MINISTRY OF URBAN DEVELOPMENT AND CONSTRUCTION

URBAN LOCAL GOVERNMENT DEVELOPMENT PROJECT
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MANUAL FOR COMMUNITY PARTICIPATION IN PROCUREMENT AND CONSTRUCTION OF COBBLESTONE ROADS UNDER ULGDP

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1 INTRODUCTION

The Urban Local Government Development Project (ULGDP) is one of the flagship projects undertaken by the Ministry of Urban Development and Construction and being implemented in 19 cities across Ethiopia. The objective of ULGDP is to support improved performance in the planning, delivery and sustained provision of priority municipal services and infrastructure by urban local governments.

One of the priority services selected by ULGs for improvement is improved road access through the construction of cobblestone roads. All participating ULGs have included cobblestone road construction as part of the prioritized Capital Investment Plans (CIPs).

Cobblestone road construction is comprehensively labour intensive and requires skilled labour. In this regard, a huge skilled labour pool is being developed in the country. There has been extensive training program launched across cities targeting women, unemployed youth, and the disadvantaged groups in local communities. The training program is specifically focusing on skills required for construction of cobblestone roads. Hence, the Project utilises these skilled labour force for the construction of cobblestone projects by applying Community Participation in Procurement (CPP) method.

The Banks’ Procurement Guideline, Procurement of Goods, Works and Non-consulting Services under IBRD Loans and IDA Credits and Grants by World Bank Borrowers January 2011, section 3.19 specifically addresses a special procurement method called “Community Participation in Procurement (CPP)”. The provision requires that the specific procedures to be followed under the CPP method must be described in detail in an appropriate implementation manual and must be approved by the Bank. It stipulates that procedures, specifications and contract packaging shall be “suitably adapted” to reflect the conditions and capacity of the community, provided they are “efficient and acceptable to the Bank.” This provision allows flexibility in defining acceptable procedures at the community level. It recognizes the need for more innovative and flexible approaches in planning and implementing Bank financed contracts where key social objectives of a project include the participation of local communities in the delivery of services, the use of labour based technologies to create employment locally, and the increased utilization of local materials.

Accordingly, this manual is prepared to provide procurement and implementation guideline for cobblestone roads construction works that are to be executed using community participation under ULGDP. It also provides technical requirements for cobblestone road construction activities. As per the requirement under section 3.19 of the Bank’s Procurement Guidelines January 2011, this manual elaborates and outlines procedures and project components to be implemented using community participation in procurement.

The manual is organised to answer the following three questions:

(i) What is the framework for applying the CPP method?
(ii) What are the procurement procedures under CPP (when involving Communities)?
(iii) What are the technical requirements for Cobblestone Roads construction?
Section two provides the overall framework and conditions for applying the CPP method. It also specifically answers the following questions: (a) Why are cobblestone projects amenable to the use of the CPP method? (b) What is the definition of ‘community’ within the context of cobblestone roads construction? (c) How do communities participate in cobblestone road construction projects?, and (d) Where is the point to shift from using the Operation Manual to using this Manual?

Section three addresses procurement procedure requirements when applying the CPP method. It specifically answers the following questions: (a) What is the procedure when a community is a supplier and/or a works provider? (b) What is the procedure when a community is a procuring entity? (c) What are the allowable procurement methods? (d) What other procurement requirements need to be fulfilled?

Section four provides technical background and details about cobblestone roads construction activities. Finally Section five lists documents that are annexed with the manual.

Expected users of this manual are mainly:

(i) Community groups who are defined as those doing procurement in this manual. However, these groups are not expected to fully understand and implement the technical contents of this manual. Nonetheless, they are required to understand and carry out procedures set out in Section three of the manual. ULGs have the responsibility of giving technical assistance to these groups during implementation of projects

(ii) ULGs, which are the implementers of ULGDP

(iii) The Ministry of Urban Development and Construction (MUDC’s) staff who are responsible for monitoring and supervising the ULGDP

2 FRAMEWORK FOR APPLYING THE CPP METHOD

This section will provide the overall framework and conditions for applying the CPP method. It starts by clarifying the reason why cobblestone projects are amenable to community participation in procurement. It will then provide definition of ‘community’ within the context of CPP. It continues by explaining the different ways that communities can participate in CPP. It will finally clarify the decision process to determine when the basis for a procurement process becomes this CPP manual, instead of the ULGDP Operation Manual.

The policy framework for CPP includes:

- Enhancing community ownership and project sustainability Encourage development of local/grassroots contractors to strengthen local construction industry
- Improvement of quality of local services
- Increasing the economy and speed of procurement, by reducing transport costs and by providing the services or materials at point of use;
- Increasing the capacity and skills of the community;
- Generating employment and economic opportunities within the community;
- Reducing the burden of centralized procurement and
facilitating the achievement of desired project objectives

2.1 Application CPP to cobblestone projects

One of the priority services selected by ULGs under the ULGDP is improved road access through the construction of cobblestone roads. All participating ULGs have included cobblestone road construction as part of the prioritized Capital Investment Plans (CIPs).

The prioritization of access roads is due to the following considerations of its benefits:

- Increased liveability of neighbourhoods and increased quality of life for the poor
- Increased mobility for the poor whose main mode of travel is walking. Cobblestone roads wipe out dust and mud which impede the movement of pedestrians.
- Improved commercial local activity.
- Generating local economic and employment creation
- Increased land value of adjacent areas thereby increasing revenues for the city.
- Empowerment of cities to develop their own infrastructure and construction sector.
- Enhancement of institutional capacity.
- Increasing local capacity and skills;
- increased use of local know-how and materials,
- Use of other labor-based technologies and
- Increasing local capacity and skills and thereby strengthening local construction industry

While any type of road construction may provide the above benefits, cities have chosen to do cobblestone road construction rather than build roads made of asphalt. The key objectives in doing cobblestone roads are for the following benefits that are specific to cobblestone roads.

- Generation of employment for the local population targeting the disadvantaged group. Employment includes the disabled, and focuses largely on unemployed women and youth.
- Activation of the local economy as all resources are locally available and produced. All the projects expenditures circulate within the city. It does not depend on imported oil as asphalt does.
- Creation of small enterprise that will grow and diversify in the future, helping increase capacity at grass root level.
- Creation of a work culture, particularly among the unemployed.
- Ease of maintenance and lifespan (cobblestone roads have a longer lifespan than asphalt roads).

Consequently, cobblestone road projects require (a) participation of communities in the delivery of works and materials, (b) utilization of local know how and materials, and (c) employment of labour intensive work technology, which are all critical elements for
a project to be suitable for the use of CPP. The cobblestone road projects are desired to satisfy a particular social objective of employment generation, while at the same time satisfying the objective of delivering improved road access. Therefore, cobblestone roads projects are chosen to be implemented through Community Participation in Procurement method because the objective and characteristics of the projects align well with stipulations of Section 3.19 of the Banks procurement guidelines.

2.2 Definition of community

It is important to understand what a “community group” or “community” means in the context of CPP. A "community" includes individuals or groups, particularly from economically disadvantaged sections, who are responsible for either (i) procuring goods, works, or services in Bank-financed projects, or (ii) supplying goods and carrying out works\(^1\) under Bank-financed projects. It refers to a broad range of people or groups including:

- Individual or groups of beneficiaries;
- Community groups with no legal status;
- Associations or groups with legal status, with or without separate legal personality as a group;
- Small-scale artisans and other local or small commercial organizations and guilds; and
- Small and local level organizations, particularly NGOs which support and facilitate the flow of Bank funds to individuals.

In the case of cobblestone road construction under UGDP, the beneficiaries are considered to be both the people who are living in the areas where the roads are being constructed as well as those doing the civil works or supplying goods (such as stones). Therefore, the following two groups are defined as community in this manual:

(i) Groups who have the labour skill to construct cobblestone roads and who are organized into micro and small enterprises (MSE/ SMALL LOCAL CONTRACTORS)

(ii) Individuals that contributed money for the cost of construction of cobblestone roads in their locality represented by Local Development Committees or Groups

2.3 Ways of community participation in Procurement

Communities may be involved in procurement in Bank-financed projects in three situations, together referred to as "community related procurement"\(^2\):

- Communities (small-scale artisans, entrepreneurs and small non-governmental organizations, together referred to as 'community groups') may be brought into the process of competitive bidding or requested for Quotations. For example, under national or local competitive bidding, community groups could bid for goods (e.g. furniture, roofing sheets, wooden sleepers, etc), or could bid for

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\(^1\) Gopal, Gita and A. Marc, World Bank-Financed Projects with Community Participation: Procurement and Disbursement Issues, 1994

\(^2\) Gopal, Gita and A. Marc, World Bank-Financed Projects with Community Participation: Procurement and Disbursement Issues, 1994
works that can be performed by them (unskilled labour, construction of small infrastructure).

- Where competitive bidding may not be feasible, e.g. when contract sums are small or works are remote or scattered, communities (formal and informal community groups or individuals) may be involved in the procurement of goods, works or services.

- A number of projects are increasingly setting up non-governmental or semi-governmental organizations as financial intermediaries or separate social funds in an attempt to channel funds to grass roots communities. These financial intermediaries and social funds by design ensure some degree of accountability and transparency, and may therefore be permitted to use innovative procurement practices.

For the case of cobblestone road construction projects under ULGDP, communities are expected to participate in two ways:

(a) To carry out cobblestone roads construction works and to supply materials for these projects. The community groups that carryout the works and supply the materials are those individuals organised within MSEs/ SMALL LOCAL CONTRACTORS at the ULGs.

(b) To procure - works and services for the construction of cobblestone road projects. The community groups that do procurement are those individuals that formed committees or groups at the locality to contribute towards the cost of projects in the area in which they are residing.

Hence community groups in ULGDP will participate in procurement mainly as groups that are doing civil works, but also, in some cases, as groups that are procuring -, works or services from other groups

2.4 Application of this manual

An Operation Manual (OM) exists for ULGDP that is prepared to facilitate the implementation and management of the project, and to provide guidelines and operating procedures. The OM assists all involved parties in ULGDP to handle the day to day operations related to utilization of the performance grants. The OM incorporates a section on Procurement Management under the project. And it provides procurement procedures for the project based on the Bank’s guidelines.

If the OM provides all procedures for procurement, why is then this manual required? The reason is that whilst the OM puts CPP as an allowable procurement method for construction of cobblestone road projects, it specifies a requirement and makes a reference to a separate manual that should stipulate the operational and procurement procedures for CPP of cobblestone projects. The procurement methods and procedures indicated in the initial cobblestone manual do not encourage competition and hence lacks transparency and efficiency. Moreover the initial manual is weak in properly addressing issues related to community participation in procurement. Hence this manual is a revision of the existing manual and is prepared to supplement the OM as required under the Bank’s guidelines.
So when is this Manual for CPP applicable? This Manual will be applicable to cobblestone projects that are determined to be implemented through community participation. The cobblestone road construction contracts eligible for CPP are those valued at less than USD 200,000.

This manual for CPP is applicable only for cobblestone projects that are approved to be implemented through CPP method in the ULGDP Procurement Plan. Figure 1 below presents a flow chart that shows when a cobblestone road project may use the CPP method and therefore the use of this Manual is triggered.

*Figure 1: Use of Operation Manual Vs this Manual for CPP*
3 PROCUREMENT PROCEDURES UNDER CPP

This Section presents the procurement procedures under the CPP method. As defined under Section 2.3 of this manual, communities participate in two ways under ULGDP. Hence this section will start by addressing procedures when a community group is participating as a works provider. It will then provide the requirement when a community group is participating as the procuring entity. It continues by providing allowable procurement methods. It will conclude by addressing other procurement requirements during implementation of cobblestone road projects.

The Overarching principle is that the basic requirements of good public procurement should not be compromised while innovative and very flexible approaches are to be used in CPP to achieve the PDOs better.

3.1 Procedure when a community is involved as works provider and goods supplier and the procurement is carried out by the ULG

As has been defined in section 2.2 and 2.3, community groups that will participate in providing works for cobblestone roads projects are MSEs/LOCAL CONTRACTORS.

The procedure for involving MSEs/SMALL LOCAL CONTRACTORS for projects is as follows:

(i) Persons (unemployed youths, men and women) are organized in MSEs/SMALL LOCAL CONTRACTORS which are locally registered. Training is provided to the MSEs/SMALL LOCAL CONTRACTORS by the ULG. ULGs are on the process of registering and training MSEs/SMALL LOCAL CONTRACTORS. The training covers a number of aspects particularly focusing on technologies of cobblestone road construction.

(ii) ULGs already have standard designs and procedure for determining BOQs for cobblestone roads. In each city, these should be appropriately modified to suit particular site conditions and same shall be well documented.

