ORIGINAL

AUTHOR: AFCAP Participants

AFCAP Report on the Low Volume Roads Symposium Cairns, Queensland, Australia 25th -27th November 2013

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List of Abbreviations

AADT	Annual Average Daily Traffic
AASHTO	American Association of State Highway and Transport Officials
AFCAP	Africa Community Access Programme
ARRB	Australia Road Research Board
ASANRA	Association of Southern Africa National Road Authorities
BS	British Standard
CAPSA	Conference on Asphalt Pavements for Southern Africa
CBR	California Bearing Ratio
CMA	Cold Mix Asphalt
CSIR	Council for Scientific and Industrial Research
DCP	Dynamic Cone Penetrometer
DFID	Department for International Development
DRC	Democratic Republic of Congo
IRF	International Road Federation
LVR	Low Volume Road
LVSR	Low Volume Sealed Road
MESA	Million Equivalent Standard Axles
SARF	South African Road Federation
SEACAP	South East Asia Community Access Programme
TRB	Transport Research Board
TRL	Transport Research Laboratory
URRAP	Universal Rural Rods Access Programme (Ethiopia)

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It should be noted that the BSI Symbol and UKAS Accreditation mark signify that Crown Agents operate a documented Quality Management System registered with the British Standards Institution to the international quality standard BS EN ISO 9001:2008. The provision of consultancy services in revenue enhancement and expenditure and debt management including: customs, taxation and trade, human institutional and organisational development, engineering, procurement management advice and reform, health logistics and procurement services. The management of third party quality assurance and inspection services related to the supply of manufactured and processed products. International freight forwarding services utilising in house sub-contract warehousing. Verification of service as follows: Air Import – Clearance UK airport; Exports – Airport of departure; Sea Imports – Clearance UK port; Sea Exports – Port of loading.

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Section 1: Introduction

The Low Volume Roads Symposium was hosted by the ARRB group in association with the Queensland Department of Transport and Main Roads. It was held at the Hilton Hotel in Cairns, Australia, from 25th to 27th November 2013. The theme of the symposium was 'Communities on the Move'. It was attended by about 200 researchers and practitioners.

The main aim of the symposium was to explore ways of improving the management, provision and operation of low volume roads and to highlight relevant technical expertise and experience within Australia and other parts of the world. Sharing of knowledge and experience was achieved through various presentations by speakers from Australia, New Zealand, USA and Africa. The main topics of discussion included innovations in construction and materials technology, appropriate standards, road safety and geometric design, management of unsealed roads, community engagement, planning and investment. It should be noted that there are many similarities between rural access in Africa and parts of Australia, particularly with regard to climate factors and other physical constraints. The symposium therefore provided the opportunity to share experiences and inform participants.

AFCAP (Africa Community Access Programme) participated in the symposium as a platform for disseminating knowledge generated through its research projects conducted since 2008. The AFCAP contribution to the symposium included eight presentations on key research findings in Africa during the parallel technical sessions. There were also two AFCAP presentations in plenary sessions: 1) to provide a general overview of AFCAP and its achievements, and 2) to summarise research needs in Africa and to convey the vision of AFCAP for establishing a vibrant research community for the rural transport sector in Africa.

The ten presentations were as follows:

- **Guidelines for the Use of Sand in Road Construction**: Kabelo Motswagole (and Mike Pinard)
- **AFCAP Research on Cold Mix Asphalt**: Esther Amimo and Jon Hongve
- **Mapping Calcretes in Mozambique**: Joana Guiuele and Gareth Hearn
- **Community Engagement in the Management of First Mile Infrastructure in Kenya**: Grace Wahome (and Les Sampson)
- **Back Analysis of Previous Constructed Low Volume Rural Roads in Mozambique**: Kenneth Mukura (and John Rolt)
- **Design and Construction of Low Volume Rural Roads in Tanzania using the Environmentally Optimized Design Method**: Salehe Juma and Nkululeko Leta
- **Use of DCP Design Method in the DRC**: Estimé Mukandila (and Mike Pinard)
- **Low Volume Rural Road Development – the Ethiopian Experience:** Yetimgeta Asrat and Les Sampson
- **Overview of AFCAP- and a Vision for the Future**: Rob Geddes
- **Research Needs- An Overseas Perspective**: Les Sampson

The eight technical presentations were prepared jointly by the lead in-country researcher ("Primary Presenter") supported by a Senior Researcher who was also intimately involved in the implementation of the project. In some cases the presentations were made jointly by the two authors, whilst in other cases the presentation was made entirely by the Primary Presenter. In the latter case the name of the Senior Researcher is in parentheses in the list above. Practice sessions were held for all presenters on the day before the symposium started.

Unfortunately the presentation by Yetmgeta Asrat from Ethiopia could not be delivered by Yetimgeta because his entry visa application was declined by the Australian authorities. This presentation was given by Les Sampson on behalf of Yetimgeta.

AFCAP sponsored an information booth at the venue, which was managed by Pat Loots. The booth became a focal point for enquiries on AFCAP activities and accessing AFCAP knowledge outputs. Posters were used to illustrate each of the technical presentations at the symposium, and samples of AFCAP technical manuals were on display.

This report includes a summary of seven of the eight technical presentations as recorded by the Primary Presenters. (Yetmgeta Asrat was unable to attend and therefore did not submit a report). Feedback from other symposium participants is recorded, as well as personal perspectives of some of the AFCAP participants on their visit to Australia and their participation in the meeting.

The AFCAP PowerPoint presentations can be found on the AFCAP website:

http://afcap.org/blog/Lists/Posts/Post.aspx?ID=17

Further information about the symposium, including the symposium programme and all presentations can be found on the ARRB website:

http://www.arrb.com.au/ARRB-Conferences/Conference.aspx?id=4#%21

There were no written papers submitted to the conference.

Section 2: Summary of Presentations, Feedback and Lessons Learned

1. Guidelines for the Use of Sand in Road Construction

Kabelo Motswagole

Managing Director, Herbco Technical Services, Botswana.

1.1 Introduction

Crown Agents asked me to prepare a presentation for the Low Volume Roads Symposium on the topic "Guidelines for the Use of Sand in Road Construction". The purpose was to present the findings of the AFCAP research project that is developing specifications for the use of sand in the upper pavement layers for low volume sealed roads. The project is being implemented in association with ASANRA, the Association of Southern Africa National Road Authorities.

Samples of sands were collected in Namibia, Mozambique, Botswana, Malawi and South Africa and subjected to a range of laboratory tests. The testing regime was designed to understand the mineralogy and engineering characteristics of the sand samples. Some of the samples were taken from existing road bases and sub-bases, thus providing the opportunity to correlate performance with engineering and mineralogical properties.

The project is building on work previously undertaken in Australia where sands were classified for road construction in terms of their mean particle size (Phi units) plotted against the standard deviation of particle sizes (Phi units). The Australian classification system is now being verified against the large volume of data collected in southern Africa.

Figure 1: Hoopstad-Bultfontein Experimental Section (South Africa) built in 1962 with neat sand base

My presentation "Guidelines for the Use of Sand in Road Construction" was delivered on 25th November 2013 in Session 1.4: Construction and Materials. The presentation was completed within the time allocated, though I felt that 12 minutes was far too short for such a wide and complex topic. The presentation generated some discussions from the participants but there was not much to take home for us in terms of input into our research. It was however clear that the Australians were very familiar with the use of sands for road construction.

1.2 Lessons Learnt from the Symposium

There were very good papers presented at the symposium, especially the paper on the first mile-access for agricultural marking in Kenya by Grace Wahome. This concept was a major take home for

me and AFCAP must be congratulated for the initiative. I shall be discussing these issues with authorities in Botswana.

On the materials and pavement side it was clear from presentations such as the following (to list a few) that Southern Africa is not alone in the challenges facing the provision of roads to the rural areas.

