for implementation of the PMGSY projects by using proven and promising innovative materials and technologies. The main focus has been to promote green technologies (cold mix, warm mix asphalt, coir technology, waste plastic) and use of locally available marginal and non conventional materials and industrial wastes. At pilot stage, a liberal view has been taken of some unintended poor performance or failure of such pilots with, of course, a laid down mechanism for supervision and monitoring during execution. Some of the States have taken good advantage of these engineering technologies. The tempo needs to continue. The support of the STAs is crucial in promotion of technologies and cost optimization.

11.2 In view of the launch of PMGSY-II and balance work of all-round connectivity of habitations with all-weather rural roads, the NRRDA – a technical and managerial arm of the MoRD is going to be a long-term institution. Besides strengthening of the NRRDA, its structure needs to provide a special cell for a continuous oversight on implementation of technologies and new materials on a sustained basis by all States. This would also help in regular interaction with the research agencies and academic institutes to accelerate progress on sponsored research studies. The technical management of the research and technology activities is critical to achieve palpable economies in construction of rural roads.

11.3 While several research schemes relating to roads, bridges and safety have been undertaken by the Central Road Research Institute, IITs and NITs, the level of Research & Development in the road sector is painfully low as is

evident from escalating costs of construction in the recent past that would justify a total relook. In case of rural roads, it is all the more critical as there are still more than 150,000 habitations (including those of population less than 500 or 250 in normal areas and special category states, beyond the scope of PMGSY) in the country that are crying for connectivity with all-weather roads. Even cost of upgradation of existing roads has to be brought down. Rural roads, therefore, justify a well thought out Resource Efficiency Strategy and Research Framework to be evolved and put in place on a permanent footing. A Centre of Excellence for rural roads needs to be identified. To start with, one of the PTAs/STAs at a place considered suitable by the MoRD may be considered. It would be necessary to have closer and regular interaction with the NRRDA and CRRI (an Apex research institute in the road sector). This can in due course be nurtured and developed as an extension arm of the National Institute of Rural Development. Major thrust areas of research for rural roads are indicated in Box 1.

11.4 Ideally, we would require such centres in four to five regions of the country.

11.5 The pavement constitutes a major component of the total construction cost in respect of rural roads. It also plays a key role in operation cost of vehicles and providing quality of service to road users. Maintenance costs are also reduced in case of an efficiently designed and properly constructed road. Cost of efficient strategies need to be continuously evolved covering methods, practices and processes of design and construction of subgrades, sub-bases, unbound and bound road bases and surfacing course. Effective drainage of pavement structure would also help in increasing the pavement life and reducing maintenance burden. The main resource efficiency indicators are :

- Reduction in pavement cost
- Improved safety of traveller, riding comfort

- High functional performance of pavement
- Minimum consumption of physical resources
- Minimum loss of vegetation cover due to borrowing of soil
- Energy efficiencies in construction operations.

Box 1: Thrust areas proposed for research

1. Effective drainage of pavement structures
2. Recycling of granular materials in full or partial depth for upgradation of roads.
3. Use of warm mix asphalt, porous pavements
4. Evolving specifications and quality control tests for new technologies
5. Accelerated bridge construction technologies
6. Evolve menu for subgrade and sub-base treatments to maximize use of marginal materials.
7. Use of industrial wastes, sea shells in coastal areas in road construction
8. Use of bio engineering measures for slope protection in hills
9. Development of pavement performance prediction models for rural roads
10. Development of Accelerated Pavement Testing Facility for low volume rural roads to monitor performance of roads constructed with marginal materials and industrial wastes.
11. Low cost thin bituminous surfacing
12. Use of low cost long lasting protection structures.
13. Alternative Surfacing technologies for rural roads.
14. Design of Cost effective cross drainage structures.
15. Traffic assessment for rural roads
16. Performance evaluation of stabilized bases and subbases in rural roads.
17. Use of Geo-textiles in rural roads

11.6 The technology evolved through R&D Laboratory would need to be piloted in the field and on successful demonstration on the ground, such pilots should be show cased for dissemination of the technology evolved among the road agencies and contractors. It would also be necessary to ensure that such pilots are documented and converted into codes of practice and guidelines for implementation on the ground. This would need to be

supported through administrative circulars from the government for upscaling on the entire rural road network – not merely the PMGSY.

11.7 There is a need for an Accelerated Pavement Testing Facility(APTF) in one of the PTAs/ STAs to enable monitoring of performance of pavements constructed with marginal materials and industrial wastes without loss of time and obtaining results of research in a time bound manner.

11.8 NRRDA may assign a research project of quick evaluation of thin bituminous pre-mix carpet surfacing (12-13 mm thickness) to CRRI using APTF. If this pilot comes out to be successful, substantial saving in cost of construction and subsequent maintenance can be achieved as the cost of surfacing alone is about 15-25% of total cost of construction.

11.9 The MoRD may consider creating a separate budget line for R&D in the rural road sector. To start with, a provision of 0.2 percent of the annual budget may be allocated for this purpose. The MoRD has recently finalised its policy on taking up R&D work and constituted a group of experts under the aegis of the NRRDA to consider and recommend proposals for R&D Schemes projected by the PTAs/STAs including CRRI. The States may also be requested by the NRRDA to indicate the areas where special focus on R&D in respect of rural roads may be given.

12. Awareness Raising among quarry and mine owners

Producers of locally available / marginal materials (like mine / quarry owners) need to be educated and sensitised about proper mode of disposing such materials. Non plastic, predominantly rock based over burden material/ low grade ore should not be mixed with soil and dumped. Such a process would render even a useful material as 'waste'. The by-product material (Over burden waste / low grade ore / tunnelling muck / dredged material, etc) should be collected and stored carefully by agencies who produce them, so that optimal use of such materials becomes possible. Unscientific disposal / mixing with soil may limit the use of

material for sub-base or subgrade only, which could otherwise be useful for even base course. Coordination with the Department of Mining and the Ministry of Environment and Forests for allowing the use of overburden material for appropriate purposes, rather than stacking it for refilling of mines, as it may be useful for road construction and refilling of mines may be done with soil or any other waste material including municipal waste.

13. Awareness raising among community

13.1 As the rural roads get constructed and upgraded as also due to influx of high speed motorized vehicles, safety is emerging as an area of concern. While safety engineering measures should receive attention during design, construction and maintenance, awareness raising is also required among drivers of farming community, agricultural tractors, jeeps, light commercial vehicles, buses in rural areas so as to encourage them to observe driving rules and traffic regulations. Physical speed reducing measures such as rumble strips, platform type speed breakers may be provided near schools, hospitals, location of sharp curves and at intersection with main highways. Road safety awareness camps need to be organised involving Panchayats, SHGs, school and road users. PIUs may draw up regular programmes for this purpose. Small leaflets in local language may be prepared and distributed among the community.

13.2 In certain cases, it has been noticed that the water sprinklers used in the agriculture farms are so close to the road that this leads to damage to the road shoulders. Such a situation can be easily avoided if awareness raising meetings are organised by the PIUs with the local communities in collaboration with Panchayati Raj Institutions. After all, they are the beneficiaries of the road.

13.3 In certain cases, it has been noticed that hand pumps are provided close to the road and the waste water gets accumulated along the road that damages the road structure. It should be ensured that hand pumps are

located away from the slopes of the road and the waste water gets discharged away from the road way through a channel.

13.4 It has been noticed that when tractors are used for working in fields (for ploughing etc), metallic rims (called cage wheels) are attached to the tractor. It is important that tractors having such attachments should not be operated over black top roads, since such wheels damage the road pavements. Such attachments can be provided in the fields and removed after work is over, before taking back the tractors to farmer's homes

13.5 There is a need for raising awareness among the community for appropriate disposal of solid waste, cattle dung, waste water from houses for creating hygienic and aesthetic conditions along the road with their participation in holistic planning of various rural development schemes for the villages/ habitations.

14. General Measures

14.1 Convergence with other schemes

In order to bring down the cost of construction of rural roads, convergence with various other schemes of Government of India such as MGNREGA / State Governments may be helpful as has been tried in limited cases in some of the States. MGNREGA funds can be used for plantation of trees and off-carriageway routine maintenance of rural roads in accordance with the extant guidelines.

14.2 Scrutiny of DPRs

Critical scrutiny of DPRs by the STAs and at NRRDA level has brought out positive reduction in the cost of construction of proposed works. A statement of such reduction in the cost is given in **Annexure 'L'**. In one of the States, a system of SRRDA level appraisal committee has been established, wherein every PIU is required to make a presentation of the annual proposals including DPRs. Such a system is helping the state in

verification of aberrations in the DPRs. Other States may also like to institute such practices.

Some incentives may also be proposed to be given to STA for proper scrutiny and efforts made for optimization of cost.

14.3 **Clearance of proposals**

An analysis of the overall size of the batch of proposal with respect to average cost has revealed that the average costs are higher where the batch size is larger, probably because the DPRs could not be prepared with greater emphasis and requisite efforts in scrutiny could not be applied. Ministry of Rural Development may indicate annual allocation of funds to all the States, in advance for sanctioning of new proposals and for expenditure on on-going works separately. This will reduce the burden on SRRDAs, STAs and NRRDA for scrutiny of more than required DPRs. On the other hand, since the number0 of DPRs will get reduced to be in harmony with the allocations available to each State, it will enable them to give sufficient time for quality preparation of DPRs by the PIUs and their scrutiny by STAs.

14.4 **Change in scope of work**

It has been observed that in some cases, after the DPRs are cleared by MoRD, changes in items / scope of work are made before bidding or during execution, against the PMGSY guidelines. The changes in items / scope of work after scrutiny of DPR, if restricted by uploading this data on OMMAS, will bring out substantial economy in construction, in such cases.

14.5 **Annual schedule of rates**

Increase in rates of items in annual schedule of rates is normally justified on the basis of trend of awarded works in recent past including that of state schemes. Schedule of rates for all rural roads should be based on the IRC Standard Data Book for analysis of rates.

15. Strengthening of NRRDA

15.1 The NRRDA has functioned as an arm of the Ministry of Rural Development (MoRD) to provide technical and managerial support for the implementation of the rural road projects under the PMGSY since its launch. With support from IRC and PTAs/ STAs, it has formulated several documents viz Specifications, Quality Assurance Hand Book, Standard Bidding Document, Guidelines for preparation of Core Network and District Rural Roads Plan (DRRP), Operations Manual etc. Recently, Guidelines on Technology Initiatives have been formulated and States are being encouraged to undertake pilots and thereafter upscale the technologies in actual projects.

15.2 For keeping an oversight on the cost economy measures as recommended in this report to be implemented by the State Road Agencies, the NRRDA is expected to undertake the following tasks:

(i) Increase in sample size for scrutiny of DPRs, which is one of the key ingredients in cost effective design.

