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CONSTRUCTION OF UBUNGO INTERCHANGE - AN OVERVIEW OF TECHNICAL ASPECTS OF ITS IMPLEMENTATION

Improving the Passability and Sustainability of Rural Roads

Julius Nyerere Hydropower Project To Spur Social Economic Development

HUPATIKANA KWENYE
MIFUKO YA 50KG, MIFUKO TANI 1.5, BULK

- Majengo Makubwa
- Zege la Ubora wa hali ya juu
- Kujenga Mabwawa na Madaraja

- Kutengeneza Matofali
- Majengo Makubwa
- Kujenga Mabwawa na Madaraja

- Ujenzi wa Nyumba
- Kutengeneza Matofali

- Utengenezaji wa Barabara
- Kuboresha Udongo

- Kupiga Lipu
- Kuweka Marumaru (tiles)

twiga cement

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COVER FEATURE

Construction of Ubungo Interchange – An overview of Technical Aspects of its Implementation

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A FOREWORD FROM CEO

On behalf of staff of the National Construction Council (NCC) I would like to profoundly thank you for reading this Journal. Our aim is to use this Journal to inform you what is happening in the construction industry particularly here in Tanzania. We will use a spectrum of ways to achieve this. To start with, the Journal will cover research reports, practitioner experiences, feature industry best practices or even challenges of the single time construction industry stakeholder.

In the above spirit, the Construction Business Journal is conceived to provide prime opportunity for stakeholders of the construction industry to share their research work, work experiences, best practices, and technical details of key projects being implemented in the country. It also allows featuring of emerging materials or technologies in the construction industry.

I am delighted to use this opportunity to also introduce you, our esteemed readers, to the range of services that the National Construction Council (NCC) offers. Firstly, I want to remind you that NCC has been around providing these services since 1982, it therefore has extensive experience with the industry. Indeed it has grown with the industry and has been instrumental to most of the industry growth and developments.

In the 37 years of its existence, NCC has provided technical assistance and general advisory services to a spectrum of stakeholders and in a range of areas in the construction industry. The most prominent mark of the NCC is the various trainings offered to build capacity of the various construction industry practitioners. The trainings were also associated with development of various technical guidelines and tender documents.

Other prominent services offered by NCC include: coordination of dispute resolution; providing technical and value for money audits of construction projects, research in construction and project management; Library services, and advisory services in construction contract management and administration.

I would like to request you to send us your comments on any improvements we could do to the Journal and other services of the NCC. Once again thank you for being one of the readers of the Journal.

Dr. Matiko Samson Mturi
Chief Executive Officer

mara
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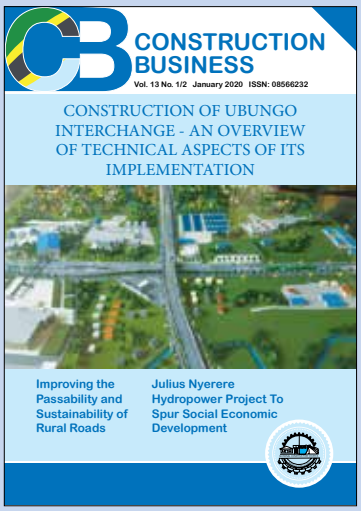

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EDITORIAL

USING THE ONGOING INFRASTRUCTURE PROJECTS FOR SKILLS ENHANCEMENT OF CONSTRUCTION INDUSTRY PROFESSIONALS

The economy of any nation and indeed the livelihood of its people depend largely on the level of development and efficiency of operation of socio-economic infrastructure in that nation. Similarly, the level of service of infrastructure is largely influenced by the quality of construction, level of maintenance and efficiency of their operation. The delivery of quality infrastructure requires professionals in the construction industry (CI) to have the required qualification, attained through adequate training and practical experience.

In recognition of the importance of continuous professional development, professional institutions in collaboration with regulatory bodies in the construction industry have continued to offer training programs to individuals involved in the construction sector. Most professionals involved in implementation of public infrastructures have benefited from these programs. Despite these efforts, the skills gap in the construction industry is still huge. This Editorial urges construction industry professionals themselves and the Private Sector to complement these efforts by funding training programs so that many more professionals have opportunity to gain the required competence to implement expected infrastructure projects in our Country, and in the economic blocks that Tanzania is a member (i.e. EAC and SADC). More so now when Tanzania is implementing many infrastructure development projects in the Country.

The major projects under construction countrywide include water supply, standard gauge railway lines, Julius Nyerere hydro-power project, international and regional airports, sea and lake ports and roads and bridges. These projects provide the golden opportunity for local professionals to advance their technical and managerial knowledge, skills and experience. Therefore, we would urge individuals, institutions, and companies alike to exploit this opportunity effectively. There is a great potential of enhancing skills and competences for Engineers, Architects, Quantity Surveyors, Land Surveyors, Technologists, Technicians and Artisans through the ongoing construction projects considering that each project present unique challenges.

In this way CI professionals will have the capacity they need to deliver infrastructure projects to the satisfaction of their clients and the public at large. Concurrently they will increase their chance of continuously advancing their capacity for even larger and complex projects envisaged in Vision 2025 and beyond. We need to understand that lifelong learning is an indispensable tool for every career. As such, acquiring new skills, discovering and learning new ways of delivering quality infrastructure projects will avoid stagnation in reaching our full potential. Hence we are encouraged to come out in good numbers whenever training programs or construction site visits are announced by the professional bodies. We could also take individual initiatives by setting aside dedicated time and funds for actively learning new skills through employment with contractors or consultants in new projects, or seeking temporary attachment to new projects, sharing knowledge regarding new skills, innovations etc. and through writing professional papers and participating in training others▪

NCC Publications

IMPROVING THE PASSABILITY AND SUSTAINABILITY OF RURAL ROADS THROUGH THE USE OF LOCALLY AVAILABLE MATERIALS AND TECHNOLOGICAL INNOVATIONS INITIAL RESULTS FROM TRIAL SECTIONS CONSTRUCTED IN TANZANIA

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Abstract

The Government of Tanzania is committed to the improvement of the rural roads network in order to catalyze socio-economic development in rural areas. Tanzania has approximately 108,000 kilometers of roads under the direct supervision of the President's Office – Regional Administration and Local Government (PO-RALG), of which 43 percent are in poor condition and 57 percent in a fair to good condition. Research and other studies conducted in the past have shown that, in order to reach the national goals, there is a need to improve rural roads by ensuring their passability throughout the year, as well as to improve their long-term sustainability, especially in view of the scarcity of good quality road construction materials.

Various research projects have been undertaken to identify solutions for improving the passability and sustainability of rural roads through the use of locally available materials and technological innovations. The United Republic of Tanzania with assistance from UKAid – Funded research for Africa Community Access Partnership (AFCAP) constructed two demonstration sites incorporating best practices as well as new innovations to demonstrate the concepts of Environmentally Optimized Design (EOD) and Spot Improvement (SI) design methodologies with the purpose of advancing new concepts that will enable the national goals for the improvement of rural roads to be achieved. The demonstration sites are located on the Bango to Talawanda road in the Bagamoyo District (about 20.3 km) and on the Lawate to Kibongoto road in the Siha District (about 13 kms).

The roads were designed using the DCP–DN method. Two groups of surfacing options were identified and used throughout the project. The first group comprises bituminous surfacing options, such as Otta seals with sand cover seal, slurry seals, double sand seals, double surface dressings and bituminous penetration macadam. The second group comprises non-bituminous surfacing solutions, such as concrete strips, concrete geocells, hand packed stone, concrete paving blocks, as well as unreinforced and lightly reinforced concrete.

Baseline monitoring data were collected for comparison with data collected in subsequent monitoring periods in order to assess the performance and suitability of the various surfacing option for low-volume rural roads. The following monitoring methods were used: visual inspections; photographic logging; measurements of surface profile, surface rutting, surface roughness and surface texture; DCP testing; traffic counts; and GPS survey.

The initial results have shown substantial improvements to the condition of the road and the provision of access when compared to the situation prior to the construction of the demonstration

sections. The improvements have also resulted in the more appropriate use of locally available materials and a reduction in maintenance costs.

The paper addresses the construction and performance monitoring of the demonstration sites, and provides interim recommendations on the applicability of the surfacing types applied on the two demonstration sites.

Key words: *Environmental optimized design, DCP- DN design method, passability and sustainability of rural roads, innovation in technology and performance monitoring*

1.0 INTRODUCTION

It is estimated that about 70% of Tanzanians lives in rural areas, whereby the majority of them are poor[1]. Investment in physical and social infrastructure is recognized as an important driver for achieving a sustainable economy and a reduction in rural poverty[2]. National Vision 2025 highlights the importance of improving rural roads infrastructure to promote rural development in Tanzania while promoting the use of science and technology to overcome national barriers[3]. National Strategy for Growth and Reduction of Poverty (MKUKUTA) also placed high priority on the improvement of rural roads to reduce poverty in Tanzania[4]. It is important for Tanzania to ensure development and improvement of socio – economy activities in rural areas is achieved by applying science and technology through the proof of evidences from research work. DFID is one of the development partner of Tanzania and is promoting research activities in the country through Africa Community Access Partnership (AFCAP) whereby scientific research evidences are used for both improvement of rural roads and are up taken for policy, regulations or procedures change.

Among the ongoing research activities in Tanzania there are two demonstration sites having various trial section using different surfacing technologies depending on the environmental factors such as existing terrain, sub-grade conditions, climate, natural gradient, availability of local construction materials, construction capacity, traffic volume and other factors[5]. Some of these factors vary from road to road and even from site to site along a road. Therefore road design varied along the length of the road with sealed concrete or concrete strips up a hill and gravel along a level section.

These sites in Tanzania demonstrated the use of both Environmentally Optimised Design approach and newly formulated DCP – DN design method with focus on reducing cost and attaining longer pavement services that are passable through a year while keeping existing requirements of Tanzanian Pavement and Material Design standards and specifications.

These trial sections aim to promote low cost, sustainable solution, produce research evidence that will help the nation to enhance science and technology to improve rural roads passability and sustainability.

Initial results from trial sections of our demonstration sites have made a major breakthrough in the improvement of rural roads history in Tanzania. The national rolls out of these technologies and major improvements have been noted countrywide in the passability and sustainability of rural roads through Improving Rural Access in Tanzania (IRAT) projects[6] and some Road Fund money.

2.0 METHODOLOGY

Construction and design of trial sections were done by following existing roads standards and specifications available in Tanzania with innovation in the use of DCP – DN method which is not incorporated in the existing design manuals of Tanzania. Bango – Talawanda road section (20.3 km) was completed in April, 2011 while Lawate – Kibongoto road section (13.5 km) was completed in September 2012.

Collection of base line data and introduction of monitoring beacons were done immediately after end of the construction work. Monitoring beacons were constructed at regular interval depending on the length of trial section; it is an interval of 20 meters for long stretch of section (200 – 300 metres) and 10 meters for

short stretch of sections (100 – 150 metres). Monitoring was done after every six months from the completion of the road construction.

The following monitoring methods were used:

1. Visual inspections done as per THM9 and THM19 standard visual assessment manual.
2. Photographic logging;
3. Surface profile measurement between beacons;
4. Surface rut measurement using a standard straight edge;
5. Surface roughness using a MERLIN apparatus;
6. Surface texture measurement using sand patch testing;
7. Dynamic Cone Penetrometer (DCP) testing;
8. Classified traffic counts; and
9. GPS survey.

From those methods we had enough data to comcision as there was a need to identify areas where deterioration was a function of the basic type of pavement being evaluated (every surfacing option has its limitation and life span) and where the type of deterioration results from basic engineering inadequacy such as poor drainage.

3.0 INITIAL RESULTS

Below is monitoring results of 18 months done at an interval of 6 months for each trial section from our two demonstration sites. The results are shown below based on two sites of Bagamoyo and Siha.

3.1 Bagamoyo site (20.3 km)

The following tables show demonstration site for trial sections of 8 different surfacing options for Bagamoyo site.

Table1: Rut Depth

Surface Type	Average Rut Depth (mm)			
	Base Line	6 months	12 months	18 months
Single Otta seal with Sand Seal	1.48	2.13	1.26	5.61
Double surface Dressing	1.80	2.28	1.74	5.96
Double sand seal	2.58	2.88	2.48	7.10
Slurry seal	1.83	2.74	2.74	7.00

Table 2: Texture Depth

Surface Type	Surface Texture Depth (mm)			
	Base Line	6 months	12 months	18 months
Single Otta seal with Sand Seal	0.63		0.66	0.224
Double surface Dressing	2.23		1.96	1.372
Double sand seal	0.49		0.62	0.264
Slurry seal	0.81		0.89	1.238

Table 3: Roughness Index (IRI)

Surface Type	IRI (m/km)			
	Base Line	6 months	12 months	18 months
Single Otta seal with Sand Seal	4.2	4.1	4.4	4.8
Double surface Dressing	6.0	6.2	5.9	6.7
Double sand seal	5.2	4.6	5.3	7.1
Slurry seal	5.6	5.8	5.7	6.9
Hand Packed Stones	9.7	9.8	N/A	13.4
Concrete strips 1	5.5	5.3	5.0	6.1
Concrete Geocells	7.3	N/A	7.9	7.9
Gravel Wearing Course 1	5.9	6.245	6.4	6.7
Concrete strips 2	5.7	5.7	5.9	6.9
Concrete strip 3	5.6	5.5	5.9	7.1
Concrete strip 4	6.5	6.5	6.7	6.9
Gravel Wearing Course 2	6.6	6.8	70	11.9

Table 4: Soil strength (DCP)

Type of Material	4 Days Soaked CBR (BS 95% Heavy)	PI	OMC	April , 2012		Sept, 2012		April, 2013	
				DN mm /blow	CRB %	DN mm/ blow	CBR %	DN mm/ blow	CBR %
Red Quartzite Gravel BP2	20	26	6.8	6.87	39	7.11	38	4.75	57
Marly Limestone BP 3	25	14	8.5	4.49	62	3.62	78	4.53	60
Marly Limestone BP 4	46	14	11.5	4.45	62	4.41	63	4.77	56

Table 5: Traffic count

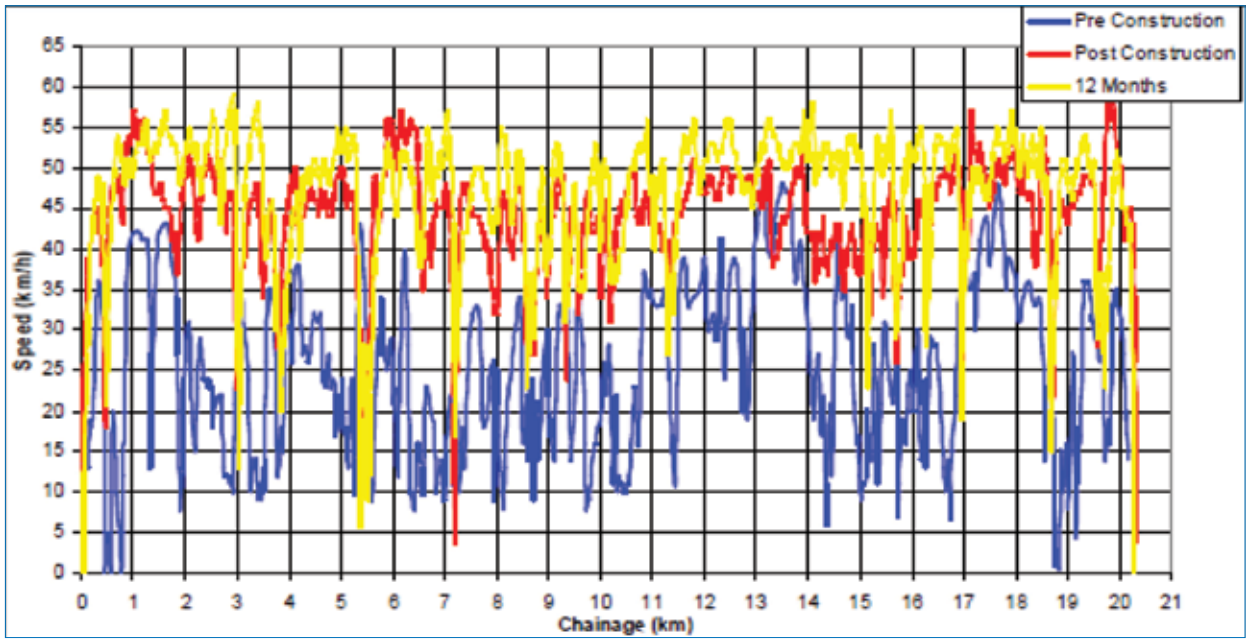
Traffic count data at station 1 (Bango village, 0 + 640)								
Date	Classification							
	Pedestrian	Bicycle	Motorcycle	Saloon car	Pick up 4WD	2-axle truck/bus	3-axle truck	Total
Sep. 2010	408	356	238	2	9	12	0	1025
Aug. 2011	180	282	226	5	15	0	0	708
April. 2012	417	423	441	32	14	19	0	1351
Sept. 2012	926	491	576	14	15	19	0	2039
April. 2013	335	188	337	11	11	14	0	896

Traffic count data at station 2 (Lundiga village, 11 + 040)								
Date	Classification							
	Pedestrian	Bicycle	Motorcycle	Saloon car	Pick up 4WD	2-axle truck/bus	3-axle truck	Total
Sep. 2010	212	197	44	1	5	0	0	460
Aug. 2011	172	211	159	2	5	0	0	549
April. 2012	328	228	235	14	16	14	0	835
Sept. 2012	628	293	247	2	5	2	0	1179
April. 2013	459	193	243	7	10	5	1	918

GPS survey

The following figure shows image of drive through GPS for Bagamoyo site

Figure 1: Image of drive through GPS



3.2 Siha Site (13.5 km)

The following tables show demonstration site for trial sections of 7 different surfacing options for Siha site.

