

## CHAPTER II

### PERFORMANCE AUDIT

#### PUBLIC WORKS DEPARTMENT

#### 2. Quality control measures in maintenance of roads by Public Works Department

##### 2.1 Introduction

The public roads in Kerala are maintained by the Public Works Department (PWD), Local Bodies, Irrigation Department, Kerala State Electricity Board Limited, Forest and Wildlife Department, Railways, etc. PWD roads constitute 15 *per cent* of the total road network in the State and carry nearly 80 *per cent* of the total road traffic. The Roads wing and National Highways (NH) wing of the State PWD undertake the maintenance and quality control measures of the roads.

The Government of Kerala (GoK) introduced a three-tier quality monitoring system<sup>1</sup> under clauses 2401 and 2406 of the Kerala PWD Manual, revised edition 2012 (PWD Manual). Subsequently, for achieving the desired level of quality in public works as envisaged in the PWD Manual, GoK also set up<sup>2</sup> a Quality Control (QC) wing in the Department with effect from 01 October 2013 and established testing laboratories in all the districts. Quality Control test results in accordance with relevant codes/standards were made mandatory for passing work bills of all works costing more than ₹15 lakh. The Quality Control tests are to be carried out with reference to the Ministry of Road Transport and Highways (MoRTH) specifications (**Appendix 2.1**).

In order to enable the engineers and supervisory staff to check the different activities of construction with reference to the quality aspects and to ensure that the standards envisaged were achieved, GoK issued (July 2015<sup>3</sup>) an exclusive manual named the Kerala PWD Quality Control Manual (QC Manual) incorporating provisions for enhancing road safety. Every officer of the PWD entrusted with the execution of public works is expected to follow the guidelines strictly in the discharge of duties. Further, the PWD also issued<sup>4</sup> PWD Quality Control Laboratory Manual (Laboratory Manual) in July 2015 for guiding the engineers and technical staff of the Quality Control Laboratories (QC Labs) and the field engineers on the procedures for conducting quality control tests.

It is the responsibility of the State PWD to maintain the traffic worthiness of the road networks throughout the year. The State has varying climatic conditions and

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<sup>1</sup>The first tier quality control tests are to be conducted by the contractor at his own cost, the second tier tests by the QC wing on random basis during execution of works and the third-tier tests to be done by technical experts after completion of the project

<sup>2</sup>In terms of G.O (MS) No. 79/PWD/2013 dated 28/09/2013

<sup>3</sup>Vide G.O (Rt) No. 1339/2015/PWD dated 10/09/2015

<sup>4</sup>Vide G.O(Rt) No. 1346/2015/PWD dated 11/09/2015

geographical patterns. There are high ranges and plains with varying temperature between 10°Celsius and 40°Celsius. The State also witnesses two rainy seasons viz. Southwest monsoon (June - September) and Northeast monsoon (October - November). These factors necessitate appropriate quality control measures for proper maintenance of roads.

The Quality Control wing is headed by Chief Engineer (Design) who is assisted by Director (Investigation and Quality Control) under whom there are three regional laboratories and 11 district laboratories. All the laboratories have the same function.

## **2.2 Audit Objectives**

To examine whether,

- the system for implementing quality control measures was efficient during the execution of works; and
- the quality control measures adopted in the maintenance of roads, including road safety, were adequate and effective.

## **2.3 Audit criteria**

The audit criteria were derived from:

- Kerala PWD Manual, Revised Edition, 2012
- Kerala PWD Quality Control Manual, 2015
- Kerala PWD Quality Control Laboratory Manual, 2015
- MoRTH/Indian Road Congress (IRC) specifications
- Orders/Circulars/Instructions issued by GoK and PWD

## **2.4 Scope and methodology of Audit**

The Performance Audit was conducted from June to October 2018 and covered the period from 2015-16 to 2017-18.

The sampling of units consisted of four<sup>5</sup> Roads<sup>6</sup> Divisions out of the 16 Divisions, selected on the basis of stratified random sampling method and two<sup>7</sup> NH Divisions out of eight divisions, selected using simple random sampling method. Six out of the 14 QC Labs related to the selected Roads and NH Divisions were also taken in to the selected sample. Audit scrutinised records relating to 282 road works costing ₹790.77 crore, of which 92 works cost more than rupees two crore each, 133 works cost between ₹15 lakh and two crore and 57 works cost ₹15 lakh each or less. Audit also

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<sup>5</sup>Thiruvananthapuram, Idukki, Palakkad and Kozhikode

<sup>6</sup>CE R&B is bifurcated into two separate offices of CE Roads and CE Bridges. The scope of the PA is limited to Roads wing only

<sup>7</sup>Alappuzha and Muvattupuzha

conducted 77 Joint Physical Verifications (JPV) of road sites including nine on-going works, along with officials of the PWD for assessing the effectiveness of the quality control measures in the maintenance of roads, including safety aspects.

In addition to these, Audit also covered offices of the PWD in the Government Secretariat, offices of Chief Engineers of Roads, National Highways, Designs and other related offices. An entry conference was held on 31 May 2018 in which the audit objectives, audit criteria, scope and methodology were discussed with the representatives of the Government/Department. The exit conference with the representatives of the Government/Department was held on 08 February 2019 to discuss the audit findings. The Government has not furnished reply despite several reminders (September 2019).

## **2.5 Audit findings**

To keep the road network traffic worthy throughout the year, the quality of roads is to be ensured through Quality Assurance and Quality Control measures. This also includes adoption of appropriate methods for the execution and maintenance of road works.

There are three tiers of quality control tests. The first tier tests consisting of 37 types of tests are to be conducted by the contractor at his cost, either at the field lab or at an approved lab (for works costing ₹15 lakh or more). The second tier tests consisting of the same tests as in the first tier are to be conducted by the Quality Control Wing. The third tier (for works costing rupees five crore or more) is a review of the first and second tier tests, to be conducted by technical experts.

The audit findings are grouped under three categories, namely (i) Quality Control, (ii) Quality Assurance and (iii) Maintenance, including road safety.

### **2.5.1 Quality Control**

Quality control encompasses the observation technique and activities used to verify that the products delivered are of acceptable quality and that they are complete and correct. It aims to identify defects in the finished products.

