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A METHODOLOGY FOR INCREASING THE USE OF LOCALLY AVAILABLE MATERIALS FOR ROAD CONSTRUCTION IN ETHIOPIA BY ALLOWING FOR CLIMATIC VARIATIONS

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Discussion Topics

1. Introduction
2. Methodology
3. Laboratory Results
4. Applications
5. Results of Applications
6. Conclusions

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1.1 Background

Name :Ethiopia (FDRE)

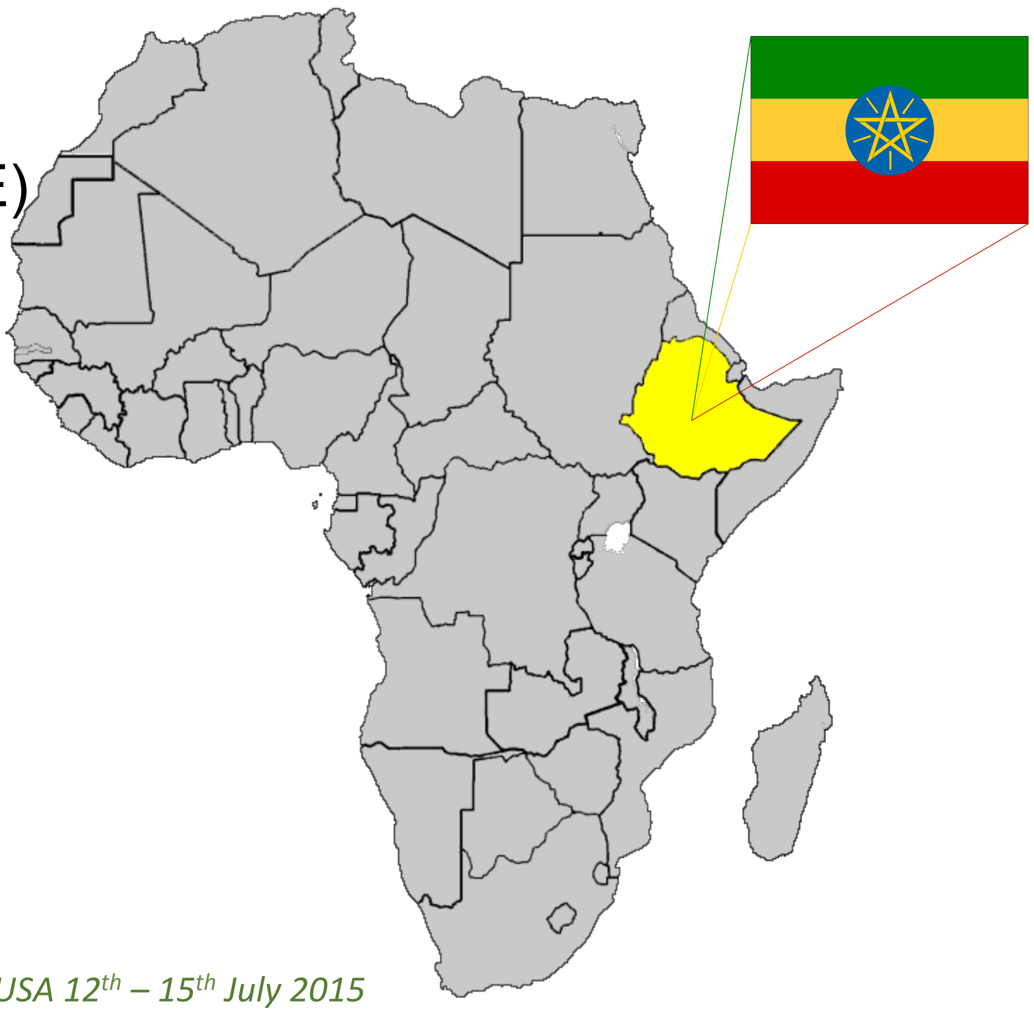
Location :East Africa

Area :1.12 mil sq.km

Population :> 90 million

Gov't Structure :Federal State

Road Network :85,966 km



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1.2 Ethiopia's Climate: Dry Areas / Dry Season

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1.3 Ethiopia's Climate: Wet Areas / Wet Season