(ii) Accelerating progress on implementing technology initiative guidelines of NRRDA issued in May, 2013.

(iii) Encouraging and pursuing with the States to promote the use of semi-arch bridges and culverts and construction of causeways (vented or other wise) and submersible bridges.

(iv) Interaction with Research agencies and Academia for formulating and approval of research proposals useful for rural roads.

(v) Tracking the progress of research schemes entrusted to Research Agencies and Academia.

(vi) Networking with International Institutions on evolving resource efficiency strategies in the construction and maintenance of rural roads with support of World Bank, ADB, CRRI, ASCAP etc.

(vii) Organizing site audit by way of ground verification in sample cases through National Quality Monitors, analysing their reports and getting implemented by the PIUs.

(viii) Preparing Status reports on actions taken and required by SRRDAs at the Regional Review Meetings.

(ix) Pursuit with training providers for imparting training to technical personnel of state road agencies and contractors at various levels and orientation programmes for STAs for their effective site visits, scrutiny of DPRs and support the road agencies in implementation of technical initiatives.

15.3 For proper and efficient execution of the tasks enumerated above, it is essential and inevitable that the NRRDA is adequately strengthened with well qualified and appropriately experienced technical officers at the level of Assistant Director, Deputy Director, Joint Director and Director. It needs hardly any emphasis that the quality of the DPR and incorporation of the cost effective strategies including the use of local marginal materials in the DPR would be the key to achieve success on the ground. Past experience has shown that additional scrutiny on sampling basis by the NRRDA has helped in cost reduction in several road projects of different States **(Annexure 'L')** already referred earlier). NRRDA has been facing acute shortage of experienced and qualified technical staff and scrutiny of even 15% sample DPRs as envisaged in Operations Manual of PMGSY is difficult. NRRDA may even need to increase their present sample framework for exercising additional scrutiny of DPRs. MoRD may consider making NRRDA as a permanent autonomous organization with its own cadre structure (either fully or partially) for providing technical guidance to rural roads sector even beyond PMGSY.

15.4 Besides scrutiny of additional sample of DPRs, the NRRDA should have a dedicated division for tracking progress on R&D studies being sponsored to CRRI, IITs, NITs and other academic and research institutes. Till the time a separate division is created, adequate technical staff at the level of Joint Director, Deputy Director and Assistant Directors, for this work may

be provided to the division looking after R&D works for immediate implementation of these measures.

15.5 Keeping in view the current mandate of the government to accelerate the implementation of the PMGSY and PMGSY-II, in a time bound manner, it is strongly recommended that suitable strengthening of the NRRDA may be undertaken with the urgency it deserves.

16. Additional Support from State Technical Agencies (STAs), National Quality Monitors (NQMs) and State Quality Monitors (SQMs).

16.1 The State Technical Agencies have been providing support to the PMGSY programme by way of scrutiny of DPRs being prepared by the SRRDAs whether in-house or through consultants or a combination of both. When technology initiatives guidelines were issued in May, 2013, these STAs were requested to guide the PIUs and the contractors in main streaming the promising and cost effective technologies. As a result, considerable progress is happening on ground. The tempo needs to continue.

16.2 Support of STAs in identification of the works and the technologies to be adopted, based on joint inspection of sites with PIU and technology provider was expected in the Technology Initiative Guidelines. However, this is not happening in some cases. Much more support from STAs is required for the PIUs. In most of the cases PIUs are not aware of the requisite tests / design process to be adopted while proposing a technology. In such cases, STAs need to guide the PIUs. However, it is possible that some of the STAs may also not be aware of the innovative technology and materials including bio-engineering measures. The STAs were provided training on new technologies after the guidelines were issued. There is need to review the progress on this account and if required the identified STAs may be provided training once again. Refresher courses and inter-active dialogues may also be arranged for STAs with the support of NRRDA.

16.3 Additional support will be required from these STAs towards implementation of measures proposed for achieving economies in construction and maintenance of rural roads. One of the urgent requirements would be to mandate site visits on certain percentage of sample DPRs to exercise check on

- Misreporting, if any, on the data relating to soil strength, traffic and HFL.
- Situations where abnormal provision for cross-drainage works is made
- Situations where costly protection structures have been proposed in the estimates.
- STAs may be mandated for certain percentage of samples to be tested in their own laboratory for cross verification of materi al properties and to have a check on tendency of under reporting a nd over designing.

This will involve additional effort and resources of the STAs for which suitable remuneration can be fixed as per current procedures and guidelines.

16.4 A few selected STAs may also be involved in site inspection of works during execution of rural road works to support the SRRDAs and contractors particularly where new technologies are being deployed.

16.5 Side by side, there is need to undertake orientation programmes for these STAs as have been done in the past, with the support of CRRI, IAHE and IIT- Bhubaneshwar so that they are sensitized on the deliverables expected from them for smooth implementation of the measures recommended in this report.

16.6 Ground verification of some sample DPRs (where aberrations are noticed) should be carried out by SRRDAs through SQMs by deputing them to the site before submission of DPRs to NRRDA. Similar ground verification in some cases can also be carried out by NRRDA through NQMs before

sanctioning of proposals. Such exercise has been carried out by NRRDA in the past in some of the States through NQMs and was found to be very effective in achieving economy bringing out severe deficiencies in DPRs such as excess provision of CDs, protection works, CC drains and CC pavements, exaggerated traffic, low CBR reporting, reporting of lower available existing crust (upgradation works) and even wrong selection of proposed work. At present, NQMs in general are involved in quality monitoring works. Wherever, STAs find it difficult to go to the site for ground verification of provision of DPRs, they may be authorized to ask the PIU for a ground verification report through SQM. This task should be coordinated by SQC on request of PIU. Honorarium to NQMs/ SQMs for such assignment be paid as per current norms of NRRDA.

17. Capacity Building and Training

17.1 For success in achieving economy in construction of rural roads without compromise with quality and safety, continued efforts are required in knowledge development and training of engineers of PIUs, DPR consultants and contractors. The NRRDA has already been sponsoring several training programmes for capacity enhancement of various stakeholders concerned with the PMGSY and other rural roads. Recently, NRRDA has prepared booklets on training in delivery of maintenance with the support of International Labour Organization under the World Bank project for Eight PMGSY States and delivered training to about six thousand PIU Engineers and Contractors. Special dedicated programmes for awareness raising of various measures proposed in this Report may be evolved and delivered with the support of training providers such as IAHE, CRRI, PTAs, STAs, IITs and NITs. Needless to add that orientation programmes will be required to be delivered to all STAs also for which IAHE, PTAs and CRRI may seek support of domain experts and practicing professionals.

17.2 At the time of Regional Review Meetings with the States, half a day may be reserved by the NRRDA for interaction on the use of the technologies and economy measures proposed in this Report and feedback on projects undertaken by adopting such technologies and measures.

17.3 The SRRDAs may also depute their selected officers to visit projects being undertaken in other States for promoting such technologies and engineering measures in their States.

17.4 Pocket books may be prepared in various local languages for engineers and support functionaries in the field.

17.5 Wide publicity should be given to successful technologies through electronic media and local newspapers.

18. Summary of Recommendations

To recapitulate, the following measures are recommended to achieve economies in construction and upgradation of rural roads under PMGSY.

1) There is positive scope for reduction of costs in construction of rural roads including PMGSY. There is need to resist temptation to over specify and over design and yet ensure well engineered roads without compromise on quality and safety.

2) One of the keys to achieve economy is to prepare a quality and cost effective DPR with due diligence and proper surveys and investigations by the PIUs and thorough scrutiny by the STAs. Where the work of DPR preparation is outsourced, it is necessary to adopt QCBS for engagement of consultant as prescribed under PMGSY.

3) Promote the use of gravel roads for traffic upto 150 motorized vehicles per day (excluding two wheelers) for areas with annual rainfall less than 500 mm and for traffic upto 50 motorized vehicles per day (excluding two wheelers) for areas with annual rainfall less than 1000 mm.

Gravel roads may also be promoted in other areas for traffic upto 50 motorized vehicles together with use of low cost sealing option (surface dressing, otta seal etc). Brick pavement or stone- set pavement or fly ash block pavement may also be considered where use of gravel is not found appropriate.

4) For design of pavements, Guidelines for Design of Low Volume Rural Roads IRC SP:72-2015 recently revised should be strictly followed. It provides for detailed process for both new pavements and upgradation of existing pavements. The use of recycled granular material for upgradation is also included.

5) Assessment of subgrade strength and preparation of DPR by the PIUs and Consultants should be test checked by STA.

6) Where katcha roads are constructed, attention should be paid for proper compaction of earthwork and other granular layers and provision of camber/ super elevation and drainage structures.

7) The STA to make a site visit and submit report in following cases.
   (a) Average Cost per km is abnormally higher than the average cost of similar works in the district/ region.
   (b) Excess provision of CD works, protection works, CC road length or CC drains as indicated by cost component break up.
   (c) Higher traffic volumes projected for design.
   (d) Height of embankment proposed is 1 m or more (the HFL must be shown on the drawings and the DPR)

8) Where cement concrete roads become necessary, for example in flood affected stretches or within the habitation, use of cell filled concrete, Interlocking Concrete Block Pavement (ICBP) or panelled cement concrete road needs to be promoted, which will provide better quality with efficient quality control.

9) The roadway width for Link Road in plains may be allowed to be 7.5m instead of 6m even when the paved carriageway is 3.0m, wherever the

land use along the link warrants wider roadway with likely higher levels of traffic and availability of land. The carriageway for link roads may be 3.75 m with road way width of 7.5 m, where projected traffic is more than 100 motorized vehicles per day (excluding two wheelers). This will improve safety.

10) For Bridges (in plains) on through routes, the width may be 7.5 m. For link roads, the width may be 5.5 m. However, where traffic in the long term say 15-20 years is expected to be higher than traffic category T_7, width may be 7.5 m. Prior approval of NRRDA may be mandated for such cases in respect of PMGSY roads.

11) Necessary steps should be taken for maximising the use of locally available marginal materials. For this, maximum lead for carriage of stone aggregates shall be 50 km. All necessary measures required for improving the strength of local materials shall be adopted as per current guidelines of the NRRDA for technology initiatives.

12) CRRI has recently completed a pilot project for database preparation of locally available materials in four districts (two each in Bihar and Madhya Pradesh). Results of this study should be enforced for modification of design of upcoming projects. The Study needs to be extended to the entire country with priority to those districts/ regions where average unit costs are high due to long leads of road aggregates.

13) It is necessary to indicate the type of soil viz hard rock, soft rock and ordinary soil at the time of preparing the DPR, duly indicating the chainages of such category and estimated percentage of quantities of each soil type

14) In hill areas, use of hill cut material with appropriate stabilization needs to be promoted. Further, in rocky areas, the exposed surface may be utilized as sub-base with profile correction.

