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REHABILITATION OF ONITSHA-ENUGU DUAL CARRIAGEWAY IN ANAMBRA STATE, NIGERIA: LESSONS LEARNED

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Abstract
The rehabilitation of Onitsha-Enugu dual carriageway in Anambra State, Nigeria, which started in 2009 was marred by inadequate rehabilitation design and gross shortfall in earthwork quantities. The project was awarded at a cost less than 60% of what was actually needed to execute it at the time of award. Delays in the approval of the supplementary bills for the project introduced another (time dependent) variation, i.e. increase in the cost of materials and labour. The fact of the matter was that rehabilitation design and preparation of the bill of engineering measurement and evaluation were done six years before the contract was awarded. Appraisal of the design specifications shows that the adopted pavement cross section was adequate. The design however, considered a greater percentage of the carriageway to be in good condition, whereas pavement evaluation carried out at the commencement of the project showed that many sections of the carriageway had failed completely. In this study, both the technical deficiencies of the rehabilitation design and the managerial problems militating against timely execution of this road rehabilitation project were identified. Various alternative proposals to execute the contract within and outside the original project cost limit were discussed and recommendations were made based on lessons learned.

Keywords: Rehabilitation, carriageway, pavement design, variation, labour, materials, quality control

1.0 Introduction

The Onitsha-Enugu dual carriageway in Nigeria was constructed late 1970s. The dual carriageway is made up of two carriageway widths of 7.3m each, separated by a central median of about 11.00m (average). There are outer road shoulders of 3.00m average width. The central median consists of median drainage, lined with either concrete or grass. There are also central median shoulders of about 4.00m average width serving each of the carriage way widths.

The Onitsha-Enugu carriageway links the traffic that are generated from Lagos, Benin, Onitsha, Awka and the adjoining towns to Enugu, Imo, Abia, Cross River, Akwa-Ibom and Rivers States, and to the Northern Nigerian States. Personnel, goods, services and communication ferried through this road are one of the heaviest in Nigeria. The Anambra section of this carriageway is 52 km long, located between latitude 6^{o} 45' E, longitude 6^{o} 04' N (Onitsha) and latitude 7^{o} 08' E, longitude 6^{0} 15' N (Anambra / Enugu border town of Amansea). It passed through evergreen rain forest vegetation zone with average annual rainfall of about 2000mm and weighted mean annual air temperature of about 27° Celsius.

The existing pavement before the recent rehabilitation program was of asphaltic concrete dual carriageway of standard 7.30m width in each travel direction, bounded by surface dressed shoulders. It was in various conditions of disrepair ranging from sections in critical conditions to completely deteriorated sections.

In 2007, the Federal Government of Nigeria awarded contract for rehabilitation of a section of the road at Onitsha from Km 0+ 00 to Km 3+ 000. Subsequent awards cover from Km 3 + 000 to Km 52+000 (Enugu bound carriageway), from Km 3 + 000 to 52 +000 (Onitsha bound carriageway), grade separated interchange from Km 6 + 750 to Km 7+ 750, provision of drainage and other omitted items on Km 0 + 000 to Km 3 + 000 and reinstatement of washout at Km 6 + 750 on Onitsha bound carriageway and two other washouts on Enugu bound carriageway at Km 30 + 400 and Km 35 + 325, Fig. 1. Thus, five different contracts were awarded on the dual carriageway involving two contractors in the rehabilitation projects as shown in Table 1. This work covers lessons learned in the process of execution of contract no 5929A.

Table 1: Details of contract award on Onitsha-Enugu dual carriageway (Onitsha bound) in Anambra state

Serial no.	Contract number	Contract description	Contractor	Project duration	Commencement date
1	5929A	Rehabilitation of Onitsha bound carriageway of Onitsha- Enugu road in Anambra State (Phase II)	CCC Construction Nig. Ltd	30months	Dec. 2009
2	5929 ADENDUM	Rehabilitation of Km 0+000 to K3+000 Onitsha-Enugu carriageways (Onitsha and Enugu bounds) in Anambra State	CCC Construction Nig. Ltd	50 months	April 2009
3	6134	Provision of omitted items in contract No. 5929 (drainage and chanelization of roads) from Km 0+000 to Km 3+000, Onitsha and Enugu Bounds in Anambra State.	Nigercat Construction Company Ltd	10 months	July, 2012
4	5660 (Part of dualization of Onitsha-Owerri Road and Onitsha Eastern Bypass Section in Anambra State)	Grade Separated Interchange at Km 7+750 - Km 8+750 Onitsha bound carriageway	CCC Construction Nig. Ltd		
5	6124	Reinstatement of washout at Km 6+750 on Onitsha bound carriageway and two others on Enugu bound carriageway, (Km 30 + 400 and Km 35 + 325)	CCC Construction Nig. Ltd	4 months	Nov. 2011

