

# **Technology Choice for Rural Roads**

Category: Technical Information/General/

## **INTRODUCTION**

This document sets out the proven technology options for the range of rural road operations in developing regions.

There are a number of Technology options open to CONTRACTORS AND ROAD AUTHORITIES for rural road works in developing regions. The technologies can be broadly grouped into heavy equipment, intermediate equipment and labour (using hand tools). Many operations involve combinations of technology, however it is not widely appreciated that **there is a range of technology options for nearly every road sector construction or maintenance activity**. There are various definitions and interpretations of terminology used in the appropriate technology road works sector. The following definitions are recommended:-

### **LOCAL RESOURCES**

These can include human resources, local government, private, NGO and community institutions, local entrepreneurs such as contractors, consultants, industrialists and artisans, local skills, locally made or intermediate equipment, local materials such as timber, stone, bricks, and marginal materials, locally raised finance or provision of materials or services in kind.

### **LABOUR BASED ROADWORKS**

Operations carried out principally by manual methods, using hand tools. They may be supported by intermediate or sophisticated equipment for activities not ideally suited to labour methods, e.g. medium-long distance haulage, heavy compaction. Labourers usually walk or cycle to work each day from their homes.

### **INTERMEDIATE EQUIPMENT**

Simple or intermediate equipment is designed for low initial and operating costs, durability and ease of maintenance and repair in the conditions typical of a limited-resource environment, rather than for high theoretical efficiency. It is preferable if the equipment can also be manufactured or fabricated locally. Modern wheeled agricultural tractors are a low cost mobile power source and with various attachments can be used to substitute for heavy equipment for a proven range of tasks in the road sector.

### **HEAVY EQUIPMENT OR PLANT**

Sophisticated civil engineering equipment is typically designed for, and manufactured in, high-wage, low-investment-charge economies. It is expected to operate with close support and high annual utilisation; usually designed for a specific single function or task with high efficiency operation.

# Rural Roads for Developing Regions

## Technical Information Note – TE1

### ***HIGH TECHNOLOGY (High Tech)***

Methods that utilise high technology and labour saving techniques, such as computer or electronic systems.

**The choice of technology has important cost implications for the owner and operator of any equipment.** These technology options should each be properly costed to ensure that the most technically compliant and cost-effective application of available resources is used.

Many problems encountered in the road sector in emerging and developing countries can be attributed to the application of inappropriate technology.

This document sets out the technology options for each group of road works construction and maintenance activities in the following matrices.

## **CONTENTS**

1. Surveying and Setting out
2. Vegetation Removal
3. Earthworks Rock & Haulage
4. Compaction
5. Aggregate Production
6. Structures
7. Surfacing and Paving
8. Vegetation and Erosion control
9. Maintenance
10. Rehabilitation/Upgrading

1. SURVEYING									
Activity/Task	Labour Based			Intermediate Equipment			Heavy Plant/High Tech		
Horizontal alignment/centre line	Ranging Rod and tape			Theodolite			Total survey station		
Vertical alignment	Profiles, traveller and tape			Surveyors level			Total survey station		
Cross section	Line-level/ hand level/water tube			Surveyors level			Total survey station		
	Templates/straight edge/spirit level								

2. VEGETATION REMOVAL									
Activity/Task	Labour Based			Intermediate Equipment			Heavy Plant/High Tech		
Tree and root removal	Saw, Axe, Rope, hoe, crowbar, shovel			Backhoe Loader			Dozer-ripper		
Bush removal	Bushknife, saw, axe, hoe			Backhoe Loader			Dozer		
Ground cover vegetation	Hoe, shovel, rake, wheelbarrow			Tractor and towed scraper			Dozer		

3. EARTHWORKS, ROCK and HAULAGE									
Activity/Task	Criteria	Labour Based			Intermediate Equipment			Heavy Plant/High Tech	
Excavation of soils and rock	Soft Soil	Hoe/Shovel				Backhoe Loader	Dozer/Tracked Excavator/Wheeled Loader/ Motor Scraper with or without pusher		
	Firm Soil								
	Hard Soil								
	Soft Rock	Pick/Mattock/Crowbar				Mini-digger	Dozer-ripper		
	Medium Rock								
Hard Rock	Hand drilling+plugs&feathers/blasting				Compressed air drill and blasting	Compressed air drill and blasting			
Loading			Shovel				Tractor loader	Tracked excavator/Wheeled Loader	
			Hoe				Backhoe Loader		
						Mini-digger			
						Tractor and towed scraper			
Hauling and Unloading	0-50m	Head Basket/Animal	Wheel barrow				Dozer/Tracked Excavator/Wheeled Loader		
	50-100m	Panniers/Stretcher							
	100-200m			Carts	Tractor and towed scraper			Scraper with or without pusher	Flat bed Truck
	200-500m								Tractor & Trailer
	500-1000m			Tipping or manual unload					Dump Truck
	1000-2000m								
	2000-5000m			Mini-truck					Barge (waterway)
over 5000m			Tipping or manual unload						
Spreading/Shaping Soils and aggregates					Hoe/Shovel/Rake				Tractor Loader/Towed Grader
					Backhoe Loader	Motorgrader			

