SOME QUALITY CONTROL ASPECTS OF ROAD PAVEMENT REHABILITATION IN SRI LANKA

by

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and P.H.M. Suraweera

Introduction

The Minister of Local Government Housing & Construction announced in 1985 that a sum of Rupees Five Billion will be allocated to carry out much needed rehabilitation to the road network of Sri Lanka. The Sections of the following roads being rehabilitated under this Project and reviewed here are:

a) Colombo-Kandy Road approx. 39km (Section from 14.5 - 53km Post)

b) Gampaha-Yakkala Road (approx. 3km)
c) Gampaha-Miriswatte Road (approx. 4km)
d) Approach Road to Oil Refinery at Sepugaskanda (3.5km)
e) Kurunegala-Narammala-Kadampa Road (61.2km)

The work to be carried out can be broadly classified as:

1) Correction of pavement for surface damages and irregularities
2) Correction of pavement for surface depressions resulting from settlement
3) Widening and correction to the edges of the pavement
4) Correction to the pavement cross fall
5) Correction to the super elevation at curves,
6) Widening and correction of shoulders, cutting and clearing of drains
7) Construction extensions to culverts and building drains and other road structures.
8) Dense Asphaltic Concrete Surfacing of the corrected pavement to roads (a) (b) and (d) listed above
9) Double Bituminous Surface Treatment (DBST) of the corrected pavement to road (e) listed above
10) Road Markings

The major items of plant and machinery used on the project included a Crusher for road metal, an Asphalt Premix Plant (with a Wet Separator to entrap dust), Premix Pavers, Pneumatic Tyred & Smooth Wheel Rollers, Motor Graders, Loaders, Bowers etc.

Quality control in this project became extremely important in aspects such as the selection of suitable aggregate for the pavement and suitable borrow soils for shoulders, control of aggregate gradations, design of asphalt

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concrete mixes, checking the quality of premixes produced at the plant, field quality control on laid pavement and shoulders. There were instances when it became imperative that certain amount of deviation from the specifications had to be effected. Such situations required carrying out research in to the problem within the constraints of limited time and resources available.

Road Aggregates

According to the Specifications, the rock chosen for aggregates should satisfy the requirements stipulated on three main tests, i.e.,
(a) Abrasion Resistance
(b) Impact Value
(c) Flakiness Index. The required limits on these tests were: a Los Angeles Abrasion Value of 40 or less, Impact Value of 30 or less, Flakiness Index Value of 30 or less.

From the point of view of costs, the ideal location for a rock quarry would be about the mid-way of the road length under construction i.e., close to the 33rd Km post on the Colombo-Kandy Road. Hence, initially, a search for a quarry was made in the Nittambuwa-Yakkel area. Rock samples collected from available quarries were tested. In all instances, the Los Angeles Abrasion Value was found to be unsatisfactory. For a given quarry, if a test indicated an abrasion value less than 40 but close to 40, then the quarry was regarded as unsatisfactory, since experience showed that there is always a high possibility of exceeding the limit 40 when more samples are tested for abrasion. This is because, a quarry being a naturally occurring mass of rock, it is hard to expect uniform physical properties due to a variety of reasons such as variations in grain size, banded structure, effects of uneven weathering, and a multiple of other geologic reasons. The Contractor was under strict instructions that if subsequent tests indicated abrasion values exceeding 40, then the crusher will have to be removed and reinstalled at a different quarry. The Contractor could not afford to take such a risk in view of the fact that road metal is the mostly used construction material in a road construction project, and being so, shifting the crusher to a new location would incur huge costs as well as serious delays to the job schedule.

Since no suitable rock quarry could be found close to the middle point of the road under construction, search for a quarry was necessary.

A Systematic search was made exploring all by-roads on both sides of the Colombo-Kandy Road starting from the Kadawata area. To the disappointment of the Contractor not a single available rock quarry was found to be satisfactory until the search reached the Warakapola-Ambevussa Road at 57th Km post on the Colombo-Kandy Road. All rocks up to that point were unsatisfactory mainly with respect to the Los Angeles Abrasion Test. A large number of potential quarries, almost 30 in number were visited. In many instances, visual examination of rock samples was sufficient to estimate if the rock would fail in the abrasion test. Rocks with highly banded gneissic structures and/or with the presence of significant quantities of biotite mica could be readily eliminated as unsuitable (see Fig. 1). In other instances, samples were subjected to the abrasion test. Results of samples collected and tested from different quarries are quoted in Table 1.

