1.4 MOBILISING THE PRIVATE SECTOR TO ENGAGE IN LABOUR-BASED INFRASTRUCTURE WORKS: A SOUTH AFRICAN PERSPECTIVE

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1.4.1 Introduction

Organs of state (in the national, provincial or local sphere of government) are responsible for the provision of public infrastructure including roads. The construction of infrastructure can either be undertaken by utilising in-house resources (force-account) or by outsourcing to the private sector (procurement). Public expenditure in the infrastructure sector, as with any other sector of the economy, will generate employment opportunities. The total number of employment opportunities and who derives benefit from such employment opportunities depends upon how a construction project is structured.

In force account operations, an organ of state has direct control over the outcome of a construction project. When outsourcing, its control is diminished. This paper is concerned with the outsourcing of work to the private sector.

The Green Paper on Public Sector Procurement Reform in South Africa (1997) suggests that procurement can facilitate the generation of jobs in South Africa by:

- ensuring that the foreign content in contracts involving goods, services and works is minimised;
- encouraging the substitution of labour for capital;
- supporting the use of "labour friendly" technologies which utilise a higher degree of labour input than is the case work conventional technologies, or are well suited to implementation by small scale enterprises; and
- encouraging and developing small scale enterprises to implement employment intensive practices and "labour-friendly" technologies.

1.4.2 Labour-based Construction Technologies

Labour-based methods and technologies have been employed in South Africa on construction projects which include rural gravel roads; low level bridges; small dams; residential township roads (surfaced and gravel); water and sewer reticulation for townships; bituminous surfacing of roads; low voltage electrical reticulations; stormwater drainage systems; and on-site sanitation. Road maintenance projects have included regravelling and routine road maintenance.

Table 1 shows the estimated number of manhours required to service an erf in a low cost township using conventional construction methods. What is immediately apparent from this table is that road work is the most capital intensive activity (highest cost / manhour) and therefore the discipline which has the highest potential for increasing employment opportunities. On civil engineering projects of this nature, the cost of materials is generally taken to be 25% of the total construction cost. This being the case, it is apparent from Table 1 that significant increases in employment opportunities can be achieved by examining materials manufacturing methods.

Table 1: Manhours required in the provision of infrastructure for a low cost township using conventional construction methods (Watermeyer and Band, 1994)

Service	Estimated manhours (%)		Estimated total number of manhours / ERF	Cost/manhours* (Rand / manhours)
	Materials	Site labour		
Water	13	87	39	20
Sewerage	16	84	43	14
Roads	14	86	21	36
Stormwater	8	92	26	16
Electricity	70	30	117	20
TOTAL	40	60	246	20

* Based on March 1992 rates which included P & G but excludes VAT and professional fees.

Labour-intensive methods of excavation can significantly increase the employment potential of the activities shown in Table 1. For example, Watermeyer and Band (1994) have shown that hand excavation of trenches can reduce the cost per manhour in respect of water and sewerage from that tabulated in Table 1 to R14 and R9 / manhour respectively. Watermeyer et al (1995) have found in the upgrading of Soweto's infrastructure, the following multipliers in employment opportunities (i.e. ratio of average total number of manhours generated in the construction of a specified structure or service using labour-based technologies to that generated in one using plant-based technologies):

- excavate and backfill trenches for water construction 1.9.
- excavate, lay pipes and backfill water reticulation 1.4.
- construct waterbound macadam roads 4.7.
- construct concrete block roads 2.3.

There has been considerable interest generated by the employment potential of roadworks. Table 2 highlights the potential employment which can be generated in road construction.

Table 2: The employment potential of various roadwork activities (Watermeyer and Band, 1994)

Activity	Thickness (mm)	Manhours to produce and construct (manhours/m^2)

		Plant-based	Labour-based
Road bed preparation (R&R)	-	0.033	0.350
Gravel wearing course (G5)	125	0.160	1.000
Gravel wearing course (G4)	150	0.192	1.200
Base course (G4)	150	0.192	1.200
Base course (G3)	125	0.165	NA
Subbase (G6)	150	0.192	1.200
Waterbound macadam base course	100	1.040	1.370
Slurry	15	0.110	2.011
Asphalt	25	0.140	1.170
Concrete blocks	60	0.930+	2.120#
Cast *in situ* (plastic cell) blocks	-	0.38	1.80

+ Factory produced block paving
# Blocks manufactured on site using employment-intensive methods

Potgieter et al (1997), when commenting on recent South African experience in this regard, state that "The cost of big machinery largely prevented micro and small contractors from owning road construction companies. The road construction fraternity made no ingress into creating ownership (empowerment) for small / micro road construction companies long after house building, water pipes, sewer networks etc were done by small independent contractors. It was only after the recent breakthrough in developing pavements that can be constructed without machines that company ownership was put within reach of the small / micro companies (machine purchases below R 15 000 (US$ 3 500))... ...these pavements are either from the last century before road machines were developed (e.g. Telford, macadams etc) or from modern developments (e.g. Gravel Emulsified Mixes, foamed bitumen etc)."

In South Africa, the following roadwork technologies have been utilised to facilitate labour-based construction by small scale enterprises (Potgieter et al. (1997):

- Telford base and sub-base construction (dump rock of size 75 x 125 x 175mm packed on a prepared level sub-base with smaller stones placed and rammed in with hammers between openings and protrusions broken off by means of hammers. Technique used in the UK at the turn of 18th century).
- dump rock kerbing and verge construction.
- cast in-situ and site manufactured precast concrete kerbing.
- dump rock kerbing with voids between rocks filled with crusher dust cement slurry.
- water bound macadam bases (single size aggregate of 37 or 53mm with a gap grading and virtually no aggregate below 19mm in size, with voids filled with fines. Construction technique pioneered by Macadam in Scotland which replaced Telford construction).
- traditional process where the fines are washed and vibrated into the voids

- dry bound where the filler "dry flows" into the voids during vibration compaction without the help of any moisture, with or without slurry penetration which fills the top 10 to 25mm of exposed aggregate
- slurry bound (penetration Macadam developed in 1907 where the large aggregate base was filled by hand with hot bitumen or tar binder and later by mechanical sprays. Potgieter et al, (1995 and 1996) developed a cold bitumen process.)
- composite Macadam (a water bound or dry bound Macadam base with a top layer of smaller coarse aggregate (typically a natural gravel) laid as a thin slurry bound Macadam acting as a durable key-in layer.)
- roller compacted concrete (dry-mix concrete produced from a continuously graded crushed stone).
- Gravel Emulsified Mixes (GEMs) (the modification of medium to marginal quality natural gravel with the addition of 2-3% emulsified bitumen, 1-2% of cement and sometimes 1-2% lime.)
- foamed bitumen (foamed bitumen is mixed in with aggregate and thereafter constructed in a layer as is the case for a natural gravel).
- dust palliatives.
- interlocking block paving
- precast concrete block paving
- plastic cells (with concrete or slurry bound Macadam)

Technologies for ancillary works have included:

- plain and reinforced masonry drainage structures (Watermeyer, 1992).
- rubble masonry bridges (Rankine et al. 1995)

Not all of the above mentioned roadwork technologies have been successful as some communities have rejected their finished appearance and / or poor riding quality.

Changes in methods and technologies, which increase the labour content in construction and in the manufacture of materials, yield the greatest increase in the number of employment opportunities generated per unit of expenditure. This requires well established companies to change their work methods and to reduce their reliance on capital intensive technologies. Such methods and technologies are usually readily implemented by small scale enterprises, who by being small, have limited access to capital and invariably operate and conduct their business in a more employment-intensive fashion and favour light equipment-based forms of construction.

