

LABOUR ENHANCED CONSTRUCTION FOR BITUMINOUS SURFACINGS

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Preface

The purpose is to provide a manual, which will give recommendations on bituminous surfacings suitable for labour enhanced construction, and to guide and advise the practitioner who may be getting involved with this for the first time. The manual brings together the experience of many years in labour enhanced construction in Africa and recent experience on various projects in the Eastern Cape and Cape Province. It is aimed at road authorities who presently use plant-intensive methods in order to give confidence in the use of labour enhanced construction for surfacings. The term “labour enhanced construction” is considered in its broadest sense; terms such as “labour based”, “labour intensive”, etc., refer to the same approach. Labour enhanced principles are suggested within the framework of existing standards of quality, the existing contractor system and by using existing plant and equipment for critical surfacing components.

Scope

In the first part the manual covers the choice of bituminous surfacings for labour enhanced construction, with information on the limitations of the construction technique to be used. It also includes criteria, which will be useful in choosing the surfacing to suit objectives of job creation, maximisation of labour component of the budget, or skills transfer. Since the work rate of labour enhanced construction is so dependent on organisation of labour, this is discussed in some detail in sections 3 and 4. The implementation is presented in section 5. In the companion publication, Manual 12, *Methods and Procedures for Labour Enhanced Construction of Bituminous Surfacings* are presented to give guidelines for the appropriate techniques. Manual 12 is intended to be used by the supervisors for training of the construction workers. It is also applicable to the client bodies, contractors and consultants.

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1. INTRODUCTION

Two manuals have been produced on this subject: Manual 11 deals with the technical and social aspects of labour enhanced construction of bituminous surfacings, and in Manual 12, the practical methods and procedures are given. In Manual 11, recommendations are made for suitable bituminous surfacings for labour enhanced construction. Recommendations are also made for surfacings which best meet sociopolitical criteria, such as job creation, maximisation of labour component of the budget, or skills transfer. The organisation of contracts and labour are discussed, and an introduction to semi-autonomous work groups and job design is given. A comparison is made between the labour component of surfacings and the labour component of other activities such as water bound macadam and laying drainage pipes.

1.1 Background to labour enhancement

The need to create employment opportunities and develop the entrepreneurial skills to satisfy the material aspirations of the burgeoning population of South Africa is of paramount national importance. The challenge which faces the construction industry is how to create and adapt construction activities in such a way as to provide some of these employment and entrepreneurial opportunities within this industry.

South Africa is a unique blend of developed and developing societies and the solutions must address the needs of both worlds. In this respect, South Africa must develop and adapt its own solutions to labour enhanced construction and not just take methods directly from under-developed countries with different social structures.

Roads form an integral part of our lives and provide a means of safe and economic transport of goods and people for various purposes. Transportation is a thread in the socio-economic fabric of society. The provision of efficient and cost-effective transportation means has a critical function to fulfil within the process of prosperity creation for the development of the people of South Africa. An important aim of an optimum transportation policy should be to ensure use of local labour resources in any civil engineering works so that the community gains maximum benefit from the construction activities

as well as from the finished product. This was initially a feature of post-World War 2 road construction in Africa, but then the increasing introduction of plant led to a shift from labour to plant.

Sabita's Social Development Issues Forum, which comprises a broad spectrum of influential decision makers in the formal and informal sectors of the South African economy, has identified the essential role that the provision of roads plays in the upliftment of the disadvantaged segments of the community. The role that the provision of roads can play in the economic empowerment of the community was further seen to be strongly promoted by the use of labour based construction methods, thereby reducing the barrier of entrance to the roads industry, promoting growth and skills transfer. Recent examples of this include the provision of over R200 million by the Department of Transport for labour-based projects.

In 1971 the World Bank initiated a programme of work to explore the increased use of labour in road construction. It began by investigating the technical feasibility of the substitution of labour for equipment in all aspects of road construction. The interim conclusions of Phase One of the study were:

It is technically feasible to substitute labour for equipment for all but about 10 to 20 percent of total road construction costs for the higher quality construction standards considered here (International Bank for Reconstruction and Development, 1971).

This conclusion was later generalised to: Labour intensive methods are technically feasible for a wide range of construction activities and can generally produce the same quality of products as equipment-intensive methods (Sud *et al*, 1976).

In applying labour enhanced construction to road surfacings in South Africa, the expertise, which has been built up on high quality bituminous surfacings to provide good performance and cost-effectiveness, must be retained. This means that the project management and technical skills of existing contractors must be used and that labour enhanced construction must fit within the existing framework of client bodies, consultants and contractors.

Another consideration is that the performance of a bituminous surfacing is critically dependent on quality of construction. The industry has invested considerable effort in developing skills, plant and equipment which can provide the close control needed for quality construction. Labour enhancement must fit into a framework of construction with this equipment. This will be done by identifying those components of bituminous surfacings where the work can be accomplished primarily by means of hand labour, with the aid of hand tools and small plant. Some components demand the use of large plant and labour enhanced construction is not suited to those.

Over the past 15 years, labour intensive road construction in Africa has progressed from being a hypothetical possibility to a practical reality. National programmes have been established in Kenya, Botswana, Lesotho, Malawi and Mozambique. Serious pilot projects are underway in Ethiopia, The Gambia, Ghana and Tanzania, while similar projects and programmes have usually been initiated by governments as part of their policies for development. These have included the creation of employment opportunities and the provision of infrastructure (McCutcheon, 1990). With the changes in South Africa, labour enhanced construction for bitumen surfacings is an important need.

1.2 Social issues

The problem of rural and urban employment has emerged as one of the most important and challenging to face South Africa today. There is a growing gap between the rate of new entries to the labour force and the capacity of the economy to absorb them. While labour-based road construction is not a panacea to resolve the entire nation's problems of unemployment, it offers an opportunity to alleviate unemployment, to increase the skills levels in the workforce and to nurture emerging entrepreneurs.

Experience has shown that there are no technical impediments to the success of labour based construction methods. The greatest problems to overcome are the attitudes and expectations of management. Government must also play its rightful role in the provision of the needs of the unemployed by creating a climate conducive to the creation of employment. It will be necessary to create an awareness among planners and engineers that alternative technologies exist.

To this end, it is necessary to adjust the educational curricula in technikons and universities so that the merits of the use of labour based road construction methods are conveyed to students.

The need to create employment opportunities and develop the entrepreneurial skills to satisfy the material aspirations of the burgeoning population of South Africa is of paramount national importance. In 1990, 51 percent of the labour force in South Africa (8,4 million people) were without formal employment. The labour absorption capacity of the formal economy has persistently decreased from 81 percent in 1965 to eight percent in 1990 (Ligthelm and Kritzinger-Van Niekerk, 1990). According to estimates by the Bureau of Market Research, 45 percent of the population (approximately 17 million) was living below subsistence level in 1989 (Kritzinger-Van Niekerk, 1991).

In addition, South Africa has a highly unequal personal income distribution. According to Haasbroek (1990), 20 percent of the population received about 60 percent of the national income, with the bottom 40 percent receiving only 15 percent in 1989. The most effective way to improve this situation is through the transfer of skills.

When these issues are addressed, efforts will be directed at:

- increasing the rate of economic growth in the poorer sector
- increasing the skills level in the poorer sector
- assisting the poor to participate effectively in the economy.

1.3 Technical feasibility of labour enhanced construction of surfacings

Certain components of surfacing and certain surfacings are better suited to labour enhanced construction than others. By way of example, moving aggregate from the stockpile to the road using shovels and wheelbarrows would be a technically feasible and cost-effective labour-based/intensive component. However, laying of asphalt to close tolerances, other than in patching operations, is not feasible for labour enhanced construction. In addition, the technical feasibility of labour enhanced construction of surfacings is related to the size of the project and the necessity for speed of construction. The hand moving of aggregate would only be practical where traffic

conditions permitted, which does not include sealing a busy national or provincial road. In this manual, the components of the various surfacing types are identified and are given a classification, albeit a fairly loose one, as to whether they are suited to a labour-based or plant-intensive operation.