(iii) ULG or its consultants prepare the designs, specifications (BOQ) and cost estimates for identified cobblestone road construction

(iv) The following criteria will be employed by the ULG to consider an MSEs/LOCAL CONTRACTORS for carrying out the works:

- Unemployed youth, women and disabled completed training in Cobblestone Road Construction with certificate of competence
- Registration as an MSEs/ SMALL LOCAL CONTRACTORS and permit for construction of cobblestone road as per the regulation and guideline of urban local government
- Capacity to hire and manage the required equipment and personnel, capacity for general and financial administration, etc)
- Those who are going to sign a contract must be self-employed MSEs with availability of trained and skilled manpower
- Past performance in similar work (if applicable). Zero years of experience for new entrants, otherwise.
(v) The MSEs may if necessary sub-contract the works to other MSEs/small local contractors (who are properly licensed under the regulations of the Ministry of Urban Development and Construction or other appropriate nongovernmental organizations with prior notification to ULGs its intention to do so in writing.

(vi) The ULG then chooses an appropriate procurement method depending on the circumstances to carry out the work. The methods are described in more detail in Section 3.3 below.

- High value contracts (above USD 200,000) can only be procured using NCB methods as specified in the Operation Manual. For Cobblestone road construction, however, all NCB should comply with the Bank’s guidelines briefly shown below and the standards bidding documents provided by the Bank:
  
a) The Bank’s Standard Prequalification Document Shall be Used
b) Margins of Preference Shall not be Used
c) Bidders Shall be Given a Minimum of 30 Days to Submit Bids from the Date of Availability of Bidding Documents
d) Use of Merit Points for Evaluation of Bids Shall not be Allowed
e) Process Shall not Preclude Participation by Local Contractors/ Foreign Bidders
f) Results of Evaluation & Award of Contract Shall be Made Public.
g) Advertising on National News paper that has wider coverage
h) Fraud and Corruption of article of the PPA (article 35) to be replaced by the Bank’s article
i) An article regarding “Obstruction practices” to be included in the General Conditions of Contract

- Contracts below US$200,000 may be procured using Local Competitive Bidding (LCB) method

- Contracts below US$100,000 may be procured using shopping

- Contracts below US$50,000 may be procured using direct contracting (as deemed necessary in case of new entrants and new ULGs)

(vii) The ULG enters into a contract agreement with the selected MSE/LOCAL CONTRACTOR to carry out the works or to supply goods. Through this contract, the MSE/LOCAL CONTRACTOR will be responsible for all or for selected activities listed below and the costs will be built into the unit prices of the works as agreed in the contract:

- surveying of the proposed road using surveying instruments or conventional methods.
- site excavation, sub grade preparation to the lines and grades shown in the drawings, and compaction.
• procuring uncut stones from the quarry.
• providing all other materials (e.g. sand, water) and equipment (e.g. excavator, compactor, hand tools etc) required.
• mobilizing the required manpower
• transporting of all materials.
• chiselling and shaping of the cobblestones
• levelling, paving and compacting (laying of the cobble stones);
• cleaning and reinstating the work sites;

(viii) The ULG pays the MSEs/ SMALL LOCAL CONTRACTOR for all work on submission of payment certificates for completed work done as per the BOQ.

(ix) The ULG may, through ULGDP, obtain consultants for the design and supervision of cobblestone road construction or can be responsible for supervision and quality control of all stages of the cobblestone road construction.

(x) A ULG may use several MSEs/SMALL LOCAL CONTRACTORS on one cobblestone road. The MSEs/ SMALL LOCAL CONTRACTORS which does the chiselling could be different from the one that does the laying of the stones (paving) etc. Under these circumstances, the ULG will sign a separate contract with each MSEs/ SMALL LOCAL CONTRACTORS, specifying in the contract the scope of work for that particular MSEs/ SMALL LOCAL CONTRACTORS. The ULG signs these agreements after assessing and ensuring that delay from an MSEs/ SMALL LOCAL CONTRACTORS on prior activities would not affect the activity of the next MSEs/ SMALL LOCAL CONTRACTORS in interdependent activities. Moreover, these separate contracts should be approved and shown in the procurement plan.

(xi) Further work to be awarded to an MSEs/ SMALL LOCAL CONTRACTORS will be subject to satisfactory performance on previous work(s).

3.2 Procedure when a community is involved as procuring entity

As has been defined in section 2.2 and 2.3, community groups that will participate in doing procurement of works and goods for cobblestone road projects are local committees. The procedure for involving local committees for projects is as follows:

(i) Local communities or residents of a particular locality may wish to contribute money for the purpose of constructing their surrounding local access road with cobblestone. Such contributed money may not be sufficient to cover the entire construction cost.

(ii) ULGs may choose to allocate a matching budget to allow communities that contributed money to implement the cobblestone roads construction.

(iii) The amount of the matching budget could vary across ULGs. Each ULG that chose to involve communities as a partner should issue a clear directive. The directive should include:

• The minimum level of contribution expected from communities to be eligible for a matching fund
• The prioritization criteria the ULGs would employ in case of long list of request from communities
• Fund administration
• The communication line of the ULG with the community. This should elaborate communication channel the community submits request for the matching fund and gets subsequent information.

(iv) The ULG shall disseminate the directive ensuring wide and uniform coverage across the ULG.

(v) Local communities that wish to contribute money shall form a representative committee. Or, if there is an existing committee, the same committee shall assume responsibility for cobblestone works. This decision needs to be context-specific, ideally decided by the community itself, (if appropriate) with the help of a facilitator from the ULG, and (if possible) through a process involving a general community assembly.

(vi) The cobblestone road project management committee, to be elected by the community, should include 5 people (chairperson, finance secretary, procurement secretary, secretary and treasurer). The ToR/duties and responsibilities of the committee is agreed and recorded and kept.

(vii) The community representative committee shall start procurement activities after their project gets approval from the ULG for financing.

(viii) The allowable procurement methods that the community representatives follow are described in Section 3.3 below.

(ix) The community representatives shall engage MSEs/SMALL LOCAL CONTRACTORS (another community groups) for the work. The procedure for engaging MSEs/SMALL LOCAL CONTRACTORS shall fulfil the same procedure described under Section 3.1 above.

(x) The community committee will follow the procurement procedure described under Section 3.3 below and will do the evaluation and selection of MSEs/SMALL LOCAL CONTRACTORS or small contractor. After the selection has been carried out, the community committee will sign a contract with MSEs/SMALL LOCAL CONTRACTORS. A copy of the contract will be submitted to the ULG.

(xi) Under ULGDP, all disbursement of funds should be done by the ULG. The ULG cannot transfer funds to the community committee. Therefore, the community committee will oversee the construction and will sign on the payment certificates, which will be submitted to the ULG for payment.

(xii) At all times, ULGs have the responsibility to provide the necessary training and standardized documentation to the signatories of the community, so that they can carry out the procurement function in a manner acceptable to the Government and the World Bank Group, as described herein. The ULGs are also responsible to provide all technical inputs required for successful implementation of cobblestone projects.
3.3 Allowable procurement methods under CPP

The procurement procedures/methods described in this manual are simplified or Local Competitive bidding procedures, shopping and direct contracting. These methods are to be applied for the following two cases:

(i) When procurement is done by ULGs to hire community groups (MSEs/SMALL LOCAL CONTRACTORS) for cobblestone construction works or supply of goods

(ii) When procurement is done by community representative committees to hire MSEs/SMALL LOCAL CONTRACTORS for cobblestone construction works

As a matter of principle, procurement of small contracts falling below the project’s NCB threshold would follow the methods described below. It is important to make sure that contracting with communities group, especially registered ones, are governed by procurement legal and regulatory framework of the Government and required to follow sound public procurement principles, and fits with the procedures and thresholds in the Project Operational Manual (POM). Community participation in procurement (CPP) may use the following three methods of procurement that are derived from the Procurement Guidelines and are consistent with the provision para.3.19 of the Bank’s Guidelines. These procedures are detailed in the Project Operational Manual. The Figure 2 in the next page shows situations when the following procurement methods are applicable.

(i) **Local Competitive Bidding (LCB):** This is simplified NCB procedure that follows NCB procedures where the advert and competition is limited to the local area only. Local Competitive Bidding can be adopted in Cobblestone construction but the procedures have to meet always the need for economy and equal opportunity to all participants and be consistent with the underlying principles of Bank procurement policies. *The simplified NCB (LCB) procedure is applicable to cobblestone road construction projects with contract value below (≤) US$200,000.* In addition to fostering competition and increasing private contractors’ participation, this type of works contract may be designed to address the problem of unemployment as well as to ensure adequate competition among eligible MSEs/SMALL LOCAL CONTRACTORS without requiring them to prepare complex bids/proposals, including detailed breakdown of prices. Under LCB, the following procedure may be followed:

- The announcement of the procurement opportunity is locally advertised so as to attract both registered MSEs, and may be interested to bid for the proposed contract for a given cobblestone road construction project. This could be in the form of placing a specific notice at the municipality level and adopting local practices for disseminating official announcements (e.g., Municipal and kebele notice boards, church notice boards, street corners, local radio announcements, local newspapers etc.)

- The bid document can be a simplified SBD for NCB and can be rewritten in simple language, describing the scope and nature of the works. Where MSEs/SMALL LOCAL CONTRACTORS might be foreseen to have problems with preparing and offering prices, the bid document could propose reference prices with some straightforward explanations about its calculation (unit prices and quantities). Bidders can be invited to bid by way of discounts either on the...
total price or on the unit prices. **It is not necessary to request bid security. Use bid security Declaration in stead of Bid Security for LCB**

- At least 15 days should be allowed for bidders to prepare and submit bids;
- A date, time and place for the public bid opening coinciding with that for the deadline for bid submission should be indicated, and bids should be opened in public in the presence of the bidders who choose to attend. The names of the bidders and prices are read out aloud at the bid opening ceremony and this is recorded in a minute.
- The analysis of the bids should be carried out confidentially by an evaluation committee set up by the ULG and the project management committee. The evaluation committee could be the same committee that opens the bids. The evaluation could be done immediately after opening the bid. The composition of this team will depend on the capacity of the ULG, but should always have a Procurement Officer or procurement proficient staff as a member. The bids will be examined to determine whether they meet the minimum requirements mentioned in the bidding documents in respect of experience, quality of works performance (track record), equipment, services offered and the delivery dates-criteria shown under 3.1(iv). Only those offers that meet these minimum requirements specified in the bid invitation will be retained for further evaluation. The committee will prepare a simple evaluation sheet of the type presented in this manual. **The evaluation shall also include a simple post qualification exercise (a) assessment of the MSEs/ SMALL LOCAL Contractor’s capabilities and capacity, and (b) assessment of the MSEs/ SMALL LOCAL Contractor’s existing work load and contracts to ensure that the MSEs/ SMALL LOCAL CONTRACTOR is not overloaded.**
- The analysis is carried out in two steps: first the committee will analyze whether the Conditions set in the tender documents are met by the bidders (certificate of competence, permit from ULGs and self-employed). The bidders who have not met the conditions will be eliminated
- The bidder who meets the minimum requirements and offers the lowest price should be selected. The evaluation committee will recommend a winner, and the head of the ULG may approve the award.
- The award and amount of the contract should be announced to all bidders and to the public through the same media that announcement was issued, and the contract should be signed within two weeks of the announcement, if there is no any complaint received. In case the MSEs/ SMALL LOCAL CONTRACTORS inordinately delays the signing of the contract, it can be awarded to the next lowest bidder. In such case, the MSEs/ SMALL LOCAL CONTRACTORS could be blacklisted and blocked from other bids unless the reason is found to be satisfactory by the ULG.

(ii) **Shopping**: When a contract is valued at less or equal to ( \( \leq \) ) US$100,000 or equivalent. It is a method based on comparing price quotations obtained from several MSEs, usually at least three qualified and certified to ensure competitive prices among MSEs/SMALL LOCAL CONTRACTORS The procedure for the
Shopping method is that, the contract has to be awarded to MSEs/LOCAL CONTRACTOR offering the lowest evaluated price on the basis of criteria mentioned in the Request for Quotations sent to as many as necessary registered MSEs/SMALL LOCAL CONTRACTORS to ensure that at least three offers are received and compared. If all offers are substantially higher than the reference prices in the ULG’s unit price database, the ULG may consider possible negotiation with the MSEs/ SMALL LOCAL CONTRACTORS that met the qualification requirements and offered the lowest price quotation. If negotiations fail to lower the price the ULGs may need to reassess the scope of the work and also revise its reference unit prices or use other options to get the works done. Sample format for Request for Quotations and procedure is included in Annex-4.