4. COMPACTION			
Activity/Task	Labour Based	Intermediate Equipment	Heavy Plant/High Tech
Compaction of soils, aggregate layers, cobble stones	Hand rammer*	Pedestrian vibrating roller Vibrating small self propelled roller Tractor towed smooth steel roller Tractor towed pneumatic tyred roller Tractor towed vibrating roller Tractor towed grid roller Tractor towed sheepsfoot roller	Self propelled smooth wheeled roller Self propelled vibrating smooth roller Self propelled sheepsfoot roller Self propelled pneumatic tyred roller Self propelled grid roller
	Animal drawn roller*		
	Vibrating plate compactor		
	Hand held mechanical rammer		
Compaction of bituminous pavement layers	NA	Pedestrian vibrating roller Vibrating small self propelled roller Tractor towed smooth steel roller Tractor towed pneumatic tyred roller Tractor towed vibrating roller	Self propelled smooth wheeled roller Self propelled vibrating smooth roller Self propelled pneumatic tyred roller
Compaction of concrete slab paving	Manual tamping screed	Vibrating poker/screed	Concrete paver with vibrating screed
Compaction of incremental block paving	Vibrating plate compactor	NA	NA
<b>Notes</b>			
* May not achieve specification compaction standards.			
NA Not appropriate			
It is essential to match the compaction equipment to the materials and standards required.			

5. AGGREGATE PRODUCTION												
Activity/Task	Labour Based				Intermediate Equipment				Heavy Plant/High Tech			
Breaking/crushing stone	Stone breaking with sledge hammer				Small or mobile crusher & screens				Crushing Plant with integral screens and conveyor loaded by wheeled loader			
	Hand knapping with hammer				loaded manually							
	Manual screening				stone pre-broken to 100-150mm							
					Tractor towed impact breaker							

6. STRUCTURES			
Activity/Task	Labour Based #	Intermediate Equipment	Heavy Plant/High Tech
Dewatering excavation	Bucket	Portable motor pump	Static or trailer mounted pump
Casting culvert rings/pipes ***	Mould, shovel, ramming rod trowel	Mould, concrete mixer shovel, vibrating poker, trowel	Mould, batch mixer, vibrator
Laying precast rings/pipes	Shovel, rake, rope*	Backhoe loader, shovel, rake, rope	Hydraulic Excavator, shovel, rake, rope
Laying & assembling corrugated metal culverts	Shovel, rake, spanners	Backhoe loader can be used to facilitate component handling	Hydraulic excavator can be used to facilitate component handling
Reinforced concrete box culvert ***	Shuttering, shovel, Masonry tools #	+ concrete mixer, vibrating poker	Maybe precast units transported to site
Masonry/brick drift/apron	Masonry tools #	NA	NA
Concrete drift/apron ***	Shuttering, shovel, Masonry tools #	Shuttering, shovel, concrete mixer shovel, vibrating poker, trowel	Shuttering, shovel, batch concrete mixer shovel, vibrating poker, trowel
Gabion drift/retaining wall	Wire cutters, pliers, crowbar	NA	NA
Masonry arch culvert/bridge	Shuttering, shovel, Masonry tools #	NA	NA
Brick arch culvert/bridge	Shuttering, shovel, Masonry tools #	NA	NA
Concrete arch culvert/bridge ***	Shuttering, shovel, Masonry tools #	+ concrete mixer, vibrating poker	+ concrete mixer (+pump), vibrating poker
Timber deck culvert/bridge	Carpentry Tools # and Timber treatment Simple lifting and winching gear	NA	NA
Masonry/brick retaining wall	Masonry tools #	NA	NA
Concrete retaining wall/deck ***	Shuttering, shovel, Masonry tools #	Shuttering, shovel, concrete mixer shovel, vibrating poker, trowel	Shuttering, shovel, batch concrete mixer shovel, vibrating poker, trowel, possibly concrete pump and crane
Sheet piling	NA	Portable vibrator	Machine based vibrator
Caisson (well type)	Simple lifting gear Excavation tools		Heavy lifting gear Crane
Concrete/timber cribwork	Carpentry tools Simple lifting gear		Crane
<b>Notes</b>			
# For full listing of hand tools see Reference 3.			
* Size limited by safe handling. Max dia usually about 900mm for labour.			
** Not Appropriate			
*** Where concrete is reinforced, then steel cutting and fixing skills and tools required.			
**** Shuttering requires carpentry and/or metal formwork skills and tools			