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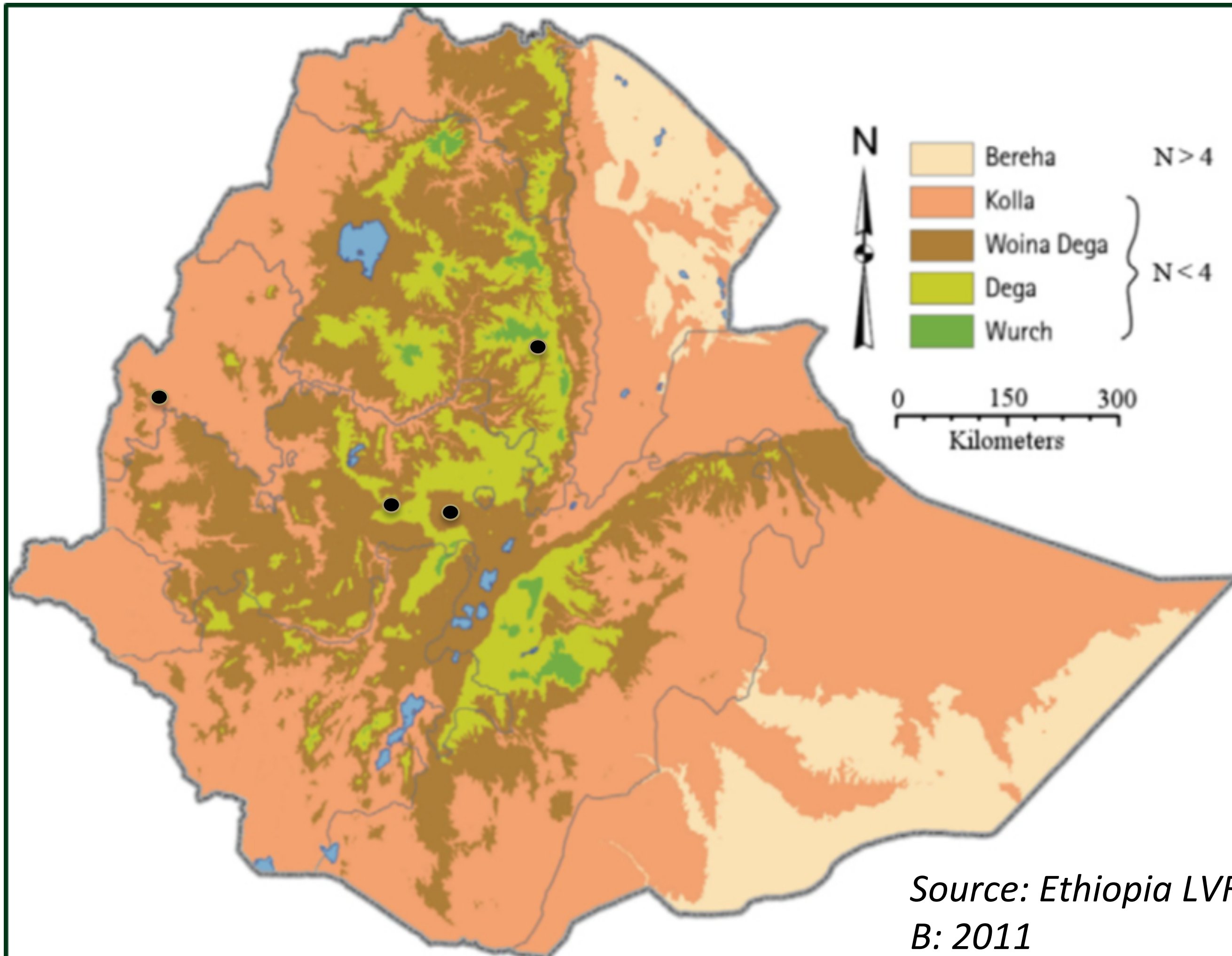
1.4 Climatic Map of Ethiopia



Source: Ethiopia LVR Manual Part B: 2011

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1.5 Current challenges

- Large proportion of road network is gravel
- For a long time LVRs standards adapted from manuals and specifications for HVRs – now being revised
- As a result difficult to find natural gravels that met the specifications
- Mostly only crushed stone materials met base requirements
- Crushed stone expensive to process – hence slow expansion of the sealed low volume roads network
- Need to adjust, revise and develop standards for LVRs

1.6 Project Objectives

- **Title: "Development of Pavement Design Standards for Low Volume Roads in Ethiopia"**
- **Main Objective: Develop standards for the use of locally available materials that currently do not meet the criteria for use in roads.**

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1.7 Study Objectives

- **Because of the varied nature of Ethiopia's climate, it is important to study the relationship between moisture and strength for different material types as a basis for specifying the moisture content at which the strength should be specified in relation to whether or not shoulder sealing is undertaken; and in turn refine the existing standards and specifications.**

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2. Methodology

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2.1 Materials

- Materials selected were those commonly used for base and sub-base in Ethiopia.
  - Natural gravels and crushed stone
  - Laterite gravel, Weathered Basalt gravel, Crushed Basalt, and Cinder gravel