3.4 Procurement record keeping

Maintaining procurement documentation is as important as following the agreed procurement procedures in all public procurement activities. Procurement documents are public financial decision documents and procuring entities are accountable for proper keeping of procurement documentations and make it available for any audit or review. Be it ULGs or community groups that has executed the procurement, the following documents are major ones to be kept, depending on the procurement category and method agreed in advance:

- Approved procurement Plans;
- Invitation for Bids/Request for expression of Interests/Request for quotations/;
- Bidding Documents/Request for Proposals;
- Any addendum to BDs/RFPs;
- Public bid/proposals opening records;
- Bid security records
- Bid/Proposal/quotation evaluation reports;
- Bid/proposal validity extensions, if any
- Contract document/purchase Orders;
- Bank’s “No objection”, if applicable;
- Advance payment and guarantee, if applicable;
- Validity of Performance Security, if applicable;
- Records of any bidders Complaint and resolutions thereto;
- Records of Contractual completion dates (extensions, amendments, variation orders , if applicable)
- Contract registers;
- Acceptance or Inspection receipt/reports;
- Copy of contractual payments;
Figure 2: Applicable procurement methods in CPP

- ULGDP eligible project in CIP
  - Is the project 'cobblestone roads construction'? **Yes**
    - Check if project is eligible for CPP method
    - Is the project value > USD 200,000? **Yes**
      - Project could be eligible for CPP method
      - Does the ULG wish to employ contractors for the work? **Yes**
        - ULG could allocate works to MSEs by direct contracting under special circumstances
      - No
    - No
  - No

- Project is eligible for CPP method / Use this Manual
  - Is there a financial contribution from the community for the project? **Yes**
    - Procurement to be carried out by community representatives / committee
    - Use LCB Method
    - Is value of project less than USD 100,000? **No**
      - Use Shopping Method. Also LCB method is applicable.
    - No
  - No
  - Use LCB Method
    - Is value of project less than USD 100,000? **Yes**
      - Use LCB Method
    - No
  - Use LCB or Shopping Method
    - Are there special circumstances where shopping and LCB can not be aplicable? **Yes**
      - May use Direct Contracting
    - No
  - Use LCB or Shopping Method
    - Are there special circumstances where shopping and LCB can not be aplicable? **No**
      - May allocate workd to MSEs through Direct Contracting if not prohibited
    - Yes
      - Allocation through direct contracting is prohibited
3.5 Review by the Bank

Contracts under the CPP method will not be subject to prior review. The Bank will not engage in prior approval for the evaluation of bids and award of contracts. Instead, a sample number of projects will be post reviewed during or after implementation. The bank may recruit and engage consultants to carry out post review of procurement processes and decisions. The ULGs shall avail procurement documents listed under section 7 for the reviewer. The Bank relies on its rights under the general provisions of the loan agreement not to disburse on contracts that violate principles set forth in its guidelines.

MUDC /UDCBB may establish its own internal review and monitoring procedure. The information and findings of such review processes may be shared with the Bank.

3.6 Fraud and corruption

It is required that all parties in the ULGDP, including ULGs and community groups (both representative committees and MSEs/SMALL LOCAL CONTRACTORS), observe the highest standard of ethics during the procurement and execution of cobblestone contracts. In pursuance of this policy, the Bank:

(a) defines, for the purposes of this provision, the terms set forth below as follows:

(i) “corrupt practice” is the offering, giving, receiving or soliciting, directly or indirectly, of anything of value to influence improperly the actions of another party;

(ii) “fraudulent practice” is any act or omission, including a misrepresentation, that knowingly or recklessly misleads, or attempts to mislead, a party to obtain a financial or other benefit or to avoid an obligation;

(iii) “collusive practice” is an arrangement between two or more parties designed to achieve an improper purpose, including to influence improperly the actions of another party;

(iv) “coercive practice” is impairing or harming, or threatening to impair or harm, directly or indirectly, any party or the property of the party to influence improperly the actions of a party;

(v) “obstructive practice” is

(aa) deliberately destroying, falsifying, altering or concealing of evidence material to the investigation or making false statements to investigators in order to materially impede a Bank investigation into allegations of a corrupt, fraudulent, coercive or collusive practice; and/or threatening, harassing or intimidating any party to prevent it from disclosing its knowledge of matters relevant to the investigation or from pursuing the investigation, or

(bb) acts intended to materially impede the exercise of the Bank’s inspection and audit rights provided for under par. 1.14 (e) below.
(b) will reject a proposal for award if it determines that the bidder recommended for award has, directly or through an agent, engaged in corrupt, fraudulent, collusive, coercive or obstructive practices in competing for the contract in question;

(c) will cancel the portion of the loan allocated to a contract if it determines at any time that representatives of the Borrower or of a beneficiary of the loan engaged in corrupt, fraudulent, collusive, or coercive practices during the procurement or the execution of that contract, without the Borrower having taken timely and appropriate action satisfactory to the Bank to address such practices when they occur;

(d) will sanction an MSE/LOCAL CONTRACTOR or committee or individual, including declaring ineligible, either indefinitely or for a stated period of time, to be awarded a Bank-financed contract if it at any time determines that the party has, directly or through an agent, engaged in corrupt, fraudulent, collusive, coercive or obstructive practices in competing for, or in executing, a Bank-financed contract.

4 TECHNICAL REQUIREMENTS FOR COBBLESTONE ROAD CONSTRUCTION

This section will provide brief background information regarding the technical aspects of cobblestone road construction activity. It is built on lessons and information gathered during the past few years since the introduction of cobblestone projects.

4.1 Stages of cobblestone road construction

The construction of cobblestone road involves a number of steps. Planning, budgeting, designing, and procurement works need to be undertaken prior to commencement of the actual construction. After these activities are completed, the actual construction activity of cobblestone road will involve the following stages:

• Stage 1: Production of cobble stones: this stage involves production of raw material at quarry, delivery of raw material to chisellers, and chiselling of stones to the required sizes.
• Stage 2: Surveying of the proposed road: this stage involves determining location, levels and grades of road as per the design.
• Stage 3: Sub grade, sub-base and/or base preparation: this stage involves cut and fill works to bring the road to the required level and grade, and then constructing sub-base and/or base layer as necessary based on design recommendations.
• Stage 4: Bedding and cobble stone laying: this stage involves constructing bedding layer that comprises either crushed stone or sand, and then putting cobblestones and the bedding layer.
• Stage 5: Finishing work: this stage involves filling the spaces between cobblestones with crushed stone or sand, completing minor finishing works, compacting and clearing the area.
4.2 Training program and the creation of MSEs/SMALL LOCAL CONTRACTORS

Cobblestone construction is a new practice in the country. It is highly labour intensive and requires special skills. To fill the demand, the government started a training program specific to skills required for the construction of cobblestone roads. Those who completed the training are allowed to form associations/groups and create a Micro and Small Scale Enterprise (MSE/LOCAL CONTRACTOR) by registering at local administration offices.

All 19 ULGDP project cities have included some cobblestone road construction in their CIP, to a greater or lesser extent. The table below shows list of cities which have included cobblestone projects in their initial Capital Investment Plan (CIP) for 2008, and also shows cities that have run training programs, either under the University Capacity Building Program (UCBP) or the Engineering Capacity Building Program (ECBP) (note: Dire Dawa has its own program, separate to the above).

<table>
<thead>
<tr>
<th>CITY</th>
<th>CIP proposal</th>
<th>UCBP</th>
<th>ECBP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dire Dawa</td>
<td>30km</td>
<td>√ (own program)</td>
<td>–</td>
</tr>
<tr>
<td>Harar</td>
<td>20.1km</td>
<td>√</td>
<td>–</td>
</tr>
<tr>
<td>Tigray:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mekelle</td>
<td>25.4km</td>
<td>√</td>
<td>–</td>
</tr>
<tr>
<td>Adigrat</td>
<td>17.1km</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Axum</td>
<td>15.8km</td>
<td></td>
<td>√</td>
</tr>
<tr>
<td>Shire</td>
<td>9.3km</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Oromia:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adama</td>
<td>50km</td>
<td>√</td>
<td>√</td>
</tr>
<tr>
<td>Bishoftu</td>
<td>16,000 m2 / 2.2km/</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Shashemene</td>
<td>4km</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Jimma</td>
<td>5km</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>SNNPRS:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Awassa</td>
<td>360,000 m2 / 51.4km/</td>
<td>√</td>
<td>–</td>
</tr>
<tr>
<td>Arba Minch</td>
<td>18km</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Dilla</td>
<td>30km</td>
<td>–</td>
<td>√</td>
</tr>
<tr>
<td>Sodo</td>
<td>15km</td>
<td>–</td>
<td>√</td>
</tr>
<tr>
<td>Amhara:</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bahir Dar</td>
<td>30km</td>
<td>√</td>
<td>–</td>
</tr>
<tr>
<td>Dessie</td>
<td>30km</td>
<td></td>
<td>–</td>
</tr>
<tr>
<td>Gondar²</td>
<td>6km</td>
<td>–</td>
<td>–</td>
</tr>
<tr>
<td>Kombolcha</td>
<td>7km</td>
<td>–</td>
<td>–</td>
</tr>
</tbody>
</table>

Table 1.1: Cities having cobblestone projects in their 2008 CIP, and having a training program during 2008.

The table shows that, as at mid-April 2008, the UCBP was working in five cities and the Engineering Capacity Building Program (ECBP) was working in a further four cities. In addition, Dire Dawa has its own program. This means that only 9 of the 18 ULGDP project cities have training under these programs, whilst Dire Dawa has its own program. The remaining 9 cities are not covered by training programs at this stage.

It takes at least three months for a training program to reach a point where there is a reasonable level of production. If any of the cities not covered by a training program
have cobblestone construction expertise, gained through other means, then they should indicate this to MWUD. If not, then the cities should have a program that shows their plan for establishment of a training program, and how this will be integrated with the planned output of cobblestone road construction under their CIP. Cities that do not have a training program, and do not have one planned at this stage, are unlikely to be able to provide any cobblestone roads during the course of implementation of ULGDP (2003 E.C onwards). If this is the case then they should program the construction of cobblestone roads accordingly and ensure that they incorporate a cobblestone road training program into their needs assessment for ULGDP. Therefore, capacity building for MSEs should focus on the following points/Capacity building interventions:

1. Skill Development and Upgrading
   a. Technical Skills (Quarying, Chiseling and paving as well as earth work)
   b. Construction Management Skills
   c. Entrepreneurship Skills and business development
   d. Integrating TVET and Cooperative Training

2. MSE Development (Contractors/Consultants)-Graduation Mechanisms

3. Finance/Contracts/Standards
   a. Standards Documents
   b. Financial Resources
   c. Contracting Documents
   d. Bid preparation and participation in tenders

4. Management
   a. Awareness Creation (What CPP is and Why CPP?)
   b. Resources Management/Technical Support
   c. Coordination Linking various inputs to get the desired final output (to attain the service delivery objective efficiently and effectively)
   d. Procurement and disbursement in CPP

4.3 Matching production capacity to the road construction plan

For cities that have had, or are undergoing, a training program in cobblestone road construction, they will need to ensure that there is sufficient capacity in the market to meet the planned output of roads in their CIP. This means that there are sufficient numbers of pavers, chisellers and supervisors to carry out the work at the programmed rate of output and that there is sufficient stone available. This section deals with the balancing of production against plan. The issues of labour and materials availability are covered in the sections that follow.

Figures provided by the UCBP indicate that one paver (i.e. the person laying the cobblestone) can lay an average of 6m²/day. Higher figures are possible. Productivity figures from Mekelle and Adama have reached 12m²/day on some projects. For planning purposes however, it is proposed that the more conservative figure of 6m²/day be used, at least in the first year.
The most time consuming task is that of cutting the stone to shape; a task carried out by chisellers. The output of cobblestones will vary, as it is strongly dependent upon the hardness of the rock. This means that output can vary from as low as 12-15 cobblestones per day (to pave one meter square approximately 90 chiselled stones are required), where the rock is very hard, to between 25-30 cobblestones per day for less hard rock conditions. Working initially on a conservative figure, approximately 40 chisellers may be required to support one paver.

The quality and durability of the constructed Cobblestone roads depends on a number of parameters. As adopting comprehensive engineering design works supervision is less feasible. It is recommended that Basic material and works quality assurance mechanism be in place. The attainments of these basic requirements in all works shall be supervised. This implies that there have to be supervisors overseeing the cutting of the rock as well as supervision of the laying of the cobblestones. For the selection, quarrying, chiselling and shaping tasks one supervisor may oversee approximately 100 chisellers, whilst each project site will require one foreman/supervisor. There will also need to be a qualified civil engineering technician allocated to the construction, to carry out line and level setting, bed preparation and supervising overall quality. The engineer has to prepare simple technical guide (standard procedure) that includes the procedure of the works, material quality visual evaluation and workmanship quality assurance procedures.

