Rehabilitation of Low-Volume Roads by Labor-Intensive Technology

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The Republic of Ghana has more than 22 000 km of low-volume roads, known as feeder roads, that provide the primary access to rural villages and to nearby agricultural crops. Feeder roads have suffered from many years of insufficient maintenance, resulting in overall deterioration of the system and interruption of the normal flow of agricultural products. Ghana recognized the importance of the feeder road system and embarked on a major campaign of rehabilitation and maintenance. Because heavy construction equipment was difficult to obtain and maintain and required substantial capital investment, a comprehensive effort was begun toward rehabilitating roads with labor-intensive technology. Privatization was emphasized in this initiative. Formal training was developed to enhance the contractors' skills in labor-intensive road building and labor management. Hands-on training in road rehabilitation activities was also provided. After the training was completed, contractors were assigned specific projects to gain further experience. The rehabilitation work generally consisted of surveying and road layout, brush clearing, grading and ditch construction, roadbed shaping, drainage structures, and gravel surfacing. Labor-intensive methods were emphasized in all phases of this work. Light construction equipment was used to haul borrow and native gravel surfacing. Since implementation, the labor-intensive program has clearly resulted in improved access from the villages to markets, has enhanced rural economies, and has created work opportunities for the local populace. It has also proven to be less costly than experience with capital-intensive methods—approximately 27 percent less expensive. Labor-intensive technology is ideally suited for the rehabilitation of the feeder road system and for the economic development of the rural areas of Ghana.

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The republic of Ghana has implemented an extensive program of low-volume road rehabilitation to improve access to rural communities. Labor-intensive technology is the primary method of operation for this effort. During this visit several project sites were reviewed to assess the magnitude of the rehabilitation work. The practices for planning, designing, constructing, and maintaining low-volume rural roads were closely examined. Special emphasis was given to an examination of the procedures used in the labor-intensive program.

How Ghana implemented labor-intensive technology in road rehabilitation is discussed, and the benefits that have accrued to the people living in the rural areas of Ghana because of the improvements to the road network are described.

Feeder Roads

Ghana, like most other countries, is heavily dependent on adequate roads to move products from the rural farming areas to the markets. The country has more than 37 000 km in the total road network, which is classified into three functional groups: urban, trunk, and feeder.

The largest group by length is the feeder road system, containing more than 22 000 km, or 60 percent of the total road network (*1*). These roads are rural, generally with a daily traffic of less than 50 vehicles. They provide primary access to the small villages and to major agricultural resources such as cocoa. The feeder road system is administered by the Department of Feeder Roads (DFR), an agency under Ghana's Ministry of Roads and Highways.

Significant road construction occurred during the 1960s and 1970s. However, as the roads aged, maintenance did not keep pace and widespread deterioration resulted. The lack of maintenance and the subsequent deterioration forced an overall slowdown in economic growth and caused a severe financial setback for the country (*2*). The economic problems and reduced road maintenance funding resulted in even further deterioration. The decline of economic resources was a problem especially for the feeder road system (*3*).

Feeder roads are categorized into four technical classes on the basis of width and a 10-year projected average daily traffic (ADT) (*4*):

- Class 1: 7 m wide, ADT between 50 and 100;
- Class 2: 6 m wide, ADT between 20 and 50;
- Class 3: 5 m wide, ADT less than 20; and
- Class 4: 4 m wide, ADT less than 10.

The major rehabilitation effort has been concentrated on Class 3 and 4 roads. These roads constitute about 15 000 km or 70 percent of the feeder road system. Emphasis is being given to these lower-use roads because they are in the worst condition and their rehabilitation will have the greatest benefit to the local populace. The Class 1 and 2 roads receive some assistance from the Ghana Highway Authority, the agency in charge of the major highways (*4*).

Rehabilitation Program

Rehabilitation of the feeder roads is a high priority for DFR, and labor-intensive technology has a very large part in this effort. With adequate financing, DFR hopes to expand the rehabilitation program to 1400 km per year, although 900 to 1000 km per year is more likely. The rehabilitation program started in the mid-1980s and has the goal of completion by the early 2000s. Currently, more than 2500 km of feeder roads has been rehabilitated (*5*).