- Reducing gravel usage and grading frequently by continuous compaction of unsealed roads with grader attached rollers
- A selection tool for unpaved road chemical treatment design
- Construction of low volume roads in Central West Queensland
- Use of natural gravel for base course and sub-base construction on roads in Western Australia

Indeed many of the initiatives that are being followed in Australia were implemented many years ago in Botswana. The participants were quite pleased that we could give them comfort in the use of these naturally occurring materials which were hitherto considered to be unsuitable. I managed to make very useful contacts for future research collaborations and exchange of information. Delegates were particularly keen to obtain the guideline on the use of sands when it is complete.

The lack of a field visit was a major setback on what was otherwise a wonderful symposium. Travelling through Queensland I noted the extent to which locally available materials were being used on low volume roads especially through farmlands. These are predominately weathered rock gravels and laterites.

In conclusion it was a worthwhile experience and I thank AFCAP for the opportunity. I thoroughly enjoyed interacting with the AFCAP team especially the young professionals. They all have a bright future in research.

2. AFCAP Research on Cold Mix Asphalt

Esther E. O. Amimo

Assistant Engineer, Materials Testing & Research Department, Ministry of Transport & infrastructure, Kenya

2.1 Introduction

My presentation at the ARRB Symposium was entitled "Cold Mix Asphalt Research in Kenya" and I was the 'Primary Presenter'. The presentation was made jointly with Jon Hongve, who has been leading the AFCAP research work in Kenya.

The presentation described research carried out in Kenya on the use of cold mix asphalt (CMA) surfacing for low volume roads. This technology is being used in Kenya to surface roads being upgraded under Roads 2000. CMA provides a durable seal with a good riding quality and is constructed using a highly labour intensive method. This supports the government policy of creating employment in rural areas through the roads sector.

Dwindling gravel resources has made construction and maintenance of low volume rural roads increasingly expensive. Surfacing of these roads is necessary to preserve the pavements and provide reliable all weather access to rural communities. Conventional surfacing techniques (Surface Dressing, Otta Seal) using hot bitumen has proven to be difficult for inexperienced contractors and frequently give low quality seals with risk of early failures.

The thin emulsion based Cold Mix Asphalt surfacing was developed in 2007/08 under the Expanded Public Works Programme in Limpopo Province, South Africa as a labour friendly alternative to bituminous surfacing using hot bitumen. The performance characteristics of graded gravel seals permit the use of lower quality aggregate than, say, for a Surface Dressing. To retain this advantage the thin Cold Mix Asphalt surfacing was designed around 0-10 mm graded aggregates. The Cold Mix Asphalt has since become very popular and has been successfully applied on a number of projects in different geographic locations (Pemba- Tanzania, Sumatra and Nias Islands– Indonesia and Central Province- Kenya) using various types of aggregates (e.g. basalts, coral gravel). The popularity is due ease of application, the simplicity of quality control and the reduced reliance on heavy and sophisticated construction plant and equipment. This makes it possible for small and emerging contractors to take part in the road construction industry. Additional benefits include reduced emissions of toxic fumes and greenhouse gases thus improving the working environment and reducing the carbon footprint of surfacing operations.

Figure 2: Mixing CMA by hand in trays

Figure 3: Spreading and levelling CMA between guide rails

2.2 Feedback from other Symposium Participants

Jon and I made our presentation on Monday, 25th November 2013 during the afternoon session (1.30pm -3.00pm). At the end of the presentation we received positive responses on the topic and the other symposium participants were ready to share their experiences on cold mix asphalt. I have since received information and publications on the topic from Kieran Sharp (ARRB Group Ltd), John E. Sullivan (Queensland TMR) and Erik Denneman of ARRB Group.

Generally in Australia, cold mix asphalt is mainly used for maintenance operations and its application is mainly machine-based unlike in Kenya where it is labour-based. The information obtained from Australian colleagues presents ideas and motivation for further research and also for the implementation of other activities required for the complete success of the cold mix asphalt research in Kenya.

2.3 Lessons Learnt from the Symposium

First, I would like to thank AFCAP and the ARRB Group for giving me the opportunity to participate in the symposium. Indeed, it was a much needed opportunity to share knowledge and ideas on the management of low volume roads. Since the symposium comprised parallel sessions, I was not able to attend all of the presentations. However, the presentations that I attended were very enriching. I particularly benefited from the following presentations among others:-

- Sustainable pavement and surfacing technology in the wet tropics by Dr Jasper Cook, Vietnam
- Innovative grading aggregate surfacing by Ryan Jansz of Australia
- Use of limestone aggregates in construction of basecourse and sprayed bituminous surfacing for roads in Western Australia by Geoffrey Cocks Australia
- Guidelines for the use of sand in road construction by Kabelo Motswagole
- A selection tool for unpaved road chemical treatments by David Jones USA
- Initial steps for pavement management of the unsealed network by Ernesto Urbaez and Kimberley Davis of Australia
- Structural assessment and granular overlay design for sealed low volume roads by Ed Baran and Jothi Ramanujam of Australia

The main lesson I learnt through each session was the need to achieve the most viable solution for the management of low volume roads by considering the function of the road, material availability, climatic conditions and available funding. The focus of the presentations was on the need to provide sustainable all weather access to communities. The symposium served as a forum for discussing

issues relating to planning, construction and management of low volume roads. From the presentations it was clear that the challenges facing the management and operations of Low Volume Roads are common to Africa, Asia and Australasia.

The participants first started by defining a 'low volume road' as one with an average daily traffic of 200-300 vehicles per day or one with traffic loading of less than 1million ESA. However, rather than designing a road based only on the traffic volume, one must also consider the value and function of the road as important factors in prioritising investment. I particularly grasped on the sustainability criteria which emphasize that decisions on the improvement of LVRs should be politically, socially, economically, environmentally and financially sound.

Roads Authorities and managers are faced with the common problem of constrained financial conditions. Engineers have a challenge in justifying investments in low volume roads to their governments. In most countries, low volume roads extend into thousands of kilometres compared to the much smaller networks of national roads, but the funding for LVRs is very little. With the limited budget Engineers and road managers are expected "to do more for less" i.e. provide access to rural communities all year round.

Innovations in road construction materials and methods provide a means of meeting the local community's expectations of smooth all weather roads on a limited budget. This also comes with the need to use non-standard methods and materials which are locally available. For instance, the use of hand crushed stone and block stone surfacing as applied in Vietnam can be considered for application in high rainfall areas. I also found the application of graded aggregate sprayed bituminous surfacing as a sustainable surface treatment option for low volume roads.

Chemical treatments for unsealed roads are widely used in USA. These treatments are very helpful in preserving fines in the gravel wearing course and for dust control on the roads. These treatments are good for maintenance operations of unsealed roads, but for the case of Kenya the chemicals can be very costly since they are not readily available.

I also benefited from the Planning & Investment and Design & Assessment sessions for low volume roads. The profiling of low volume roads using the ground penetrating radar (GPR) and a vehicle fitted with cameras and computers for collecting data was interesting. In Kenya, structural evaluation of low volume roads is not always carried out because of the high cost of commissioning the Falling Weight Deflectometer (FWD) equipment. We could benefit by using the light weight FWD for structural evaluation on these roads.

2.4 Recommendations

In future, I would recommend that a site visit is organised to some of the low volume roads where the various innovations have been applied for better sharing of knowledge.

As for Kenya, many LVR projects are currently being implemented in various regions with different approaches to rehabilitation and upgrading to all-weather standard. I think a workshop with key stakeholders would be useful to build on the momentum from the AFCAP research findings as well as information gained from the symposium to see how one can best address the LVR challenge in the coming years.

3. Mapping Calcretes in Mozambique

Joana Guiuele

Technician in the Maintenance Department, Mozambique National Roads Administration

3.1 Introduction

I made my presentation jointly with Dr Gareth Hearn. We described research carried out in the Inhambane Province of Mozambique for the identification of calcrete deposits that could be used in road works.