Table 1.2 below shows typical output rates that can be used for planning of cobblestone construction. The figures are based upon an assumption of 6m²/paver/day, with 40 chisellers per paver. The production is given for three widths of road: 6m, 7m and 10m. It should be emphasized that the figures in the table are average figures that are recommended for initial calculations. Once a program has been in operation in a city for a period of 4-6 months, new rates of output can be determined based upon the specific experience of that city.

<table>
<thead>
<tr>
<th>Width of road</th>
<th>No. of Pavers</th>
<th>No. of chisellers</th>
<th>Output/day (m²)</th>
<th>No. of working days required/km</th>
</tr>
</thead>
<tbody>
<tr>
<td>6</td>
<td>20</td>
<td>800</td>
<td>120</td>
<td>50 days</td>
</tr>
<tr>
<td>6</td>
<td>40</td>
<td>1,600</td>
<td>240</td>
<td>25 days</td>
</tr>
<tr>
<td>6</td>
<td>60</td>
<td>2,400</td>
<td>360</td>
<td>16.6 days</td>
</tr>
<tr>
<td>7</td>
<td>20</td>
<td>800</td>
<td>120</td>
<td>58.3 days</td>
</tr>
<tr>
<td>7</td>
<td>40</td>
<td>1,600</td>
<td>240</td>
<td>29.2 days</td>
</tr>
<tr>
<td>7</td>
<td>60</td>
<td>2,400</td>
<td>360</td>
<td>19.5 days</td>
</tr>
<tr>
<td>10</td>
<td>20</td>
<td>800</td>
<td>120</td>
<td>83.3 days</td>
</tr>
<tr>
<td>10</td>
<td>40</td>
<td>1,600</td>
<td>240</td>
<td>41.7 days</td>
</tr>
<tr>
<td>10</td>
<td>60</td>
<td>2,400</td>
<td>360</td>
<td>27.8 days</td>
</tr>
</tbody>
</table>

Table 1.2: Road Construction Rates for Cobblestone Roads with different levels of labour

The table indicates that production rates (i.e. square metre constructed) are quite low. Larger cities, such as Adama and Mekelle, are likely to be able to run large numbers of pavers (e.g. 60 pavers). However smaller cities would probably be operating with numbers in the range of 20-40 pavers in total. Hence planned output in any one year needs to be linked to the number of pavers and their output (productivity). At this stage, experience indicates that maintaining work for 60 pavers, which includes managing very large teams of chisellers and bringing in large volumes of stone, is a major logistical exercise. Whilst it is being well-managed in Adama, and it is theoretically
possible to increase these numbers, cities should work within the range given above for the total number of pavers used on municipal projects until they have gained at least one year experience and have been able to address the issues raised in sections 3 and 4 below.

4.4 Matching planned production to availability of labour

Cobblestone road construction is an activity that is highly labour intensive, and can generate jobs in significant numbers. The CIPs submitted by cities indicate that many of them have high rates of unemployment. Hence the construction of cobblestone roads should, in theory, be a major contributor to job creation in a city. However, this should not be an automatic assumption from which a city makes a decision to move immediately to a high level of training for pavers and chisellers. In economic terms there is something called the elasticity of supply, which indicates the potential to access a labour pool. In a city with a population of, say, 90,000 people, 3,000 chisellers represent 3.3% of the total market. Yet this could be as high as 10% of the economically active working population. In this market there are also constraints. Not everyone wants to work in hard manual labour, which limits the pool of labour. And chiselling stones needs to be compared to other job opportunities, even where these are less well paid, or casual. This means that a city planning to introduce cobblestone road construction should carry out a study of labour markets as part of their planning process. And more importantly, the feasibility of the cobblestone roads construction has to be assessed as compared to other investment priorities for the respective cities administrations.

4.5 Ensuring an adequate supply of stone

Stone is heavy, weighing between 2.2 and 2.6 tonnes/m³. It also has to be transported. Hence cities wishing to initiate a cobblestone road project should determine the following, and build this information into their planning and costing calculations:

- Is there a quarry within a reasonable distance? This will vary but a reasonable maximum distance should be 20-30km. Distances further than this will require a more detailed economic analysis and a cost-benefit analysis.
- Is the stone suited to use as cobblestone? The stone should not be friable, flaky or prone to cleavage.
- Has an Environmental Impact Assessment been carried out on the quarry, to determine that the quarrying of stone satisfied environmental criteria?
- Is there sufficient stone to meet future needs across a reasonable time frame (10 years minimum)?
- Can the stone be accessed at a reasonable price that makes the construction of cobblestone roads competitive?

Depending on the nature of the source quarry, the production of cobblestones by hand may be, relatively, inefficient technique. It takes 100 m³ of rock to produce 20 m³ of cobblestones. One cobblestone has surface dimensions (i.e. the dimensions seen on plan after laying) of 10cm * 10cm. Assuming 10-12cm depth (the underside cone gives a greater depth overall, but this is different from the volumetric depth) then 1 m² of cobblestone has a volume of approximately 0.1m³, producing 0.3m³ of waste (in the original stone). In practice, when stone if broken it bulks (i.e. it occupies a greater volume). This means that the process of producing cobblestones will produce almost as
much waste (by volume) as the original stone delivered. Cities should therefore decide whether it is more efficient to cut the stone at the quarry (which would mean the large scale transporting of chisellers) or bringing the stone to the site. If the latter option is chosen then the city should develop a plan to remove the waste stone in a productive or at least environmentally acceptable way. This entails planning for the efficient removal of approximately 2,000m$^3$ of waste rock per km of 6m wide road.

4.6 Construction activities associated with cobblestone roads that may require procurement

ULGs are the implementing agencies for cobblestone road construction. There are however different steps to the construction activity and some activities can be done by ULGs the MSEs.SMALL LOCAL CONTRACTORS while other activities can be procured. The following provides a list of activities which may be subject to procurement:

- Purchase of stone from quarry
- Delivery/transport of quarried stone to a chiselling area in the city
- Cutting of the stone into various sizes (Chiselling)
- Preparation of sub-grade, sub-base and base layer (when necessary)
- Setting out, levelling and grading of road, compaction.
- Purchase and delivery of crushed fine aggregate for bedding and for filling between stones
- Transporting of cobblestones to the construction site
- Laying of the cobblestones to line and level, filling of joints and vibrating/compacting;
- Construction of minor drainage structures (including: ditches, crossing pipes, culverts, retaining walls, etc)
- Supervision of the paving process.

Where the ULG has the capacity, they can do some of this work themselves. Or ULGs can choose to hire existing contractors/suppliers/MSES.SMALL LOCAL CONTRACTORS, or newly created MSES.SMALL LOCAL CONTRACTORS to do the work. Where the ULG chooses to hire existing MSES.SMALL LOCAL CONTRACTORS/newly created MSES.SMALL LOCAL CONTRACTORS to do the work, the next chapter 4.7 describes the procurement procedures to be followed. Under special circumstances, communities might be contributing significant amounts of funds for the construction of cobblestone roads, in such cases ULGs can also enlist community committees to procure the required services/works. The procedures for such cases are described in the coming chapter 5.

4.7 Unit Price Database

ULGs shall collect and maintain a unit costs data base for all items commonly required for cobblestone road project implementation. The project engineers should collect, on a quarterly basis, costs and rates from all of the most commonly required items. For this purpose, the ULG will make a data base of material, labour and equipment from places such unit prices can be collected. These base prices will be used to calculate compound prices for commonly required items of work. Consequently the ULGs should develop a schedule of standard prices for the completion of different types of work activities. The data base will be used as a planning, appraisal and monitoring tool and as a reference
guide when procurement is carried out. The database prices will particularly be useful
for each procurement type as follows:

(i) LCB: To check and control bid prices so that collusive prices are identified
(ii) Shopping: To check and control proposed prices are reasonable, and to
negotiate prices with potential winners
(iii) Allocation through direct contracting: To be used for fixing prices in projects
that are to be allocated to MSEs/SMALL LOCAL CONTRACTORS.

The MUDC/UDCBB should establish a central database of unit prices of cobblestone
construction subprojects by gathering data from the 19 ULGs semi-annually. Such
schedule of unit prices must be updated on a regular basis and must be supplemented by
rigorous accountability mechanisms. The MUDC/UDCBB should make analysis of
price variation across cities to understand the underlying factors for variations. Should
there exist inconsistent and unreasonable price building up practice, MUDC/UDCBB
need to provide advice to cities to correct inaccuracies and foster competition to insure
economy and transparency of the public fund utilization. Though costs vary depending
on different factors (such as: availability of materials, labour, transportation distances
and others), the cost difference should not be that much exaggerated. As just one good
practice, all Cities whose unit prices are above 125% of that of the average of all the
participating Cities need to justify the reason for such high unit prices and consider
more competitive procurement methods to get best values for public money.

5 CONTRACT DOCUMENTS, FORMS AND ANNEXES

Procurement procedures under community related procurement need to adopt
simplified bidding documents. The documents usually consist of agreement
form/form of contract, general condition, Special Conditions of Contract,
Technical requirements (including Schedule of requirements, designs,
specification, Bill of Quantities), and additional forms and documents, as found
necessary

The contents of contract documents and a typical order of priority are shown below:

- The form of Agreement
- Letter of Acceptance
- Contractor’s bid
- Special (particular) conditions of contract
- General Conditions of Contract (PPA, 2006)
- Special specifications
- Specifications
- The Drawings
- The Priced Bill of Quantities
- Any Other Document forming part of the contract.

Applicable documents for community related procurement are prepared. These
documents could be revised and improved from time to time based on lessons learnt
during implementation. Documents applicable for community related procurement and
works for cobblestone projects are included in the following Appendices:
- Appendix 1: Sample Tender Forms
  o Invitation to tender
  o Conditions of tender
  o Schedule of information about the contractor
  o Form of tender
  o Tender evaluation report
- Appendix 2: Form of agreement
- Appendix 3: General condition of contract
  o Annexure
    • Appointment of the project manager
    • Contract data
    • Schedule of prices
    • Works information
    • Site information
    • Payment certificate
    • Certificate of completion
    • Defects correction certificate
    • Final certificate
    • Termination certificate
    • Take off sheet
- Appendix 4: Sample Format for Shopping: Invitation to Quote
- Appendix 5: Standard designs, technical specifications and bill of quantities for cobblestone roads
- Appendix 6: Standard Bill of Quantities for construction of cobblestone roads
- Appendix 7: Labour based construction methods for roads
APPENDIX-1: Sample Tender Forms

1. INVITATION TO TENDER

AUTHORITY LETTERHEAD

TENDER NUMBER
TITLE OF CONTRACT

DATE:

Dear Sirs

You are invited to tender for the work described above.

A Site Inspection will be held on (date) at (time) and all prospective bidders should meet our representative at (description of meeting place).

The attached Tender Conditions apply.

I look forward to receiving your tender.

Yours faithfully,

MANAGER
2. **CONDITIONS OF TENDER**

**TIME**  
The tender closing time is . . . . . . . . . . . . (time) on . . . . . . . . . . . . . (date)

**LATE TENDERS WILL NOT BE CONSIDERED**

Your tender should be valid for a period of . . . . . . days commencing from the Tender Closing Date above.

Your tender must be in duplicate and must consist of the following:

- Form of Tender, filled in and signed
- Schedule of Prices, with rates and amounts filled in and totalled
- Schedule of Information about the Contractor.

The completed tender documents should be sealed in an envelope, marked CONFIDENTIAL – TENDER NUMBER . . . . . . and deposited in the TENDER BOX at . . . . . . . . . . . . . . . . . . before the Tender Closing Time

We reserve the right to correct arithmetic errors on the basis that the tendered rates remain fixed.

Should your tender be accepted, the resulting CONTRACT will be based upon the following:

- the Form of Tender
- the Contract
- Schedule of Prices
- Works Information
- Site Information
- Specifications
- Drawings
### SCHEDULE OF INFORMATION ABOUT THE MSE/LOCAL CONTRACTOR

**TENDER NUMBER** ..........................
**TITLE OF CONTRACT** .............................

Certified copy of authority to act as agent for the Contractor

Details of training received:

<table>
<thead>
<tr>
<th>Start date</th>
<th>End date</th>
<th>Course Title</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Other information required

Signed .................................
Name in block letters ..........................
Position .................................
Authorised to sign on behalf of
Company .................................
4. **FORM OF TENDER** for CONTRACT NUMBER . . . . .

DATE . . . . .

TO: .................................................................................. (the Client)
ADDRESS: ................................................................

With reference to your Invitation to Tender, we offer to provide the Works described as
...........................................................................................................
for the total price of Birr ...................................................................................................................... which
includes VAT at 15%, in accordance with the Contract and the Specifications.