1.4.3 Implementing Labour-based Projects

In force account works, the true cost of construction is seldom known as records invariably only reflect the cost of outsourced items viz., materials and labour. (The supervision, plant, establishment costs etc are invariably absorbed in the overall running cost of the organ of state and are seldom separated out.) When outsourcing works in their entirety, the construction cost is very visible as it is simply the contract cost. (Ancillary costs e.g. professional fees and administration costs, are usually costed as a percentage of the construction cost.)

The tendering / contracting system permits organs of state to gather statistics on the cost of labour-based works and plant-based works. Comparisons are inevitable. Many of the aforementioned technologies, although being effective in generating increases in the total quantity of employment on a project, are very inefficient when the expenditure per unit of employment is considered. As a result, many labour-intensive techniques and technologies are simply not viable or justifiable. In South Africa, there is a constitutional requirement (section 217 of the Constitution of the Republic of South Africa) for organs of state to procure goods and services *in accordance with a system which is fair, equitable, transparent, competitive and cost effective.*

The choice of technology is generally made during the basic design phase of works contracts, whereas the choice of construction method / method of manufacture is usually decided upon during the construction phase. Two alternative approaches to implementing labour-based works can be adopted.

Method 1 : lay down the use of specific employment-intensive technologies and methods of construction / manufacture in the contract document.

Method 2 : afford tenderers the opportunity to choose the technology / construction method / method of materials manufacture which they wish to use in order to implement employment-intensive methods and to reward them for the degree to which they embrace such technologies.

Either method may be used to increase the quantity of employment generated per unit of expenditure. Method 1 usually achieves the objective by restricting the use of certain types of plant / manufacturing methods and by specifying particular technologies. Method 2, on the other hand, requires tenderers to tender the amount of labour, which they undertake to engage in the performance of the contract and to be rewarded at tender stage for this. Method 2, accordingly, permits tenderers to use their knowledge, skill and creativity in arriving at an optimum economic mix of equipment, technologies and labour in order to meet their obligations e.g., a tenderer on a roads contract may choose to manufacture kerbs and precast concrete components on site rather than to excavate the box cut for the road by hand in order to provide employment for a target group.

Method 1 is well suited to the targeting of local labour. The economic viability of this approach is, however, dependent on the ability of the designer / specifier to forecast cost. Method 2 can be used for the employment of relatively unskilled labour and any potential price premium can be readily assessed during the adjudication of tenders. Method 2 therefore has the distinct advantage that tender prices will usually fall within acceptable limits and economic justification of decisions relating to employment generation will not be necessary. Method 1 runs the risk that tenderers may out price some technologies which don't suit their companies in an effort to dissuade an organ of state from utilising certain labour-based technologies.

What is also required is a strategy to engage small, medium and micro enterprises in a cost effective manner as these enterprises are most likely to implement labour-based technologies. An approach which forces the private sector to embrace labour-based technologies in order to secure a competitive advantage over their competitors is one which is likely to succeed.

The remainder of this paper will examine the tools required to engage the private sector in labour-based infrastructure works viz.:

- appropriate specifications.
- contract strategies.

1.4.4 Specifications

SABS 0120 : Part 1 defines a specification as a technical description of the standards of materials and workmanship that the contractor is to use in the works to be executed, the performance of the works when completed, and the manner in which payment will be made.

There is considerable merit in separating payment from specifications. For the purposes of this paper, however, payment methods will be linked to specifications.

Specifications are an important tool for securing and administering labour-based methods and technologies in infrastructure works contracts. Some aspects which need to be addressed in specifications are reviewed by way of examples.

1.4.4.1 Earthworks specifications

Any earthworks specifications for labour-based earthworks activities, irrespective of whether or not they are a modification of a standardised specification such as SABS 1200, should, inter alia, address:

- the manner in which material is to be excavated/compacted.
- the degree of compaction required.
- testing requirements.
- how the work is to be measured and paid for.

1.4.4.2 Excavation

Labour-based excavation practices can be implemented by restricting the use of plant permitted on the contract and only using plant in exceptional circumstances. Generally plant is required when the depth of excavation becomes unmanageable or excessive, ground conditions are adverse or the material to be excavated becomes too hard for economic removal by means of hand tools.

Simple clauses can be included in earthworks specifications to permit the use of plant where excavation depths become unmanageable, e.g., 2.0 m deep trenches or where adverse ground conditions exist, e.g. below the water table. The challenge, however, is to produce an appropriate and workable earthworks classification which will enable engineers, in the first instance, to identify projects which are eminently suitable for labour-based construction methods and, secondly, to administer contracts where labour-based earthworks practices are employed.

SABS 1200 D classifies earthworks as being one of five categories, viz. soft, intermediate, hard rock, boulder class A and boulder class B. Boulder class excavation is classified in terms of the size and volume of boulders contained in the soil matrix whereas the classifications for soft, intermediate and hard rock are in terms of the capabilities of specific items of plant as set out in Table 3. In terms of the specification, the engineer decides on the classification of the material based on a visual inspection and the criteria set out in Table 3. In the event that a disagreement arises between the contractor and engineer, the contractor is responsible for making available at his cost the plant referred to in Table 3 *in order to assess the reasonable removability or otherwise of the material.* The engineer then decides whether or not the specified plant can *efficiently* remove or rip the material in question whereupon his decision shall be final and binding.

Table 3 : SABS 1200 D earthworks classification (SABS)

Classification	Description
Restricted excavation	
Soft	Material which can be efficiently removed by a back-acting excavator of fly wheel power >0,10 kW for each mm of tined-bucket width.
Intermediate	Material which can be removed by a back-acting excavator having a fly wheel power > 0.10kW for each mm of tined-bucket width or with the use of pneumatic tools before removal by a machine capable of removing soft material.
Hard Rock	Material that cannot be removed without blasting or wedging and splitting.
Non-restricted excavation	
Soft	Material which can be efficiently removed or loaded, without prior ripping, by any of the following plant: • a bulldozer or a track type front end loader having an approximate mass of 22 tonnes and a fly wheel power of 145 kW. • a tractor-scraper unit having an approximate mass of 28 tonnes and fly wheel power of 245 kW, pushed during loading by a bulldozer equivalent to that described above.
Intermediate	Material which can be efficiently ripped by a bulldozer having an approximate mass of 35 tonnes and a fly wheel power of 220 kW.
Hard Rock	Material that cannot be efficiently ripped by a bulldozer having an approximate mass of 35 tonnes and a fly wheel power of 220 kW.

The SABS 1200 earthworks classification in its very formulation has an element of subjectivity built into it since the definitions for the classes of excavation are dependent on the interpretation of the word "efficiently". Although SABS 1200 D does define "efficiently" as *in a manner that can reasonably be expected of a contractor, having regard to the production achieved*, the engineer is still required to exercise engineering judgement. It is therefore unreasonable to expect that an earthworks specification for labour-based construction practices will be devoid of all subjectivity.

Coukis (1983) in a World Bank publication has produced some guidelines on the determination of rates of productivity which may be expected in different types of soils. This information is reproduced in Tables 4 and 5. In terms of this classification, materials are firstly classified as being cohesive or non-cohesive and are thereafter codified in terms of a field recognition test, unconfined compressive strength and liquidity index. (The liquidity index equals the quotient of the natural water content minus the plastic limit and the liquid limit minus the plastic limit). Once the material code is known, the expected rates of production can be determined for standard conditions from Table 5. (Standard conditions relate to situations which have fair to average site management and low to average incentives for workers. Actual production may vary from 0.25 to 4 times the standard productivity. The productivity data assume that two-thirds of an eight hour day is actually spent working.)