15) For disposal of materials from slip clearance, suitable dumping places may be planned along motorable roads.

16) Stone pitching and bio-engineering measures need to be adopted for protection of hill slopes as a measure for saving avoidable costs in landslide removal.

17) For construction of retaining walls and breast walls in hills, the use of gabions over CC wall should be preferred and promoted.

18) The stretches of road prone to floods should be identified by the PIU and certified at the Chief Engineer level in the SRRDA. The proposed road top level for such stretches should be clearly indicated in the drawings and the DPR.

19) The number of cross drainage structures should be specific to location and keeping in view the catchment served by the road. In majority of cases, hume pipe culverts can serve the purpose. Accordingly, their use should be maximised to save on costs.

20) There is need to encourage use of semi-circular arch culverts and bridges. M-10 Fly ash CC Blocks 1.4m dia culverts can serve in several cases.

21) There is a need to also go in for submersible bridges and causeways as per the IRC guidelines on acceptable interruptions in case of rural roads. Refer IRC SP 82 for Design of Causeways and Submersible Bridges.

22) For cross drainage structures on rural roads, wing walls may be splayed in place of return /head walls.

23) Wherever box culverts are proposed, the STAs shall carry out a site visit and submit a report on the need or otherwise of such options.

24) For side drains, the cross-section should be provided as per actual needs of discharge flow with low depth at the start point.

25) Design of protection structures should allow for reduced height of wall by placing it away from the roadway edge.

26) Sometimes protection structures are being proposed for restricting the ROW and avoiding costly land acquisition. Such protection structures should not be permitted.

27) At the entry point of villages/ habitations and junctions of internal village road and external road, generally undesirable heaps of cattle dung and accumulation of waste water are noticed. This presents unhygienic conditions. There is a need for holistic planning of Rural Development Schemes and raising awareness among the community.

28) Timely and adequate maintenance of rural roads also reduces the burden of accelerated renewal of surface and rehabilitation of roads. The states need to provide adequate funds for maintenance of rural roads and ensure proper delivery on the ground through their road agencies.

29) The technology evolved through R&D Laboratory would need to be piloted in the field and on successful demonstration on the ground, such pilots should be show cased for dissemination of the technology evolved among the road agencies and contractors. It would also be necessary to ensure that such pilots are documented and converted into codes of practice and guidelines for implementation on the ground. This would need to be supported through administrative circulars from the government for upscaling on the entire rural road network – not merely the PMGSY

30) The NRRDA need to have a dedicated special cell for a continuous oversight on implementation of technologies and new materials.

31) The MoRD may consider sponsoring research studies in such areas which hold promise for cost reduction or higher performance and identify a few Centres of Excellence for this purpose. These may be within the existing/ proposed STAs and other academic institutions.

32) There is need to open a dialogue with Department of Mines and MoEF for allowing the use of over burden material for road construction rather than for refilling of mines which can be done with other waste material.

33) Awareness raising leaflets should be prepared and campaigns undertaken among communities to encourage them to protect the road assets and avoid damaging the pavement and shoulders and other traffic control devices as also for safe driving and use of road.

34) The States need to be constantly discouraged to propose changes in the scope of work after sanction of DPR and clearance of proposals by the Empowered Committee.

35) The STAs would be requested to undertake site visits for cross-checking the provisions made in the DPR for cross-drainage structures, protection works and technology initiatives and scrutiny of additional sample DPRs. For this, the NRRDA may consider suitable remuneration for additional support expected from these STAs.

36) The NRRDA and SRRDA, may continue with the existing system of training of PIUs in different aspects of implementation of PMGSY projects. There is need to cover personnel of consultants and contractors also. Orientation programmes are also needed for STAs so that they are abreast of the support required by the SRRDAs and the NRRDA.

37) Statement of component wise cost of roads (in percentage) in some selected States is given in **Annexure – 'M'**. A summary of possible cost reduction based on above recommendations is given in **Annexure- 'N'.**

38) For exercising oversight on the implementation of the economy measures recommended in this Report, it is essential to strengthen the NRRDA at various levels with well qualified and experienced technical personnel.

Annexures

Annexure-A

No. P-10018/1/2015/P-III
National Rural Roads Development Agency
Ministry of Rural Development,
Government of India

ORDER

Subject: Formation of Expert Group for suggesting measures for Cost Reduction in Rural Roads.

With the approval of Competent Authority, an Expert Group has been constituted for Suggesting Measures for Cost Reduction in Rural Roads with the following members :

(a) Officials Members from the States/ NRRDA

1. Shri R.P. Singh, Addl. CEO, BRRDA,
2. Shri M.K. Gupta, Engineer-in-Chief, MPRRDA
3. Shri A.K. Dinkar, Chief Engineer, URRDA,
4. Shri S.M. Hassan, Empowered Officer, ASRRDA, Guwahati
5. Shri Mahesh Hiremath Chief Operating Officer, SRRDA, Karnataka
6. Shri Chaman Lal, Director (Projects-III), NRRDA
7. Dr. I.K. Pateriya, Director (Technical), NRRDA -**Convener**

(b) Non Officials members from the reputed institutions

1. Shri U K Guruvitthal, Sr. Principal Scientist, CRRI
2. Smt Lakshmi Parameswaran Chief Scientist CRRI
3. Dr. C.S.R.K. Prasad, NIT, Warangal,
4. Dr. U.C. Sahoo, IIT, Bhubaneswar

(C) Non Official Expert Members

1. Shri D.P. Gupta Former DG, MoRTH, - **Chairman**
2. Shri S.C.Sharma Former DG, MoRTH
3. Shri P.L. Bongirwar, Former Secretary (PWD), Maharashtra
4. Shri V.S.Singh, Former CE, UPPWD and Former NQM

The Expert Group will go through the recommendations of earlier expert committee, will look into the issue raised by various stake holders and finalize its recommendations **within a period of 6 weeks**.

Honorarium, TA & DA for the non- official members will be reimbursed as per the norms of NRRDA.

(I.K. Pateriya)
Director (Technical)

Distribution:
All Concerned.

Annexure-B

Statement of average cost of construction (per km) in different states over last 10 years (New Connectivity)

Sr.No.	State Name	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015
		U	U	U	U	U	U	U	U	U	U	U	U	U	U	U
1	Andhra Pradesh	8.54	12.32	--	13.04	13.77	19.66	25.76	35.10	53.98	--	29.30	--	--	--	--
2	Arunachal Pradesh	10.00	--	--	--	--	--	--	--	65.01	--	--	--	--	66.46	44.06
3	Assam	--	25.55	--	--	--	19.08	21.81	55.11	--	--	--	--	--	--	--
4	Bihar	15.49	--	--	50.66	29.42	34.20	42.05	43.85	56.87	--	--	--	--	57.95	--
5	Chhattisgarh	10.18	14.53	--	--	17.16	19.18	26.34	27.35	28.57	--	--	--	38.87	41.32	--
6	Goa	7.47	--	--	--	--	--	--	--	--	--	--	--	--	--	--
7	Gujarat	8.51	9.54	--	10.08	--	10.92	14.42	15.12	20.80	--	--	--	--	35.23	--
8	Haryana	5.60	17.00	--	17.48	21.97	23.28	32.26	41.17	57.32	40.72	--	--	--	--	--
9	Himachal Pradesh	--	--	--	--	--	--	15.67	18.66	29.61	38.72	--	--	--	--	33.67
10	Jammu And Kashmir	18.02	--	--	24.58	--	--	64.82	114.00	--	--	--	--	--	--	--
11	Jharkhand	14.98	--	--	--	--	--	--	--	--	--	--	--	--	42.90	--
12	Karnataka	6.67	8.50	--	10.76	--	16.66	19.90	26.83	29.94	29.07	32.26	--	38.60	--	--
13	Kerala	11.52	14.66	--	--	--	26.14	39.54	--	42.30	--	--	--	--	68.56	--
14	Madhya Pradesh	10.00	11.25	--	--	21.84	17.27	22.03	23.43	28.85	27.27	--	--	--	--	--
15	Maharashtra	8.64	12.28	--	11.16	11.29	17.05	31.04	26.23	27.14	25.71	--	--	62.51	45.96	--
16	Manipur	8.10	11.77	--	--	--	--	33.27	--	37.25	--	--	--	--	45.85	48.64
17	Meghalaya	--	--	--	--	--	--	--	--	--	--	--	--	--	42.20	--
18	Mizoram	10.93	--	--	--	--	--	--	--	--	--	--	--	--	--	--
19	Nagaland	7.50	12.77	--	10.89	--	17.43	27.73	--	--	--	--	--	--	--	--
20	Odisha	13.80	16.34	--	--	21.31	25.68	31.60	37.02	35.85	--	--	--	--	--	--
21	Punjab	--	12.44	--	--	19.70	--	37.57	45.06	49.86	--	--	47.13	48.61	54.29	53.30
22	Rajasthan	6.87	--	--	--	--	--	--	22.79	22.99	25.38	--	--	--	--	--
23	Sikkim	1.36	10.75	--	--	--	23.49	--	39.93	--	--	--	--	--	--	--
24	Tamilnadu	9.13	12.21	--	13.60	11.33	20.37	22.34	28.00	--	--	--	--	33.71	--	36.48
25	Telangana	6.13	11.02	--	13.11	14.15	18.21	24.51	34.62	29.80	--	31.51	--	--	--	--
26	Tripura	8.40	18.97	--	--	--	--	--	59.40	61.90	--	--	--	--	68.47	--
27	Uttar Pradesh	3.59	16.24	--	16.62	18.51	28.00	34.40	35.14	--	31.04	--	--	36.73	--	--
28	Uttarakhand	19.25	--	--	--	23.52	--	--	--	--	--	--	--	--	34.94	--
29	West Bengal	16.14	--	--	--	--	31.54	--	28.20	34.59	--	46.17	--	53.79	53.06	51.54