According to the PWD Manual and the QC Manual, quality control measures mainly consist of the conduct of first tier quality control tests at the cost of the contractor, setting up of field laboratory, conduct of second tier tests by the Quality Control wing of PWD, ensuring quality control during the execution and proper monitoring.

According to the MoRTH specifications, 37 types of quality control tests are required to be conducted for construction of roads, depending on the item of work and the quantity of work executed. Audit observed the following lapses in this regard:

#### **2.5.1.1 Inadequacy of quality control tests in works costing above ₹15 lakh**

First tier Quality Control tests are mandatory for all road works having estimated cost of more than ₹15 lakh. Out of the 282 works test checked, in 225 such works costing ₹784.73 crore, Audit noticed the following:

- In 99 works costing ₹355.13 crore, the first-tier tests conducted were limited to only four tests consisting of sieve analysis, gradation of aggregate, bitumen content and compressive strength of concrete.
- In seven works costing ₹63.51 crore, in addition to the above, tests such as California Bearing Ratio (CBR) value, elongation and flakiness index, water absorption test, core density and specific gravity and spread rate of bitumen were also conducted. The balance 119 works costing ₹366.09 crore did not have any of the first-tier quality control tests.

As this was a test audit in the sampled works in selected road divisions and the audit observation is of a nature that may reflect in other works not covered in test audit, Department may, therefore, like to internally examine the position in rest of the works with a view to ensure that requirements of quality control, as prescribed, are being met. The Department should take necessary remedial measures and also fix responsibility for the lapses in all such cases.

In the exit conference the Department stated that directives would be issued to enforce the first-tier quality control tests strictly in all works.

#### **2.5.1.2 Non-establishment of field laboratory for works costing more than rupees two crore**

According to the Government Circular<sup>8</sup>, contractors shall establish a field laboratory at the project site if the estimated cost of the project is above rupees two crore. As per the MoRTH specification 901.2, the contractor's laboratory shall be manned by qualified Materials Engineer/Civil Engineer assisted by experienced technicians and the set-up should be got approved by the PWD Engineer.

If the quality control tests are done in the field laboratory, the test results shall be signed by the Overseer/Assistant Engineer supervising the work and by the contractor. A copy of the test results shall be forwarded by the Assistant Engineer to the Assistant Executive Engineer/Executive Engineer for review.

Audit noticed that out of the 282 works test checked, the cost of 92 works exceeded the limit of rupees two crore; but field laboratories were set up by the contractors only in seven works costing ₹101.69 crore. There was no evidence of setting up of field laboratories by the contractors in respect of 85 works<sup>9</sup> costing ₹611.85crore.

In the seven cases where field laboratories were set up, the required number of tests was not conducted and the required number of samples was not tested.

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<sup>8</sup> No. 23631/G2/2013/PWD dated 1/11/2013

<sup>9</sup> Seven out of eight such works in NH Division, Alappuzha, 16 out of 17 works in NH Division, Muvattupuzha, 20 out of 21 works in Roads Division, Thiruvananthapuram; 11 out of 15 works in Roads Division, Kozhikode; 18 works in Roads Division, Idukki and 13 works in Roads Division, Palakkad

Failure in setting up of field laboratories and non-conduct of the required tests is a compromise on the quality of works and an undue favour to the contractors to the extent of the expenses involved in the setting up of field laboratories, their manning and the cost of quality control tests.

As this was a test audit in the sampled works in selected road divisions and the audit observation is of a nature that may reflect in other works not covered in test audit, Department may, therefore, like to internally examine the position in rest of the works with a view to ensure that requirements of quality control, as prescribed, are being met. The Department should take necessary remedial measures and also fix responsibility for the lapses in all such cases.

### **2.5.1.3 Shortcomings in the conduct of second tier quality control tests**

The Quality Control Wing is authorised to inspect and conduct Quality tests in all projects undertaken by the PWD including maintenance and repair works, irrespective of the estimated cost. Quality control tests as per IRC/MoRTH specifications/QC Manual are to be conducted depending on the item of work and the quantity of work executed.

Audit test checked 282 works and observed the following:

- Second tier tests were conducted only in 85 works costing ₹495.32 crore.
- In the entire works test checked, it was also noticed that the QC Labs conducted mostly four types of tests, viz. gradation of aggregates, binder content, sieve analysis and compressive strength of cement concrete. Other essential tests like assessing of viscosity using bitumen viscometer and assessing of dry density of the compacted layer using modified proctor compaction apparatus were not conducted even though the QC Labs had the required equipment.

This left the equipment idle and the quality tests conducted by the QC Labs inadequate. Inadequacy of tests affected the life expectancy of roads.

JPV revealed the following issues:

- In the Bituminous Concrete sample taken<sup>10</sup> during the JPV in Alappuzha district, bitumen content was found to be more than the tolerance limit given in the job mix formula. Excess bitumen content caused bleeding of bitumen making the road slippery.
- Bituminous concrete surfacing in another road work<sup>11</sup> under NH Division, Alappuzha was done without consolidation which created voids in the road and exposed the aggregates.

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<sup>10</sup>IRQP from Chainage 0/000 km to 428/000 km in NH 66 in Alappuzha district

<sup>11</sup>CRF 2016-17 Improvements to Channavaly–Thiruvizha–Thuruthankavala-Kayippuram Road in Alappuzha district

- In another road work<sup>12</sup> in Kozhikode district, the road surface close to a culvert sank due to improper compaction of sub base. Audit noticed that quality control test to ascertain the density of the compacted layer was not done in the work.

As this was a test audit in the sampled works in selected road divisions and the audit observation is of a nature that may reflect in other works not covered in test audit, Department may, therefore, like to internally examine the position in rest of the works with a view to ensure that requirements of quality control, as prescribed, are being met. The Department should take necessary remedial measures and also fix responsibility for the lapses in all such cases.

#### **2.5.1.4 Lapses in quality control during execution of works**

##### **➤ Absence of proper job mix formula affecting the quality of road**

Job mix formula is the end result of a successful mix design of recommended mixture aggregate and bitumen binder arrived at after various tests on materials. Its correct application ensures the life of the road.

