# Equipment for Implementing Low-Cost Rural Road Surfacing and How to Decide on its Use?

This brochure summarises the findings of a study* on the low-cost equipment to support the emerging low-cost rural road surfacing technologies. This brochure is designed for small-scale contractors in the rural roads sub sector. The objective of the brochure is to provide information on suitable equipment that will be necessary to implement the low-cost road surfacing technologies. It also provides specific information on available options and the optimum strategies in relation to grading of roads and crushing of aggregate.

**Background**

One of the main target groups is the small scale contractors (SSC), involved in the construction and maintenance of rural roads. The main focus of this research was in Cambodia, although some activities of the research were carried out in Vietnam and Laos. This information pack will first introduce the equipment that is required for SSC and possible finance opportunities. A brief discussion on the usefulness of towed graders and mobile crushers will also be provided.

**What is the appropriate equipment?**

There are many surfacing options ranging from engineered natural surface to ottaseals and geo-cell paving. The following equipment has been found to be essential to support the emerging low-cost road surfacing technologies.

**Haulage Equipment**

- Tipper truck
- Flat truck
- 2WD Tractor
- 4WD Tractor
- Trailer
- Wheelbarrow

**Compaction Equipment**

- Roller, ride on vibratory
- Roller, pedestrian vibratory
- Roller, towed vibratory
- Roller, ride on deadweight
- Roller, hand drawn deadweight
- Roller, towed deadweight
- Plate compactor

**Watering Equipment**

- Motorised water bowser
- Towed water bowser

**Concreting Equipment**

- Concrete mixer
- Concrete vibrator

**Grading Equipment**

- Motor grader
- Towed grader

**Other Equipment**

- Bitumen heater
- Bitumen hand sprayers
- Mobile crushers

**How do the contractors currently source their equipment?**

Contractor surveys in Cambodia and Vietnam show that the vast majority of contractors own at least one truck and one compaction equipment. The ownership of tractor-towed based technology is low. Only one in five contractors own tractors and/or trailers.

An analysis of the rural road development plans of the region indicates that there will be substantial demand for conventional equipment (e.g. tipper truck and ride on deadweight roller). However, the demand for low-cost equipment (particularly tractor-towed technology) is expected to be lower.

Market analysis shows that the current supply of different construction equipment is adequate in the region. It is highly unlikely that there will be a supply shortage of construction equipment if the rural roads are constructed as per the current plans.

**Operating costs**

Operating costs depend on many variables including fixed (e.g. purchase price) and variable components (e.g. fuel). In general, the towed technology is the least expensive to operate. Self propelled haulage/watering and compaction equipment have been found to be the most expensive equipment type.

**What equipment financing opportunities are available?**

Most contractors purchase their equipment by raising private capital independently. However, there are now many credit services available to small businesses from banking institutions (e.g. ACLEDA Bank of Cambodia and Vietcom Bank in Vietnam). Although terms and conditions for borrowing capital will vary between institutions, the sample terms and conditions for borrowing from ACLEDA Bank of Cambodia is provided in the box below. It appears the borrowing terms and conditions are tough and the maximum loan value is limited. However, it is necessary to shop around for raising capital as there may be suitable other offers available.

**Sample Borrowing Terms and Conditions for Small Business Loan in Cambodia**

- Minimum loan of 6 million Riels (approximately US$1,500)
- Maximum loan of 40 million Riels (approximately US$10,000)
- Interest rate of 2.75% per month
- Maximum loan period of 24 months;
- Liquid deposits amounting to 100% of the loan value OR secured with property amounting to 125% of the loan value

Source: ACLEDA Bank, Cambodia

**How does one decide on grader type to be used?**

Grading is an important activity for maintaining rural roads. This section provides guidance on the grading options available to contractors and the choice of the best option.

There are two general types of graders:

- **motor graders**, which provide their own power source; and
- **towed grader**, which require an external tractive source

**What graders are available in the region?**

An investigation into the suitability of the use of graders for different roads suggests that large motor graders (180HP or above) are not appropriate for works on rural roads because they are heavier and have a wide turning circle. Medium sized motor graders (120 – 180 HP) are the most common in the region. The most common available model is the CAT 120H. Small motor graders (under 120 HP) are rare in the region. A typical small motor grader model available in the US is the LeeBoy 635, manufactured by VT LeeBoy Inc. of North Carolina, US.

Two types of towed graders were found in the region. The CamGrader, produced in Cambodia by DTW. It weighs less than 1 Tonne and only requires a 2WD tractor with more than 35HP. However, it is only suitable for light grading work on earth roads.

There is also the UK manufactured Simba which weighs 1.35 Tonnes and is significantly more expensive than the CamGrader. It requires a 4WD tractor with more than 70 HP. It is capable of performing light grading operations on both earth and gravel roads. Large towed graders (heavier than 5 Tonnes) are available to purchase globally, however, they are uncommon in the region. There are a wide variety of tractors available in the region.

