Guidelines for the Use of Sand in Road construction

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Outline of the Presentation

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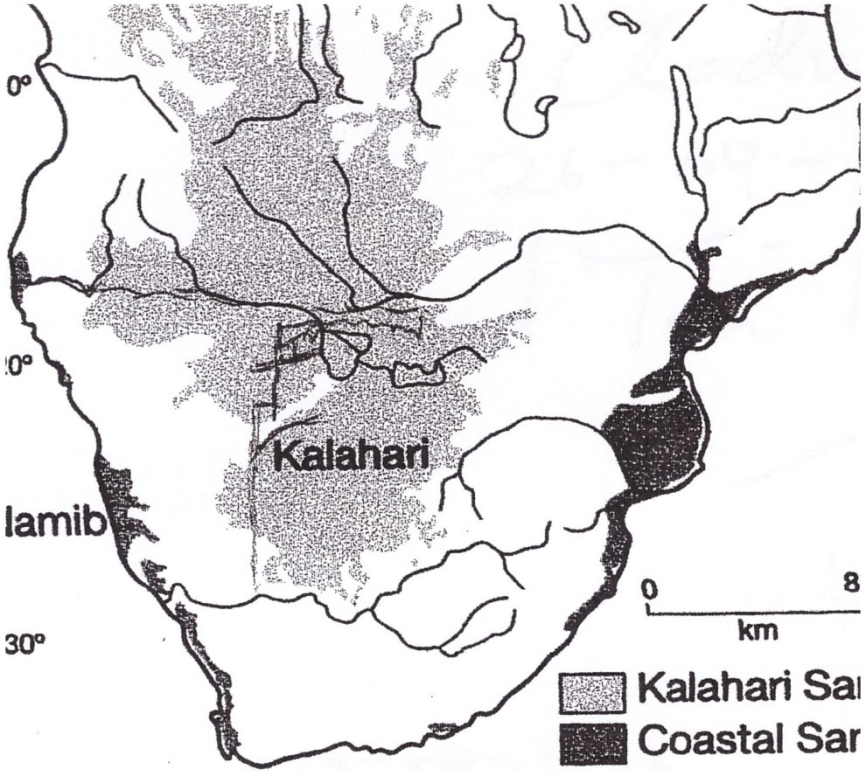
Background

- In Southern Africa sand covers a large surface area making it probably the largest source of naturally occurring material for road building
- Sands are traditionally considered unsuitable for road construction especially in Africa
- Sands have been used in road construction in other countries such as Australia, Brazil, South Africa, Botswana
- The traditionally suitable road building gravels are being depleted and becoming increasingly scarce
- Haulage costs of traditionally accepted road construction materials make LVR prohibitively expensive and in some cases not viable.



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Objectives of the study

- Improve the provision of road network to rural and remote areas of Africa though the use of naturally occurring materials along the road corridor thus reducing construction costs.

- Increase the understanding of the properties and behavior of sand as a road building material

- Establish a method for classifying sands and develop guidelines and specifications for their use in road construction

- Encourage the incorporation of sand in the national standards and specifications

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Initial work

- Hoopstad-Bultfontein Road, Free State Province. South Africa.
- Constructed in 1962
- Light brown sand used on base course
- Road still in fair condition

Initial work

- Serowe – Orapa road, 1989
  - Neat red sand on the base course
  - Pavement still in good condition – resealed once

- Neat sands of various colours used in subbase of many LVR
  - Still intact – > 20 years, 0.2 to 0.5 MESA, very limited maintenance

- Sands from base and subbase tested and compared with the sands used in Australia

Initial Work

Sands have a complex array of colours

- Colour of sand could indicate the road building potential but not definitive
- Other simpler parameters required

Further Work

- Extensive sampling program in Mozambique, Namibia, Botswana and South Africa
- Sample site selection influenced primarily by;
  - Sand type – colour, grain sizes, etc
  - Origin - Aeolian, alluvial, coastal, weathering etc
  - Borrow pits - Sand extracted for use on road construction especially on pavement layers or wearing course
  - Roads - where sands were used on pavement layers or wearing course
- Intensive laboratory testing of over 90 sand samples
  - Atterberg Limits (on fines passing 0.425 mm and 0.075 mm sieves)
  - Particle Size Distribution
  - Strength tests
  - Other tests