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2.2 Material Properties – (AASHTO Test Methods)

Materials	Assosa Laterite	Combel Weathered Basalt	Combolcha Crushed Basalt	Awash Crushed Basalt	Non-Plastic Cinder	Plastic Cinder
Liquid Limit	44	42	30	34	NA	32
Plastic Limit	32	19	18	25	NA	19
Plasticity Index	12	23	12	9	NA	13
OMC (%)	12	8.7	3.8	3.9	6.8	29.5
MDD (g/cc)	1.85	2.26	1.86	2.2	1.29	1.37

2.3 Laboratory Methodology

- Laboratory based testing
  - California Bearing Ratio (CBR) used as a measure of strength
- Specimens (15) prepared in CBR moulds at predetermined levels of compaction at Optimum Moisture Content (OMC)
- Some specimens tested at OMC, others soaked for 2days, 4 days and others air-dried to 0.8OMC, 0.6OMC
- Equilibrated then CBR tested and moisture tested

3. Laboratory Results

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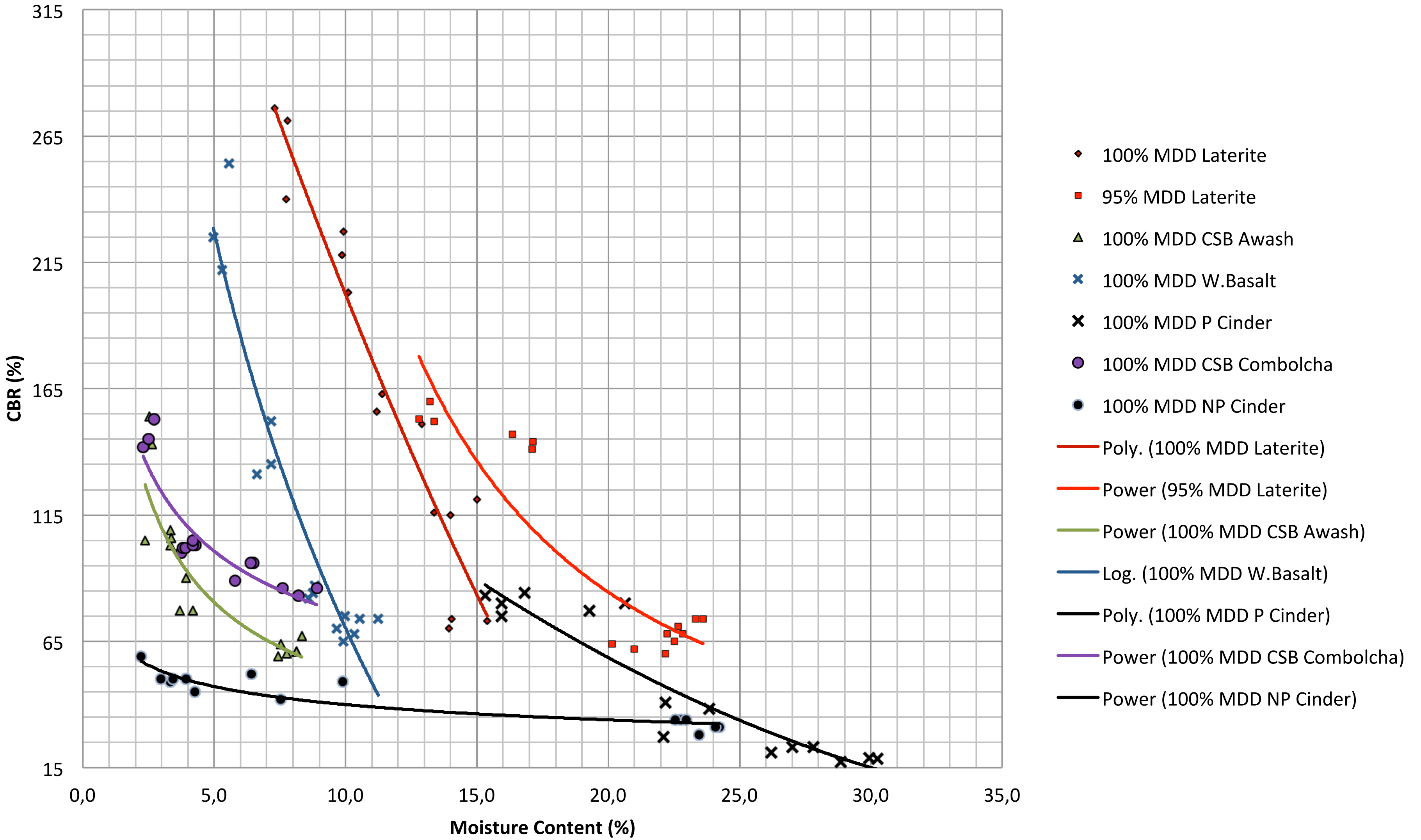
3.1 CBR vs Absolute Moisture Content of Material