The following table below briefly presents different aspects of the grading related equipment including appropriate models and costs.

| Equipment | Model | Description | Price (US$) |
|---|---|---|---|
| Motor Grader | CAT14G | 140HP | 140,000 |
| | LeeBoy635 | 48HP | 60,200 |
| Towed Grader | Cam Grader | 0.88 Tonnes | 2,500 |
| | Simba | 1.35 Tonnes | 16,000 |
| Tractor | Kobuta MX500 | 44HP, 2WD | 42,000 |
| | Kobuta 9570 | 95HP, 4WD | 25,000 |
| | | | |

**What are the grader operating costs?**

The estimated operating costs of towed graders and small motor graders vary between US$30 and 100 per km. The operating costs of motor graders vary between US$30 and 300 per km. The operating costs of the graders are largely dependent on the extent of the use of the equipment (e.g. number of hours per year). The higher the number of hours of use of the equipment, the lower the unit costs of their operation.

**What grading strategies are to be followed?**

The best strategies for the selection of graders, depending on their extent of use and the road surface on which they would be used, are presented in the following table. If a contractor has enough workload to use a grader for more than 2,000 hours per year then the most cost effective strategy will be to purchase (either new or second-hand) or to hire a small motor grader. If 2,000 hours per year utilisation rate cannot be achieved, for earth road the best option is to purchase a CamGrader (either new or second-hand). For the same utilisation rate the best options for gravel roads are: (i) use a small motor grader if purchased new; (ii) use a Simba towed-grader if purchased second-hand. In all other cases use a small motor grader.

| Option | Surface | Utilisation rates (hours/year) | |
|---|---|---|---|
| | | <2,000 | >2,000 |
| Purchase (New) | Gravel | Small Motor Grader | Small Motor Grader |
| | Earth | Cam-Grader | Small Motor Grader/Cam-Grader |
| Purchase (Second-hand) | Gravel | Simba | Small Motor Grader |
| | Earth | Cam-Grader | Small Motor Grader |
| Hire | Gravel | Small Motor Grader | Small Motor Grader |
| | Earth | Small Motor Grader | Small Motor Grader |

## What are the available options for sourcing crushed aggregate?

Crushed aggregate (stone) has extensive uses in road improvement and construction.

There are three ways of sourcing crushed rock or gravel (aggregate):

- excavating/purchase of un-crushed rock/stone and manually breaking it into the required size. This is known as **hand knapping**;

- purchase ready-crushed material from a **commercial quarry**; or
- excavation/purchase of un-crushed rock/stone and crushing it into the required size using a **mobile crusher**


## What mobile crushers are available in the region?

There are many models of mobile crushers available in the region. The two main manufacturers are Hoa Phat (Vietnam) and Shibang (China).The table below shows further details on the models of these crushers.

| Crusher model, Brand | Price (US$) | Weight (tonnes) |
|---|---|---|
| NHHP-PEX15, Hoa Phat | 1,420 | 0.4 |
| NHHP-PEX175, Hoa Phat | 2,560 | 0.9 |
| NHHP-PEX215, Hoa Phat | 4,245 | 2.0 |
| PE150x250, Shibang | 1,850 | 0.81 |
| PE250x400, Shibang | 5,400 | 2.8 |
| PE400x600, Shibang | 12,000 | 6.5 |

## What are crusher operating Costs?

Depending on the size, the operating costs of the Hoa Phat mobile crushers vary between US$1.4 and US$2.2 per cubic metre of crushed material. These estimates are based on the assumption of 1,000 hours of operation per year. The cost will be lower in the case of higher utilisation rates. The main components of the variable costs include the fuel costs, jaw replacement costs and operator wages.

## What are the optimum strategies for sourcing the crushed aggregate?

- Choose **hand knapping** only if the required volume of broken stone aggregate is low (under 15 cubic metres for the entire operation) and the construction site is located in remote areas.
- Choose **medium and large sized mobile crushers** (preferably Hoa Phat) if the required volume of aggregate is 15 cubic metres (for the entire operation) or over. If the crusher can be utilised intensively (say over 1,000 hours per year) then buy a mobile crusher. For a low utilisation rate hire a mobile crusher.
- Buy **crushed aggregate** from a commercial quarry only if one finds it difficult to organise the manpower and crushing machines. One may also need to buy from commercial quarries if the required material quality is too stringent or specification of the material is such that it cannot be met using mobile crushers.

| itt | DFID |
|---|---|

**For further information visit http://www.seacap-info.org or contact David Salter, on +855 (0) 12 1 886 474 or davidsalter@online.com.kh. Alternatively contact Farhad Ahmed or Masam Abedin on +44 (01235) 833 753 or itt@ittransport.co.uk.**

This document is an output from a project funded by DFID for the benefit of developing countries. The views expressed are not necessarily those of DFID

* The study entitled "Enhancing the Use of Locally Made, Low Cost Equipment for the Road Sector" was funded by the Department for International Development (DFID), UK, under its South Asia Community Access Programme (SEACAP).