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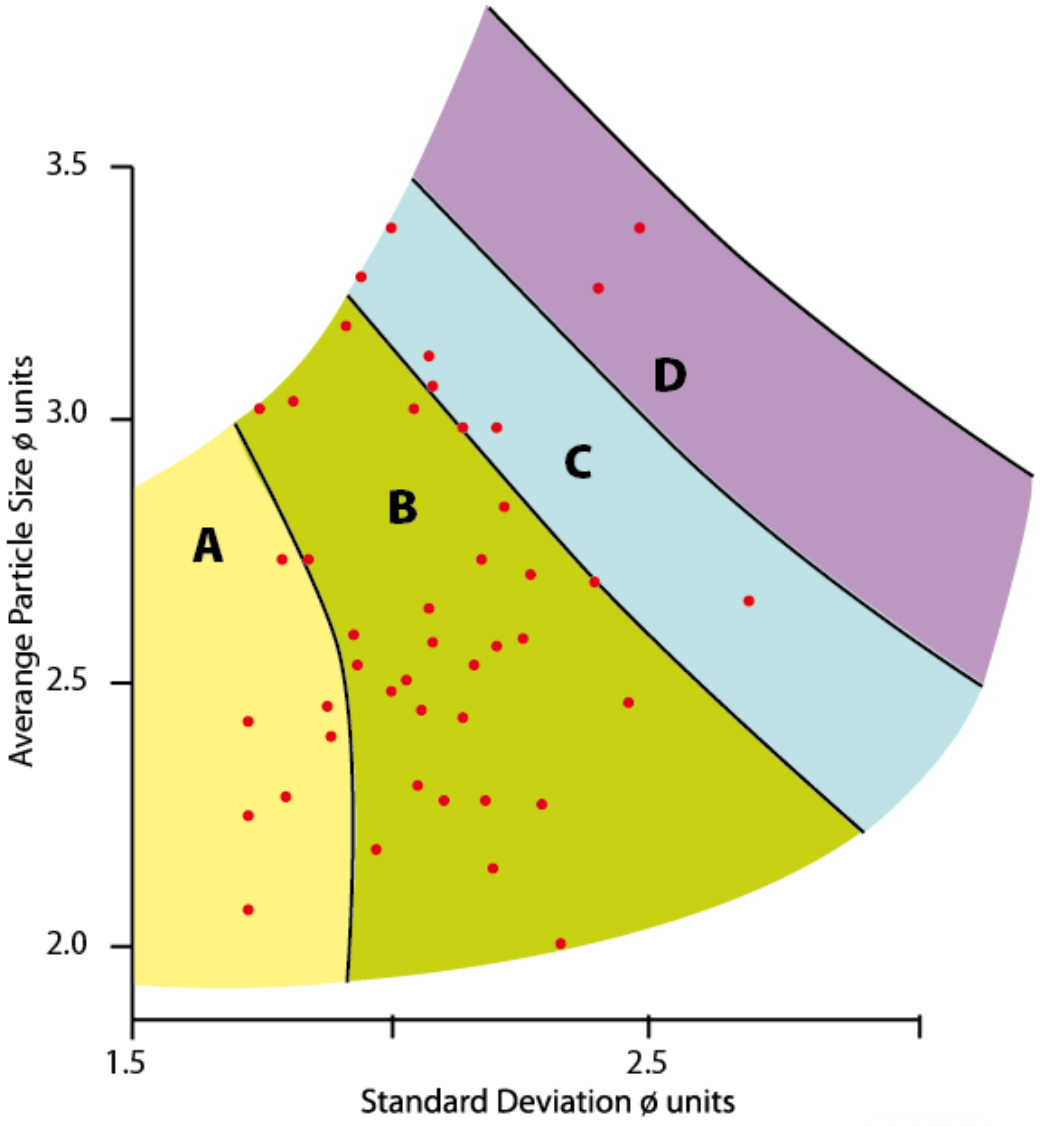
Analysis and Findings