In Botswana and Kenya the methods have been used successfully, mainly for the construction and maintenance of rural roads with low traffic volumes (Department of Transport, 1989). Climatic conditions have varied from arid to tropical, while terrain has varied from flat to mountainous. Little has been done in Africa on labour enhanced construction of surfacings, but it has been used for high standard construction in Asia. Theory and practice show potential even in relation to high-standard construction (World Bank, 1978). A major proviso is the lead time necessary to carry out the initial technical studies, train staff and set-up a competent organisation to cope with this new socioeconomic and technical challenge, and these issues are highlighted throughout this manual (McCutcheon, 1991). The myth that the lead time for such projects is greater than for a conventional one must be dispelled once and for all. It must be recognised that the lead-time for such projects is no different from that of conventional projects.

1.4 The national approach to labour enhancement in construction

Historically there have been two approaches to labour enhanced construction. There has been a short-term approach (often in developed countries) where it has been used to stimulate employment levels. Such programmes are laudable attempts to alleviate poverty, often in rural areas where no alternative employment exists. The productivity resulting from the employment is secondary to this objective, and such programmes are difficult to compare with traditional engineering projects. Through labour enhanced construction of bituminous surfacings both objectives can be achieved, and it is certainly a more permanent project than say rubbish removal or weed clearing. This manual will assist in the selection of bituminous surfacings to be used on these short-term programmes.

The other approach is where labour has been employed as a realistic and economic alternative to machine-based methods. This has mainly been through the hiring of individual casually employed labourers, whereas in South Africa some projects have also aimed to provide the “locals” with the necessary skills to become entrepreneurs in their own right (Croswell 1986, 1989) (DBSA, 1992). In these projects the efficiency of the labour force is a crucial factor. Labour has to be regarded for the purpose of production as a power source subject to the same analysis as any productive unit in a maintenance or construction operation.

At the same time, the work can and should be structured to retain human dignity and respect; the essence of labour enhanced construction is to generate opportunities and not to turn the worker into a pack animal. Our national need to create employment in a meaningful manner can be brought together with our national need for social upliftment of much of the population through labour enhanced construction of bituminous surfacings.

Because the greatest problems to overcome are the attitude and expectation of management, it is essential that a training programme be implemented for managers/supervisors as well as labourers. Preferably there should be two levels of training - “National Level” and “Project Level”. The training programmes must cover the technical, organisational, contractual and financial aspects. This would fit into a framework of a long term national Employment Creation Programme.

Future national prosperity in South African will be created, not inherited. It will not only grow out of our natural resources, but out of our labour pool. To increase our competitiveness, we need to build skills, entrepreneurship, and a positive attitude to work. Government must also play its rightful role in the provision of the needs of the unemployed by creating a climate conducive to the creation of employment. At the same time, the nation will seek to uplift the quality of life for many of its residents. The use of labour-based/intensive construction methods should be viewed as an innovative way, albeit at a low technical level but with a high managerial input, that the road industry can seek a meaningful share in the new South Africa; furthermore it is a way that will be endorsed by the various funding agencies.

2. BITUMINOUS SURFACINGS FOR LABOUR ENHANCED CONSTRUCTION

The premise behind this manual is labour enhancement in constructing surfacings which meet good standards of quality and performance. This manual covers new surfacings and reseals. It does not cover maintenance to any large extent, which is dealt with in the Methods and Procedures Manual 12. Naturally labour enhanced construction can be used in many other aspects of road construction, not just surfacings.

In choosing surfacings for use with labour enhanced construction, the appropriate surfacing must be selected on the basis of its suitability for labour enhancement, its performance and its ability to meet sociopolitical project goals.

2.1 Suitability for labour enhancement

The suitability for labour enhanced construction of a surfacing depends to a large extent on quality issues. This interacts with performance because for a surfacing, performance depends on the quality of its construction.

As an example, for surfacings such as seals, the application rates of the bitumen and stone must be closely controlled to avoid bleeding and yet get good stone retention and the development of a well knit matrix. Double seals are more critical than single seals because of the need to get good interlock between the two layers and to minimise air voids in the matrix.

For asphalts, the production of the asphalt mix requires close control over quantities, temperature and moisture to achieve a mix with good performance, unless some concessions are made to standards. For surfacings using hot bitumen and some modified binders, certain processes such as chipping or rolling must be initiated or completed while the bitumen is at very high temperatures and this causes problems with rate of production before the bitumen cools, as well as the safety of workers.

However, within each bitumen surfacing there are components which can be performed using labour enhanced techniques without sacrificing quality, and this is the basis used here for successfully building surfacings using labour enhancement. Some surfacings have very few such components and are not suited to labour enhancement, while some can be built using labour enhancement for all components.

In these labour components, it has been assumed that the machines used would tend to be small scale (tractor drawn 1000-2000 litre sprayers, drum trolleys with hand sprayers, pedestrian rollers, brooms, etc). Table 1 was prepared on the basis of the small-scale plant and equipment available on the market in 1991/92. This is not to say that labour enhanced construction cannot be done with large items of plant and equipment. Rolling is one example where it can be done using laden trucks (discussed in Manual 12) which are easy items of plant for emerging entrepreneurs to source. The binder typically would be a bitumen emulsion (modified or unmodified) which overcomes the problems of premature cooling and of safety that can be encountered using hot bitumen in labour enhanced construction.

To identify suitable surfacings for labour enhanced construction, the main surfacing types have been broken down into components and the suitability for labour enhancement noted for each component (Table 1). A cross-section of surfacing types are presented in this table, and the suitability of combination surfacings such as double seals (13 mm chip and sand) can be interpolated from these.

Table 1 Suitability of surfacing components for labour enhancement

Prepare base and prime

Component	Key issue	Suitability for labour enhancement
Shape and smooth	quality	poor; preferably use plant
Sweeping	quality	good; handheld broom, accept variances
Watering	spray rate	good; drum sprayer or trailer tanker; can accept variances
Prime	spray rate	reasonable; drum sprayer or trailer tanker; can accept some variances; use hand lance with appropriate skills training

Chip and spray surfacing

Component	Key issue	Suitability for labour enhancement
Spray	application rate	not suitable - this is critical for performance and plant needed for close control
Stone	application	reasonable; spread by hand in demarcated areas; can accept few variances which is achievable with appropriate skills training
Rolling	coverages	reasonable; with a pedestrian roller

Slurry^a

Component	Key Issue	Suitability for labour enhancement
Manufacture	quantities	reasonable; mix in concrete mixers; can accept some variances
Applications	application rate	reasonable; can accept some variances; use wheelbarrows and squeegees with appropriate skills training
Rolling	coverages	reasonable; with a pedestrian roller

Notes *a*: when used in a labour enhanced environment, the relatively small scale of production per team (compared to machine laid slurry) has been found to overcome any problems with trafficking of the slurry before it has set up.

Asphalt

Component	Key Issue	Suitability for labour enhancement
Manufacture	quantity, temperature	reasonable; suitable for small quantities required for road maintenance, not suitable for large quantities required for new construction
Application	finished levels	reasonable; suitable for small quantities required for road maintenance, not suitable for large quantities where plant control is needed for accurate laying.
Rolling	coverages	reasonable, suitable for small quantities. Not suitable for large quantities where it must be rolled while still hot.

Geotextile component of geotextile/bituminous surfacing

Component	Key issue	Suitability for labour enhancement
Basecourse prime	spray rate	reasonable; can accept some variances; use hand lance with appropriate skills training
Geotextile prime	spray rate	good; can accept variances; use hand lance with appropriate skills training
Geotextile	smooth laydown	excellent; this is suited to hand laydown
Armour layer	low spread rate	excellent; best done by hand
Rolling	coverages	reasonable; with a pedestrian roller

Dust palliative^b

Component	Key issue	Suitability for labour enhancement
Spray	application rate	reasonable; can accept some variances; needs appropriate skills training
Cover sand	application	good; can accept wide variances
Rolling	coverages	reasonable; either a pedestrian roller or traffic

Notes *b*: this is a cutback bitumen, which acts as a prime and seal: it is laid with a sand blanket on top. It should be distinguished from an engineered sand seal.