Calcrete is a pedogenic material that commonly occurs in arid and semi-arid regions of Southern Africa. It is one of the locally available materials for road construction found in Inhambane Province, where there are very few sources of hard rock. Calcrete is used for:

- Wearing course on gravel roads and base layer for paved roads where it is mixed with sand to reduce the plasticity. (The sand:calcrete mixture is usually 70:30, 60:40 or 50:50 depending on the plasticity of the calcrete).
- As coating aggregate with Otta seals.
- As aggregate for macadam pavements.
- For armouring of neat sand road bases: a 50mm thick layer of calcrete is applied over the base and rolled in prior to application of a bituminous seal.

Although there are a small number of large calcrete borrow areas already in production, the material is required for road construction and maintenance across the entire province and therefore additional sources of material were required to be found.

The study used a combination of remote sensing, field mapping, probing and trial pit investigations to locate calcrete deposits. It built on experience obtained elsewhere in Southern Africa, notably Botswana and South Africa, which had led to the recognition of characteristic ‘pan’ landforms associated with the development of calcrete. These classic ‘pan’ landforms were identified in Inhambane from small scale stereo aerial photography and investigated in the field using a calcrete probe, but most of these failed to yield any calcrete. Therefore the locations of existing calcrete borrow pits were examined in terms of their topography, geomorphology and vegetation pattern to see if common indicators could be found. This analysis indicated that known calcrete deposits were located in areas of very subtle low-lying, poorly-drained ground, where vegetation was sparse and dominated by certain varieties of thorn bush. Surface soils were grey or greyish brown silty fine sand.

The interpretation of stereo aerial photographs, Landsat 7 imagery, ASTER DEM topographic data, on-screen interpretation of Google Earth SPOT imagery taken in 2006, combined with field reconnaissance, was then used to identify other potential source areas of calcrete. These were investigated first by calcrete probe and then by trial pitting at 13 locations. Of these 13 locations, ten yielded calcrete, one yielded limestone and the other two yielded sand only.

Figure 4: Typical thorn bush land and grey sand soils – characteristic locations for calcrete

3.2 Feedback from other Symposium Participants

After the presentation we received compliments from the participants. Generally the participants considered that the subject was interesting, useful and can reduce costs and shorten construction periods of roads in those areas covered by the study by using calcretes. Participants wanted to know more about the indicators used in the study to identify the areas of occurrence of calcrete and the availability of manpower for carrying out the surveys. Another question was related to the current use of calcrete on the roads in Inhambane Province.

3.3 Lessons Learnt from the Symposium

I learnt more about how we can better manage low volume roads through optimizing the use of locally available materials and technology.

- The symposium showed that there is an increasing need to surface roads with low traffic volumes. It is possible to use materials with far lower acceptance values than are currently conventionally used, such as using materials with CBR values of less than 60% for road bases and still get good performance in service. It has been noted that the existing conventional specifications are too conservative especially in dry and semi dry environments where the use of the soaked CBR values can result in overdesign and the rejection of locally available materials.
- Experience of other countries shows that it is possible to produce good results with the use of lower quality soils, even when they are outside of the specifications: the art of the roads engineer consists for a good part in defining appropriate specifications that will make possible the use of materials he finds in the vicinity of the road works. Unfortunately, force of habit, inadequate specifications and lack of initiative have suppressed the use of local materials and innovative construction technologies. We need to consider whether materials are “fit for purpose” and “make specifications fit materials rather than materials fit specifications”. This approach needs to be supported by ongoing research.
- Revised specifications and techniques are required to allow the use of weaker aggregates for surfacing of low volume roads.

3.4 Recommendations

The following are recommendations for further actions related to the subject of our presentation that could be supported by AFCAP in the future.

- Extend the methodology applied in this study to other provinces in Mozambique where there is a potential presence of calcrete. According to the rainfall map of Mozambique, this would include Maputo, Gaza, Tete, Sofala and Zambezia Provinces.
- Provide guidance on the use of specifications for Low Volume Roads that allow more flexibility in the interpretation of the specifications in situations where material meeting conventional specifications is not available. The development of "armoured base" is an example of innovation in the use of local materials.
- Conduct further research on other pedogenic materials such as laterites which exist in large quantities in Mozambique so that these materials may be used in the construction of low volume roads. Publicise and implement the findings of research already carried out, including through the implementation of appropriate technical specifications.

4. Community Engagement in the Management of First Mile Infrastructure in Kenya

Grace Nyambura Wahome

International Forum for Rural Transport and Development (IFRTD)

4.1 Introduction

I made a presentation to the ARRB Symposium on Tuesday 26th November 2013. It was titled "Community Engagement in The Management of First Mile Infrastructure in Kenya". Prior to my participation at the symposium, I was asked to contribute an article to ARRB Low Volume Newsletter (Issue 140, December 2013).

The presentation was based on an AFCAP funded project known as "Rural Logistics for Smallholder Farmers to Meet New Agricultural Market Demands" implemented in 2012/13 in Kenya. The presentation highlighted the various stages of the transport chain in the small holder sector. These consist of the section from the farm to the primary collection point and the various intermediate stages (from collection points, to local depots/cooling points) and on to the terminal delivery points (for national/international markets).

The main focus of the presentation was the downstream transport segment – between the small holder farm and the 1st collection point - which is referred to as the 1st mile. The research highlighted the inordinately high costs in the 1st mile that can contribute up to 1/5 of the total cost of transport mainly on account of the poor infrastructure. Transport roles are gendered with women head loading and men using low-cost mechanized transport. Transport here is conducted on local paths and tracks that are typically in very poor condition and are particularly treacherous in the rainy season.

Figure 5: The difficulties of the first mile

Key findings of the research were:

- There is a need for complete network planning encompassing farm access infrastructure linking small-holder farms to the rural road network.
- There were examples of community efforts to ensure all season access for their agricultural produce, but the community requires technical guidance.
- There is a need for community, public and private sector partnerships in maintaining and improving the farm access infrastructure.

4.2 Feedback Received

The presentation was very well received. It had a different focus from other presentations that were on engineering dimensions of low volume roads. It was acknowledged that it was refreshing to bring in a planning perspective in which the concerns of the users of low volume roads were made visible. The following is a brief summary of the observations from the audience:

1. The first mile is important in determining traffic and freight volumes on the rest of the rural network. As such there is need to carry out research on transport bottlenecks between homesteads and the low volume roads to determine if there are simple planning and engineering solutions that can unlock such problems.
2. The presentation was based on indicative costs of the 1st mile transport. It was felt that it is important to carry out more rigorous research on agricultural transport costs and post harvest losses of the 1st mile. This would better help inform decision makers and planners on the benefit/costs of investing in the improvements of the 1st mile infrastructure.
3. The audience felt that there is need for more research in regard to models of community participation in the management of community roads and an assessment of basic technical capacity that members of the communities require to manage their infrastructure.
4. It was also expressed that there is a dearth of young researches in this field. This raised a lot of concern and was discussed at length at the final meeting on Thursday facilitated by Mr. Tyrone Toole of ARRB.

4.3 Lessons Learnt from the Symposium

I would like to expresses gratitude to AFCAP and ARRB for providing this platform for sharing, networking and learning. It was also an opportunity to get an introduction to the engineering aspects of rural roads. Hopefully, there will be more opportunities to participate in inter-disciplinary forums where engineering and non-engineering perspectives can come together. The symposium gave me an opportunity to network and it has been amazing to interact with the same networks on email subsequent to the symposium. I learned a lot as a young person and I was grateful to AFCAP for synchronizing the young and senior researchers. This helped a great deal and gave me confidence with my presentation.

4.4 Recommendations

I felt there was truly such a huge gap due to lack of young people in the symposium; all that wisdom with no one to transfer it to. There needs to be caucus that will focus on training of young people.