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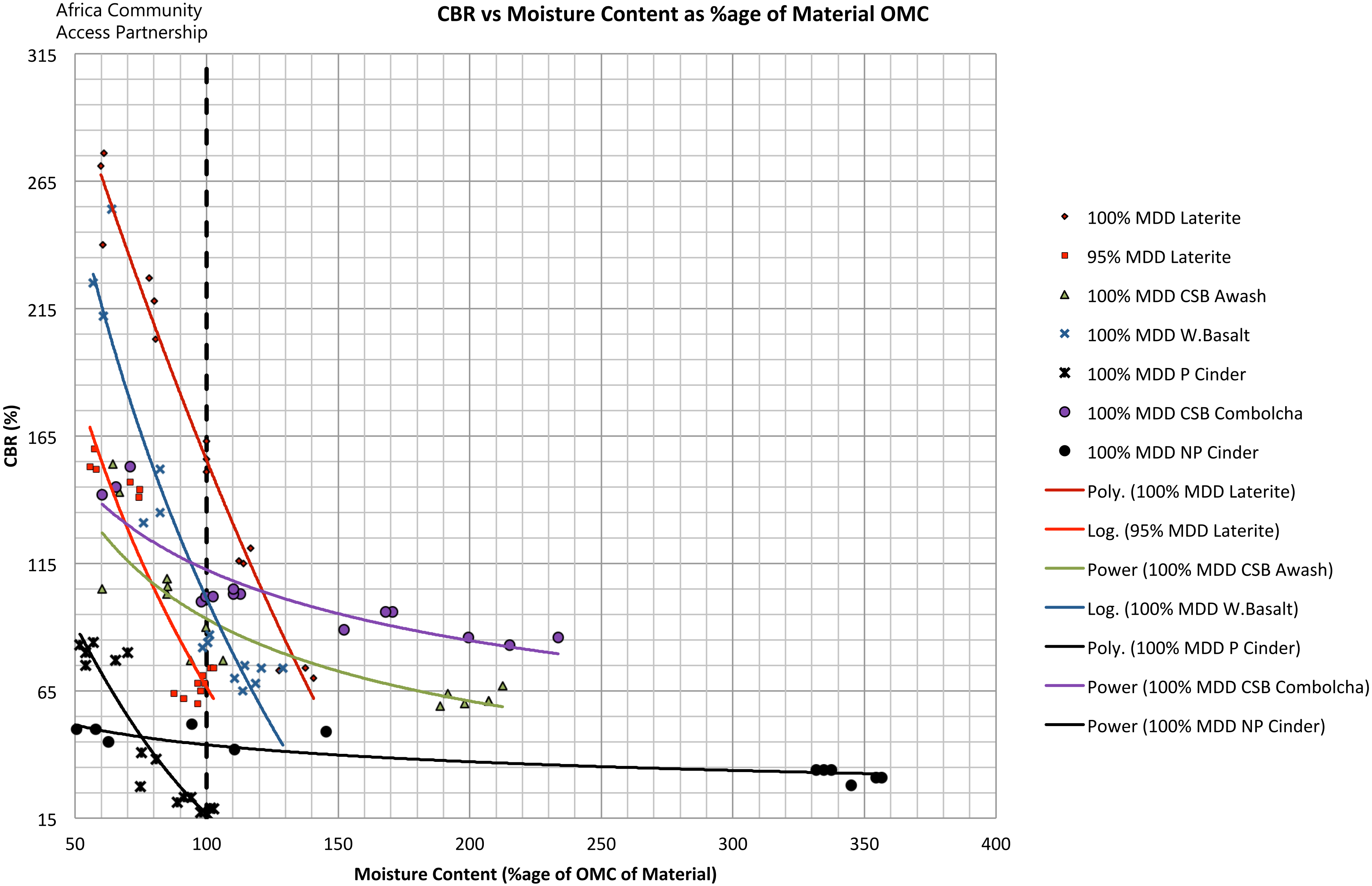
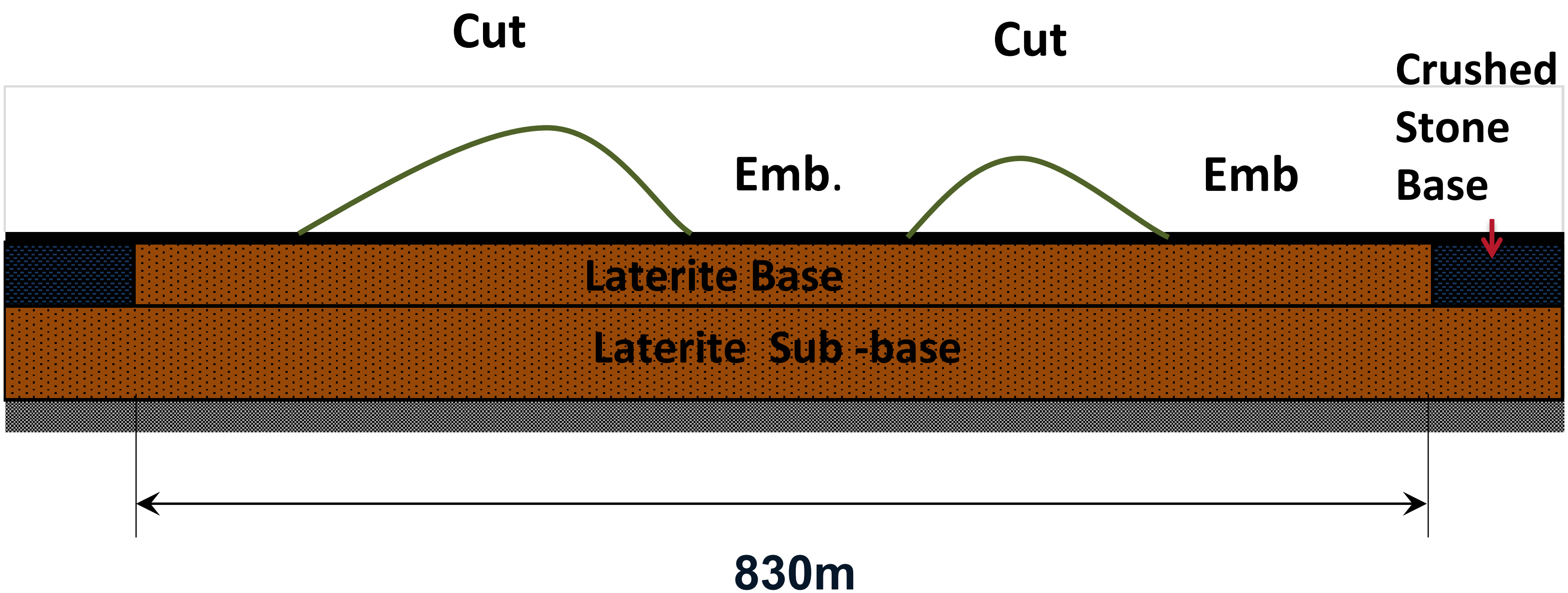