7. SURFACING AND PAVING - Part 1 SURFACING				
<i>For further information on hand tools and equipment refer to Reference 3.</i>				
Activity/Task	Labour Based		Intermediate Equipment	Heavy Plant/High Tech
<b>SURFACING</b>				
Engineered Natural Surface	✓		✓	✓
Gravel Surface	✓		✓	✓
Stone Chippings	✓		✓	✓
Waterbound Macadam	✓		✗	✗
Drybound Macadam	✓		✗	✗
Hand Packed Stone	✓		✗	✗
Stone Setts or Pavé	✓		✗	✗
Mortared Stone	✓		✗	✗
Dressed Stone/cobble stone	✓		✗	✗
Irregular Cobble Stone	✓		✗	✗
Telford Paving	✓		✗	✗
Fired Clay Brick Paving	✓		✗	✗
Concrete Brick Paving	✓		✗	✗
Bituminous Chip Seal	✓		✓	✓
Bituminous Sand Seal	✓		✓	✓
Bituminous Slurry Seal	✓		✓	✓
Bituminous Cape Seal	✓		✓	✓
Bituminous Otta Seal	✗		✗	✓
Penetration Macadam	✓		✗	✗
Premix Macadam/AC	✗		✗	✓
Non-Reinforced Concrete	✓		✓	✓
Reinforced Concrete	✓		✓	✓
Geocell Paving	✓		✗	✗
<b>Notes</b>				
✓	Suitable			
✗	Not Suitable			
AC : Asphalt Concrete				



7. SURFACING AND PAVING - Part 2 PAVEMENT LAYERS & SHOULDERS			
<i>For further information on hand tools and equipment refer to Reference 3.</i>			
Activity/Task	Labour Based	Intermediate Equipment	Heavy Plant/High Tech
<b>PAVEMENT LAYERS &amp; SHOULDERS</b>			
Engineered Natural Surface	✓	✓	✓
Natural Gravel	✓	✓	✓
Armoured Gravel	✓	✓	✓
Crushed Stone	✓	✓	✓
Crushed Brick	✓	✓	✓
Waterbound Macadam	✓	✗	✗
Drybound Macadam	✓	✗	✗
Hand Packed Stone	✓	✗	✗
Cement Stabilised Soil	✗	✓	✓
Lime Stabilised Soil	✗	✓	✓
Emulsion Stabilised Soil	✗	✓	✓
Mechanical Stabilisation	✗	✓	✓
Telford Paving	✓	✗	✗
<b>Notes</b>			
✓	Suitable		
✗	Not Suitable		

8. VEGETATION & EROSION CONTROL									
Activity/Task	Labour Based			Intermediate Equipment			Heavy Plant/High Tech		
Grass seeding	Manual casting			Hydro seeding equipment			Hydro seeding equipment		
Grass planting (seedlings)	Trowel/hoe			NA			NA		
Turfing	Pegging if on slopes			NA			NA		
Sodding	Trowel/hoe			NA			NA		
Wattling/brushwood	Bush knife, axe, hammer			NA			NA		
Stone pitching	Masonry tools			NA			NA		
Watering	Watering can, bucket, panier, cart			Tractor towed bowser			Truck bowser		
Grasscutting	Slasher, scythe			Tractor mower/rotary cutter			NA		
Scour checks	Timber/stone/masonry/concrete			NA			NA		
Scour protection	Timber/stone/masonry/concrete			NA			NA		
Check dam construction	Timber/stone			NA			NA		
Gabions	Wire cutters, pliers, crowbar			NA			NA		
<b>Notes</b>									
NA Not appropriate									