Table 4 : Earthworks classifications (Coukis, 1983)

Cohesion Soils

Code	Description	Field recognition test	Unconfined compressive strength (kN/sq m)	Liquidity index
2	Soft	Easily moulded in the fingers	25 to 50	0.7 to 1.4
3	Firm	Can be moulded in the fingers by strong pressure	50 to 100	0.2 to 0.7
4	Stiff	Cannot be moulded in the fingers	100 to 200	-0.1 to 0.2
5	Very stiff	Brittle or very tough - crowbar useful for hand digging	200 to 400	-0.3 to-0.1
6	Hard	Difficult to dig by hand even with a crowbar	more than 400	less than-0.3

Non-cohesive Soils

Code	Description	Field recognition test	Relative density
2	Very loose	Easily excavated with a shovel	less than 0.2
3	Loose	Can be dug with a shovel	0.2 to 0.4
4	Compact	Pick or other swung tool required	0.4 to 0.6
5	Dense	Crowbar useful for hand digging	0.6 to 0.8
6	Very dense	Difficult to dig by hand even with a crowbar	more than 0.8
7	Soft rock	Crowbar and pick required	-

Table 5 : Productivity data for excavation by hand (Coukis, 1983)

		Standard input coefficient (cu. m/man-day)					
Excavation parameter	**Material type**	**Excavation only**	**Excavation-loading at given loading height (m)**				
			0	0.5	1.0	1.5	2.0
2	Soft/very loose soil	6.7	6.7	5.6	4.5	3.7	3.0
3	Firm/loose soil	4.2	4.2	3.7	3.2	2.8	2.4
4	Stiff/compact soil	3.0	-	-	-	-	-
5	Very stiff/dense soil	2.4	-	-	-	-	-
6	Hard/very dense soil	2.0	-	-	-	-	-
7	Soft rock	1.7	-	-	-	-	-

The World Bank classification and associated productivity rates for the different materials encountered is intended for the planning and management of labour-based programmes. It is, however, not suited to South African contract practices in that it does not allow for excavation by pneumatic tools and the codification of materials requires in certain instances, laboratory testing. Nevertheless, the philosophy behind the classification can be readily translated into a classification for South African conditions.

A South African classification (Soderlund & Schutte, 1994) for labour-based excavation practices is presented in Table 6. This classification makes provision for the excavation by means of a shovel only, a pick and shovel and pneumatic tools. It contains five classes of excavation, three of which relate to excavation by means of hand tools only.

As is the current practice when using SABS 1200 D, the engineer will classify the material on the basis of a visual inspection and his knowledge of expected productivity rates in terms of Table 6. In practice, however, the establishment of the boundaries between soft class 2 and soft class 3, and soft class 3 and intermediate can be highly subjective and the engineer requires a less subjective means of determining the classification of a particular material in the event of a dispute arising. In the event of a disagreement on the classification between the contractor ad the engineer, the engineer can be called upon to classify the material in accordance with Tables 7 and 8. Typical rates of production in trench excavation for the soft classes of material are tabulated in Table 9.

The World Bank use three parameters to classify materials, viz., field recognition, unconfined compressive strength and liquidity index. Soderlund & Schutte's

S100D specification, on the other hand, also makes use of one parameter, viz. field recognition or in-situ shear strength. The latter method permits labour-based contractors to classify material themselves should they be in possession of a dynamic cone penetrometer (DCP).

Table 6 : Classification of materials (Soderlund & Schutte, 1994)

Classification	Description
Soft, Class 1	Material which can be excavated by means of a suitable shovel without the use of a pick or other hand swung tool.
Soft, Class 2	Material which can be readily excavated with the aid of a pick or other hand swung tool.
Soft, Class 3	Material which can be excavated with difficulty with the aid of a pick or other hand swung tool.
Intermediate	Material which is difficult to excavate by hand even with the aid of a crow bar and requires the assistance of pneumatic tools for economical removal.
Rock	Material which cannot be economically fragmented and loosened for removal by hand implements and pneumatic tools except by drilling and blasting or the use of rock breaking equipment.

Table 7 : Classification of materials in terms of consistency and shear strength (Soderlund & Schutte, 1994)

Materials Classification	**Consistency (as defined in table 6)**		**Typical number of blows that a DCP # requires to penetrate 100 mm of material +**	
	Granular Soil	**Cohesive Soil**	**Granular Soil**	**Cohesive Soil**
Soft, Class 1	Very Loose/Loose	Very Soft/Soft	≤2	≤1
Soft, Class 2	Loose/Medium Dense	Soft/Stiff	2-6	1 - 5
Soft, Class 3	Dense	Stiff/Very Stiff	7-15	6 - 8
Intermediate	Very Dense	Very Stiff	16-50	8 - 15
Rock	-	-	-	-

\+ Only applicable to materials comprising not more than 10% gravel (particles having dimensions 2.5 mm) of size less than 10 mm and materials containing no isolated small boulders.

\# Refer to Appendix A for description of DCP and its common usage in South Africa.

1.4.4.3 Service trenches

Extracts from Soderlund and Schutte's pre SABS 1200 backfilling specification required that the initial refill material up to 0.3 m above the barrels of pipes shall consist of selected material, free of stones with a largest dimension in excess of 20 mm, well compacted by the use of approved hand tools under the direction of the pipe layer. The refilling of trenches above the initial refilling layer shall be carried out in layers not exceeding 150 mm compacted thickness. All refill material shall be readily compactible material, free from roots and other vegetable matter, building rubble, etc. Refilling under existing, or future, road surfaces shall be compacted to 93% Modified AASHTO maximum density and other refilling to 87% Modified AASHTO maximum density. Where practicable, approved mechanical compacting equipment shall be used. Refilled trenches shall be finished off approximately 50 mm proud of original ground surfaces.

This specification placed the onus of prevention of settlement on the contractor viz., during the whole period that the works are in his hands, including the maintenance period, and as often as necessary, the contractor shall make good promptly and at his own cost all surface settlements caused by his excavations. He shall be held liable for any accidents or damage arising from such settlements.

The SABS 1200 series set a minimum compaction requirement of 90% Modified AASHTO density at optimum moisture content. This level of compaction is in excess of what is required to contain trench settlements to within acceptable limits (87 - 88%) in untrafficked areas. It can only be achieved by using mechanical compaction equipment and not by means of hand methods with any degree of consistency.

A test to provide compaction characteristics of soil was first introduced by Proctor in the USA in 1993 as a means of controlling the degree of compaction during construction. Proctor's test represented in the laboratory the state of compaction which could be reasonably achieved in the field. However, with the subsequent introduction of heavier earth moving and compaction equipment, higher densities became obtainable in practice. A laboratory test using increased energy of compaction was then introduced to reproduce higher compacted densities viz. Modified AASHTO test. (It should be noted that the current test equipment (mould size and hammer mass), drop height of the hammer and test procedures (number of layers and number of blows per layers) vary from country to country.)