4. Applications

4.1 Demonstration and Trial Sections



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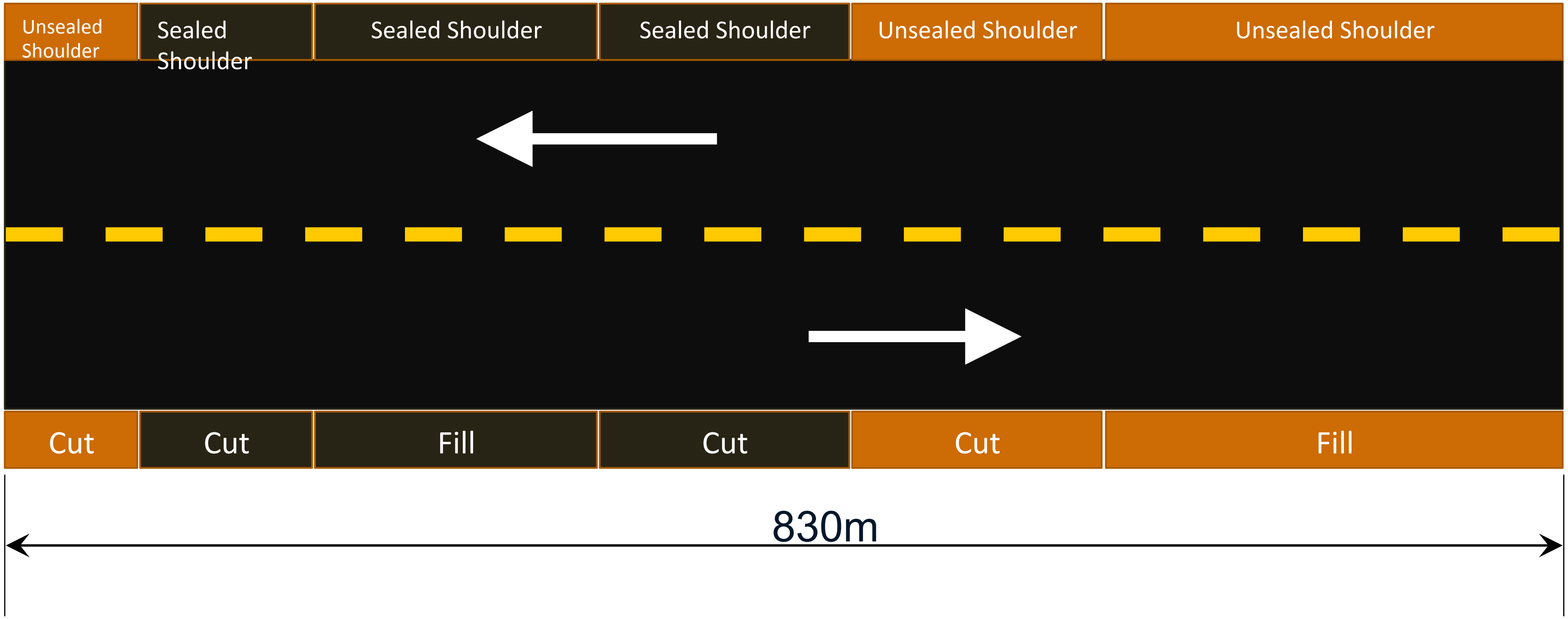
4.2 Sections Layout