During initial planning, DFR evaluated several different approaches for implementing a major road rehabilitation and maintenance program. A capital-intensive method was given strong consideration. However, it would necessitate a large heavy-equipment pool, equipment operating and repair skills, and a ready supply of replacement parts. DFR conceded that these capital-intensive needs were generally unavailable and too expensive to obtain. Other alternatives were carefully evaluated, but the labor-intensive technology was superior (*6*).

Three key resources were available to DFR that gave strong support to labor-intensive technology (*6*):

1. Several small road construction firms operated in the rural areas and needed work;
2. A large, unemployed, rural workforce existed; and
3. The rural workforce had experience in hand- or labor-oriented maintenance of feeder roads.

As a result, DFR decided that these resources could be harnessed to implement a labor-intensive road rehabilitation program. The benefits were considered to be significant:

- The local economy would be greatly improved because of the change in the movement of agricultural products from headloading to cargo trucks (*1*);
- Local employment opportunities would be greatly increased;
- The employment opportunities would allow the local populace to develop pride in and support for the rehabilitation program and the subsequent maintenance of the roads that serve their immediate needs;
- The local villages would be able to utilize the skilled labor force in future routine maintenance activities;
- Contracting to the private sector would be strongly emphasized, downplaying government operations; and
- The program would lower costs [DFR studies show that the labor-intensive method is about 27 percent less costly than equipment-based methods ($10,500 versus $14,500) (*1*)].

Labor-Intensive Procedures

DFR developed a step-by-step procedure for rehabilitating feeder roads, resulting in the following construction steps (*6*):

1. Construction staking and string-line controls are established to define the road template.

2. Vegetation is cleared and grubbed from within the roadway.

3. Roadside ditches and wing or turnout ditches are excavated.

4. The roadbed is shaped and the surface camber is developed.

5. Drainage systems, small culverts, and bridges are constructed.

6. Native gravel surfacing is placed.

Some light construction equipment is used to supplement the labor operation (*6*):

- Chainsaws for brushing work;
- Farm-type tractors with trailers that are used to haul native gravel and borrow material from the sources to the road;
- Pedestrian rollers that are used to compact the roadbed and the gravel surfacing;
- Tractor-towed water tank to enhance compaction.

Special attention is also given to the selection of good-quality hand tools (picks, shovels, rakes, forks, axes, and machetes) because these tools are a necessary part of a labor-intensive operation and are vital to production.

The rehabilitation projects usually follow existing roads or trails. As a result, horizontal and vertical alignments are generally fixed. This situation, combined with the low standard of roads, reduces the need for precise construction controls. Construction surveys are only needed to define the layout and template of the road. Usually, only the centerline and ditches are marked. At critical locations, such as a drainage crossing, the survey is expanded to collect enough information to ensure an adequate design and appropriate construction requirements.

Roadside clearing and grubbing, ditch excavation, and roadbed formation are all major labor-intensive activities. Brush is cut and scattered along the road. After clearing and grubbing, the ditches are located and excavated. Material from the ditches is distributed within the roadbed to help form the camber needed for drainage. Borrow may be needed in some locations and is hauled from sources located close to the project to minimize costs. The terrain generally precludes the need for large cuts and fills. Roadbed compaction, where needed, is achieved with a small pedestrian-type roller. The labor-intensive procedures would not be suitable for heavy earthwork or for major embankment construction.

Native gravel sources may be located close to the project; this greatly minimizes costs. The gravel material is loaded by the work force into small trailers and then hauled to the road site. It is distributed and shaped on the road by the work force.

Drainage control is a major concern because of the abundant rainfall, hilly locations, and erosive soils. DFR places great emphasis on ensuring that drainage designs are adequate. Various drainage techniques are used, including road camber, ditch scour checks, turnout or wing ditches, concrete cross drains, and log bridges. All are labor-intensive.

Concrete box culverts are most commonly used on cross drains. A wood deck on the concrete culvert has been the standard design, but because of decay problems a concrete deck is being given strong consideration. The construction techniques for concrete placement are relatively easy to learn and are suitable for labor-intensive operations. Reinforcing steel is not readily available, so mass concrete is often required in the smaller installations. These labor-intensive concrete culvert designs can be easily adapted to fit the local ground conditions.

