

**SAFE, CLEAN AND AFFORDABLE ...
TRANSPORT FOR DEVELOPMENT**

**IMPROVING THE PROVISION OF
BASIC ACCESS TO THE RURAL POOR
AT REDUCED COST**

**PRESENTATION BY
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INTRODUCTORY STATEMENTS

- 1. Millennium Development Goals - All Rural communities to be within the reach of 2km of a road.**
- 2. Vehicle ownership is very low in rural communities in developing countries.**
- 3. The food and cash crops produced in rural areas attract transport from the urban areas.**
- 4. All-weather access roads promote socio-economic activities and provision of services in rural areas.**
- 5. Governance is promoted by basic access, and the rural communities have a sense of belonging to a country.**
- 6. Central Governments are responsible for the provision of basic access to rural poor communities.**
- 7. The private sector is to be largely in charge of the provision and maintenance of rural transport on commercial basis.**
- 8. Which is worse: Roads without Transport or Transport without Roads?**

INVENTORY OF ROAD NETWORK IN GHANA

HIGHWAYS		FEEDER ROADS		URBAN ROADS		TOTAL NETWORK	
PAVED (km)	UNPAVED (km)	PAVED (km)	UNPAVED (km)	PAVED (km)	UNPAVED (km)	PAVED (km)	UNPAVED (km)
6,212	7,155	1,323	39,667	3,182	6,582	10,717	53,404
						16.7%	83.3%
						64,121 km	

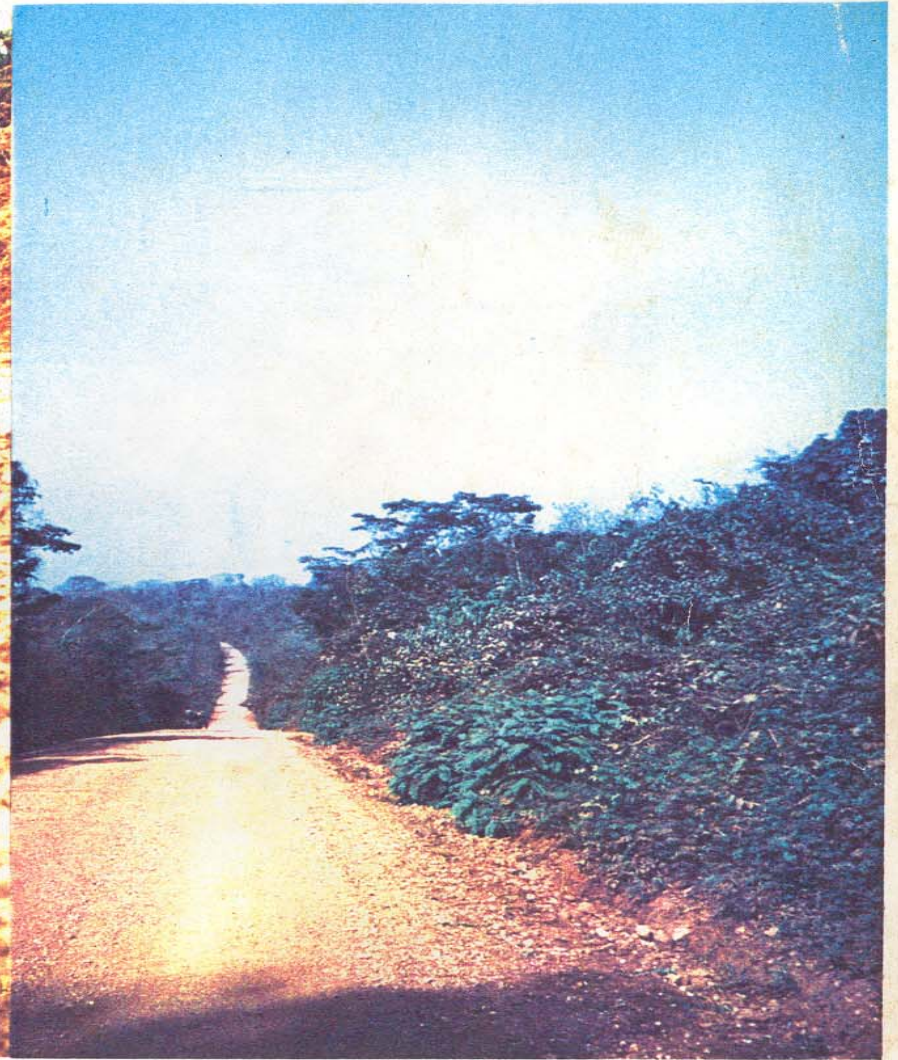
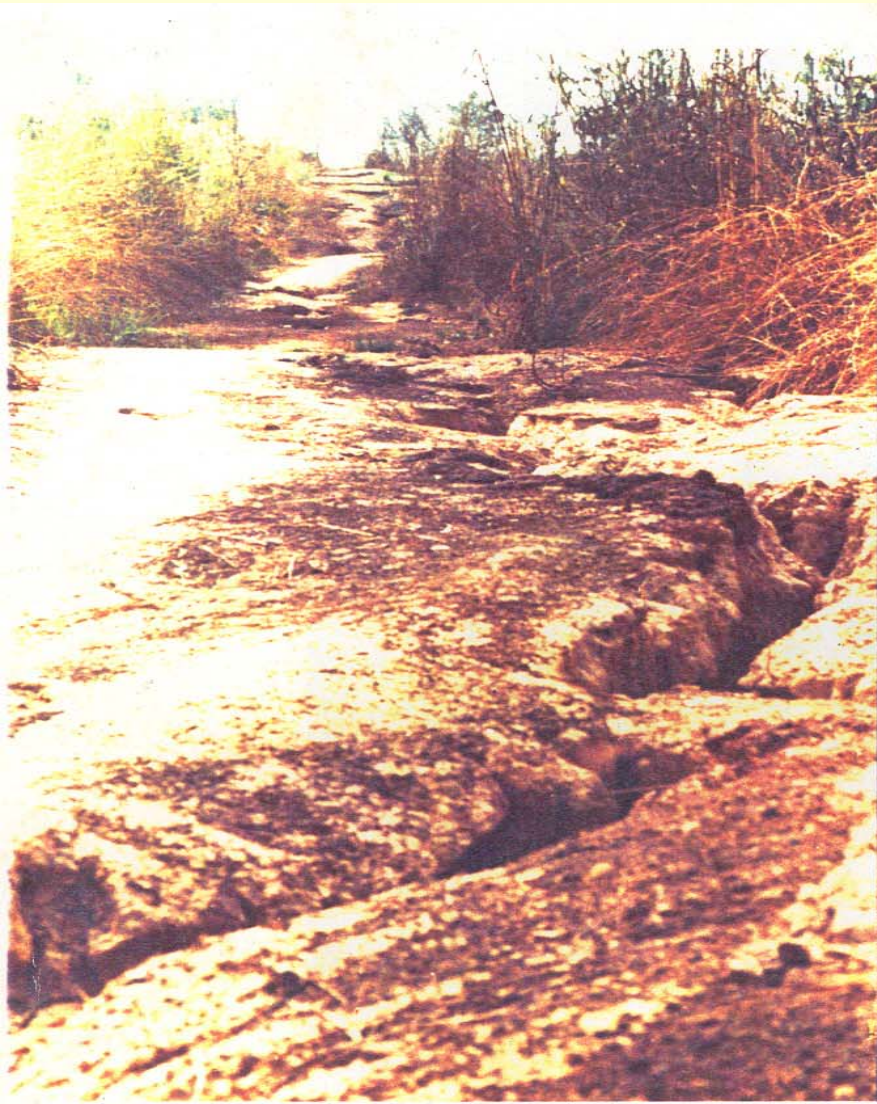
The Estimated length of un-engineered roads (tracks) is 10,550 km