Ironically, all rocks investigated up to about 57th Km post were found to be unsatisfactory, whereas all three quarries found on the Warakapola-Ambevussa Road were found to be satisfactory, see Table 1. Furthermore, most rocks beyond the 57th Km post towards Kandy also appeared to be satisfactory in abrasion resistance. This kind of rock property variations along the length of the road was obviously due to geologic reasons. Depending on their history of formation rocks found in some areas are different from rocks in other areas. It was noticed that rocks up to 57th Km post were chiefly granitic gneisses with lower abrasion resistance properties while rocks located beyond 57th Km post were mainly chernockite, generally good in abrasion resistance. This observation is further confirmed by the tests carried out on rock samples obtained in Kurunegala area. Out of four rocks tested for a road project there, three were found to be quite satisfactory chernockites, see Table 1. Chernockitic rocks are quite commonly found in the Kandy and Kurunegala regions. As found in these areas, chernockite is a greenish-black rock with a high degree of uniformity in its structure, see Figure 1.

The Contractor was successful in leasing out one of the three rocks found on the Warakapola-Ambevussa Road, which had satisfactory abrasion resistance. The crusher was installed at this site, identified as the Ambevussa Quarry, which was owned by the Railway Department.
**TABLE 1**

**AGGREGATE TEST RESULTS FROM DIFFERENT QUARRIES**

(Colombo-Kandy Road & Kurunegala-Narammala-Madampe Road)

<table>
<thead>
<tr>
<th>SOURCE</th>
<th>Los Angeles Abrasion %</th>
<th>Impact Value %</th>
<th>Flakiness Index</th>
<th>Remarks: Rock Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Kalalpitiya, Nittambuwa</td>
<td>36</td>
<td></td>
<td>33</td>
<td>Biotite Gneiss</td>
</tr>
<tr>
<td></td>
<td>43</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>52</td>
<td></td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>Thambigewatte Quarry, off Yakkala</td>
<td>42</td>
<td></td>
<td>51</td>
<td>Biotite Gneiss</td>
</tr>
<tr>
<td>J.E.D.B. Quarry at Weliveriya</td>
<td>38</td>
<td></td>
<td>39</td>
<td>Pink granite with high % of large feldspar grains</td>
</tr>
<tr>
<td>Ambagasipitiya, Yakkala</td>
<td>46</td>
<td></td>
<td>35</td>
<td>Pink granite with high % of large feldspar grains</td>
</tr>
<tr>
<td></td>
<td>37</td>
<td></td>
<td>22</td>
<td></td>
</tr>
<tr>
<td>Viharekanda, Ambepussa</td>
<td>33</td>
<td></td>
<td>28</td>
<td>Charnockite</td>
</tr>
<tr>
<td>J.E.D.B. Quarry, Ambepussa</td>
<td>24</td>
<td></td>
<td>23</td>
<td>Charnockite</td>
</tr>
<tr>
<td>Railway Quarry, Ambepussa</td>
<td>31</td>
<td></td>
<td>27</td>
<td>Charnockite</td>
</tr>
<tr>
<td></td>
<td>34</td>
<td></td>
<td>19</td>
<td></td>
</tr>
<tr>
<td>Dharmasena Quarry, Malwane</td>
<td>39</td>
<td></td>
<td></td>
<td>Charnockite Gneiss</td>
</tr>
<tr>
<td>S.E.C. Quarry, Mahara</td>
<td>37</td>
<td></td>
<td>25</td>
<td>Charnockite Gneiss and Charnockite</td>
</tr>
<tr>
<td></td>
<td>31</td>
<td></td>
<td>22</td>
<td></td>
</tr>
</tbody>
</table>

**Following 4 Samples were from Kurunegala District:**

<table>
<thead>
<tr>
<th></th>
<th>Los Angeles Abrasion %</th>
<th>Impact Value %</th>
<th>Flakiness Index</th>
<th>Remarks: Rock Type</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bemmulegedera</td>
<td>27</td>
<td></td>
<td>8</td>
<td>22</td>
</tr>
<tr>
<td>Ganegoda</td>
<td>29</td>
<td></td>
<td>9</td>
<td>25</td>
</tr>
<tr>
<td>Bihalpola</td>
<td>33</td>
<td></td>
<td>11</td>
<td>28</td>
</tr>
<tr>
<td>Bulupitiya</td>
<td>40</td>
<td></td>
<td>13</td>
<td>37</td>
</tr>
</tbody>
</table>
(a) Gneissic rock with heavy banding.  (b) Charnockite exhibiting much uniform texture.  (c) Pink granite with large grains of feldspar.