Table 6: Rut Depth in mm

Surface Type	Average Rut Depth (mm)	
	Base Line	6 months
Double Surface Dressing	4.29	6.18
Bituminous Penetration Macadam	9.10	11.34

Table 7: Texture Depth in mm

Section	Surface Type	Average Rut Depth (mm)	
		Base Line	6 months
7	Double Surface Dressing	1.24	0.87
16	Bituminous Penetration Macadam.	2.86	2.44

Table 8: Soil strength (DCP)

Material	4 Day Soaked CBR (BS 100% Heavy)	MDD (kg/ m3)	OMC	Base Line, Jan 2013		April 2013	
				DN mm/ blow	CBR %	DN mm/ blow	CBR %
Brown Clay CL4	19	2043	6.8	3.33	89	7.35	33
Dark Reddish Clay CL3	20	1961	7.8	4.47	61	5.48	47
Light Brown Clay	8	1647	23.4	3.93	72	3.93	72

Table 9: Traffic Count Lawate village 2+580

Date	Classfication							Total
	Pedestrian	Bicycle	Motorcycle	Saloon Car	Pick up/4WD	2-axle truck/bus	3-axle truck	
Baseline	308	5	201	11	21	1	4	551
April 2013	395	7	160	3	18	1	0	584

Table 10: Traffic Count Kibongoto village 12+640

Date	Classfication							Total
	Pedestrian	Bicycle	Motorcycle	Saloon Car	Pick up/4WD	2-axle truck/bus	3-axle truck	
Baseline	259	13	111	22	1	0	4	410
April 2013	320	15	132	7	17	0	0	491

Table 11: Roughness Index (m/km)

section	Surface Type	Baseline January, 2013	April 2013
1	Concrete paving Blocks	5.30	6.29
2	Unreinforced Concrete slab (100mm)	10.80	12.37
3	Flexible Geocells (75mm)	10.00	11.24
4	Unreinforced Concrete slab (75mm)	9.90	11.94
5	Gravel Wearing Course	6.39	6.57
6	Concrete Strips	8.13	8.27
7	Double Surface Dressing	4.19	5.30
8	Concrete strips	7.68	9.97
9	Unreinforced Concrete slab (100mm)	9.79	10.39
10	Concrete strips	7.24	9.26
11	Unreinforced Concrete slab (100mm)	9.18	10.48
12	Concrete Strips	7.60	8.98
13	Unreinforced Concrete slab (75mm)	9.08	10.39
14	Concrete Strips	7.80	9.45
15	Concrete Strips	8.49	9.78
16	Bituminous Penetration Macadam	6.34	8.51
17	Lightly Reinforced Concrete Slab (100mm)	10.03	12.13
18	Lightly Reinforced Concrete Slab (75mm)	10.68	12.74
19	Lightly Reinforced Concrete Slab (100mm)	10.03	11.66
20	Gravel Wearing Course	6.55	8.98

4.0 DISCUSSION OF THE RESULTS

(a) Visual inspection and photographic logging

Various mode of surface distress and deformation were located and recorded, photograph provided a visual record of deterioration identified in visual inspection. Concrete slabs in Siha site have shown longitudinal and transverse cracks, minor depression at localized areas and gravel wearing course has shown erosion at the centre of the road.

(b) Surface profile measurement

Surface profile measurement was done at every beacon to compare surface profiles and collected data. Most of surface profiles matched with collected data except for hand packed stone section, large changes were noted and may be due to depression and erosion evident along the section.

Surface profiles to some sections in Bagamoyo were found to be higher than the level taken at baseline stage. It is thought to be caused by human error or movement of beacons due to various factors.

(c) Surface roughness

Surface roughness measurement results happened as was expected that there will be a slightly increase in IRI value for most of the demonstration section between baseline and other surveys except for hand packed stones and gravel. Hand packed stones recorded the roughest surfacing option having the highest number of IRI (13.4m/km) and is thought to be due to nature of construction followed by gravel wearing course (11.9 m/km) and is thought to be mainly caused by wash away that caused large pieces of aggregates to be visible protruding through the surface.

Otta seal surfacing option has given the smooth finish among all sections with IRI = 4.8m/km.

At Siha site the IRI value for concrete slabs are high because was made rough to provide skid resistance on the steep downhill sections.

(d) Surface texture

In month 12 there is slightly decrease on Double Surface dressing surfacing option while other options shows slightly increase on surface texture on Otta Seal, Double Sand seal and Slurry seal. This increase in surface texture depth may suggest that surface have become slightly rougher.

(e) Dynamic cone penetrometer

Dynamic Cone Penetrometer (DCP) test was carried out to explore the perceived self cementing properties of the Marly Limestone used in the construction in Bagamoyo. The obtained data confirmed the theory though a decrease in CBR is noted in April due to heavy rain (high moisture content in soil) but in general there is increase in strength as compared to baseline data.

(f) Traffic count

There is small decrease in traffic during construction period but there is increase after construction. The number of Pedestrian is higher in August and September as compared to April while number of Saloon cars, Pick up vehicles and 2- axle busses/trucks increases in April as compared to August and September. This suggests that mode of transport changes depending on climatic condition (Dry or Rain Season). September and August are dry season while April is a rainy season.

(g) GPS

GPS drive through data was taken before construction, after completion of construction and 12 months after construction. An average speed of 20 km/h was observed before construction and the average speed increased to 45 km/h after completion of construction. There was a slightly increase in speed 12 months after construction. Slightly increase in speed after 12 months is thought to be caused by driver's experience after using the road several times. Increase of average drive through speed means reducing journey time by more than one half.

4.1 Performance of the Trial Section for Bagamoyo Site

4.1.1 General

Many sections are performing well and provide all weather access throughout a year for more

than 5 years since construction. In general there is big improvement as compared to the condition of the road before intervention. Figures 2 and 3 below show the contrast

Figure 2: Intervention through stone packing and gravelling (all local materials)

Before	After

Figure 3: Intervention by Otta seal

Before	After

4.1.2 Specific Results

- **The Otta seal with sand cover seal** and **double surface dressing** sections have shown so far to perform well with low ruts, IRI and higher surface texture. Surface dressing requires selection of aggregate materials having adequate quality but if suitable aggregates for double surface dressing are not available, the Otta seal is a highly effective alternative.
- **Slurry Seal** did not perform well. Large stones, severe cracks and surface loss were noted during monitoring and are thought to be caused by wrong construction methods.
- **Concrete Strips** performed very well though there were localized failures caused by cattle crossing road when concrete was premature. Concrete strips are suitable in flat or rolling areas and have the advantage of being constructed using local labour.
- **Concrete Geocells** performed well though there was failure along the edge concrete cells. Geocells are not available locally in Tanzania

and needs expertise during construction therefore is not recommended for further use though they have shown positive results.

- **Hand packed stones** did not perform well as they have very high roughness index and are suitable for rural roads with pedestrian only.
- **Plain Concrete and Light reinforced concrete** performed well despite of longitudinal and transverse cracks observed at Siha sites. Site supervisor suggested that the cracks may have been caused by poor construction techniques and heavy vehicles were allowed to pass before the concrete had gained full strength.
- **Bituminous penetration macadam** did not perform well as was expected as there is loss of aggregates on the surface. It is thought that the problems were due to construction irregularities.

4.1.3 General Challenges Observed

- **Increase of tricycles in the village.**
  The concept of concrete parallel strips must be modified to accommodate the increase of tricycles in villages transport. The dramatic increase of using tricycle in transporting farm produce from villages to market calls for innovative ideas for modification of the existing concrete parallel strips.
- **Bad driver's behaviour**
  Lack of knowledge on the principles of road sharing makes many drivers with vehicles not to yield on motorcycle or bicycles and may cause unnecessary accidents.
- **Improper construction procedures**

Many sections showed distresses due to improper construction procedures and poor selection of construction materials such as base course materials with oversized aggregates [8].

- **Wrong placed or no road signs in rural roads.**
  Many rural roads have no traffic signs and it may be a source of accidents.
- **Lack of timely road maintenance.**
  Road maintenance especially at the end edges of concrete may course accident [9].

5.0 CONCLUSION

- Hand Packed Stones are not recommended for use in rural roads that carries car, motorcycles and bicycles.
- Geocells should be used where there is enough expertise but in general should not be recommended as they are not available in local market instead concrete slabs or parallel concrete strips can be used instead.
- Gravel can do better when geometry and in situ materials are favorable, and risk of excessive deterioration is at minimum.
- Parallel Concrete Strips and Concrete slabs have shown to be good on flat or rolling terrain. They can be constructed using local labor and maximize the use of concrete.
- Slurry seal did not perform well and new trial will be required

6.0 RECOMMENDATIONS

It is recommended that monitoring activities be continued for another 4 years and mathematical methods be applied to make available data more consistency and meaningful.

It is also important for Tanzania as a country or with neighbouring countries as regional block having similar problem in collecting research data to develop a clear protocol that will ensure a more meaningful and consistent data from various trial sections.

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MECHANICAL STABILISATION AS CHEAP BUT EFFECTIVE WAY OF IMPROVING THE MARGINAL MATERIALS FOR ROAD CONSTRUCTION

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Abstract

This paper presents the cost effective method of improving the quality of geo-materials through mechanical stabilisation. Two case studies of the mechanical stabilisation were used during construction of two projects in Tanzania namely Mwika – Kilacha whereby the contract specified stabilised subbase CM was substituted with mechanically modified subbase of G45 quality and Songea-Namtumbo road project whereby the contract specified lime improved upper subgrade was substituted with G15 mechanically modified upper improved subgrade. In both cases, substantial savings to the contract were realised. In this paper, the geo-technical and geo-mechanical properties of the geo-materials from these two cited projects before and after modification are presented and discussed. From the laboratory results as well as field test results, it can be concluded that mechanical stabilisation is one of the simplest but yet cost effective means of improving the geo-technical and geo-mechanical properties of the geo-materials.

1.0 INTRODUCTION

The upgrading of Songea – Namtumbo road project design, on which the tender included the pricing of lime stabilized improved upper subgrade [*G15*] while the design of Marangu – Mkuu and Mwika – Kilacha road project on which the tender included the pricing for cement stabilised subbase materials of CM quality. The intent of doing lime stabilisation for the Songea – Namtumbo road project as was provided in the Material Report was to guarantee the uniformity of the road structure by stabilizing the available natural geo-material using lime with two simultaneous objectives namely:

a) To reduce the plasticity index of the naturally available geo-material to the specified minimum of 25 %. In accordance with the Materials Report, this was the primary objective of the lime stabilisation/ modification.
b) To improve the bearing capacity of the available natural gravel to achieve consistently a CBR value of more than 15 % after soaking for 4 days. This was the secondary objective of the lime stabilisation/ modification.

For the Marangu – Mkuu and Mwika – Kilacha roads project, the intention of cement stabilisation was also to guarantee the uniformity of the road structure by stabilizing the available natural volcanic materials with cement for two primary objectives:

1) To bind the poorly graded [*gap graded*] volcanic soil into a stable and homogenous soil mass.
2) To improve the bearing capacity of the available volcanic gravel to a CBR value of at least 45% after soaking for 4 days.

It is clear that for both projects, the design engineer was unable to locate a suitable geo-material to be used in "as dug" state compelling to specify chemical [*cement or lime*] stabilisation as means of improving the quality of geo-materials available within the project vicinity.

In this paper, simple yet cost effective

means of improving the geo-technical and geo-mechanical properties of the geo-materials by means of mechanical stabilisation using natural pit-run sand as was applied for the two cited projects is presented.

2.0 PAVEMENT DESIGN

For the Namtumbo – Songea Road Project, the materials investigation carried out by design consultant as reported in Materials Investigation Report, indicated that the existing alignment soil can be classified as S3 subgrade i.e. a subgrade geo-material having CBR in range 3-6. During pavement design, improved lower subgrade of G7 quality was provided as part of strengthening the pavement in line with the recommendation given in MoW Pavement and Material Design Manual [*1999*]. Furthermore, the investigation revealed that the material available from borrow area which were within the project vicinity are not consistently meeting the G15 requirement for upper improved subgrade. Thus, it was deemed necessary by the design Engineer to specify to lime-stabilise the borrow geo-materials so as to reduce the plasticity index to less than the maximum specified value of 25 % and to increase the CBR value to more than minimum specified value of 15 %.

As part of the value engineering concept, new investigation was carried out during construction to ascertain the quality of the materials available within the project vicinity. The investigation confirmed that it was difficult to get the improved upper subgrade material of G15 quality in its "as dug" state. But through laboratory testing, it was established that the geo-materials from borrow areas can be mechanically improved by blending it with pit-run natural sand to achieve the prerequisite requirements of G15 geo-materials as given in Mow 2000 specifications.

Through laboratory testing it was confirmed that after blending the geo-materials with pit-run natural sand, the geo-material available within the project vicinity met primary objectives of the lime stabilization/modification of improving the soaked CBR to more than 15 % and lowering the plasticity index to less than 25 %. After blending the borrow material, the resultant geo-material met the G15 material requirement as provided in Table 3602/1 of the Standard Specifications for Road Works.

For the Mwika – Kilacha road, the pavement was designed to carry 1-3 million equivalent standard axles, in accordance with MoW Pavement and Materials Design Manual, the pavement structure was made of 150 of crushed stone CRR and 200 mm of natural gravel subbase of G45 quality. However, due to nature of the volcanic soil available within the project vicinity, it was difficult to get the geo-material which meets the project specification for the G45 geo-materials in its "as dug" state. The solution adopted by the Designer Engineer was to chemical-stabilise the available volcanic geo-materials so as to improve its quality to bound materials of CM quality [*bound materials with UCS of more than 0.5 MPa*] and use this available volcanic soil a subbase. Stabilising volcanic geo-materials normally poses a problem owing to the fact that one of the intrinsic property of the of volcanic soil is lack of clay-like materials which are required to initiate the soil-cement reaction. In order to improve this property, it was provided in the Materials report that the volcanic soil need to be mixed with natural soil and thereafter stabilised with 3-4% of cement. As it can be seen, the amount of cement was exorbitant in particular considering the fact that 3-4% of cement was required to improve the geo-materials to achieve unconfined compressive strength of 0.5 MPa only. For normal soils, this improvement of geo-material to get CM bound geo-materials can be achieved easily using cement content of less than 1.5% [*compare this with 3-4% of cement as was given in the contract document*].

Once again, value engineering came into play here whereby through laboratory investigation, it was established that by blending the available volcanic geo-materials with pit-run natural sand in range 20-25%, the geotechnical as well as the geo-mechanical properties of the volcanic geo-materials can be improved to meet the minimum requirements of G45 geo-materials as provided in the contract document.

3.0 BORROW AREA INVESTIGATION

For both projects the area investigated for the borrow area covered the entire project alignment, with aim of locating suitable sand/gravel which could meet at least G7 requirement for the Songea – Namtumbo project. Principally, the type of natural gravel found within the project vicinity is lateritic gravel interspersed with quarztic gravel covered with about 30-50 cm of overburden.

For the Mwika – Kilacha road, the investigation aimed at least getting the geo-materials which meets G15 or G25 requirements such that when mechanically modified the geo-materials can meet the prerequisite of G45 geo-materials. The type of natural gravel materials found within the project vicinity were volcanic gravel interspersed with quartzitic and/or lateritic gravel in form of cinder cone, covered with about 30-50 cm of overburden. Normally, the volcanic geo-materials is associated with low density, poorly graded, cohesion-less nature and is highly porous. In most cases, in unmodified form, the volcanic soils have undesirable engineering properties in terms of pavement performance.

Using geo-materials which were one grade or two grades lower than the requisite geo-materials, for both projects it was possible to get the geo-materials which were mechanically modified to achieve the geo-technical and geo-mechanical properties of G15 for Songea – Namtumbo project and G45 for Mwika Kilacha road project which resulted into substantial monetary savings to the contract.

4.0 GEOTECHNICAL PROPERTIES OF THE BORROW MATERIALS

Several samples of borrow geo-material were gathered and tested in laboratory for each project. The geo-material along Songea – Namtumbo project is characterized by high void ratio which is intrinsic nature of the geo-material available within the project vicinity due to its geological formation. The high void ratio within the soil mass is proved by formation of gullies inside unlined ditches making the soil within the project vicinity to be highly erodible.

For the Mwika- Kilacha road, the project soil is cohesion-less and gap graded which is the typical characteristic property of the volcanic soil available within the project vicinity. From each borrow area, three to five samples were collected in order to determine the geotechnical and geo-mechanical properties of the geo-materials. For all borrow areas, the geotechnical and geo-mechanical properties of the borrow area were tested in "as dug" state and also tested after blending the borrow area geo-materials with 25% of natural pit-run sand. The tests conducted were: Particle size distribution [*CML 1.7*], CBR and Swell [CML 1.11], Atterberg limits (CML 1.2 & 1.3) and MDD/OMC [CML 1.9].