SOUTHERN AFRICA DEVELOPMENT COMMUNITY (SADC)
INVENTORY OF REGIONAL ROAD NETWORK

MAIN ROADS			RURAL ROADS		
Paved (km)	Unpaved (km)	Total (km)	Paved (km)	Unpaved (km)	Total (km)
105,122	395,900	501,022	21,559	409,626	431,185
21.0%	79.0%	100.0%	5.0%	95.0%	100.0%

TOTAL NETWORK		
Paved (km)	Unpaved (km)	Total (km)
126,681	805,526	932,207
13.6%	86.4%	100.0%

- About 80 to 90 per cent of roads in Sub-Saharan African countries are unpaved.
- These roads serve mainly the rural poor who constitute about 70% of the population of the region.
- Their main occupation is agriculture i.e. farming and rearing of animals. The type of farming in this region depends mainly on rainfall.
- Most of the critical farming activities i.e. land preparation, planting, harvesting, conveyance of produce to markets therefore take place during the rainy seasons when the soils are wet.
- Access roads rendered impassable during the wet seasons have significant negative impacts on the output and income of farmers.





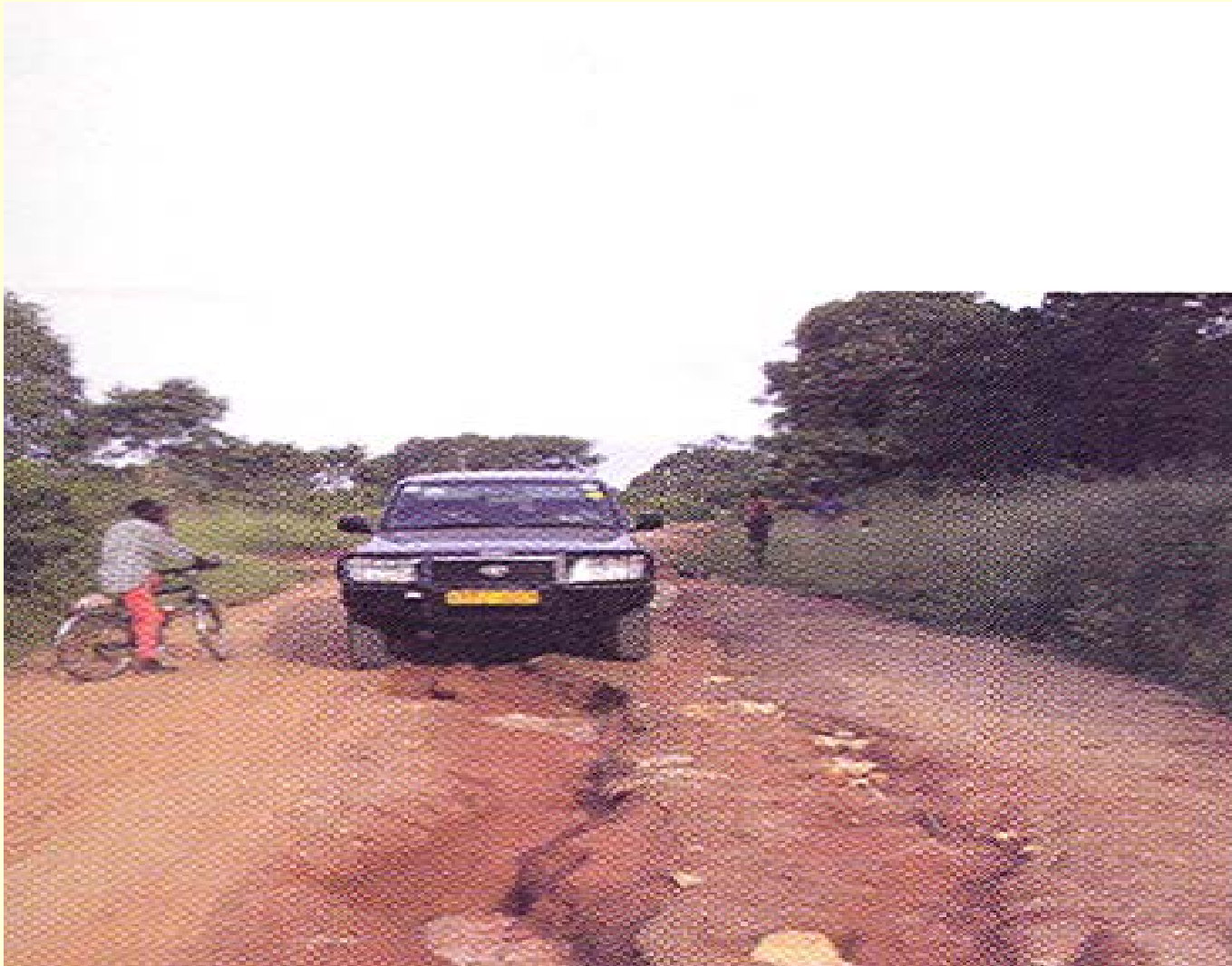
Earth/gravel road (Tanzania).



Short sections of road in poor condition can benefit significantly from spot improvement works.



Trafficability of unpaved roads is adversely affected during the wet season.



**The bulk of the SADC rural road network is still unsurfaced
and in relatively poor condition.**

CLASSIFICATION OF MATERIALS **AS EARTH OR GRAVEL**

The bearing capacity of soils under traffic depends largely on their composition and gradation. The fine proportions of the soils i.e. humus, clay, silt and sand are beneficial for crops but weak for road construction.

For road construction and maintenance purposes it is necessary to classify soils as earth or gravel to aid their selection and use.

Two main criteria are recommended:

- Sieve analysis
- California Bearing Ratio (CBR)

Earth

- (i) If $\geq 30\%$ of a material (soil) passes the 75 μm sieve it is earth.
- (ii) If its CBR $\leq 10\%$ it is earth.

Gravel

- (i) If $< 30\%$ of a material (soil) passes the 75 μm sieve it is gravel.
- (ii) If its CBR $> 10\%$ it is gravel.

Ghanaian practice:

CBR of gravel $>35\%$ although a minimum of 20% is specified for gravel wearing courses in our standard specifications.

Materials with $20\% < \text{CBR} > 35\%$ recommended to be used for gravelling to reduce the cost of hauling gravel over long distances to minimise environmental degradation.

