

LABOUR BASED CONSTRUCTION OF BITUMEN SURFACINGS BY SMALL CONTRACTORS

S.J.Emery, N.Alli and B.H.W.Veldman

Professor of Asphalt Pavement Engineering
Department of Civil Engineering, University of Stellenbosch
Stellenbosch, South Africa

Principal Engineer
Ninham Shand, Cape Town, South Africa

Principal
Ben Veldman and Associates, East London, South Africa

Abstract

This paper presents a framework for the inclusion of small and emerging labour based contractors within the bitumen industry. The issues of business skills and finance are discussed, and the option of franchising is presented. The selection of surfacing type in terms of its suitability to labour based construction is derived, and recommendations are made for various selection criteria. The training needs of small contractors are discussed, with a specific technical programme outlined for the bitumen industry.

1 INTRODUCTION

Traditionally bitumen surfacings are constructed by established contractors, whose operations are highly mechanised. These established contractors possess all the resources required to execute such projects, i.e. labour, materials, machines and money. They have the finances required for salaries and wages and the purchase of materials; the credibility in commercial circles to obtain sureties, to open accounts with suppliers and to hire plant; the managerial, commercial, technical and administrative skills required to secure and execute contracts (Watermeyer,1).

SABITA's Social Development Issues Forum comprises a broad spectrum of influential decision makers in the formal and informal sectors of the South African economy. It 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 through integrated and comprehensive emerging contractor development programmes. These need to address and remove all the barriers of entrance to the road construction and maintenance industry. A major component of such programmes would be the use of, and training in, labour based construction methods.

If small and emerging contractors are to be developed to construct bitumen surfacings within their own settlements, both the methods of construction and the construction process need to be able to accommodate them. However this must be done within a framework of practical and commercial reality, such that all the parties to the construction process - from financier to supplier, from client to community - support and sustain the process.

This paper addresses both method (the selection of bitumen surfacings for labour based construction), and process (model for the involvement of small contractors and their organisation and training). It is based on research which culminated in the SABITA Manuals 11 and 12 (2,3) on labour based construction of bitumen surfacings. In this paper, the generic term 'labour based construction' is used to

cover both of labour enhanced and labour intensive construction.

2 MODELS FOR THE INVOLVEMENT OF SMALL CONTRACTORS

2.1 Contractual models

The model for involvement of the small contractor depends to a large extent on the contract itself. This defines the role of the small bitumen contractor as either a main contractor or a specialist sub-contractor. 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 based construction.

There are five main contractual models which are likely to be considered, but only three are suited to labour based construction by small contractors:

2.1.1 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 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 model is suited to labour based 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 model is also suited to labour based 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.

A subset of this model is the "Client/consultant/trainer" approach. Here the role of the Consultant remains that of designer and quality controller, whilst the role of the trainer is that of counsellor to the emerging contractors. This avoids the comprise that must occur if the consultant's resident engineer is to be both quality controller and counsellor.

2.1.2 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 model is suited to labour based 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 model is also suited to labour based construction where the contractor is functioning as an emerging contractor, although again the costs of supervision will be higher.

2.1.3 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:

- (i) the areas of emphasis on management (which is considered as a separate and contractually defined discipline),
- (ii) the payment mechanism (which is usually cost-reimbursable plus fee), and
- (iii) the different allocation of risk between Client body, management contractor and construction contractors.

This model is becoming more common (Watermeyer,4) since it is well suited to labour based construction.

The following (and remaining two) contractual models are not suitable because the same opportunities and/or support for the small and emerging contractor are usually not present.

2.1.4 Direct works

The authority-contractor model may be developed to the extent that all or most of the construction work is undertaken by resources owned or directly employed by the authority. The direct works model is not strictly a contract system. It is included as it may be one of the alternatives to be considered by the client body when determining contract strategy. This model 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 based construction to be effective.

2.1.5 Package deal model

In this model, the contractor will undertake design and 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 model is not well suited to labour based construction where the contractor is functioning as a main contractor. The control over objectives and training by the Client body is from a distance and difficult. This model is also not suited to labour based construction where the contractor is functioning as an emerging contractor. This is because of the lack of sophisticated design and management skills in the emerging contractor.