- In order to compare the study samples with the Australia sands, the Wylde chart was used
- To use the Wylde Chart needed to use – Mean and standard deviation of Phi (∅)units
- Phi expresses particle size as $-\log_2$ x d(particle size in mm).
- A particle of 1 mm is equivalent to 0.0 ∅ units & a particle of 0.125mm is equivalent to 3 ∅ units
- The finer the grading the higher the ∅ units

PSD (Phi Units) Related to Performance Zones



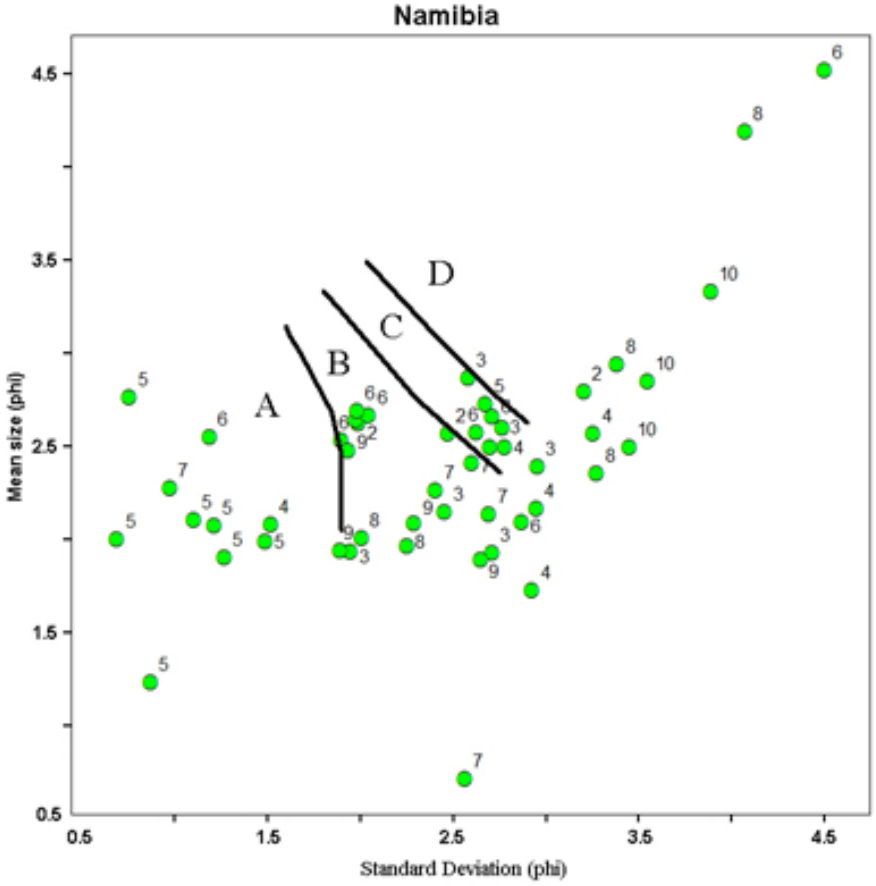
Analysis and Findings

- Atterberg Limits on P0.075mm sieve yields relatively high PI
- Atterberg Limits on P0.425mm sieve yields NP – not discriminatory
- Atterberg Limits not related to the colour of the sand