Annexure-B

Statement of average cost of construction (per km) in different states over last 10 years (Upgradation)																
Sr.No.	State Name	2000-2001	2001-2002	2002-2003	2003-2004	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011	2011-2012	2012-2013	2013-2014	2014-2015
		N	N	N	N	N	N	N	N	N	N	N	N	N	N	N
1	Andhra Pradesh	6.95	13.26	--	10.29	--	--	21.81	--	34.97	--	--	--	53.67	31.77	--
2	Arunachal Pradesh	12.90	11.86	--	--	30.74	51.03	41.90	65.38	69.10	70.20	--	--	65.60	85.38	91.13
3	Assam	41.74	26.16	--	24.96	32.57	45.35	54.46	63.46	67.63	--	--	--	61.07	51.58	--
4	Bihar	19.11	19.78	--	45.82	37.79	43.69	41.02	44.50	51.78	43.42	62.47	48.61	58.39	65.29	--
5	Chhattisgarh	14.36	17.02	--	20.01	21.29	23.34	28.50	29.30	29.57	--	--	37.53	42.91	43.02	--
6	Goa	--	16.85	--	--	--	--	--	--	--	--	--	--	--	--	--
7	Gujarat	11.50	13.23	--	14.00	17.77	17.57	21.22	22.49	31.82	29.85	36.84	--	44.57	39.69	--
8	Haryana	--	--	--	--	--	--	--	--	45.95	--	--	--	--	--	--
9	Himachal Pradesh	11.22	13.81	--	13.91	22.78	24.89	25.44	30.83	37.73	41.00	26.75	--	--	35.42	43.81
10	Jammu And Kashmir	23.40	28.64	--	30.91	35.04	44.99	50.85	62.13	--	--	--	44.99	61.75	--	--
11	Jharkhand	17.82	20.17	--	20.73	--	23.97	--	29.71	31.10	26.81	--	29.07	41.79	47.40	--
12	Karnataka	6.77	10.43	--	--	--	--	--	--	--	--	--	--	--	43.69	--
13	Kerala	18.95	20.67	--	22.01	29.31	30.01	--	--	--	--	--	--	--	--	--
14	Madhya Pradesh	12.14	14.77	--	20.43	20.53	19.85	24.30	26.02	35.25	29.94	--	33.73	38.12	46.10	--
15	Maharashtra	8.40	16.36	--	18.19	19.22	30.11	49.50	44.13	38.87	50.52	--	--	57.56	68.75	--
16	Manipur	10.29	11.07	--	--	--	--	26.09	--	30.24	--	31.45	--	37.62	43.07	45.16
17	Meghalaya	7.40	26.31	--	--	--	30.20	37.52	--	70.01	--	--	89.54	--	67.54	--
18	Mizoram	11.15	18.60	--	16.74	31.49	24.52	--	36.84	40.57	--	--	--	--	68.58	--
19	Nagaland	1.00	17.69	--	11.13	16.71	18.27	25.14	26.33	--	--	--	37.26	--	--	--
20	Odisha	17.23	20.13	--	21.92	26.20	29.08	37.58	41.28	39.42	40.46	--	39.94	47.13	49.17	--
21	Punjab	15.91	16.46	--	16.50	17.57	--	--	--	--	--	--	--	48.67	--	50.41
22	Rajasthan	11.52	12.30	--	13.60	--	18.19	17.13	16.48	--	--	--	24.58	28.98	30.15	--
23	Sikkim	--	33.14	--	33.32	43.68	46.68	--	44.78	52.09	--	--	52.23	--	63.17	69.96
24	Tamilnadu	11.42	15.40	--	14.54	15.11	22.46	28.62	46.23	--	--	--	--	43.36	--	37.13
25	Telangana	5.55	12.52	--	10.95	--	--	--	--	36.99	--	22.61	--	47.99	--	--
26	Tripura	3.21	21.93	--	--	--	48.54	59.95	60.83	54.75	--	--	91.67	--	78.70	--
27	Uttar Pradesh	3.97	19.76	--	22.84	24.51	28.73	32.82	39.08	--	33.65	45.31	49.46	46.91	--	--
28	Uttarakhand	30.75	29.10	--	13.51	17.36	22.88	--	30.22	--	34.03	30.72	52.12	40.39	49.94	--
29	West Bengal	18.47	27.78	--	29.57	--	31.57	39.80	36.98	42.45	--	48.44	48.25	57.16	52.05	--

Statement of average cost of construction (per km) in different states over last 10 years (PMGSY-II)				
Sr. No.	State Name	2013-2014	2014-2015	Total
1	Andhra Pradesh	50.77	0.00	50.77
2	Gujarat	57.36	0.00	57.36
3	Haryana	88.74	0.00	88.74
4	Karnataka	45.91	0.00	45.91
5	Maharashtra	54.96	56.65	55.31
6	Telangana	57.09	0.00	57.09
7	Uttar Pradesh	59.22	0.00	59.22
	Total	**56.87**	**56.65**	**56.86**

Major reasons for increase in Average Cost of Construction of PMGSY Rural Roads

1. Non-utilization of locally available and non-conventional materials including industrial wastes.

2. No efforts for using alternate designs using New Materials and Technologies for optimality.

3. Inadequate investigations and failure to check correlations in the soil properties.

4. Inaccurate estimation of Design Parameters such as traffic, sub-grade soil strength (CBR), thickness and strength of existing road crust, hydrological data,

5. Non adherence to the provisions of relevant IRC guidelines/ PMGSY guidelines for Pavement Component Design and other items.

6. Inadequate Geometric Design involving deep cuttings, higher embankments and costly protection structures.

7. Inappropriate location, type, numbers and design of Cross Drainage Works.

8. Substantial length of road proposed as Cement Concrete roads, adding to the cost.

9. Proposing higher than required length and cross section of Cement Concrete drains.

10. Disposal of the hill cut material and using borrowed material for Sub-base Courses and shoulders etc.

11. Use of Costly Protection structures to support the Roadway width, as adequate land width is not available.

12. Use of Bituminous Macadam or Modified Penetration Macadam Base(MPM) as Base course even in very Low Volume Rural Roads.

13. Use of costly provision of pre-mix carpet and seal coat even for very low volume roads.

14. Inadequate efforts in scrutiny of the proposals with verification of provisions in select cases at ground.

15. Increase in Schedule of Rates (SoRs).

Low Cost Concrete Pavements

Two types of long lasting concrete surfaced pavements with thickness of concrete ranging from 75mm to 100mm can be constructed for low volume roads. Details of these pavements are given below:-

1. Cell filled concrete pavement

It consists of filling up cells of plastic material (recycled plastic) with concrete having a slump of about 60mm and compacting it with skid vibrators or surface vibrators/compactor. It is a form of cast-in-situ concrete block pavement which has a good interlocking unlike precast concrete block pavement. Thickness can be anything from 60mm to 100mm. The subbase may consist of GSB with 2 to 3 % cement to provide for a strong support for occasional heavy vehicles carrying construction materials such as bricks, stone chips, sand, cement etc. The formwork of cells is spread over the foundation and kept tight during placement of concrete into the cells. Curing can be done by covering the surface with paddy straw/grass/ leaves/jute/coir mat with spray of water. It can be opened to light traffic (motor cycle, bicycle, rickshaws) within two days and it is fit for tractors after 14 days of curing. Half lane construction is possible to allow restricted traffic during the construction and curing using shoulder.

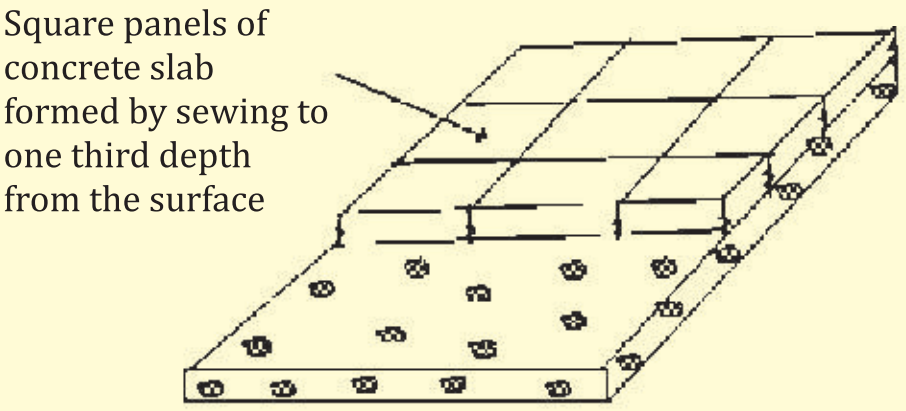
Cost: Cost of 100mm thick cell filled concrete pavement is about 70% of 60-70mm thick precast concrete block pavement.

This technology has been developed in IIT, Kharagpur and a few roads have already been constructed in West Bengal, Karnataka, Mizoram, Rajasthan, Madhya Pradesh including a few roads under PMGSY.

2 . Panelled Concrete Pavement

This consists of 100mm thick concrete slab laid over granular subbase (GSB). If heavy traffic is anticipated, the GSB may be treated with 2 to 3% cement to get a strength of about 3 MPa at 7 days. The cement concrete slab is weakened by cutting 25mm to 30mm deep grooves by a stone cutter so that the slab forms interlocking panels. The grooves may be filled with bitumen.

The panelled concrete pavement can be laid over damaged premix carpet for rehabilitation.



Concrete slab panels over Cement treated or untreated Granular subbase

Cost: For 1 km length, 3.75m wide and 100 mm thick panelled concrete pavement, the concrete needed is 375 m3 whereas for the same length and width the thickness required for plain concrete pavement as per IRC SP : 62- 2014 is about 200 mm and concrete required is 750 m3. The panel size is 0.5m x 0.5m for thickness of 100mm and for a maximum wheel load of 8 tons. The cost is almost 60% of the cost of 200mm thick M 30 grade standard cement concrete pavement considering the cost of cutting of joints in panelled cement concrete pavement. This gives a saving of almost 30 to 40% in the cost of cement concrete pavement.

Details of Cement Fly Ash Khadanza Pavements

Specification of concrete used for blocks:

Blocks of size315+4 mm*150+3 mm*150+3 mm can be economically produced using cement flyash, sand coarse aggregate using simple equipment to get the strength of M30 which can be used as road pavement over a suitable base

FaL-G block production in a simple plant of Rs. 5.50 lakhs that can manufacture over 10 cu.m of blocks per shift.

I. Specification of mortar used for filling the gaps:

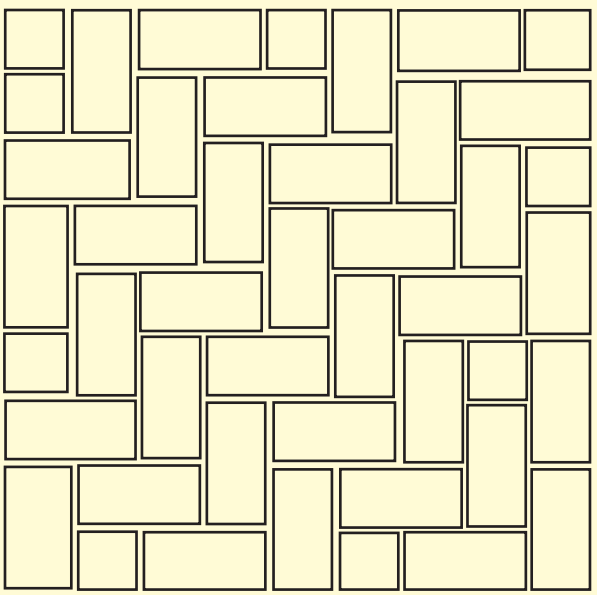
Mortar made of 1:3 where 1 is cementitious material and 3 is manufactured sand as prescribed for concrete.