2.2 Business models

2.2.1 Single unit business

Small contractors and emerging entrepreneurs in the construction industry have historically adopted the model of the single unit business. The owner is also the executive, and operates independently of any other business. The entry barriers for the single-unit businesses in labour based construction can and have been reduced by the adoption of appropriate technology (Watermeyer,1). However there are a number of problems that have to be addressed:

- (i) the lack of financial resources to purchase materials, hire plant and tools, and pay wages,
- (ii) the lack of commercial, contractual, managerial and administrative skills, and
- (iii) the lack of technical skills.

These problems are not unique to South Africa. A recent World Bank project undertaken by the CSIR studied the development of small contractors in the construction industry in ten southern African countries (Ministry of Works,5) and the countries involved all identified these problems as hindering the development of local contractors.

For the small contractor in the bitumen industry, there are various solutions to these problems. In this section of the paper, the access to finance will be considered, and in the following section, training to

overcome the lack of skills will be addressed.

The lack of financial resources presents the usual problems listed above, but in addition presents some industry specific problems. The bitumen industry can be characterised by high volumes and fast turnover, particularly in plant-based construction. However this is true even for small labour based contractors, relative to their colleagues in other labour based construction businesses. A small contractor with two teams can easily apply 9 000 litres of bitumen a day. Given adequate access to a prepared basecourse, the small contractor can use 40-50 000 litres of bitumen in a week. This is far more than the wages bill or even the contractors fixed costs (rent, tool allowance, lease of vehicle, etc.), and requires much more working capital than is usual for small labour based contractors.

The large plant based bitumen contractors can finance this through reserves of capital and/or credit facilities. These sources are not likely to be open to the small labour based contractor. Various financial solutions have been developed, but they apply more to the general order of labour based construction. Solutions such as improved payment systems by the client, purchase of materials by the client, and/or weekly payments for labour to the contractor by the consultant/managing contractor all have their place for small bitumen contractors.

However it should be recognised that these may not be adequate because of the high turnover and the nature of the material. If the small contractor has not met quality standards, bitumen is difficult to tear up and re-use (unlike say electrical fittings or roadbase). The practical limits to the amount of contract supervision which can take place mean that several days work could be rejected. This would result in a loss of tens of thousands of rand, and the need to purchase the same amount of new material. While the profit and contingencies built into the contract pricing can probably accommodate some setbacks, the cashflow or credit reserves most likely cannot.

Therefore additional guarantees and/or extraordinary credit facilities are needed for the single unit small bitumen contractor. This goes beyond the usual commercial credit risk, and possibly needs to be operated through an institutional based guarantee scheme.

2.2.2 Franchise operation

The franchise model is suited to the small bitumen contractor, and overcomes some of the problems of the single unit business model. The key components of franchise schemes such as economies of scale, access to technology and specialised equipment, and a working business plan (Kotler,6) are all applicable to the success of an emerging bitumen contractor:

- (i) the economies of scale allows the small contractor to fit logically into an industry which is necessarily based on large scale operations at the manufacturing end,
- (ii) access is needed to technology and specialised equipment such as new bitumen products, or small trailer-mounted bitumen sprayers capable of being calibrated, etc., and
- (iii) a working business plan will ensure that the complexities of a bitumen contractor such as marketing support, supply and storage systems, credit facilities and quality control, are all provided for with proven solutions.

At the same time, franchising fits in well to the evolving South African business and socio-political scene. In an environment where there is substantial external funding looking to support viable affirmative action projects, franchising is a very attractive lower risk investment option to support emerging entrepreneurs. As a sophisticated form of capital raising, it can overcome some of the problems of access to working capital discussed above.

In practical terms, the franchisees are often well known in their own community and under those local conditions they invariably get their business off the ground more easily (Meredith,7) which is a particular advantage in South Africa's politicised developing communities.

There are a number of bitumen industry technologies suitable for franchising, and these range from complex ones needing a high level of technical support, through to package operations using less complex technologies bound together in a 'turn-key' package. An example of the complex technologies would be small scale quick-setting slurry systems for essentially labour based operations. An example of an operating package for new contractors would be a slurry operation with vehicle, mixer, tanks, wheelbarrows, hand tools, training, storage depot, etc. Even a franchise operation of asphalt pavers by emerging contractors is possible, although this is moving somewhat outside labour based construction.