5. Back Analysis of Previous Constructed Low Volume Rural Roads in Mozambique

Kenneth Mukura

Senior Engineer, Transport Research Laboratory (TRL)

5.1 Introduction

This is a report on the ARRB Symposium on low volume roads, which I attended in Cairns Australia. The main aspects covered in this report include:

1. Content of the symposium.
2. New knowledge gained.
3. Overview of the symposium.
4. Conclusions and recommendations.

Attending this symposium was a great opportunity and the key areas of interest included:

1. Widening the scope of knowledge.
2. Learning about new approaches.
3. Recent research work being carried out by a sister organization (ARRB) and others.
4. Challenges being faced by other authorities in relation to provision of low volume roads.
5. Having used a number of references from Australia, it was an opportunity to get first-hand information.
6. Comparison of low volume roads in a developed country and low volume roads in developing countries was of great interest – looking at the opportunities to improve on approaches and technologies that could be adopted for situations in Africa.
7. Information on other fields outside engineering particularly the economics of rural roads provision and social issues.

The symposium was well attended and it was intriguing that most disciplines were represented and that the coverage was wide. The interactions with the experts in the different fields both in the workshops and outside gave participants new contacts for future consultations.

The symposium focused on low volume roads (LVRs), but it was interesting that a universal definition of “low volume roads” has remained elusive. Each region has adopted its own definition. This has led to complications downstream because the designs and specifications for LVRs depend on this definition.

It was also interesting to note that dwindling resources and high demand for low volume roads is not unique to Africa and the developing world, but also to the developed world where authorities are becoming less and less financially viable. This has become the main driver for seeking alternative approaches and more viable technologies even for the developed world. These sentiments were raised by the Mayor of Cairns, Cr Bob Manning and Dr. Dave Jones from the USA.

The symposium was therefore a platform to share knowledge and experience for the benefit of all, with the economists challenging the engineers to think outside the box in looking at road provision from an asset value perspective and sociologists pointing at service demand in relation to provision of transport services. The situations in the developing and developed world were surprisingly similar, though the communities in the developed world appear to be more vocal and assertive.

5.2 Content of the symposium

Below are some key subject matters that were of interest, the issues discussed and lessons learnt.

Subject	Issues	Mozambique situation
Low volume roads resource allocations	1. Low financial allocations $10,000 to $12,000/km/yr. This is higher that most Africa countries can afford. 2. Low volume roads suffer the most damage during floods. 3. There is no tolerance for road closures during the wet season to prevent rapid deterioration 4. Traffic is not high enough to justify investment. 5. LVRs are usually built in a hurry thus compromising quality. 6. There is a perception that specifications do not matter for LVRs 7. Acceptance of innovations is usually a big challenge. 8. Evaluation of options e.g. pavement and surfacings (appropriate and cost efficient) is very important. 9. Lack of maintenance renders good solutions into failures.	1. This is much more than is spent on maintenance in Mozambique (at most $1000/km per yr.) 2. Floods take place annually inducing high costs. 3. Traffic on unpaved roads in wet weather is a major cause of damage on unpaved roads in Mozambique. 4. Low traffic affects the justification of main roads too. 5. Quality control is a major problem in Mozambique. 6. Quality control has improved but a lot remains to be done. 7. Uptake of research is relatively good in Mozambique. 8. Options have increased through recent research but they may not always be considered. 9. Crack sealing, rejuvenation and reseals are almost non-existent.
Innovations	1. Graded aggregate total surfacing treatment (GATT) a. No prime used. b. No need for pre-coating. c. Used mainly for reseals, soft binders helping crack healing.	1. Otta seals or graded seals increasingly a preferred option. a. 0.6L/m2 prime used b. No pre-coating c. Not used for reseals but need to embrace the idea.
	2. Strategies to increase life of sealed LVRs. a. Pavement preservation through sealing. b. Rejuvenation through fog sprays. c. Surfacing preservation through fibre glass in surfacing, 35years + sounds viable.	2. Back Analysis Project showed that surfacing was deteriorating twice as fast as expected. a. Pavements are performing well. b. Rejuvenation is rare – already started discussions with ANE to implement. c. Need to trial fibre glass in surfacing at small scale
	3. Automated road condition signs a. Centralised control and management of the network using satellite connectivity b. Involves affected communities to report on the condition of the network.	3. Too advanced for Mozambique a. Centralised real time network condition is a good idea. b. It is possible to collect information from the public at no cost (worked for Zimbabwe on policy that a pothole should not last for more than 48hrs.)
	4. Use of limestone in the construction of bases. a. Low traffic (50vpd) => design. b. Now 5,000 very heavy off road train trucks yet no failures. c. Double surface dressing, no prime 1.6L/m^2 tack and 1.0l/m^2 seal.	4. There is limestone in Inhambane Province (ANE/TRL Calcrete Project) a. Traffic is low (< 100vpd) b. Logging is bringing in very heavy trucks. c. The surfacing design seems low cost and should be trialled.
	5. Use of screened gravel waste – very coarse material. a. Cheaper. b. Very high strength.	5. TRL discussing use of very coarse gravels for bases and sub-bases. a. Used on Cumbana-Chacane calcrete/sand base and Inhacufera-Machaze projects.

		b. Very strong, hard to penetrate with DCP.
	6. Chemical stabilisers – USA experience a. Not all are "snake oils" b. Robust evaluation process developed in USA. c. Some chemicals had proven performance over 50 yrs.	6. Chemicals like ROMIX were trailed unsuccessfully. a. Need to learn from USA experience. b. TRL evaluation process can be improved. c. Need to trial properly proven chemicals.
	7. Maintenance of gravel roads – blending of materials for better performance.	7. This is already being researched and used in Mozambique – cross pollination of ideas will be fruitful.
	8. Drainage design in tropical climates a. Link-slab bridge decks b. Link-slab causeway	8. Mozambique uses Bailey bridges which are fast running out due to continued flood damage. a. Link-slab bridge decks can be bolted on and off and can be manufactured locally and cheaply. b. Link-slab causeways are particularly useful on crossings with soft sand.
	9. Design and construction of LVRs in Queensland a. Mud rock – CBR 30-80% b. Red loam – CBR 30-60% c. Sand stone – CBR 20-30%	10. Design and construction of LVRs in Mozambique. a. Have used sands and other materials with CBR < 40% not sure whether it was appropriate or not. b. Weaker materials can be used as bases. c. Need further research to determine lower limits of strength.

5.3 Overview of the symposium

Many topics were discussed and some were very practical and clearly demonstrated the value of research. The following issues are worth noting.

1. There is little coordination and dissemination of research outputs and importantly vital findings.
2. The platform offered by the symposium was very important particularly for researchers in that:
    a. New research approaches were discussed.
    b. New knowledge gaps were identified and could guide future undertakings.
    c. Learning about failures and challenges from experience elsewhere minimises loss of time and resources through avoiding "reinventing the wheel".
    d. Discussion of research findings at such high level meetings leads to in-depth assessment which enriches research.
3. The spectrum of expertise was also a positive development which means many issues could be decided on from a perspective of credible knowledge and experience.
4. The negatives were also there:
    a. The relative absence of young engineers and practitioners was not appreciated and will certainly lead to loss of memory institutionally: AFCAP should take note of this.
    b. Privatisation has led to loss of training ground for engineers as companies are not able to accommodate young inexperienced practitioners.
    c. Time was very limited and as such some important discussions were cut short.
5. The AFCAP team shone at the symposium with high standards of presentation, interesting research work and tangible and implementable results.

5.4 Conclusion

Attending this symposium was very useful and beneficial and there was a lot to learn on how to do things and also how not to do things. The cross-pollination of ideas and sharing of knowledge and technologies is important for improved efficiency and effectiveness in the provision of community access.

It is recommended that in the future such opportunities be taken advantage of and should include more of the country champions in innovation and research. There should be a central electronic or technical media forum where discussions can be continued outside conferences.