We have attached the tender information required by you.

Yours faithfully

Signed ..........................................................
Name in block letters ..........................................................
Position ..........................................................
Authorised to sign on behalf of
Company ..........................................................
Address ..........................................................

**ACCEPTANCE** for CONTRACT NUMBER . . . . .

DATE . . . . .

The Client, .................................................................................. accepts the Contractor's offer to provide the Works according to the Contract and as
described and specified in the Works Information.

AUTHORISING MANAGER

Signature ....................................................... Name ........................................ Title ........................................ Date

SUPERVISING MANAGER

Signature ....................................................... Name ........................................ Title ........................................ Date

PROJECT MANAGER (CONTRACT)

Signature ....................................................... Name ........................................ Date
5. **TENDER EVALUATION REPORT:** CONTRACT NUMBER ...............  

**CONTRACT DESCRIPTION:**  

---

**DATES:**  
- Tenders invited  
- Tenders received  
- Tender validity expires on  

**ESTIMATE OF CONTRACT VALUE:** Birr ...............  

**SUMMARY OF LOWEST FIVE TENDERS RECEIVED**

<table>
<thead>
<tr>
<th>Tenderer</th>
<th>Tender price including VAT</th>
<th>Acceptability rating</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>Corrected</td>
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<td></td>
</tr>
</tbody>
</table>

**RECOMMEND ACCEPTANCE OF TENDERER:**  
---

**CONTRACT VALUE AT ACCEPTANCE:** ...............  
**CONTINGENCY ALLOWANCE:** ...............  
**TOTAL APPROVED CONTRACT AMOUNT:** ...............  

**STARTING DATE:** ...............  
**CONTRACT PERIOD:** ...............  
**CONTINGENCY ALLOWANCE:** ...............  
**ESTIMATED COMPLETION DATE:** ...............  

**SIGNED BY THE PROJECT MANAGER (CONTRACT)**

---

Signature Name Date
TENDER EVALUATION REPORT: CONTRACT NUMBER ..............

TENDER ANALYSIS AND RECOMMENDATION
APPENDIX-2: Sample Form of Agreement between Urban Local Government and MSE/Local Contractor to construct cobblestone road
FEDERAL DEMOCRATIC GOVERNMENT OF ETHIOPIA

MINISTRY OF
URBAN DEVELOPMENT AND CONSTRUCTION

FORM OF AGREEMENT BETWEEN

MICRO-SMALL-ENTERPRISES/LOCAL CONTRACTOR

AND

THE CLIENT

This *CONTRACT* is intended for use where:

- the risks involved in the Works are low
- the Works are simple and straightforward, and make very limited use of equipment
- payment is made to the Contractor for completion of work done at fortnightly or monthly intervals
- changes of scope are confined to an increase or decrease of quantities of work already specified
- tools and materials are supplied by the Client or the Contractor

This contract should only be used together with the standard contract forms provided in the Annexure.
URBAN LOCAL GOVERNMENT DEVELOPMENT PROJECT

CONTRACT AGREEMENT

BETWEEN

…………………………………………………………………………………………
URBAN LOCAL GOVERNMENT (ULG)

AND

…………………………………………………………………………………………
MICRO AND SMALL ENTERPRISE (MSE)/LOCAL CONTRACTOR

FOR

CONSTRUCTION OF COBBLESTONE ROAD

1. Purpose of Contract Agreement

(a) Pursuant to the Financing Agreement between the Federal Democratic Republic of Ethiopia and the International Development Association (IDA) dated ………………. for the Urban Local Government Development Project (ULGDP); this Agreement is a written understanding reached between ………………………………………………………. (ULG), Physical Address:……………………………………………………. Tel No ……………………..

and ………………………………………………………..(MSE/LOCAL CONTRACTOR) Physical Address:……………………………………………………. Tel No.

……………………

for the construction of the cobblestone road …………………………………………………………………..(Name of road).

2. Scope of the Agreement:

(a) The overall objective of the ULGDP is to support improved performance in the planning, delivery and sustained provision of priority municipal services and infrastructure by urban local governments.

(b) As part of project implementation of the ULGDP Component 1 (performance Grants), the ………………………………………………………. (ULG) is using a number of Micro and Small Enterprise to construct cobblestone roads in the city. In this regard, the ……………………………………………………….. (ULG) has appointed……………………………………………………..(MSE/LOCAL CONTRACTOR) to construct the following road using cobblestones:
3. **Responsibilities of the Urban Local Government**

- The ULG shall handover the site to the MSE/LOCAL CONTRACTOR within a period of ……… after signing of this MOU
- The ULG shall provide the tools and materials specified in the Works Information. All other Tools and Materials needed for the Works are supplied by the MSE/LOCAL CONTRACTOR.
- Other responsibilities are as provided in the General Conditions for Provision of the Works.

4. **Responsibilities of …………………………(Micro and Small Enterprise/LOCAL CONTRACTOR)**

- Providing the Works: The MSE/LOCAL CONTRACTOR shall provide the Works in accordance with this MOU, including all incidental work and services, as specified and described in the Works Information.
- Tools and Materials: The Works Information specifies the Tools and Materials that will be provided by the ULG. All other Tools and Materials needed for the Works are supplied by the MSE/LOCAL CONTRACTOR.
- Safety: The MSE/LOCAL CONTRACTOR shall take all reasonable precautions to ensure the Safety and Health of its workforce.
- Other responsibilities are as provided in the General Conditions for Provision of the Works.

5. **Works Information**

1. **Description of the Works**

   ..........................................................................................................................
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2. **Specifications and drawings for the Works**

   The Specifications of the Works are listed below and a full copy is included in the Appendix, bound separately.
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(Name of road).
Drawings of the Works are listed below and a full set is included in the Appendix, bound separately.

3 Things supplied by the ULG

Works supplied by the ULG (describe any works that are supplied by the ULG upon which or around which the MSE/LOCAL CONTRACTOR is to construct his portion of the Works)

Materials supplied by the ULG (describe the materials that the ULG will supply to the MSE/LOCAL CONTRACTOR)

Tools and Equipment supplied by the ULG for the use of the MSE/LOCAL CONTRACTOR for constructing the Works (describe equipment and state if operators and/or fuel are supplied).
4 ULG's key date schedule
   The Starting Date is ____________________________
   The Completion Date is ____________________________

The following statutory and other non-working days are included within the MOU period:
   ........................................................................
   ........................................................................
   ........................................................................
   .................................................................

5 Limitations on the MSE/LOCAL CONTRACTOR's performance
   Additional safety regulations:  ........................................................................
   ........................................................................
   ........................................................................
   ........................................................................
   ........................................................................

   Other limitations: (list sources of materials that the MSE/LOCAL CONTRACTOR must use; limitations on suppliers, etc)
   ........................................................................
   ........................................................................
   ........................................................................
   ........................................................................
   ........................................................................

6. Site Information

   Site information is factual information about the physical conditions on the site and its surroundings, for the use of the MSE/LOCAL CONTRACTOR to prepare and decide on his method of working and program.

   The Site Information is listed below and a full copy is included in the Appendix, bound separately.
   ........................................................................
   ........................................................................
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   ........................................................................
   ........................................................................
   ........................................................................
   ........................................................................
   ........................................................................
APPENDIX-3: General conditions of contract
GENERAL CONDITION OF CONTRACT

CONTENTS

GENERAL CONDITIONS
1. General
2. Providing the Works
3. Time
4. Defects
5. Payment
6. Compensation
7. Insurance
8. Disputes and termination

ANNEXURES
1. Appointment of project manager
2. Contract data
3. Schedule of prices
   o Bill of quantities
4. Works information
   o Description of the Works
   o Specifications and drawings for the Works
   o Things supplied by the Client
   o Client's key date schedule
   o Limitations on the Contractor's performance
5. Site information
   o List of information, drawings of existing infrastructure and reports, other relevant information.
6. Payment Certificate
7. Certificate of completion
8. Defects correction certificate
9. Final Certificate
10. Termination Certificate
11. Take –off Sheet
GENERAL CONDITIONS

1  General

1.1 The Contract consists of
- the Form of Tender
- these General Conditions
- the Schedule of Prices
- the Works Information
- the Site Information

1.2 The Parties to the Contract are the Client and the MSE/LOCAL CONTRACTOR, whose names, addresses and contact details are given in the Contract Data.

1.3 The Project Manager is the person appointed by the Client to administer the contract on his behalf. The Project Manager's name and contact details are given in the Contract Data.

1.4 The Client, MSE/LOCAL CONTRACTOR and Project Manager shall carry out the duties and procedures stated in the contract.

1.5 Communications are delivered to the recipient in writing that can conveniently be read, copied and filled.

2  Providing the Works

2.1 The MSE’S/LOCAL CONTRACTOR’S responsibilities
The MSE/LOCAL CONTRACTOR shall provide the Works in accordance with the Contract, including all incidental work and services, as specified and described in the Works Information.

2.2 Tools and Materials
The Works Information specifies the Tools and Materials that will be provided by the Client. All other Tools and Materials needed for the Works are supplied by the MSE/LOCAL CONTRACTOR.

2.3 Safety
The MSE/LOCAL CONTRACTOR shall take all reasonable precautions to ensure the Safety and Health of his workforce.

3  Time

3.1 Starting and Completion
3.1.1 The Starting Date is stated in the Works Information.
3.1.2 The Completion Date is stated in the Works Information and is subject to adjustment in accordance with the Contract.
3.1.3 Completion is the date decided by the Project Manager when all work needed to complete the Works in terms of the Contract, has been done.
3.1.4 The MSE/LOCAL CONTRACTOR is to achieve Completion on or before the contractual Completion Date.

3.2 Delay Warnings
The MSE/LOCAL CONTRACTOR will be warned in letter and/or blacklisted or to be denied the next job for the delay penalties as stated in the Contract Data.

3.3 Programme
3.3.1 The key dates schedule sets out
- the Starting and Completion Dates
3.3.2 The Project Manager prepares the Programme in consultation with the MSE/LOCAL CONTRACTOR. The Programme sets out
• the sequence and timing of principal construction activities
• the dates when the MSE/LOCAL CONTRACTOR will require consents, tools or materials that are to be provided by the Client.

4 Defects
4.1 A Defect is a part of the Works that is not completed in accordance with the Works Information.
4.2 The MSE/LOCAL CONTRACTOR corrects defects.
4.3 The Project Manager issues a Defects Certificate at the end of the Defects Correction Period. This Certificate lists uncorrected defects.
4.4 Uncorrected defects not corrected within the Defects Correction Period shall be assessed by the Project Manager and the cost of having such defects corrected by others is paid by the MSE/LOCAL CONTRACTOR.

5 Payment
5.1.1 The Client undertakes to pay the MSE/LOCAL CONTRACTOR the total of the Prices in the Schedule of Prices or such other sum as may become payable under the Contract, for providing the Works.
5.1.2 Payments are made for work completed in weekly or monthly intervals.
5.2 Inflation
Prices are fixed for the duration of the Contract and no inflation adjustment is paid.
5.3 Payment Certificates
The Project Manager assesses the amount due to or from the MSE/LOCAL CONTRACTOR and produces a payment certificate, showing details of take-off sheet to show on of how the amount is made up.
5.4 Final Certificate
The Project Manager issues the Final Certificate within 15 days of the issue of the Defects Certificate, provided that
• all duties and procedures are complete
• all payments due by either party to the other under the Contract have been finally assessed and agreed.
5.5 Late payment
If the Client or the MSE/LOCAL CONTRACTOR does not pay a certified amount within 30 days after the approval of the Final Certificate, he will be liable as stated in the Contract Data for the delay to effect the payment.

6 Compensation
6.1 Compensation Events
6.1.1 The following are compensation events:
1) The Project Manager gives an instruction changing the Works Information.
2) The Client does not give possession of the Site; provide Tools, Materials, drawings, permission or another thing which he is to provide, by the date shown in the latest Programme.
3) The Project Manager gives an instruction to change the Scope of the work.
4) The MSE/LOCAL CONTRACTOR encounters problematic physical conditions within the Site which at tender he could not reasonably have expected.

5) Bad weather occurs within the Site which the Project Manager and the Contractor agree renders the progress of work to be less than half of what could normally be expected.

6.2 Procedure for Compensation Events

6.2.1 The MSE/LOCAL CONTRACTOR or the Project Manager notifies the other as soon as he becomes aware of a Compensation Event which has occurred or may occur. No Compensation Events are notified later than one month after they start to occur.

6.2.2 If the Compensation Event has the effect of changing the Prices and the time, the MSE/LOCAL CONTRACTOR gives the Project Manager a notification of such changes, to be valued and to be extended by the MSE/LOCAL CONTRACTOR or project manager.