Fig.1- Main Rock Types Encountered Within The Project Area.
FIG. 2 - ENVELOPES OF JOB MIX FORMULAS (JMFS) USED FOR
BASE COURSE & WEARING COURSE MIX DESIGNS
It was observed that some parts of the rock at this quarry had undergone partial weathering and some parts were overlain by considerable amounts of overburden. Therefore, a seismic survey was carried out at the site in order to find out if sufficient quantities of good rock will be available. Field studies together with the seismic survey to determine overburden thicknesses indicated that this quarry in all probability will have quite sufficient quantities to meet the requirements of the project.

Asphalt Concrete Premixes

Like cement concrete, asphalt concrete too can be called a 'Wonder' material discovered by man. When metal with the correct gradation is mixed with the correct bitumen content at the right temperature, and the resulting mix is given the right amount of compaction, the final product is a surprisingly hard material found to be ideal for constructing flexible road pavements.

For rehabilitation of the Colombo-Kandy Road, two asphalt concrete premixes were recommended, i.e., a base course to be laid on the existing road pavement and a wearing course on top. Henceforth, the base course will be referred to in this paper by the abbreviation ABB (asphalt-bound base) and the wearing course by simply WC. At certain stages of the project it became necessary to obtain aggregates, particularly the fines fraction, from sources other than the Contractor's Assebuppa quarry. This necessitated conducting a considerable number of mix-designs for both the ABB and WC, because various combinations of the three aggregate sizes (20mm, 10mm and fines) obtained from different sources had to be used. Results of these mix designs will be quoted here for comparative study.

Asphalt bound base (ABB)

The ABB used for the road consisted of a premix layer of thickness varying from 20mm to about 300mm. The envelope of job mix formulations used for the ABB is stated in Figure 2(a). Results of all ABB mix designs conducted with combinations of aggregates obtained from different sources are plotted together in the graphs of Figure 3 so that the designs get directly compared with each other. Each set of curves presented in Fig. 3 also gives an indication of the amount of variability of such design parameters as maximum unit weight, maximum Marshall Stability, etc., against optimum asphalt content. All design asphalt contents satisfy the Specification requirement, viz. 4.7 ± 0.3 percent. The bulk specific gravity of the total aggregate varied between 2.701 to 2.782 while the design asphalt content varied between 4.43 to 4.78% for the mix designs carried out.

One of the mix designs for ABB shown in Fig. 3 was done using a fine aggregate consisting of a mixture of quarry dust and river sand in the ratios of quarry dust:river sand = 3:1. This design showed that river sand could be successfully used as fine aggregate when quarry dust is in short supply. The river sand had to be mixed with quarry dust in order to make the gradation confirm to the job mix formula.

Wearing Course (WC)

The thickness of the wearing course laid was between 40-50mm. The envelope of job mix formula used is indicated in Fig. 2(b). As for the asphalt-bound base course, many mix designs were done for the wearing course as well, because, aggregates for the WC were also used from various sources. The mix design curves are presented in Fig. 4. As in the case of ABB, the sets of curves for WC give an indication of the amount of variability of the parameter in the mix designs. The design asphalt contents satisfy the requirement of the Specifications, i.e., between 5 to 7%. In these mix designs the bulk specific gravity of the total aggregate varied between 2.723 to 2.784 and the design asphalt content between 5.08 to 5.69%.

A Premix to Replace the Water Bound Macadam

The edges of the existing road were not in sound condition, and hence, before laying the base course and the wearing course the edge required to be corrected maintaining a uniform width of the road. The edge corrections were initially done using a water bound macadam (WBM). Before laying the WBM the edges were first excavated by 150mm. A graded aggregate with a maximum size of 63mm was used for the WBM. Procuring this aggregate confirmed to a specified gradation and storing and handling of it on the roadside was found to be too involved a process, and this gave rise to the idea of substituting the WBM with a suitable
Fig. 3 - Design curves for base course
Fig. 4 - Mix Design Curves for Wearing Course
lean premix of asphalt concrete which could be used more cost effectively. In overall assessment, it was found to be quicker for construction and cheaper to use a lean premix in place of WCM.