4.1 Grading

The wet sieving was carried for all soil samples collected from the borrow areas available along Songea – Namtumbo road and Mwika – Kilacha road. For the borrow samples taken from Songea- Namtumbo road, it can be seen that after additional of pit-run sand, the amount passing 0.075 mm sieve was reduced thereby improving the shear strength of the soil through improved inter-particle friction and partly due to cohesion thus leading to increase in bearing capacity of the soil.

The grading borrow soil samples taken from Mwika – Kilacha road indicates that is gap graded, particularly at 2-5 mm, which is critical particle range necessary for enhancing the compact-ability of the soil matrix, as this particle size acts as an interceptor. Owing to the fact

that the soil is gap graded lacking particle from 2-5mm and also the fine content which acts as binder [*passing 0.075 mm*] is very low typically less than 2%, this makes the soil available along Mwika – Kilacha road to be difficult to compact. In order to improve this deficiency, it was imperative to blend the soil with continuously graded natural pit-run sand with sufficient fine so as to improve the grading. The analysis indicates that, by adding about 25% of pit-run sand, the grading of the blended geo-material was improved by transforming it from gap-graded soil to uniformly-graded soil leading to improvement in density, compact-ability as well as bearing strength as measured using CBR.

The grading test results before and after blending for Songea – Namtumbo and Mwika – Kilacha project is given in Figure 1(a) and 1(b) respectively.

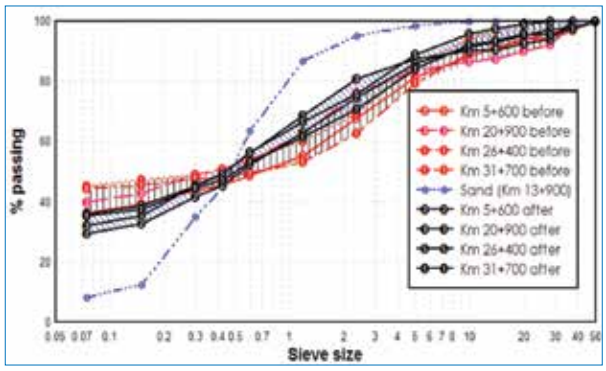

Figure 1(a): grading of the borrow area geo-material before and after blending [Namtumbo – Songea Project]

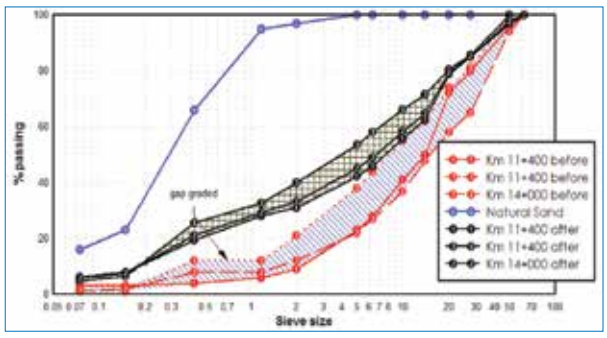

Figure 1(b): Grading of borrow area along Mwika Kilacha raod before and after blending

4.2 Liquid Limit and Plasticity index

For Songea – Namtumbo road project, borrow areas geo-materials samples were tested, the liquid limit was found to be in range 53-64 %. After blending with 25% of natural pit-run sand the liquid limit was lowered from the maximum recorded of 64 % to 47% while the plasticity index was lowered to less than 25%, thus, transforming [*upgrading*] the G7 geo-materials to G15 compliant geo-materials.

In most cases, the volcanic soils are non-plastic, however, they have artificially high liquid limit due to its geological formation. For the Mwika – Kilacha road, the volcanic soil was non-plastic but the liquid limit was found to be range of 32–45%. After modification, the liquid limit was lowered from the recorded maximum of 45% to 34%, making it suitable to be used as G45 geo-materials in accordance with Table 3702/4 of the Standard Specifications for Road Works (2000).

The reduction of plasticity index is normally associated with reduction in swelling potential, therefore, addition of pit-run sand reduced the swelling potential of the geo-materials. The summary of liquid limit and plasticity index before and after blending for the Songea – Namtumbo and Mwika-Kilacha is shown in Figure 2(a) and 2(b) respectively.

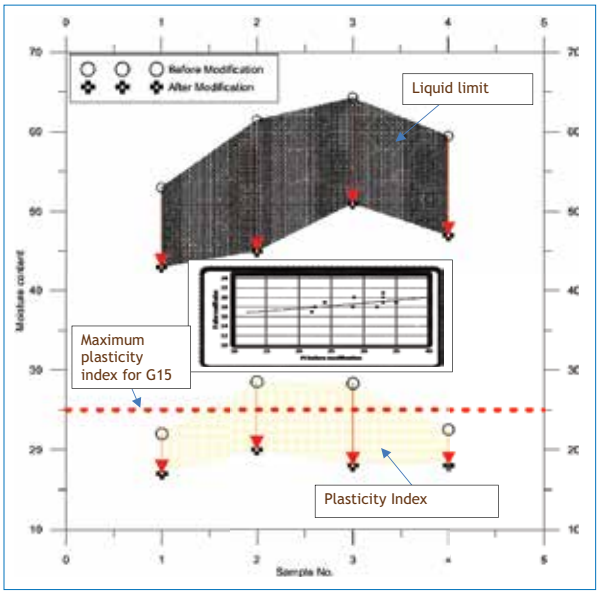

Figure 2(a): Plasticity index before and after modification for the Songea – Namtumbo project

The Atterberg limits tests were carried before and after blending the geo-material with 25% of pit-run sand. The Atterberg limit data of borrow geo-materials for Songea – Namtumbo are plotted in Casagrande plasticity chart and is given as Figure 2(c). The soil from Mwika –

Kilacha is not plotted on the A-line plot owing to the fact that it was found to be non-plastic. The plasticity chart indicates that the Songea - Namtumbo borrow material after and before modification are plotting just below A-line signifying that the soil is predominantly silt of high plasticity [*before modification*] and is transformed into silt of low plasticity after modification [*liquid limit of less than 50 %*]. Based on the plasticity plot, it can further be inferred that the most predominant clay mineral is kaolinite as it can be seen that before modification or even after modification, the soil is still plotting within the band of kaolinite clay. The soil is classified as kaolinite clay due to the fact that normally kaolinite clay plots below the A-line while illite clay plots just above the A-line and montmorillonite plots just below the U-line. The A-line plot suggests that there is no expansive montmorillonite clay within the project vicinity of Songea – Namtumbo.

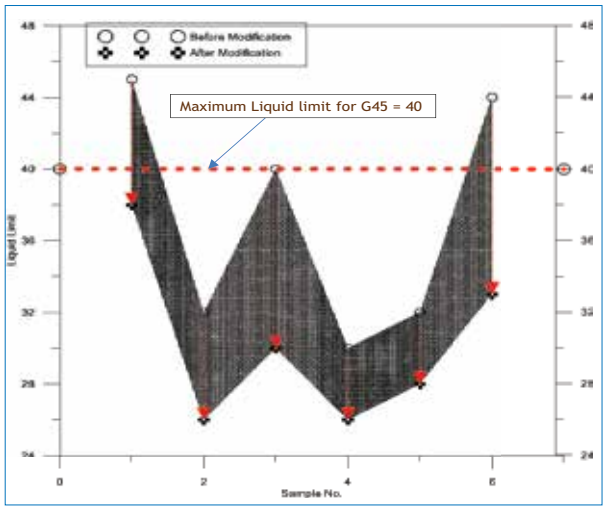

Figure 2(b): Liquid limit before and after modification [Mwika – Kilacha road]

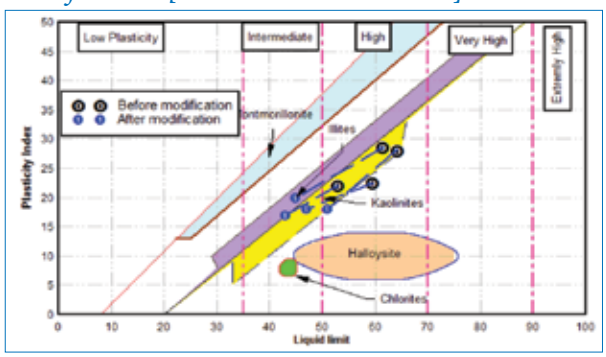

Figure 2(c): Position of soil on plasticity chart for Namtumbo – Songea project

4.3 California bearing ratio

The material from the investigated borrow area for the Songea – Namtumbo road project is generally of lateritic or quartizic nature with CBR consistently in excess of 15% after 4 days soaking in "as dug" state, while after mechanically modifying the material the CBR value increased by about 40% resulting in material having CBR value in excess of 20 %. The increase in CBR was due to reduction of fine which improved the inter-particle friction as well as the density of soil by improving the particle packing characteristic of the geo-materials.

The geo-materials from the investigated borrow areas for Mwika - Kilacha were generally of volcanic nature, with CBR consistently in excess of 45% after 4 days soaking in its "as dug" state, while after mechanical modification, the bearing strength increased by about 30% resulting in the CBR value in excess of 60%. Thus it is seen that addition of 25% of natural sand improved the CBR in both cases by about 30%. Therefore, it is obvious that blending the geo-materials with natural pit-run sand improves the bearing strength of the geo-materials.

The California bearing ratio was determined using standard procedure of CML 1.11. The soil was compacted to 95 % of BS-Heavy compaction and soaked for 4 days in water. The summary of test results before and after modifications for both cited projects are shown in Figure 3.

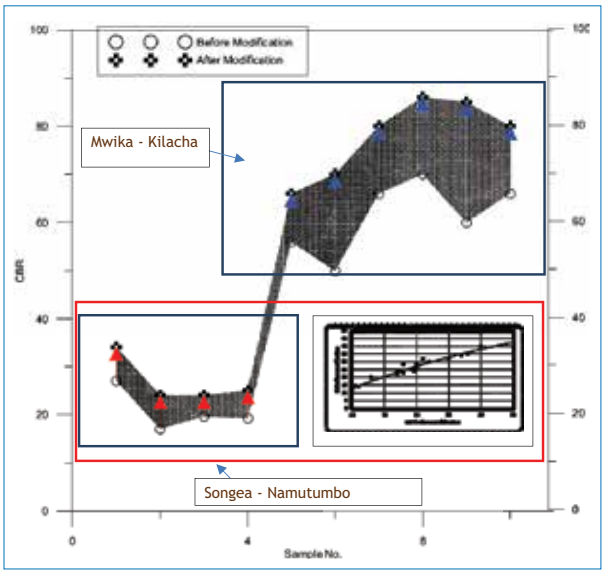

Figure 3: CBR test results before and after modification

5.0 DISCUSSION OF THE TEST RESULTS

The grading test results indicates that by blending the geo-materials with pit-run natural sand, the amount of fine [*% passing 0.075 mm*] in the soil was reduced for the Songea – Namtumbo project, while for the Mwika – Kilacha project the soil was lacking fines. Thus, by blending with 25% of sand, in which the amount of fine was increased leading to increase in density of the soil. Therefore, addition of natural sand to the geo-materials improved the grading in two different form, for the Songea - Namatumbo road, the grading was improved by reducing the excessive fines within the soil matrix, while for the Mwika – Kilacha road, the grading was improved by transforming the gap-graded soil to continuous well graded soil. In both cases, the density was improved due to rearrangement of soil particle and the shear strength was increased due to improved inter-particle friction.

The improvement of the plasticity index of the soil for songea – Namtumbo road was due to introduction of non-plastic fine which intimately mixed with plastic fines thereby changing the water retention characteristic, the chemical composition of the plastic fines and physically altering the particle arrangement of the fine within the soil matrix leading reduction of plasticity index.

The volcanic soil is non-plastic, but due to its geological formation, tends to exhibit high value of liquid limit. Introduction of the pit-run sand, jas for the case of Songea – Namtumbo soil, improved the particle arrangement of the plastic fines and physical composition of the plastic fines geo-soil leading to reduction of the liquid limit.

The improvement for the CBR value of the geo-materials for both cases, was due to improved inter-particle friction caused by reduction of fine for the Songea- Namtumbo road project and improvement in particle packing resulting into improved density which resulted into increase in bearing strength of the soil.

The effect of improvement in particle packing and increase in density was more marked for the volcanic soils of Mwika – Kilacha whereby the inherent characteristic of gap-graded volcanic soil was transformed to be continuous and well graded soils leading to substantial increase in bearing capacity of the soils as was measured using CBR.

6.0 CONCLUSION

Using test results from two projects, it has been demonstrated that, substantial saving can be realised to the project by using a simple but yet cost effective method of improving the geo-technical and geo-mechanical properties of the soil by mechanical stabilisation. For the Mwika – Kilacha road project, substitution of cement stabilised subbase CM with natural gravel subbase of G45 quality resulted into saving of Tshs. 176,451,900 to the contract, while for Songea – Namtumbo road project, substitution of lime stabilised upper improved subgrade [CM] with mechanically modified upper improved subgrade [G15] resulted into net savings of 1,702,350 USD to the contract which is equivalent to Tshs. 3,745,170,000 [*using exchange rate of Tshs. 2200/USD*]

Furthermore, by using mechanically stabilised geo-materials, placing operation can be expedited due to the fact that the placing operation is carried out in full width as opposed to chemically-stabilised geo-materials which requires 7 days curing while restricting traffic movement on top of stabilised geo-materials. Therefore, the use of mechanically stabilised geo-materials makes the traffic accommodation within the constrained construction corridor easier and cheap leading to hassle-free traffic movement on top of the mechanically stabilised geo-materials▪

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MICA IN CONCRETE

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Abstract

The Udzungwa escarpment is located in Iringa region extending its boundary to Morogoro region. The fine and coarse aggregates produced from rocks available within these scarps contains abundant amount of mica. The pit-run sand which is formed from mechanical and chemical disintegration of the parent rocks available within these scarps are equally contaminated with mica. Depending upon some geological formation, the mica content [biotite, muscovite] of Udzungwa scarp aggregates is invariably high. In this paper, the effect of mica on compressive strength as well as on the water demand of the concrete made using coarse aggregates and fine aggregates from these scarp is presented. From the laboratory test results, it was established that the presence of mica in fine aggregates causes reduction of the compressive strength and it increases the water demand.

1.0 INTRODUCTION

Aggregates takes about 75% by volume of concrete ingredients and are included in a concrete as bulking to reduce the cost, but also they can improve the concrete volumetric properties such as shrinkage, thermal movements and abrasion resistance. Although the aggregate is considered as inert filler, but is an important ingredient owing to the fact that it dictates thermal properties, elastic properties as well as dimensional stability. Furthermore, the compressive strength of the concrete is governing the choice of the aggregates to be used. The compressive strength of the concrete is also affected by physical and mineralogical properties of the aggregates such as shape, mineralogical composition, texture, grading, moisture content, specific gravity, reactivity, soundness and unit weight. These properties not only influence the strength of the concrete but also it affects the workability as well as the durability of the concrete.

Mica is one of the known deleterious minerals which affects the compressive strength of the concrete as well as the water demand of the concrete. Mica in both forms biotite also known as black mica and muscovite also known as white mica is known to affect the compressive strength of concrete as well as the water demand of the concrete. In this paper, the negative impact of presence of mica in reducing the compressive strength of the concrete and effect of increasing the demand is presented. The test results presented in this paper is based on the test results carried out during construction of Kihansi dam.

2.0 AREA OF STUDY

The data used for analysis of both compressive strength and water demand was collected during the exercise of carrying out concrete mix design of concrete used for the construction of Lower Kihansi dam which occupies a segment of Udzungwa escarpment in Iringa region *[area occupied by Lower Kihansi Hydropower Project]*. The coarse aggregates used for concrete mix design was crushed from "mucking" stone drilled and blasted during tunnelling. The fine aggregates used during this study were from the investigated nearby sources of natural sand namely Kalengakelo [*19 Km South of Kihansi*], Chita [*17 Km East of Kihansi*], Ngwasi *[17 Km South of Kihansi*], Mpanga [*44 Km South west of Kihansi*], Chisano [*9 Km South of Kihansi*],

Ikule [*31 Km North east of Kihansi*] and Kimbi [*40 Km North east of Kihansi*].

The rock formation in this area is characterised by high content of both white and black mica [*biotite/muscovite*] content which affects the concrete making properties of the aggregates available within this area.

The presence of Mica in the soil as well as in the fine and coarse aggregates in this area is not only an engineering problem but an economical problem as well. It has serious and harmful implications on the concrete production by reducing the compressive strength and increasing the water demand. Furthermore, the presence of mica in soil makes the compaction difficult owing the "springing" effect of the mica platelets in the soil.

3.0 GEOTECHNICAL PROPERTIES OF THE AGGREGATES

The rock available from Kihansi is mainly granitic gneiss with high percentage of mica mainly in form of biotite. The summary of the geotechnical properties of the aggregates as determined in the laboratory is shown in Table 1.