6. Design and Construction of Low Volume Rural Roads in Tanzania using the "Environmentally Optimized Design" Method

Salehe Juma

Maintenance Engineer- Tanzania National Roads Agency (Tanroads)

6.1 Introduction

First of all, I would like to thank AFCAP under Crown Agents for giving me the opportunity to attend the Low Volume Roads Symposium 2013. This Symposium was very interesting and gave the opportunity to learn many issues in regards to low volume roads. Given the nature of my daily duties, which mainly consists of managing low volume roads in Ulanga and Kilombero Districts in Tanzania, it was a very enriching experience for me to attend this Symposium.

The aim of this Symposium was to explore ways to improve low volume road management, operations and construction and to highlight the technical expertise within Australia and overseas regarding the management of low volume roads.

The Symposium was well organized and the presentations were grouped into closely related themes like accessibility, appropriate standards, planning and investment, innovations in construction and materials, design and assessment, safety and geometric design. However there were parallel sessions thus making it difficult to attend all interesting presentations, but I tried to make the most of it by attending as many as possible of the most relevant presentations. The presentations were organized in a way that the parallel sessions were on different themes, and also the posters were available to view from day one and throughout the length of the Symposium, so even if you could not be present for one of sessions, there was plenty of time for viewing the posters, introductions to other experts and discussions after the presentations and during coffee breaks.

The main thing I learned from this Symposium through each session I attend was about the importance of conducting research to understand the real situation related to the challenges and available resources for providing access to communities. Not only did I hear about wonderful strategies for Design, Construction and Management of Low Volume Roads, but I had a chance to present to an international audience and to share experience of what I have been doing in my country to provide all weather accessibility.

I presented one of the nine presentations from our group, and it was well received. The presentation was on "Design and construction of low volume rural roads in Tanzania". The presentation was under Session 3.1 Design and Assessment, which included 4 presentations. The time allocated for each presentation was 15 minutes.

6.2 Lessons Learnt from the Symposium

I will describe briefly below some interesting issues discussed in the Symposium.

Use of the DCP design method in the Democratic Republic of Congo

This presentation discussed the DCP design parameters in the DRC environment and compared the DCP method against existing practice for designing the upgrading of low volume roads. The presentation highlighted the social benefits of implementing the DCP method such as knowledge transfer and job creation, including training of local technicians and engineers (the DCP test is relatively simple and local people can be trained to use the device). The provision of improved access to remote areas through low cost sealing of roads will lead to elimination of dust, better riding quality, and improved safety, reduction of accidents and increase of interaction between

communities. The purpose of the research project is to verify the application of the DCP design method under the environmental conditions found in DRC, particularly the high rainfall.

Low volume road construction insights – Queensland flood recovery program

This paper discussed how to overcome four challenges in the field. These were: conditioning locally sources of gravel material to achieve compliance, maintaining a consistent uniform final surface prior to sealing, the implementation of highly mobile dynamic Traffic Guidance Schemes, and balancing the risks associated with opening up large numbers of schemes.

A central factor in overcoming these challenges was contractors proactively examining their process and making changes where required. A second factor was the steps implemented by the construction administration team to assist the contractors to overcome these challenges.

Use of limestone aggregates in construction of base course and sprayed bituminous surfacing for roads in Western Australia

This presentation described the design and construction of granular pavement and sprayed bituminous surfacing for a remote road network using local limestone aggregates for one of the largest liquid natural gas (LNG) projects in Australia. The road network is situated on a "Class A' nature reserve island. The following challenges relevant to local geology and potential sources of pavement and sealing aggregates were identified.

- The importing of good quality pavement and aggregates from the mainland was expensive.
- Stringent quarantine issues were associated with imported material
- Potential delays in the logistics chain for the main LNG project works would occur due to importing of aggregates
- Use of local limestone material sourced during construction of the LNG plant was the only alternative to importing materials.
- Closing of roads to traffic was generally not permitted.

Material from the island generally comprised micro – brecciate bioclastic limestone with calcareous sandy mudstone infill. Laboratory tests included petrography analysis, particle size distribution, Atterberg limits, California Bearing Ratio, average least dimension, flakiness index, degradation factor, Los Angeles Abrasion etc. The base course of the roads comprised locally sourced crushed limestone material. Stringent environmental conditions did not allow construction of temporary bypass roads during seal application on existing roads. Sprayed bitumen prime on the base course was not acceptable due to potential disruption in regular large heavy vehicle movements.

A non conventional 14 mm primer seal followed by a 7 mm seal was selected as the sprayed bituminous surfacing option for large heavy vehicle movements with delays of less than an hour during construction for the seal. Class 320 bitumen was used as the binder. Adjustment was applied for absorptive base course and sealing aggregates.

Other topics of interest included the review of the sustainable pavement and surfacing technology in the wet tropics which offered a very timely overview of the state of knowledge on this area, as this is another area I am just getting involved. The presenter Dr. Cook talked about three key principles. They were: Sustainability- the road must meet key sustainability criteria; Environmental: the road design must be compatible with the local environment, and; Task based- road must suit its identified function.

6.3 Conclusion

In conclusion, the Symposium was worthwhile and in this instance I was able to achieve my objectives as I gained an overview of different aspects of Low Volume Roads, and also had useful

discussions with key researchers in the area, making a few useful contacts along the way. Since this was my first international conference I also know what to expect from my next one, especially if I am to make an oral contribution. Finally I would like to take this opportunity to thank the AFCAP under Crown Agents for their financial contribution, which made it possible for me to benefit from such experience

7. Use of DCP Design Method in the DRC

Estimé Mukandila

Materials and Pavement Engineer, Aurecon, Pretoria.

7.1 Introduction

The African Communities Access Programme (AFCAP) is supporting the design of two Low Volume Sealed Road research sections in the Democratic Republic of Congo (DRC). This project is using the Dynamic Cone Penetrometer (DCP) design method for evaluation of the existing road pavements and assessment of materials required for pavement strengthening prior to surfacing.

The Dynamic Cone Penetrometer (DCP) has been used successfully for the design of low volume sealed roads in a number of African countries including South Africa, Kenya and Tanzania. The DCP design method substantially reduces the cost of expensive materials investigations and testing, while the relative simplicity of the approach and analysis reduces the time involved in the design of these pavements. The purpose of the research project is to verify the application of the DCP design method for the upgrading of roads within the particular environmental conditions found in DRC, including the high rainfall and local tropical soils.

The Democratic Republic of Congo (DRC) is one of the largest counties in Africa by land area (2,345 km^2) with an unpaved road network of more than 30,000 km, which represents the majority of the total classified network. Due to its long history of conflicts, less than 40 per cent of these roads are believed to be in a good or fair condition leaving many communities without reliable access. The use of the DCP design method in this environment offers potential reductions in design and construction costs, thus enabling a greater proportion of the network to be upgraded with the funds available.

The presentation discussed the DCP design parameters under the project environmental conditions and compared the DCP method to more conventional approaches to designing LVSRs. The presentation highlighted some social benefits of using the DCP method such as:

- Knowledge Transfer and job creation, including training of local technicians and engineers: the DCP test is relatively simple and local people can be trained to use the device.
- Provision of improved access to remote areas through low cost sealing of roads leads to elimination of dust, better riding quality, improved safety, reduction of accidents, and increase of interactions between communities.

Figure 6: DCP testing in DRC

7.2 Feedback from other Symposium Participants

One of the aims of our presentation was to promote the DCP design method in comparison with the CBR method. In this regards we expected conservative resistance to the criticism of the CBR testing, but surprisingly the audience received and accepted the message of promoting the DCP method as an alternative to the CBR method. Although we were the last presenters at the symposium, we received some reactions, most of which were positive or constructive including:

- The DCP design method should be investigated for use on high traffic roads (highways);
- An alternative method for the determination of uniform sections such as statistical cluster analysis using R statistic programming should be investigated as an alternative to the CUSUM method;
- Long term in-situ moisture content should be accurately assessed during the design stage to ensure optimum performance and long life of the LVR pavement.