The design of 'khadanza' pavements involves the orientation of bricks in specific manner where the headers make a perpendicular angle with stretcher which, in turn, makes another right angle with header. The orientation continues in ascending or descending order till the last brick reaches the edge of the road.

No mortar joint will have a length more than the total of length and breadth of the brick. The joints are normally maintained with considerable width, say 10 - 15 mm, to facilitate easy penetration of mortar slurry.

The mortar slurry is filled through gravity feed than poking into the gaps. Thereby the mortar settles down in the gaps of bricks, if any, even at the bottom plane of placement in order to render better rigidity and absolute filling. Such orientation of joints is considered to make the pavement crack-free and more rigid. In view of high WCF required for slurrying, mortar is made of rich mix at 1:3.

Khadanza pavement with FaL-G blocks executed in 2009 at INSWAREB Building Centre, Paravada Village, Visakhapatnam.



Review of Geometric Design Standards for Rural Roads in Hill Areas (Recommendations of previous expert committee-Reviewed)

S. No.	Item	As per IRC:SP:20 (Rural Roads Manual) / Hill Road Manual IRC:SP:48	Amendments Recommended	
			New Construction	Existing Roads (Tolerances that can be accepted)
1.	Classification	(a) Other District Roads (b) Village Roads	Same system as defined in NRRDA guidelines	Same system as defined in NRRDA guidelines
2.	Carriageway width	3.75m but can be reduced to 3.0 0m where traffic less than 100 motorised vehicles per day.	Through Roads – 3.75 m Link Roads* – 3.00 m * If a link road carries traffic more than 100 motorised vehicles per day (excluding two wheelers) , the carriageway width will be 3.75 m.	<u>Through Roads</u> Existing roads with carriageway 3.0 m or more can wait unless evidence of safety hazard. <u>Link Roads</u> As for new construction.
3.	Roadway width minimum	6m in SP:20 (virtually 6.7 m including parapet and drain) 5.95 m in Hill Road Manual for ODR 5.20 m in Hill Road Manual for VR	(a) Through Roads: 6.0 m (including parapet and drain) (b) Link Roads: 6.0 m (including parapet and drain) Notes The width indicated is for roads in straight. This is to be increased on horizontal curves.	Existing roads with formation upto 5.0m may wait. Notes: (i) In hard rock stretches, an additional tolerance of 0.5 m can be considered i.e. existing roads with formation width upto 4.5 m may wait. (ii) For curves see item 4 below. (iii) Provide passing places at suitable locations.

S. No.	Item	As per IRC:SP:20 (Rural Roads Manual) / Hill Road Manual IRC:SP:48	Amendments Recommended	
			New Construction	Existing Roads (Tolerances that can be accepted)
4.	Widening at Curves	Widening of Pavement and Roadway Upto 20m radius – 0.9 m 21 – 60m radius – 0.6 m More than 60 m radius - Nil	Widening of Pavement and Roadway Upto 20m radius – 0.9 m 21 – 60m radius – 0.6 m More than 60 m radius - Nil	For existing roads, widening of pavement and roadway can wait unless there is evidence of safety hazard.
5.	Width of Bridges	5.5 m Rural Roads Manual SP: 20 4.25 m clear width between kerbs Hill Road Manual SP:48	Through roads : 5.5 m Link roads* : 4.25 m *Bridge of length more than 50m may have 5.5m width.	For existing bridges, widening may be undertaken at the time of replacing the old and distressed bridges unless there is evidence of safety hazard. Need to provide cautionary sign posts.
6.	Roadway width for culverts and causeways	6m in SP:20 (virtually 6.7 m including parapet and drain) 5.95 m in Hill Road Manual for ODR 5.20 m in Hill Road Manual for VR	(a) Through Roads: 6.0 m (including parapet and drain) (b) Link Roads: 6.0 m (including parapet and drain)	For existing culverts, widening may be undertaken at the time of replacing the old and dilapidated/distressed culverts and causeways unless there is evidence of safety hazard. Need to provide cautionary sign posts

<table>
<tr><th>S. No.</th><th>Item</th><th>As per IRC:SP:20 (Rural Roads Manual) / Hill Road Manual IRC:SP:48</th><th colspan="2">Amendments Recommended</th></tr>
<tr><th></th><th></th><th></th><th>New Construction</th><th>Existing Roads (Tolerances that can be accepted)</th></tr>
<tr><td>7.</td><td>Minimum radius of horizontal curves</td><td>As per IRCSP:20
<table>
<tr><td></td><td colspan="2">Mountainous terrain</td><td colspan="2">Steep Terrain</td></tr>
<tr><td></td><td>Not affected with snow</td><td>Snow bound</td><td>Not affected with snow</td><td>Snow bound</td></tr>
<tr><td colspan="5">(i) ODR</td></tr>
<tr><td>Ruling</td><td>30m</td><td>33m</td><td>20m</td><td>23m</td></tr>
<tr><td>Absolute minimum</td><td>20m</td><td>23m</td><td>14m</td><td>15m</td></tr>
<tr><td colspan="5">(ii) VR</td></tr>
<tr><td>Ruling</td><td>20m</td><td>23m</td><td>20m</td><td>23m</td></tr>
<tr><td>Absolute minimum</td><td>14m</td><td>15m</td><td>14m</td><td>15m</td></tr>
</table></td><td>
<table>
<tr><td></td><td colspan="2">Mountainous terrain</td><td colspan="2">Steep Terrain</td></tr>
<tr><td></td><td>Not affected with snow</td><td>Snow bound</td><td>Not affected with snow</td><td>Snow bound</td></tr>
<tr><td colspan="5">(i) Through roads</td></tr>
<tr><td>Ruling</td><td>30m</td><td>33m</td><td>20m</td><td>23m</td></tr>
<tr><td>Absolute minimum</td><td>12m</td><td>15m</td><td>12m</td><td>15m</td></tr>
<tr><td colspan="5">(ii) Link roads</td></tr>
<tr><td>Ruling</td><td>30m</td><td>33m</td><td>20m</td><td>23m</td></tr>
<tr><td>Absolute minimum</td><td>12m</td><td>15m</td><td>12m</td><td>15m</td></tr>
</table></td><td>(i) Through roads

For existing roads, the horizontal geometry upto absolute minimum may be considered acceptable unless there is evidence of site -specific safety problem related to horizontal curvature such as skid marks, complaints from users, history of crashes, etc.

Need to provide cautionary sign posts.

(ii) Link roads

For existing roads, the existing horizontal geometry may be considered acceptable unless there is evidence of site -specific safety problem related to horizontal curvature such as skid marks, complaints from users, history of crashes, etc.

Need to provide cautionary sign posts.</td></tr>
</table>

<table>
<tr><th>S. No.</th><th>Item</th><th>As per IRC:SP:20 (Rural Roads Manual) / Hill Road Manual IRC:SP:48</th><th colspan="2">Amendments Recommended</th></tr>
<tr><th></th><th></th><th></th><th>New Construction</th><th>Existing Roads (Tolerances that can be accepted)</th></tr>
<tr><td>8.</td><td>Longitudinal gradients (except hairpin bends)</td><td><table><tr><th></th><th>Mountainous Terrain</th><th>Steep Terrain</th></tr><tr><td>Ruling Gradient</td><td>5%</td><td>6%</td></tr><tr><td>Limiting Gradient</td><td>6%</td><td>7%</td></tr><tr><td>Exceptional Gradient</td><td>7%</td><td>8%</td></tr></table></td><td><table><tr><th></th><th>Mountainous Terrain</th><th>Steep Terrain</th></tr><tr><td>Ruling Gradient</td><td>5%</td><td>6%</td></tr><tr><td>Limiting Gradient</td><td>7%</td><td>8%</td></tr><tr><td>Exceptional Gradient*</td><td>10%</td><td>10%</td></tr></table>* Length of exceptional gradient not to exceed 100m at a stretch. Successive stretches to be separated by a minimum length of 100 m with gradient ruling or flatter</td><td>For existing roads, the existing vertical curves up to limiting gradient may be considered acceptable. Gradients steeper than limiting gradient but upto exceptional gradient in short stretches could also be considered acceptable unless there is evidence of site-specific problem.

Need to provide cautionary sign posts.</td></tr>
<tr><td>9.</td><td>Hairpin Bends</td><td><table><tr><td>(i)</td><td>Minimum design speed</td><td>20 km/hour</td></tr><tr><td rowspan="3">(ii)</td><td>Minimum roadway</td><td></td></tr><tr><td>(a) ODR</td><td>7.5 m</td></tr><tr><td>(b) VR</td><td>6.5 m</td></tr><tr><td>(iii)</td><td>Minimum radius for the inner curve</td><td>14 m</td></tr><tr><td>(iv)</td><td>Minimum length of transition curve</td><td>15 m</td></tr></table></td><td><table><tr><td>(i)</td><td>Minimum design speed</td><td>20 km/hour</td></tr><tr><td rowspan="3">(ii)</td><td>Minimum roadway</td><td></td></tr><tr><td>(a) Through Roads / Link Roads</td><td>7.5 m</td></tr><tr><td>(b) Through Roads / Link Roads</td><td>6.5 m</td></tr><tr><td>(iii)</td><td>Minimum radius for the curve at central line</td><td>12 m</td></tr></table></td><td>The existing hair pin bends may be considered acceptable unless there is site-specific problem and evidence of complaints from users, history of crashes.