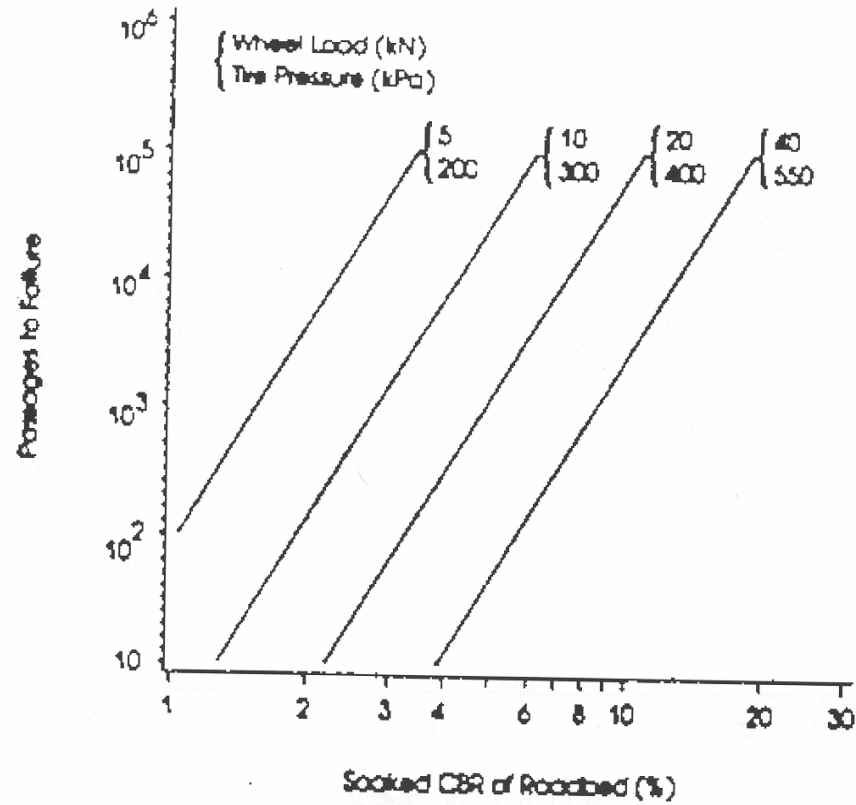
HDM III DESIGN CRITERIA FOR EARTH ROADS

- Model developed by Greenstein and Livneh (1981) with data from Thailand and Ecuador
- $C2 = 0.0138 (N^{0.175})(P^{0.580})(Q^{0.490})$

Where

- C2 = soaked CBR of roadbed soil, in percent
- N= the number of passages to failure
- P= equivalent single wheel load, kN
- Q = Tyre inflation pressure, kPa
- Failure criterion: 75 mm rut depth.

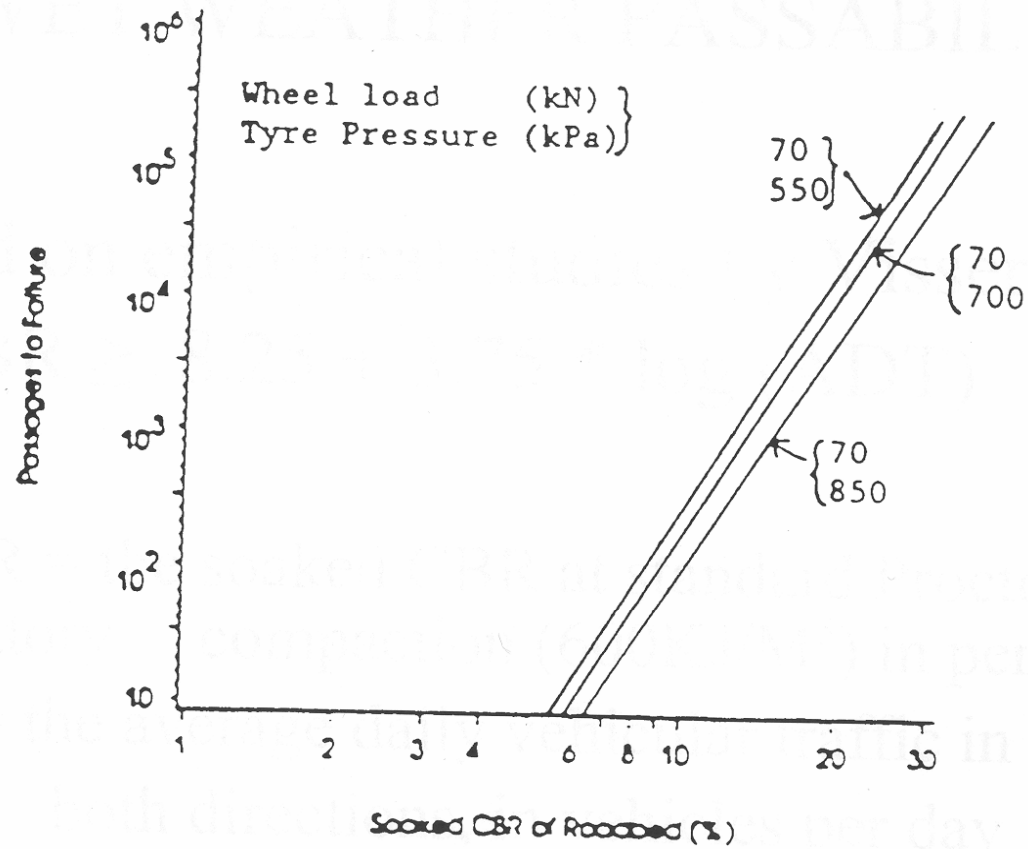
Design Criteria for Earth Roads



Note: Failure criterion 75mm rut depth.