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4.3 Construction

5. Results of Applications

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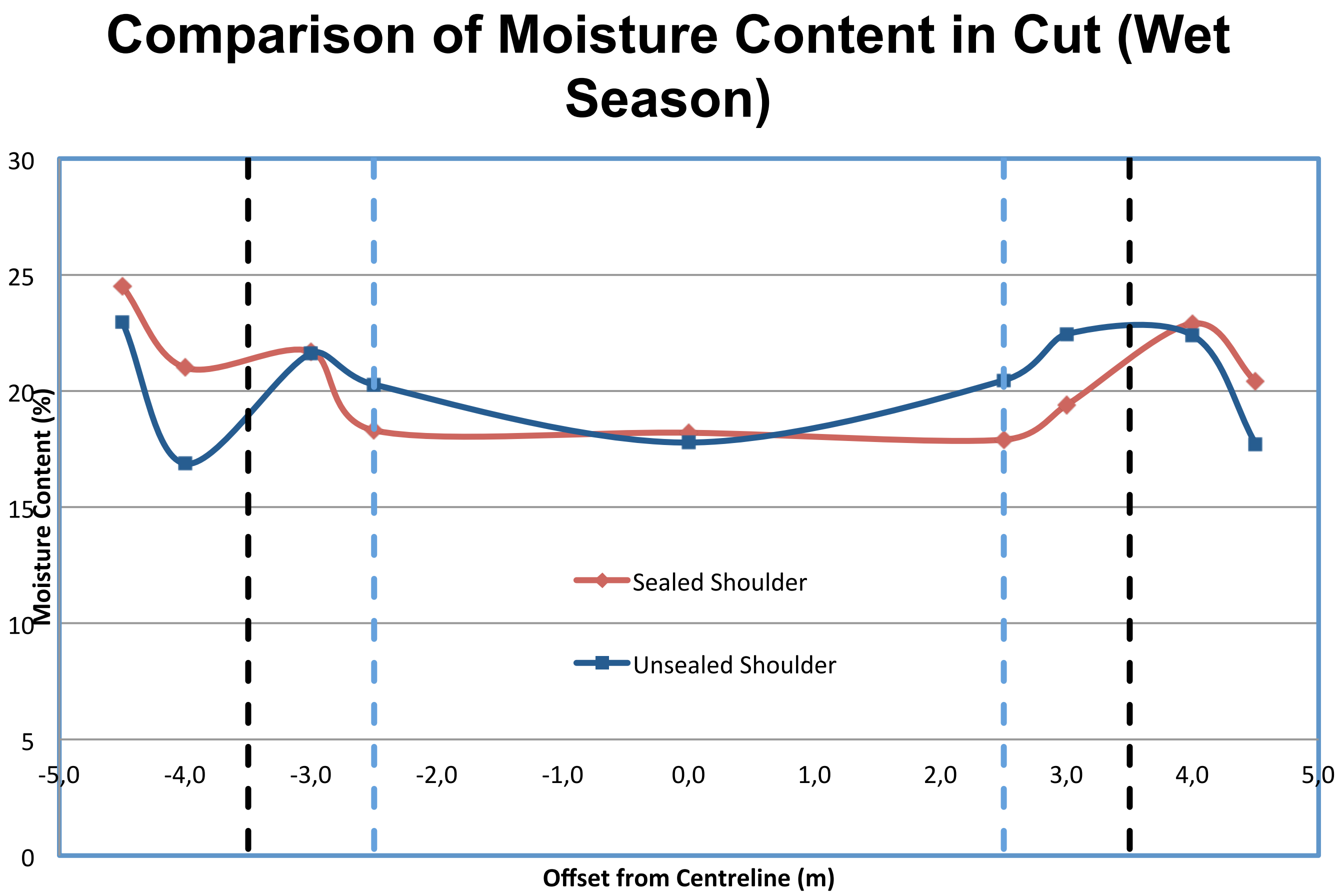
5.1 Moisture Profile