Other surfacing related tasks

Component	Key issue	Suitability for labour enhancement
Fogspray	application rate	reasonable; can accept some variances; needs appropriate skills training
Linemarking	accuracy	reasonable with appropriate skills training
Precoating stone	coverage	good
Loading material	volume	good where quantities are small

Summary of selected surfacing types

SURFACING TYPE	SUITABILITY FOR LABOUR ENHANCED CONSTRUCTION
Dust palliative	Suitable
Single seal	reasonably suitable
Double seal	reasonably suitable
Cape Seal	very suitable
Asphalt - new layer	not really suitable
Asphalt - patching	suitable
Slurry	very suitable

2.2 Selection for performance

Some surfacings perform better under certain conditions than others, and surfacings must be selected to ensure good performance. For a bituminous surfacing, performance largely depends on the environment in which it is operating. It has been shown in Manual 10 (Emery *et al*, 1991) that in South Africa there are four distinct environments in which bitumen surfaced roads are found:

- Developed region, good standard pavements
- Developed region, light pavements
- Developing regions
- Wet/hilly

Each of these environments has its own implications in terms of gradient, drainage, maintenance and suitability for intersections. For each of these environments it is possible to select appropriate surfacings which will provide a good standard of performance (Table 2; for more detail see Emery *et al*, 1991).

Table 2 Selection for performance

Is surfacing suitable given conditions below (Yes/No)				
Surfacing Type	No maintenance capability	Steep gradient	Wet climate or bad drainage	Turning trucks, i.e. intersections
Dust palliative	No	No	No	No
Single seal ^a	No	No	Yes	No
Double seal	Yes	Yes ^b	Yes	Yes
Cape Seal	Yes	Yes ^b	Yes	Yes
Asphalt	Yes	Yes ^c	Yes	Yes
Slurry	Yes ^d	No	Yes	Yes ^d

- Notes
- a: with or without modified binder
 - b: maximum suggested gradient - 10-12 percent
 - c: maximum suggested gradient - 16-18 percent
 - d: only if thick

In residential streets in urban areas, another aspect of surfacing selection to consider is the effect on the habitat. In areas of high population density, the street forms a large part of the visual landscape, and the bituminous surfacing can play an important role in improving the quality of the habitat. Smooth surfacings are recommended in these situations because of their visual attractiveness and their suitability for use as a playground. The preferred surfacings, in descending order, are:

- asphalt and sand asphalt
- slurry
- Cape Seal

2.3 Selection to meet social and political needs

Labour enhanced projects are likely to contain elements of social and political decision making. Varying needs, such as the reduction of unemployment or development of skills levels in the community, can be met using labour enhanced construction.

Good effect can be given to political and social needs by choosing the surfacing according to various criteria such as maximising the use of labour. These criteria are shown in Table 3.

Table 3 Social and political criteria

Criteria	Measure
Maximise funding to labour	Labour spending per square metre
Maximise labour share of budget	Percentage of total surfacing cost per square metre used for labour
Maximise skills transfer	Skill points
Improve quality of life, better access to schools, hospitals, industry	Provide bitumen surfacing to unpaved roads

A range of bituminous surfacings have been classified according to these criteria (tables 4, 5 and 6). These tables can be used singly or in combination to select surfacings which best meet the social and political needs.

The labour rates used in these and following tables are in line with ruling rates that the authors use for this type of work. In seminars held in Johannesburg and Cape Town in 1992, it was commented that rates of R8 to R19,90 per day were then applied in Eastern Cape on Development Bank of South Africa projects, and R5 to R35 per day were used in the Department of Transport labour based road projects during 1992 with funds from oil sales.

Table 4 Surfacing choice to maximise funding to labour

SURFACING TYPE	LABOUR COST (R per square metre)	
	R10/day	R25/day
Slurry 15mm thick	0.38	0.96
Cape Seal 13mm stone	0.32	0.80
Double seal 13/6mm stone	0.25	0.64
Asphalt 25mm thick	0.20	0.51
Single seal 9,5mm stone	0.14	0.34
Dust palliative	0.12	0.31

Table 5 Surfacing choice to maximise labour share of budget

SURFACING TYPE	PERCENTAGE OF BUDGET SPENT ON LABOUR	
	R10/day	R25/day
Cape Seal 13mm stone	5.6%	13.0%
Slurry 15mm thick	5.3%	12.3%
Single seal 9,5mm stone	4.9%	11.4%
Dust palliative	5.2%	11.3%
Double seal 13/6mm stone	4.9%	11.2%

Table 6 Surfacing choice to maximise skills transfer

SURFACING TYPE	SKILL POINTS					
	broom	prime	spray/ slurry	chipping	rolling	SUM
Cape Seal 13mm stone	2	6	0	4	3	15
Double seal 13/6mm stone	2	6	0	4	3	15
Single seal 9,5mm stone	2	6	0	4	3	15
Slurry 15mm thick	2	6	5	0	0	13
Dust palliative	2	0	6	2	0	10
Asphalt patching	2	4	6	0	3	15
Asphalt new layer	2	4	0	0	0	6

Note: the labour component and skills transfer does not include the labour component of plant based operations.

The skills points used in Table 6 have been calculated by considering the attributes needed for each job. For each of the attributes, various levels of complexity and therefore varying skill points have been assigned, as shown in Table 7. Thus brooming would rate 1 skill point for the basic skill, 1 skill point for quality control to achieve a clean and dust free finish and 0 skill points for the use of machines; a total of 2 points. The spraying of prime would rate 2 skill points for the basic skill, 2 skill points for quality control to achieve the correct application rate and spray an even and neat job, and for the use of machines: either 1 skill point if applied from drum and hand lance or 2 skill points if applied from a tractor and trailer, a total of 5 or 6 points.

Table 7 Basis for skill points used in Table 6

ATTRIBUTE	POINTS	DESCRIPTION
Basic skill	1	lower level of complexity, simple training
	2	higher level of complexity, more involved training
Quality control	0	nil
	1	control either quality or quantity i.e. dampen base with water
	2	control both quality and quantity, i.e. spray prime
Use of machines	0	simple hand tool i.e. broom
	1	complex hand tool i.e. drum trolley and hand lance
	2	motorised plant i.e. tractor

2.4 Comparison of labour enhancement component of surfacings with other road construction activities

The labour component involved in labour enhanced construction of bituminous surfacings has been compared to the labour component of other road construction activities. In Africa, labour enhancement has historically been used for the construction of fills, subgrade, selected subgrade, gravel wearing courses, drains and similar works. However, the objectives of job creation and skills transfer can be equally achieved by applying labour enhanced construction to surfacings.

There are three important measures to be considered when considering labour enhancement in South Africa. Firstly, in the matter of upgrading existing township facilities or developing new townships, it must be recognised that the scope of work is finite, although massive. Taking a long-term perspective, the backlog will be addressed eventually, and the immediate goal must be to ensure that each year's work is effective in achieving the goals of labour enhancement. If the project in one year is to upgrade roads in a given township using labour enhancement, the number of roads in that township is fixed then to maximise the funding which goes to labour; the measurement to consider is the money spent on labour per square metre.

Construction of bituminous surfacings compares well with the more traditional labour enhanced construction activities and with recent labour enhanced activities such as waterbound macadam (Table 8). The comparison with waterbound macadam is notable. The construction of waterbound macadam basecourses is labour intensive and gives structural performance superior to roads with crushed stone base courses. In terms of creating employment, it requires 10 times as many unskilled labourers as are needed to produce crushed stone basecourses (Phillips *et al*, 1991). However, on road projects, the construction of bituminous surfacings by labour enhanced means actually creates more employment than even water bound macadam.

Table 8 Money spent on labour for various road construction activities

ACTIVITY	LABOUR COST (per sq. m)	
	R10/day	R25/day
Fill: haul short distance and place 150mm thick	R1,05	R2,62
Drain: excavate, lay pipe and backfill	R0,49	R1,23
Waterbound macadam: construct 150mm thick using labour based means	R0,24	R0,60
Surface with slurry and prime	R0,38	R0,96
Surface with Cape Seal and prime	R0,32	R0,80

Note: data for waterbound macadam is from Phillips, 1992.