The contractor is to submit the job mix formula before the commencement of work, after ensuring that it is based on a correct and truly representative sample of the materials that will actually be used in the work and that the mixture and its different ingredients satisfy the physical strength requirements. All the Bituminous Macadam (BM) and Bituminous Concrete (BC) works on roads shall be done by adopting job mix formula. A test check of 88 BM and BC works revealed the following:

- Job mix formula of 15 works out of 48 works subjected to second tier quality control tests by QC Labs varied from the approved formula.
- Bitumen VG 30 was used for laying BC overlay in two works in place of Natural Rubber Modified Bitumen specified for the works.
- JPV of two works in Idukki<sup>13</sup> and Thiruvananthapuram<sup>14</sup> districts revealed that the surface of the roads was damaged at many locations within the Defect Liability Period (DLP). It was noticed that instead of submitting job mix formula suitable for these works, the contractors adopted job mix formula of other works.



**Picture 1:** Aggregates stripped off the BC surface of a road in Thiruvananthapuram district (photo taken on 04/10/2018)

There was no evidence in the records to show that rectification works were carried out.

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<sup>12</sup>Name of road: Cherooppa - Kuttikadavu Road

<sup>13</sup>NABARD RIDF- XXI improvements of Marika – Kolani Road

<sup>14</sup>Peroorkada - Manikanteswaram – Nettayam Road



In the exit conference the Department confirmed that each work should have separate job mix formula and that adoption of job mix formula of other works affected the quality of work.

➤ **Non-maintenance of proper temperature of bitumen**

As per MoRTH specifications, temperature of bitumen mix varies from 80°Celsius to 175°Celsius depending upon the grade of bitumen, stages of work, location of work and item of work.

Audit observed that

- In six works executed under three Divisions<sup>15</sup>, the Quality Control wing found the temperature of the bitumen mix used to be lower than the minimum temperature required.

In a meeting (August 2018) held with contractors in the presence of Executive Engineer, Roads Division, Idukki, the contractors admitted that they used small mixing machines and carriage auto rickshaws to mix and carry the bitumen mix to the work sites and that due to the lower atmospheric temperature of Idukki district, the minimum temperature of bitumen mix could not be maintained. This reflected adversely on the quality of the roads.

There was no evidence in the records to show that any rectification work was carried out.

In the exit conference, the Department accepted the audit observations and stated that the issue in Idukki district would be solved in future as more road works would be executed using BM and BC.

➤ **Non conduct of Roughness Index tests**

BM and BC were introduced in road works to improve the riding quality of roads. Failure to adhere to the specifications on mixing, laying and compaction of bituminous surface affects the riding quality. In order to assess the riding quality of the road, the contractors are to conduct Roughness Index Tests after completion of BC layer.

Audit noticed that out of 79 (13 NH and 66 Roads works) completed works of BM and BC, roughness index test was conducted only in six NH works.

No test was conducted in the 66 works costing ₹352 crore executed under Roads wing due to which the Department was unable to assess whether the specifications for mixing, laying and compaction of bituminous surface were correctly followed.

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<sup>15</sup>Roads Divisions, at Thiruvananthapuram and Palakkad and NH Division, Muvattupuzha

In the exit conference, the Department stated that direction would be issued to conduct the tests henceforth at the contractor's cost. The Department need to ensure that the directions issued are followed by all concerned.

➤ **Non-conduct of third party tests wherever required**

As per QC Manual 2015, third party test is carried out by an independent laboratory other than that of the contractor or the Department. This is required when certain specific tests cannot be carried out with the facilities available in the laboratory of the contractor or the Department.

Audit noticed that none of the six QC Labs selected for audit had the facility for conducting quality control tests of road safety items like road marking paints, sign boards, retro reflective sign boards, crash barriers, road studs, delineators, etc. Audit also noticed that first tier quality control tests of road safety items were not conducted in 55 completed works test checked. The Department should have insisted on conducting third party quality control tests in such cases. Instances of early damage to road safety items were noticed during JPV under three quality control Sub Divisions<sup>16</sup>.

In the exit conference the Department stated that the result of quality control test of items shall be called for before paying work bills in future.

➤ **Non deployment of qualified personnel by contractors at work sites**

According to Section 2102 of the PWD Manual, in the case of works costing more than rupees two lakh, the contractor shall engage engineering personnel to ensure effective supervision.

JPV of the nine on-going works showed that engineering personnel of the contractor were not present during the execution of eight works. Audit also noticed the following lapses in quality control due lack of supervision:

- At a worksite<sup>17</sup> on the Thrissur-Shoranur Road where side drains were under construction, there was no supervision either by the Department or by the contractor. As a result, cement concrete in the ratio of 1:2:4 was used instead of adopting design mix of M20 grade as agreed in the contract.
- At the site of another road work<sup>18</sup> on NH 49, in the absence of supervision the contractor executed 20 mm thick open graded chipping carpet using only one layer of six mm aggregates instead of using two layers of 12mm and six mm aggregates. Skipping of one layer of 12mm affected the quality of work.

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<sup>16</sup>Kozhikode, Alappuzha and Thiruvananthapuram

<sup>17</sup>PR. work 2017-18 improvements to Kodungallur - Shoranur Road using cement concrete drain at chainage km 42/600

<sup>18</sup>Near Puthencruetz Police Station in Ernakulam on NH 85 Madurai – Kochi Road 2018-19 urgent patch repair from chainage km 202/000 to 274/000



The Department may look into other similar cases and take action to rectify the defects. Responsibility for the lapses may be fixed on the officials concerned.

During the exit conference the Department agreed that qualified personnel of the contractor should be present at work sites and assured their presence at the work sites in future. Non-ensuring of supervision by qualified persons affected the quality of work adversely and benefitted the contractor.

**Recommendation No.1: The Department may strengthen the quality control mechanism by ensuring compliance with the provisions of quality control/PWD Manuals and MoRTH specifications by the contractors.**

### **2.5.2 Quality Assurance**

According to the QC Manual, quality assurance is the planned and systematic activities implemented in a quality system so that quality requirements for a product/service will be fulfilled. Quality Assurance consists of inclusion of mandatory quality control tests in the contracts, intimation of works to QC Labs for the conduct of second tier quality control tests, identifying and empanelling of approved laboratories for quality control tests, supervision and monitoring of work by the Department. The lapses in this regard noticed by Audit are narrated in the following paras:

#### **2.5.2.1 Non-inclusion of list of mandatory quality control tests in the tender and contract documents**

According to Section 2103 of the PWD Manual, a list of mandatory tests should be prepared and attached with the tender documents. This would help to ensure quality control in the works, as contract conditions are legally binding on both the contractor and the Department. Audit observed that the tendering authorities did not incorporate the list of quality control tests and their frequency in the tender documents.