Source: Equation 3.4, after Greenstein and Livneh (1981).

Design Criteria for Earth Roads



Note Failure criterion 75mm rut depth.

EFFECTS OF HIGH WHEEL LOADS AND HIGH TYRE PRESURES

- Shown in graphs
Education of heavy truck drivers required:
 - I. To check deterioration
 - II. To reduce road maintenance cost
 - III. To avoid blockage of roads

32% reduction in tyre pressure of heavy trucks can increase the life of an earth road by 3 times.

Material selection criteria for wet weather passability

- Based on empirical studies by Visser (1981)
 $SFCBR \geq 8.25 + 3.75 \times \log(ADT)$

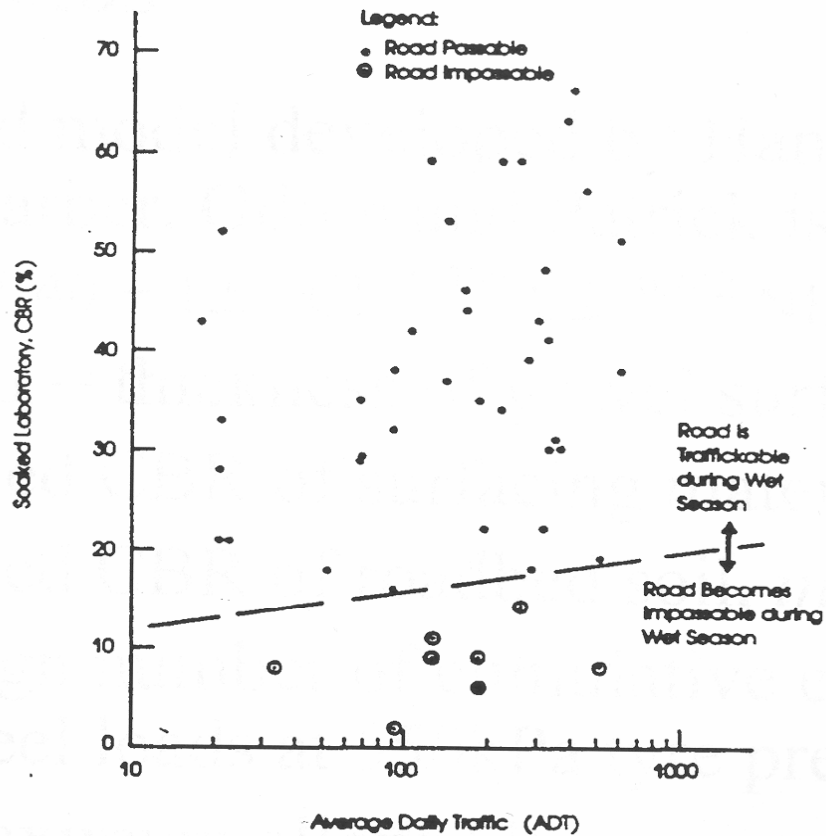
where

SFCBR = the soaked CBR in per cent at standard Proctor Laboratory compaction (600 kJ/m³)

ADT = the average daily vehicular traffic in both directions, in vehicles per day

Log is logarithm to base 10

Figure 3.1: Suggested material selection criteria to ensure the passability of unpaved roads in wet weather



(Source: ref.1)

US CORPS OF ENGINEERS DESIGN CRITERIA FOR THICKNESS OF SURFACING MATERIAL OF GRAVEL ROADS

Metricated model developed by Hammitt (1970) and later by Barber, Odom and Patrick is as follows:

$$\text{Log HG} = 1.40 + 12.3 C1^{-0.466} C2^{-0.142} NE^{0.124} RDC^{-0.5}$$

Where HG = thickness of gravel surfacing, *in mm*;

C1 = soaked CBR of surfacing material, *in percent*,

C2 = soaked CBR of roadbed soil, *in percent*;