1.1 ***Statement of the problem***

The following observations were made after the site was handed over to the contractor. (a) The road alignment was entirely different from the existing road to be rehabilitated for a substantial length of the carriageway. (b) The quantity of work needed to be executed at site was much more than the provisions made in the bill of engineering measurement and evaluation (BEME), particularly in Bill No. 2 - earthwork quantities.

The contractor, the supervising consultant and the representative of the client adjusted the quantities in the BEME by reducing the work quantities in pavement and surfacing (Bill no 4), while increasing the work quantities in culverts and drains (Bill no. 3) in order to accommodate some of the omitted earth work quantities in the BEME. The provision for contingencies was also adjusted to restore equilibrium between the revised estimated total cost (RETC No. 1) and the original contract value. The omitted items of work which could not be accommodated in RETC No. 1 was compiled and added to RETC No. 1 and re-named RETC No. 2 / AUGMENTATION which was forwarded to the client for approval.

In the process of time [1], RETC No. 1 was approved but RETC No. 2 /augmentation which was about 70% higher than original contract value was kept on abeyance. Incidentally, most of the omitted items in the original contract BEME were earthwork quantities which must be provided before pavement work and surfacing can be started. Prolonged delay in approval of RETC No 2 / AUGMENTATION caused the contractor to slow down the work and after the sixth month of waiting for the approval, he pulled out of the site. At this time the percentage completion of the project was 6.29% and time lapsed was 20%. With pressure, the contractor returned back to site 18 months later, at a time when the completed but unprotected earth works on the carriageway shoulders were partially or completely eroded. At this time, RETC No. 2 / AUGMENTATION proposal was yet to be approved. The contractor's skeletal work was on reconstruction of damaged drainage channels at their own expense.

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1.2 Administrative / technical problems.

Investigations carried out concerning delays in approval of RETC No 2 / AUGMENTATION reveal the following facts. (a) The contract was awarded six years after the design was made. Thus, the road had deteriorated much more than it was when the rehabilitation design was carried out [2]. (b) RETC No. 2/AUGMENTATION amount was much more than the approval limit of the Minister of Works and

so the approval of the bill would have to be given by the National Executive Council, NEC. (c) Cabinet reshuffle in Government brought in a new Minister of Works who was not there when the contract was awarded and who felt reluctant to defend another man's error.

The fact that road alignment was entirely different from the existing road to be rehabilitated for a section of the carriageway suggest that the design consultants did not actually visit the site to appreciate the problems on the carriageway.

1.3 The political problem

Most projects have political linkages; they are usually attracted by political heavy weights whose constituencies interface the project areas. The interference of political juggernauts cannot be wished away. The financing of the projects is usually influenced by the political class. Their influence which could be positive or negative should be understood. The ability to appreciate that what is professionally right might not be politically expedient makes for smooth running of the project [3].

During one of the visits to the site by the Minister in charge of the project, the Minister expressed disappointment with the level of completion of the project and announced to the public that part of the contract (six kilometer stretch) had been awarded to another named contractor for immediate completion. He further directed the Engineers representative to hand over the site for that portion of the contract to the named contractor. The Minister's action generated both positive and negative thoughts in different circles; State and Federal circles. The Minister who must have acted under pressure did not realize that his pronouncement was tantamount to breach of the original contract. May be he also forgot that RETC No 3 proposal which would form the basis for payment to any contractor on the road project had spent a couple of months in his office waiting for approval. Understandably, the Minister's intended action was not backed by professionals in his Ministry and he had to soft pedaled on that decision. Thus, the apparent confusion in the management of the project brought about by the supervising Ministry's directive was timely controlled.

1.4 Variation of prices of labour and materials

The project which started in December 2009 was 8.46% completed at the expiration of the contract period in June 2012. The basic rates, i.e. the basic market prices at the time of award of the contract and at the time of expiration of the contract construction period are shown in Table 2. This table forms the basis for which variation in prices could be claimed by the contractor [2], [4]. However, in view of the complexities and controversies involved in the calculation of variations, [3] recommends that Engineer's Representative of the Ministry and the supervising consultant must have a desk officer at the plant yard to daily record and countersign the fuel supplied to all plants and relevant equipment used every day at site. These equipment's diesel consumption rates must not deviate from the list submitted by the contractor every month.