7.3 Lessons Learnt from the Symposium

The following is a summary of key lessons learned as a result of participation in the symposium.

- Power Point Presentations should be clear, brief, focused on the main object of the message, and simple. The presentation should be drafted, reviewed and finalised timeously (at least a week before the event).
- Confirmation of the fact that DCP testing procedure is a potential alternative to CBR testing: this seems to have an international agreement.
- Design of LVRs is fairly advanced in southern Africa compared to some other parts of the world.
- Some in-situ materials that don't fulfil standard specifications (e.g. laterite) can be used to construct good performing LVR.

7.4 Recommendations

The following are some recommendations related to the subject of the presentation that could be supported by AFCAP.

- The moisture content is one of the key parameters in the performance of LVR. We suggest monitoring the moisture variation during the construction period and the life time of the two research sections in the DRC. After a certain period (2 to 3 years) of usage of the road, moisture data collected should be compared to the anticipated long-term in-service moisture content assumed during the design. The correlation and calibration between the two moistures should be investigated.
- The use of the 20^{th}, 50^{th} or 80^{th} percentile of DCP penetration (DN) values from the field survey should be investigated in relation to the moisture content. What are the upper and lower tolerances of average in-situ moisture that will define the following relationships: higher than OMC, lower than OMC and equal to OMC? These cut-off values determine the use of 20th, 50th or 80th percentile of DN values in the design.

This was a very welcome and essential initiative from AFCAP as it allowed not only knowledge transfer but exposed AFCAP research activities to an international audience. This initiative permitted social interaction between different people working on AFCAP projects. More engagement of AFCAP in such activities would bring more international recognition and more knowledge of AFCAP projects.

8. Low Volume Rural Road Development – the Ethiopian Experience

Les Sampson on behalf of Yetimgeta Asrat

8.1 Comments on presentation

The presentation was very well received with many positive comments during informal discussions.

A general comment made by the Chairperson of the session was that the participants were impressed with the development plans and achievements of the Ethiopian Road Sector Development Plan and especially the commitment to improving basic access to rural communities through URRAP.

The importance of ensuring that communities who were involved in the construction of the all-weather access roads, are also involved in the maintenance of the roads on an ongoing basis, was mentioned by one participant during question time. The sustainability and permanence of the 300,000 job opportunities that have been created was also highlighted as an issue that needs to be addressed by programmes such as URRAP. The presenter responded that the Ethiopian Roads Authority were very much aware of these issues and were optimising the permanent job opportunities emanating from the programme. It was also pointed out that capacity building at Wereda (District) level and the importance of maintenance was integral to the programme.

There were also many very positive comments on the Low Volume Roads Design manual and the other manuals that form part of the ERA suite on manuals and documents used in the design, construction, maintenance and management of the Ethiopian road infrastructure. Because of Yetimgeta's unfortunate non-participation in the symposium there were no hard copies of the Ethiopia LVR manuals on the AFCAP stand for delegates to look at the contents. However, the ERA and AFCAP web site addresses was given to the many participants who wanted to access a soft copy of the various manuals.

8.2 General Comments on the Symposium by Les Sampson

The following comments are provided based on my experience of the symposium:

- The visit provided African researchers with exposure to international practice and the wider international environment. This was a great success and should be repeated on a more regular basis, but the capacity development component should be managed in a strategic manner that responds to needs at different levels in road transport institutions in Africa, including senior decision makers and technical staff. This challenge should be a core feature of the proposed AFCAP 2.
- The mentorship and training in giving presentations was a key positive output of the event and contributed to the success of the visit. Several positive comments were received on this approach from non-African participants at the symposium. It is recommended that further opportunities should be provided for the AFCAP participants to repeat their presentations to different audiences.
- Based on comments received on my keynote presentation on future research needs and initiatives, it was interesting to compare the Australian perspective given by Richard Yeo with the African perspective presented by myself. As pointed out in a previous presentation related to road management, but very much relevant to the research agenda, the first step is to gain external acceptance by stakeholders that there is a need for research to improve delivery and management of roads and the associated transport services. Secondly there needs to be good institutional capacity; and finally there needs to be technical focus to address the needs. The Australian road research capacity is well established and

institutionalised and it was highlighted that without a solid institutional base for research it is difficult to provide a sustainable technical focus. The maturity of the Australian situation dictates that their focus is very much on the technical needs as presented by Richard Yeo. The situation in Africa is that while the need for sustainable roads and transport research is well accepted, the institutional capacity still needs to be developed in all countries in Africa (apart from South Africa). Without sound institutional capacity, it will be difficult to sustain the technical priorities for research that are identified. The feedback from non-African participants at the symposium confirmed that the strategic approach being adopted by AFCAP in developing national research centres and supporting structures to sustain the centres are fundamental to addressing the many technical needs that have and will be identified.

9. A Personal Perspective – by Mike Pinard

9.1 Scope of Conference

The wide variety of topics presented at the conference under the heading "low volume roads" underscores the importance of adopting a holistic and integrated approach to the provision of such roads. Not surprisingly, there were a number of papers presented on asset management, road maintenance, planning and investment which provided a good appreciation of "the big picture". The most innovative approaches to the specification and designs of LVRs using non-standard materials will come to little if other inter-related aspects are not also adequately addressed.

The importance of adopting eco-friendly approaches to the provision of LVRs was not specifically addressed in any presentation, although mention was made of environmentally friendly pavement preservation treatments (Session 1.2: Strategies to maximize the life of sealed low volume roads) and the importance of reducing demand for use of naturally occurring materials, particularly as gravel roads with their accompanying dust problems.

Lesson learnt from the symposium: An enhanced awareness of the complementary aspects of LVR provision, some of which could be the subject of greater attention in the planned AFCAP 2. Also, greater attention to the use of more eco-friendly methods of road provision including conservation and sustainability considerations.

9.2 Definition of a LVR

It became apparent from the examples given by a number of presenters that the definition of LVRs is not just related to AADT and MESA. In fact, there are a number of other attributes which should all be part of a more holistic definition of a LVR. These other attributes include:

- almost exclusive reliance on the use of naturally occurring, often non-standard materials, many of which are quite moisture sensitive;
- the "relaxation" of geometric design standards within an "Extended Domain Design" context without undue increase in the risk of road users, coupled with a focus on traffic calming measures in built up areas;
- pavement deterioration is driven primarily by environmental factors (particularly moisture), with traffic loading being a lesser influential factor in deterioration;
- conventional economic analysis often cannot justify the investment of public funds in the construction and maintenance of these roads.

Lesson learnt from the symposium: We should avoid the notion that a LVR is defined only in terms of traffic numbers and loading as this obscures a number of other integral attributes of such roads which should be clearly appreciated by funding agencies, political decision makers and technocrats. An appreciation of the other LVR attributes indicated above will guide designers in producing more "complete" LVR designs with an emphasis on using a fit-for-purpose, context sensitive, environmentally optimized approach to design and construction.

9.3 Knowledge Sharing Through Technology Transfer

Since Australia and Southern Africa are located at more or less on the same geographic latitude, the environments of these two regions, in terms of climate, type of materials, etc., is very similar. Climate imposes certain similar constraints and stresses on pavement materials, and the use of naturally occurring, non-standard materials is a common challenge that both regions are pursuing in slightly different ways. Not surprisingly, a number of papers from both Australia and the Southern

African region dealt with the innovative use of sands and pedogenic materials and the greater sharing of such information can only be beneficial to both regions.

Lesson learnt from symposium: The importance of engendering a closer, mutually beneficial, collaboration programme between ARRB and research organisations in Africa.