A mix design was done in this connection in order to see if the use of a lower bitumen content will still yield satisfactory values of Marshall Stability, air voids etc. The results of the mix design done for this purpose are shown plotted in Fig. 5. An asphalt content of 2.5% was chosen for the lean mix which had satisfactory values for the most crucial parameters viz. stability, flow and air voids.

Shoulder Soils

As in the case of the rock quarry, finding a soil borrow pit for shoulders that satisfied the specifications became extremely difficult. The major requirements of the shoulder soil were: LL < 40; PI < 16; clay + silt fraction > 30%; CBR > 25% and degree of field compaction > 96% of Modified compaction test.

A thorough search was made right along the length of the road covering even areas such as Mattala, Malwane, Mirigama, etc. situated a considerable distance away from the road. The effort made in finding a suitable borrow soil was such that, in all, about 80 potential borrow sites were visited and soils were examined and tested. Finally, only a single borrow pit could be located that satisfied the above soil criteria. Thus, the search was done against the odds of about 1 in 80. The single borrow pit that satisfied the above requirement was located at Mahara, and even then, the quantity in it was not sufficient for the entire road. This Mahara soil is identified in this paper as Mahara soil-1. It should be mentioned that most soils failed to satisfy either the plasticity characteristics or the CBR specification.

Although Mahara soil-1 satisfied the specifications, in actual field operations it was discovered that the problems were far from being over. The various problems encountered and corrective measures taken in respect of shoulder soils are described below.

Mahara Borrow Soil

Inquiries revealed that Mahara soil-1, a heap containing about 1500 cubes, was stock piled about 10 years ago while removing the overburden before quarrying for rock. The entire heap of soil was surprisingly uniform in its soil characteristics which are given in Table 2.

The main problem with this soil arose when the specified degree of compaction viz. 96% of the Modified Density, was found to be difficult to achieve in the field. Numerous trial tests were carried out in the field in an attempt to find out the cause of the problem. The following measures were taken in the trials:

* Thickness of loose fill layer was varied from 100mm to 200mm
* Moisture content was varied from dry of optimum to wet of optimum
* The subgrade itself was thoroughly compacted and scarified before placing the fill
* Width of the shoulder at the test sections varied from 1.5m to 3.5m and some test sections were well confined on both sides
* Different sized rollers were tried out varying the number of passes from about 6 to 50

Results of the field compaction trials with different types of rollers, ranging from 2.5T to 13T are presented in Fig. 6. None of the rollers could yield the required 96% Modified Compaction. Yet the results of these trials are of much interest from a soil mechanics point of view, for it can be seen in Fig. 6, that compaction curves of those rollers with higher contact pressures begin to show at some stage, a decreasing trend in the degree of compaction. This phenomenon was actually observed in the field as the loosening of the compacted soil due to shear failure. Typical shear failure was characterised by the heaving and cracking of soil just in front of the roller. The ground heaving in front of the roller is an indication of the failure wedge adjacent to the loaded area when a soil undergoes bearing failure. Only the 8T tandem roller managed to provide a maximum of 92% Modified compaction for a practically viable number of passes.

The fact that compaction greater than 92% could not be achieved in the field posed a puzzle because 100% compaction on the same soil was achieved in the laboratory. The cause for this was thought to be the fact (45)
Asphalt Content Chosen for
Lean premix = 2.5 %
Marshall stability = 9.8 KN
Air voids = 10 %

**JOB MIX FORMULA**

<table>
<thead>
<tr>
<th>size (mm)</th>
<th>25</th>
<th>20</th>
<th>12.5</th>
<th>5</th>
<th>2.36</th>
<th>0.75</th>
</tr>
</thead>
<tbody>
<tr>
<td>% passing</td>
<td>100</td>
<td>99.8</td>
<td>75.4</td>
<td>25.5</td>
<td>19.4</td>
<td>3.9</td>
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<tr>
<td>specification</td>
<td>100</td>
<td>90-100</td>
<td>50-80</td>
<td>25-35</td>
<td>10-20</td>
<td>3-6</td>
</tr>
</tbody>
</table>