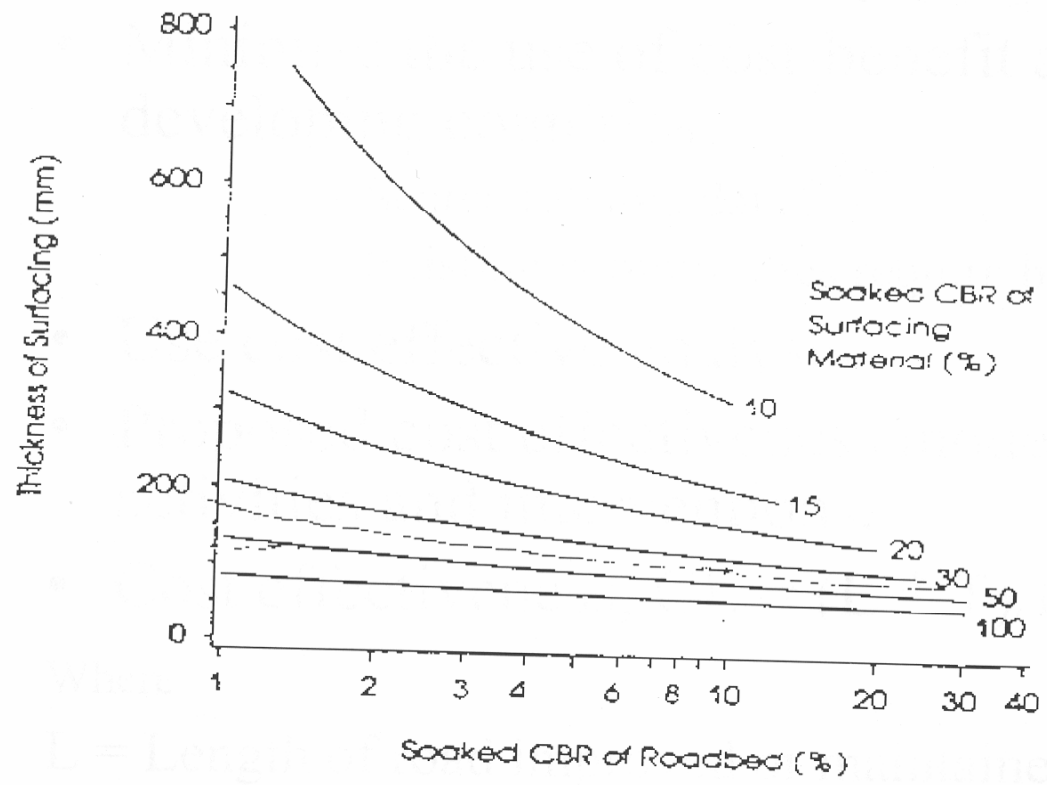
NE = design number of cumulative equivalent 40kN single wheel loads at 550 kPa tyre pressure;

RDC = maximum allowable mean rut depth, *in mm*

Replace the co-efficient 12.3 by $0.856 P^{0.235} Q^{0.285}$ where the wheel load and the tyre pressure are significantly different.

Where P = equivalent single wheel load, kN
Q = Tyre pressure, kPa

U.S. Corps of Engineers' design criteria for thickness of surface material of gravel roads based on soaked California Bearing Ratio



Note: Criteria: 75mm rut depth; 10,000 coverages equivalent to 40 kN single wheel loads.