Need to provide cautionary sign posts.</td></tr>
</table>

S. No.	Item	As per IRC:SP:20 (Rural Roads Manual) / Hill Road Manual IRC:SP:48	Amendments Recommended	
			New Construction	Existing Roads (Tolerances that can be accepted)
		(v) Gradient (a) Maximum 2.5% (1 in 40) (b) Minimum 0.5% (1 in 200) (vi) Maximum Superelevation 10 %	(iv) Minimum length of transition curve 15 m (v) Gradient (a) Maximum 2.5% (1 in 40) (b) Minimum 0.5% (1 in 200) (vi) Maximum Superelevation 10 %	

Review of Geometric Design Standards for Rural Roads in Plains (Recommendations of previous expert committee-Reviewed)

S. No.	Item	As per IRC:SP:20 (Rural Roads Manual)	Amendments Recommended	
			New Construction	Existing Roads (Tolerances that can be accepted)
1.	Classification	(a) Other District Roads (b) Village Roads	Same system as defined in NRRDA guidelines	Same system as defined in NRRDA guidelines
2.	Carriageway width	3.75m but can be reduced to 3.00m where traffic less than 100 motorised vehicles per day.	Through Roads : 3.75 m Link Roads* : 3.00 m * If a link road carries traffic more than 100 motorised vehicles per day (excluding two wheelers) the carriageway width will be 3.75 m.	Through Roads Existing roads with carriageway 3.0 m or more can wait unless evidence of safety hazard. Link Roads As for new construction . However, If a link road carries traffic more than 100 motorised vehicles per day (excluding two wheelers) the carriageway width will be 3.75 m
3.	Roadway width minimum	ODR and VR : 7.5 m for traffic more than 100 motorised vehicles per day : 6.0 m for traffic less than 100 motorised vehicles per day	(a) Through Roads : 7.5 m (b) Link Roads : 6.0 m Notes: (i) The roadway width for Link Road may be allowed to be 7.5m instead of 6 m even when the paved carriageway is 3.0m, wherever the land use along the link warrants wider roadway with likely higher levels of traffic and availability of land (ii) The widths indicated are for roads in straight. These are to be increased on horizontal curves.	(a) Through Roads: 7.5 m (b) Link Roads :Existing roads with formation upto 5.0 m may wait. Notes: (i) For curves see item 4 below. (iii) Provide passing places at suitable locations on link roads if formation 5.0 m or less.

S. No.	Item	As per IRC:SP:20 (Rural Roads Manual)	Amendments Recommended	
			New Construction	Existing Roads (Tolerances that can be accepted)
4.	Widening at Curves	Widening of Pavement and Roadway Upto 20m radius – 0.9 m 21 – 60m radius – 0.6 m More than 60 m radius - Nil	Widening of Pavement and Roadway Upto 20m radius – 0.9 m 21 – 60m radius – 0.6 m More than 60 m radius - Nil	For existing roads, widening of pavement and roadway can wait unless there is evidence of safety hazard.
5.	Width of Bridges	5.5 m 4.25 m w here traffic less than 100 motorised vehicles per day	Clear width between kerbs Through roads : 7.5 m Link roads : 5.5 m Notes: (i) For link roads the width may be 5.5 m. However, where traffic in the long term say 15-20 years is expected to be higher than traffic category T7, width may be 7.5 m. Prior approval of NRRDA may be mandated for such cases in respect of PMGSY roads.	For existing bridges, widening may be undertaken at the time of replacing the old and distressed bridges unless there is evidence of safety hazard. Need to provide cautionary sign posts.
6.	Roadway width for culverts and causeways	7.5 m	(a) Through Roads : 7.5 m (b) Link Roads : 6.0 m Notes (i) The roadway width for culvers and cause ways on Link Road may be allowed to be 7.5m instead of 6m even when the paved carriageway is 3.0m, wherever the land use along the link warrants wider roadway with likely higher levels of traffic and availability of land.	For existing culverts, widening may be undertaken at the time of replacing the old and dilapidated/distressed culverts and causeways unless there is evidence of safety hazard. Need to provide cautionary sign posts

<table>
<tr><th rowspan="2">S. No.</th><th rowspan="2">Item</th><th rowspan="2">As per IRC:SP:20 (Rural Roads Manual)</th><th colspan="2">Amendments Recommended</th></tr>
<tr><th>New Construction</th><th>Existing Roads (Tolerances that can be accepted)</th></tr>
<tr><td>7.</td><td>Minimum radius of horizontal curves</td><td>As per IRC:SP:20
<table><tr><th></th><th>Plain Terrain</th><th>Rolling Terrain</th></tr><tr><td>(i) ODR</td><td></td><td></td></tr><tr><td>Ruling</td><td>90 m</td><td>60 m</td></tr><tr><td>Absolute Minimum</td><td>60 m</td><td>45 m</td></tr><tr><td>(ii) VR</td><td></td><td></td></tr><tr><td>Ruling</td><td>90 m</td><td>60 m</td></tr><tr><td>Absolute Minimum</td><td>60 m</td><td>45 m</td></tr></table></td><td>Applicable for both Through roads and Link roads
<table><tr><th></th><th>Plain Terrain</th><th>Rolling Terrain</th></tr><tr><td>Ruling</td><td>90 m</td><td>60 m</td></tr><tr><td>Absolute Minimum</td><td>60 m</td><td>45 m</td></tr><tr><td>Exceptional</td><td>40 m</td><td>35 m</td></tr></table>Need to provide cautionary sign posts where these requirements are not met due to constraints of land acquisition.</td><td>(i) Through roads
For existing roads, the horizontal geometry upto absolute minimum may be considered acceptable unless there is evidence of site-specific safety problem related to horizontal curvature such as skid marks, complaints from users, history of crashes, etc.
Need to provide cautionary sign posts.
(ii) Link roads
For existing roads, the existing horizontal geometry may be considered acceptable unless there is evidence of site-specific safety problem related to horizontal curvature such as skid marks, complaints from users, history of crashes, etc.
Need to provide cautionary sign posts.</td></tr>
</table>

<table>
<tr><th>S. No.</th><th>Item</th><th>As per IRC:SP:20 (Rural Roads Manual)</th><th colspan="2">Amendments Recommended</th></tr>
<tr><th></th><th></th><th></th><th>New Construction</th><th>Existing Roads (Tolerances that can be accepted)</th></tr>
<tr>
<td>8.</td>
<td>Longitudinal gradients</td>
<td>
<table>
<tr><th></th><th>Plain Terrain</th><th>Rolling Terrain</th></tr>
<tr><td>Ruling Gradient</td><td>3.3 %</td><td>3.3 %</td></tr>
<tr><td>Limiting Gradient</td><td>5 %</td><td>5 %</td></tr>
<tr><td>Exceptional Gradient</td><td>6 %</td><td>6 %</td></tr>
</table>
</td>
<td>
<table>
<tr><th></th><th>Plain Terrain</th><th>Rolling Terrain</th></tr>
<tr><td>Ruling Gradient</td><td>3.3 %</td><td>3.3 %</td></tr>
<tr><td>Limiting Gradient</td><td>5 %</td><td>5 %</td></tr>
<tr><td>Exceptional Gradient*</td><td>8 %</td><td>10 %</td></tr>
</table>
* Length of exceptional gradient not to exceed 200m at a stretch. Successive stretches to be separated by a minimum length of 100 m with gradient ruling or flatter
</td>
<td>For existing roads, the existing vertical curves upto limiting gradient may be considered acceptable. Gradients steeper than limiting gradient but upto exceptional gradient in short stretches could also be considered acceptable unless there is evidence of site-specific problem.

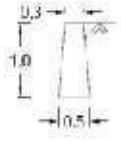
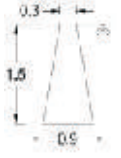
Need to provide cautionary sign posts.</td>
</tr>
</table>

Advantages of Gabion wall over PCC wall

Comparison Parameter	Gabion Wall	PCC Wall
Flexibility	It is a flexible structure. It can accommodate differential settlement without compromising structural integrity.	It is a rigid structure. Cracks will occur due to differential settlement.
Permeability	The system is made up of gabion boxes filled with stones. The permeability of the front face ensures the drainage of the backfill resulting in less hydrostatic pressure.	Being impermeable structure, if sufficient drainage measures are not provided, very high hydrostatic pressure can occur.
Simplicity / Economy	Being simple, Gabions do not require a skilled labour force or special equipment. Simple tools are usually needed such as pliers, tweezers, crowbars and occasionally, any other easily available tools.	Specialized labour, steel formwork and machinery required. Material cost is also high comparatively.
Environmental Friendliness	The most distinct advantage of this kind of system is that it has a very positive impact on the environment. Gabion wall covered with a lush green vegetation topping offer an excellent opportunity to enhance the urban landscape. In general, Carbon foot print emission for gabion facia structures are relatively less	Cement concrete construction has proved to be a largely non-eco friendly technology. Growth of vegetation leads to cracks thereby making the structure more unstable. Doesn't have noise absorbing property; instead, echo is created that results in noise pollution.
Impact Resistance	Good shock absorbent during sudden impact. Flexible facia are well resistant to damages.	Crack develops in the rigid concrete when there is sudden impact. Being a continuous structure, local rectification is not possible.
Foundation Consideration	Being flexible in nature, it can be founded on yielding foundations. Hence chances of failure due to settlement are	These systems are rigid in nature. They are highly sensitive to slightest of settlement in foundations. They

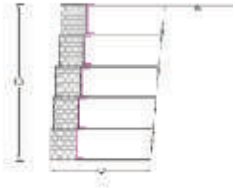
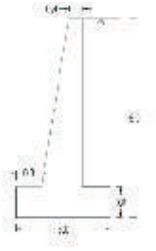
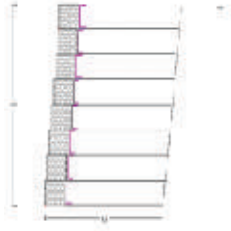
Comparison Parameter	Gabion Wall	PCC Wall
	minimum. In extreme cases, systems can be placed with nominal ground improvement techniques like soil replacement etc.	exert huge amount of pressures in the foundation and hence extensive ground improvement techniques are required or wall needs to be founded on hard strata.Thisinviteshugeearth work, extra items and extra cost.
Seismic and Dynamic forces	Being flexible in nature, these systems are accommodative to dynamic forces and do not collapse in event of seismic action	This system attracts huge intertial forces due to rigidity and can fail instantly in case of seismic action.
Failure Mode	Being a flexible system, failure signs can be detected and rectified.	Being rigid system, failure is spontaneous.

Cost Comparision of Gabion and PCC Walls (Case of Pune, Maharashtra)

Gabion Wall								PCC Retaining Wall						
Height of Section	Cross Section	Material	Qty	Unit	Rate	Amount	Total Amount/m	Height of Section	Cross Section	Material	Qty	Unit	Rate (Rs.)	Amount/m (Rs)
1		Gabion 1x1x1	1	Nos.	1900	1900	1900	1		PCC	0.404	Cum	4533.8	1832
1.5		Gabion 1x1x1	1	Nos.	1900	1900	3850	1.5		PCC	0.9	Cum	4533.8	4080
		Gabion 1.5x1x0.5	1	Nos.	1950	1950								
3		Gabion 2x1x1	1	Nos.	1850	1850	5630	3		PCC	2.3	Cum	4533.8	10428
		Gabion 1.5x1x1	1	Nos.	1880	1880								
		Gabion 1x1x1	1	Nos.	1900	1900								
5		Gabion 3x1x1	1	Nos.	1790	1790	11200	5		PCC	6	Cum	4533.8	27203
		Gabion 2x1x1	1	Nos.	1850	1850								
		Gabion 1.5x1x1	2	Nos.	1880	3760								
		Gabion 1x1x1	2	Nos.	1900	3800								

Note: These Gabbions are typical comnparitive sections based on analysis and needs to be tested.