The quantity of diesel used in the asphalt plant and batching plants can be compared with the established consumption pattern of 12 to 14 litres for the production of one tone of asphalt for new plants or 15 to 17 litres for old plants. Using the area of asphalt laid, it is usually easy to calculate the quantity of diesel used, bearing in mind that one tone of asphalt covers $10m^2$ of 40mm thick. asphalt, [3]. Variation of prize of labour was also calculated using Government approved minimum wage.

2.0 The search for a way forward

As the contract continued to stall, awareness was created by the media and both the Governor of Anambra State where the project is located and the Federal Government of Nigeria funding the project began to show deep concern. Several schools of thought were initiated by the Supervising Ministry of Works to get the contract executed as quickly as possible and at reasonable cost. The proposals that caught the attention of the authors are presented as follows.

2.1 Carry out the contract as awarded

This school of thought was of the opinion that the omitted items in the original BEME should be minimally provided by reduction of work in bill no. 3 (culverts and drains) and bill no. 4 (pavement and surfacing). The intension was to provide drains at selected lengths of the carriageway and by allowing any section of the existing asphaltic binder course that was intact on the carriageway to remain.

Table 2(a) Basic Market Prices of Materials

Materials	Unit	Dec. 2009 Rate on site ($)	Dec. 2012 Rate on site ($)
Cement	tonne	140.63	268.75
Mild steel reinforcement	tonne	593.75	-
High tensile steel	tonne	612.50	1050.00
Metal expansion joints	tonne	493.75	-
Emulsion paint, slow setting	drum	112.50	-
Emulsion paint, medium setting	drum	93.75	-
Emulsion paint, rapid setting	drum	118.75	-
Bitumen, cutback MC1	tonne (bulk)	437.50	-
Bitumen, cutback 125 sec. STV	tonne (bulk)	443.75	-
Bitumen, straight run 60/70 pen	tonne (bulk)	425.00	756.25
Bitumen emulsion, slow setting	tonne (drum)	-	84.38
Bitumen emulsion, medium setting	tonne (drum)	-	70.31
Bitumen emulsion, rapid setting	tonne (drum)	-	89.06
Petrol	litre	0.41	0.61
Diesel	litre	0.50	1.03

Table 2(b) Basic Market Prices of Labour

Government labour category	Category Index	Dec, 2009 Federal Government daily rates of pay in category for a 5 day-40 hours week	Dec. 2012 Federal Government daily rates of pay in category for a 5 day-40 hours week
General labour	A	$1.463	$2.414
Semi-skilled labour	B	&1.465	$2.483
Skilled labour	C	$1.550	$2.514

Table 3 Values of Various Proposals

Contract Value / RETC No. 1 (For 49Km), [Sept. 2009]	Value of RETC No. 2 / Augmentation (For 49 Km), [Dec. 2010]	Value of RETC No. 3 Part 1, from Km 3+000 to Km 32+000 (29Km)	Value of RETC No. 3 Part 2, from Km 32+000 to Km 52+000 (20Km).	Value of NEW RETC No.3 (For 48Km)* [Jan. 2013]
$ 28.838M	$48.944M	$28.838M	$24.775M	$47.650M
		Total Value of RETC No. 3 ; $53.613M [June 2012]		

*The grade separated intersection from CH 7+750 to CH 8+ 750 was not part of this contract but the distance was erroneously included in the other proposals

By this way, savings in culverts and drains, pavement and surfacing, coupled with the provision for contingencies would provide for the omitted items in the original BEME and keep the contract within the original contract value.

This proposal was short lived as it was flawed by the interest of some of the decision makers in the Ministry and Government who apparently come from the geo-political zone of the project location. Technically, this consideration had inherent problems which if not solved then, may linger for the next 30 years or so. Such problems include inadequate drainage facility for the roads, inadequate provision of cross sectional elements of the road project; for example, the existing carriageway has no stone base material. Therefore, building on the existing asphaltic concrete binder course material would not allow for the introduction of adequate materials for sub-base and base course which had outlived their usefulness based on the volume of traffic currently using the facility.