In the exit conference, the Chief Engineer (Roads) stated that the second phase of the Project Information and Cost Estimation (PRICE) software scheduled to be introduced in April 2019 would contain a provision for including the list of mandatory quality control tests in the tender and contract documents.

#### **2.5.2.2 Non-intimation of works**

According to the QC Manual, the agreement authority shall forward a copy of the contract documents to the Assistant Executive Engineer of the concerned QC Lab within 10 days of executing the agreement. The Assistant Executive Engineer-in-charge of the work shall ensure that the date of commencement of each item of work is intimated to the QC Lab in a timely manner so that the second tier quality control tests can be arranged by the QC Lab.

Audit observed that the four selected Roads divisions executed 2,557 works during the period covered in audit, but agreement copy of only 683 works (26.71 per cent)

were received in the respective QC Labs. Roads Division, Thiruvananthapuram which executed 971 work agreements did not send any contract document to the QC Lab. Out of 279 agreements intimated by two divisions<sup>19</sup>, 27 works were received in the respective QC Labs after completion of the works. As a result, those works escaped from the ambit of second tier quality control tests. Further, Audit also noticed that the Quality Control Wing did not have a mechanism to monitor timely receipt of contract details from the agreement executing authorities.

JPVs conducted by Audit revealed that the status of nine on-going works was not intimated to the concerned QC Labs.

During the exit conference, the Chief Engineer (Designs) accepted the audit finding and assured that the issue would be addressed on implementation of the second phase of PRICE software which would include a module for monitoring the execution and progress of works.

### **2.5.2.3 Absence of approved QC Labs to conduct first tier QC tests**

According to the PWD Manual, all works executed by the PWD shall be tested in laboratories approved by PWD and the expense thereof shall be borne by the contractor. In case of any difference between the results of the first and second tier tests or when certain specific tests cannot be carried out with the facilities available in the laboratory of the Contractor/Department or when the results are suspected to be manipulated, third party testing is to be carried out in another approved laboratory.

Audit noticed that the Department did not identify or empanel any approved laboratory and that neither the selected divisions and QC Labs nor the office of the Chief Engineer (Designs) which controls the Quality Control wing had a panel of approved laboratories. As a result, the contractors depended on other sources for conducting first tier quality control tests. The correctness of those test results was not verifiable as those agencies were not liable to provide the details to PWD.

Audit found that the Department did not take quality control seriously even after six years of implementing the revised PWD Manual 2012.

During the exit conference, the Department stated that a proposal to consider all Government/Government aided Engineering Colleges as approved labs would be submitted to the Government soon. This is indicative of the fact that the very basis of quality control which is the first tier quality control tests was neither ascertained affirmatively in the contract condition, nor was the requirement of quality control considered as an integral part of the road works. The roads so constructed were thus, devoid of the important quality control assurance and for such lapses responsibilities need to be fixed on the officials responsible.

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<sup>19</sup>Roads Divisions, Palakkad and Kozhikode

#### **2.5.2.4 Absence of periodic training on quality control**

According to para 313.8 of the PWD Manual, periodic training on quality control shall be given to the field officers to familiarize themselves with the various quality control measures.

Audit noticed that this was not being followed by the Department as shown below:

- During 2016-17 no training was conducted by the QC Labs in Thiruvananthapuram, Idukki and Alappuzha districts.
- The list of officials not trained in quality control as furnished by the Department consisted of 343 technical staff, including Executive Engineers, Assistant Executive Engineers, Assistant Engineers and Overseers who supervise and monitor works in the field.

In the exit conference, the Department stated that training was an important aspect in strengthening quality assurance of works and that training would be conducted at regular intervals in future.

#### **2.5.2.5 Circumventing the requirement of quality control tests by restricting the cost of works**

##### **➤ Splitting up of works to escape the first tier quality control tests**

According to the PWD Manual, all works executed by the PWD shall be tested in PWD approved laboratories and the expenses thereon borne by the contractor. But, as per QC Manual, 2015 first tier quality control tests are mandatory only for works costing more than ₹15 lakh. Executive Engineer has the financial power to issue Technical Sanction to works costing up to ₹50 lakh and execute contracts of such works.

Audit noticed that 28 works relating to five Divisions having a total value of ₹8.16 crore were split into 63 small works of ₹15 lakh each or less. By doing so, those works which were arranged on continuous stretches of roads during the period 2015-16 to 2017-18 escaped from the ambit of first tier quality control tests.

During the exit conference, the Department accepted that it was not a good practice as it would affect the quality and economy of the works.

##### **➤ Necessity of quality checks by QC Labs (Tier II tests) at work sites without prior intimation**

According to QC Manual, the progress of all works being carried out is to be intimated to the QC Labs. The Department did not comply with the requirement. Further, officials of the Quality Control wing visited the work sites after giving prior intimation. This made the contractors and the field staff vigilant and the quality control tests conducted on those occasions always produced satisfactory results.

JPVs conducted unannounced at nine on-going works revealed the following:

- In seven works, MoRTH specifications were not observed.
- One work<sup>20</sup> in Ernakulam district, reported as completed on 31 May 2018 was still going on at the time of visit.
- In Palakkad district, the poor quality of a cement concrete structure in a work<sup>21</sup> gave it a honey comb like appearance. The retaining wall of the road constructed was not stable.