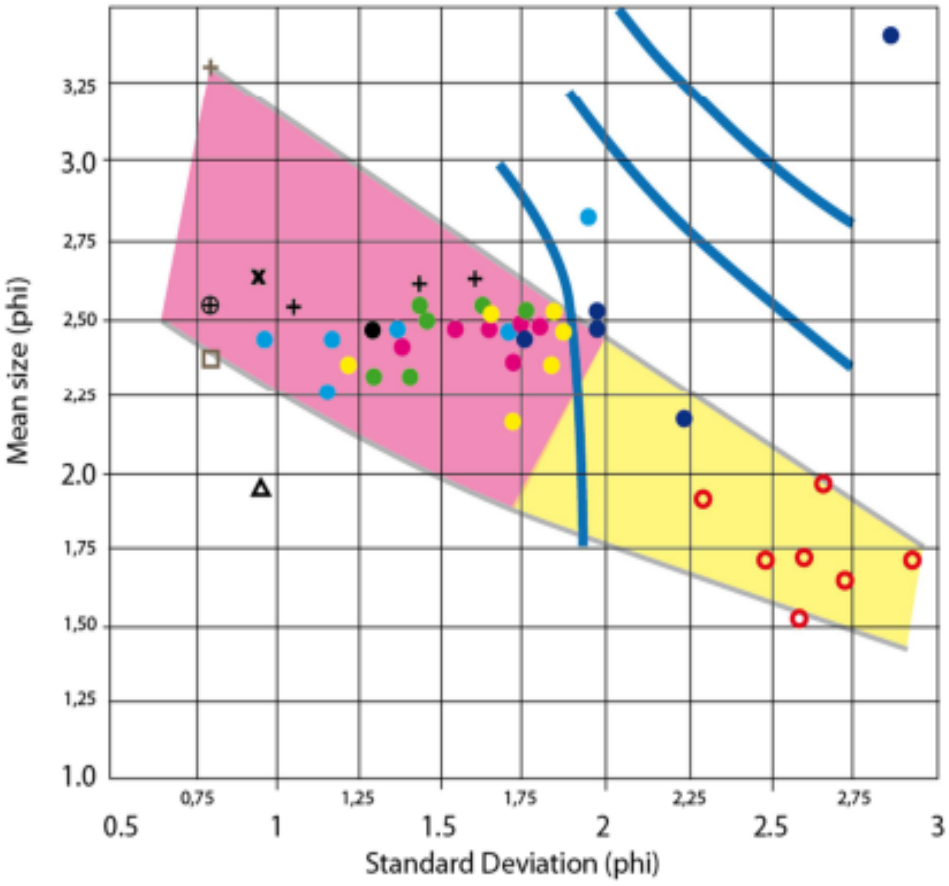
Colour	Sand (%)			Sand Total (%)	Silt Total (%)	Clay Total (%)	Atterberg limits and shrinkage ((P075)			
	Coarse	Medium	Fine				LL (%)	PL (%)	PI (%)	LS (%)
White	0	42	50	92	0	8	NP			0
Lt brown	36	34	17	87	4	9	47	28	19	9.0
Yellow br	8	70	18	96	1	2	-	-	-	-
Dark br	14	25	30	69	7	23	52	28	24	10.0
V dk gr br	11	39	31	81	3	16	48	21	27	9.0
Red	21	20	37	78	8	5	22	15	7	3.0
Red*	6	44	37	87	2	11	NP			0
Brown	30	32	29	91	6	2	NP			0
Dk red	20	24	37	81	4	14	33	21	12	7.5
Dk red br	18	22	36	76	8	14	40	22	18	10.0