The second measure to be considered is the amount of skill level transfer. In contrast to labour enhanced projects such as rubbish removal from the road reserve, the construction of bituminous surfacings offers an excellent opportunity to transfer a wide range of skills. The levels of quality control demanded in bituminous surfacings and the interaction with plant, tools and equipment, all combine to offer a high level of skills transfer.

The third measure to be considered in South Africa is the relevance of the project. The social issues facing much of the community are such that they demand meaningful solutions. The budget limitations in South Africa are such that there is no money to be wasted on creating jobs which achieve little of permanent benefit. The construction of bituminous surfacings is particularly relevant. It offers ongoing benefits in terms of dust free, all-weather access, and improved access to schools, hospitals and development.

3. ORGANISATION

It is uncommon to encounter social, psychological and political issues in a bitumen manual. More common are issues such as spraying temperature, spread rate and Marshall stability. However labour enhanced construction demands that organisation and labour become an integral part of the production process - a power source subject to the same analysis as any productive unit. Rather than tank size or engine power, the concerns are man-days and productivity. And just as one would not run a sprayer or hauler fleet without mechanics and workshops, one does not run a labour unit without organisation and training. These issues will be addressed in the next two sections.

The same unexpected issues arise from funding. The traditional government funding of bituminous surfacings is engineering driven. It comes through road and local authorities in response to engineering demands such as traffic volumes, resealing programmes etc. For bituminous surfacings, these are well covered in various TRH and Sabita documents. When government funding moves away from being engineering driven, and is driven by sociopolitical issues, then the bituminous surfacing manuals must cover these as well. Labour enhanced construction is driven by sociopolitical issues, and in this section they are discussed as another factor to be dealt with in constructing a good bituminous surfacing.

3.1 Organisation of client bodies

For the client bodies, labour enhanced construction will require changes in project prioritisation, contract structure, tendering systems, community involvement and construction. However, these changes can be accommodated within the time frame of normal project planning. As one example, a conventional road project of 50 km of new construction would typically take 24 months to plan, investigate and design, and six months to document, tender, award and mobilise. Within this period, there is ample time to incorporate the elements of labour enhanced construction. As another example, Figure 1 shows how a project would incorporate labour enhanced construction. This is based on an actual project to upgrade an existing township with 5 000 stands.

This R35 million project included roads, water, sewerage, electrical installation and storm water.

Even within rush projects there is still time to incorporate the elements of labour enhanced construction.

When embarking on a labour enhanced and/or emerging contractor approach the client bodies should ensure that the following elements are included during project design and implementation:

- there needs to be an advance system to manage the training and development of the labour force and/or emerging contractors in order to develop the labour pools in time for construction.
- An appropriate system for the identification and appointment of emerging contractors needs to be in place;
- establish the principles of counseling and joint decision making by the client's representative and the contractor needed for the supervision of such contracts;
- amend the contract payment system to reduce the cash flow constraints faced by emerging contractors;
- negotiate with finance institutions to assist emerging entrepreneurs with finance and with collateral for plant and equipment; and
- consider committing to a longer-term flow of labour enhanced projects, to provide a stable and continuous flow of work and to benefit from the improved productivities of experience.

For client bodies moving into labour enhanced construction, the establishment of a labour enhanced construction programme is an effective approach. The labour enhanced construction programme would liaise and coordinate with other client bodies, training institutions, financiers, consultants, supervisors and trainers. The labour enhanced construction programme would also develop the measurements of its own success. These are just properties such as network riding quality or average life of a surfacing, but are measured by jobs created and skills transferred.

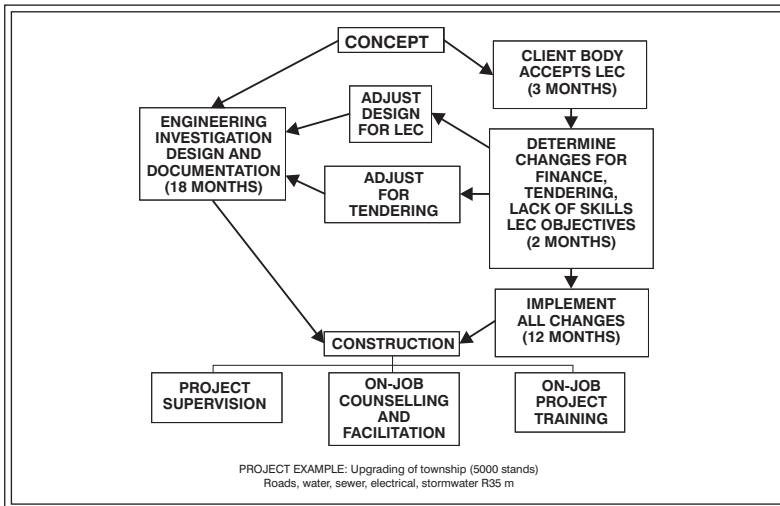


Figure 1 Incorporation of labour enhancement into project design

3.2 Organisation of contracts

The organisation of contracts for labour enhanced construction must be in such a way as to ensure that the expertise which has been built up in South Africa in construction contracting is not discarded. This means that the project management and technical skills of the existing contractors must be mobilised. Labour enhanced construction should fit within the existing framework of client bodies, consultants and contractors, albeit with slight adaptation to accommodate its particular needs. At the same time, the performance of a bituminous surfacing is critically dependent on quality of construction. The contracting industry has invested considerable effort in developing skills, plant and equipment which can provide the close control needed for quality of construction. The contracts for labour enhancement need to fit into a framework of construction with this equipment insofar as it is used to achieve high levels of quality control. At the same time, new items of small plant and equipment need to be specifically developed for labour enhanced construction. In this section, the various approaches to contract organisation are discussed and their suitability to labour enhanced construction is noted (substantially based on Thompson, 1981, 1984).

3.2.1 Contract Strategy

Because of the diversity of both construction work and the client bodies' requirements, no single uniform approach to contractual arrangements can be specified or advocated in the case of labour enhanced construction. A number of alternative strategies are available and each contract should be formulated with the specific job in mind. Special requirements may include:

- the client body may wish to be directly involved in site management or may prefer to delegate this responsibility entirely to the contractor;
- risks may be apportioned in various ways between the parties;
- the contractor may be required to provide training for the local labour force, not only in technical skills, but also in developing their entrepreneurial skills;
- the client body may wish to assess the success of the project on the manner in which the contractor has met the training requirements of the point above;
- the contractor may be required to provide varying amounts of finance; and
- the empowerment of a community through the development of its available human talent.

3.2.2 Contract Options

There are five contract options, which can be considered:

- client/consultant approach
- client/contractor approach
- direct works systems
- package deal system
- management contracting

Client/consultant approach

In the conventional approach to civil engineering, the consulting engineer (or clients' in-house engineering team) is responsible for the design, the engineer for administration of the construction contract, and the contractor for construction. Management of both

the design and the construction is divided between the various parties. The scope for involvement of the client in management and construction is limited.

This type of approach is suited to labour enhanced construction where the contractor is functioning as a main contractor. The client body can easily embody their objectives into the contract. The consultant can provide the supervision to ensure good levels of training and quality control. This type of approach is also suited to labour enhanced construction where the contractor is functioning as an emerging contractor and the project is broken down into many smaller projects; however the costs of contract supervision and administration will be higher because of the larger number of contracts.

Client/contractor approach

The client here is a large public or private firm, or organisation that promotes projects and employs its own professional engineering staff. The contract between the client body, and the contractor will be administered directly without the services of a consulting engineer.

This type of contract is suited to labour enhanced construction where the contractor is functioning as a main contractor. The client body can easily embody their objectives into the contract, and can provide the supervision to ensure good levels of training and quality control. This type of contract is also suited to labour enhanced construction where the contractor is functioning as an emerging contractor, although again the costs of supervision will be higher.