2.2 Re-definition of scope of work

As soon as the first school of thought was debunked, the supervising Ministry of Works directed that the contractor, the supervising consultants and the Ministry's Field Officers should carry out a joint measurement to produce a BEME for the extent of work that can be covered within the original contract value while making provision for the omitted items in RETC no.1. This involved re-defining the scope of the project. At the time of this decision, 80% of the contract construction time had

lapsed. The problem of allowing for the omitted items of work in the original BEME was compounded by variation of prizes of materials and labour shown in Tables 2(a) and 2(b). Putting all these into consideration, the project team obtained a new BEME quantities, RETC 3: parts 1 and 2, and advised that the original contract sum can, at ''today's rate'' complete work on only 29 Km stretch of the carriageway out of 49 Km provided for in the original contract. The team also carried out measurements to determine the cost of completing work on the outstanding 20 Km stretch of the road. The details are shown in Table 3.

The problem with re-defining the scope of the project in order to remain within the ambits of the original contract sum while accommodating the omitted items in the original BEME, results to splitting of the contract into two parts; from Km 3+000 to Km 32+000 and from Km 32+000 to Km 52+000. The total contract sum for this proposal ($53.613M) is 85.91% higher than original contract sum and 12% higher than RETC 2 / AUGMENTATION which the client could not approve earlier on. Thus the second proposal was unacceptable to the client.

2.3 Payment on account

Still in search for the best alternative way to execute the project speedily, the Petroleum Subsidy and Re-investment Commission (SURE-P), a subsidiary arm of the Federal Government directly reporting to Mr. President, invited all the contractors, Federal Controllers of Work and supervising consultants handling the project and all other SURE-P projects to a meeting at Abuja. In that meeting, parties involved were informed that the Presidency had approved the release of some funds for Onitsha bound and Enugu bound projects in Anambra State. This information did not help the matter in any way as the problem was not in the release of funds but in the approval of omitted items of work in the contract BEME. Moreover payments to contractors were based on interim certificate of work executed. Therefore, without approval of the omitted earthwork quantities the contractor cannot be paid for earth works which precedes road pavement and surfacing. Thus the meeting with SURE-P achieved little or no result.

The supervising Ministry in consultation with SURE-P and Bureau for Public Procurement (BPP), agreed that the contractor should continue to work and be 'paid on account' while the Ministry needed more time to sort out the problem of securing approval for the inclusion of omitted items and variation of price (VOP) of materials and labour in the BEME. Payment on account actually implies that all certified work done by the contractor with evidence of supply / procurement receipts should be paid for, provided that the total payment to the contractor was within the project cost limit. This proposal paved a way forward as the contractor returned back to site on the premise that he would continue to work pending the approval of RETC No. 3 which captured the omitted items and VOP in the BEME, or stop work as soon as the total value of interim certificates reaches the contract sum.

2.4 The think tank solution

Still worried about the high value of the revised contract sum RETC No. 3, and the continued delay in execution of the contract, the supervising Ministry sent out a high powered team of Engineers made up of Directors and Deputy Directors in the Ministry, for site inspection of the project. At the end of their site meeting they directed the Ministry's Field Headquarter in Anambra state, the Consultants and the Contractor handling the project to jointly carry out a thorough assessment of the project with a view to produce a more realistic BEME based on their joint site inspection and condition survey observations. The result of that exercise was the provision of revised bill of engineering measurement and evaluation, New RETC No. 3 shown in Table 2, and working drawings which were forwarded to the Minister for approval.

3.0 Analysis of various proposals

3.1 RETC No. 1 proposal

At the time of the contract award, the project involved the rehabilitation of 49Km section of Onitsha bound carriageway of Onitsha- Enugu road in Anambra State. The carriageway width was 14.6m with adjoining inner and outer shoulders. The scope of work included the execution of the following works.

(1) Scarification of the failed sections of the road to receive additional fill.
(2) Provision of additional fill material to attain formation level
(3) Construction and extension of culverts including provision of concrete kerbs
(4) Provision of lateritic material 200mm thick as sub-base.
(5) Provision of wet mix crushed rock base 200mm thick
(6) Provision of 60mm thick asphaltic concrete binder course
(7) Provision of 40mm thick asphaltic concrete wearing course
(8) Construction of concrete lined drains

(9) Provision of road signs, road markings and kilometer posts.