Plot of the sand samples on the Wylde chart

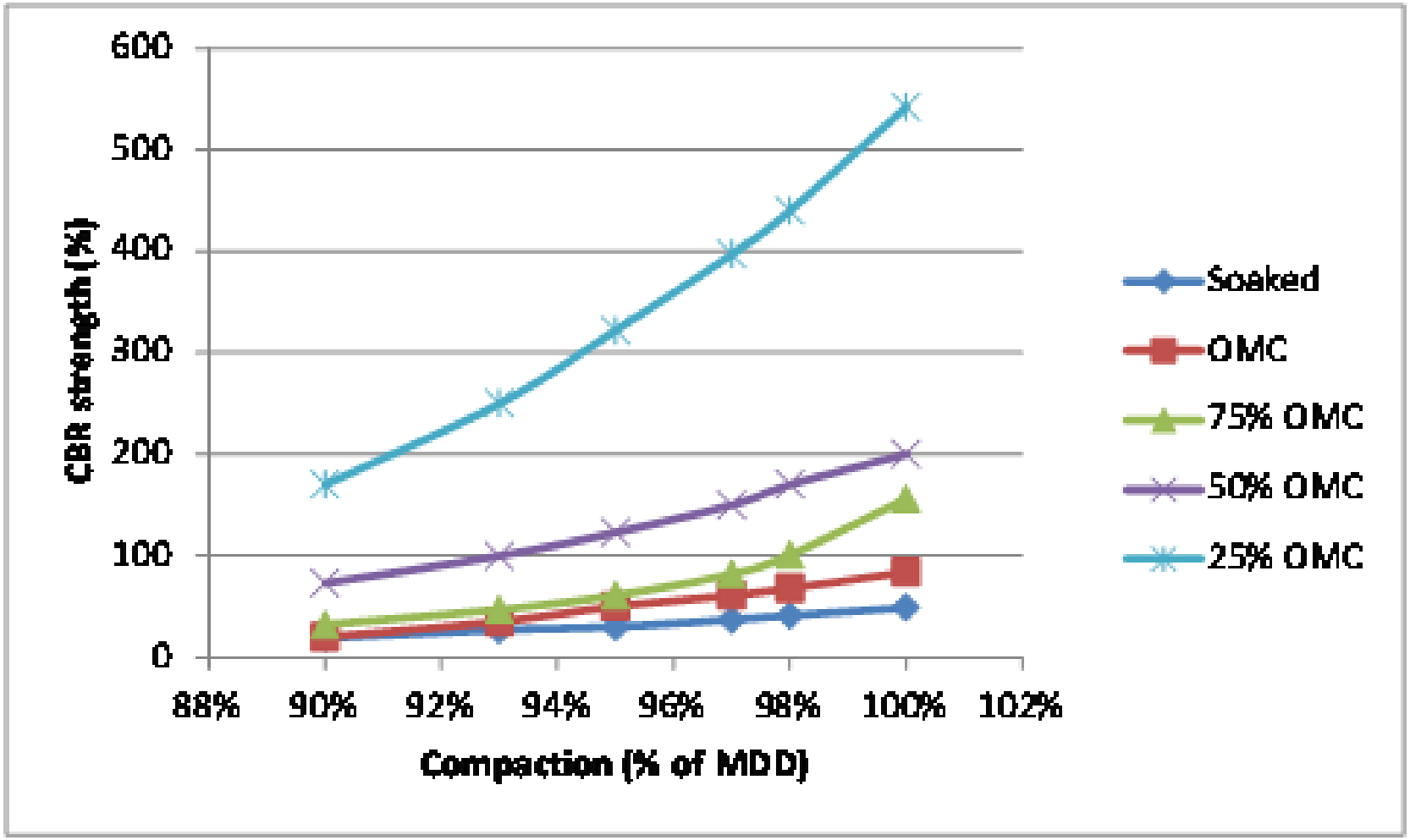
Namibia samples from borrow areas



Botswana samples from roads



The effect of increased compaction and drying back on CBR



Thorough processing, good compaction, good finish, proper surfacing

Conclusions

1. Sand has been successfully used on the base course of LVR
   - Hoopstad-Bultfontein Road, South Africa. > 50 years
   - Serowe Orapa Road, Botswana. >20 years
2. Conventional tests are not adequate in classifying sand for use on road pavement layers
3. The use of the Wylde chart for the classification of sands for use on the road has shown good potential but it is not conclusive at the moment.
4. By compacting to higher densities and keeping the operating moisture low one can tremendously increase the strength of the material, thus allowing the use of sands that would have been otherwise considered unsuitable.
5. Based on 1, 3 and 4 above we are confident that sands suitable for road construction can be selected. This is a major breakthrough in the provision of road infrastructure in rural/remote areas in southern Africa.

Way Forward

- There is need to find out why some potentially ‘good sands’ do not plot within area A and B of the Wylde chart. There may be need to redefine the Wylde zone for the study area?

- We need to establish whether there is a difference in performance between sands plotting in area A and area B of the Wylde zone in view of the advances in testing and compaction

- Ensure that Road Authorities, design engineers, funding agencies are on board

- The tests and selection criteria need to be imbedded into the national standards and specifications

Thank you