6.2.3 Quotations and time extensions are submitted within 30 days of confirmation of a Compensation Event.

6.2.4 The Project Manager changes the Prices and time adjustment in accordance with the notification that he has accepted, or if necessary, his own assessment or valuation. The Project Manager revises the Programme in consultation with the MSE/LOCAL CONTRACTOR.

7 Risks

7.1 Risk allocation

The risks of loss of or damage to physical property and of personal injury and death which arise in connection with the Contract, except those allocated to the Client, are allocated to and are the responsibility of the Contractor.

7.2 Care of the Works

7.2.1 The Contractor is responsible for the care of the Works and Materials delivered to him and carries the risks allocated to him from the Starting Date until Completion.

7.2.2 Responsibility passes to the Client for the care of any part of the Works he takes over and uses before Completion.

7.2.3 From Completion until all defects have been corrected, the Contractor carries only the risks of loss or damage to any work that was not complete or had a Defect at Completion.

7.3 Liability

7.3.1 Each party is liable for and indemnifies the other against claims, proceedings, compensation and costs for loss of or damage to physical property (other than the Works), personal injury and death caused by risks which he carries.

8 Disputes

8.1 Conciliation or Mediation

8.1.1 If the Client or the MSE/LOCAL CONTRACTOR disagrees with an action of the Project Manager or believes that it was outside his authority, he may refer it within four weeks of the action to conciliation or mediation to be carried out by a competent person to be agreed to by both parties.

8.1.2 Payment for conciliation or mediation is shared equally between the parties.

8.1.3 Any change in cost or time that results from the conciliation or mediation is assessed in the same way as a Compensation Event is assessed.
9 **Termination**

9.2.1 Termination ends the Contractor's right and responsibility to provide the Works.

9.2.2 If either party wishes to terminate, he notifies the Project Manager giving details of the grounds on which he considers he may terminate. If the Project Manager decides the grounds justify termination, he issues a Termination Certificate promptly.

9.3 Payment on termination

The Project Manager's assessment of the payment on termination includes:

- an amount due assessed or valued as for normal payments,
- the actual cost for Materials supplied by the MSE/LOCAL CONTRACTOR that are on Site or which the MSE/LOCAL CONTRACTOR is liable to accept delivery,
- the forecast cost for removing from Site the equipment and tools supplied by the MSE/LOCAL CONTRACTOR,
- any other amounts retained or due by either party to the other.

10. **Contract Administration**

10.1 The project manager, duly delegated by the Client, shall be responsible for interpreting and administering the contract in accordance with the Contract Documents specified in Article 2 herein above and witnesses this Agreement as hereunder.

11. **Status of Contract**

11.1 It is agreed and understood that the said Contract Document shall be interpreted in accordance with the Ethiopian Law.

**ANNEXURES:**
1. **APPOINTMENT OF THE PROJECT MANAGER DEFINED IN TERMS OF THE CONTRACT**

CONSTRUCTION CONTRACT NUMBER ....................
DESCRIPTION OF THE WORKS: ........................

I hereby appoint you to act as PROJECT MANAGER for the construction works described above.

You are to be responsible for every contract that you manage, for:

1. Coordination and administration of the development of the Tender.
2. Issue of the Tender Invitations
3. Evaluation of the tenders received and preparation of the tender report.
4. Obtaining approval from the Authority for the tender and arranging the signing of the contract
5. Administering the construction contract as Project Manager in terms of the Contract. You may approve changes of cost up to the pre-approved 10% contingency allowance, and similarly, extensions of time up to 10% of the approved construction period. Any further changes to cost or time must be motivated by you to and approved by the Authority

**AUTHORISING MANAGER**

<table>
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<th>Signature</th>
<th>Name</th>
<th>Title</th>
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**SUPERVISING MANAGER**

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<th>Title</th>
<th>Date</th>
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**ACCEPTED BY THE PROJECT MANAGER (CONTRACT)**

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<th>Name</th>
<th>Date</th>
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2. CONTRACT DATA

CONTRACT NUMBER ............... 

The contracting parties

The Client stated in clause 1.2 is ........................................
    and is represented by ........................................
of .................................................................
postal address: .....................................................
                          ..................................................
telephone: .....................
fax: .................................
physical address: ................................................
                          ..................................................

The Contractor stated in clause 1.2 is ...........................
    and is represented by ........................................
of .................................................................
postal address: .....................................................
                          ..................................................
telephone: .....................
fax: .................................
physical address: ................................................
                          ..................................................

The Project Manager is : ........................................
of .................................................................
postal address: .....................................................
                          ..................................................
telephone: .....................
fax: .................................
physical address: ................................................
                          ..................................................

Delay penalties are Birr . . . . . per day.
The Defects Correction Period is ............... days and starts at .........

Completion time............C.days

Interest on late payment is at the rate of . . . . % per annum.

The minimum third party liability insurance cover is Birr ...............
### 3. SCHEDULE OF PRICES

<table>
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<th>Description</th>
<th>Unit</th>
<th>Quantity</th>
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**SUBTOTAL**

**VAT at 15%**

**TOTAL TENDER PRICE**

The TENDER PRICE is ..................................................

.................................................................

(write the amount in words)
4. WORKS INFORMATION

1. Description of the Works

The Specifications of the Works are listed below and a full copy is included in the Appendix, bound separately.

Drawings of the Works are listed below and a full set is included in the Appendix, bound separately.

2. Specifications and drawings for the Works

3. Things supplied by the Client

   Works supplied by the Client (describe any works that are supplied by the Client upon which or around which the Contractor is to construct his portion of the Works)

   Materials supplied by the Client (describe the materials that the Client will supply to the Contractor)
Tools and Equipment supplied by the Client for the use of the Contractor for constructing the Works (describe equipment and state if operators and/or fuel are supplied).

4 Client’s key date schedule
The Starting Date is ........................................
The Completion Date is ...............................  

The following statutory and other non-working days are included within the Contract period:

5 Limitations on the Contractor’s performance
Additional safety regulations: ...........................................  

Other limitations: (list sources of materials that the Contractor must use; limitations on suppliers, etc)

.................................................................
5. **SITE INFORMATION**

Site information is factual information about the physical conditions on the site and its surroundings, for the use of the Contractor to prepare his tender and to decide his method of working and programme.

The Site Information is listed below and a full copy is included in the Appendix, bound separately.

---

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6. **PAYMENT CERTIFICATE**

**CONTRACT NUMBER** ................. **CERTIFICATE No.** ..............

To Contractor: ................. To Client: .................

.................................................................

Attention: ......................... Attention: .........................

**TITLE OF CONTRACT** .................................................................

.................................................................

**DATE OF ASSESSMENT** .........................

Cumulative value of work done .................

Cumulative value of Compensation Events .................

Subtotal .................

Other amounts due to or due by the Contractor .................

Less penalties (when authorised) .................

Subtotal .................

Add VAT at 15% .................

Cumulative amount certified .................

Less previous amount .................

Amount due to or due by the Contractor .................

Assessment checked by

.................................................................

Signature .................................................... Name .................................................... Date .................................................................

Certified by Project Manager

.................................................................

Signature .................................................... Name .................................................... Date .................................................................
7. CERTIFICATE OF COMPLETION

CONTRACT NUMBER .................

To Contractor: ................. To Client: .................
........................................................................
........................................................................
Attention: ................. Attention: .................

TITLE OF CONTRACT .................................................................
........................................................................

This is to confirm that the Works described above:

ACHIEVED COMPLETION ON .................
THE CONTRACTUAL COMPLETION DATE WAS .................
Hence the DELAY PENALTY DAYS is ....................

DEFECTS listed in the attached schedule are to be corrected within the DEFECTS
CORRECTION PERIOD which ends on ....................

Care of the Works now passes to the Client.

SIGNED BY THE PROJECT MANAGER (CONTRACT)

........................................................................
Signature Name Date
8. DEFECTS CORRECTION CERTIFICATE

CONTRACT NUMBER ..................

To Contractor: .................. To Client: ..................

........................................ ........................................

Attention: .................. Attention: ..................

TITLE OF CONTRACT .................................................................

.................................................................

DEFECTS CORRECTION PERIOD ends on .........................

This certificate confirms that all defects notified during the construction period have been corrected, with the exception of the following:

<table>
<thead>
<tr>
<th>Uncorrected defects</th>
<th>Valuation</th>
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</table>

Works checked by

.................................................................
Signature Name Date

Certified by Project Manager

.................................................................
Signature Name Date
9. FINAL CERTIFICATE

CONTRACT NUMBER . . . . . . . . .

To Contractor: . . . . . . . . . . . . . To Client: . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Attention: . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

TITLE OF CONTRACT . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

This Final Certificate confirms that:

- all duties and procedures are complete
- all defects have been completed except those listed on the Defects Correction Certificate dated .
- all payments due by either party to the other have been finally assessed and agreed

Payment Certificate Number . . . . . is attached giving details of final adjustments and deductions for uncorrected defects

Final Certificate checked by

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Signature Name Date

Certified by Project Manager

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Signature Name Date

Agreed and accepted on behalf of the Contractor by

. . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .

Signature Name Date
10. **TERMINATION CERTIFICATE**

**CONTRACT NUMBER** .................

**TITLE OF CONTRACT** ........................................................................

To Contractor .................................................................

........................................................................................................

Attention: .................................................................

Your right and responsibility to Provide the Works ceases on ............

In order that a termination account can be prepared you are required to submit within 7 days substantiated statements as follows:

- of the actual cost for Materials supplied by the Contractor that are on Site or which the Contractor is liable to accept delivery,
- the forecast cost for removing from Site the equipment and tools supplied by the Contractor
- any other amount that you consider is due to the Contractor.

Grounds for termination are supported by:

**AUTHORISING MANAGER**

Signature  Name  Title  Date

**SUPERVISING MANAGER**

Signature  Name  Title  Date

**PROJECT MANAGER (CONTRACT)**

Signature  Name  Date
11. Take-off Sheet for MOU

Project Site: ________________________________________ Page 1 of
MSE/LOCAL CONTRACTOR: ___________________________________________ Take-off Sheet No. __
Period covered: from ________ to _________

Table. Recording of works executed in this period

Record the executed works as per the list in the Bill of Quantities

<table>
<thead>
<tr>
<th>Item</th>
<th>Description of Works</th>
<th>Measurements for the executed work</th>
<th>Summarized Quantity</th>
<th>Remark</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>A. Surveying and Setting out</td>
<td></td>
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<tr>
<td>2</td>
<td>B. Earthwork</td>
<td></td>
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<td></td>
</tr>
<tr>
<td>3</td>
<td>C. Paving of Cobblestones</td>
<td></td>
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</tr>
<tr>
<td>4</td>
<td>D. Curbstones</td>
<td></td>
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<tr>
<td>5</td>
<td>E. Drains</td>
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</tbody>
</table>

Take-off Sheet prepared by: ___________________________ Date: __________
Position/Responsibility: ___________________________ Signature __________
Sources

New Engineering Contract: The Engineering and Construction Short Contract 1999


Eskom Minor Works Contract 1992

South African Institution of Civil Engineers: General Conditions of Contract for Works of Civil Engineering Construction
APPENDIX-4: Sample Format for Shopping: Invitation to Quote
Sample Format for Shopping

Date:

INVITATION TO QUOTE

To:

__________________________

Gentlemen/Ladies:

Regarding: _______________________

1. You are invited to submit your price quotation(s) in a proforma invoice format for the supply of the following items/works:
   (i) ______________________
   (ii) ______________________
   (iii) ______________________

2. Information on technical specifications and required quantities/BOQ is contained in Attachment 1.

3. The Government of Ethiopia has received a loan from the IDA in various currencies and intends to apply the proceeds of this loan to eligible payments under the contracts for which this invitation for quotation is issued.

4. You may quote for any item/work in this invitation. Each item/work shall be evaluated and contract awarded separately.

5. Your quotation(s) in the required format should be addressed to

__________________________

Telephone: Fax:

6. The proforma invoice, in duplicate and in English language/Local language, should be accompanied by adequate technical documentation and catalogue(s) and other printed material or pertinent information (in English language) for each item quoted, including names and addresses of firms providing services facilities in ____________.

7. The deadline for receipt of your quotation is ____________.

8. Quotations by Telex or Fax are acceptable.

9. Other Conditions of Supply are as follows:
(i) **PRICES** are to be quoted in local currency.
(ii) **PAYMENT** for your invoice will be made 100% against delivery documents,
(iii) **DELIVERY** prices should be quoted for delivery at the purchaser’s store.
(iv) **DELIVERY SCHEDULE:** The delivery shall be completed within a week after receipt of Purchase orders (PO).
(v) **WARRANTY**

........................................................................................................................................

(vi) **ORIGIN** Goods offered should have their origin from the World Bank member countries
(vii) **VALIDITY** your quotation should be valid for a period of 15 days from the date of your quotation.