Direct works system

The client/contractor system may be developed to the extent that all, or most of, the construction work is undertaken by resources owned or directly employed by the client. The direct works approach is not strictly a contract system, but is included as it may be one of the alternatives to be considered by the client body when determining its contract strategy.

This type of system is not a desirable method of creating employment because of the inevitable lack of productivity. It

also lacks the important component of incentive that is needed for labour enhanced construction to be effective.

Package deal system

In this system, the contractor will undertake design, construction and commissioning, where relevant, of the works in accordance with a specification prepared by the client body. The price tendered by the contractor is frequently a single lump sum, with little supporting detail of the price of the constituents.

This type of approach is not well suited to labour enhanced construction where the contractor is functioning as a main contractor, because control over objectives and training by the client body is from a distance and difficult. This type of approach is also not suited to labour enhanced construction where the contractor is functioning as an emerging contractor because of the lack of sophisticated design and management skills in the emerging contractor.

Management contracting

When management contracting is used, a contractual and organisational system significantly different from the conventional approach is created. The management contractor becomes part of the client body's team. He is precluded from executing any of the permanent works. Hence management contracting is more closely related to a professional service than to a normal construction contract. This is reflected in three areas:

- emphasis on management, which is considered as a separate and contractually defined discipline;
- the payment mechanism, which is usually cost-reimbursable plus fee; and
- different allocation of risk between client body, management contractor and construction contractors.

One contractual and organisational relationship between the client and his team are shown in Figure 2. This type of contract is suited to labour enhanced construction. The client body can easily embody their objectives into the contract.

The management contractor can provide the supervision to ensure good levels of training and quality control.

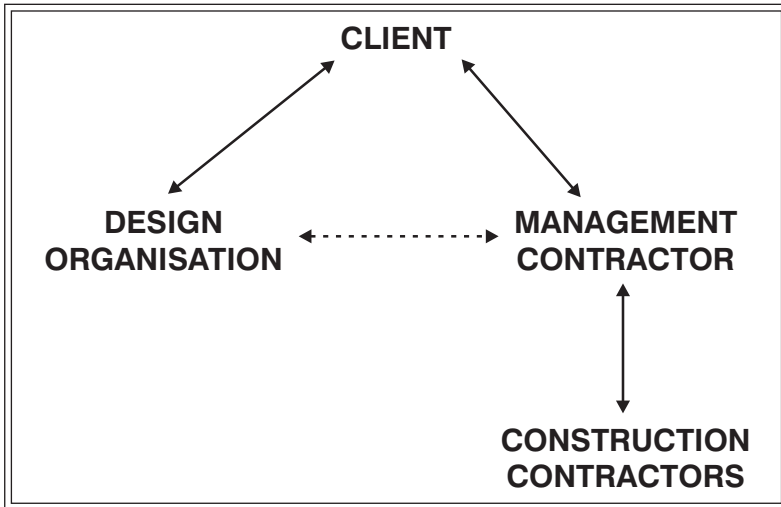


Figure 2 Organisational relationship

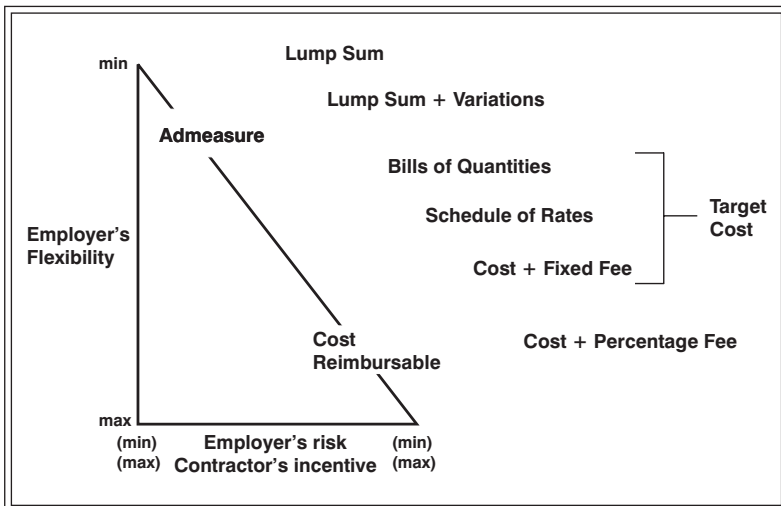


Figure 3 Characteristics of different types of construction

3.2.3 Contractual payment methods

Construction contracts are generally classified by reference to the method of payment by the client body to the contractor, and these may range from a single lump sum to the actual cost plus a fee. The different types of contract offer different degrees of flexibility, incentive and allocation of risk between the parties as shown in Figure 3.

Lump sum contract

At one extreme, a single lump sum price may be quoted for the completion of the specified work to the satisfaction of the client body by a certain date.

Use of this type of contract implies that design is complete and final, as there is no mechanism within the contract for adjustment of the price in consequence of variation in the client body's requirements. This type of payment system is suited to labour enhanced construction, provided that the payments are made regularly and frequently for the labour brokers, and that there has been adequate training in cash flow budgeting and there are suitable financial arrangements to provide working capital for the emerging contractor.

Cost-reimbursable contract

Cost-reimbursable contracts are used when the requirements of the client body are vague, or when it is desirable for design to proceed concurrently with construction, or when innovative methods are being implemented. Such contracts are also used when the client body wishes to be directly involved in the management of the contract or to reduce the financial risk to the contractor.

This type of payment system is suited to labour enhanced construction, especially in the early stages of implementation by a client body. It enables all parties to develop the expertise in control of labour enhanced construction projects without undue risk loading. However it is only suitable where the contractor is functioning as a main contractor, since it could lead to major cost overruns with emerging contractors.

Cost-plus contract

A cost-plus contract is the extreme form of the cost-reimbursable type and is so called because the contractor is reimbursed for all costs incurred during the fulfilment of the contract, plus an agreed fee to cover overheads and profit.

This type of payment system is suited to labour enhanced construction in the early stages of implementation by a client body, especially when setting up the training procedure. It enables all parties to develop the expertise in control of labour enhanced construction projects without undue risk loading. However, it is only suitable where the contractor is functioning as a main contractor, since it could lead to major cost overruns with emerging contractors.

Admeasurement contracts

Between the extremes described above, lie the more common types of construction contract which facilitate competitive tendering, but which incorporate some mechanism for the introduction and evaluation of changes in the work content of the contract.

Bill of quantities: A bill of quantities is used for the majority of building and civil engineering contracts. Tenderers are required to enter unit prices against the estimated quantities of many items of completed work. This is suited to labour enhanced construction because the breakdown of the job into tasks facilitates tendering by emerging contractors.

Schedule of rates: A schedule of rates type of contract is similar to the bill of quantities, but the estimated quantities of work items are expected to be less accurate than those given in the former. This is not suited to labour enhanced construction because it removes the incentive of reward for tasks achieved that is an important component.

Both bills of quantities and schedules of rates offer systematic adjustment of the contract price for changes in quantity of work actually performed relative to the original estimate. They offer the contractor the facility to claim additional payment should he

incur extra costs due to circumstances that could not have been envisaged at the time of tendering.

Target contracts

A client body may introduce additional incentives into a contract by offering the contractor a bonus payment for the achievement of some previously defined target in terms of time, cost or performance. Time or performance targets may be set in any type of contract. Thus, a contractor may earn a bonus for meeting the client body's objectives in terms of the transfer of technology or skills or early completion of the whole or some section of the works, in addition to the normal contractual payment related to work completed.

The target and bonus/penalty will be selected to encourage the contractor to achieve the client body's dominant objective. There are many types of incentive mechanisms. The simplest is that, in addition to the reimbursement of actual costs plus a percentage fee, the contractor will be paid a share of any saving between target and actual cost, while the fee will be reduced should actual cost exceed the target. There are many examples of the successful use of such contracts for work involving exceptional risk or for the use of innovative construction methods and where there is a particular benefit to the client body to be gained by direct involvement in contract management. This type of payment system is well suited to labour enhanced construction.