**Picture 2:** Improperly constructed retaining wall of a road leaning inward in a work in Palakkad district (photo taken on 29/09/2018)

- The cement concreting of side drain going on at the site of a work<sup>22</sup> in Thrissur district was not intimated to the QC Lab. The findings of the JPV were at variance with those observed by the Quality Control wing during their pre-intimated quality checks, as mentioned in Table 2.2 below:

**Table 2.2**

**Observations on quality control aspects in pre-intimated and un-intimated visits conducted by the Quality Control wing at a work site**

Components of cement concrete work	Observations made by QC wing during the pre-intimated visits to the work sites	Observation made during the JPV on 24/09/2018 without intimation
Cement	Major branded OPC grade cement was used.	The properties of the brand of PPC grade cement being used were neither known nor tested for quality by QC Labs.
Vibrator	Vibrators were used.	Vibrator was not used.
Mixer	Cement concrete mixed in a mixer for two to three minutes for homogeneous combination.	Cement concrete was mixed for less than two minutes.
Aggregates	Aggregates of different grades were kept in different heaps.	Aggregates were kept in one heap.
Supervision	Technical staffs of both the department and the contractor were present at the work site.	No technical staff were present at site.

The Department may look into other similar cases and take action to rectify the defects. Responsibility for the lapses may be fixed on the officials concerned.

<sup>20</sup>MLA ADS 2016-17- Improvements to Keezhillam - Manari Road by providing BM and BC between Chainage 0/000 km to 2/000 km

<sup>21</sup>Para – Karattukalam Road in Palakkad district

<sup>22</sup>RP work 2017-18 improvements to Kodungallur – Shoranur Road with cement concrete drain at Chainage 42/600 km

### 2.5.2.6 Lapses in supervision at work sites

Supervision is the act of monitoring an activity and making certain that everything is done correctly.

#### ➤ Inadequate supervision by departmental staff

According to Section 2103 of the PWD Manual, every work has to be properly supervised to ensure that it is carried out in accordance with the required specifications. The Overseer having control of a work shall be responsible for maintaining the quality of all items of work. Certain important items of work shall be supervised by the Assistant Engineer/Assistant Executive Engineer.

During JPV Audit came across four on-going works which did not have departmental supervision.

- At one work site<sup>23</sup> where a departmental Overseer was present, the construction of an Irish drain using cement concrete mix of M20 grade was carried out without using a vibrator to ensure that the mix was free of air bubbles and was even.



- In road works, the uniform application of tack coat (bitumen) on the entire surface is essential to ensure the bonding of a new layer with the existing surface. In a road work in Ernakulam district<sup>24</sup>, the aggregates were spread without applying bitumen uniformly on the entire surface of the road even though the Overseer of the Department was present at the site.

**Picture 3:** New bituminous layer laid on non-bituminous surface without clearing the loose soil and applying prime coat for bonding caused peeling off of the new layer (photo taken on 14/09/2018)

- Prime coat is a coat of bitumen emulsion required to be applied on a non-bituminous layer before spreading a bituminous layer over it, for proper bonding. This item was included in the work schedule of the contract, but the Overseer at the work site was not aware of it. As a result, the work was executed without doing the item. This lapse caused the aggregates to come off the surface and revert the road to its damaged condition. Leaving the loose aggregates on the road caused accidents to two wheelers.

<sup>23</sup>At Challikkal in Palakkad –Perinthalmanna Road

<sup>24</sup>Deposit work 2017-18, restoration work in Puthencruetz - Brahmapuram Road from Puthencruetz junction, Pannikuzhy OH tank to Karimugal near Community Hall

Audit observed that the checklists mentioned in Appendices III to VI<sup>25</sup> of the QC Manual for concrete pour monitoring, earth work monitoring, non-bituminous sub base/base layers and bituminous layer which were to be prepared by the technical staff, especially the Overseer supervising the work, were not prepared. The Department attributed the lapse to the heavy workload being faced by the staff during working seasons.

The response of the Department is not acceptable as this indicated failure in the optimum utilisation of available manpower. The Department may look into such cases and take remedial action. Responsibility for the lapses may be fixed on the officials concerned.

#### **2.5.2.7 Absence of monitoring mechanism**

The lapses in quality assurance measures mentioned above could have been addressed through proper monitoring. Lapses were noticed in monitoring also as narrated below:

➤ **Non-review of quality control activities by Superintending Engineers and Director (Investigation and Quality Control)**

Review by higher officials is necessary to monitor and check any lapse/deficiency in the quality control system. As per the Government Circular<sup>26</sup> the Director, Investigation and Quality Control (I&QC) shall conduct quarterly review of quality control activities and submit recommendations to the Chief Engineer (Designs). The Superintending Engineer shall also conduct quarterly review of implementation of the two tier quality control system and forward reports to the Government under intimation to the Chief Engineers and the Director (I&QC). The Chief Engineer's Committee shall give timely instructions for effective implementation of the quality control system in the Department.

Audit noticed that the five selected Circle offices and the Director (I&QC) did not conduct quarterly review of quality control activities and submit recommendations to the Chief Engineer (Designs).

Non-compliance with the Government instructions on review and monitoring of quality control activities by higher authorities weakened the quality control mechanism.

In the exit conference, the Department stated that the second phase of PRICE software scheduled to be implemented in April 2019 would enable review and monitoring of quality control measures more effectively.

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<sup>25</sup> These appendices contain various information of an item of work executed so that quality of work can be ensured through many parameters

<sup>26</sup> No.10434/C3/2014/PWD (May 2014)



➤ **Payment of work bills without ensuring check list for quality control monitoring**

According to section 2214 of PWD Manual 2012, the work bill submitted for payment shall be accompanied by quality control test results. Checklists for monitoring quality control<sup>27</sup> are to be furnished along with the work bills for making payment to the contractor. They are a summary of the first and second tier quality control tests conducted on various items of work and materials. It helps the divisional authorities to take appropriate action before making payments.

Audit noticed that none of the work bills of 282 works test checked were accompanied by check lists. Bills payments amounting to ₹595.23 crore were made without ensuring conduct of quality control tests.

The Department, during the exit conference assured that steps would be taken to ensure attachment of the checklists along with each work bill in future. The above lapses points to the fact that the Departmental officials did not give any importance to quality control.

➤ **Daily/weekly/monthly reports of quality control tests not prepared**

According to section 903.1 of MoRTH specifications, testing frequencies are to be set forth<sup>28</sup> and daily, weekly, monthly reports on test results shall be prepared by departmental officials. The reports should indicate the location of sampling and testing, deviation from the specified values for materials and works and remedial action taken by the Contractor for removal of defective work. The Engineer shall certify the test record stating that the tests were done in his presence and as per the methodology prescribed.