Table 8 : Consistency of materials (SABS 0161)

Granular materials		Cohesive materials	
Consistency	**Description**	**Consistency**	**Description**
Very loose	Crumbles very easily when scraped with a geological pick.	Very soft	Geological pick head can easily be pushed in as far as the shaft of the handle.
Loose	Small resistance to penetration by sharp end of a geological pick.	Soft	Easily dented by thumb; sharp end of a geological pick can be pushed in 30-40 mm; can be moulded by fingers with some pressure.
Medium dense	Considerable resistance to penetration by sharp end of a geological pick.	Firm	Indented by thumb with effort; sharp end of geological pick can be pushed in up to 10 mm; very difficult to mould with fingers; can just be penetrated with an ordinary hand spade.
Dense	Very high resistance to penetration by the sharp end of geological pick; requires many blows for excavation.	Stiff	Can be indented by thumb-nail; slight indentation produced by pushing geological pick point into soil; cannot be moulded by fingers.
Very dense	High resistance to repeated blows of a geological pick.	Very stiff	Indented by thumb-nail with difficulty; slight indentation produced by blow of a geological pick point.

Table 9: Typical rates of production for different classes of materials in trench excavations. (Watermeyer and Band, 1994)

Excavation Type	Typical Daily Production For Depth Range (M^3)		
	0 - 1.0	1.0 - 1.5	1.5 - 2.0
Soft, Class 1	3.5	3.0	2.4
Soft, Class 2	2.8	2.4	1.9
Soft, Class 3	1.7	1.5	1.2

The increase in the dry density of soil produced by compaction depends mainly on the moisture content of the soil and on the amount of compaction applied. Table 10 compares the differences between the Proctor and Modified AASHTO compaction tests. It is immediately evident from Table 10 that heavier plant requires significantly more moisture to reach maximum dry density.

Table 10: Comparison of results of the standard Proctor and Modified AASHTO Compaction Tests

Type of soil	Average results of BS Compaction Test		Average effect on modified AASHTO test	
	Maximum dry density (kg/m³)	Optimum moisture content (%)	Maximum dry density	Optimum moisture content
Heavy clay	1555	28	Increased by 20%	Decreased by 10%
Silty clay	1670	21	Increased by 17%	Decreased by 9%
Sandy clay	1840	14	Increased by 13%	Decreased by 3%
Sand	1940	11	Increased by 9%	Decreased by 2%
Gravel-sand clay	2070	9	Increased by .8%	Decreased by 1%

Accordingly, density requirements where light equipment or hand stamping is used should rather be measured in terms of Proctor densities and a value of 90% Proctor density should suffice for untrafficked areas. This is achievable by means of hand stamping.

DCPs can be readily used to control compaction in untrafficked trenches. Material with a medium dense / stiff consistency (refer to Table 7) is unlikely to settle. A value of not more than five blows / 100 mm of material can be used to specify the compaction requirements. Horak (1993) produced a specification for trench reinstatements across trafficked areas using DCPs and Rapid Compaction Control Devices (a spring loaded steel rod with a 32 degree cone shaped point complete with trigger mechanism). Horak's specification is reproduced in Table 11. It is based on CBR requirements of the various layers (refer to Appendix A).

1.4.4.4 Pipe bedding material

The material placed around a pipe (bedding) significantly influences the engineering performance of a pipe i.e. its load capacity and its deflection for a given load. The performance of flexible pipelines is particularly sensitive to the bedding material which is used. As the value of the soil modulus is related to both the soil type and the degree of compaction. Conventional specifications usually set grading and Atterburg limits for the material and require that this layer be compacted to a density of not less than 90% modified AASHTO without giving a thought as to how this density is to be measured.

A more pragmatic solution is to perform the compaction fraction test described below to determine if the material can be readily compacted. An acceptable bedding material will be one which can be readily compacted with minimal compactive effort.

Compaction fraction tests

Apparatus

A 250 mm long open-ended cylinder with a bore of diameter approximately 150 mm, a metal rammer 40 mm in diameter and weighing 1 kg, and a measuring rule.

Procedure

a) Obtain a representative sample more than sufficient to fill the cylinder.

b) Place the cylinder on a firm, flat surface and put the sample into the cylinder, loosely and without tamping, until it is over-filled.

c) Strike off the top surface of the material level with the top of the cylinder and remove the surplus material.

d) Lift the cylinder clear of its contents and place on a clean area of the work surface.

e) Place about one quarter of the material into the cylinder and tamp until no further compaction is obtained.

f) Repeat for the remaining quarters, ensuring the final surface is as level as possible. Measure down from the top of the cylinder to the top of the compacted material and express this measurement as a fraction of 250 mm to give the compaction fraction (CF).

Suitability of material

Material with a CF greater than 0.30 (i.e. the distance from the top of the cylinder to the top of trenches, the compacted material exceeds 100 mm) should not be used as selected bedding cradle material.

Table 11 : Trench reinstatement compaction specification (roads and footways) (Horak 1993)

Road (footways) layer	Material description	Thickness [road category]	Compaction standard	DCP penetration [mm/blow]	RCCD penetration [mm/3 blows]
Surfacing	BS and BS cold mix or hot mix	50 mm [all roads]	95% Marshall	Less than 2 [only as a guide]	Less than 9 [only as a guide]
Surfacing base	BC and BS cold mix or hot premix	50 mm [resident-ial] 150 mm [arterials]	05% Marshall	Less than 2 [only as a guide]	Less than 9 [only as a guide]
Base	G3, G4 crushed stone or natural gravel or C3, C4 cementitious gravel or BT emulsion treated gravel	150 mm [all roads]	98% MAASHTO	Less than 9	Less than 45
Subbase [footway base]	G4, G5, G6 natural gravel or C3, C4 cementitious gravel or BT emulsion treated gravel	150 mm [all roads]	98% MAASHTO	Less than 4	Less than 18
Subgrade [footways and roads]	G5, G6, G6, G8 natural gravel	Anything below 600 mm in lifts of 150 mm	90% MAASHTO	Less than 19	Less than 95
Selected subgrade [footway subbase]	G5, G6, G7 natural gravel or cementitious or emulsion modification	150 mm [all roads]	93% MAASHTO	Less than 14	Less than 75

* *Refer to TRH14 for material descriptions*

1.4.4.5 Construction materials

Quality may be regarded as conformance to stated requirements (specifications) rather than fitness for a given purpose. It is achieved by executing a contract to stated requirements. Small scale entrepreneurs have particular problems in achieving quality, depending upon how quality is measured and defined. Current practice is to define quality in terms of certain accepted criteria and to measure acceptance in terms of prescribed test methods and procedures. These are usually set out in national specifications such as those published by the South African Bureau of Standards, or test methods which have, to a large extent, been formulated or drafted with the approval of industry and industry-related research and development organisations.

It may be argued that these standards have been drafted to suit the well established industry and are framed around plant-based methods of manufacture and medium to large scale enterprises which have a reasonable degree of technical competency and testing resources. In addition, the test methods and procedures for quality assurance are generally written for a scale of operation where sufficient quantities for statistical purposes are manufactured, and the cost of testing by external authorities (or that associated with the establishment of in house laboratories) can be written off against the volume of the article which is manufactured. Failure by a small scale manufacturer to comply with one of the requirements of these specifications, albeit a relatively minor lack of compliance, means that compliance with a national standard cannot be claimed. Thus, in effect, many of the current specifications present a barrier to entry to small scale entrepreneurs and exclude their participation in particular markets.

The National Home Builder's Registration Council in drafting their Standards and Guidelines (1995), a document which was prepared to manage mortgage lenders' risk of defects arising in housing to acceptable limits, departed from the conventional approach to drafting standards and kept references to South African national standards and codes of practice to an absolute minimum. The Standards and Guidelines rather listed salient and relevant requirements which needed to be satisfied. Two examples of the manner in which masonry and sands for mortar are described in their updated, unpublished second edition are reproduced below.