V.M.A = Voids in Mineral Aggregate
A.C = Asphalt Content

Fig. 5 - Mix Design Used To Substitute for WBM
TABLE 2 (a)
PLASTICITY CHARACTERISTICS OF SOILS COLLECTED FROM ROAD SHOULDERS

<table>
<thead>
<tr>
<th>Location of Shoulder Material</th>
<th>High Level Road Makumbura</th>
<th>High Level Road Kottawa</th>
<th>Samurdhi Mawatha EJZ Biyagama (Location 1)</th>
<th>Samurdhi Mawatha EJZ Biyagama (Location 2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Property</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LL</td>
<td>40</td>
<td>54</td>
<td>47</td>
<td>70</td>
</tr>
<tr>
<td>PI</td>
<td>17</td>
<td>26</td>
<td>23</td>
<td>27</td>
</tr>
</tbody>
</table>

TABLE 2 (b)
PROPERTIES OF SOILS PROPOSED FOR SHOULDER CONSTRUCTION

<table>
<thead>
<tr>
<th>Name of Soil</th>
<th>Mahar (Soil -1)</th>
<th>Imbulgoda</th>
<th>Mirissatte</th>
<th>Nittambuwa</th>
<th>Mahar (Soil -2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Soil Property</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Std. Proctor Max. d.d (gm/cc) &amp; Optimum m.c. (%)</td>
<td>1.89 @ 12.8%</td>
<td>1.69 @ 16.8%</td>
<td>1.89 @ 15.7%</td>
<td>1.78 @ 18%</td>
<td>1.81 @ 15.2%</td>
</tr>
<tr>
<td>Modified Compaction Max. d.d (gm/cc) &amp; Optimum m.c. (%)</td>
<td>2.02@ 11%</td>
<td>1.89@13.7%</td>
<td>2.02@ 13%</td>
<td>1.84@16.5%</td>
<td>1.88@14.5%</td>
</tr>
<tr>
<td>Soaked CBR @ Std. Proctor Max. d.d.(%)</td>
<td>32</td>
<td>20</td>
<td>29</td>
<td>20</td>
<td>16</td>
</tr>
<tr>
<td>Soaked CBR @ 90% Modified d.d. &amp; Optimum m.c. (%)</td>
<td>34</td>
<td>20</td>
<td>40</td>
<td>39</td>
<td>18</td>
</tr>
<tr>
<td>Gravel %</td>
<td>7</td>
<td>11</td>
<td>42</td>
<td>33</td>
<td>15</td>
</tr>
<tr>
<td>Sand %</td>
<td>70</td>
<td>54</td>
<td>36</td>
<td>43</td>
<td>53</td>
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<tr>
<td>Silt + Clay %</td>
<td>23</td>
<td>35</td>
<td>22</td>
<td>24</td>
<td>32</td>
</tr>
<tr>
<td>Plasticity Gradation</td>
<td>37</td>
<td>56</td>
<td>69</td>
<td>67</td>
<td>51</td>
</tr>
<tr>
<td>Plasticity Limit %</td>
<td>14</td>
<td>17</td>
<td>35</td>
<td>33</td>
<td>22</td>
</tr>
</tbody>
</table>

* This is the only soil that met the job specification  Note: d.d.=Dry Density  m.c. =Moisture Content
that Mahara soil-1, according to Unified Soil Classification (2) was essentially a sand with little silt and clay. The soil had a very little gravel-sized particles although the requirements of the specifications were met. Being a sand, it is speculated that the soil absorbed and released energy elastically because of the inability to provide the same type of confinement in the field as that provided by the 6" dia. steel mould for the laboratory sample.

In order to resolve the problem of the inability to get 96% modified compaction, a laboratory study was carried out to determine what could be the minimum acceptable degree of modified compaction with which the required soil strength of 25% CBR could be maintained. In this study, a number of soaked CBR tests were carried out on samples of Mahara soil-1 compacted to different degree of Modified compaction. The results are shown plotted in Fig. 7. All test results lied within a band shown in the figure from which it could be seen that a modified degree of compaction of 90% would generally assure that sufficiently good soil strength (i.e. with CBR 25%) could be achieved. Furthermore it was found that the 90% Modified density of this soil was about the same as 100% Standard Proctor density. These findings were submitted by the Contractor to the authorities concerned with the request that the Specifications be revised in view of the problem faced. The request was granted stating that 100% Proctor compaction will be sufficient in the field.