3.3 Organisation of site

The organisation of site will flow from the contract type used (from the previous sub-section) and will interact with the organisation of labour (in the next sub-section). It is not possible to be prescriptive about the site organisation because of the many variations possible. Manual 12, *Methods and Procedures for Labour Enhanced Construction of Bituminous Surfacing*, will assist in planning the organisation of the site as it details the layout and plant needs for each surfacing component.

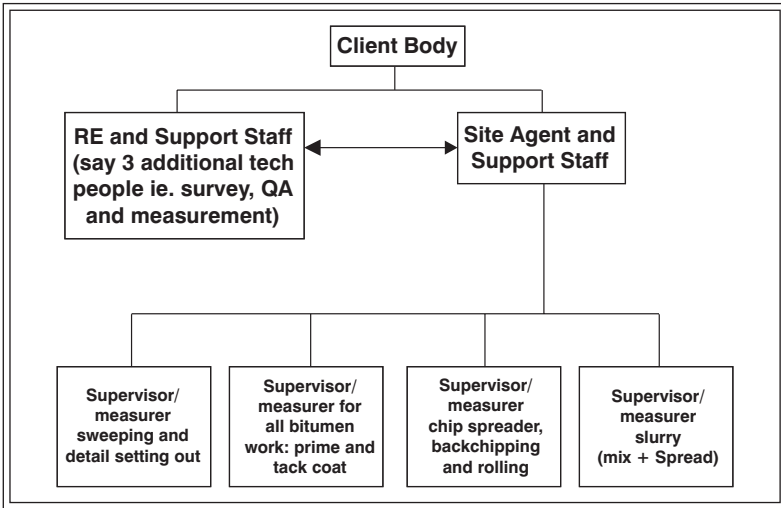


Figure 4 Possible site organisation

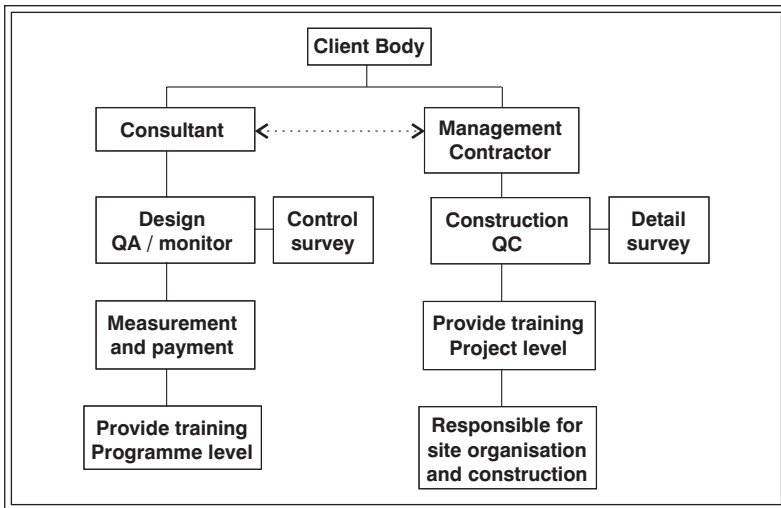


Figure 5 Possible contractual relationship

Two examples of site organisation are given in Figures 4 and 5. However, the only consistent demand is that the site organisation must provide for:

- training of supervisors before the work gets underway
- ongoing training and retraining of the workers, probably on a weekly basis
- adequate quality control systems

4. LABOUR

The organisation of labour must be such that there is joint optimisation of the social and technical systems. (Emery and Thorsrud, 1976; most of this section comes from the same reference). Neither system can make its maximum contribution to constructing the bituminous surfacing to a high quality standard with good productivity unless each is optimised with respect to each other. Development of a technical system (such as the plant and equipment) beyond the point where its operation by human being can effectively link together its 'open ends' is self-defeating. It is equally self-defeating to concentrate on the social system to the point where the workers lose interest in linking together the open technical ends to make a productive sociotechnical system. The client body, consultant and contractor can optimise the social and technical systems by the correct application of the principles discussed in this section; the authors have been involved at all levels and have successfully built bituminous surfacings (and other road components) using these principles.

To give effect to these psychological requirements, the way that each particular contractor organises his labour will differ, and each could be equally effective. The authors have been involved with developing various site organisations, and it is clear that one can not be prescriptive about the way that labour should be organised. It is important however for the contractor to ensure that the theoretical aspects of labour motivation are included as an element of the training programme.

4.1 Productivity

Since labour costs as a percentage of total costs are higher for labour enhanced construction, it is imperative that the labour is employed productively. The following criteria should be met to achieve maximum productivity:

- adequate financial reward must be set, preferably through an incentive system;
- the task to be performed must be of such a nature and carried out under such conditions that the workers can take pride in their work;

- the workers must be given training in the correct methods of doing their tasks;
- the workers' needs in terms of nutritious food and adequate shelter must be met;
- management must be good and the workers must feel it to be so.

These criteria are fairly well understood within the roads industry, and need little explanation. However, organisation of labour must also include at least some of the following psychological requirements for the most effective results (this is dealt with more fully in Emery and Thorsrud, 1976). These aspects are spelt out here in some detail because they may be less familiar to many practitioners.

In designing the jobs for labour enhanced construction, it is logical to break the tasks down to the very simplest level (such as 'basecourse sweeper') to facilitate the use of hitherto unskilled labour. Unfortunately, such jobs are often so narrow and meaningless that supervisors and higher levels of management are sucked into control and coordination of details. This will in itself cause frustration rather than participation and there will be little time for constructive long-term improvement.

To avoid this, the workforce should be organised into semi-autonomous work groups. Such a group could consist of, say, 10 - 20 workers who collectively have the simple skills necessary to complete a more complex task. As an example, the stone spreading semi-autonomous work group would themselves manage the tasks of chipping, backchipping and rolling to achieve their set quality standard. The group would move its multi-skilled members amongst the various tasks to adjust for difficult sections, individual problems or individual quality deficiencies. The group is collectively responsible to the foreman for the quality of the total product. The foreman concentrates on facilitating the interaction between his group and the rest of the site.

This contrasts with the conventional approach where a foreman is managing, on an individual basis, numerous workers who are spreading stone chips, a few workers who are backchipping and a few who are rolling. How often will the foreman be simultaneously

sorting out complaints by a backchipper that the chipper in front of them failed to spread their stone properly, a problem with a chipper who has spread all the stone over only half their allotted area and a problem with the roller operator who has run out of fuel. The problems of control of detail become overwhelming.

4.2 Semi-autonomous work groups

The development of semi-autonomous work groups came about because the individual has his limitations as a building block in organisational design for technological reasons. Process control and information handling can not be dealt with entirely on an individual level. Teamwork has always been an important part of traditional work culture; particularly in African culture. A series of industrial experiments were carried out by the Tavistock Institute of Human Relations (in British coal-mining and Indian textiles; Trist, 1957) where steps to reduce alienation had been successful in these terms. Supporting this were parallel studies that had been done in Holland and the USA. A very considerable body of social scientific experience existed to define some of the principles of industrial organisation and job design which tend to reduce work alienation. This can be applied to the design of labour enhanced construction to reduce alienation and improve quality without loss of productivity.

The judgement that it is possible to design or redesign jobs in this way rests upon the evidence that men have requirements of their work other than those usually specified in a contract of employment (i.e. other than wages, hours, safety, security of tenure, etc.). The following list represents at least some of the general psychological requirements that pertain to the content of a job; to what a person needs if he is called upon to carry out his job from hour to hour, from week to week:

- the need for the content of the job to be reasonably demanding (challenging) in terms other than sheer endurance and yet providing some variety (not necessarily novelty);
- the need for being able to learn on the job and go on learning (which imply known and appropriate standards, and knowledge of results). Again it is a question of neither too much nor too little;

- the need for some minimal area of decision-making that the individual can call his own;
- the need for some minimal degree of helpfulness and recognition in the workplace;
- the need to be able to relate what he does and what he produces to his social life;
- the need to feel that the job leads to some sort of desirable future.