1.4.4.6 Sand for mortar

Sand for use in mortar shall either comply with the relevant requirements of SABS 1090 or all of the following:-

- contain no organic material (material produced by animal or plant activities).
- does not contain any particles which are retained on a sieve of nominal size 5mm.
- have a clay content such that a "worm" 3mm in diameter cannot be rolled in the palm of the hand, by adding a few drops of water to material obtained from the sieving of a sample of dry sand through a nylon stocking.
- when 2.5kg of common cement is mixed to 12.5kg of air-dry sand, the mixture does not require more than 3.0 litres of water to be added to reach a consistency suitable for plastering and the laying of masonry.
- when mixed with common cement in accordance with the mix proportions, has adequate workability.

The standards and guidelines offer the following guidelines in this regard:

- Mortars are best when coarse and medium sand fractions are predominant. These sizes can be viewed through a transparent plastic ruler using a hand lens. (Place graduals on ruler over sand):-

    Very coarse 5-2.5mm

Coarse sand 2.5-1.0mm

Medium sand 1.0-0.25mm

Fine sand 0.25-0.125mm

The visual examination should reveal a high proportion of coarse and medium sand fractions but also some very coarse sand.

If the visual measurement of sand indicates that it is too coarse or too fine, a complimentary sand should be sought and blended with the original sand to improve performance.

- The clay content of a sand can be assessed by rolling the portion of the material which passes through a 0.075 mm sieve into a worm. 0.075 mm sieves are normally only found in a laboratory. For a field test, place a few handfuls of sand in the foot of a nylon stocking with its end tied. Shake the sand and collect the dust in a container.

The Standards and Guidelines offer the following advice on assessing and improving the workability of the mortar:

- Place a small quantity of the mix (at plastering / masonry laying consistency) on a non-absorbent surface and form a flattened heap about 100 mm high and 200 mm in diameter. Place a plasterer's trowel face down on top of the heap and push the trowel downwards.
- A mix with adequate workability is one which permits the mix to squeeze out from under the trowel and allows the trowel to be pushed to within a few millimetres of the underlying surface. An unworkable mix will "lock up" once the trowel has moved a few millimetres and prevents further downward movement of the trowel.
- The workability of a mix may be improved by adding hydrated bedding lime to the mix (limes used in South Africa do not have cementing properties. They cannot be used to replace cement but are used in addition to common cement). Alternatively, a masonry cement (a blend of Portland cement, ground limestone or hydrated lime and/or an air entrainment agent) may be used in place of a common cement to improve the cohesiveness and plasticity of the mix.

1.4.4.7 Masonry units

Masonry units shall:-

- have an average and minimum individual compressive system of not less than that contained in Table 12.
- have dimensions such that the units can be built into walls within prescribed joint tolerances, to the required bond pattern and corners can be constructed in accordance with certain prescribed requirements (elsewhere described).
- not exhibit excessive surface pop-outs, should units contain slag, clinker or burnt clay aggregate.

Table 12: Minimum compressive strengths of masonry units

Description	Hollow Units		Solid Units	
	Average (MPa)	Individual MPa)	Average (MPa)	Individual (MPa)
Single storey construction				
• on-site manufacture	3.0	2.4	4.0	3.2
• off-site manufacture	3.0	2.4	5.0	4.0
Double storey construction	7.0	5.6	10.0	8.0
Cladding and internal walls in concrete framed housing units	3.0	2.4	5.0	4.0

Notes

1. The average compressive strength shall be determined on a minimum of five samples based on the gross surface area.

2. On site manufacture is where units do not require to be transported more than 25m to the place where they are built into walls.

- Masonry units shall be of a quality such that, when delivered to the point of use, they are intact and have no corner chips having horizontal and vertical dimensions exceeding 15mm.
- Face shells and webs of hollow units shall not be less than 25mm thick.
- Calcium silicate units shall either have a demonstrated drying shrinkage of not more than 0.045% or not be built into walls within 10 days from the date of manufacture.
- Concrete masonry units shall either have a demonstrated drying shrinkage of not more than 0.06% or not be built into walls within 21 days from the date of manufacture.
- Burnt clay masonry units shall in general have an irreversible moisture expansion of not more than 0.20% and, in faced applications, a demonstrated satisfactory performance with respect to durability unless it can be reasonable demonstrated by other means that the units are fit for the specified purpose.

The commentary to their specification, inter alia, states that manufacturers should manufacture units having a target strength in excess of the average to ensure that the average and minimum strength requirements are met. Experience has shown that in the manufacture of concrete masonry units, the target strength is a function of the degree of quality control that is exercised. The target strengths set out in Table 13 are recommended for the manufacture of concrete masonry units to ensure that there is a 95% certainty that the average strengths will be achieved.

Table 13: Target compressive strengths for manufacturing purposes

Specified average compressive strength (MPa)	Target compressive strength (Mpa)		
	Level of manufacturing		
	Poor	Average	Good
3.0	5.0	4.5	4.0
4.0	6.6	6.0	5.3
5.0	8.3	7.5	6.6
7.0	12.0	10.5	9.5
10.0	17.5	15.0	13.5

The above mentioned masonry specification enables on site manufacture of concrete masonry units to be performed in a cost effective manner. (Higher compressive strengths favour plant-based manufacturers with relatively high capital investments as such manufacturers can produce adequate strength blocks with low cement : aggregate ratios. Simple equipment requires higher cement : aggregate ratios to achieve similar strengths.)

The NHBRC's requirements facilitates the entry of small scale / local manufacturers / producers into the market without sacrificing quality as the product which is incorporated into a housing unit is fit for its intended purpose. Should ancillary roadworks materials be described in a similar manner, local / small scale manufacturers will be able to access the market.

1.4.5 Targeted Procurement

1.4.5.1 Overview

Targeted or affirmative procurement is a form of procurement which has been developed in South Africa by a task team overseen by the Procurement Forum (an initiative of the Ministry of Finance and Ministry of Public Works) which was tasked with effecting public sector procurement reform in South Africa.

The Procurement Forum's Affirmative Procurement Policy (APP) makes provision for the setting of the socio-economic targets and has developed delivery systems designed to facilitate the participation of these targeted groups in a manner which is :-

- definable;
- quantifiable;
- measurable;
- auditable; and

- verifiable

This is achieved without compromising the principles of fairness, competition, cost efficiency and inclusion, through a combination of :

- the classification of contracts;
- the use of human resource specifications; and
- the use of development objectives/price mechanisms (i.e., points scoring tender adjudication systems in terms of which tenderers are awarded points for, in the first instance, their financial offers and, in the second instance, the extent to which their offers exceed socio-economic objectives, or for their current enterprise status).

1.4.5.2 Human resource specifications

Human resource specifications govern the manner in which prime or main contractors structure and marshall their resources in order to meet their contractual obligations. They define and set goals for targeted small, medium and micro enterprise participation, or the engagement of targeted labour / local resources, in the performance of contracts in such a manner that they can be quantified, measured, verified and audited. Human resource specifications require prime contractors to "unpack" their contracts into smaller contracts in order to procure the services of targeted small, medium and micro enterprises and to administer such contracts. Alternatively, they require prime contractors to structure their resources in the performance of their contracts in order to provide work opportunities to targeted labour or to measure the increase in the number of employment opportunities generated per unit of expenditure or to engage in joint ventures with targeted groups.

The Procurement Task Team has released through the Procurement Forum the following human resource specifications which may be used in engineering and construction works contracts:

Affirmative Procurement Policy (APP1): The Targeting of Affirmable Business Enterprises

APP2: Structured Joint Ventures (General)

APP3: Structured Joint Ventures (Targeted)

APP4: Targeting of Local Resources

APP5: Engagement of Targeted Labour

Typically, these specifications provide for:

- the setting of targets (contractual goals) to secure the participation of the targeted group; and
- the measurement of key participation indicators to be used in the evaluation of tenders and the audit of participation compliance during the execution of the contract.