Audit noticed that none of the six divisions test checked prepared such reports, which indicated lapses in conducting the prescribed tests.

➤ **Non conduct of tier three tests**

As per PWD/QC Manual, third tier quality control tests (Technical Audit) for projects costing more than rupees five crore shall be conducted by an external agency/expert empanelled for the purpose within six months of the completion of a project. All tests carried out in the first and second tier shall be reviewed during the technical audit.

Audit observed that, out of the 282 works test checked, 33 works costing ₹448.95 crore were of more than rupees five crore, but none of the works was subjected to Technical Audit as envisaged, which resulted in non-review of the quality control measures in those works.

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<sup>27</sup> Summary of quality control tests done and action taken on failed items prepared in Appendix I/II of Quality Control Manual

<sup>28</sup> Targets and achievements in respect of quality control tests

During the exit conference, the Department stated that tier three tests would be ensured in works arranged through Kerala Infrastructure Investment Fund Board (KIIFB) fund. The Department should ensure that not only the works arranged through KIIFB but also all works costing more than rupees five crore are subjected to tier three tests.

**Recommendation No.2: The Department may include a list of mandatory first tier quality control tests in the bid documents, ensure intimation of works to Quality Control wing and impart adequate training on quality control to the field staff.**

### **2.5.3 Maintenance Strategy, including Road Safety**

The maintenance of roads is an elaborate activity. It comprises maintenance of basic records as well as maintenance of structures including their inspection at prescribed intervals. The basic objectives of maintenance are to afford riding comfort, convenience and safety to the public. Even the good quality roads show signs of distress over a period of time due to the increasing vehicular traffic, changing climate and other reasons. Road maintenance on a regular basis is required to minimise these effects and to extend the life of the road. The PWD/Quality Control Manuals and IRC/MoRTH specifications describe the maintenance strategy of roads in detail.

Audit found that the Department did not carry out road maintenance works as prescribed in the Manuals and IRC/MoRTH specifications, as narrated below:

#### **2.5.3.1 Non-maintenance of road chart**

Section 2602.4.2 of the PWD Manual specifies that for each important road a road chart shall be maintained in the form given in Appendix 2600H which would give all the data about the history of renewal of surface of different sections of the road. This would help in the selection of reaches requiring renewal or special attention.

Audit observed that three out of the four Roads Divisions selected did not maintain a road chart. As a result, resurfacing work of many roads was not done for years. At the same time in three cases early resurfacing of roads and overlapping of works were noticed.

In the exit conference, the Department stated that the issue of road chart was expected to be resolved with the introduction of second phase of PRICE software.

### 2.5.3.2 Use of unsuitable methods for maintenance works

As per Section 3004.1 of MoRTH specification adopted by PWD, the materials (particularly patching and overlay materials) used in maintenance operations shall be of a standard not less than those specified for the original construction. Maintenance treatments required under the contract or instructed by the Engineer may include pothole and patch repair, crack-sealing, fog spray, dusting, slurry sealing, surface dressing, overlays and specialist repairs.



**Picture 4:** Potholes filled with 36 mm aggregates without cutting the potholes into regular shape (photo taken on 24/09/2018)



**Picture 5:** Usage of 36mm aggregate for bitumen levelling course in violation of GOK stipulation (photo taken on 27/09/2018)

Use of unsuitable methods for road maintenance works compromises the quality of roads and make them accident prone.

During JPVs irregular methods<sup>29</sup> were seen used for maintenance works. In addition to the above, Audit also found the following lapses in maintenance of roads:

- Pothole filling was done in two road works<sup>30</sup> using 36 mm metal without using bitumen binder, in violation of MoRTH specification.
- As per the contract specification of a work<sup>31</sup> in Kozhikode district, damages to the road were to be rectified using Wet Mix Macadam. Instead, the rectification work was done using 36 mm metal, violating the contract condition and MoRTH specification.



**Picture 6:** Detached loose aggregates from filled up potholes being cleared by the public due to improper method of construction (photo taken on 24/09/2018)

<sup>29</sup> Such as earth filled potholes, oversized stone used for filling potholes, chipping carpet over BC surface and cement concrete used for filling potholes in bituminous road were noticed in 11 Roads

<sup>30</sup> Pre-monsoon works 2018-19 to Kodungallur-Shoranur Road and Pre-monsoon works 2018-19 to Cheruthuruthy-Ponnani Road

<sup>31</sup> Flood damage work-Urgent pothole repair in Kattangal - Mavoor Road between chainage 4/000 km to 7/400 km

- GoK prohibited (February 2017) the use of 36 mm metal in levelling course since it has voids. In a road work<sup>32</sup> in Palakkad District, 36 mm metal was used as levelling course disregarding the GoK direction.
- In Thrissur-Shoranur Road, at Mulloorkara Junction, the local people were seen clearing loose 12 mm aggregates from the road using iron broom. People expressed concern over the inferior quality of rectification work done. It was stated that there were recurrent two-wheeler accidents due to skidding over the loose aggregates.
- As per Specification 501.6 of the MoRTH, the wheels of roller machine shall be in good working order, to prevent the mix from sticking to the wheels. Only sufficient moisture to prevent adhesion between the wheels of the rollers and the mix should be used. In a road work<sup>33</sup> in Ernakulam district it was found that excess water was being poured on the wheels of the road roller which flowed down on the newly laid road surface which could cause early damage to the road.
- On a visit to the above road work, it was found that chipping carpet work was going on over an existing bituminous concrete layer. As per the PWD norms, chipping carpet was not to be laid over existing bituminous concrete.

Besides, a surprise inspection by the technical inspection wing of the Finance Department on NH 66 in Alappuzha district revealed rectification works being carried out using 36 mm aggregates and premix chipping carpet, instead of BM and BC originally used in the work. The Chief Technical Examiner of the inspection wing remarked that non usage of standard items not only damaged the new surface but also damaged the old bituminous concrete layer.

The Department may look into other similar cases and take action to rectify the defects. Responsibility for the lapses may be fixed on the officials concerned.