3 SMALL CONTRACTOR TRAINING AND ORGANISATION

3.1 Training

The provision of a well planned and coordinated training programme for small contractors is an essential requirement for a successful and sustained business. The training of small bitumen contractors can be divided into that at a national level and that at the project level.

At the national level, training will primarily deal with the emerging contractors. Its objectives will be to overcome:

- (i) lack of business skills,
- (ii) lack of finance,
- (iii) lack of opportunities,
- (iv) lack of technical skills and industry knowledge, and
- (v) entry barriers such as tendering procedures and qualifications.

It is feasible that such training would be undertaken by one or other central training institution such as those belonging to SAFCEC and/or SBDC. Obviously the need for business skills applies to all aspects of construction and is not confined to bitumen surfacing contractors. Therefore generic rather than industry specific programmes can be expected. The technical skills covered at the national level will tend to be generalised rather than specific, and the bitumen industry should consider its input to this level of training in that light. The overall goals for these programmes are well covered in other papers (such as Watermeyer,1; Crowell,8; DBSA,9), and will not be dealt with any further here.

The bitumen industry technical training will probably take place more at the project level. This would be far more detailed and practical than any national or business training. It would be designed to expand on technical aspects, as well as to assist with the day to day problems that the contractor might experience during project implementations. The National Committee on Labour Intensive Construction (NICLIC) Framework agreement (Ruiters,10) provides for a lump sum tender amount to cover such training. The agreement has already been applied in practice (Armstrong,11).

For the bitumen industry therefore, the challenge is to develop industry specific training programmes. Three would be needed:

- (i) the first would deal with the broad principles and would be applied at the national level; this would be expected to be rather short;
- (ii) the second would be at the project level, but administered outside of specific projects, probably

- as an industry training initiative; and
- (iii) the third would be project specific, covering the technical aspects of a particular project. It would expand on the second programme, and administered by the project managers. This will mostly be done on site, and will interact with the on-job training of workers by the main contractor (if the small contractor is a sub-contractor) or the management contractor. In addition to the technical training, it would include elements of on-site problem solving as and when the need arises.

An initial step in the preparation of these programmes has been taken by SABITA with the publication of their Manual 12 (SABITA,3) covering methods and procedures for labour based construction of bituminous surfacings. To this must be added other topics to cover the full range of technical tasks; Table 1 is an partial listing of these.

Table 1 : Technical training topics at the project level

Construction	Maintenance
C01 ^a Preparing of basecourse surface	M01 ^a Base and Surface repair
C02 Watering of basecourse	M01 Base and Surface repair (Repair of Subbase/Subgrade)
C03 Priming	M02 Pothole repair
C04 Spraying dust palliative or geotextile bitumen	M03 Blacktop edge repair
C05 Spreading surfacing aggregates	M04 Crack sealing (3 mm or less)
C06 Mixing of slurry	M05 Crack sealing (> 3 mm)
C07 Application of slurry	M06 Slack removal
C08 Application of dust palliative and sand	M07 Slurry seal
C09 Rolling	M08 Cold asphalt preparation
C10 Placing of geotextile	M09 Pre-packed cold asphalt
Operations	Health, safety and environment
Types of bitumen products	Handling of bitumen
Storage procedures	Worker protection
Pumping procedures	Fire hazards
Operation of equipment	First aid
Maintenance of equipment	

Notes: a: topic headings from SABITA Manual 12 (3)

3.2 Organisation

Small contractor organisation will necessarily tend to be less formal than large contractors, and focused on the organisation of labour. It is worthwhile therefore to look at the fundamentals of organisation of labour before looking at the practical aspects of organisation.

The organisation of labour by the small contractor must be such that there is joint optimisation of the social and technical systems. 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 tools and equipment) beyond the point where its operation by human beings 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 socio-technical system (Emery and Thorsrud,12).

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 addressed. In practical terms it means that the following issues must be addressed:

- (i) adequate financial reward,
- (ii) the task must be such that the workers can take pride in their work,
- (iii) adequate training for the workers,
- (iv) recognition of contribution by the workers,
- (v) feedback and accountability for the results, and
- (vi) workers' needs in terms of food and shelter must be met.