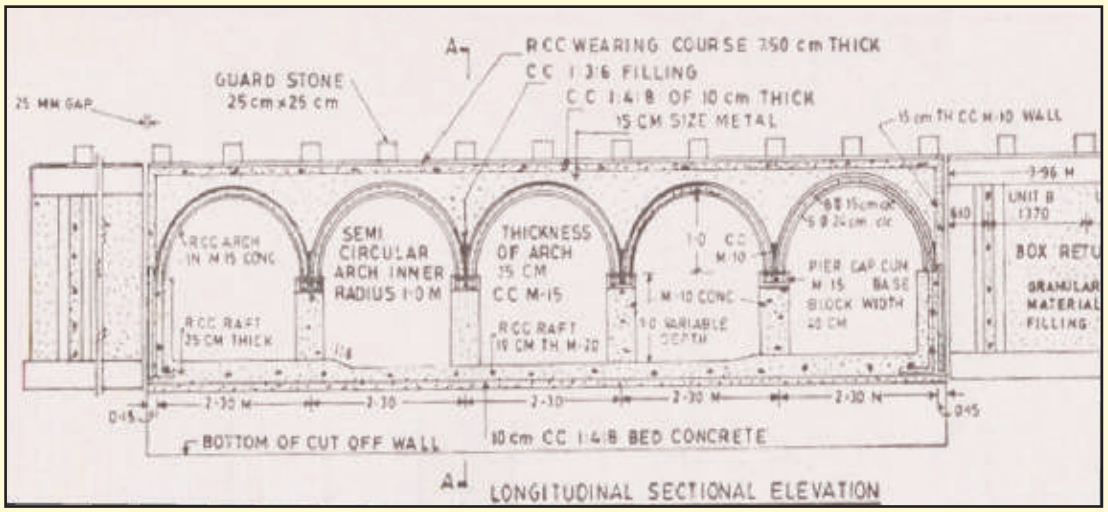
Cost Comparision of Gabion and PCC Walls (Case of Pune, Maharashtra)

Terramesh Wall								RCC Retaining Wall							
Height of Section	Cross Section	Material	Qty/2m	Unit	Rate (Rs)	Amount (Rs.)	Total Amount (Rs)	Height of Section	Cross Section	Material	Qty	Unit	Rate (Rs)	Amount (Rs.)	Total Amount (Rs)
5		TMS 3x2x1	5	Nos.	2350	11750	16050	5		RCC	6	Cum	5859.5	35157	39763
		Backfill	30.8	Cum	660.7	20350				Steel	76	Kg	60.6	4606	
6		TMS 3x2x1	6	Nos.	2350	14100	23237	6		RCC	8.7	Cum	5859.5	50978	53886
		Backfill	49	Cum	660.7	32374				Steel	48	Kg	60.6	2909	
8		TMS 3x2x1	8	Nos.	2350	18800	36357	8		RCC	15.8	Cum	5859.5	92580	95186
		Backfill	81.6	Cum	660.7	53913				Steel	43	Kg	60.6	2606	

Note: These Gabbions are typical comnparitive sections based on analysis and needs to be tested.

Semicircular Arch Culvert

1. Optimum cost effective structure to cover 3m water flow due to thin elements.
2. For 80% streams, flood depth is less than 3m
3. Two meter semicircle arch supported on raft foundation having dwarf pier of 1.5m.
4. Arches are ideal for super structure and raft as foundation element.
5. Special technology for construction centering element.
6. Fast constructions and easier for execution.
7. Large numbers of rivers having different flood depth and water velocity can be covered.



Cement Concrete Block Arches in place of Hume Pipe

1. M 10 Cement Concrete blocks to construct 1.4m dia semi circle arch.
2. Equivalent to 1m Hume pipe.
3. Special centering for convenient execution, face wall can be omitted.
4. Construction cost just 40 to 50% of equivalent Hume pipe culvert.



Splayed Wing walls vs Return walls/Head walls/ Parapet walls on CD works

E = Height of Embankment in m.,

L = Length of splayed/Return walls in m. at embankment slope of 1 vert. to 1.5 horizontal,

W = Average width of wall in m.= top 0.45m and bottom is 0.45 + H/2 ,

H = average height of wall in m. = for splayed wall height at embankment at one end and 0.50m at other end

V = Volume of wall in Cum.

E	Item	Splayed Wing Wall	Return wall / Head wall
1.5	L	√2 x (E-0.5) +0.50 = 1.914	1.5 x E – {0.45+0.45+E/2}/2= 1.42
	H	(0.5+ 1.5)/2 = 1	1.5
	W	{0.45+0.45+H/2}/2 = 0.7	{0.45+0.45+H/2}/2 = 0.83
	V	1.914x1x0.7 = **1.33**	1.42x1.5x0.83 = **1.76**
2.5	L	√2 x (E-0.5) +0.50 = 3.33	1.5 x E – {0.45+0.45+E/2}/2= 2.68
	H	(0.5+ 2.5)/2 = 1.5	2.5
	W	{0.45+0.45+H/2}/2 = 0.83	{0.45+0.45+H/2}/2 = 1.07
	V	3.33x1.5x0.83 = **4.14**	2.68x2.5x1.07 = **7.16**
3.5	L	√2 x (E-0.5) +0.50 = 4.74	1.5 x E – {0.45+0.45+E/2}/2= 3.93
	H	(0.5+ 3.5)/2 = 2	3.5
	W	{0.45+0.45+H/2}/2 = 0..95	{0.45+0.45+H/2}/2 = 1.32
	V	4.74x2x0.95 = **9**	3.93x3.5x1.32 = **18.15**
Average		1.33+4.14+9 = 14.47/3 = **4.82**	1.76+7.16+18.15 = 27.07/3 = **9.02**

Thus average cost reduction above foundation is about 50%. If foundation is also accounted for, average reduction of cost of Splayed Wing walls will be about 25% to 30% less than straight return/ head walls.

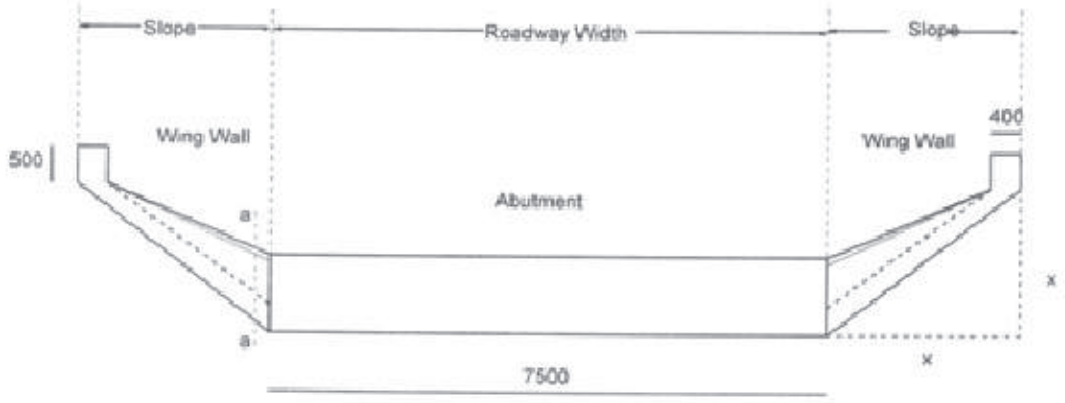
Besides this, entire cost of filter and pitching will be saved, which is must with Return/Head walls. If this factor is also accounted for, about 25% to 30% cost saving can be achieved in the total cost of CD.

From maintenance point of view, it has been observed that ends of straight Return walls/Head walls/Parapet walls get eroded after every monsoon and need immediate repair. Otherwise erosion becomes dangerous when it proceeds towards pavement edge. In case of splayed wing walls, practically there is no chance of erosion and it is maintenance free for years and years.

Splayed Wing Wall

Abutment as per IRC SP-20

Plan of Abutment and wing wall

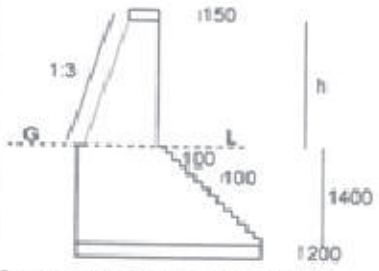


Elevation of abutment and splayed wing wall

400

x

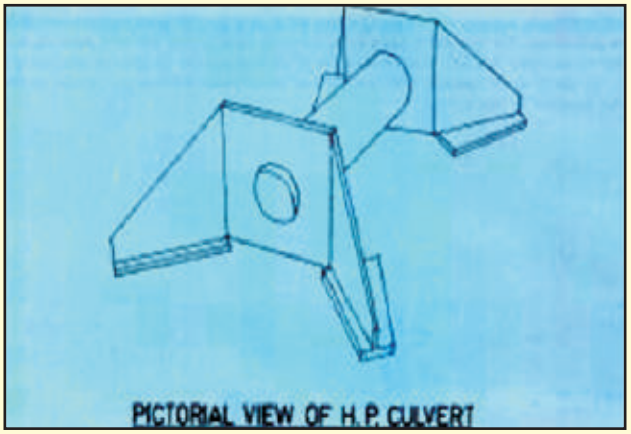
x = (Height of embankment in meters - 0.50) * Slope of embankment (Horizontal/Vertical)

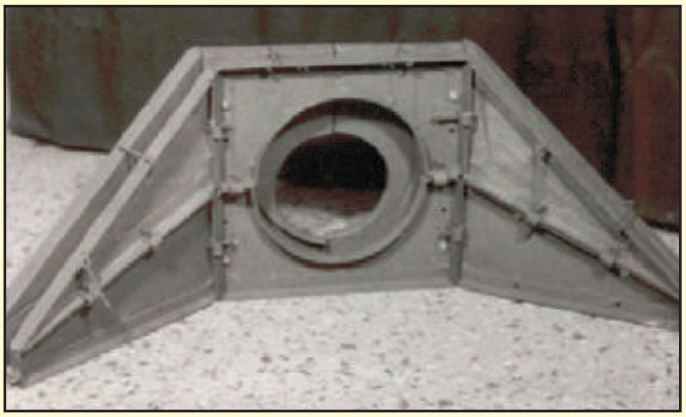


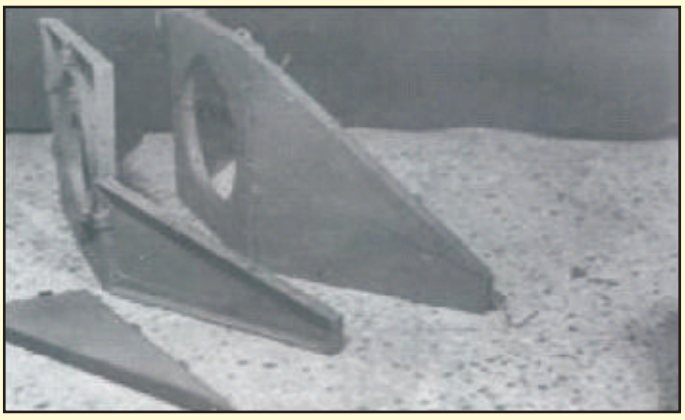
Cross Section of Splayed Wing Wall
(near abutment at a-a)

RCC Flared Wall for Cross Drainage Structures

1. Efficient structural system requiring about 3.23 cum concrete and 210 kg steel.
2. Flumed shape - hydraulically efficient
3. Special centering is required.
4. Fast and quality work.
5. Laying of pipe and concrete can be done independently.