### **2.5.3.3 Use of unsuitable items for road overlay works using open graded premix chipping carpet**

#### **➤ Violation of MoRTH specification**

MoRTH specifications were adopted in Kerala by PWD in October 2013, according to which, bitumen overlay of Open Graded Premix Chipping Carpet<sup>34</sup> (OGPC) work was to be done using graded aggregates<sup>35</sup>. Audit observed the following violations:

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<sup>32</sup> Near Puthur junction in Kalmandapam –Kalpathy Road

<sup>33</sup> Near Puthencruetz Police Station in NH 49

<sup>34</sup> OGPC is a two centimetre thick bituminous wearing course laid over old bituminous surface or over Water Bound Macadam (WBM) surface, in which two grades of aggregates with binder content are spread separately and each time compacted using road roller

<sup>35</sup> Graded aggregate means using different size of aggregates so as to have a uniform consistency in concrete

- Under Roads Division, Idukki, out of 81 works test checked, 39 OGPC works costing ₹26.44 crore were done using 12 mm and 6mm aggregates, instead of graded aggregates.
- Further, a tack coat was to be provided using bitumen emulsion or bitumen VG 10 as part of the chipping carpet work. Out of 81 works test-checked, in 24 works VG 30 was used instead of bitumen emulsion/VG 10 which undermined the quality of work. During the meeting of contractors arranged (August 2018) by the Executive Engineer at the instance of Audit, the contractors confirmed that they used VG 30, pouring it like threads instead of spraying it over the entire area.

Adoption of improper methods of work can reduce the life of the road constructed.

➤ **Violation of GoK direction**

GoK directed (February 2017) that OGPC shall be replaced with Close Graded Premixed Chipping Carpet (CGPC)/Mix Seal Surfacing (MSS). Audit noticed that, 79 chipping carpet works arranged under Roads Division, Idukki did not adopt CGPC/MSS even after issue of the Government direction.

During the JPV conducted in Idukki district, it was noticed that a 200 metre long portion of road constructed (May 2018) using OGPC instead of CGPC between chainage 55/000 km to 56/000 km of the Thodupuzha–Puliyamala Road had peeled off.

During the exit conference, the Department stated that CGPC had more life and quality than OGPC and confirmed that in Idukki district OGPC was still being used in road works as it was cost effective.

Cost effectiveness should not be allowed to prevail over the quality and life of roads.

**2.5.3.4 Non conduct of timely maintenance**

➤ According to the PWD manual, the Assistant Engineer/Overseer shall inspect the roads under his control at least once a month and report on the condition of roads for taking preventive maintenance. The frequency of this inspection shall be increased during the monsoons and calamities.

Audit found no evidence of routine inspection conducted in any of the four selected Roads Divisions. Absence of periodical inspections allowed initial defects like cracks to go unnoticed and later to develop into potholes.

➤ Section 2601.1 of the PWD Manual states that road maintenance is required on a regular basis to keep the effect of road distress to a minimum, to extend the life of the road and to provide a high level of service to users. As per section 514.2 of MoRTH specification, preventive maintenance measures such as micro surfacing may be used as surface sealing treatment to improve skid resistance, surface durability and

to seal fine and medium cracks on an existing pavement surface which is structurally sound, but shows signs of premature ageing, aggregate loss, cracks etc.

JPV conducted in 77 reaches revealed the following:

- Cracks, the initial symptoms of road damage, were seen in 12 road reaches in Idukki<sup>36</sup>, Ernakulam<sup>37</sup>, Thrissur<sup>38</sup> and Palakkad<sup>39</sup> Districts.
- Potholes/stripping of road surface were found in 29 road reaches in Thiruvananthapuram<sup>40</sup>, Alappuzha<sup>41</sup>, Idukki<sup>42</sup>, Ernakulam<sup>43</sup>, Palakkad<sup>44</sup> and Kozhikode<sup>45</sup> Districts.



**Picture 7:** Potholes in front of Taluk Hospital, Thuravur in NH 66

Failure in rectification of minor cracks and other initial defects in time leads to developing of potholes, causing hardships to road users and increase in the maintenance cost.

In the exit conference, the Department stated that introduction of a separate maintenance wing might help in improving maintenance activities of roads in the coming years.

#### **2.5.3.5 Arrangement of work during defect liability period**

A Defect Liability Period (DLP) is a period of time following the practical completion of a work during which the contractor remains liable under contract for rectifying any defects which become apparent.

According to the agreement conditions, every time the Engineer gives notice of a defect to the Contractor before the end of the DLP, the Contractor shall correct the notified defect within the time specified in the notice. If the contractor has not corrected the defect within the specified time, the Engineer will assess the cost for correcting the defect and the contractor will pay this amount.

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<sup>36</sup> At many places between Paramada Junction and Cheruthoni Junction in Thodupuzha – Puliyanmala Road

<sup>37</sup> Between Manakkakadavu bridge and Pallikkara Junction in Ernakulam – Muvattupuzha Road

<sup>38</sup> Between Vazhakode and Cheruthuruthi in Thrissur – Shoranur Road

<sup>39</sup> Mundur – Koottupatha Road in Palakkad district

<sup>40</sup> Perrorkada – Manikanteswaram – Nettayam Road

<sup>41</sup> Chainage 368/000 to 387/300 km of NH 66

<sup>42</sup> Chainage 2/600,3/300 and 3/400 km of Uppukunnu – Paramada Road

<sup>43</sup> Valayanchirangara – Mannoor Road

<sup>44</sup> Between Koottupatha and Para in Palakkad – Para – Pollachi Road

<sup>45</sup> East Hill – Karaparamba Road in Kozhikode district



Audit noticed that the Department awarded three new works costing ₹31.61 crore during the DLP of three<sup>46</sup> existing road works in order to rectify the inferior quality of work done. It was also noticed that in respect of another work<sup>47</sup> the Department awarded eight new works costing ₹1.06 crore, immediately after the DLP of the work.

The Department issued notices to contractors of three<sup>48</sup> of the works during the DLP of the works for rectification of defects, but they did not comply. Notice was not issued to the contractor in respect of one work.<sup>49</sup>

In reply to an audit enquiry, the Superintending Engineer, North Circle, Kozhikode stated that the expenditure incurred on rectification of defects of one<sup>50</sup> work would be recovered from the contractor concerned. No action was proposed or taken by the Department in the other three cases.