Table 1. Geotechnical properties of coarse and fine aggregates

Source	Chloride	Sulphate	SG	Absorption	Clay/dust	SSS	TPF	LAAV
Kihansi		0.02	2.69	0.25		1.91	120kN	42%
Mpanga	0.005				3.2%			
Chisano	0.004				8.6%			
Ngwasi	0.004				2.3%			
Chita	0.006	0.08			4.8%			
Ikule	0.006	0.06	2.61	0.84	1.0%			
Kimbi	0.004	0.03	2.69	0.33	3.7%			

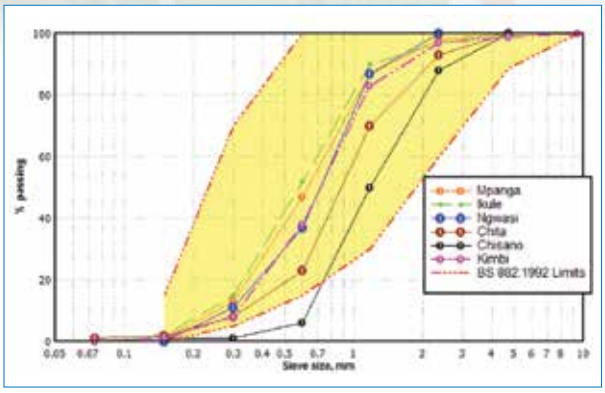

Figure 1: Grading plots of fine aggregates

From the test results of the aggregates as provided in Table 1, it can be seen that both fine and coarse aggregates used during this study is complying with national and international standard specifying aggregates for concrete making. The grading plots of all fine aggregates samples with exception of one sample are within the envelope of overall limits of fine aggregates as provided in BS 882:1992. Generally, from the test results as presented in Table 1, it obvious that the aggregates used during this study is a good aggregate which can be used to produce concrete of satisfactory quality.

4.0 MINERALOGICAL/PETROGRAPHIC ANALYSIS OF AGGREGATES

The rock samples as well as the crushed fine aggregates and natural sand from various sources available within the Kihansi hydropower project area were sampled and its mineralogical composition analysed. It was found that the rock available within the project area is characterised by high biotite [*black mica*] content. The most predominant rock was found to be biotite gneiss although some tested sample showed a granitic composition. The main minerals present are quartz, feldspar and biotite which in most case is the main constituents.

The mineralogical analysis of nearby natural sand source showed that these sources were equally contaminated with mica mainly in form of biotite [*black mica*]. Presence of muscovite [*white mica*] was also noted, the content of white mica was more noticeable in pit-run sand from Kimbi in which the percentage of white mica was found to be up to 16%. The

percentage of minerals from different sources of fine aggregates found within the proximity of lower Kihansi hydropower project are shown Table 2.

Table 2: Mineralogical composition of coarse and fine aggregates

Source	quartz	feldspar	Biotite	Muscovite
Kihansi [*crushed*]	20-80%	15-55%	25-60%	Trace to 8%
Ikule [*natural*]	55-60	20-25	5-10	Trace to 5%
Kimbi [*natural*]	53	25	10-16	Trace to 16%
Mgungwe [*natural*]			Trace to 10%	Trace to 10%

5.0 EXPERIMENT DESIGN

In order to study the effect of presence of mica on compressive strength as well as on water demand, an experiment design was carried out. The experiment design was formulated such that the impact of secondary variance which affects the compressive strength as well as the water demand of the concrete are minimised. The cement quality varies from batch to batch, in order to ensure that resultant strength of the concrete is not affected by batch to batch cement variation, the concrete mix design was carried out using cement from the same batch. The concrete was made at a fixed water cement ratio of 0.6 and aggregate cement ratio of 5.1. Neglecting other secondary variables which are likely to influence the compressive strength of the concrete, theoretically, the compressive strength of concrete made from the same batch of cement and batched to the same water-cement ratio is supposed to be the same. In order to minimise the effect of aggregate strength on the compressive strength of concrete, a water cement ratio of 0.6 which gives 28 days' compressive strength of less than 35 MPa was selected. Additionally, in order to minimise any variation of concrete strength caused by water source, the same source of water was used for the control mix as well as for experimental group.

For purpose of this study, the standard water demand was defined as the water demand which gives a slump of 75±25 mm. In order to achieve this slump, the mix design was carried out and water content adjusted, until the desired slump was achieved. In order to improve the reliability of the test results, the tests were made in replicates and the average water demand was taken as the standard water demand required to give the concrete mix the desired slump of 75±25 mm. Ignoring other factors which influence water demand such as fineness of the sand, shape of the sand, the water demand to achieve the standard slump of 75±25 mm were determined for both non-micaceous and micaceous sand; the increase in water demand above the amount used in control mix was deemed to be caused by the presence of mica within the sand.

The non-micaceous Mpiji sand which is one of the sand source within the coast region with proven performance was used as standard sand so was used to make control group concrete mixes for assessing both compressive strength and water demand of the mixes.

6.0 COMPRESSIVE STRENGTH

The concrete trial mixes for determination compressive strength of the mixes were made at a constant water cement ratio of 0.6 and fixed aggregate cement ratio of 5.1 in accordance with experiment design. The concrete mixes were made using identically the same mix having the same cement content and the same water content. Due to variation in water demand, the slump was found to be varying depending on the quality of fine aggregate used. Neglecting other secondary effects which make the strength of concrete vary, the concrete made using the same batch of cement at the same water cement ratio is supposed to have the same compressive strength. therefore, any reduction in compressive strength below that achieved by the control mix was deemed to be caused by presence of mica in the fine aggregates. In order to reduce the variability of the test results due to inherent testing repeatability, the test results were taken as an average of six cubes. The comparison of control mix and the experimental group mixes is shown in Table 3.

Table 3: The compressive strength of micaceous sand and non-micaceous

	W/C	*7 days' cube strength (Mpa)*	*28 days' cube strength (Mpa)*	*7 days (% of control)*	*28 days (% of control)*	*Remarks*
Control	0.6	23.9	32.9	100	100	Natural sand
Kimbi	0.6	17.9	25.2	75	77	Natural sand
Kihansi	0.6	22.0	29.9	92	91	Crushed sand
Ikule	0.6	22.1	30.3	92	92	Natural sand
Mgugwe	0.6	20.5	28.7	87	87	Natural sand

7.0 WATER DEMAND OF CONCRETE

The effect of presence of mica in sand on water demand were investigated by making a concrete with standard slump of 75±25 mm. The water demand which yielded a standard slump of 75±25 was taken as the standard water demand for that natural sand source. The test was carried using non-micaceous sand [*control*] and micaceous sand which formed an experimental group. The water content to required achieve the standard slump of 75 ±25 mm for sand sources investigated are given in Table 4.

Table 4: Water demand to achieve slump of 75±25 mm

Source	Water Demand, litres/m^3	Increase	% increase
Control [*natural*]	205		
Kimbi [*natural*]	238	33	16.1%
Ikule [*natural*]	222	17	8.1%
Mgugwe [*natural*]	225	20	9.8%

8.0 DISCUSSION OF THE RESULTS

Based on the compressive strength test results as presented in Table 3, neglecting all other extraneous factors which are likely to influence the compressive strength of the hardened concrete, it can be seen that the presence of mica in the fine aggregates can reduce the compressive strength of the concrete in range of 9-23%. It has been reported that compressive strength of concrete is greatly affected by presence of mica in fine aggregates, research has shown that whilst mica [*biotite and muscovite*] is less likely to cause problems when incorporated in the stone portion of the mix, in the sand the presence of mica can influence

the water demand, compressive strength and flexural strength. The research has shown 5% biotite content resulted in 6% decrease in compressive strength whilst 10% content resulted in a 10% loss of strength [*Hoon, R.C and Sharma, K.R*] . Davis *at el* reported that the compressive strength can be reduced in order of 20 -30 %. Research carried out by PCI in South Africa reported that the presence of muscovite mica in sand can reduce the compressive strength in order of 35% for 5% inclusion and 60% for 10% inclusion.

The compressive strength of the concrete reported in Table 3 indicates that the compressive strength of the concrete made using Kimbi pit-run sand is 23% less than the control mix. Table 2 gives the mineralogical composition of sand source shows that Kimbi pit-run sand is having muscovite mica up to 16%, therefore the substantial reduction of the compressive strength of the concrete made from Kimbi sand can be attributed to the presence of muscovite [*white*] mica in the sand.

The presence of mica in fine aggregates is one of the known factor which affects the water demand. Research conducted by PCI of South Africa reported that the water demand is increased by about 6 litres/m^3 for every 1% of muscovite contained in the sand.

Neglecting all other extraneous factors such as shape, fineness and surface area which influence the water demand of the fine aggregates, the test result given in Table 4 indicates that water demand is increased in range of 17- 33 litres/m^3. From Table 4, it can be seen that the Kimbi sand source exhibited high water demand compared to the rest of the sand sources. The high-water demand of the Kimbi sand can be associated with the presence of muscovite [*white*] mica in the sand.

9.0 SUMMARY AND CONCLUSION

The study has shown that the compressive strength of concrete made using micaceous sand is reduced compared to concrete made from non-micaceous sand. Based on the compressive strength test results obtained using pit-run micaceous-sand from Udzungwa scarp, the compressive strength is reduced in range of 9-23% as determined from concrete mixes with maximum cube compressive strength of 32.9 MPa. It can be inferred that the injurious effect of presence of mica on the compressive strength is more appreciable when the content of white [*muscovite*] mica is predominant; when black mica [*biotite*] is present the reduction of compressive strength is noted but not so pronounced compared to when muscovite mica is present.

It was also noted that the water demand of for concrete made using micaceous sand is higher than that made from non-micaceous sand. The water demand was found to increase in range of 17-33 l/m^3 as tested using 20 mm nominal size of aggregate. The test results suggest that when the natural sand contains significant amount muscovite mica, more water is required to achieve the desired workability compared to when black mica [*biotite*] is present.

Based on the test result recorded during this study, the compressive strength as well as the water demand is negatively impacted by the presence of mica in both forms [*white and black mica*], but the presence of white mica is more injurious to compressive strength and water demand compared to black mica.

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CONSTRUCTION OF UBUNGO INTERCHANGE - AN OVERVIEW OF TECHNICAL ASPECTS OF ITS IMPLEMENTATION

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Abstract

Ubungo interchange which is currently under construction at Ubungo junction is a major gateway to and from the city of Dar es Salaam. Construction commenced in May 2017and is scheduled to be take 38 months to complete. The contractor is M/S. China Civil Engineering Construction Cooperation (CCECC) under the supervision of M/S Leporogo Specialist Engineers in joint venture with M/S. Soosung Engineering Corporation Ltd. and in association of M/S. Afrisa Consulting Ltd. The Employer is TANROADS on behalf of the Government of the United Republic of Tanzania. This paper presents the details of project implementation, exploring challenges encountered and how they were solved. Based on available documentation and on site interview with the Resident Engineer, Contractor's Highway Engineer and the Employer, the project has experienced various challenges related to site constraints since its inception and their solution were sorted out judiciously through alternative designs, additional soil explorations and tests, strict vehicular and pedestrian

traffic management, excellent plan for relocation of massive utility infrastructure, the use of synergy of well-coordinated inclusive organizational and site management practices as well as proactive logistics in ordering and supply of local and imported materials. All these have enabled the project implementation progress to be in a full swing despite the challenges, thus promising project delivery as per contract.

1.0 INTRODUCTION

The Government of Tanzania has continued to invest heavily in construction, rehabilitation and maintenance of roads and bridges in order to attain a sustainable network of good roads in the country. The investment has already brought impacts on the reduction of transportation costs, enhancing socio-economic development and improving social cohesion and integration among the people. Good roads have hastened the attainment of higher quality of life and equality among the citizens of this country as well as facilitating cooperation and trade with the neighbouring countries.

Ubungo junction is the major entry and exit gateway to and from the City of Dar es Salaam for up-country destinations. Similarly, it is the main road through which the land locked neighbouring countries at the Western borders of the country transport goods. Domestic and transit goods in heavy commercial vehicles are easily linked to the Port of Dar es Salaam through Morogoro road. They turn right and left at Ubungo junction through Nelson Mandela road, causing persistent heavy congestion at the junction. In order to avoid disrupting the operation of the Bus Rapid Transit (BRT), it was necessary that a grade separated intersection be constructed concurrently with the construction of infrastructure under the BRT project. Implementation of this project has required innovative management approaches to be employed.

The traditional project management practices which are based on three-dimensional life cycle approach where the project manager seeks to optimize cost, quality and design proved not to be adequate in this project. Ubungo Interchange project needs multi-dimensional management approach to fully address complexities such as massive service lines relocation, construction space constraints, difficult choices between cast in situ versus precast and steel girder structures, selecting appropriate alternative designs, management of heavy traffic during construction and organizational and site management challenges. The aim of this paper is to detail complexity and challenges faced in the implementation of Ubungo Interchange project and the measures that are being taken to address them so as to ensure smooth and successful completion of the project.

The paper is made up of twelve sections, Section One presents the introduction, Section Two describes project background and technical details of Ubungo interchange. The outline of project key information is described in Section Three while project procurement processes is elaborated in Section Four. The challenges encountered during design and construction works are described in Section Five followed by contract management approach in Section Six. The examination of traffic management initiatives during construction is described in Section Seven while the scope of construction works is detailed in Section Eight. This is followed by local content input in this project as highlighted in Section Nine. The current progress of the works is briefly elucidated in Section Ten and conclusions are drawn in Section Eleven. Finally acknowledgement to various people who assisted in making this paper a success is given in Section Twelve.

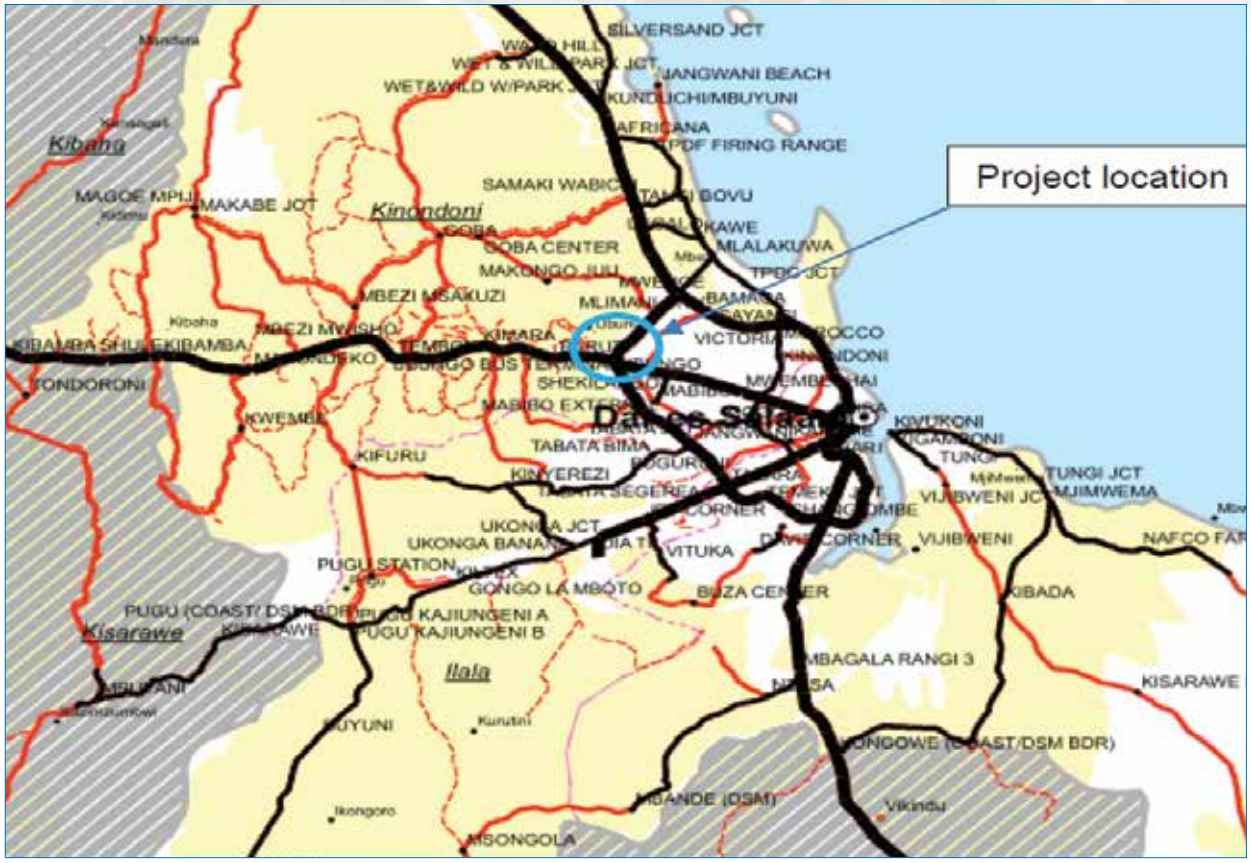

Fig. 1: Location Map of Ubungo Intersection (TANROADS, 2014)

2.0 DESCRIPTION OF UBUNGO INTERCHANGE

2.1 Project Background

Ubungo intersection has been of particular concern for being located along major multi-lane roads, namely Morogoro, Sam Nujoma and Nelson Mandela. These roads accommodate major arteries of traffic movements including considerable volumes of turning heavy commercial vehicles as it can be seen in Figure 1.

Prior to the interchange project, traffic at this intersection used to be controlled by signalized system except when under manual control by a traffic police. It had one of the highest morning and evening peak hour ratios and it experienced performance shortfalls, including many constraints for its improvement.