9.4 The Significance of Testing Standards

The issue of the significance of the different testing standards used in undertaking research was not mentioned at all during the conference. This is of critical importance when comparing specifications for material selection. Australia's test standards are aligned to BS standards and, as we are now well aware, these standards differ in a number of important respects from AASHTO standards. Thus, comparing CBRs or PIs obtained from Australian research with that obtained from similar material in say Ethiopia or Mozambique, where AASHTO standards are used, would be very misleading. (Some countries in Africa, particularly ex-British colonies, use BS testing standards).

Lesson learnt from the symposium: Research from one region cannot simply be transferred to another unless the environments in which such research has been carried out are very similar and, equally importantly, the testing standards used are the same. In the case of the Australia/Southern Africa regions, the environments are similar but the testing standards are different in terms of the use of AASHTO or BS standards. Thus, comparison of results should be treated with caution.

9.5 Take Home Issues

(1) AFCAP presentations

The eight AFCAP presentations were all of a commendable standard and, indeed, probably took the non-AFCAP participants by surprise, more so as there was only one female presenter from non-African countries whilst from AFCAP there were three!

In a number of respects, the AFCAP research work has produced some significant insights into the use of naturally occurring, non-standard materials and the design of LVRs that would be of particular interest to others at the conference. For example:

- The use of the DCP as a sound, simplified and robust approach to the design of LVRs (the DRC and Tanzania presentations) in preference to the more traditional and notoriously, unreproducible, CBR method.
- The lack of correlation between road performance and traditionally, separately specified parameters such as PI and grading (the Mozambique Back-Analysis project) and the significance of more representative parameters, such as the DCP DN value (DRC DCP presentation).
- The use of a wide range of surfacings such as CMA (the Kenya presentation), and various hybrid seals (trialled in Mozambique but not reported upon at the conference), which are not yet used in Australia. Interestingly, Australia is currently involved in Otta seal trials (Session 1.2: Innovative grading aggregate surfacings) based on the pioneering work carried out in Botswana
- The importance of considering the so-called 'first mile" in road network planning which often escapes the attention of road planners (the Kenya presentation).
- The importance of undertaking LVR provision in the context of an all-encompassing EOD approach (the Tanzania presentation) in which all seven dimensions of sustainability are addressed.
- The extension of the research work on sands that has been carried out in Australia through a back-analysis of existing roads in the Southern African region as a basis for relating the

engineering and mineralogical properties of these materials to their performance (the Botswana presentation).
- The benefits of efficiently and economically locating road construction materials using appropriate mapping techniques (the Mozambique calcrete mapping presentation).

(ii) Non-AFCAP presentations

A number of non-AFCAP presentations offered some valuable pointers for consideration in the Southern African region. They include:

- The use of appropriately selected road chemical additives for treating unpaved roads to reduce fines loss, dust, maintenance and gravel replacement (Session 1.6: A selection tool for unpaved road chemical treatments).
- The application of context sensitive design in situations where the existing alignment places limitations or constraints on design. This approach allows the adoption of geometric design values outside the normal design domain, i.e. in the extended design domain - EDD (Session 1.5: Geometric Design Criteria for Low Volume Roads in Brownfield Sites).
- The use of continuous roller compaction via grader-attached rollers which can reduce gravel usage and grading frequency by up to 50%. (Session 1.6: Reducing Metal[1] Usage and Grading Frequency by Continuous Compaction of Unsealed Roads with Grader Attached Rollers).

9.6 Follow-up on LVR Symposium

Attendance at conferences, such as the LVR Symposium, is a necessary component of Continuing Professional Development. It is only by attendance at such events that researchers and practitioners can interact with their peers, establish contacts for further collaboration, share knowledge and benefit from others' experiences. As a minimum, these benefits are most likely to have been realized by the AFCAP team who participated in the conference.

In the wake of the LVR symposium, the question that arises is - how can the benefits of attending the symposium be disseminated and sustained by the AFCAP community of researchers? At the primary level, this must rest on the establishment of research institutions in a number of countries in the region whose mandate would include knowledge sharing and dissemination via conferences and symposia. However, the establishment of such institutions is still a few years in the offing and something should be done in the interim to sustain the initiative. This could include:

- Dissemination of the AFCAP presentations made at the LVR symposium to a wider, regional audience before the end of AFCAP 1 as well as to country audiences by the country representatives who attended the symposium.
- Participation in upcoming LVR conferences such as the 11th International Conference on Low-Volume Roads, Pittsburgh, USA, 2015 (held every 4 years), the SARF conferences in South Africa, the CAPSA conferences (held every 4 years in South Africa or the region), etc.
- The type of research work being undertaken in the African region is "home grown", focussed and responsive to the needs of the region. The wealth of information that is emerging from such work is unique and is not yet being adequately harnessed by the countries of the region. Every effort should therefore be made to package this wealth of information and to

[1] In Australia and New Zealand gravel is referred to as "metal".

disseminate it via regional low volume roads courses. The return on such an investment is likely to be substantial. Should we not strike whilst the iron is hot?

9.7 Summary

AFCAP participation in the LVR symposium was undoubtedly a great success. Not only did it provide an opportunity for younger presenters to be exposed to, and interact with, an international audience but, also, it showcased the valuable research work being undertaken by AFCAP in fulfilling its mandate of "promoting safe and sustainable access to markets, healthcare, education, employment and social and political networks for rural communities in Africa." Indeed, it would not be an exaggeration to say that the research work being undertaken by AFCAP, and the significant outputs to date, are probably at least on par with the equivalent aspects of such work being carried out in Australia.

In many respects, the LVR symposium was a good start for the younger researchers as the demands made on them were not overly onerous – simply the preparation of a PowerPoint presentation which, nonetheless, required a fair amount of guided preparation. However, participation in future conferences (rather than symposia) will require the discipline of preparing well structured papers for peer review – a graduated step to which all the younger presenters are expected to aspire.

Section 3: Conclusions and Recommendations

The LVR Symposium provided AFCAP representatives with an opportunity to share knowledge and experience generated through five years of intensive project activity in Africa. It also provided an opportunity to benchmark our research against research being carried out in Australia, New Zealand and the Pacific Region. The AFCAP participants were surprised how similar many rural transport issues faced in Africa were also being encountered in Australia. This includes the scarcity of conventional road building materials, shortage of funds, and lack of young professionals entering the sector. Similarly there were notable differences between challenges faced in Africa and Australia that were remarked on by our Australian colleagues. These included the high costs incurred by small farmers in transporting their produce to the nearest trafficable road (the "first mile"), and the difficulty of regulating motorcycle taxis (boda-bodas) to improve safety without undermining the industry.

In some cases AFCAP research has built on work done previously in Australia. This includes the use of the DCP to assess the in situ strength of materials in road pavements and the classification system for sands (Wylde Chart). The symposium provided an opportunity to update our Australian colleagues on progress made in Africa with advancing, refining and applying some of these concepts. The consensus was that research on rural roads and rural transport services in Africa has moved beyond the work being done in Australia in several of these areas.

There was considerable interest from non-African participants in obtaining copies of design manuals and other documentation that has now been published in different countries under AFCAP. This included the suite of design manuals and specifications developed under AFCAP for URRAP in Ethiopia, and described in the presentation by Yetmgeta Asrat and Les Sampson. Directions were provided to participants on how to access AFCAP documents through the AFCAP and R4D web sites.

The symposium provided young professionals from Africa with an opportunity to present the findings of their own work to an appreciative and knowledgeable international audience. The effort given to preparation and the partnership approach through joint presentations ensured that the PowerPoint presentations were all of high quality. The practice sessions on the day before the start of the symposium gave additional confidence to the presenters and ensured that all AFCAP presenters were able to convey their messages as well as to comply with strict time limits set by the organisers.

The following lessons learned and recommendations should be considered by AFCAP management (AFCAP 1 and the possible AFCAP 2) in order to take forward the initiatives started with the ARRB Symposium.