These requirements, however true they may be, are too general to serve as principles for job design. For this purpose they need to be linked to the objective characteristic of industrial jobs through job design.

4.3 Job design in a labour enhanced construction environment

The principles of job design are as follows:

Optimum variety of tasks within the job.

While multi-skilling is important, too much variety can be inefficient for training and production as well as frustrating for the worker. However, too little can be conducive to boredom or fatigue. The optimum level would be that which allows the operator to take a rest from a high level of attention or effort or a demanding activity by working at another related but less demanding task and, conversely, allow him to stretch himself and his capacities after a period of routine activity.

A meaningful pattern of tasks that gives to each job a semblance of a single overall task.

The tasks should be such that, although involving difference levels of attention, degrees of effort or kinds of skill, they are interdependent: that is, carrying out one task makes it easier to get on with the next or gives a better end result to the overall task. Given such a pattern, the worker can more easily find a method of working suitable to his requirements and can more easily relate his job to that of others.

Optimum length of work cycle

Too short a cycle means too much finishing and starting: too long a cycle makes it difficult to build up a rhythm of work.

Some scope for setting standards of quantity and quality of production and a suitable feedback of knowledge of results.
Minimum standards generally have to be set by management to determine whether a worker is sufficiently trained, skilled or careful to hold the job. Workers are more likely to accept responsibility for higher standards if they have some freedom in setting them and are more likely to learn from the job if there is feedback. They can neither effectively set standards nor learn if there is not a quick enough feedback of knowledge of results.

The inclusion in the job of some of the auxiliary and preparatory tasks.

The worker cannot and will not accept responsibility for matters outside his control. Insofar as the preceding criteria are met then the inclusion of such 'boundary tasks' will extend the scope of the workers' responsibility and make for a higher level of quality in the job. They will be his responsibility, not his excuses.

The tasks included in the job should include some degree of care, skill, knowledge or effort that is worthy of respect in the community.

The job should make some perceivable contribution to the utility of the product for the consumer.

4.4 Job design at the group level

The design at the group level should include:

Providing for 'interlocking' tasks, job rotation or physical proximity where there is a necessary interdependence of jobs (for technical or psychological reasons).

At a minimum this helps to sustain communication and to create mutual understanding between workers whose tasks are interdependent and thus lessens friction, recriminations and 'scapegoating'. At best, this procedure will help to create work groups that enforce standards of cooperation and mutual help.

Providing for interlocking tasks, job rotation or physical proximity where the individual jobs do not make an obvious perceivable contribution to the utility of the end product.

Where a number of jobs are linked together by interlocking tasks or job rotation they should as a group:

- have some semblance of an overall task which makes a contribution to the social utility of the product;
- have some scope for setting standards and receiving knowledge of results;
- have some control over the 'boundary tasks'.

The distinguishing principles of this particular method of organisation are: First, the building blocks of the organisation are the individual man and his task; second, the coordination of tasks is as far as possible coped with by supervisory arrangements, systems of payment, etc.

4.5 Problems with conventional control of individual jobs

At the start of this section, an example was given to compare the semi-autonomous work group with conventional control of individual jobs. The problems that arose for the foreman working on a conventional basis are explored here in more detail. In a conventional control system, the almost inevitable inadequacies of the supervisory devices, when controlling large amounts of labour working at jobs which have been broken down into the simplest jobs, seem to have acted as an incentive to management to:

- reduce the variance arising within their man task units. To this end we find pressures towards tighter task definition, closer supervision, rating systems, piecework systems and the like;
- maximise a reserve of power and authority at the top of the management structure in readiness for the unpredicted eventualities that those lower down are eventually unable to cope with. The tendency is thus to delegate only such authorities as can be precisely accounted for in behavioural terms, i.e. in terms of what is predictable, and to delegate such powers for as short a time as is possible.

Operating with these principles sets up forces which will develop into a vicious circle when conditions deviate from normal operating conditions. The more management tries to tightly control the man-task relation, the greater the probability that the man will develop informal practices and informal groups to defeat these efforts. Likewise, with tighter, more explicit and more detailed specification of their task responsibilities, men will increasingly neglect anything that does not come under the job definition even though it would obviously contribute to the outcome of the work. Both of these tendencies act to increase uncontrolled variability in the system.

When an organisation that is being run on these principles gets into an externally induced crisis, the expected response is to tighten the screws on middle management and men. The expected result, unless the crisis is short-lived, is that the degree of uncontrolled variance will increase. The response is to tighten up further. Each tightening up brings every level of management further down into the affairs of the level below and by making it increasingly harder for the operators to buck the system, which they will increasingly wish to do, increases the emotional tension in management-worker relations. The use of semi-autonomous work groups, together with the appropriate training, discussed in section 4, act to avoid these problems.

5. IMPLEMENTATION

The detailed implementation of labour enhanced construction of bituminous surfacings is provided in Manual 12. In this section the implementation issues of project location, production planning, wages and training are discussed. However, before these issues are considered, the broader issue of community acceptance must be addressed. Nothing will work in the community unless it has community acceptance, and this is especially true in developing communities. This means that there must be consultation and agreement with the community before any implementation attempt is made. Only then will the project be accepted and be likely to succeed. This applies to plant based construction as much as labour based construction.

5.1 Application to rural or urban location

Labour enhanced construction is technically applicable to both urban and rural areas. It has been mainly applied in rural areas elsewhere in Africa, but while some rural areas in South Africa might be as physically isolated as those in Botswana and Kenya, there are generally closer links to the industrial heartland. This brings a complication in that the utilisation rates of equipment would be greater and resultant productivities much higher in South Africa than many other countries. Under these circumstances, the economic efficiency of labour-intensive methods cannot be assumed. The closer one approaches the industrial centre, the more economic considerations would be required to justify the use of labour-intensive methods.

In an urban context the major question to answer would be “what is the cost to the nation of an unemployed person?” Once the economic question has been explored it would also be necessary to investigate the social and institutional factors that would be affected by the attempt to implement such a programme. Foremost amongst these would be the role of trade unions, the attitude of small contractors and bureaucratic suspicion regarding standards achieved. One positive example from current labour enhanced construction initiatives in Soweto is the success of their small contractor development programme, with 35 - 45 percent of the project funding being retained in the community (Davis, 1992).

Overlaid on the cost issue is the issue of speed of construction. The speed of construction with labour enhanced construction can be slower than with plant based methods. This places a constraint on the application for time-sensitive roads such as rehabilitation of existing main rural roads or existing major urban roads.

At the present time the application of labour enhanced construction to rural or urban projects is shown in Table 9. This table must be considered in conjunction with the availability of labour, which can be a problem in some areas. However the overseas experience is that labour is transportable, and for medium to large-scale construction projects, the provision of a camp on the project can be used to overcome labour supply problems. It is felt that with a national long-term training plan in place, Table 9 may be less applicable.

Table 9 Application of labour enhanced construction

LOCATION	COST COMPETITIVE WITH PLANT BASED CONSTRUCTION	MORE EXPENSIVE THAN PLANT BASED CONSTRUCTION AND SO NEEDS SPECIAL JUSTIFICATION	NOT APPROPRIATE DUE TO SLOW SPEED OF LABOUR ENHANCED CONSTRUCTION
rural and minor towns	small projects; maintenance	large projects	high traffic volumes
major urban	maintenance	small to medium projects	medium to high traffic volumes; large projects

Note: It is difficult to define small or large here and the size is included as a guide only. Some practitioners believe labour enhanced construction can be cost competitive on very large projects.

5.2 Production planning

The first aspect of production planning is continuity. It is desirable from the perspective of the labour force to have continuity of work. This must be tempered with the engineering reality of the finite size of most projects and the geographical diversity of roads projects. One method of building in some continuity is to provide maintenance projects as well as construction projects.