In 2007, a traffic survey was carried out at Ubungo intersection. This was done through the Dar es Salaam Transport Master Plan survey program. The Survey involved traffic counts and travel time monitoring during morning, off-peak and evening peak hours. The Survey revealed that over three hour morning peak period (0600-0900 hours), some 11,100 vehicles (equivalent of 3,700 vehicles per hour) passed through the intersection. The morning peak period was operating at critical levels with intersection saturation at unity. Consequently, an optimum allocation of cycle time and phasing was no longer possible. Particularly the critical approaches included Nelson Mandela Road (Northbound) as well as Morogoro Road (Eastbound) (JICA, 2008).

Similarly, it was also established, through the cargo transport survey of the City of Dar es Salaam, that 43 percent of mix of commercial vehicles in Dar es Salaam used Nelson Mandela road while 22 percent used Morogoro road, the rest of commercial vehicles used the other City roads. In this Survey, the dominant truck type used by trucking companies was found to be a two-axle configuration. In the case of Nelson

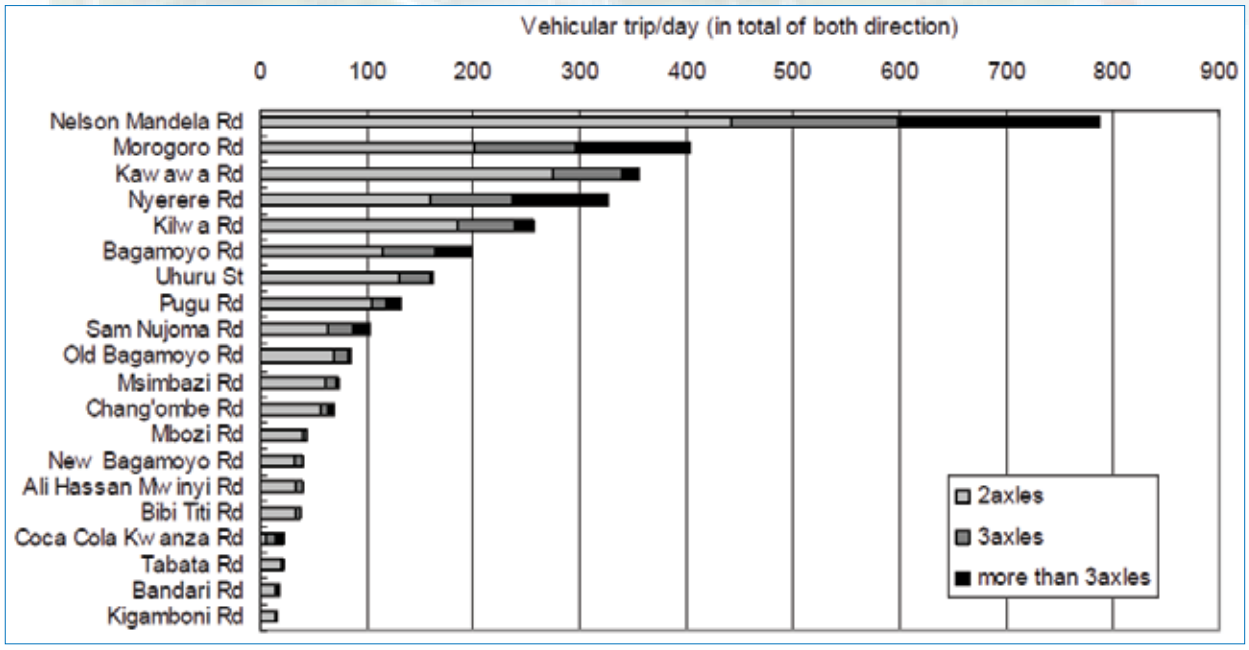

Fig. 2: Travel Routes of Trucking Company Vehicles along Dar es Salaam Roads (JICA, 2008)

Mandela road trips, roughly 440 trips were via two-axle trucks, 160 via three (3) axle trucks and 190 via commercial vehicles of more than three axles as depicted in Figure 2.

Further, during detailed design of the current project, another traffic count was carried out at Ubungo Intersection in 2014 by M/S Hamza Associates in association with Advance Engineering Solution of Tanzania. However, at that time construction of Bus Rapid Transit (BRT) project along Morogoro road was on going. This to a great extent disrupted normal travel routes as most traffic tended to divert from the junction to use alternative roads in order to avoid heavy congestions. This being the case, the traffic count done during this stage was judged to be unrealistic. Thus, the most realistic traffic count along the intersection was the count carried out under Dar es Salaam Transport Master Plan survey program in 2007 with projected traffic demand for the year 2015 (TANROADS, 2014).

The projected traffic demand indicated that Ubungo intersection was still operating at a critical level of saturation at unity both during morning and evening peak hours as well as off-peak hours. Hence the junction could not be left to work with signalized intersection even with optimization of signal cycle time. The traffic demand for buses and commercial vehicles along the Nelson Mandela road, which is the most heavily loaded road compared to the rest of the roads was total of 5,282 vehicles per day comprised of 385 buses, 2,175 two (2) axle trucks, 696 three (3) axle trucks and 2,026 trailer trucks with more than 3 axle trucks . This information illustrates the continued worsening situation of the Ubungo junction over many years, thus prompting the Government to look for the most feasible technical solution which would free the intersection from persistent intermittent clogging.

2.2 Technical Description

Ubungo interchange is being constructed in order to alleviate traffic congestion and enhance mobility at Ubungo intersection. When completed, the Interchange is set to have a life span of 100 years just like many other such infrastructures elsewhere across the world. The project involves the construction of

a one kilometre, six (6) lanes elevated bridge, including BRT lanes along the Sam Nujoma/ Nelson Mandela Road at fourteen (14) metres height with its approach up and down ramps. A second bridge with ramps on both sides is to be elevated at seven (7) metres height in order to allow for uninterrupted Bus Rapid Transit (BRT) and mixed traffic across the intersection

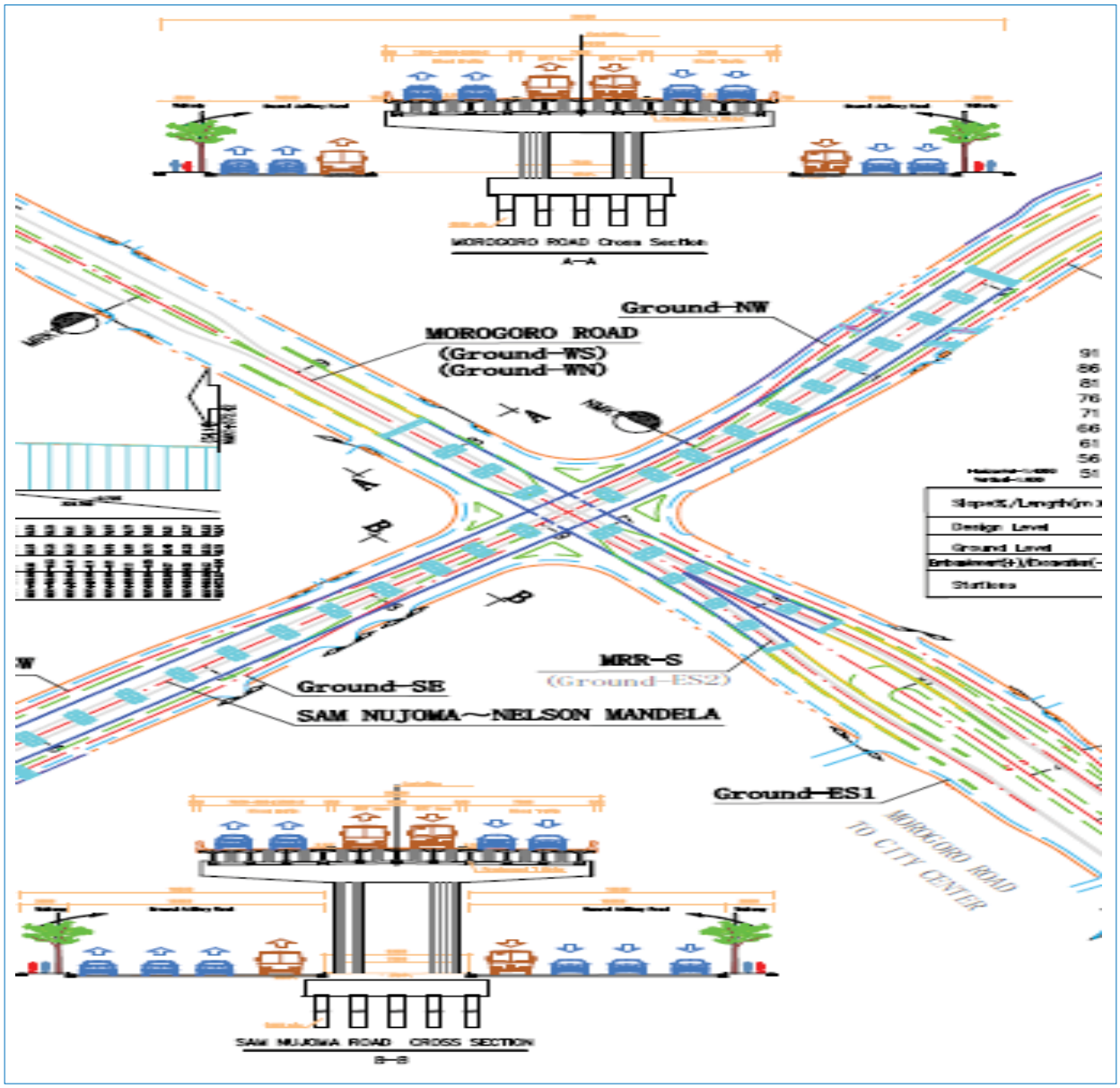

Fig. 3 Layout Plan and Cross Sections of Ubungo Interchange (TANROADS, 2014)

along Morogoro road. On completion, the interchange will allow trac along Morogoro Road (East - West direction) and Sam Nujoma road and Mandela Road (South - North direction) to flow at diferent levels through grade separation. Equally the left and right-turning traffic from the two intersecting roads will flow at the ground level under the two elevated bridges, served by traffic lights. The layout plan and sections of Ubungo Interchange are depicted in Figure 3.

3.0 PROJECT KEY INFORMATION

Project Name:

Construction of Ubungo Interchange and Associated Works

Project Financing:

The Government of the United Republic of Tanzania through the International Development Association (IDA) financing in the form of credit toward the cost of Dar es Salaam Urban Transport Improvement Project (DUTP).

Implementing Agency:

Tanzania National Roads Agency (TANROADS), an Agency under the Ministry of Works, Transport and Communication.

Design Consultant:

Egyptian Consultant Hamza Associates working in association with Advanced Engineering Solutions of Tanzania.

Supervision Consultant:

M/S. Leporogo Specialist Engineers from South Africa in joint venture with M/S. Soosung Engineering Corporation Ltd. of South Korea in association with M/S. Afrisa Consulting Ltd. of Tanzania.

Contractor:

M/S. China Civil Engineering Construction Corporation (CCECC)

Project Cost:

The Contract Amount is TZS 200 billion (exclusive of VAT).

Project Commencement:

Commencement Date: 22nd May 2017.

Project Duration:

Time required for completion of the project is 38 months.

Estimated Some Major Quantities:

- Piles = 596 piles of 0.9m diameter;
- Piers = 50 piers of 1.7m diameter;
- Concrete class C50 = 22,250m³;
- Concrete class C40 = 34,000m³;
- Reinforcements = 11,100 ton;
- Asphalt Concrete = 2,014 ton;
- Improved Subgrade = 51,290 m³;
- Base Course (CRR) = 7,700 m³;
- Stabilised layer = 17,236 m³; and
- Steel beams 50 mx 2m x 0.7m = 22 No.

Elements of Major Road and Bridgeworks:

Ground Level Roads

- Morogoro Road Length = 1,110.00m; Width = 28.5 to 83.5 m
- Nelson Mandela/Sam Nujoma Roads Length = 1,510.00 m; Width = 9.00 to 53.0 m.

Bridges

Flyover 1 (Nelson Mandela – Sam Nujoma)

- Length=701.8 m; Width=25.1 m.

Flyover 2 (Morogoro Road)

- Length 265.6 m; Width=24.1 m. & 12.9 m.

4.0 PROJECT PROCUREMENT

Ubungo Interchange project is being financed by Government of the United Republic of Tanzania through the International Development Association (IDA) in the form of credit toward the cost of Dar es Salaam Urban Transport Improvement Project (DUTP). Thus the project procurement followed the World Bank Standard Procurement Documents (SPD). Henceforth TANROADS prepared separately international shortlist, first for design consultant and later for works supervision consultant. Similarly the contractor was procured following the World Bank Standard Procurement Document for Works.

4.1 Procurement of Consultants

Procedure for procurement of consultants for both design and supervision of works commenced with invitation of international consultants for expression of interest followed by shortlisting of eligible consultants and issuing them with Request for Proposal (RFP)

documents. Procurement of consultants was on Quality and Cost-Based Selection (QCBS) method for which procurement of design consultant culminated on 20th January 2014 whereby M/S Hamza Associates of Egypt in association with Advanced Engineering solutions Ltd. of Tanzania were engaged to design Ubungo interchange. Similarly, procurement of works supervision consultant led to signing of consultancy services contract on 21st August 2015 between TANROADS and M/S Dasan Consultants of South Korea. The Consultant commenced design review on March 2016 and proceeded with supervision services up until 30th October 2018.

TANROADS had to repeat the aforementioned process to procure another supervising consultant named M/S Leporogo Specialist Engineers of South Africa in joint venture with M/S Soosung Engineering Corporation Ltd. from South Korea in association with M/S Afrisa Consulting Ltd, of Tanzania due to the aforementioned project complexity. The consultancy contract was signed on 23rd May 2019 and supervision services commenced on 1st June 2019. An interim supervision team under TANROADS Engineering Consulting Unit (TECU) was engaged from 1st November 2018 to 31st May 2019 to supervise construction works during the period when procurement of the second supervision consultant was in progress.

4.2 Procurement of Contractor

Procurement of contractor was undertaken using the World Bank Standard Bidding Document for Works under International Competitive Bidding (ICB). During tendering process 48 bidders collected tender documents but only 14 bidders returned completed tender documents at closing time. Following completion of tender evaluation process, the Employer, informed the successful bidder M/S. CCECC of acceptance of its tender and the Construction Contract was signed on 22nd February 2017.

5.0 DESIGN AND CONSTRUCTION CHALLENGES

Complexity in design and construction of Ubungo interchange stems from the following constraints:

(i) Small working area which could not be expanded due to presence of major power station adjacent to the intersection to the South-East and South-West locations;

(ii) Presence of known and unknown numerous under-ground and overhead utility infrastructure within the working area of the interchange. These include main and small water pipe lines, low, medium and high tension power lines, gas pipelines, National ICT fibre-optic broadband infrastructure cables and other networks for telecommunication cables;

(iii) Constrain of space for accommodating utilities infrastructure that required to be relocated;

(iv) Presence of dedicated lane for operating Bus Rapid Transit (BRT) services, two bus stations along Morogoro road and facilities for pedestrian elevated crossing which had to be maintained;

(v) Existing two bridges close to the intersection along approach roads of Nelson Mandela and Sam Nujoma respectively leading to limitation in the alignment of ramps of the flyover bridge;

(vi) The layout of the upcountry bus terminal, BRT depot and its required accessibility on both Morogoro and Sam Nujoma roads controlled the geometric layout in order to accommodate the related traffic circulation;

(vii) Maintaining access to the interchange and tie in to intersecting roads that are within vicinity;

(viii) Management of existing traffic so as to maintain continuous undisturbed flow of vehicular and pedestrian traffic throughout the construction period considering also that Ubungo intersection is the busiest in the country, with more than 65,000 vehicles passing through it on a daily basis. This includes an average of 500-600 upcountry and transnational passenger buses entering or exiting the city via its main gateway; and

(ix) Future interoperability of BRT services already in place along Morogoro road in Phase One (1) with Phases Four (4) and Five (5) still in design stage along Nelson Mandela and Sam Nujoma roads respectively.

5.1 Designs by Design Consultant

Detailed design included geometric, structural, hydrology, and pavement design as well as resettlement action plan. Additionally, the consultant was also required to determine construction quantities, prepare cost estimates and tender documents as well as performing traffic management plan to be implemented during the construction period. During the course of design, three viable and economically successful alternative designs of the interchange were proposed for grade separated intersection. Given the presence of constraints of existing structures, the Bus Rapid Transit (BRT) in particular, TANROADS required alternative two (2) to be modified and designed in detail. This design allowed for uninterrupted traffic of the BRT and construction of two levels and four ramps for elevated bridges for through traffic.

5.1.1 Field Investigation and Foundation Design

Trial pit soil sample tests were supplemented by Dynamic Cone Penetrometer (DCP) tests in order to establish in-situ soil profile. Concurrently 60 initial boreholes were drilled at the site in order to obtain samples for laboratory tests as well as for carrying out in situ Standard Penetration Tests (STP) and ground water monitoring at intervals of 1.0 metre throughout their depths. Additional 10 boreholes were drilled in order to verify the adequacy of ground investigation report and to review pile foundation calculations from test results of the initial boreholes. All these soil tests were performed in order to elicit geotechnical characterization of subsoils for foundation design of reinforced concrete structural systems of elevated bridges of the interchange. Other soil test results were needed for the design of road flexible pavement.