Investigations show that the BEME on which RETC No.1 used for the award of the contract, was prepared based on the design carried out six years before the contract was awarded. Obviously the condition of the road at the time of the rehabilitation design would not be the same six years later, at contract award. If a review of the 'present' condition of the carriageway was made at the time of the contract award, the BEME quantities would have reflected a modification of RETC 1, capturing all items of work needed to be done. Hence the project would not have ran into difficulties in the process of its execution.

Suffice it to say that at the end of the project duration time only 8.46% of the permanent work was executed. The delay being mainly due to inadequate bill of engineering measurement and evaluation used to obtain RETC No.1 for the contract award.

3.2 RETC No. 2 / augmentation proposal

In terms of scope of work, the original contract work was expanded to include the provision of the following.

(a) Excavation and earthwork quantities omitted in RETC No. 1. (b) Additional site clearance and earthwork quantities for additional 15Km service lane within Onitsha and Awka towns (c) Crushed stone base to be extended to cover the carriageway shoulders in the towns (Awka and (Onitsha), a total of 15Km stretch in addition to the carriageway width. (d) Other new provisions include New Jersey type reinforced concrete barriers, concrete cover slabs at selected locations. Thus, RETC No.2 / augmentation proposal did not only address the shortfall in BEME quantities of RETC No.1 but also took care of the introduction of a new 10Km service lane at Onitsha and 5Km service lane at Awka towns. These additional service lanes at Awka and Onitsha were not in the original design but were considered necessary for free flow of traffic in urban areas.

3.3 RETC No. 3: part 1 and part 2 proposal

The intention of this proposal was to break the contract into two so that the original contract sum for 49 Km stretch of the carriageway may be used to execute only 29 Km stretch of the carriageway at "today's rate" , while the remainder of the work (20 Km stretch) could be considered probably as a new contract. The total job content was the same for RETC No. 2 / Augmentation proposal. The total cost of the two parts to the proposal was however higher than that of RETC No. 2 / augmentation.

3.4 New RETC No.3 proposal

This proposal involved the rehabilitation of 48Km (not 49Km) stretch of the Onitsha bound Carriageway of Onitsha-Enugu expressway. The grade separated intersection at Chainage CH 7+750 to CH 8+ 750 (see Fig.1), which was erroneously included in the job contents of the other proposals was expunged from this proposal. Moreover 27.0Km of the existing road was considered to be in a fair condition requiring minor repairs and overlay while the remaining 21.0Km stretch of the road required total reconstruction. Provision for street lighting at Onitsha and Awka towns was included as well as for drainage structures including an offshoot drain to discharge water at CH 12 + 500. The provision of additional lane (15 Km in RETC No. 3) was limited to 10 Km in this proposal.

Even though this proposal was intended to be financially more frugal than RETC No.3, the consideration of 27 Km stretch of the road being in fair condition and requiring minor repairs and overlay, remained a contentious issue among the engineers.

4.0 Appraisal of design specifications

4.1 Pavement evaluation report

Visual inspection of the carriageway before rehabilitation showed that many sections of the carriageway had failed completely. Many sections of the shoulders, the median and the side slopes were eroded, thereby becoming a threat to the highway pavement. Complete rehabilitation was required in such sections. Only very few short sections were found to be in fair condition. Therefore the entire carriageway should be treated as in critical-to- poor condition, Federal Ministry of Works report [5].

Common distress and failure types observed on the highway pavement were wide cracks, potholes, erosion gullies and erosion threat to the carriageway and shoulders. Drainage was not adequate in most sections of the highway. Many existing lined drains were blocked: stagnant water was observed in some locations. Very little drainage system was installed to intercept lateral surface flow from higher ground level on the sides onto the carriageway shoulders. Again, many sections of the shoulders and median were eroded [5].These were expected to be addressed by the rehabilitation design.

4.2 Geotechnical investigation

Investigation of the geotechnical properties of the materials in service in the highway pavement and the road base was carried out by the Federal Ministry of Works, Pavement Evaluation Unit prior to rehabilitation design. Test pits were opened at

selected failed and sound sections along the carriageway. Asphaltic concrete base course and sub-base thickness measurements were carried out and samples of the in-service materials were collected and tested in the laboratory. Samples of subgrade / fill materials were also collected to depths of about 1.0m using hand auger. The following tests were carried out on the material samples. (a) **Asphaltic Concrete**: i) thickness, ii) bulk density, iii) maximum specific gravity, iv) extraction, (b) **Soils**: i) moisture content, ii) compaction test, iii) particle size analysis, iv) Atterberg limits, v) CBR.