Annexure-L

Reduction in Cost of Proposals based on sample scrutiny of DPRs at NRRDA (2012-13 & 2013-14)

Sl No	State	Value (Rs. in Crores) (State Proposed)	No. of road works/Bridges (State Proposed)	Length in km (State Proposed)	Value of Road works cleared by Ministry (Rs. In Crores)	No of Roads works and Bridges cleared by Ministry	Length in KM (Cleared by Ministry)	Reduction in Cost (Rs. in Crores)	% reduction cost
1	Andhra Pradesh	1532.34	333 road 20 bridges	2742.71	1421.55	333 roads 20 bridges	2742.71	110.79	7.23
2	Arunachal Pradesh	1068.02	63 roads 66 bridges	943.38	880.48	63 roads 66 bridges	943.38	187.54	17.56
3	Assam	536.36	121 roads 257 briges	278.72	510.02	121 roads 257 bridges	262.52	26.34	4.91
4	Bihar-RWD	8786.07	6014 roads 344 bridges	13324.41	8162.94	5163 roads 256 bridges	11457.77	623.13	7.09
5	Chattisgarh	870.03	452 roads 118 bridges	1522.05	861.46	452 roads 118 bridges	1484.94	8.57	0.99
6	Gujarat	1064.02	919 roads	2834.06	992.21	919 roads	2802.99	71.81	6.75
7	Haryana	959.23	83 roads 18 bridges	1010.56	917.45	83 roads 18 bridges	989.32	41.78	4.36
8	Himachal Pradesh	302.76	141 roads 3 bridges	800.37	285.75	141 roads 3 bridges	800.37	17.01	5.62
9	Jammu & Kashmir	1809.84	603 roads 55 bridges	3506.73	1774.52	603 roads 55 bridges	3494.75	35.32	1.95
10	Jharkhand	32.86	19 roads	56.08	30.01	19 roads	56.08	2.85	8.67
11	Karnataka	82.00	28 roads 39 bridges	92.24	74.78	28 roads 38 bridges	92.24	7.22	8.80
12	Kerala	473.34	320 roads	906.6	457.04	320 roads	745.94	16.30	3.44
13	Madhya Pradesh	1234.38	691 roads 112 bridges	1941.26	1185.85	691 roads 112 bridges	1952.57	48.53	3.93
14	Maharashtra	1761.41	414 roads 114 bridges	2726.17	1567.10	414 roads 84 bridges	2726.17	194.31	11.03
15	Manipur	756.39	194 roads 6 bridges	1404.57	577.75	194 roads 6 bridges	1301.98	178.64	23.62
16	Meghalaya	260.32	75 roads 4 bridges	271.74	230.58	75 roads 4 bridges	266.94	29.74	11.42
17	Mizoram	304.19	29 roads	414.92	284.57	29 roads	414.92	19.62	6.45
18	Odisha	2514.33	1137 roads 157 bridges	4167.18	2453.60	1137 roads 157 bridges	3925.78	60.73	2.42
19	Punjab	254.16	46 roads	455.23999	247.16	46 roads	455.24	7.00	2.75
20	Rajasthan	1311.41	1435 roads	4332.54	1306.36	1435 roads	4332.30	5.05	0.39
21	Rajasthan	541.55	571 roads	1717.51	510.18	571 roads	1714.97	31.37	5.79
22	Sikkim	149.18	40 roads	224.06	112.11	40 roads	177.49	37.07	24.85
23	Tripura	504.46	197 roads 7 Bridges	579.272	462.41	197 roads 7 Bridges	579.27	42.05	8.34

Sl No	State	Value (Rs. in Crores) (State Proposed)	No. of road works/Bridges (State Proposed)	Length in km (State Proposed)	Value of Road works cleared by Ministry (Rs. In Crores)	No of Roads works and Bridges cleared by Ministry	Length in KM (Cleared by Ministry)	Reduction in Cost (Rs. in Crores)	% reduction cost
24	Tripura	686.15	141 roads 30 Bridges	843.17	642.43	141 roads 30 Bridges	843.17	43.72	6.37
25	Uttar Pradesh	1226.32	252 roads	2132.39	1134.54	252 roads	1913.33	91.78	7.48
26	Uttarakhand	346.80	82 roads 27 briges	668.8	335.54	82 roads 27 briges	674.85	11.26	3.25
27	West Bengal	3506.49	1425 roads	6147.17	3483.19	1425 roads	6143.96	23.30	0.66
	Total	**32874.41**		**56043.90**	**30901.58**		**53295.95**	**1972.83**	**6.00**

Note: 1. No proposals sanctioned to Nagaland and Goa during 2012-13 & 2013-14

2. This reduction in the cost is based on scrutiny of sample DPRs and applying observations to entire batch of propsoals in general, as finalized by the State and proposals cleared by the Ministry.

Annexure-M

Component wise cost of roads in States (in Percentage)

Sl No	Percentage of Component wise Pavement cost						CD	Protection	Others	Total
	State	Earth work	Sub base	Base	Surfacing	Total Percentage				
1	Andhra Pradesh	11.26	13.87	25.86	23.44	**74.43**	12.63	11.50	1.44	100.00
2	Arunachal Pradesh	28.42	9.15	8.87	6.70	**53.14**	29.23	16.34	1.29	100.00
3	Assam	21.45	10.22	14.59	12.04	**58.30**	38.56	0.94	2.20	100.00
4	Bihar	21.74	16.29	22.97	20.56	**81.56**	13.09	4.20	1.15	100.00
5	Gujarat	18.40	10.80	13.26	22.93	**65.39**	19.27	13.37	1.97	100.00
6	Hariyana	13.42	12.68	26.46	33.55	**86.11**	6.63	5.68	1.58	100.00
7	Himachal	23.64	8.89	5.05	6.12	**43.70**	23.45	30.71	2.14	100.00
8	Jammu and Kashmir	29.29	6.50	6.40	7.85	**50.04**	23.46	26.10	0.40	100.00
9	Jharkhand	21.22	14.37	19.21	27.05	**81.85**	5.40	6.34	6.41	100.00
10	Kerala	9.68	20.78	24.90	16.57	**71.93**	9.82	16.48	1.77	100.00
11	Madhya Pradesh	19.13	11.78	17.64	22.84	**71.39**	19.87	4.59	4.15	100.00
12	Maharashtra	22.08	5.91	15.98	31.21	**75.18**	17.76	5.57	1.49	100.00
13	Manipur	32.77	8.00	8.34	11.52	**60.63**	24.79	9.86	4.72	100.00
14	Meghalaya	31.80	12.07	13.56	10.28	**67.71**	20.38	8.87	3.04	100.00
15	Mizoram	27.31	11.04	11.57	7.09	**57.01**	20.02	9.50	13.47	100.00
16	Nagaland	14.44	14.91	23.92	22.34	**75.61**	12.80	11.30	0.29	100.00
17	Odisha	17.46	10.43	16.22	23.26	**67.37**	22.76	9.09	0.78	100.00
18	Punjab	16.63	11.25	22.58	27.25	**77.71**	8.47	11.29	2.53	100.00
19	Rajasthan	22.95	1.82	29.16	29.55	**83.48**	12.07	3.22	1.23	100.00
20	Sikkim	30.90	4.90	5.80	6.60	**48.20**	18.86	32.24	0.70	100.00
21	Tamil Nadu	14.01	17.26	21.87	27.80	**80.94**	12.90	4.69	1.47	100.00
22	Telangana	15.41	12.65	19.54	27.96	**75.56**	16.08	5.65	2.71	100.00
23	Tripura	30.40	10.55	12.39	8.25	**61.59**	22.92	13.58	1.91	100.00
24	Uttar Pradesh	12.02	16.50	30.99	29.45	**88.96**	4.53	5.54	0.97	100.00
25	Uttarakhand	30.04	8.26	10.60	10.38	**59.28**	16.99	22.97	0.76	100.00

Sl No	Percentage of Component wise Pavement cost						CD	Protection	Others	Total
	State	Earth work	Sub base	Base	Surfacing	Total Percentage				
25	Uttarakhand	30.04	8.26	10.60	10.38	**59.28**	16.99	22.97	0.76	100.00
26	West Bengal	9.51	15.19	19.36	25.63	**69.69**	16.21	12.25	1.85	100.00
	Average (%)	**20.98**	**11.39**	**17.20**	**19.16**	**68.72**	**17.27**	**11.61**	**2.40**	**100.00**

Note: As the data has been extracted from OMMAS website:-

1. In some of the cases, in hill States, cost of Stage I only has been included, as Stage II projects for the same are yet to be sanctioned.
2. Variations in component wise costs may be due to inclusion of the cost in an inappropriate sub component.
3. Sub component wise break up has been worked out from analysis of sample DPRs.

Annexure-N

Summary of Item-wise possible cost reduction

S.No.	Item(s)	Possible percentage cost reduction w.r.t cost of relevant item used traditionally (%)
1	Use of gravel roads for lower traffic volume as per IRC SP:72-2015 and Gravel Roads Manual.	30-40
2	Use of stabilized base and sub -base courses in place of traditional WBM layers as per IRC SP:72 -2015.	20-40
3	Use of thin bituminous surfacing like surface dressing / mix seal surfacing for lower traffic volume as per IRC SP:72-2015.	15-25
4	Use of improved sub -grade strength as per IRC SP:72-2015.	5-15
5	Using low cost cement concrete road as suggested in Annexure 'D'	20-30
6	Use of low cost marginal and local materials including industrial wastes such as fly ash and slag, wherever available.	10-25
7	Use of hill cut material with appropriate processing	10-30
8	Use of Gabions as protection structures in place of PCC wall.	30-40
9	Use of Splayed wing wall in place of straight head wall.	25-30
10	Using concrete block and semi circular arches	20-30
11	General Measures as suggested in Para 11	5-10
12	With additional support of ground verification through STAs, NQMs by NRRDA	2-15