- The visit provided African researchers with exposure to international practice and the wider international environment. This was a great success and should be repeated on a more regular basis, but the capacity development component should be managed in a strategic manner that responds to needs at different levels in road transport institutions in Africa, including senior decision makers and technical staff. This challenge should be a core feature of the proposed AFCAP 2.
- The mentorship and training in giving presentations was a key positive output of the event and contributed to the success of the visit. Several positive comments were received on this approach from non-African participants at the symposium. It is recommended that further opportunities should be provided for the AFCAP participants to repeat their presentations to different audiences. Several opportunities are on the horizon including the SARF/IRF conference in South Africa in Sept 2014, CAPSA '15 (also to be held in South Africa), and the TRB's 11th International Conference on Low-Volume Roads to be held in Pittsburgh, USA, in

July 2015 (AFCAP has received an invitation to participate from the organisers). For these conferences it will be necessary for the presenters to submit technical papers which will be peer reviewed.

- It is clear from the development of research capacity for the rural transport sector in Africa depends on establishing sound institutional structures in the sector. This ensures that researchers can work in a well resourced environment and with the long term perspective required for robust research outputs. Feedback from non-AFCAP participants at the symposium confirmed that the strategic approach being adopted by AFCAP in developing national research centres and supporting structures is fundamental to addressing the many technical needs of the sector.
- The lack of a field trip to understand more about how the host country deals with the management of LVRs was mentioned as a constraint by some of the group.

Annex A: Final Delegates List

First Name	Last Name	Organisation	Country
Stephen	Adam	Croydon Shire Council	Australia
Rod	Adams	Dept. of Transport & Main Roads	Australia
Peter	Agar	Department of Transport and Main Roads	Australia
Laith	Alazawi	Department of Transport and Main Roads	Australia
Esther Emmy	Amimo	Ministry of Roads Kenya	Kenya
Bob	Andrews	ARRB Group	Australia
David	Atkinson	Dept. of Transport & Main Roads	Australia
Yeshveer	Balaram	VNA Consulting	South Africa
Guru	Balasubramanian	Dept. of Transport & Main Roads	Australia
Arnab	Bandyopadhyay	THE WORLD BANK	India
Ed	Baran	Dept. of Transport & Main Roads	Australia
Michelle	Baran	Dept. of Transport & Main Roads	Australia
Susan	Barlow	DEPARTMENT OF TRANSPORT & MAIN ROADS	Australia
Andrew	Beecroft	ARRB Group	Australia
John	Benge	Downer Infrastructure West	Australia
Richard	Bennett	Santos Limited	Australia
Prasenjit	Bhattacharyya	Dept. of Transport & Main Roads	Australia
Pat	Bosman	Sampson Consulting	South Africa
David	Bremert	Dept. of Transport & Main Roads	Australia
Allen	Browne	Hiway Stabilizers	Australia
Shane	Campbell	Dept. Transport & Main Roads	Australia
Harold	Carn	DPTI	Australia
Chris	Cartledge	Stornoway	Australia
Graeme	Chalmers	ARRB Group	Australia
Geoffrey	Cocks	Coffey	Australia
Alan	Conaghan	RoadTek	Australia
Jasper	Cook	OTB Vietnam Ltd	United Kingdom
David	Corcia	ARRB Group	Australia
Rex	Cowan	Dept of Transport & Main Roads	Australia
Ricky	Cox	Dept. of Transport & Main Roads	Australia
Norm	Cribbin	Hydro Tasmania	Australia
Stephen	Cullinan	Dept. of Transport & Main Roads	Australia
Peter	Damen	ARRB Group	Australia
Wayne	Davies	Transport and Main Roads	Australia
Kimberley	Davis	Toowoomba Regional Council	Australia
Daryl	Davis	Sinclair Knight Merz	Australia
Kim	Dawes	CGI Consulting	Australia
Brian	Dearlove	DPTI	Australia
Erik	Denneman	ARRB Group	Australia
Narelle	Dobson	Dept. of Transport & Main Roads	Australia
Bruce	Duncan		Australia
Fred	Eames	Dept. of Transport & Main Roads	Australia
Richard	Evans	Department of Transport and Main Roads	Australia
Lambert	Ezeajugh	Dept. of Transport & Main Roads	Australia
Greg	Farrell	Geofabrics Australasia	Australia
Martin	Faulkner	District Council of Streaky Bay	Australia
Paul	Faux	Stabilised Pavements of Australia	Australia

First Name	Last Name	Organisation	Country
Brad	Fisher	Department of Environment & Primary Industries	Australia
Leah	Fisher	AustStab Limited	Australia
Jon	Frew	Sinclair Knight Merz	Australia
Don	Frost	Walk 'n' Roll Packers	Australia
Rob	Geddes	Civil Design Solutions	Zimbabwe
David	Goodman	Cassowary Coast Regional Council	Australia
Christopher	Gray	Scenic Rim Regional Council	Australia
Briarlea	Green	ARRB Group	Australia
Jonathon	Griffin	ARRB Group	Australia
Joana	Guiuele	Administracao Nacional de Estradas	Mozambique
Ananda	Gunawardana	Logan City Council	Australia
Jim	Harding-Smith	Department of Transport and Main Roads	Australia
Mark	Harvey	BITRE	Australia
Bruce	Hasbargen	Beltrami County	United States
Gareth	Hearn	Hearn Geoserve Limited	United Kingdom
Craig	Heck	Scenic Rim Regional Council	Australia
David	Hemmings	Dept. of Transport & Main Roads	Australia
Mervyn	Henderson	ARRB Group	Australia
Paul	Herbison	Walk'n'Roll International	New Zealand
Errol	Hill	Boral Resources (Qld) Pty Ltd	Australia
Paul	Hillier	ARRB Group	Australia
Steve	Hogan	QUT	Australia
Jon	Hongve	Jon Hongve	Norway
Phil	Hunt	Road Engineering Services	Australia
Tim	Hurn	Bundaberg Regional Council	Australia
Ross	IOAKIM	Downer	Australia
Kobe	Ip	Dept. of Transport & Main Roads	Australia
Jess	Jackson	ARRB Group	Australia
David	Jackson	Dept. of Transport & Main Roads	Australia
Ryan	Jansz	Boral Asphalt	Australia
Semba	Jayaratne	Dept. of Transport & Main Roads	Australia
Bradley	Jones	UDP Group	Australia
David	Jones	University of California Pavement Research Center	USA
Jason	Jones	Dept. of Transport & Main Roads	Australia
Salehe	Juma (Eng)	Tanzania National Roads Agency	Tanzania
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Tony	Lickiss	Cook Shire Council	Australia
Peter	Lossberg	Aurecon Australia	Australia
William	Lu	BITRE	Australia
Danny	Lynch	Stabilised Pavements of Australia	Australia
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Kenneth	Mukura	TRL	Zimbabwe
Johann	Muller	Longreach Regional Council	Australia
Steve	Murrin	NZTA	New Zealand
Wayne	Oldfield	NZTA	New Zealand
David	Olds	Santos Limited	Australia
Alby	Paolucci	Sinclair Knight Merz	Australia
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Jose	Pereira	Pitt&Sherry	Australia
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Garry	Pickering	Croydon Shire Council	Australia
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Tony	Potter	Dept. of Transport & Main Roads	Australia
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Darren	Richardson	Dept. of Transport & Main Roads	Australia
Jon	Roberts	ARRB Group	Australia
Paul	Robinson	Private	Australia
Rick	Rolfe	Dept. of Transport & Main Roads	Australia
John	Rolt	John Rolt	United Kingdom
John	Roworth	Longreach Regional Council	Australia
Les	Sampson	Sampson Consulting	South Africa
Mick	Savage	IPWEA (NSW)	Australia
Paul	Schutz	PNG-Australia Transport Sector Support Program	Papua New Guinea
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