In allocating the jobs in labour based 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 the contractor is sucked into control and co-ordination 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 small contractor should organise his workforce into 'semi-autonomous work groups'. Such a group could comprise 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 are collectively responsible to the contractor for the quality of the total product.

The contractor concentrates on facilitating the interaction between his group and the rest of the site. The size of the semi-autonomous work group is well suited to act as a building block for the small bitumen contractor, who starts off with a single group then adds teams as the capabilities grow.

4 SURFACINGS SUITED TO LABOUR BASED CONSTRUCTION

4.1 Selection criteria

In choosing surfacings for use with labour based construction, the surfacing should be selected on the basis of all of:

- (i) suitability to labour enhancement,
- (ii) its ability to meet macro-economic and skills transfer goals, and
- (iii) the usual criteria of performance and traffic (not discussed here, but summarised in SABITA Manual 10 (13) and Emery et al.(14)).

The suitability of bitumen surfacings for labour based construction is governed to a large extent by quality issues. Thus the ability of the small contractor to control sufficient dimensions of quality is needed to ensure that the surfacing meets the standards expected from plant construction. There is

ample evidence that labour based construction does not mean sacrificing good standards of quality and performance (Crowell,15; McCutcheon,16,17).

To give an example of this, for a surfacing seal the application rates of the bitumen and stone must be closely controlled. This is to avoid bleeding and get good stone retention and the development of a well knit matrix. The quality issue for this example then revolves around the ability of the contractor to control these application rates.

For each bitumen surfacing type, there are components that can be done using labour based techniques without sacrificing quality. Within each labour component, it has been assumed that basic, almost hand held, machines could be used. These would tend to be small scale: tractor drawn 1000-2000 litre sprayers, drum trolleys with hand sprayers, pedestrian rollers, brooms, etc. This is not to say that labour based construction cannot be done with large items of plant and equipment that might be available to small contractors. Rolling is one example where it can be done using laden trucks (discussed in SABITA Manual 12 (3)) which are easy items of plant for emerging entrepreneurs to source.

It has been assumed in this paper that the binder would be a bitumen emulsion (modified or unmodified). This overcomes the problems of premature cooling and safety that can occur using hot bitumen in labour based construction.

4.2 Surfacing suitable for labour based construction

The suitability of surfacings to labour enhancement depended on the number of suited components; the surfacings most suited can be built using labour enhancement for the most components.

An example is given of a single seal, broken down into components, and the suitability of each assessed labour enhancement (Table 2); the breakdown for other surfacings is presented in SABITA Manual 11 (2).

Table 2 : Suitability of a single seal for labour enhancement

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

The suitability of surfacings for labour based construction is given in Table 3, and the suitability of combination surfacings (such as double seal: 13mm chip and sand) can be interpolated from this.

Table 3 : Suitability of surfacings for labour based construction

Surfacing type	Suitability for labour based construction
Dust palliative	suitable
Single seal	reasonably suitable
Double seal	reasonably suitable
Cape Seal	very suitable
Asphalt - new layer	varied opinions ^a
Asphalt - patching	suitable
Slurry	highly suited ^a

Note: a: Recently revised; see section 4.3

4.3 Reassessment of the suitability of asphalt and slurry

The assessment of the suitability of asphalt and slurry made in SABITA Manual 11 (2) has been modified in the light of subsequent experience. Originally asphalt for new layers was 'not really suited', because there was no documented or personal experience with manufacturing and/or laying asphalt in large quantities by hand for new layers. Since the quality of construction was not proven to be assured, then it was felt better to exclude it.

Since then, there have been a number of discussions with practitioners who report having laid asphalt by hand successfully (Winfield,18; Newell,19). Although none of these projects have been documented or researched, it does give an indication that hand laying is possible for large quantities. As yet, there is no documented evidence that suitable asphalt can be made in large quantities by hand, although cold asphalt can obviously be made in small quantities for patching. Further research is needed here, particularly since asphalt is an appropriate surfacing for urban roads in high density developing areas (SABITA Manual 11, 2).