10. Further information can be obtained from:

______________________________

Telephone: ____________ Telex: ___________ Fax: ______________

11. Please confirm by fax or telex the receipt of this invitation and whether or not you will submit the price quotations.

Sincerely,
Attachment 1
TECHNICAL REQUIREMENTS
Project Name: _________________
Name of Item/Work: _________________
Quantity: _________________

TECHNICAL DETAILS
1. General Description.
2. Technical Specifications
3. Accessories and Attachments
4. Tools or Other Required Items
5. Maintenance Requirements
6. Spare Parts Required
7. Manuals
8. Required Performance
10. Quantity required;
11. BoQ
12. Works completion period;
13. Price quotation format

Procedure for Shopping

Shopping for Goods

Under this procedure, quotations are solicited from at least three qualified suppliers on basis of simplified documents. In order to enhance efficiency and remove the inherent risk of compromise, communities are advised to ensure that request for and submission of quotations should be in writing. Quotations should be opened at the same time and to the extent possible in the presence of community members. As a general rule, the supplier who offers the lowest price should be awarded the contract. The Basic steps in using shopping method are as follows:

i. The item to be purchased should be included in Procurement Plans (PP);

ii. Quotations are to be solicited from at least three qualified suppliers (the more the better);

iii. The Request for quotation (RFQ) shall include adequate technical and commercial conditions/terms. As a minimum the RFQ should include the followings: condition, place and deadline for quotation submission, place and time of Quotations opening, the description of the item, unit of measurement, quantity, Date and place of delivery, Quotation validity period, detail specification of the item or the work and mode of payment.

iv. The quotations shall be opened in public, preferably in the presence of the bidders;

v. Quotations shall be opened the same date of quotations submissions;

vi. Minutes of Quotation opening shall be prepared and signed by the committee;
vii. The Quotation evaluation shall be conducted based on the requirements of the RFQ only;

viii. The lowest evaluated bidder (the bid that meets the minimum requirement as set in the RFQ and offered the lowest price) shall be awarded the contract;

ix. The Quotation evaluation report and the award recommendation shall be approved by the right official;

x. OP shall be issued as a simple contract to the supplier

xi. All the documentation shall be kept properly both within the procurement unit and the finance unit of the procuring entity.

Shopping *for works*

Just like in the case of shopping for goods, quotations are obtained from at least three contractors who are invited to submit quotations on basis of simplified quotation forms. The forms describe the scope of the works, detail specifications and where possible include drawings. Quotations should be opened at the same time and to the extent possible in the presence of community members. As a general rule, the contractor who offers the lowest price should be awarded the contract. The steps in shopping for works are similar to the above.
APPENDIX-5: Standard designs, technical specifications and bill of quantities for cobblestone roads
STANDARD DESIGNS, TECHNICAL SPECIFICATIONS AND BILL OF QUANTITIES FOR COBBLESTONE ROADS

Federal Democratic Government of Ethiopia

MINISTRY OF WORKS AND URBAN DEVELOPMENT

ROAD AND STORMWATER DRAINAGE DESIGNS FOR CONSTRUCTION BY LABOUR-BASED METHODS

October, 2008
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6. Bill of Quantities (BoQ) for Cobble Stone Road Construction
1. Road and storm water drainage design

1.1 Introduction

This design manual document for labour based construction consists of six parts. The first part introduces and defines what does labour based construction and what should be taken into consideration during. The second part shows step by step for geometric design. The third part also clearly shows the steps of pavement design and recommends pavement thickness on the actual situation of Ethiopian towns. The fourth part shows the design steps for storm water. Specification for cobble stone also describes under part five. Finally part six shows a bill of quantities for cobble stone.

1.2 Definition

Labour-based technology can be defined as the construction technologies which, while maintaining cost competitiveness and acceptable engineering quality standards, maximizes opportunities for the employment of labour (Skilled and Unskilled) together with the support of light equipment and with utilization of locally available material and Resources

![Diagram](image.png)

Figure 1-0-1: Definition for labour based

Labour-based construction is defined as “the construction technology which, while maintaining cost competitiveness and acceptable engineering quality standards, maximizes opportunities for the employment of labour (skilled and unskilled) together with the support of light equipment and with the utilization of locally available
materials and resources” (Johannesen, 1997). And, as Tournée and van Esch (2002) state “Labour-based technologies are not about simply substituting machines with workers at any cost. They rather aim at optimising employment and local resource mobilisation in any given infrastructure investment, using - preferably light - equipment only when necessary. The technician responsible for planning the works would therefore first ask “which operations can be done using labour and other local resources?” and only then “when equipment is needed in support of the labour?” The satisfactory use of labour-based methods relies on suitable designs and working methods and they are to be accompanied by training and capacity building.
2. Geometric Design Parameters

2.1 Introduction
There is no as such design standards parameter for a labour based construction in urban area, both in ERA and AACRA specification. But it is appropriate some how to adapt ACCRA design specification for labour based construction for Ethiopian towns based on specific condition of each town and master plan road classification of each town.

2.2 Geometric design

2.2.1 Design speed

The design futures of each type of road convey to the driver its primary functions encourage appropriate driver behaviour or walking comforts in the case of pedestrian use. This can be achieved by complying with the following requirements where ever possible.

- Traffic volume and speed should be compatible with residential, school and other functions of the roads
- The integration of pedestrian bicycle and vehicular movements
- Ensuring that access connivance is not un dually impaired as a result of speed restraints

Therefore based on the above factors and surfacing material a design speed of the following can be used for geometric design.

- Low volume residential feeder roads(<300 vpd) use a speed of 20-30km/h
- Local residential street 10-20km/h
- Access places 10km/h

2.2.2 Alignment design

A holistic approach to the alignment design is required where the various element of the road design has to be considered as a whole in the context trough which the road passes and expectations of the community affected by the road. To achieve the best result the designer must consider the engineering requirements.

- City Master Plan
• Physical characteristic of the area including property access requirements
• Use of the corridor
• Vegetation in the corridor
• Historic features
• Existing road

2.2.3 Horizontal Alignment

Design speed of horizontal curve in urban area can be the following

• Radius of 36-60m
• Super elevation 5-3 percent
• Minimum curve length 40m

![Horizontal curve principles](image)

2.2.4 Vertical curve

The vertical alignment must be designed in conjunction with horizontal alignment and the following parameters are recommended.

• Flat terrain grade 4-5%.
• Hilly terrain grade 7-12% grade.
Figure 2-0-3 vertical curve principles
Generally rising or falling section of the road should have a consideration of possible grade with respect to construction of cobblestone.

2.2.5 Road width
Road width hinges on safety in terms of there being a possibility of two large vehicles passing each other safely at a low speed for very low traffic volumes where such vehicular conflict is minimal. Road width $\geq 4.5\text{m}$ and $< 6\text{m}$ is acceptable on condition that the road is constructed by cobble stone in existing urban area.

2.2.6 Gate access
A vertical alignment should take into consideration gate access of each and every house in urban area unless and other wise a big cut or fill is required. In such case a parallel ramp should be provided.

2.2.7 Intersection design
- Identify and include all users of the intersection in the design consideration (e.g. pedestrian crossing, Public transport priority)
- Widen the road at intersection so that other big trucks use the road occasionally will not cause property damage.
3. Pavement Design

The aim of structural design is to limit the level of pavement distress, measured primarily in terms of riding quality, and predetermined values for base and sub base structures. It is assumed that failure in cobble stone at the end of the design period is relatively very low and minimum deterioration will be occurred based on the type of rock used in the construction of cobble stone.

There are fundamental steps to be followed in designing a new road pavement (adopted from TRL, 1993):

- estimating the amount of traffic and the cumulative number of equivalent standard axles (ESA) that will use the road over the selected design life;
- assessing the strength of the sub grade soil over which the road is to be built and environmental and cross-sectional effects;
- Selecting the most economical combination of pavement materials and layer thicknesses that will provide satisfactory service over the design life of the pavement

3.1 Traffic analysis

3.1.1 Base Year Traffic

The base year traffic has to be calculated as the sum of the Normal traffic of the existing road applied to each section of the project road, plus divertible traffic (if any) and generated traffic. The following combination of two direction AADT count can be used to calculate a design traffic (ESA)

3.1.1.1 Low volume motorised traffic

ERA class T1; design traffic < 300 000 ESA
This traffic class comprises light motor vehicles with some busses or trucks and would lie between 75 and 220 vehicles per lane per day.

3.1.1.2 Low volume mixed use roads

Design traffic < 30 000 ESA
Traffic would comprise a mixture of light motor vehicles with an occasional bus or truck, motor cycles, bicycles, Bajaji, animal-drawn carts and pedestrians. The number of four-or-more-wheeled vehicles would lie between 10 and 20 vehicles per lane per day.

3.1.1.3 Non-motorised traffic

Design traffic < 3 000 ESA

Traffic would comprise light motor vehicles with a few delivery trucks per week, on average less than 3 motor vehicles per lane per day and a mix of bicycles, hand-drawn carts, animal-drawn vehicles and pedestrians.

In most Ethiopian secondary towns this number can be used for design traffic for cobble stone roads.

3.2 Sub grade soil investigation

Sub grade soil being the main integral element carrying loads transmitted from pavement layers, investigation of their type, property and load carrying property is very essential. The sub grade investigation should focus on identifying, quantifying and qualifying the engineering properties of the in situ material. It includes visual identification, test pitting and sampling of the representative portions for laboratory testing or in situ stiffness determination with experienced persons or DCP methods.

3.2.1 Visual sub grade and soil extension survey

Soil extension surveys, together with outcomes of test pit excavation and local geologic and physiographic features, will help in the preliminary delineation and estimation of the depth and quantity of excavations.

3.2.2 Test Pit Investigations

Further investigation on type and extent of soil can be done by test pits dug at an average interval of 100m to get a representative samples at depth of the 35-50cm below the surface (to avoid top soil material) for sub grade. The depth and type of materials encountered in each of the test pits must be carefully recorded and taken for further Laboratory tests.

Laboratory investigations such as identification and classification tests, CBR tests and other indicative tests should be done on samples retrieved from the test pits.
3.2.4 Sub grade classification

After a test result the sub grade classification will be classified as it shown in the following table.

<table>
<thead>
<tr>
<th>Sub grade class designation</th>
<th>Sub grade</th>
<th>S1</th>
<th>S2</th>
<th>S3</th>
<th>S4</th>
<th>S5</th>
<th>S6</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBR ranges</td>
<td>%</td>
<td>2</td>
<td>3-4</td>
<td>5-7</td>
<td>8-14</td>
<td>15-29</td>
<td>30+</td>
</tr>
</tbody>
</table>

Table 3-0-1 sub grade designation

3.2.5. Determination of Design CBR

Sub grade strength being the main design input for determining the pavement layers, its strength has to be assessed using laboratory CBR test. For the low volume traffic it also recommended that to take a minimum CBR value. But when it is difficult to forecast a future traffic it is recommended to take a higher value of CBR, which is in this case a CBR of 7% can be considered for most secondary towns where the majority of the area has a sandy property. But for the areas with expansive soil the depth of bulk excavation should be deep and replaced by better CBR material to get a proposed CBR.

3.3 Layer thickness design for cobble stone

The purpose of structural design is to limit the stresses induced in the sub grade by traffic to a safe level at which sub grade deformation is insignificant whilst at the same time ensuring that the road pavement layers the MSE/Local Contractorlves do not deteriorate to any serious extent within a specified period of time. Accordingly, The following layer thickness is proposed to use in cobble stone construction works for different volume of traffic.

3.3.3 Low volume motorised traffic

The traffic class (T1) traffic < 0.3 x 10^6 ESA and 7% CBR for design period of 10 years the following layer can be used:
3.3.3 Low volume mixed use roads

The traffic class (T1) traffic < 0.3 x 30000 ESA and 7% CBR for design period of 10 years the following layer can be used:

[Diagram: Typical cross section for mixed traffic]

Figure 3.2 Typical cross section for mixed traffic

3.3.5 Non-motorised traffic

For Traffic class < 3 000 ESA and CBR value of sub grade greater than 7%. The following typical pavement design can be used.

[Diagram: Typical cross section for low volume traffic]

Figure 3.3 Typical cross section for low volume traffic
3.4 Layer Thickness for Otta seal

An Otta seal is different to surface treatment in that a graded gravel or crushed aggregate containing all sizes, including filler, is used instead of single sized-chippings. There is no formal design procedure but recommendations based on case studies have been published. An Otta seal may be applied in a single or double layer. Evidence on the performance of these types of seal has shown them to carrying up to 300 vehicles per day (ERA design manual). The grading of the material is based on the level of traffic expected. Recommended grading envelopes are given in Table 3.2. Generally for roads carrying light traffic (<100 vehicles per day), a ‘coarse’ grading should be chosen while a ‘dense’ grading should be applied to one carrying greater than 100 vehicles per day.