5.1.2 Pavement Design

Generally, soil tests results indicated that the soil within the project area is typical well graded coralline sand interspersed with quarzitic sand, which can be classified as clayey sand of low plasticity. In terms of pavement design requirements, the strength of the alignment soil is classified as S7 subgrade material in accordance with Tanzania Ministry of Works (MoW) Pavement and Materials Design Manual, 1999 and project Standard Specifications, i.e. materials with CBR in the range of 7-14 values. According to Dar es Salaam Transport Master Plan survey, the projected traffic demand for Ubungo intersection for 2015 was found to be 257.9 Million Equivalent Standard Axles (MESA). This loading was found to be outside the maximum range of 50 MESA stipulated in the MoW Pavement and Materials Design Manual 1999.

Based on traffic data, as well as geotechnical and geo-mechanical properties of geo-materials available within the project vicinity, the road pavement has been designed in accordance with AASHTO Pavement Design Procedures. Referring to Figure 4 below, the

pavement designed consists of two layers of 150 mm thick improved subgrade materials, the bottom G7 and G15 on top. This is followed by two layers of 150 mm thick cement stabilized subbase materials as C1 bottom and C2 top. The pavement structure also has base course materials, made up of 150mm thick granular layer of crushed rock (CRR) and 160mm thick Dense Bitumen Macadam (DBM) of maximum 40mm particle size. The wearing course is made up of 60mm bottom layer of Asphaltic Concrete (SP 19) and 40 mm layer of Asphalt Concrete (SP 12.5) at the top.

5.1.3 Reinforced Concrete Foundation Design

The subsoil characteristics obtained from borehole soil profile indicated that the upper layers of soils above 10.0 metres are characterized by alternating layers of clean sand and slightly plastic silty/clayey sand. A coarse sand layer with sub rounded quartz gravels showing presence of ground water was observed between 11.0 to 16.0 metres below ground level. Below 15.0 metres, the site is characterized mainly by a thick homogeneous clayey sand layer underlain by silty /fine sand and weathered coral limestone occurring in some locations below 26.0 metres below ground level. Based on geotechnical investigation, laboratory test results of geo-materials, soil stratification and Standard Penetration Tests N values, pile bearing capacities were computed. Results indicated that pile tip resistance had higher contribution to the overall pile bearing capacity compared with pile shaft resistance. Hence pile foundation for piers and abutments with varying depth from 22.0 to 29.0 metres was recommended.

5.2 Designs Made by the Contractor

The World Bank Standard Bidding Document for Works under traditional Design, Bid and Construct type of contract, Clause 13.2 of General Conditions of Contract GCC), provides for alternative design to be proposed by the contractor at any time. He has to submit a written proposal to the Engineer showing that in his opinion the proposed alternative design will: (i) accelerate completion, (ii) reduce the cost to the Employer of executing, maintaining or operating the Works, (iii) improve the efficiency or value to the Employer of the completed Works, or (iv) otherwise be of benefit to the Employer if adopted (World Bank, 2017). The Contractor submitted a proposal for modifying part of design of the interchange under Value Engineering clause 13.2 as provided for within the Contract, indicating that it would be beneficial to the Employer.

Given the complexity of the Ubungo interchange project, the Employer agreed in principle to adopt contractor's proposed design of parts of the interchange with the view of reduction in cost, improving quality and constructability. A refined modified design was submitted to the Employer in July 2017, two months after commencement of works. As a means for verifying contractor's submission, TANROADS engaged an independent consultant M/S. ARUP from South Africa to undertake peer review on the Contractor's design proposal. Having been satisfied with Contractor's proposed alternative design proposal after a number of iterations, it was accepted formally by signing of Addendum in March, 2019.

The Employer accepted in principle the Contractor's Design proposal and agreed that it had the following benefits:

(a) Reduced risk of accidents for right turn traffic from Morogoro to the Port, which involves mainly heavy trucks;
(b) Lowered the mixed traffic turning lanes to existing ground level;
(c) Minimized interference with BRT operations during construction;

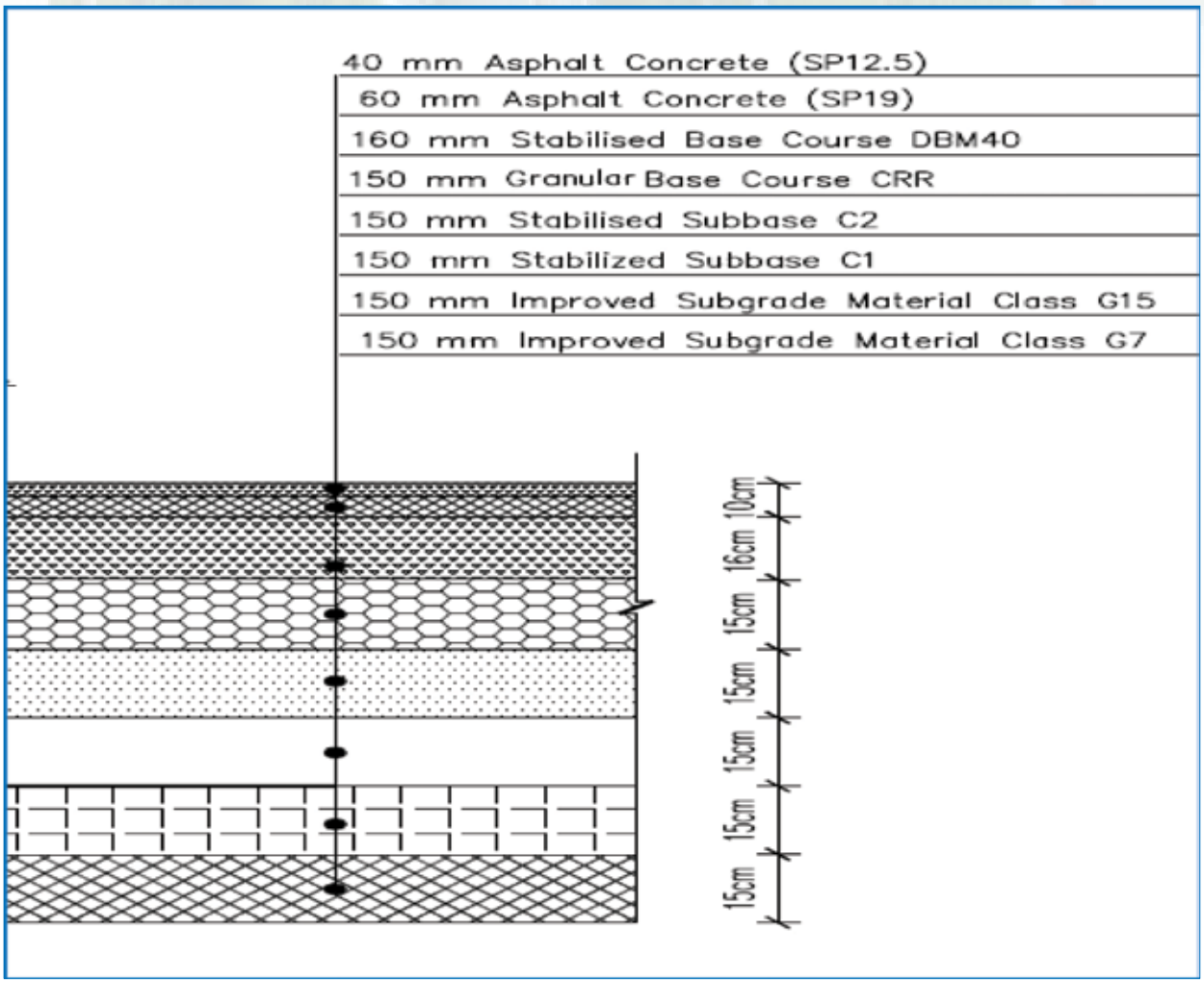

Fig. 4: Configuration of Pavement Layers (TANROADS,2014)

(d) Reduced risk of accidents for traversing in between cluster of columns;
(e) Enhanced traffic management during construction;
(f) Provided pedestrian crossing on Morogoro road; and
(g) Availed space for relocation of utilities.

5.2.1 Alternative Designs Implemented by the Contractor

Under the original design, level one bridge was used as platform with eight (8) ramps for turning traffic. The ground level had been designed for BRT and mixed traffic along Morogoro road as well as left turning vehicles. The alternative design will use level one bridge for through BRT and mixed traffic along Morogoro road. The ground level will be used for both right-turning and left-turning vehicles controlled through two phase traffic lights.

This arrangement has also led to re-arrangement of piers by increasing span length through the provision of pre-stressed concrete girders, thereby reducing the number of piers compared to the originally designed piers. It also introduced 50 metre long steel girders at spans of precast beams in the middle of intersection. The new design reduced the risk of safety hazard that would have been posed by high level obstruction to traffic due to scaffolding for beams during construction and piers which were to be erected at short spans as per the original design. Hence the modified design has been able to create enough space

to allow for uninterrupted traffic flow at the intersection during construction and after construction as well as enabling safety mobility for pedestrian at ground by having adequate median as island at pedestrian crossings.

6.0 CONTRACT MANAGEMENT APPROACH

The primary goal of contract management is to ensure that the project is completed safely as specified, on schedule and within the budgeted funds. Given the complexity of Ubungo interchange project, achievement of this goal meant that the construction team had to cut across many organizational and functional lines that involved virtually every department of the contractor in collaboration with consultant team of experts while abiding with the contract provisions. Important documents in the contract which the parties to the contract had to adhere to include the General Conditions of Contract (GCC) which are basically Bank harmonised edition of the Conditions of Contract for Construction prepared and copyrighted by the International Federation of Consulting Engineers (FIDIC) and Particular Conditions of Contract, comprised of Contract Data and Specific Provisions, containing clauses specific to Ubungo Interchange contract.

One important area of the Ubungo Interchange project is Quality Assurance as per Clause 4.9 of GCC. In this case, at the beginning of the project the Contractor was obliged to institute a quality assurance system to demonstrate compliance with the requirements of the Contract. The contractor prepared two Project Quality Control Plans, one for Bridgeworks and the other for Roadworks. During discussion with the Acting Resident Engineer, it was revealed that these two plans form the basis for supervision of quality compliance of all the construction works at the site. He informed that quality of the works have continuously improved with time to the extent that contractor's technicians are now delivering quality works with minimum supervision from their immediate supervisors. Equally the key technical staffs of both the Contractor and the Consultant, (e.g. structural engineers of the consultant and that of the contractor) were working collaboratively in pairs so as to ensure that every constructed item was discussed and agreed between the parties before and during construction.

7.0 TRAFFIC MANAGEMENT DURING CONSTRUCTION

The Special Specifications requires the contractor to submit to the Engineer two types of traffic management plan. The first is the General Traffic Management Plan (TMP) which is a working document describing the way construction activities in the Ubungo Interchange Project will be carried out in a way that they minimize inconvenience to the general public and help to ensure road users and workers remain as safe as possible.

The second plan is Site-Specific Traffic Management Plans (SSTMPs) which addresses the actual operation and implementation of traffic management activities occurring through the approval process by the Engineer and through on-going monitoring by the Contractor himself under the guidance and supervision of the Engineer's Traffic Engineer. In this way, for every construction activity which has impacts on traffic (either vehicular traffic or pedestrians), the complete traffic management procedure requires the contractor to seek Engineer's approval after submitting AutoCAD drawings for each particular stretch illustrating relevant road features that require consideration in managing the impacts of construction including the closures and/or detours. And if the plan has major impacts on traffic the Engineer under the consent of the Employer will organize a technical

meeting and invite key stakeholders (such as TANROADS Regional Manager, DART, TEMESA, Traffic Police, TANESCO etc.) to provide guidance and direction on Contractor's Traffic Management Plans to be adopted with a view to producing safe workable plans which minimize interference with vehicular and pedestrian traffic and the effect on BRT operations.

8.0 SCOPE OF CONSTRUCTION WORKS

The scope of construction works is comprised of three levels grade separated intersection made of reinforced concrete bridges, approach road and new Ubungo terminal access road with bituminous pavement for mixed traffic and rigid pavement for Bus Rapid Transit. The preliminary task involved relocation of utilities including trunk networks for telecommunication cables, low, medium and high tension power lines, main water pipelines and gas pipeline. The actual construction involved methodology for both cast in situ and precast pre-stressed concrete structures using equipment ordered in advance of final approval of the method statement. The works started with geotechnical investigations and trial piles followed by substructure works, road drainage, pavement works and thereafter superstructure works and road furniture.

The Contractor's design changed the nature of the project work from the original design which in its entirety was to be constructed by using normal reinforced concrete structures for both cast in situ and pre-cast structures and pre-stressed concrete. The alternative design by the Contractor used normal concrete at the substructure but varied the superstructure concrete largely by adopting precast pre-stressed concrete, post tensioned concrete and cast in situ reinforced concrete decks and long span (50m) sections constructed from steel beams with in-situ concrete deck where the two flyovers intersect. The steel beams were necessary for reduction of the 'clutter' of columns at ground level which existed under the original design. Similarly the capping beams for the substructure were also changed to pre-stressed, post tensioned elements. These significant design changes had a direct bearing on the equipment needed for this project such as pre-stressing and post tensioning equipment as well as hoisting equipment for precast and steel beams elements.

9.0 MANAGEMENT OF LOCAL CONTENT

Ubungo interchange can be said to be among the major and complex projects being implemented in the country. Hence it is important that the Tanzania Construction Industry benefit from this project in terms of advancement of the local capacities. In the case of using locally produced materials, steel reinforcement, cement and PVC and steel pipes are all being supplied to the site from Tanzania manufacturing industries. Similarly Tanzanians as local sub-contractors were engaged for relocation of utilities as well as for geotechnical investigation.

On training aspect for engineers, quantity surveyors, land surveyors, technicians and artisans, several engineers were posted to the site by Engineers Registration Board (ERB) for undertaking Structured Engineering Apprenticeship Program. Also university engineering students under Practical Training in industry program were received and trained at the site. Similarly, Technology Transfer to local professionals engaged directly in the project under the contractor and the consultant was effected particularly in pile foundation works, pre stressed concrete and also in installation of new underground 132kV powerline. Currently under the works supervision Consultant, there are five (5) local experts (LE) out of nine (9) key

technical staff employed by the consultant. The Key positions include Resident Engineer, Highway Engineer (LE), Materials/Soils Engineer, Land Surveyor, Quantity Surveyor (LE), Environmentalist (LE), Sociologist (LE) and Electrical Engineer (LE). Additionally four engineers including one traffic engineers, two structural engineers and one highway engineer are employed as site inspectors for the consultant.

As for the contractor, seven (7) local key technical staff out of total 15 Key technical staff are employed in senior positions including one quality control engineer, soil/materials engineer, electrical engineer, environmentalist, workshop manager and a health and safety officer. The contractor has also employed six (15) local site engineers. Hence it can be said that technology transfer through employment of local technical staff could be satisfactory considering that fulfilment of contractual obligations surpasses other requirements.

10.0 STATUS OF WORKS PROGRESS

10.1 Utility Relocation

Permanent works for utility relocations were largely completed by end of May 2018 thus enabling the follow-on work of roadworks including ground level diversion roads and bridge widenings. Approximately 2.6 kilometres of water pipelines and a total of 1.2 kilometres of natural gas pipelines were relocated while a new natural gas pipeline was installed across Nelson Mandela Road by horizontal drilling. During the same period 2.6 kilometres of copper/fibre cables for telecommunication network were relocated and TANESCO's 132kV power line was also relocated in accordance with the outage schedule agreed with TANESCO. Thereafter, completion of the 33kv/11kv/400v relocation work was completed in February 2019.

10.2 Progress of Works

The Contractor has been working through Public Holidays and Sundays and additionally has worked extended hours on a daily basis in order to complete scheduled work. He undertook a proactive approach of early ordering and delivering to the site various major items of equipment such as gantry cranes at precast yard, two special beam transporter vehicles and various items of permanent works materials e.g. 300 ton of pre-stressing strand anchorages and ducts for the post tensioning works. Five sets of steel side formwork for the 344 precast beams enabled casting of beams and thereafter continued production of precast beams.

By the end of November 2019, the project overall progress was approximately 62% complete. Precast concrete beams for Morogoro Flyover where 91 out of required 91 beams have now been erected followed by casting of crossing tie beams and casting of decks to the Up and Down ramps. Concurrently Bridgeworks at Sam Nujoma and Nelson Mandela Bridge widening on both sides (LHS/RHS) are now opened to public traffic. Other ongoing works include drainage works, earthworks and pavement layers, asphalt paving, retaining wall works, piles/bases/columns/capping beams to Piers along Nelson Mandela and Sam Nujoma Road. The casting of capping beams, piling work for total 148 piles for Morogoro road Flyover is now completed (100%) while for Nelson Mandela/Sam Nujoma Flyover, 332 piles out of required 372 piles (89%) have been completed. Following successful installation of all 22 steel beams of 50m span at the middle of intersection of Morogoro Road and Nelson Mandela / Sam Nujoma Flyovers, the casting of in-situ 25mm thick concrete deck on top of these beams was also successfully accomplished. Figure 5 depicts aerial view of Morogoro Flyover after erection of all precast

concrete beams and casting of concrete deck for both flyovers at the middle of the interchange.