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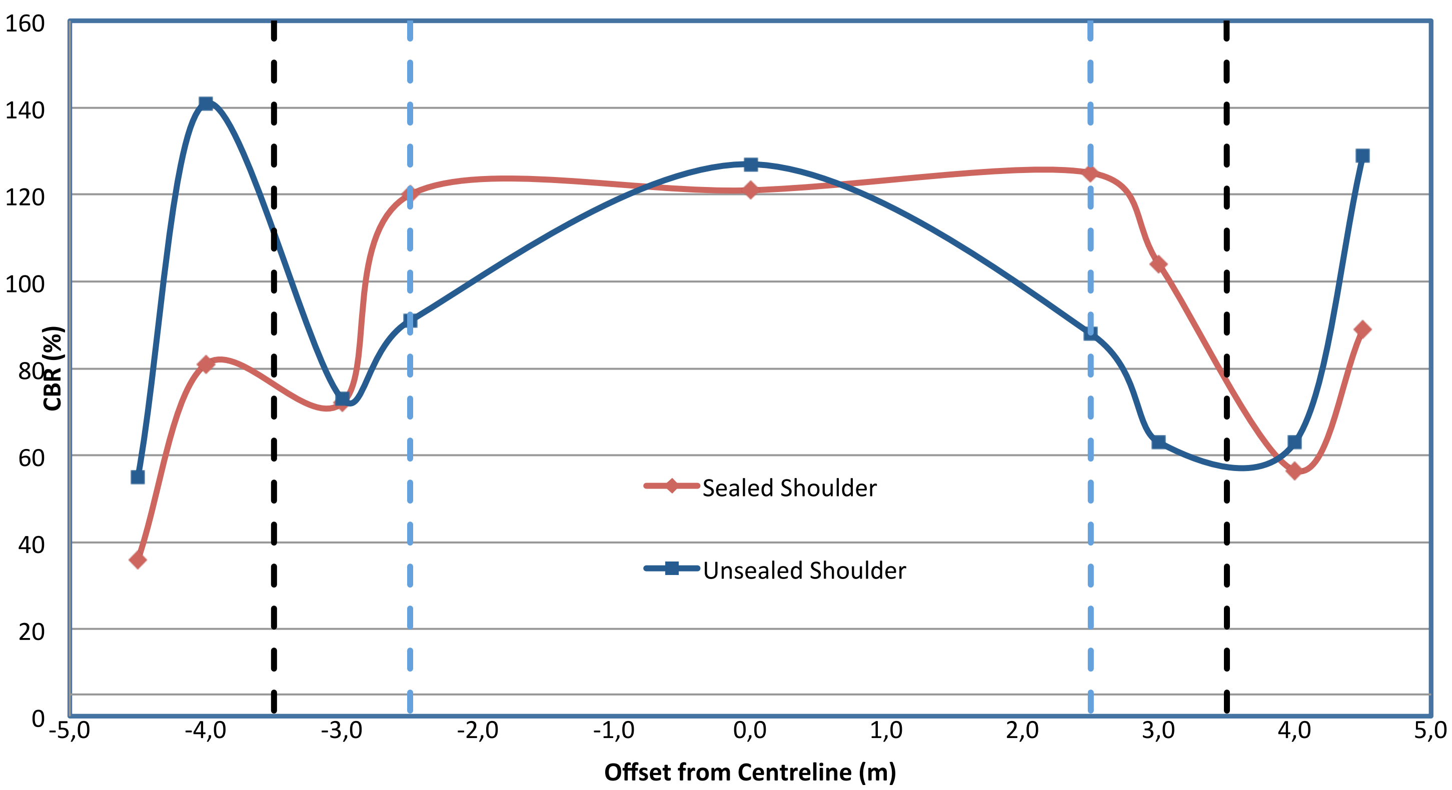
5.2 CBR Profile