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9. MAINTENANCE - ROUTINE				
Activity/Task	Labour Based	Intermediate Equipment	Heavy Plant/High Tech	
<b>Roadside</b>				
Brush clearing	Bushknife, saw, axe, hoe	Backhoe Loader	NA	
Shoulder Rehabilitation	Pick/mattock/shovel/hand rammer	Backhoe Loader, pedestrian roller	NA	
Shoulder Reshaping	Pick/mattock/shovel/hand rammer	Tractor towed grader	Motor grader	
Plant grass and water	Trowel/hoe, wWatering can, bucket	NA	NA	
Cut grass	Slasher, scythe	Tractor mower/rotary cutter	NA	
Wattling	Bush knife, axe, hammer	NA	NA	
<b>Drainage</b>				
Culvert Cleaning	Crowbar, hoe, shovel	Water jetting		
Ditch Clearing	Hoe, shovel	Backhoe loader, tractor towed grader	Motor grader	
Repair Erosion Damage (Selected Fill)	Pick/mattock/shovel/hand rammer	Backhoe Loader	NA	
Repair Erosion Damage (Rockfill)	Pick/mattock/shovel/sledgehammer	Backhoe Loader	NA	
Mortared Masonry Repair	Masonry tools #	NA	NA	
Dry Masonry Repair	Masonry tools #	NA	NA	
Gabion Structure Repair	Wire cutters, pliers, crowbar	NA	NA	
Build wooden/stone scour check	Bush knife, axe, hammer	NA	NA	
<b>Road Surface</b>				
Light reshape earth/gravel camber	Hoe, mattock, shovel, rake, rammer	Tractor light towed grader	Motor grader	
Heavy reshape earth/gravel camber	Hoe, mattock, shovel, rake, rammer	Tractor heavy towed grader + towed bowser + towed compactor	Motorgrader+ truck bowser + truck bowser + compactor	
Spot Repairs	Pick/mattock/shovel/hand rammer	Compressor and tools, compactor	NA	
<b>Structures</b>				
Clearing/cleaning Structure/inlets/outlets	Pick/mattock/shovel/hand rammer	Backhoe loader	NA	
Repair of loose/missing connectors/fixings	Metalwork tools	NA	NA	
Replace damaged/missing planks or kerbs	Carpentry tools	NA	NA	
Paint parts of structure/furniture	Painting tools	NA	NA	
Apply timber preservative/treatment	Brushes/spray tools	NA	NA	
Pointing or repair of masonry/concrete	Masonry tools #	NA	NA	
Repair parapets or other furniture	Metalwork tools	NA	NA	
<b>Notes</b>				
# For full listing of hand tools see Reference 3.		NA Not Appropriate		

9. MAINTENANCE - PERIODIC			
Activity/Task	Labour Based	Intermediate Equipment	Heavy Plant/High Tech
<b>Engineered Natural Surface</b>			
Heavy reshape earth camber	Hoe, mattock, shovel, rake, rammer	Tractor heavy towed grader	Motorgrader+ truck bowser
Watering and Compaction	Refer to Matrices 4 and 8	→	
<b>Gravel Surface</b>			
Heavy reshape gravel camber	Hoe, mattock, shovel, rake, rammer	Tractor heavy towed grader	Motorgrader+ truck bowser
Excavation and load gravel	Refer to Matrix 3	→	
Regravelling haulage	Animal cart, tractor trailer, minitruck	Tractor trailer, minitruck	Truck, dump truck
Unloading and spreading	Refer to Matrix 3	→	
Watering and Compaction	Refer to Matrices 4 and 8	→	
<b>Bituminous seals</b>			
Seal application	Hand heater/dispenser/spray	Tractor heater/dispenser/spray	Truck heater/distributor/spray
Chipping/aggregate application	Manual/manual chipper		Tailgate/self propelled chipper
Compaction	Pedestrian roller	Mini-roller	Self propelled roller

10. REHABILITATION-UPGRADING			
Activity/Task	Labour Based	Intermediate Equipment	Heavy Plant/High Tech
<b>Pavement Layer Rehabilitation (example)</b>			
Break up existing Pavement	Pick, mattock, sledgehammer, crowbar, shovel Compressor & breaker tools	Wheeled tractor & ripper Wheeled tractor pulveriser/miller	Tracked tractor & ripper Self propelled pulveriser/miller
Break down material to acceptable size	Sledgehammer, stone hammer, steel mesh grill	Wheeled tractor & towed roller Wheeled tractor pulveriser/miller	Self propelled pulveriser/miller
Apply Bitumen Emulsion	Fixed volume containers/unit area Squeegee/spreader One barrel hand lance	Wheeled tractor & towed/attached bitumen distributor	Truck mounted bitumen distributor
Mix emulsion and recycled pavement materials	Power tiller with mixer attachment	Wheeled tractor & HD disc harrow Wheeled tractor & reciprocating harrow Wheeled tractor & heavy towed grader	Motorgrader
Shape mixed material to form new pavement layer	Shovel, rake	Wheeled tractor & heavy towed grader	Motorgrader
Compact new pavement layer	twin drum pedestrian vibro roller	Wheeled tractor & towed DW roller Wheeled tractor & towed vibro roller	Self propelled DW roller Self propelled vibro roller

## **Rural Roads for Developing Regions**

### **Technical Information Note – TE1**

#### **FURTHER INFORMATION**

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13. Manufacturers' and Contractors' documentation.

#### **KNOWLEDGE SHARING**

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If you have any comments or contributions to improve this Technical Information Note, Please contact [rob@intech-associates.co.uk](mailto:rob@intech-associates.co.uk)