By comparing the results of the tests with FMW General Specification [6], the Pavement Evaluation Unit made the following conclusions

1. Asphaltic concrete of good – to - poor quality was used. 2. Good quality stone base material was used at earlier repaired sections while the soil- cement base was weak and cracked. 3. Fine and plastic base soil were encountered in few locations. 4. Generally the subgrade layer was either too fine or too fine and plastic in many locations. 5. Failure on this highway pavement was due to poor drainage. The drains were silted due to lack of maintenance and this resulted in the percolation of water into the lower pavement layers and fine/ plastic road bed.

4.3 Adequacy of the pavement Cross Section

To determine the adequacy of the proposed rehabilitation pavement thickness of the highway, the Pavement Evaluation Unit (PEU) carried out pavement structural design using an estimated projected standard axle and subgrade CBR values obtained during the geotechnical investigation. Pavement structural design method adopted was TRL Overseas Road Note 31 [7]. Twenty years design life was adopted with a projected total standard axle of 1,980,000. The adopted cross section of the carriageway consists of ; 100mm asphaltic concrete (binder and wearing course), 200mm stone base (new stone base), 200mm pulverized layer (existing surface plus existing base), 150mm laterite sub-base (existing sub-base) .

This design was aimed at confirming or otherwise, what the design consultants provided for, six years earlier. The pavement cross sectional elements obtained by PEU was in tandem with the design consultants specifications.

5.0 Quality control measures

Asphalt concrete is the primary material being used for highway surfacing in Nigeria. Either as a wearing course or as a binder course, it forms the final layer in a flexible pavement structure. Being what is generally seen by the public, and used to judge the road performance, proper monitoring is very essential. It is therefore necessary that strict control be maintained in testing of materials throughout the period of production, laying, and compaction. The Federal Ministry of Work's specification [6] for materials used for subgrade/fill, sub-base, lateritic base course, stone base and asphaltic concrete is a good guide. The problem lies in enforcement of these specifications. To ensure that these technical standards are strictly adhered to, continuous monitoring of the construction process is essential. Because it may not be possible for the supervising engineers to witness all quality control tests right from the point of sample collection to the actual testing, checks and balances should be put in place to ensure that the quality and results of the tests conducted are acceptable and that the tests are carried out in laboratories of proven integrity.

The current practice by which the contractor carries out quality control tests most often not witnessed by the supervising engineers should be discontinued forth with. The supervising consultant must insist on witnessing all quality control tests especially on bituminous materials both at the batching yard and on site. In doing so, the following deficiencies must be watched out for in bitumen mixtures, [8].

Too hot asphalt: Blue smoke rising from the mix in the tipper or in the pavers hopper usually indicates an overheated batch. The material should be rejected if the temperature exceeds the maximum allowed in the specification.

***Too cold asphalt*:** A generally stiff appearance, or improper coating of the large particles, indicates a cold mixture which should be returned back to the batching plant.

***Too much bitumen*:** Excess bitumen may be detected under the pavers by a slick and greasy appearance.

***Too little bitumen*:** A mix containing too little bitumen generally can be detected by its lean, granular appearance, improper coating of the aggregate and lack of the typical glossy black luster. On the road it can be detected by its lean, brown dull appearance on the surface and by unsatisfactory compaction under the roller.

Segregation: Segregation of the aggregates in the mix may occur because of improper handling and results in non-uniform distribution of the materials in the pavement. This can lead to a patching

appearance as well as early structural distress, and any such material already laid should be rejected and removed.

5.1 Use of bitumen emulsion for prime coat, tack coat and surface dressing

With effect from January 2012 the use of cut back bitumen in all Federal roads in Nigeria was phased out and all the stake holders in the execution of Federal road projects were directed to enforce the use of bitumen emulsion in the Ministry's road projects. The reason for this decision was based on the research carried out by the Materials and Geotechnical and Quality Control Department of the Federal Ministry of Works. Accordingly, bitumen emulsion is to form part of the bill item in all road projects. For all on-going projects, the directive stated, the contractor is to use bitumen emulsion as prime coat, as tack coat and in surface dressing.

The enforcement of this directive particularly on Onitsha bound carriageway of Onitsha-Enugu carriageway is not yet 100% achieved. Even though the cost of bitumen emulsion is generally lower than the cost of cut back bitumen the contractors were reluctant to use bitumen emulsion which must be supplied to them by manufacturing companies, whereas they can produce cut back bitumen from the bitumen they stocked for the asphalt plant.