Each specification:

- establishes the general principles for the participation of the targeted group

- provides information on the contractual goals and how these goals may be achieved
- specifies requirements for contractors and how they may fulfil these requirements
- defines and interprets the words and expressions.

1.4.5.3 Contract classification

General

The Procurement Forum recognised that a classification of contracts is required to enable contracts to be :

- packaged (unbundled) in a manner which facilitates targeted small, medium and micro enterprise participation; or
- structured in a manner to permit emerging / historically disadvantaged contractors to participate, develop and be integrated into the mainstream of the economy.

The Procurement Forum in the 10 Point (Interim Strategies) Plan (1995) developed such a classification by classifying contracts in the first instance on the basis of risk to the parties and the scale of the resources required to execute a contract (class) and in the second instance on who the contracting parties are (type).

Class of contract

Contracts may be classified on the basis of risk to the parties and the scale of the resources required to execute the contract as follows :

- international
- major
- micro
- minor

The 10 Point Plan defines a minor contracts in terms of size, complexity, novelty / innovation, intensity (speed of design and construction), physical location, likelihood of variations in scope, quality of completed works and responsibilities viz., a contract in which:

- the risks for both contracting parties are adjudged to be small;
- the period for completion of the contract does not normally exceed six months and certainly not 12 months;
- the contract value is usually less than R1 million, but in no circumstances exceeds R2 million;
- the works are of a straightforward nature and the possibility of significant variation from the work envisaged is adjudged to be relatively low;
- the site establishment requirements are adjudged not to be onerous;

- the contractor has no responsibility for the design of the permanent works other than for possible minor items;
- the design of the works, save for design work for which the contractor is made responsible, is complete in all essentials before tenders are invited;
- the contractor's responsibility for the appointment of nominated/selected sub-contractors is limited;
- the contractor is not required to undertake work of a specialist nature.

Major contracts have more onerous requirements than those for minor contracts. International contracts are those for which the necessary resources are adjudged to be beyond the capacity / capabilities of most large South African companies. Alternatively, they are contracts which are likely to attract foreign competition. Micro contracts, on the other hand, are contracts which have less onerous requirements than minor contracts.

Type of contract

Contracts may also be classified in terms of who the contracting parties are as follows :

- prime
- structured joint ventures
- community/development

This classification of contracts is based on the premise that construction is the synthesis of four functional activities, viz., construction management; materials management; materials supply and physical work (labour, plant and equipment).

A prime contract is accordingly a contract in which :

- the contractor has the resources to perform all these functional activities unassisted by other contracting parties, separately appointed by the employer; or
- the contractor has the resources to perform some of the functional activities and is able to marshall resources for the remainder.

A structured joint venture contract is a contract in which :

- the senior joint venture contractor is a prime contractor and the junior partner, who may lack skills in certain functional areas, is able, through the joint venture formation to participate and develop in these areas; or
- both joint venture partners may be prime contractors with one of the parties having limited resources and capacity.

A development contract is a contract in which :

- the employer appoints third parties to provide certain resources which community / emerging contractors may lack
- the contractor who performs the physical work, or aspects thereof, has a contract with the employer.

- There is no contract between the third party support and the contractor.
- The contractor supported by a third party management support may be collectively regarded as the “prime contractor”.

A community contract is a labour-only contract which is conceived and structured in a manner which secures the participation of groups or teams of residents within specific communities in projects.

(A development contract is identical to Level 1 to Level 3 contracts in terms of Soweto’s Contractor Development Programme, Watermeyer, 1992; prime minor contracts are the same as Levels 4 and 5 contracts.)

Combining contract type and class

The type and class of prime contracts may be combined as follows:

- prime (international);
- prime (major)
- prime (minor)
- prime (micro)

Typically prime (micro) contracts are aimed at providing work opportunities for small and micro enterprises; operating as prime contractors; prime (minor) contracts for small and medium enterprises; and prime (major) contracts for medium and large enterprises.

Implications of the contract classification

The system of contract classification can be used as a tool for redressing the skewed nature of the economy. Development contracts can be used to facilitate the successive introduction of labour, transport, materials, plant and finance into community-based/developing enterprises in structured programmes. Certainly, the associated contractual arrangements will permit such enterprises, through the execution of contracts, to establish themselves and to acquire the necessary skills required in respect of materials supply, materials management and construction management.

Work opportunities can be created for those exiting such programmes to ensure the sustainability of the enterprises that have been developed. This can be achieved by making prime contracts (micro) and (minor) accessible to those who have been developed through development contracts and by requiring prime contractors operating in the prime (major) class of contract to make use of the services of emerging contractors.

The contractor classification system can also be effectively utilised to create work opportunities for targeted groups and individuals without guaranteeing them work.

The classification of contracts on the basis of risk, permits the level of performance bonds to be varied without exposing the client body to unacceptable risk, viz.:

- prime (major and international) 10%

• prime (minor) - contract value < R1.0m	2.5%
• contract value between R1.0m and R2.0m	5%
• prime (micro)	nil
• structured joint venture	10%
• development	nil

It should be noted in development contracts the third party management support is frequently required to carry professional indemnity insurance.

Development objective/Price mechanisms

General

A development objective/price mechanism is a point scoring system in terms of which tenderers are awarded, in the first instance, points for their financial offers and in the second instance, for the extent to which their offers exceed socio-economic objectives, or their current enterprise status.

Development objective points are awarded to tenderers who exceed minimum goals set in terms of human resource specifications in order to encourage tenderers to make the optimum economic use of one of more of the following in the performance of the contract :

- local labour
- targeted labour
- local resources
- Affirmable Business Enterprises (ABEs: Black owned small, medium and micro enterprises)
- targeted enterprises

In this manner, the premium payable for incorporating socio-economic objectives into projects is minimised, as tenderers compete both on the basis of price and of meeting socio-economic objectives. Market forces dictate the degree to which contractors can meet socio-economic objectives in the most cost effective manner.

Development objective points can also be awarded to enterprises on the basis of their status as an ABE or the amount of Women Equity Ownership within an enterprise. The use of the development objective/price mechanism in this instance is a form of price preference. Although the target group receives a price preference, they nevertheless have to submit competitive tenders to be awarded contracts.

The successful tender is the one which is awarded the most points, subject always to technical factors, previous contractual performance/recommendations, financial references, unit rates and prices, alternative offers, qualifications etc., being acceptable. This system of tender adjudication replaces the practice of awarding the tender to the lowest priced offer, as it permits human resource / socio-economic objective offers to be considered together with the financial offer.

The use of a development objective / price mechanism :

- enables tenderers to use their skill, knowledge and creativity in arriving at a favourable mix between economic and development objectives.
- penalises those persons who fall outside the targeted groups, or who offer to meet certain socio-economic objectives to only a limited degree, but does not preclude them from tendering (i.e. engaging in economic activity) in a meaningful manner.
- prevents those who fall within a targeted group from presenting grossly non-competitive tender prices, as the reward for compliance with socio-economic objectives will be outweighed by the loss of points incurred through non-competitive tender prices.

Points awarded for the financial offer

Points awarded in respect of the financial offer are calculated as follows :

$$Np = Z \left(1 - \frac{(P - Pm)}{Pm}\right)$$

where :

Np = the number of tender adjudication points awarded on the basis of price

Pm = the price of the lowest responsive tender adjusted to a common base, if applicable.

P = the price of the responsive tender under consideration adjusted to a common base, if applicable.