The suitability of slurry has been re-assessed upwards to 'highly suitable'. A number of successful examples of this have been observed following the original research project. Slurry has been applied using labour based techniques by a full range from small contractors to large municipalities. Low cost innovative techniques have been seen such as:

- (i) cut down buckets to measure exact quantities of bitumen emulsion and cement,
- (ii) the use of timber screed boards to demarcate the spread for each mixer load and to assist in depth control and even spreading, and
- (iii) the use of a 'mother' truck to drop off materials and water to a number of crews on the road.

4.4 Selection to meet macro-economic goals

The choice of surfacing type has only a limited influence on macro-economic goals, and so the selection of surfacing is more supportive than fundamental to these goals. However it can have some effect on levels of unemployment and financial upliftment to the community, and so is considered here.

The criterion used here to assess the effect on unemployment was the amount of labour used in surfacing construction (Labour spending per square metre: Table 4). It must be noted that this is a short-term criteria and does not take account of longer term issues such as the development of entrepreneurs. The criterion used here to assess the financial upliftment to the community is labour's share of the budget (Percentage of total surfacing cost spent on labour: Table 5). This can be qualitatively related to the useful measure from the Soweto Contractor Development Programme: 'money retained in the community' (Watermeyer and Davis,20).

Table 4 : Surfacing choice to maximise funding to labour

Surfacing type	Labour spending per square metre (Rand)		
	R10/day ^a	R25/day ^a	R35/day ^a
Slurry 15mm thick	0.38	0.96	1.34
Cape Seal 13mm stone	0.32	0.80	1.12
Double seal 13/6mm stone	0.25	0.64	0.90
Asphalt 25mm thick	0.20	0.51	0.71
Single seal 9,5mm stone	0.14	0.34	0.48
Dust palliative	0.12	0.31	0.43

Note: a: The labour rates used in these projects generally lie in this range. At the SABITA labour based construction seminars in 1992, rates of R8 to R20 per day were noted. At the 1993 Midrand labour based construction seminar, 13 rates were quoted ranging from R6 to R35 per day with an average of R15,50.

Table 5 : Surfacing choice to maximise labour share of budget

Surfacing type	Percent of total surfacing cost spent on labour		
	R10/day	R25/day	R35/day
Cape Seal 13mm stone	5.6%	13.0%	18.2%
Slurry 15mm thick	5.3%	12.3%	17.2%
Single seal 9,5mm stone	4.9%	11.4%	16.0%
Dust palliative	5.2%	11.3%	15.8%
Double seal 13/6mm stone	4.9%	11.2%	15.7%

4.5 Selection to meet skills transfer goals

Bitumen surfacings can also be selected to maximise skills transfer, although the skills transferred are limited to technical skills. However the benefits of technical skills transfer extend down from the level of the small contractor to his workers, which is important. With the current emphasis on developing emerging entrepreneurs, there is a chance of ignoring the people at the lowest levels - the workers. These are just as much in need of opportunities to improve basic skills and learn the attributes of quality control and performance. The technical skills transfer associated with bituminous surfacing offers them the chance to do that.

The skills transfer was assessed by considering the attributes needed for each job. For each attribute, various levels of complexity and therefore varying skill points were assigned (Table 6).

Table 6 : Basis for calculating skills transfer

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
	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	motorized plant i.e. tractor

Table 6 can be illustrated by some examples:

- (i) brooming would rate low (1 skill point) for the basic skill, low (1 skill point) for quality control to achieve a clean and dust free finish, and nil (0 skill points) for the use of machines; a total of 2 points;
- (ii) the spraying of prime would rate high (2 skill points) for the basic skill, high (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 low (1 skill point) if applied from a drum and hand lance or high (2 skill points) if applied from a tractor and trailer; a total of 5 or 6 points.

The surfacing choice for skills transfer is given in Table 7. In this table, the labour component and skills transfer does not include the labour component of associated plant based operations. The preferred surfacings have the highest number of skill points.

Table 7 : Surfacing choice to maximise skills transfer

Surfacing type	Skill points					
	broom	prime	spray/ slurry	chipping	rolling	SUM
Cape Seal	2	6	0 ^a	4	3	15
Double seal	2	6	0	4	3	15
Single seal	2	6	0	4	3	15
Slurry	2	6	5	0 ^b	0 ^b	13
Dust palliative	2	0 ^b	6	2	0 ^b	10
Asphalt patching	2	4	6	0	3	15
Asphalt new layer	2	4	0 ^a	0 ^b	0 ^a	6

Notes: a: assumed to be done by plant
b: not needed/done

5 CONCLUSIONS

Small business has increasingly come to be recognised as a valued attribute of a successful economy. Small businesses have the ability to use small amounts of capital productively and to operate under demanding conditions of competition. It is important therefore that the road industry makes a contribution in this regard, and a most suitable approach is through the development and support of small labour based contractors. They are labour intensive, as labour is cheaper than capital, and they reward individual initiative, innovation and effort, all essential human attributes in any successful economy.