Fig. 5: Aerial View of Morogoro Flyover after Erection of all Precast Concrete Beams

11.0 CONCLUSSION

Ubungo Interchange under construction through grade separation is an important gateway to and from the city of Dar es Salaam. When completed, it will drastically reduce traffic congestion at the junction which previously operated at a critical level of saturation both during morning and evening peak hours and even at off-peak hours. The interchange will allow current BRT operations and in the future to flow uninterrupted within the Grade Separated Intersection. Design and construction of the interchange has necessitated the use of multi-dimensional project management approaches to address the many constraints entangling the project so as to ensure successful project completion. These included the use of innovative alternative designs, employing strict traffic management practices during construction, excellent plan for relocation of massive utility infrastructure, the use of synergy of well-coordinated inclusive organizational and site management practices, and articulate logistics in supply of both local and imported construction materials. All these have the potential for ensuring that the work progress continues to be in full swing despite the challenges so as to ensure that the project is delivered complete as per contract.

12.0 ACKNOWLEDGEMENT

The authors would like to express their profound appreciation to Eng. Patrick A. Mfugale, Chief Executive of TANROADS for his noteworthy advice that Ubungo interchange project was the most appropriate project to write a paper on as well as for granting the permission to do so. We are also indebted to Eng. Hendrish H. Nyange, the Consultant's Highway Engineer and Acting Resident Engineer for sparing his precious time to assist with making available the required information and for providing structured exploration of the construction site. Thanks are also due to QS Bahati Mbambe, the Quantity Surveyor for the Consultant and Eng. Zhong Zhengjun, Contractor's Highway Engineer also for providing some project information used in this paper.

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Fun Page

CONSTRUCT WORDS

L	J	A	Z	N	U	Q	I	V	E	I	V	K	M	T
Z	Z	S	R	O	O	I	T	X	N	D	T	H	A	N
L	N	M	W	B	L	I	C	M	E	H	R	Y	I	E
T	A	Q	M	E	I	A	T	L	G	U	J	Q	N	M
X	Z	B	N	F	V	T	U	A	J	L	D	Y	T	P
T	Q	I	O	A	Z	D	R	Z	T	D	M	U	E	I
Z	E	S	T	U	E	O	K	A	T	O	Q	A	N	U
O	C	I	L	H	R	F	L	F	T	B	U	W	A	Q
G	O	O	C	E	M	E	N	T	S	I	U	Q	N	E
N	Z	S	J	U	M	G	R	S	H	N	O	G	C	G
J	C	O	N	S	T	R	U	C	T	I	O	N	E	L
N	O	I	T	A	V	O	N	E	R	B	B	J	P	R
K	X	E	J	H	U	J	T	O	X	N	S	M	Z	A
I	O	B	Y	I	O	O	K	O	Q	L	S	W	Z	S
I	G	O	A	K	B	C	T	G	P	K	D	M	C	U

Arbitration Construction Excavation Maintenance Renovation
Cement Equipment Labour Quotation Schedule

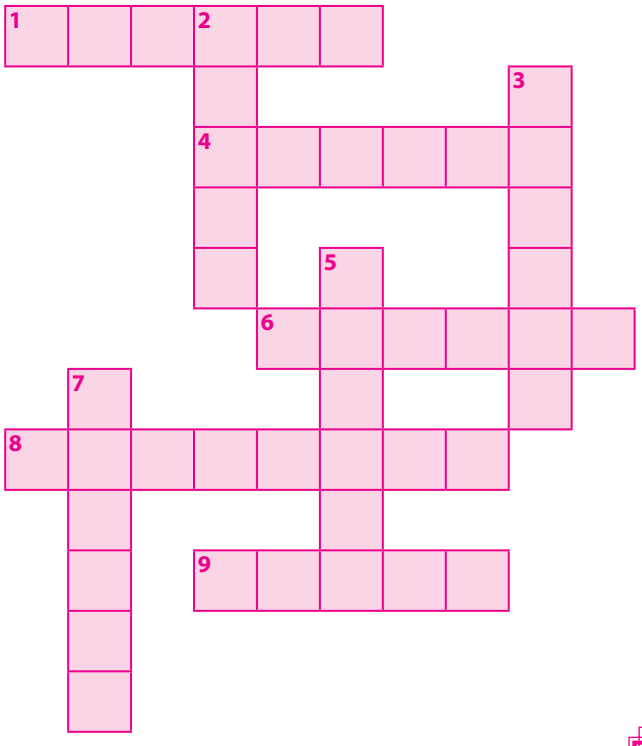
JENGA MANENO

Kuelekea Kulia

1. Mwanzo wa ujenzi
4. Kifaa cha kugongea
6. Kinga ya jua na mvua
8. Inayotumika kuunganisha mbao au bati
9. Hubeba mzigo wa jengo kwenda kwenye msingi

Kuelekea Chini

2. Huongeza uimara
3. Inayotokana na jiwe kubwa
5. Sehemu ya jengo inayokanyagwa
7. Kifaa moja wapo kwenye mlango



THE CHALLENGES FACING THE LOCAL CIVIL ENGINEERING CONSULTING FIRMS IN TANZANIA

John Kisunge,
ASL.CET, PgdEM

Abstract

The growing demand for professional services and inspiration in entrepreneurship has stimulated many local engineers to establish and register their own firms for providing engineering consultancy services. The need for such services in Tanzania is heightened by the rapid development in construction industry, advancement of construction technology and enactment of the policies that restrict the traditional construction practices (especially in urban areas). Such policies include the Engineers Registration Act No.15 (1997) and it's Amendment Act No.24 (2007), which instituted the Engineers Registration Board for regulating the engineering activities in the country.

By March 2019, the number of the registered local civil engineering consulting firms trading in the country was 186. The number of such local firms is increasing rapidly, however ambiguous business environment, competition pressure in the market, technical weaknesses and economic constraints have made it difficult for their business to grow and cross borders. This article is specifically exploring some factors contributing to the poor performance of local civil engineering consulting firms.

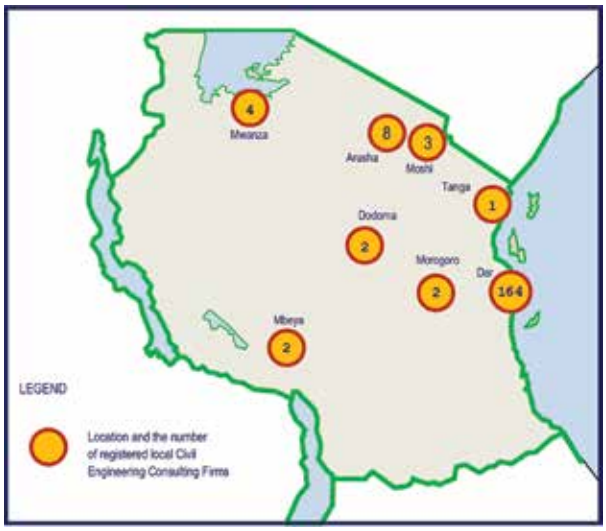
1.0 INTRODUCTION

Native consultancy services in Tanzania started some time back before introduction of the formal education in the country, as the ancient society used to get such assistances from well-known craftsmen (*fundis)*. In those days, social works were carried out communally and technical plans or spiritual practices were offered by prominent *fundis* (either for free or at a petty fee). The crafters (creative persons in manual or spiritual arts) were therefore being consulted by the individuals or social clans in case of technological or social challenges. The system fulfilled the societal desires; however, the engineering part of it was actually being practiced based on the use of commonsense (creativity) and imitation rather than scientific approach, which is based on calculations, formulations, testing and proof.

The modern engineering consultancy is a business-oriented process of providing specialized services to customers on some specific objectives related to practical applications of science to human activities. The demand for such services comes out when there is a situation that is thought about, which the initiator or the organiser cannot figure out him/themselves due to the level of expertise needed to accomplish the task.

Demand for such engineering advices (or assistances) is heightened by the rapid development in construction industry, advancement of construction technology and enactment of the policies that restrict traditional engineering practices in the country. That evolutionary change and inspiration in entrepreneurship have encouraged many local engineers to institute some firms for providing engineering consultancy services under the Engineers Registration Act No.15 of 1997.
Typical services offered by such local engineering consulting firms (in a single or multiple discipline) include; project planning, design development, supervision support, forensic investigation and other intellectual advices on challenges facing the societal undertakings. By March 2019, the number of local civil engineering consulting firms that

offer consultancy services in the country was 186. However, due to market forces, all 186 firms are based in eight major towns only, with Dar es Salaam as a home to 164 of them.



Source: Author/ERB

Fig 1 The distribution of local Civil Engineering Consulting Firms in Tanzania (by March 2019)

2.0 THE CHALLENGES TO THE LOCAL CONSULTING FIRMS

2.1 Traditional Practices

Until today, when the Engineers Registration Act is in force and is compelling the general public and all consumers of engineering consultancy services to use the services of the registered consulting firms, the roving craftsmen (*fundis)* are still the most illustrious consultants in the society than the registered consulting firms are. The engineering advices or practices offered by those *fundis* are not only treasured by the indigenous groups, but also by some of the organizations (especially in private sector) which put more importance to imitations than innovations.

Though partial distribution of the firms across the country is one of the factors impeding the indigenous groups from acquiring their services, economic consideration has made it much more difficult for the individuals and small societal groups to acquire such services, especially when comes that the fee has to include the administration costs (i.e., indirect labour, statute taxes, consumables, etc.) contrary to the roving *fundis* whose charges consider the direct labour only. Therefore, employing the roving *fundis* becomes the cheap option, regardless of the risks inflicted to the property owners.

Then again, it is noticeable all around the country that the focus of the construction regulations is shifted somehow to metropolitan areas than suburban and rural areas where the society is being served by home-based *fundis* anyhow beyond the reach of laws. In general, the large society is still unaware of the benefits of using the engineering consulting firms in safeguarding life and in sustainable development.

2.2 Ambiguous Regulations

The Engineers Registration Board compels the general public and all consumers of engineering consultancy services to use the services of the registered consulting firms only, and that *"the consulting engineers should offer the services in the name of the firms under which they have been registered"*. Furthermore, the Board underlines that *"it is unethical for any engineer to display his name on the construction site signboard"*. However, this decree contradicts with Section 10 clause (2) of the Engineers Registration amendment Act No. 24 (2007), which allows that (partly quoted) *"a consulting engineer may practice as an independent consultant or individual consultant as stipulated in the Public Procurement Act provided that he has satisfied the Board to have fulfilled the requirements as may be determined by the Board"*.

On the other hand, Section 3 of the Public Procurement Act 2011 defines a consultant as *"a firm, company, corporation, organization, partnership or an individual person engaged in*

or able to be engaged in the business of providing services in architecture, economics, engineering, surveying or any field of professional services, and who is, according to the context, a potential party or the party to a contract with the procuring entity"

Therefore, such contradictory regulations create dilemma on how to practice the engineering consultancy business in the country (is it absolutely under a registered **firm?** or also as an **individual**?). However, it is a viewpoint that practicing the engineering consultancy services solely in the name of the firm under which a particular engineer has been registered is focusing on transferring liabilities and reputes from an individual engineer to a firm rather than promoting the competitiveness amongst local engineers; since, the innovation and proficiency of an individual engineer cannot be singled out and acquired privately by the middle and lower-class society at economical charge.

2.3 Distracted Procurement Practices

The number of local civil engineering consulting firms is growing rapidly; however, the dominant market for their services is held by the public sector (central and local governments) that continually plans and undertakes major and mega projects for community welfare. Private sector offers a limited market for such firms as the majority tends to dodge the laws (construction regulations) for economic concerns.

The client (be it an entity or a person) is the manager of the procurement plan and his interest has a great power over the business. At this time of increasing competition in the consultancy business and immoral inspirations, the consulting firms are being coerced to woo the client's interest not only through professionalism, creativity and service quality, but also by 'ten-percent' move. This means that, for a local consulting firm to get business opportunities in the public sector the director has to craft a good connection and effective network in the procurement bodies for a favour and repay of illicit amounts (infamous '*ten-percent*').

Despite being contrary to the procurement act and good governance policy, the 'ten-percent' move draws back the performance of the local civil engineering firms, as they have been competing on creating connections and luring the procurement bodies rather than building the internal capacity, professionalism and creativity as major tools for competition in the market, in and outside the country.

2.4 Financial Constraints

Consultancy is a business-oriented service, which is expected to yield revenue for the property owner (client) and gain to the consultant. Prof. B. Kundi from the University of Dar es Salaam, in one of his lecture notes on Consulting Management (MG622) wrote that; *"from the client's point of view, the benefits obtained should be more than the price of the service, while in the consultant's view point the payment he receives should exceed his cost for undertaking the task"*.

The civil engineering consulting firms are required under professional ethics to provide objective and respectable solutions to the client's problems with professional independence (free from emotional, administrative, political or financial pressures). Such a reputable service can possibly be offered in an environment in which the client is committed in the business and service quality, and the consultant has a relevant experience and technology to tackle the assignment at a reasonable budget without tying his passions to other interests.

The Public Procurement Regulations 2013, GN 446 (Selection and Employment of Consultants) has set some criteria for selecting a consultant. However, the *least cost consideration* has paramount influence in

most bids than other technical values, thus forcing the bidders to compete on fixing very low rates in order to get the highest score in financial evaluation.

Such risky practices bring in severe blow on the financial powers and performance of the local firms, especially after securing a bid that requires deployment of substantial resources. The move to balance the operational costs with the available budget so often results in replacement of the high quality professionals recommended for the bid by recent graduates (cheap labour), evasion of some important engineering aspects (e.g., detailed investigation, advanced equipment, etc.) or production of a 'copy and paste' services.

Delay in payments is another mishap for the business. It has been unending tendency for the consultancy fees to delay by several months before being paid by the clients (especially in the public sector). Despite holding up the organizational revenues and development, the move detains the personnel salaries and incites unethical passions amongst site personnel, leading to a substandard performance.

2.5 Inadequate Proficiency

Despite the applied technologies and supporting tools, the engineering consulting firms basically invest in the professional expertise of the individuals they hire for providing the services. The increase of the number of universities and engineering colleges in the last decade has eased the difficulties of obtaining local graduate civil engineers to fill some posts in such firms. However, experience is still inadequate among many local engineers. It should be noted at this point that the construction industry in Tanzania got to its fast pace just in the last decade. Those who graduated some time back lacked (or had very limited) construction sites for attaining a substantial practical training. Therefore, a large number of the local civil engineers are still in a transition period of acquiring a considerable experience.

For that reason, foreign consulting firms appear to be more advantaged than their local counterparts are, as regards to an organizational structure and staff experiences. Still, the rates fixed for the local tenders are not lucrative enough to enable the local firms to employ foreign engineers. That makes it difficult for the local firms to compete with such giants in a market.

However, the government has reckoned this shortfall and has already introduced an empowerment policy in the public procurement regulations. The policy directs procurement bodies to grant a margin of preference for local consultants or association between local consultants or between foreign and local consultants. This preference drives the foreign consulting firms to associate with the local firms during bidding; hence, facilitating knowledge transfer to the locals. Due to their elegant profiles, these giant firms normally take the lead in the association and bring in the top-level personnel for supervision services or design contracts.

It has been noticed however that the large number of the foreign engineers mobilized into the country by the foreign consultants to take charge of the projects are just replacements of the highly qualified and experienced engineers proposed in the bids (business tricks). Regrettably, some of those replacements are just incompetent engineers or skilled personnel that come in through fictional CVs while they do not have significant experience required for their posts. This is evident in many projects around the country, where some foreigners are just there as 'rubberstamp' engineers to sign the paperwork produced by the local subordinate engineers or technicians. Therefore, the move has not so far benefited the local firms, due to the fact that most of these supposed expatriates are no help.

Although associating with the foreign consulting firms aimed at knowledge transfer to the local firms and complement to their respective areas of expertise, experience has shown that the foreign firms have been using their local associates just for logistics and collection of field data for design works that are to be carried out of the country; hence, no chance for knowledge transfer. In short, the move is being biased by business ambitions and is now (in my view) a contained illness that makes the local civil engineering consulting firms unable to perform to their full capacity.

Therefore, it worth concluding here that ambiguous business environment, competition pressures in the market, economic constraints and technical weaknesses have made it more difficult for the local civil engineering consulting firms to grow and cross borders.