To understand the reason for the phasing out of cut back bitumen in the country, it is necessary to go back to the antecedents. Before the ban on importation of bitumen into the country, road construction industry depended on the use of foreign bitumen, grades MCO, MC1 and S125. These imported grades of bitumen were of very high quality that when they were mixed with kerosene to produce cut back bitumen, the result was of acceptable standard. Experience has shown that the MCO, MC1 and S125 grades of bitumen produced in this country are not as good as the imported ones. When they were used in the production of cut back bitumen the result was also not satisfactory. More over, unscrupulous contractors would always over dilute the cut back bitumen with kerosene so that the binding property of the cut back bitumen was lost.

Recently, the Federal Government of Nigeria realized that scarcity of kerosene can be minimized if the bulk supply to the construction industries can be avoided. It was also realized that water dispersed bitumen in the form of bitumen emulsion, performs satisfactorily on the roads and is more environmental friendly than cut back bitumen.

For these reasons, the Federal Government directed that bitumen emulsion should now be used in all Federal Government road projects in Nigeria.

6. Contractor's matter

The first permanent work undertaken by a contractor on any new road project is clearing of site within the limits of construction. For road rehabilitation projects like Onitsha-Enugu carriageway, site clearing may include scarification of existing bituminous surface on shoulders, shaping and compacting to receive additional fill. A few months after the contractor took over the site, this item of work was completed 100% and also paid for in the 2nd interim certificate. The job was however not protected when the project ran into a hitch months later, forcing the contractor to abandon the site for 18 months. When the contractor returned back to the site the condition of the road was worse than the way it was when the project started.

Even though it was the responsibility of the contractor to make good all jobs paid for but not protected, level of erosion devastation and the attendant discomfort to the motorists when such abandonment of site occurs is unimaginable. In this particular road project the road shoulders on the entire 48Km stretch were cleared, filled with additional materials, compacted and left like that. More than 90% of the length of the road remained under that condition for more than three years.

In order to put an end to this kind of problem, the authors suggest that interim payment certificates be raised for only completed part of the road project. This means that earth work quantities can be paid for only when they have bituminous overlay on them. This way, the contractor will concentrate on a selected section of the road project, making sure that bituminous overlay is achieved before moving to another section of the road project. It requires that the contractor should use any payment made to him to complete a section of the road project before embarking on another section. Payment for concrete works (Bill no.4) is not limited by this earth work protection requirement.

7. Conclusions and recommendations

The rehabilitation of Onitsha-Enugu dual carriageway in Anambra State, Nigeria was 8.46% completed when the project construction time elapsed. The delay was mainly due to non-approval of the omitted quantities in the bill of engineering measurement and evaluation, which total estimate increased the cost of the project by 96%. For a period in excess of construction time of the project, computations and re-computations were made to reduce the cost of the omitted quantities in the BEME. While this was going on, variation of prices of material and labour, VOP, caught up with the

project and the savings from a refined computation of BEME was swallowed up by VOP.

The lessons learned can be summarized as follows.

(a) Improper rehabilitation design and poor evaluation of the scope of work to be done were the contributory factors for the delays in completion of the rehabilitation project.

(b) Rehabilitation design and computation of the bill of engineering measurement and evaluation were carried out six years prior to the contract award without a review of the state of the road at the time of award.

(c) Delays in the approval of the supplementary bill for the omitted items of work forced the contractor to abandon the site for more than 50% of the contract construction period, and at a time when most of the permanent work already executed and paid for were yet to be protected.

(d) Variation of the prices of materials and labour caught up with the project to the extent that the revised estimated total contract sum was about 96% higher than the original RETC sum used for the award of the contract.

(e) In situations where the BEME becomes inadequate for execution of the project such that augmentation bill would be required, the method of "payment on account" presented in this report can be used to honour interim statements, pending the approval of the augmentation bill, so that the contractor could work progressively to deliver within the contract time schedule.

(f) Interim payment certificates should be raised for only completed (protected) part of the road project so that if situation arises such that the contractor pulls out of the site, the problem of erosion and degradation of the carriageway by vehicular traffic will be minimal.

(g) The use of bitumen emulsion for prime coat, tack coat and surface dressing in place of cut back bitumen should be enshrined in the engineering specifications for roads in Nigeria.