There are three suitable contract models for the involvement of small contractors in labour based construction: client/consultant (with or without a trainer), client/contractor and management contracting. Within these models, the small contractor faces the difficulties of access to business skills and finance. It is suggested that franchise operation might be a suitable option to address the particular factors of the bitumen industry.

The training needs of the small contractor are identified at two levels: a national level which primarily addresses the business skills with some industry training, and the project level which addresses the specific technical skills. The core subjects for an initial technical programme in bituminous surfacings are listed. The organisation of labour by the small contractor is addressed, with the emphasis on semi-autonomous work groups.

From the technical aspects of quality and labour usage, suitability criteria are developed for the selection of bituminous surfacings suited to labour based construction. The slurry was found to be the most suited to labour based construction, with Cape Seal also well suited.

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7 REFERENCES

1. Watermeyer, R (1993) **Community based construction** Symposium on labour based construction. Jointly organised by SAICE, SARF, SAACE, SAFCEC, and IMESA, Midrand.
2. SABITA (1993) **Labour enhanced construction for bituminous surfacings - Manual 11** Cape Town
3. SABITA (1993) **Methods and procedures: labour enhanced construction for bituminous surfacings - Manual 12** Cape Town
4. Watermeyer, R (1994) **Personal communication** Sonderland and Schutte, Johannesburg
5. Ministry of Works and Construction (1993) **Southern Africa Construction Industry Initiative - Report** Prepared by CSIR for the Ministry, Swaziland
6. Kotler, P (1988) **Marketing Management** Prentice-Hall, New Jersey
7. Meredith G.G. (1986) **Small business Management in Australia** McGraw-Hill, Sydney
8. Crosswell, J.A. (1989) **Practical details for success - summary of details which require attention.** Course paper Employment Creation in Construction. Univ. Witwatersrand, Johannesburg.
9. Development Bank of Southern Africa (DBSA) (1992) **Interim guidelines for appropriate contract procedures and documentation for labour-based construction.** Midrand.
10. Ruiters, T (1993) **Labour based construction** Symposium on labour based construction. Jointly organised by SAICE, SARF, SAACE, SAFCEC, and IMESA, Midrand.
11. Armstrong, A (1993) **Training system** In: Symposium on the background to and key aspects of the Framework Agreement. Organised by SARF for National Committee for Labour Intensive Construction, 31 August, Cape Town.
12. Emery, F.E. and Thorsrud, E. (1976) **Democracy at work** Martinus Nijhoff Social Sciences Division, Leiden.
13. SABITA (1993) **Appropriate standards for bituminous surfacings - Manual 10** Cape Town
14. Emery, S.J., Van Huyssteen, S. and Van Zyl, G. (1991) **Appropriate Standards for Bituminous Surfacing - Final Report** RDT Report 17/91 for SABITA, CSIR, Pretoria.
15. Crosswell, J (1993) **The role of the consultant** Symposium on labour based construction. Jointly organised by SAICE, SARF, SAACE, SAFCEC, and IMESA, Midrand.
16. McCutcheon, R. (1990) **Labour-intensive road construction in Africa: an introduction.** The

Civil Engineer in South Africa, Vol II. Nov., pp483-491

17. McCutcheon, R. (1991) **A strategy for innovative and productive employment creation in the construction industry.** Managing people and communications in projects. Proc. International Symposium, Project Management Institute, Midrand.
18. Winfield, M (1994) **Personal communication** Zebra Bitumen Surfacing, Cape Town.
19. Newell, J (1993) **Personal communication** Protea Asphalt Natal, Durban.
20. Watermeyer, R.B. and Davis, A.D. (1993) **Professional Support Structures employed in community based construction projects in Soweto** Journal of IMIESA, May, Johannesburg.