Z = a number, usually 90

Points awarded for development objectives

The maximum number of development objective points awarded to a tenderer should in general not exceed 10.

Points awarded in terms of an enterprises status are fixed in respect of ABEs and vary, depending on the ownership percentages, in respect of Women Equity Ownership.

Points awarded in respect of increased human resource goals in respect of specifications APP1, APP2, APP3, APP4 and APP5 are awarded in terms of the following formula :

$$Nc = X \frac{(D - Ds)}{Y - Ds}$$

where

Nc = number of tender adjudication points awarded.
D = the tendered goal percentage in the tender under consideration.
Ds = the specified minimum goal percentage
X = maximum number of adjudication points assigned for the socio-economic aspect of the tender (usually 10 points).
Y = goal percentage above which no further tender adjudication points are awarded.

Tenderers, in terms of the above formula, obtain the maximum number of points (Nc) should they tender a goal of Y% and have no advantage over their competitors, should they tender a value in excess of Y%.

Standard delivery options

The standard delivery options for various targeted groups which have been provided for are as set out in Table 14. The framework can be used to create work opportunities for targeted groups and individuals.

Table 14 : Standard delivery options: Engineering and construction works contracts

Contract		Targeting Options	
Type	**Class**	**Target**	**Human resource specifications**
Prime	Major	• SMMEs owned and controlled by previously disadvantaged individuals • local resources (i.e. local enterprises, manufacturers and labour). • increase in number of person hours employment generated per unit of expenditure • local labour	APP1 : Targeting of Affirmable Business Enterprises. APP4 : Targeting of Local Resources. APP5 : Engagement of Targeted Labour.
Prime	Minor	• small and medium enterprises particularly those having women equity ownership or which are owned and controlled by previously disadvantaged individuals.	-
Prime	Micro	• small and micro enterprises particularly those having women equity ownership or which are owned and controlled by previously disadvantaged individuals.	-
Structured Joint Venture	-	• emerging enterprises owned and controlled by previously disadvantaged individuals • specific emerging enterprises.	APP2 : Joint Ventures (General) APP3 : Joint Ventures (Targeted)
Development	-	• emerging enterprises or aspirant entrepreneurs who do not have the capabilities or resources to contract as prime contractors.	-
Community	-	• groups or teams of residents within specific communities who, with support and training, can undertake labour only contracts and so participate in projects.	

Contract classification is a form of targeting and can as such be used to secure in an indirect manner work for contractors who are operating within certain sectors within the construction industry. For example, development contracts are aimed at emerging contractors who carry no significant overhead costs and do not have in their employ persons with the necessary management skills to perform all the materials procurement and construction management functions required in prime contracts. Established contractors who possess these resources, carry higher associated overhead costs and contracting capacities and as such are not attracted to this type of contract. Furthermore they normally cannot match the tendered prices of the targeted group.

Unbundling strategies (breakout procurement)

Small, medium and micro enterprises can participate in public sector procurement in one of two ways. They can either contract directly with an organ of state or participate as a subcontractor, supplier or service provider to a prime contractor in the delivery chain.

The breaking down of tenders into smaller components is not always justifiable owing to the division of responsibilities, interdependence of activities, programming, duplication of establishment charges and under utilisation of resources. Furthermore, the administration of such contracts by organs of state and their agents is more complex and costly than is that of fewer larger ones.

The targeted procurement strategies enable contracts to be unbundled in a number of ways, viz.:

- by procuring works in the smallest practicable quantities (prime (minor and micro)).
- by obligating prime contractors to engage targeted businesses in the performance of their contracts (prime (international and major) with APP1 and APP4 specifications).
- by requiring joint venture formation between established businesses and targeted emerging business enterprises (structured joint venture with APP2 and APP3 specifications).
- by providing third party management support to enterprises which are not capable of operating as prime contractors (development contracts).

The options which make use of human resource specifications require prime contractors to "unpack" their contracts into smaller contracts and to procure the services of small, medium and micro enterprises to perform such contracts and to administer them.

The unbundling strategies, with the exception of the prime (minor and micro) option, afford the full spectrum of small, medium and micro contractors i.e. those operating as labour-only contractors to those operating as prime contractors, opportunities of participation. It is therefore not a prerequisite for a contractor to have the necessary tools and equipment to participate in contracts as the prime (major) contractors, established senior joint venture partners as the third party management support may provide or make available such tools and equipment in order to secure their participation.

1.4.5.4 Encouraging contractors to make more use of targeted labour in excavation activities

In order to meet goals for the engagement of targeted labour or to tender increased goals, contractors may have to undertake some or all soft excavations by the use of hand labour. In order to minimise their risk exposure to performing such activities, there needs to be :

- a labour policy in place which sets out the conditions of employment for temporary workers (i.e. project specific workers)

- a mechanism in terms of which contractors can define the portion of the excavation works which will be excavated by hand methods.

If this is not done, contractors will not be able to increase job opportunities in earthworks activities as they would be exposed to unacceptable risks. The above mentioned employment policy and mechanism should accordingly be clearly set out in the tender documents and form an integral part of the contract.

A suitable mechanism to enable contractors to define portions of excavation work which may be excavated by means of hand methods, is to permit contractors during the tender stage to nominate the quantity of materials which they wish to execute using hand methods. The approach outlined below is suggested.

The initial classification of material to be excavated should be in accordance with the relevant provisions of standard earthworks specifications such as SABS 1200 D and 1200 DA. However, soft excavation to be undertaken by hand labour, using hand tools, can be further broken down by the introduction of an additional class of material, viz., soft excavation Class A, in accordance with the provisions of the project specification as tabulated in Table 15.

Table 15 : Criteria for classifying materials as soft class A excavation

Material type	Granular materials	Cohesive materials
Dynamic cone penetrometer - minimum number of blows required to penetrate 100 mm	7 - 15	6 - 8
Consistency	Dense - high resistance to penetration by the point of a geological pick; several blows required for removal of material.	

**Soft excavation Class A is material which, using a pick or equivalent hand swing tool, can only be excavated with difficulty.*

The total estimated quantity of excavation, as classified in terms of a standard earthworks specification, should be indicated in the Schedules. The tenderer should be permitted to sub divide this quantity into two components, viz., the quantity of material to be excavated by the use of powered, mechanical equipment and the quantity to be excavated by hand labour using hand tools.

One third (a) of every quantity of excavation to be undertaken by hand labour should be entered against the appropriate extra-over items provided in the Schedules, but left blank, for soft excavation Class A. This will ensure that material which can be picked with difficulty is catered for and the transition from hand excavation to machine excavation is graded.

Should the tenderer fail to indicate a quantity of excavation to be undertaken by hand labour, notwithstanding that he would find it necessary to utilise hand labour, it will be assumed that all excavation, whether undertaken by machine, or by hand labour, is to be paid for at the rates tendered for machine excavation.

The contractor should be required to undertake at least the quantities of excavation by hand labour which he tendered, unless the total quantity of excavation proves to be less than scheduled, in which case the minimum quantity to be undertaken by hand labour will be reduced pro-rata by the employer's representative. This procedure will also provide a basis for reducing targeted labour goals should such adjustments be necessary.

Should the total quantity of excavation prove to be greater than that scheduled, the contractor may choose the method of excavation for the excess quantity, unless the rates for excavation by machine would result in lower costs than hand excavation, in which case the employer's representative will have the right to instruct the contractor to undertake the excavation by machine.