Native log stringer bridges have had extensive use. They are relatively easy to assemble and are labor-intensive. They are generally suitable for local road use. However, since decay is a major problem, they do have a limited life span, especially with the deck. The problem is compounded because preservative treatment facilities are not available. Alternative designs are being considered, such as large concrete boxes, which are a reasonable labor-intensive solution. However, large structures are not appropriate for labor-intensive techniques.

The labor force may involve as many as 250 people per project, an average of 25 percent of which are women (*1*). Because of the number and diversity of workers, very skilled supervision and rigid management controls are required. Supervisory and management training is an extremely important part of the implementation of the labor-intensive technology program (*6*).

Labor payments are generally made on a daily basis, roughly amounting to $1.00 (U.S.) per day. Maintaining a consistent labor force during certain times of the year has been a problem because the majority of the labor force have agricultural crops. Seasonal obligations to plant and harvest often interfered with the road work. To resolve this problem, and to ensure a consistent labor force to maintain production, some modifications to the normal daily wage system were implemented. One modification was to introduce a system of defining daily work tasks. Under this system, a specific quantity of work was designated as a measure of an 8-hour day's production. Efficient and hard-working laborers could accomplish the day's task in less than the normal workday, allowing time for other activities. Another modification was to pay a bonus to workers who maintained a consistent work schedule. For example, 2 extra days of pay were granted for every 6 consecutive days of work. Four extra days of pay were granted at the end of a consecutive month of work (*1*).

COST OF LABOR-INTENSIVE METHOD

The costs given here are averages. The labor costs are approximately 45 percent of the total (*1*):

Work Activity	*Cost ($U.S./km)*
Clearing, grubbing	500
Ditching, earthwork	4,700
Drainage	2,900
Surfacing	2,400
Total	10,500

TRAINING

Privatization was emphasized in the rehabilitation work. Because the labor-intensive road rehabilitation and maintenance program was relatively new, contractor skills had to be expanded. DFR provided extensive training to selected contractors.

The contractors' supervisors and foremen received 23 weeks of classroom and on-site training. Theoretical and practical subjects were addressed, including construction techniques, programming, organization, quality control, measurements, labor management, incentives, and cost controls. During this training, the participants completed the rehabilitation of a 10-km road as a practice project using workers from local villages (*1*).

After completing the training, each qualified contractor was assigned rehabilitation work under a trial program. Technical assistance was provided by DFR. Upon successful completion of the trial phase, the contractor was assigned several rehabilitation projects. A production rate of 2 km per month was expected. Contractors were closely monitored by DFR (*6*).

CONCLUSIONS

The labor-intensive program has been successful in rehabilitating many low-volume feeder roads that serve the rural agricultural areas of Ghana. This success has provided an incentive to continue with the program and to implement an expansion if financing can be secured. The labor-intensive program has had significant advantages over a capital-intensive approach by accomplishing the following:

- Significantly reducing the rehabilitation cost per kilometer,
- Creating more jobs in rural areas,
- Providing equal job opportunities for men and women,
- Developing construction skills that can be utilized in subsequent maintenance work,
- Injecting cash into the rural economies, and
- Encouraging small-scale private enterprise.

The labor-intensive program has helped to develop a cadre of small private contractors. The support by DFR has enabled the contractors to increase productivity and the quality of work, The contractors embraced this technology, seeing the benefits of technically simple operations, smaller bank loan commitments, less reliance on machine performance, and a steady future workload.

The labor-intensive program has also been quite beneficial to the people of the rural areas by improving access from the village to the market, enhancing the economy of the rural areas, creating work opportunities and an income source for the local populace, and providing the local people with skills to maintain access to their village.

Labor-based work has the following limitations (*7,8*):

- New road construction is not practical,
- Major earthwork is not cost-effective,
- The construction of large culverts and bridges is not practical,
- Extensive hauling of borrow or surfacing is not cost-effective, and
- A large number of laborers is always needed.

Overall, labor-intensive technology has been ideally suited to the road rehabilitation needs of the rural areas of Ghana. The labor-intensive program developed by the republic of Ghana is highly recommended for countries with similar development needs and similar construction conditions in their rural areas.

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