(h) Strict control should be maintained in testing of asphaltic concrete materials throughout the period of production, laying and compaction, and continuous monitoring of the construction process is essential for quality control. The supervising engineers should put checks and balances in place to ensure that the quality and results of the tests conducted are correct and that the tests are carried out in laboratories of proven integrity.

Geotechnical aspect of the rehabilitation project forms the main thrust of the continuation of this work.

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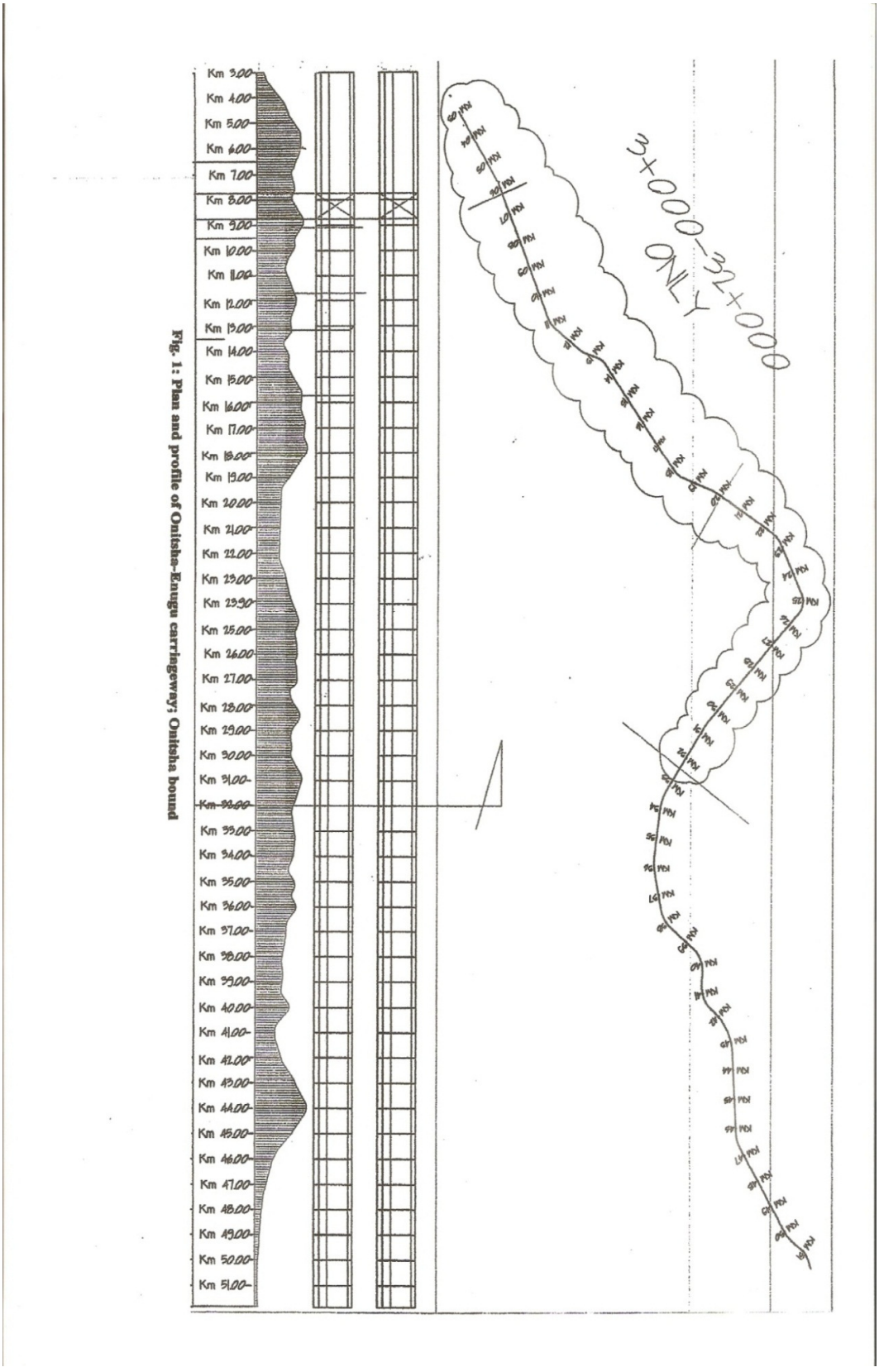

Fig. 1: Plan and profile of Onitsha-Enugu carriageway; Onitsha bound

Figure 1: Plan and profile of Enugu-Onitsha dual carriagway: Onitsha bound