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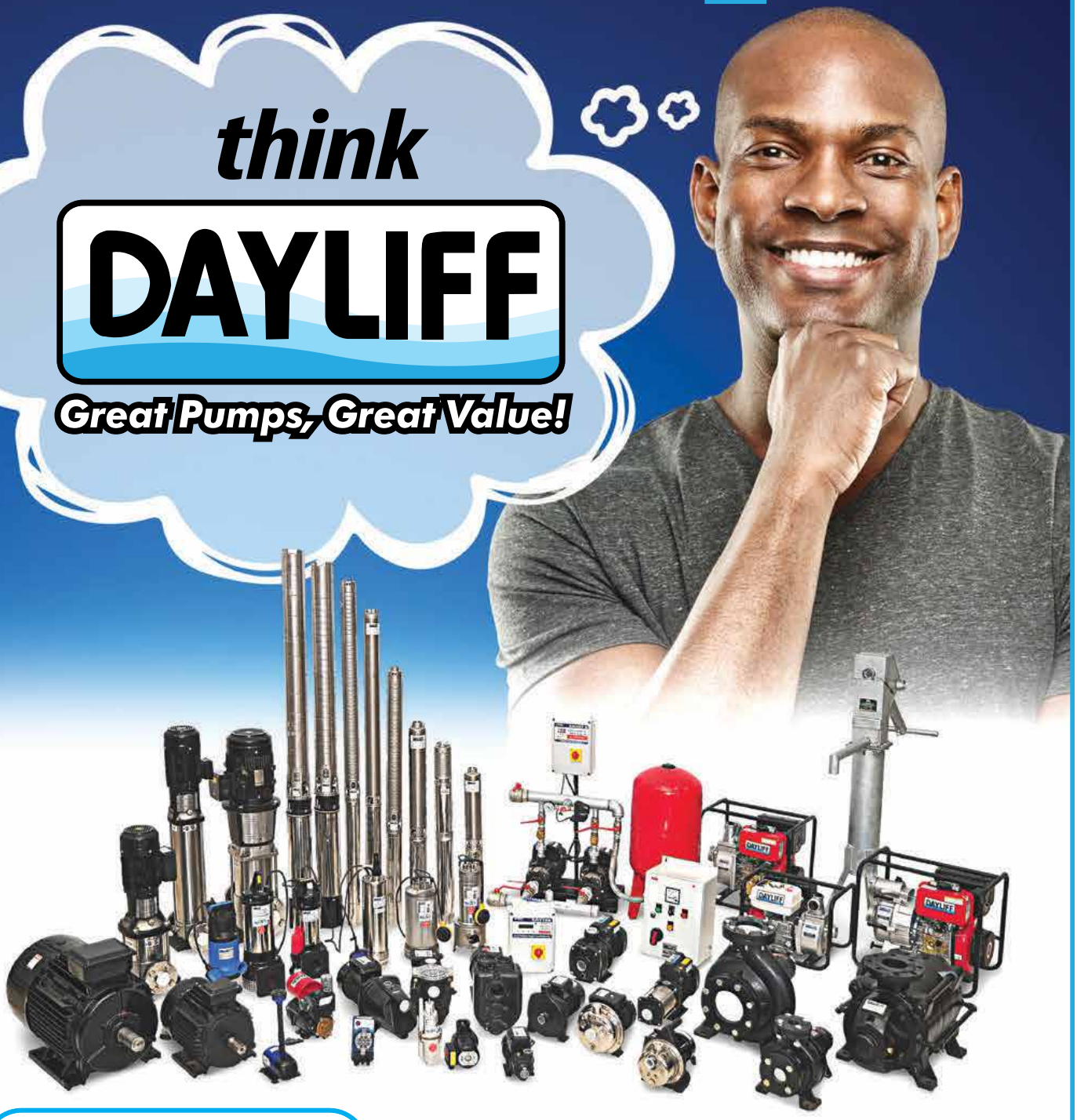

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NATIONAL CONSTRUCTION COUNCIL ARBITRATION PROCEEDINGS OVERVIEW

By Qs. Dorine J. Silayo

1.0 INTRODUCTION

National Construction Council (NCC) is the Government institution established by Act of Parliament No. 20 of 1979 (National Construction Council Act CAP 162 Revised Edition 2008). The mission of the Council is to promote and provide strategic leadership for the development of the construction industry in Tanzania. The mission is implemented through the execution of 15 functions embodied in the NCC Act that includes facilitation of efficient resolution of disputes in the Tanzanian construction industry.

In the course of coordinating and or facilitating dispute resolution, there are stages through which disputes are to be resolved. i.e. at the first instant, once there is a disagreement between the parties it has to be resolved through amicable settlement, failure of which it will have to be referred to adjudication depending on the provisions of the contract. In case of disagreement with the decisions of the adjudicator, the dispute will be referred to arbitration; this will also mainly depend on the provision of the form of contract which has been used.

The National Construction Council has been coordinating resolution of disputes since 1984. NCC coordinates resolution of construction project disputes, by mainly appointing conciliators, adjudicators and arbitrators. Under such a mandate of coordinating dispute resolution, the National Construction Council found out that it is necessary to have institutional rules to govern arbitral proceedings. The rules give guidance to a step by step way of instituting and manners of proceeding in arbitration. These rules help all parties to the arbitration to know their roles and what is required of them so as to foresee an expedited resolution of dispute. Furthermore, the rules are set in a way that they provide a leveled field where each party is given an equal chance to present and argue facts of their cases. Practically, the conduct of the parties can have a great influence on time and expenses incurred in the whole arbitration proceedings. Since the first publication in 1984, the rules have been greatly used in guiding the arbitration proceedings for disputes that arise under domestic contracts and at times under international contracts.

However, over the years there has been several misguided interpretation of the rules and the involvement of the National Construction Council in its role of coordinating Arbitration proceedings. Thus, this paper aims at giving a simplified guide on institution of Arbitration proceeding, conduct of arbitration proceeding and the role of the National Construction Council in coordination of the Arbitration proceedings.

2.0 INSTITUTION OF ARBITRATION PROCEEDING.

All Arbitration rules and conduct are established under Arbitration Act Ordinance No. 10 of 1971. That means, where there is limitation to

the rules, the Arbitration Act is to be referred. In instituting Arbitration Proceeding using the National Construction Council Arbitration Rules 2001 Edition, there are three facts that should be observed.

One, the contract in dispute should have a clause that clearly state that in the event of a dispute and the matter has reached a stage that it has to be referred to Arbitration, proceedings shall be guided by the National Construction Council Arbitration Rules. However, greater caution should be taken regarding dispute resolution clauses as some of them require parties before referring the matter for arbitration to have exhausted all the possible avenues such as amicable settlement, mediation or adjudication and that when they fail or disagree with the resolutions then they can refer that matter to Arbitration.

Second, parties have entered into a dispute then they can agree to use the National Construction Council Arbitration rules 2001 Edition and the same be communicated to the National Construction Council.

Third, whereas the matter in dispute was referred to court before it was brought for Arbitration and the court gives order to refer the matter to Arbitration under the National Construction Council, then parties are legally subjected to the National Construction Council Arbitration Rules 2001 Edition.

With regard to the above facts, when a dispute is referred for Arbitration at the Council by the claimant, the Council in the spirit of goodwill will request to hear the position of the respondent. The reason why this is done is to bring awareness to the other party of the intention to institute Arbitration Proceeding. Bringing awareness to the other party has sometimes succeeded in resolving the matter without actually going for arbitration.

In the event that, the respondent has indicated his/her readiness to go for arbitration as guided by the National Construction Council Arbitration Rules 2001 Edition, the Council will guide the parties in appointing an Arbitrator as per Rule 5 of the Arbitration rule. However, there are instances where the respondent may not either respond to the letter from the Council or agree to subject themselves to the arbitration rules.

In the event the respondent does not respond to any form of communication from the Council, then the Council will advise the claimant to refer the matter to court. The reason for reference to court is to get a legal mandate to subject the respondent to Arbitration. Furthermore, in the event respondent refuse to subject to arbitration proceedings while the contract provide for it as a means to dispute resolution, then the Council will advise the claimant to continue the matter ex-parte(with respect to or in the interests of one side only or of an interested outside party).

The National Construction Council Arbitration Rules 2001 Edition, under Rule 5 show all the procedures of appointing an Arbitrator and what is to be done in the event the appointed Arbitrator cannot perform his roles. It should be understood that, the selection of the initial three names is done by the Claimant and not the Respondent. However, the Respondent may reject all three names and thus require the Claimant to select another set of three names. It is only where parties are to have a tribunal with three Arbitrators that each party will have to nominate one name and the Presiding Arbitrator is selected by the National Construction Council.

3.0 CONDUCT OF ARBITRATION PROCEEDING

Under the National Construction Council Arbitration Rules 2001 Edition, once an Arbitrator is appointed, the National Construction Council role in the matter in dispute cease to exist. All communications in form of request, enquiry or any other clarification with regards to the matter in disputes are to be

addressed to the appointed Arbitrator and not to the Council.

Furthermore, when, where and how the arbitration proceeding are to take place is solemnly decided by the Arbitrator in agreement with the parties to the matter in dispute. However, time frame given under the rule will be used as a basis for any divergence.

It should be understood that, although the arbitration proceedings are flexible in the manner they are conducted, the parties should not abuse the flexibility as it has severe impact on cost and time. This is to say, parties should not entertain unnecessary adjournments and over the top request for extension of time for submissions.

4.0 ROLE OF THE NATIONAL CONSTRUCTION COUNCIL IN COORDINATION OF THE ARBITRATION PROCEEDINGS

The National Construction Council is the owner and custodian of the National Construction Council Arbitration Rules 2001 Edition together with the list of Panel of Arbitrators. However, the role of the Council with regard to the application and conduct of Arbitration proceedings is limited only to that of a facilitator.

The National Construction Council under Rule 6.4 of the National Construction Council Arbitration Rule 2001 Edition is conferred with authorization to retain one copy of any submission done by parties. This is to enable the parties or the Arbitrator to have a saved copy that they can refer to when one has misallocated or misplaced their own copy.

Furthermore, the Council will only act on directions and orders given by the Arbitrator to the Council. At no any particular time, can the Council give orders or directions to the tribunal with regards to the matter in dispute. Any communication from the Council will be addressed to the Arbitrator and that any communication to parties will only be made as per the Arbitrator's order or directions.

5.0 CONCLUSION

There are still various challenges with regards to the National Construction Council Arbitration Rules 2001 Edition which may be resolved by reviewing the rules. Nevertheless, the current Edition still serves as a greater guide in providing a quick and less costly means of dispute resolution.

We are to argue however that it is the conduct of the parties to the dispute that has turned Arbitration into a long and costly procedure that doesn't adhere to the rules, but rather left to linger on in the spirit of flexibility that is comforted in Arbitration▪

NEWS BRIEF

President Dr. Magufuli Opens Terminal 3 Building at Julius Nyerere International Airport

Tanzania's President Dr. John Magufuli (left) officiates the opening of the new terminal 3 at Julius Nyerere International Airport, which is expected to serve up to six million passengers per year

On 1st August 2019, Tanzanian President Dr. John Pombe Magufuli inaugurated a new state-of-the-art Terminal 3 of the Julius Nyerere International Airport (JNIA) in Dar es Salaam.

Terminal 3, which cost 722 billion Tanzanian shillings (about 314 million U.S. dollars) to build, will help the airport increase the number of passengers from 2 million to 8 million annually.

The president said that the construction of the terminal had been done using local funding. "Terminal 3 has been built using taxpayers money. As it stands, they need to feel the pinch of their money", noted the president.

"By accomplishing this grand project it shows that Tanzanians can achieve toward implementation of mega projects without depending on foreign funding," said president Dr. Magufuli.

He said it was now high time Tanzanians decided to implement and accomplish mega projects without donor dependence.

Dr. Magufuli mentioned other mega projected being implemented using local funding as the Rufiji hydropower project expected to generate 2,115 megawatts, the upgrading and renovation of 15 airports, the standard railway gauge, the longest bridge over Lake Victoria and the construction of roads, among others.

He urged the Ministry of Works, Transport and Communication and the Tanzania National Roads Agency to ensure that the new terminal was well maintained because it acted as the country's mirror for foreign visitors using the airport.

JULIUS NYERERE HYDROPOWER PROJECT TO SPUR SOCIAL ECONOMIC DEVELOPMENT IN THE COUNTRY

Talking of large hydropower plants in Africa, the Julius Nyerere Hydropower Project (JNHPP) is among them and it actually ranks number one in Tanzania. The project is located in Coast region, about 220 km southwest of the city of Dar es Salaam. The hydropower plant is planned to have an installed capacity of 2,115 megawatts (MW) when completed in June 2022. Project implementation became a reality on 26th July 2019 when the President of the United Republic of Tanzania, his Excellency Dr. John Pombe Joseph Magufuli, laid the foundation stone for the construction of Julius Nyerere Hydropower Project.

The project invigorates the Government of Tanzania's strong desire to providing its citizens with reliable and affordable electricity. The noble undertaking is intended to steer improvement and growth of social economic activities in the country. In turn this will enable sustainable economic growth through industrialization. Reliable supply of electricity at reasonable prices will reduce production costs, attract more investments and drive up the competitiveness of our industries. It will also enable establishment of many more large, medium and small business ventures in the country. These industries and businesses are crucial for spurring national economic growth and improved livelihood of the citizens. Agriculture contributes significantly to the national Gross Domestic Product (GDP). Therefore, improvement in agro-processing industries will tremendously enhance the income of rural population whose livelihood is mainly dependent on agriculture.

Despite its expected huge contribution to the economic development of the country, the project is expected to bring about positive impact to the indigenous people in terms of local content during the construction period. The local content involves employment of local engineers, technicians and labourers and using locally produced building materials as well as subcontracting some works and contracting out some services and supplies to local companies. Such undertaking will greatly enhance the income of the people close to the project and other Tanzanians as it will provide opportunities down to the levels of *mama lishe*. So, it will have a vast impact on the social and economic development of the people, especially those surrounding the project.

Currently the project has employed 316 local engineers or 92% of planned employment of 341 engineers and 160 local technicians or 24% of the planned employment of 678 technicians. As for the unskilled and semi-skilled labourers, a total of 1,169 labourers or 39% of the overall expected employment of 3014 labourers are presently working at the project site. Similarly 18 local companies have been employed in the project as subcontractors, service providers and suppliers of materials. Furthermore the project is expected to use more than 515,000 tons of cement and 67,500 tons of steel reinforcement produced by local industries.

Initially on 12th December, 2018, Tanzanians witnessed signing of the contract for the project between the Tanzania Electric Supply Company (TANESCO), ElSewedy Electric in joint venture with Arab Contractors. Arab contractors are undertaking the civils works while El Sewedy will install the electro-mechanical equipment including the turbines, generators and transmission lines. This historical project is expected to be implemented in 42 months since its commencement for a contract sum of Tanzanian Shillings 6.5 trillions.

In that occasion, his Excellency the President reminded Tanzanians that the project is part of Government's strategy to attaining sufficiency in electric supply. The plan is to increase output capacity from the current 1,601 megawatts to 10,000 megawatts by 2025.The planned output will be achieved through different sources including thermal (gas, coal and petroleum), geothermal energy, wind, solar and hydropower. Several hydropower projects are currently being implemented to contribute to this target, they include, Ruhudji (358 MW), Rusumo (80 MW), Kakono (87 MW), Malagarasi (44.8 MW), Mpanga (160 MW) and Rumakali (222 MW). Concurrently, several power transmission (400kV) projects are being constructed to enable every part of the country to be supplied with reliable electricity. The projects include construction of Iringa to Mtwara, Iringa to Mbeya and Mbeya to Sumbawanga, Kigoma and Nyakanazi as well as Dar es Salaam to Arusha and Singida to Namanga high tension power lines.

Gradually the Government has connected electricity to 5,109 villages in the past three years. It is projected that by 2020 more than 10,278 villages or about 84% of all villages in the country will be supplied with electricity at an affordable rate. The ultimate goal is for all 12,319 villages in the country to be supplied with electricity by 2025. These projects will further propel to the next level the efforts of fulfilling and sustaining Tanzania's goal of becoming a middle income nation by 2025 of course by blending with other planned economic activities and other infrastructure development projects▪

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SERVICES AVAILABLE AT NCC

The major services provided by the NCC include sector coordination, advisory services, and settlement of disputes, training, technical auditing, research, publications and information support.

Sector Co-ordination

National Construction Council coordinates the construction sector through policy is formulated by Ministry ! and Strategic Interventions, promoting the evolution of a conducive Institutional Framework and organizing Construction Industry Forums.

Advisory Services

National Construction Council provides advisory services to various stakeholders of the construction industry in areas including project planning, procurement and contract administration of works and consultancy services, project cost management, value for money auditing to mention just a few.

Settlement of Disputes

Since 1982, National Construction Council has been coordinating resolution of construction project disputes, by mainly appointing Conciliators, adjudicators and arbitrators.

Accordingly, NCC has a panel of Arbitrators from whom parties can choose mediators, adjudicators and arbitrators. Dispute through arbitration and adjudication resolution is guided by the NCC Arbitration Rules and NCC Adjudication Rules respectively. The number of cases handled by NCC since it started coordinating is more than two hundred arbitration cases.

Training

The National Construction Council is continuously implementing a number of practical oriented training initiatives. The major areas covered include: procurement, contract administration, project management, cost estimating. legal aspects of construction contracts, technical auditing, arbitration, claims management, contractor training, Public Private Partnerships (PPPs), labour based technology in road maintenance rehabilitation and construction, building maintenance, computer – based cost estimating and project management. Taylor-made courses are conducted on need basis from clients.

Technical Audit Services

The aim of technical auditing of construction projects is to provide top management and investors/financiers with an independent review, analysis, appraisal, comments and recommendations on those project management activities, which are adversely affecting successful project performance. This is in line with the requirements of the Act, which requires NCC to promote quality management including provision of technical auditing services in the construction industry. Technical audit of construction projects are being carried out for the purpose of highlighting deficiencies and recommending measures for improved performance.

Technical Publications and Information Support

Over the years, NCC has been progressively establishing a central reservoir of information for the construction industry. NCC publishes technical guidelines, maintains data banks, and manages a reference library. Available publications include: price fluctuation formula and indices, arbitration rules, adjudication rule, directory of construction materials, construction industry technical guidelines, basic statistical data for the construction industry and standard contract agreements for building works. This is also a technical publication of NCC.

Regional and International Collaboration

The Council has been participating in the World Road Association (PIARC) activities, International Council for Research and Innovation in Building and Construction and has been receiving documents from the same.
At the moment NCC is coordinating the activities of Construction Sector Transparency Initiatives (CoST) an Organization with international membership aimed at promoting transparency and accountability in the construction sector.

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