Comparison of CBR in Cut (Wet Season)



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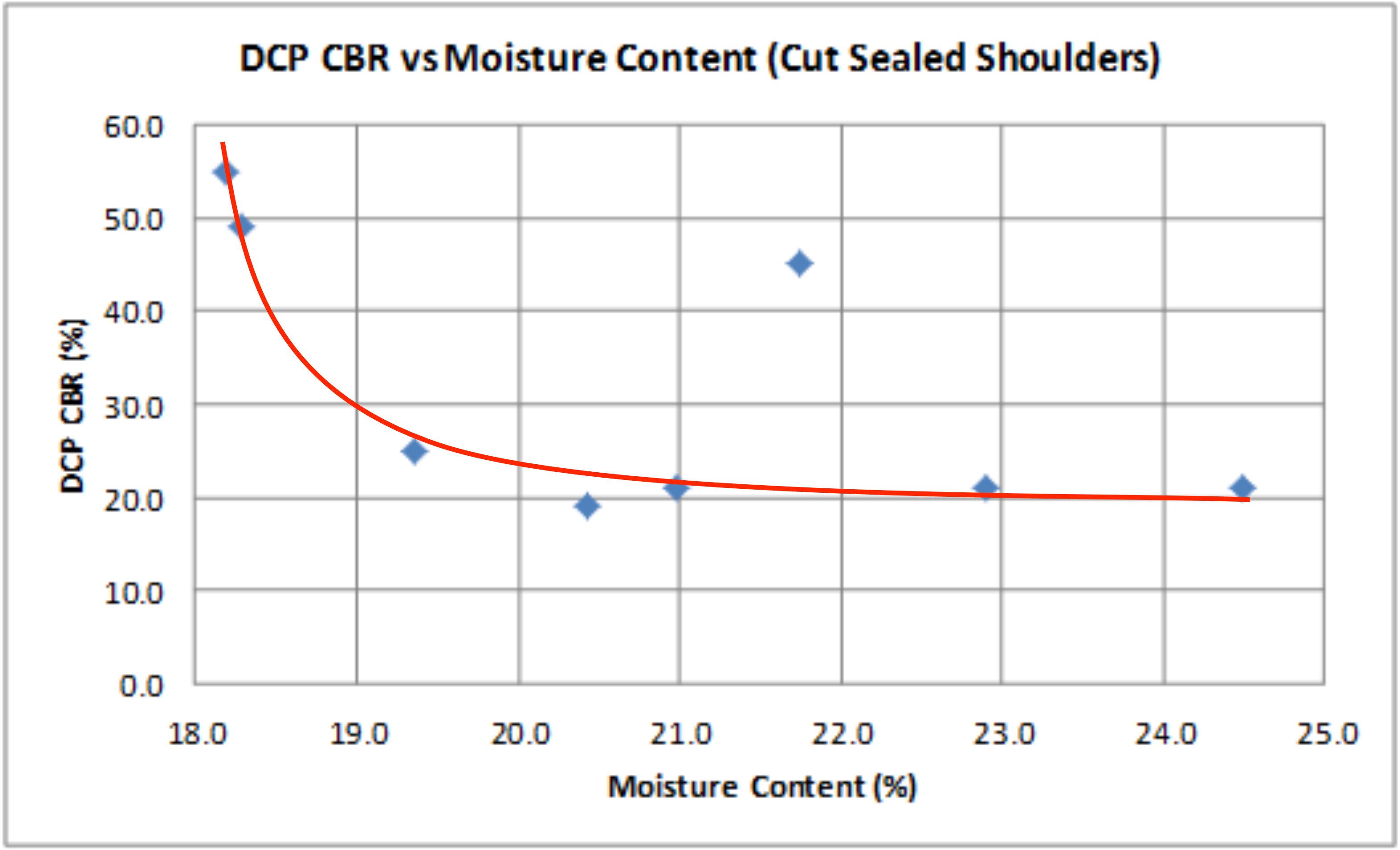
5.3 Field Strength Curve



6. Conclusions

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Conclusions

- **High PI (PM) implies high strength range with varying moisture**
- **Stating a single CBR value is inadequate. Range over different MCs is ideal for natural gravels**
- **Slight increases in compaction effort results in high increases in strength. Specify compaction at 100%MDD of material does not degrade**
- **Sealed shoulders and high crowns beneficial to pavement strength**
- **Enables the engineer in Ethiopia to understand how their local materials behave in their environment**

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Way Forward

Long-term Monitoring of all Sites

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Thank you

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