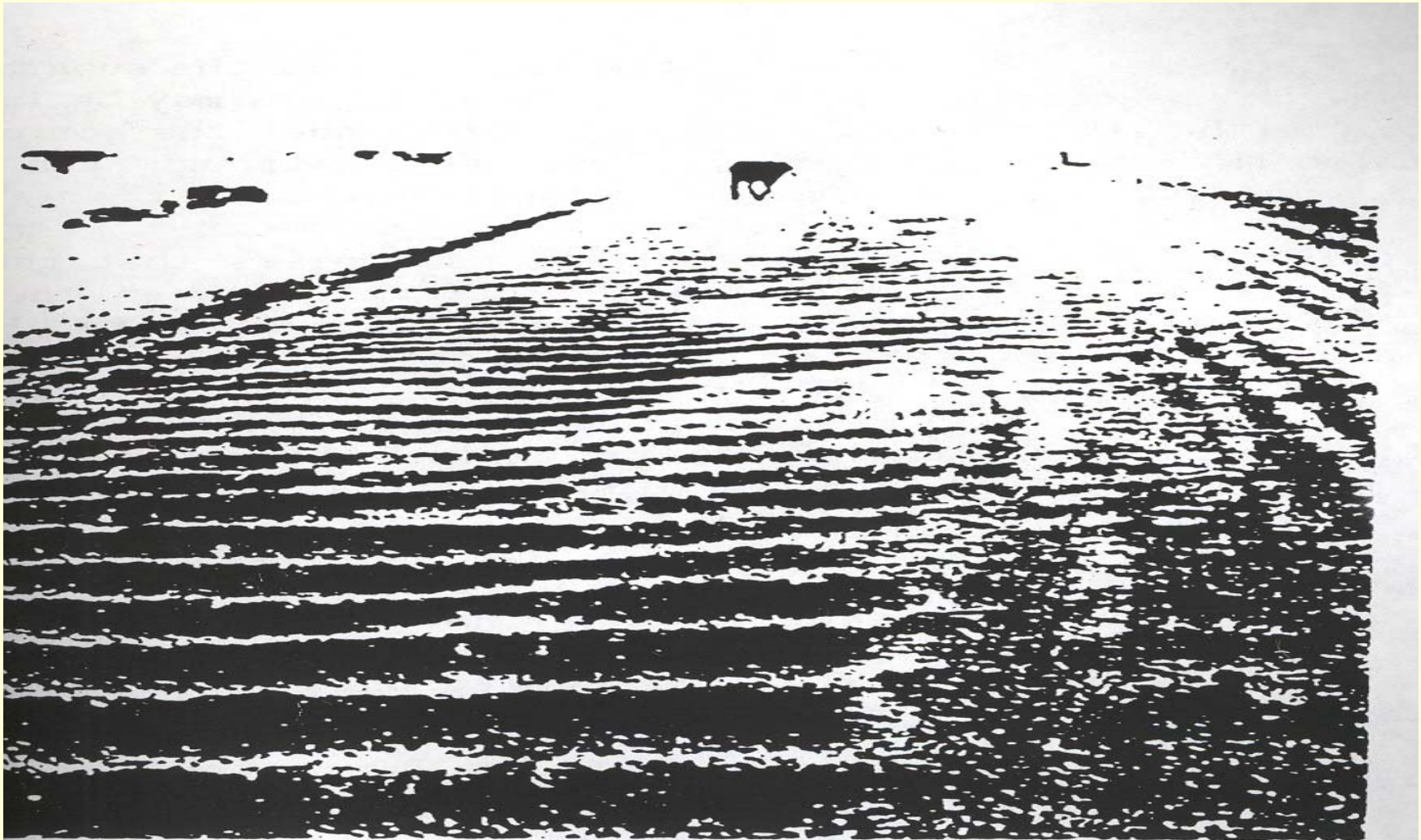


Fig. 2.3 Corrugation in a dry country

For the unpaved roads the CBR testing of soils in laboratories is time consuming and relatively more expensive. The linear shrinkage test and sieve analysis of soils can be conveniently performed in the field. The test results expressed in the following:

- Shrinkage product (S_p) and
- Grading co-efficient (G_c) are recommended to be used in determining the suitability of materials as wearing course for unpaved roads.

Linear shrinkage L_s , is calculated as

$$L_s = \left(1 - \frac{L_D}{L_O}\right) \times 100$$

Where L_O and L_D are the lengths of the test sample at liquid limit and dried conditions respectively.

Shrinkage product S_p = linear shrinkage x % passing 425 μm sieve.

Grading co-efficient G_c = [(% passing 25mm sieve - % passing 2.0 mm sieve) x % passing 4.75 mm sieve]/100.