The second aspect is production rates, which are an important determinant of the effectiveness of labour enhanced construction. They are highly variable, and this variation is one of the main problems in applying labour enhancement. The output for excavation has been known to vary from a low of 0,12m³ per man-day on one daily pay project to a high 9m³ on one piece-work project (McCutcheon, 1992). However, more typical are the outputs expected in labour enhanced projects in South African and Angola in the '50s and '60s, of 1 yd³ of soft ground per hour - 5m³ per day and current South African rates of 3m³ for excavation in soft rock.

To develop the production rates for bituminous surfacing, the production rates for the various components have been estimated from South African experience and from correlations with known production rates in other road construction activities in Southern Africa (Table 10). These production rates include allowances for traffic control, delays, loading the sprayer, heating, marking out, cleaning up, and all the associated tasks. These are preliminary estimates and must be treated as such; more accurate figures will require a proper work-study to be undertaken. There are no published overseas bitumen surfacing production rates to compare with these derived rates.

It must be emphasised again that the South African experience (Ninham Shand, 1988) is that the output on labour enhanced construction projects is variable and is inter alia dependent on:

- main contractor attitude;
- incentive system;
- worker morale;
- level of training;
- work structure;
- perception of management by labour.

The training and organisational structures in this manual are intended to lay the basis for addressing these issues effectively. If the actual production rates are substantially lower than shown in Table 10, experience in South Africa has shown that the root cause of low production rates can often be traced to an organisational culture problem which can be addressed with further training at the organisation level.

Table 10 Preliminary South African bitumen surfacing production rates under average condition

ITEM	METHOD	PRODUCTION RATE
Sweep basecourse	hand broom	1 000m ² / man day
Load and spray water and prime	tractor, trailer, 2000 litre tank, pump, spraybar	6 100m ² / 5 man days
	bakkie, 750 litre tank, hand lances	3 800m ² / 5 man days
	200 litre drum on trolley	3 300m ² / 5 man days
Load, heat, spray dust palliative or bitumen onto geotextile	tractor, trailer, 2000 litre tank, pump, spraybar	2 800m ² / 5 man days
	bakkie, 750 litre tank, hand lances	1 800m ² / 5 man days
	200 litre drum on trolley	1 500m ² / 5 man days
Spread chip and backchip as required	stone or sand	200 - 400m ² / man day
Slurry mix on site and spread	small concrete mixer, hand tools	10m ³ / 15 man days

5.3 Wage rates and payment system

The two aspects to consider are the amount to be paid and the system of payment on a daily or task basis. The importance of settling on the right wage cannot be overstated, both from a practical and philosophical point of view. At the practical level, too low a rate will cause disruption, low productivity and difficulty in attracting labour. Too high a level will reduce the cost competitiveness of labour enhancement. The use of labour brokers, possibly under a tender system, will allow the local community to have an input into wage rates for each project. The current indications (Irwin, 1992) are that the union leaders will accept a floating wage for projects promoting upliftment, provided there is community involvement and agreement and that this can be achieved in a non-unionised environment.

At the philosophical level, all parties must agree prior to the initiation of the programme. During implementation, no site must be opened without full consultation with the communities involved. While the possibility of the programme being viewed as exploitative exists elsewhere in Africa, it has more pointed connotations in southern Africa. Probably the issue would be more sensitive in the urban than the rural environment. It is suspected that the skepticism regarding the potential of labour-intensive methods in the urban environment is unduly high. Probably greater success would be achieved than hitherto imagined, provided that consultation is carried out, the correct wage is found, the conditions of employment are clear and fair, the work is technically sound and the results tangibly beneficial.

For the payment system, it is considered very important that the payment system be on a task basis rather than daily wages. This provides the incentive to complete the work while moving the onerous burden of controlling large levels of labour from the main contractor to the sub-contractor. The experience is that the outputs with task-based systems are significantly higher than with daily rates.

5.4 Training

The provision of a well-planned and coordinated training programme for all levels is an essential requirement for successful labour enhanced construction. The training is not to be confined to “technical” training on matters such as how to make a slurry. It also needs to encompass a “small contractors’ development programme” (as Soweto City Council term it), which covers the operational aspect of people management and financial management, and the business aspects such as tendering and marketing.

The training must span from the client bodies to the labour force (Table 11).

Table 11 Training needs at the various levels

GROUP	TRAINING
Client bodies	Principles of LEC, limits to its application, contract structuring, tendering, finance, developing entrepreneurs
Contractors/consultants	Principles of LEC, limits to its application, quality systems, productivity, how to do on-job training, skills transfer
Labour force	Short on-job skills training, repeated at frequent intervals to allow for staff turnover and multi-skilling

5.4.1 National training

At the national level, training will primarily deal with the emerging contractor and would be primarily the responsibility of the client bodies. Since labour enhanced construction implies an effort to alleviate poverty and unemployment and assistance to the poor to effectively participate in the economy, the objectives will be to overcome:

- lack of operational and business skills;
- lack of finance;
- lack of opportunities; and
- entry barriers such as tendering procedures and qualifications.

This training must take place prior to the implementation of any single project. Its benefits also extend beyond the immediate project and even beyond the needs of any single client. It would also be beneficial if the contractor staff (supervisors and trainers) had the opportunity to attend relevant courses being offered at the national level.

It is desirable that this training be formalised and acceptable to other client bodies and financiers. This means that ‘lesson plans’ need to be developed, that recognised and accepted teaching methods be applied and that trainees be tested and recognised through the issuing of certificates. It is therefore feasible that such training be undertaken by one or other central training institution such as those belonging to SAFCEC and/or SBDC. It would be important however that various client bodies have had an input in the content of such training.

In South Africa we will have to address the question of how many coordinating authorities and training schools are required. From the point of view of making the best use of scarce skilled resources, it would be best to have as few organisations and training schools as possible. It is unlikely that we will be able to optimise matters but a closer match would be achieved if development in labour-intensive work was viewed over the long-term in the context of a national perspective on employment as a whole. It has been found that the expertise required for a pilot project is more than sufficient, over time, to develop the training centre to produce enough trained personnel for a national programme.

The content of the national level training would include:

Technical and organisational aspects

Through practical ‘hands-on’ exercises, using the Methods and Procedures Manual 12, the entrepreneur learns how to construct and maintain bitumen surfacings. At the same time he/she is made aware of the manpower and material resources required for each activity and how these are to be managed effectively.

Operational and contractual aspects

Through simulation exercises, the trainees would become familiar with the Terms and Conditions of Contract. It is suggested that a simplified standard document be developed which would be acceptable to most client bodies.

Financial aspects

Knowing the resources involved with each activity, the entrepreneur is taught how to cost each activity. Through simulation exercises they are taught how to:

- complete the tender documentation; and
- do cash flow projections.

Basic bookkeeping

The training would include the following elements:

- Petty cash journal
- Cash book
- Progress payments journal
- Asset register

5.4.2 Project level training

At the project level, training entails the training/counseling of the contractor and his staff. It is far more detailed and practical than the national training and is designed to deal with any deviations from the above that a particular client body wishes to institute, as well as to assist with the day to day problems that the contractor might experience during project implementations.

The project level training need not be as structured and as formal as the national level training. It will mostly be done on site and will interact with the on-job training of workers by the contractors or the contract supervisors. It would include elements of on-site problem solving as and when the need arises.

6. CONCLUSIONS

The use of labour enhancement for the construction of bituminous surfacings has been shown in this manual to be viable. It is possible to build surfacings to a high standard of quality, with minor or no penalties in terms of speed and costs, and with major benefits in terms of job creation, economic empowerment and skills transfer.

Indeed, a comparison between labour used in the construction of bituminous surfacings with other known labour based construction activities such as water bound macadam, shows that road surfacings generate a high level of employment and skills transfer.

There are a number of organisational, labour and training issues to be addressed before labour enhanced construction can be used successfully. The introduction of labour enhanced construction requires commitment from client bodies, consultants and contractors, as well as an ongoing national commitment.

Notwithstanding the factors that have to be addressed, this manual provides the background and framework for decision making in the use of bituminous surfacing for roads. Manual 12, *Methods and Procedures of Labour Enhanced Construction*, offers the practitioner easy to follow guidelines in undertaking a labour enhanced construction surfacing project.

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