Other Borrow Soils

As mentioned earlier, from about 80 potential borrow sites only Mahara soil-1 confirmed to the specifications and the quantity available was only about a quarter of the total requirement. Now the Contractor was faced with the task of getting approval for soils that did not conform to the specifications, but appeared to be quite satisfactory as shoulder material.

Apparantly no sufficiently detailed study has been done on local gravelly soils (especially abundantly found lateritic soils) to determine their performance as road shoulder material. It was quite evident that some of the gravels found would perform well as shoulder material even though they failed to conform to the specifications laid down for the project. In these circumstances, a certain amount of research work had to be done in order to obtain approval for those soils to be used as shoulder material.

The research study, which had to be done within the constraints of limited time and resources, consisted of three main aspects:

a) Testing of soil samples collected from already constructed shoulders in other areas
b) Conducting sufficiently comprehensive tests for relevant geotechnical properties of the proposed shoulder soils
c) Preparation of actual test sections of shoulders with the proposed soils and studying their performances in actual conditions of vehicle travel, rain etc.

The most difficult item to be satisfied in the specifications was plasticity characteristics (i.e. liquid limit & plasticity index). Hence samples collected from already built shoulders and gravel roads were subjected to plasticity tests. Samples were collected from two locations of the High Level Road and two locations of Samurdhi Mawatha, Free Trade Zone, Biyagama.

The results of these soils are quoted in Table 2(a). All these soils appeared to perform well as shoulder material except for the distress caused due to lack of confinement or insufficient drainage provisions. The value in Table 2(a) show that the plasticity characteristics of those soils, already in use as shoulder material, were often well outside the specification limits of this project.

Results of all relevant physical property tests and strength tests carried out on the proposed soils are given in Table 2(b). The soils are identified by a name that refers to the location of borrow-pit.

Trial test sections of shoulder were constructed with the proposed soils. They were examined after rains and after they were subjected to wheel loads of vehicles.

The final task of this study was to select the soils that would be good for the construction of shoulders. The test results were studied and the test sections were inspected by the Consultants as well as representatives of the Client. Mirisawatte and Nittambuwa soils were approved for use as shoulder materials. These two soils appeared much superior to the other soils for the basic reason that
Fig. 6—Effect of Different Types of Rollers on Degree of Compaction of Mahara Soil—1

Fig. 7—Soaked CBR Vs Degree of Modified Compaction For Mahara Soil—1
they had a much larger gravel content (see Table 2(b)) than the other soils.

Kurunegala-Narammala-Madampe Road

In regard to the 61km of Kurunegala-Narammala-Madampe Road, the problems regarding soils for shoulder work did not reach the same proportions as those of the Colombo-Kandy Road, and in fact the problem was confined to the Dummasuriya borrow pit, which, after some use, yielded CBR, PI and LL values of 20, 19 & 5; whereas what was specified were respectively $\geq$ 25, 4-16 (inclusive) and $\leq$ 40, and the solution was no different to that achieved for the Colombo-Kandy Road. Hence no elaboration would be made here. There were quality control problems, however, in other fields, and can be summarised as follows:

Penetration Macadam on Surface Correction

There were difficulties in maintaining an appropriate rate of application of Bitumen, in view of the wedge shaped nature of the surface correction where correction of cross-falls had also to be integrated, and consequently leaving one extremity of the correction as a 'feathering' operation, such as shown in the diagram given below:

```
Max. size 50mm choked with 20mm 2-4% crossfall Feathering

150mm

3.5 litres/m$^2$ 1.5 litres/m$^2$

of Bitumen of Bitumen
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Values of Bitumen coverage varying from 5 litres per m$^2$ to 1.5 litres per m$^2$ were tried, and it was found that, to avoid bleeding, values of 3.5 and 1.5 litres per m$^2$ had to be adopted to the 2 segments shown in the above diagram. The problem of course was how bleeding was to be avoided at the 'feathering' end where there was zero correction. No sacrifying was done.

Double Bitumen Surface Treatment (DBST)

This was applied over the Penetration Macadam work which roughly covered about 20% of the road surface, leaving 80% of the DBST work to be done on the existing surface.

Control of the correct quantitative application of Bitumen became a difficult task in view of several reasons, such as:

a) Fatty spots on the existing road surface due to past extensive patching.

b) Varying amounts of Bituminous coverage on the old surface due to successive years of neglect.

c) Excess Bitumen left in areas where feathering and zero-correction had been done in Surface Correction with Penetration Macadam, as discussed above.

d) Undulations on the road surface causing different behaviour under the roller, and the wheel loads from passing vehicles.

The result was 'bleeding' and, by trial and error, rates of application of 1.3 and 0.7 litres per m$^2$ of Bitumen for DBST 1(14mm Max. size Aggregate) and DBST 2(19mm Max. size Aggregate) were adopted, with reasonable success. Complete success is not possible with DBST when the road to be sealed is one which has suffered years of neglect in the past, and having widely varying surface conditions.

Comments and Conclusions

It is deemed useful to mention in this paper, certain noteworthy aspects that came to light during the construction of the Colombo-Kandy Road. These aspects are presented below with the hope that any thought given to them will help build better and more cost effective
roads in Sri Lanka.

Shoulders on Colombo-Kandy Road

As explained in Section (Shoulder Soils), much effort was made in order to find suitable soils for shoulder construction. All the studies carried out and the energy spent on tackling the problems of earthen shoulder construction would be in vain unless sufficiently satisfactory measures are taken to minimize or prevent easy erosion of the drain edge of the shoulder. Any distress that may now be viewed on the road is purely due to the lack of confinement on the drain edge of the shoulder. However, good a soil is, as a shoulder material, a soil has its inherent limitations, especially when subjected to adverse conditions.

Maintaining Records of Available Rock Quarries and Sources of Borrow Soils

As described in Section (Road Aggregates) of this paper, locating a suitable rock quarry for the project became a tedious task. Extensive searching for a quarry and testing of rock samples required much time and energy. Corresponding delay to the project could have had a considerable effect on the overall cost of the project. Much of this could be avoided if rock quality records were maintained by a central authority for all quarries in use as well as for rock outcrops suitable for quarrying. In the absence of properly maintained records, those responsible for any future major road project between Colombo and Kandy will face the same problems and will inevitably repeat the same 'wild' search for quarries to conform to the Specifications.

Advantages of maintaining such records can be manifold. Apart from saving of time, money, and energy, otherwise wasted in repetitive searches, this will also ensure that resources are used more effectively. That is, better quality aggregate can be used for construction projects such as roads, dams etc., as against projects such as building construction that do not need to meet that stringent specifications.

What was mentioned above for rock quarries applies to sources of borrow soils as well. Records could be of the form of a simple document consisting of a map indicating locations of the source; relevant physical property test values, ownership, and any other information. Little effort on these lines should certainly help build better quality civil engineering structures.

Development of Specifications to Suit Local Conditions

In fact, local conditions could mean many things. With regard to road building many factors such as types of traffic and their frequency, weather conditions, locally available materials of construction etc, need to be taken into account. For instance, if the road is not quite wide, often vehicles tend to travel on shoulders, and if the shoulder is not strongly built, it will begin to give way. Also, Specifications drawn up in foreign countries would invariably have taken into account the prevailing conditions there, such as frost heaving etc. and not necessarily ideal for our roads. For example, studies may show that some of the abundantly available local soils will prove to be satisfactory eventhough they may not quite conform to specifications drawn up in foreign countries. Formulation of specifications to suit local conditions can be a challenging task involving continuous revision and upgrading of conclusions as more and more information is gathered with time.

Economical and Stable Drainage Systems

Experience on the Colombo-Kandy Road as well as inspections of other newly constructed roads close to Colombo indicated the need to pay greater attention in the design and construction of better drainage systems. It is all the more important because the chief cause that affects the integrity of a road, its sub-grade and shoulders, is poor drainage conditions. It is true that insufficient funds may often be the reason why built-up concrete drains cannot be always provided alongside the roads. In many instances, the open earth drains provided on the road were observed to have failed badly, and by the time they are restored, avoidable expenses and damage have indeed taken place.

In these circumstances, a research study to develop best possible open earth drains would be most useful. Turfing can generally be helpful to prevent erosion of soil, although it can create certain other problems (3). When a modern and expensive road pavement is built, it will be hard to justify not providing a good drainage system by attributing it to the lack of funds.
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References