7.3 Determination of the requirement for a gravel wearing course

Figure 7.1: Soil groups based on Sp and Gc

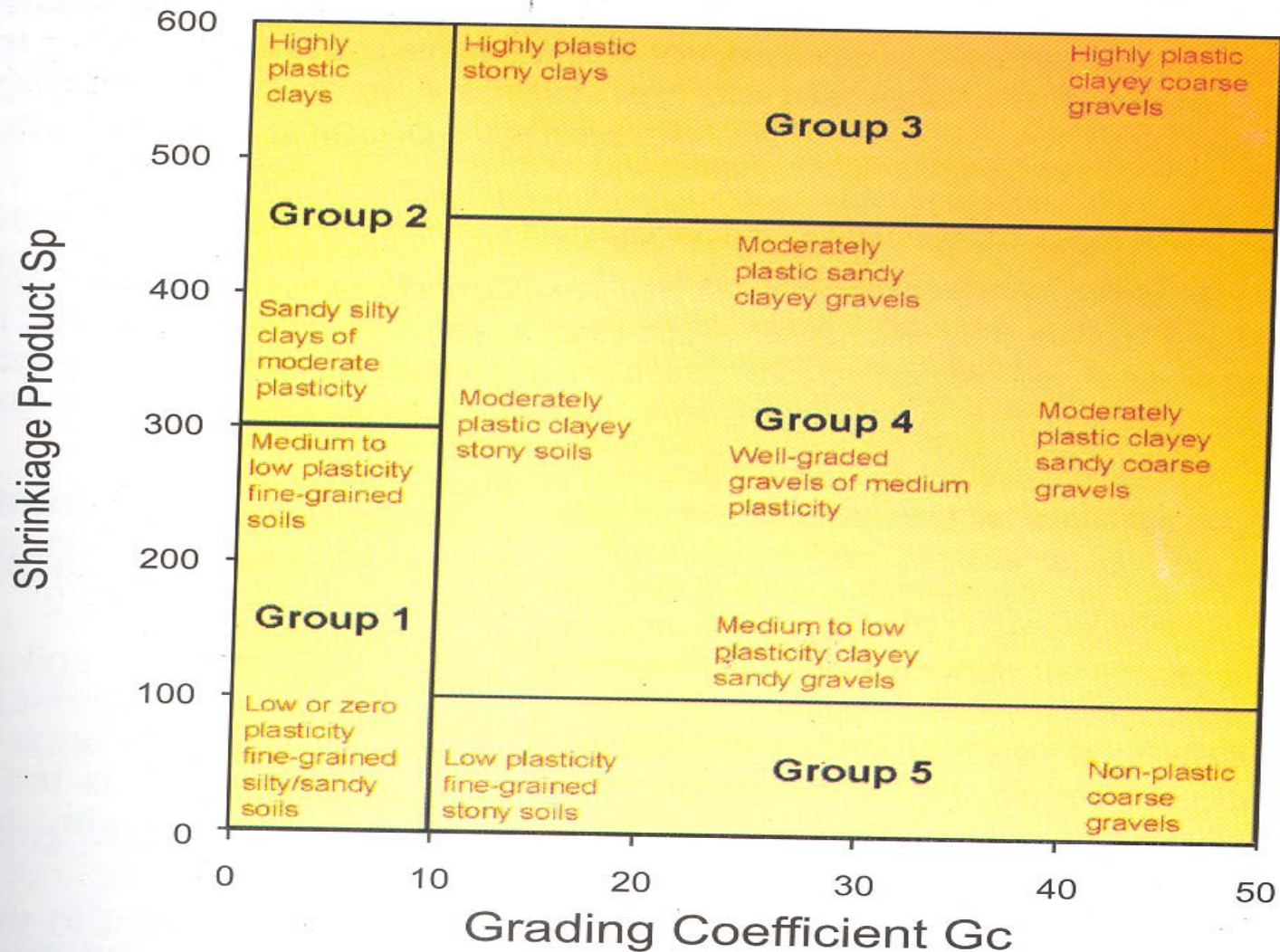


Table 7.1: Suitability of soil groups for feeder road construction

Subgrade Soil Group	Form road using material from side drain excavation		Embankment construction	
	ADT < 100 vpd	ADT > 100 vpd	ADT < 100 vpd	ADT > 100 vpd
Group 1	Provide a gravel wearing course and erosion protection measures in drains		Not suitable. Construct embankments using Group 4 material or better obtained from borrow areas.	
Group 2	Provide a gravel wearing course		May be suitable but requires a gravel wearing course	
Group 3	Provide a gravel wearing course on steep grades and bends		May be suitable and may require gravel wearing course	
Group 4	Suitable for the running surface	Spot gravelling may be required after one rainy season	Suitable for the running surface	Spot gravelling may be required after one rainy season
Group 5	Spot gravelling may be required after one rainy season	Provide a gravel wearing course	Spot gravelling may be required after one rainy season	Provide a gravel wearing course

STRATEGIES TO REDUCE THE COST OF CONSTRUCTION AND MAINTENANCE OF EARTH AND GRAVEL ROADS

Adopt stage construction/improvement of tracks that serve rural farming communities.

Stage I

- **Provide basic wet weather access through the installation of critical culverts and bridges.**
- **Make optimum use of the natural, in-situ strong sub-grade materials.**
- **Gravel roads only on sectional basis with particular emphasis on slippery steep slopes and weak flat sections.**
- **Raise low-lying sections where necessary.**
- **Avoid excavating material to spoil; rather, build embankments about 600 to 700mm above water table levels in swampy areas.**

STRATEGIES TO REDUCE THE COST OF CONSTRUCTION AND MAINTENANCE OF EARTH AND GRAVEL ROADS (contd...)

- **Cushion rock outcrops on roadways.**
- **Provide foot bridges for streams and rivers where vehicular bridges cannot be economically justified e.g. footpaths to farms and small communities.**
- **Safety of all road users should not be compromised in all aspects.**

Figure 4.10: Otta seal in Central Region



STRATEGIES TO REDUCE THE COST OF CONSTRUCTION AND MAINTENANCE OF EARTH AND GRAVEL ROADS (contd...)

Stage II

Improve the design of the more heavily trafficked unpaved roads with traffic greater than 100 vehicles per day.

- **Improve drainage in towns and villages.**
- **Pave roads in towns and villages to reduce dust nuisance.**
- **Pave roads when traffic volumes exceed 200 v.p.d.**
- **(Adopt Otta Seal wherever economically feasible).**
- **Improve upon the safety of identified blackspots.**
- **Introduce speed calming measures in towns and villages.**
- **The choice of road width should consider the use of roads by pedestrians, cyclists and other non-motorised transport users.**

OTHER RECOMMENDATIONS TO ENSURE THE TARGETTING OF THE POOR AND THE ROADS THEY DEPEND ON

1. Establish dedicated organisations or departments to be solely responsible for the development and maintenance of tertiary roads in developing countries.
2. Involve all stakeholders at the district level in the selection and prioritisation of roads and tracks for improvement.
3. Involve the stakeholders in choosing the interventions and activities under the budgetary constraints.
4. Carry out regular routine and recurrent maintenance of the engineered roads to reduce their roughness and vehicle operation cost and also to avoid the need for their periodic rehabilitation at high cost.
5. Promote the use of non-motorised transport.

END OF PRESENTATION

THANK YOU