In the exit conference, the Department accepted that new works were not permissible during DLP. However, negligence of the departmental officials enabled the contractors to compromise on the quality of works. Further the department did not recover the cost of the defective work from the contractors in three works, and incurred extra expenditure on correcting defects. Responsibility for lapses may be fixed on the officials concerned.

#### 2.5.3.6 Inadequacy/Absence of drainage

As per Section 1503.13 and 2407.19 of the PWD Manual, drains are an integral part of roads and must be provided for all roads. They must be permanent structures and must be properly maintained, considering the heavy



**Picture 8:** Lack of drainage caused water logging and potholes, reducing the width of carriageway in NH 66 (photo taken on 14/08/2018)



**Picture 9:** Lack of side drain caused water logging preventing access to bus waiting shed in NH 66

monsoon rains in the State. The main objective of drainage is to prevent early damage

<sup>46</sup> One work each under Roads Divisions Palakkad-(A), Kozhikode-(B) and NH Division, Alappuzha-(C)

<sup>47</sup> Under NH Division, Alappuzha-(D)

<sup>48</sup> Works (A), (C) and (D)

<sup>49</sup> Work (B)

<sup>50</sup> Work (A)

to the pavement due to the entry of excess water and to prevent saturation up to a depth of one meter below the top of the sub grade. Strength and life of the pavement greatly depends on the moisture present in and below the pavement. Performance and durability of the pavement is inversely proportional to the quantum and duration of the presence of moisture in the road structure. Absence of drainage facilities and improper construction of drainages lead to water logging and damage of roads.

Audit noticed lapses in the maintenance of drainages in 18 road reaches visited during JPVs which included issues such as water logging of roads and consequent damage of road surface, non-construction of drainage/improper construction of drainage, etc.

In one instance<sup>51</sup>, under Roads Division, Idukki, absence of flood water drainage facility necessitated the reconstruction of a retaining wall and cement concrete drain.

The Department accepted that absence of proper drainages affected the quality of roads and stated that fund shortage was a major concern in maintaining drainages and shoulders.

#### **2.5.3.7 Improper maintenance of shoulder**

According to the PWD Manual, maintenance of shoulder is an important part of maintenance activity so as to facilitate easy access and drainage. Audit noticed that the Department did not take periodical action to maintain the shoulder except at the time of carrying out resurfacing work.

During the JPV of 20 road reaches, Audit noticed lapses in the maintenance of shoulders. The lapses consisted of non-maintenance of correct gradient of shoulder which blocked the flow of rain water to the drain/caused drop at the edges of the roads.

#### **2.5.3.8 Lapses in road cutting and restoration works**

According to the PWD Manual, for any work involving cutting of the PWD roads, the organizations which request permission for cutting the roads themselves shall restore the roads to their original condition within a stipulated time, under the supervision of PWD.

Audit noticed the following lapses in this regard.

- Kerala Water Authority dug a portion of the NH 220 under NH Division, Muvattupuzha without the permission of the PWD. The PWD demanded ₹2.84 crore which was not remitted by Kerala Water Authority.

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<sup>51</sup> FD - 2013-14 Construction of retaining wall and CC drain at eroded portion of Vellathooval-Ponmudi Road at km 00/700 and km 01/200 (Agreement No. 316/EE/13-14 dated 19/09/2013)

- In Thrippunithura, immediately after completion of a road surfacing work using BM and BC by the NH wing of PWD, the Roads wing granted permission for digging the road without consulting the NH wing.



**Picture 10:** Unattended restoration works after laying of pipelines reduced the width of carriage way(photo taken on 07/09/2018)



**Picture 11:** Unattended pipe leakage caused pothole in newly resurfaced road (photo taken on 07/09/2018)

In addition to the above, similar lapses were noticed during JPV of restoration works in 10 road reaches. The lapses included long delay in restoration of road surface to its original condition after road cutting, restoration of road surface using non-compacted 36mm aggregates instead of bituminous overlay specified by MoRTH, improper restoration of road leading to settlement of the restored portion, trenching of hilly area roads along the filling side instead of the cutting side and formation of potholes due to unattended pipe leakage.

As this was a test audit in the sampled works in selected road divisions and the audit observation is of a nature that may reflect in other works not covered in test audit, Department may, therefore, like to internally examine the position in rest of the works with a view to ensure that requirements of quality control, as prescribed, are being met. The Department should take necessary remedial measures and also fix responsibility for the lapses in all such cases.

**Recommendation No.3: The Department may strengthen the road maintenance system by preparing and maintaining Road Charts and by ensuring that the maintenance activities are carried out in compliance with MoRTH and GoK stipulations.**

## 2.6 Conclusions

Review of the quality control system revealed that the Department was not able to implement the quality improvement programme satisfactorily due to the following:

- The Department did not ensure setting up of field labs, continuous monitoring of quality, proper supervision and monitoring of works. Performance of the Quality Control wing was poor and the departmental supervision of works was inadequate. These lapses defeated the benefits envisaged by the introduction of the quality control system and compromised on the riding quality of roads.

- The Department failed to include mandatory Quality Control tests in the contract documents, to intimate contracts/ progress of work to Quality Control wing and to identify and empanel approved labs for conducting quality control tests. The Department also diluted the MoRTH specifications for road works. As a result, quality assurance of works could not be ensured.
- The Department did not maintain road charts, did not follow the maintenance strategy for timely identification and rectification of defects and did not adopt a preventive maintenance strategy. Unsuitable materials and improper methods were adopted for road maintenance. This affected the quality and life of roads adversely.
- The drainage systems of roads were inadequate and were not maintained properly. Improper maintenance of shoulder of roads coupled with lapses in road cutting and restoration works reduced the life and usability of roads, necessitating frequent repairs and maintenance.

Departmental lapses in ensuring quality assurance and quality control in the maintenance of roads resulted in compromising of value for the money spent on the sampled 282 works worth ₹790.77 crore examined by Audit. The objective of ensuring quality control in road works was thus, defeated due to the lackadaisical approach of the Department. As this was a test audit in the sampled works in selected road divisions and the audit observation is of a nature that may reflect in other works not covered in test audit, Department may, therefore, like to internally examine the position in rest of the works with a view to ensure that requirements of quality control, as prescribed, are being met. The Department should take necessary remedial measures and also fix responsibility for the lapses in all such cases.