1.4.5.5 Implementing targeted procurement in South Africa

The National Department of Public Works first made use of a human resource specification during the early part of 1996 on the Malmesbury Prison and Housing Project, on develop and build contracts having a contract value of US$ 41m. The Affirmable Business Enterprise (ABE) participation which was achieved, as measured in terms of the APP1 specification, amounted to 38,8% (Gounden 1997).

Since August 1996, the department has applied an Affirmative Procurement Policy (APP) to all its construction projects. Gounden (1997) writes; *"for the period August 1996 to July 1997, 2,206 building and civil contracts totalling US$ 190 million were let utilising the Affirmative Procurement Policy specifications. 38.4% (US$ 73m) of the total financial value of these contracts went to ABEs either as prime contractors on the smaller projects or as joint venture partners, subcontractors and service providers on the larger projects".*

When the programme commenced in August 1996, some commentators predicted that a financial premium of the order of 10 - 15% per project would be incurred by the implementations of the APP specifications. Table 16 indicates the actual premiums paid for the period under review (August 1996 - July 1997). As can be seen from Table 16, the overall financial premium that has been paid to date is 1.23%. Measured against the benefits that will accrue to the country by broadening the construction base, this premium can be justified.

Gounden (1997) has also gathered data on the increase of ABE participation in the National Public Works Department's construction projects over a period of three years (see Table 17). He attributes the significant increase in ABE participation largely to the implementation of the Affirmative Procurement Policy which commenced in August 1996.

Table 16: Analysis of ABE participation in 2206 construction contracts (Gounden 1997)

Range of contract (US$)	No of ABE contracts awarded	ABE contract total (US$)	Sum of lowest bids (US$)	Difference between ABE awards and lowest bids (US $)	% premium
0 - 9800	561	870, 000	859, 000	11,000	1.28
9800 - 22000	92	1,353,000	1,337,000	16,000	1.20
22000 - 110,000	75	2,845 000	2,696,000	149,000	5.53
110,000 - 430,000	13	2,335 000	2,176 000	159,000	7.31
+ 430,000	18	48,592,000	48,249,000	343,000	0.71
Total	759	55,995,999	55,317,000	678,000	1.23

Table 17: Participation of ABEs in National Department Public Works Construction projects 1994-1997 (Gounden 1997)

Financial Year	Total Number of Contracts with ABE participation (%)	Total Financial Value of Contracts with ABE participation %
1994/1995	7.6	16.5
1995/1996	33.1	22.0
1996/1997*	48.3	37.3

**: This significant increase in ABE participation in Public Works construction projects during this period could largely be attributed to the implementation of the Affirmative Procurement Policy which commenced in August 1996.*

Watermeyer (1997) reports that the Southern Metropolitan Local Council (SMLC) of the Greater Johannesburg Metropolitan Council has recently implemented a number of projects using the APP5 specification and development objective price mechanisms. Targeted labour has been defined as South African citizens residing within the geographical area over which the SMLC has jurisdiction and who earn less than R9-00 per hour. The targeted labour goals (Rand value of wages and allowances for which the contractor contracts to engage targeted labour in the performance of the contract, expressed as a percentage of the net tender value) of the successful tenderer and the cost premium associated with the first nine tenders which were called for in this manner are reproduced in Table 18. As tenderers become more familiar with the system and become more experienced in managing targeted labour, the targeted labour goals which are achieved are expected to increase.

Watermeyer and Band (1994), based on information obtained from the Bloekombos project (a pilot project which was undertaken under the National Co-ordinating Committee for Labour Intensive Construction in the Western Cape, prior to the April 1994 election in South Africa, in terms of the Framework

Agreement for Public Works Projects using Labour Intensive Construction Systems (Stofberg 1995)), found that approximately 12% of the construction cost was spent on labour drawn from the targeted group. They found from various sources that the accepted cost premium for projects of this nature was between 10 and 15%. This being the case, targeted procurement, based on the preliminary results tabulated in Table 18, appears to be able to deliver the same levels of participation to the target group at a fraction of the cost premium. (It is also interesting to note that the wage levels on the Bloekombos project were just over half of the prevailing statutory minimum wages whereas those in the SMLC were in accordance with the minimum statutory wages.)

Table 18 : Recent tender results of 9 municipal capital works projects where use was made of the APP5 specification

Contract Description	Tender Value (US$)	Targeted Labour Goal (%)[1]	Cost Premium(%)[2]
Construction of water mains	$0,77 m	5 (5)	NIL
As and when roads and stormwater	$1,10 m	20 (15)	NIL
Construction of sewers	$0,36m	15 (5)	NIL
Construction of sewers	$0,26m	25 (5)	8
Construction of sewers	$0,36m	10 (5)	NIL
Construction of sewers	$0,58m	10 (5)	NIL
Construction of sewers	$0,34m	10 (5)	NIL
Improvement to stormwater drainage	$0,26m	20 (7)	1
Culvert repair	$0,30m	4 (4)	NIL
Total	$4,33 m	13 (8)	(0,5)

Notes

1. *The minimum targeted labour goal which was set is given in brackets.*
2. *The cost premium is based on lowest tendered price.*
3. *90 points (max) were awarded for price; 10 points (max) were awarded for targeted labour goals.*

Tender value excludes VAT and contingencies.

1.4.6 Conclusions

Increased and targeted employment opportunities can be generated in engineering and construction works projects by :

- encouraging the substitution of labour for capital and local resources for imports.
- substituting the use of "labour-friendly" technologies which utilise a higher degree of labour input than is the case for conventional technologies, or are well suited to implementation by small scale enterprises.
- encouraging and developing small scale enterprises to implement employment intensive practices and "labour-intensive" technologies.

Targeted procurement which makes use of human resource specifications and development objective price mechanisms can be used to encourage cost effective employment intensive practices when outsourcing works to the private sector.

Targeted procurement can also facilitate significant levels of participation of targeted small enterprises ranging from labour-only contractors to prime contractors. Various contracting strategies associated with targeted procurement can be used effectively to overcome the problems commonly associated with equipping small contractors with specialised or costly items of plant and equipment. It also ensures that any enterprises which are developed in development programmes have access to markets provided that they remain competitive.

Appropriate standards are required to optimise the engagement of smaller contractors and the increase in employment opportunities per unit of expenditure. The measures of quality i.e. conformance to stated requirements, should not involve complex or expensive laboratory procedures. Tests need to be developed to enable quality to be assessed at the point of production upon completion of an activity.

Success in engaging the private sector in labour-based infrastructure works is to a large extent dependent on there being in place appropriate standards and innovative contracting systems.

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Appendix A: The Dynamic (Drop Weight) Cone Penetrometer

The dynamic (drop weight) cone penetrometer is an instrument which may be used to measure the *in situ* shear strength of a soil. It comprises a drop weight of approximately 10kg which falls through a height of 460mm and drives a cone having a maximum diameter of 20mm (cone angle of 60^0 with respect to the horizontal) into the material being tested.

It is an instrument which has been used for many years in South Africa to evaluate the *in situ* structural condition of a road pavement.

The penetration rate of the DCP, which is proportional to the *in situ* shear strength of the material has been correlated to the CBR of the material (or UCS for cemented materials) by Kleyn et al (1989), is measured in terms of millimetres per blow of the DCP hammer and is called the DCP number (DN). (The value of DN decreases as the strength of the material increases) viz.

$CBR = 410 \times (DN)^{-1.27}$ for DN>2.

$UCS = 2900 \times (DN)^{-1.09}$ for DN>2.

The DCP has been used in South Africa since the early 1970s in road construction for identifying potentially collapsible soil, construction control, evaluation of the effectiveness of compaction, monitoring stabilised layers and augmenting centreline sampling.