Table 3.2 Otta Seal Aggregate Grading Requirements

<table>
<thead>
<tr>
<th>Sieve (mm)</th>
<th>Percentage Passing</th>
<th>Coarse</th>
</tr>
</thead>
<tbody>
<tr>
<td>19</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>16</td>
<td>79-100</td>
<td>77-100</td>
</tr>
<tr>
<td>12</td>
<td>61-100</td>
<td>59-100</td>
</tr>
<tr>
<td>9.5</td>
<td>42-100</td>
<td>40-85</td>
</tr>
<tr>
<td>4.75</td>
<td>19-68</td>
<td>17-46</td>
</tr>
<tr>
<td>2.36</td>
<td>8-51</td>
<td>1-20</td>
</tr>
<tr>
<td>1.18</td>
<td>6-40</td>
<td>0-10</td>
</tr>
<tr>
<td>0.60</td>
<td>3-30</td>
<td>0-3</td>
</tr>
<tr>
<td>0.30</td>
<td>2-21</td>
<td>0-2</td>
</tr>
<tr>
<td>0.15</td>
<td>1-16</td>
<td>0-1</td>
</tr>
<tr>
<td>0.075</td>
<td>0-10</td>
<td>0-1</td>
</tr>
</tbody>
</table>

Aggregate should be screened to remove stone greater than 19mm

The viscosities of binders used in construction should reflect the quality of aggregate employed but normally cut back bitumen MC 3000 or 150/200 penetration grade bitumen is used depending upon the traffic volumes and type of aggregate cover. Spray rates cannot be calculated by design and must be chosen empirically. Typically, spray rates (hot) for single seals are between 1.6 and 2.0 l/m² so that necessary detailed adjustments can be made.

It is because of the broad range of materials that may be used and the empirical nature of the design of this type of seal that it is imperative that pre-construction trials be carried out. This strategy will identify any special local conditions concerning the available aggregates and binders to become apparent to enable the engineer to adjust the nominal design. An important aspect of Otta seal construction is the need for
extensive rolling by pneumatic rollers for two or three days after construction. The action of rolling ensures the binder is forced upwards, coating the aggregate, and thereby initiating the process, continued by subsequent trafficking, of forming a premix like appearance to the surface. After care can take as long as twelve days and involves sweeping dislodged aggregate back into the wheelpaths for further compaction by traffic. For labour based construction in the case of Otta seal replace a cobble stone layer, the following cross section will be recommended.

### 3.4.1 Low volume motorised traffic

The traffic class (T1) traffic < 0.3 x 10^6 ESA and 7% CBR for design period of 10 years the following layer can be used:

![Figure 3-4 Typical cross section low volume](image)

### 3.3.3 Low volume mixed use roads

The traffic class (T1) traffic < 0.3 x 30000 ESA and 7% CBR for design period of 10 years the following layer can be used:

![Figure 3-5 Typical cross section low volume](image)
3.5 Layer Thickness for Gravel wearing course

For labour based construction of gravel road by considering low volume ERA pavement design manual propose the following requirements.

The total required gravel thickness consists of

1. Minimum thickness required to prevent excessive compressive strain in the sub grade designated as D1 and
2. Extra gravel thickness required to compensate for the gravel loss due to traffic during the period between the re-gravelling operations, designated as D2.

The total thickness is therefore the sum of the two thickness i.e.

\[ D = D_1 + nD_2, \]

Where: \( n \) is period between the re-gravelling operation, assumed to be 2 years.

6.5.1.1 Minimum Gravel Thickness:

It is obtained using the design CBR of 7% and Estimated AADT for the roads which is going to build in the towns. The minimum gravel thickness for this towns roads can be determined from chart of pavement and improved sub grade for gravel roads with AADT is equal to low volume for wet zone(The worst case) shown in figure below.

The minimum gravel determined using ERA manual is shown in table.

![Figure 3-6 Typical cross section low volume gravel roads](image_url)
4. Drainage design

4.1 Introduction

As storm water drainage in urban areas is largely the drainage of fairly small areas, the "Rational Method", which may be used for drainage areas less than 50 hectares is recommended. This method also has the advantage of requiring only rainfall and runoff coefficients as input. It is therefore recommended that the Rational Method, as set out in the *ERA Drainage Design Manual – 2002*, is used. This is summarised below.

Different types of structures are employed in drainage systems. The types relevant to urban drainage are:

- Open channels, whether artificial or natural conveyances of the flows of water.
- Culvert and bridges, used when storm water channels cross roads or embankments.
- Energy dissipaters, used to control the velocities of flows, especially at culvert outlets.
- Storm drainage facilities, used to collect the runoff of the carriageway and surrounding areas and direct it to the channels.

4.2 Roadside Channels Design Criteria

The following criteria apply to roadside channels:

Channel side slopes should not exceed the angle of repose of the soil and/or lining and shall be 2:1 or flatter in the case of rock-riprap lining. Flexible linings shall be designed according to the method of Allowable Tractive Force. The design discharge for permanent roadside ditch linings should have a 10-year frequency while temporary linings shall be designed for the 2-year frequency flow. All roadside channels and/or ditches shall be hydraulically designed as per this manual. Channel freeboard shall be 0.3m or two velocity heads, whichever is larger.
4.3 Longitudinal drains
Longitudinal drains carry storm water parallel to the roadway, or along the length of the road. These drains collect runoff and deliver it to cross drains or are emptied by means of mitre drains. Mitre drains run at an angle to the road (usually between 30° and 45°) and drain into vacant land beside the road.

4.4 Cross drains
Cross-drains take storm water from one side of a road to the other, by means of structures. These structures comprise:

Culverts,
Which are divided, depending upon their shape and the way that they carry traffic loads to the foundations, into:
pipe culverts,
box culverts,
arch culverts.

Drifts (sometimes called fords)

4.5 Drain gradients
All drains must have a gradient in order to allow the flow of storm water. The drawings will give the gradient at which the drain is to be built.

4.6 Side drains
Side drains are open ditches, running parallel to the road, that collect storm water from the area beside the road and from the road itself. The drain is dug far enough away from the road that seepage of the water into the ground will not affect the road foundation. The depth of the side drain is chosen so that it can drain the road foundation and keep it dry enough for the road to be able to carry heavy trucks and buses.

Side drains are emptied at regular intervals by means of mitre drains or culverts. Mitre drains work best when the road runs directly down the ground slope. Culverts, however, function best when the ground slopes towards the road. Culverts must also be built in every stream or streambed, to prevent storm water being dammed up against the road. Culverts have two functions:
to empty the side drain by taking the water under the road to the other side
to drain streams across the road.

4.6.1 UNLINED TRAPEZOIDAL DRAINS

PROBLEMS: scour, weed growth, siltation
Scour: limit flow speed to 80% of scouring velocity by designing shallow and wide channels with flat bottoms.
Weed growth: encourage growth of creeping grass or similar vegetation, remove all upright growth regularly.
Siltation: firstly prevent scour or erosion; then by careful design eliminate sediment traps or slacks to maintain reasonably constant flow speed in the channel. Open earth side drains usually have a flat bottom not less than 1 m wide, with sloping sides.
4.6.2 Mitre drains  
A mitre drain must have the same capacity as the side drain it is emptying (if less, it will not be able to empty the side drain). If the side drain has a 1.5 m bottom width, the mitre drain must not be any less. The mitre drain must be long enough to take the storm water away from the road and must also become so shallow at its end that the water can flow out across the ground. This means that the drain gradient must be less than the ground slope. Minimum gradient should be 1 in 80 and the preferred gradient is 1 in 50.

From the drawing above, note that the side-drain stops and turns through an angle to become the mitre drain. The bend in the drain may require to be armoured with stone pitching if the soil is very erodible. The side drain is re-started at least 5 m from the bend and the soil between the bend and the start is not disturbed.

4.6.3 Interceptor or catch-water drains  
Interceptor drains catch overland flow before it reaches the roadway. The soil dug from the drain is often used to make a small berm on the downstream side of the drain and should be compacted. The preferred gradient for the drain is 1:50.
4.7 Masonry-lined drains
Masonry is frequently used to line drains in towns or villages to reduce their width from the wide open earth drains. Such drains may be lined with rough stone, neatly mortared with a cement mortar. Alternatively, semi-dressed stone can be used to construct vertical or sloping walls on a concrete or stone base, to carry the storm water flows.

To protect pedestrians and vehicles, such masonry drains may be roofed with concrete beams or slabs. See the following illustrations for typical examples.

Figure 4-0-7 Masonry-lined open drain
Figure 4-0-8 Masonry-walled open drain

Figure 4-0-9 Masonry culvert with concrete cover

4.8 Culverts

4.8.1 Pipe culverts
Pipe culverts are usually constructed with precast factory-made concrete pipes. These pipes are made in certain lengths. Precast concrete pipes are heavy and must be handled carefully in order not to break them and for safety reasons. Pipes made from other materials like plastic or fiber glass are sometimes used for storm water and are much lighter than concrete pipes.

Figure 4-0-10 pipe culverts
All pipes must be laid on a prepared bed. The type of bedding depends on many factors: the drawing will give the necessary details. Pipes are backfilled with a carefully selected material and compacted in thin layers. The depth of backfill over the pipe is called the “cover” and should be greater than half the pipe diameter. If a flexible pipe is used (like plastic) then the cover should at least equal the pipe diameter.

Pipe culverts are generally laid in a trench excavated through the road embankment. It is good practice to construct the road fill to such a level that when the pipe is laid and backfilled, the needed cover can easily be achieved. It is bad practice to lay a pipe culvert on the ground and then to fill over it to build up the embankment, as this often results in broken pipes.

4.8.2 Box culverts
Foundations for box culverts are made of concrete. The width and thickness should be made as given on the drawing details. Walls are constructed of brickwork or stone masonry with a deck slab of concrete. As for the pipe culverts, headwalls and wing walls are needed. The wing walls are extensions of the walls and are usually bent back to better control the flow of water into and out of the culvert. The cross-section below shows some of the details.

Figure 4-0-11 Box culvert
4.9 Drifts
Drifts are portions of a roadway that are lowered to allow storm water to flow freely across the road in such a way as to prevent damage to the road. A drift usually comprises a stone masonry wall or a gabion along the lower side. The road surface itself may be protected with a layer of stone or concrete.

A drift must have a cross-fall of about 1 in 50, so that water does not stagnate on the road surface. The ends of the drift are raised to retain the water flow within the protected area of the drift. The road ramps down to the drift level, crosses the drift and ramps up again at the other side.

[Source: PIARC: International Road Maintenance Handbook, Volume 1, 1994]

Figure 4-0-12 Drift

The picture above shows a river drift crossing. Note the side drains that discharge into the river away from the road; the marker posts to guide drivers across the drift when it is under water; the large rocks placed against the downstream side to prevent erosion.

4.10 Headwalls and wing walls
Headwalls and wing walls should be constructed at the inlet and outlet of every culvert. The headwalls keep soil from falling into the inlet or outlet and, when they are painted white, can be easily seen by vehicle drivers. Wing walls form part of the structure and guide the water in or out while also holding up the soil at each side of the pipe opening. Most culvert outlets are protected with stone and/or grass to prevent erosion. See drawings for details.
All culvert headwall and wing walls need maintenance: they must be kept clean of sediment and debris and at the outlets vegetation must be controlled. Due to the concentration of water at an outlet, vegetation will grow prolifically. If not controlled, this vegetation will block the outlet and soon enough prevent the drainage structure from working as it should.

Figure 4-0-13 Head and wing walls

Figure 4-0-14 Double pipe culvert outlet
4.11  Erosion control
Soil erosion is controlled by covering the soil or by slowing down the flow.

In earth drains, the simplest form of erosion control is the **scour check**. This is a small dam made of stones or timber that slows down the flow of water in the drain. The scour check:
- must be low enough in the middle to let the storm water flood flow over without letting the water erode the sides of the drain,
- must have a non-erodible base (like stone) at the foot of the scour check for the overflowing water to fall onto.

4.11.1 Grass prevents erosion.
The type of grass should be a low-growing kind that spreads out. Grass or bushes that grow upright should be removed from drains, as they cause too much obstruction to the flow of water (note: for maintenance). If grass of the right type is available from clearing and grubbing, it should be reserved and planted as soon as possible in earth drains.

4.11.2 Plain stone pitching
**Plain stone pitching** is the name given to a layer of rocks placed closely together on the bottom and sides of an earth drain. Note that the function of the stone pitching is twofold:
- protect the earth below it from erosion,
- slow down the water flow by the roughness of the pitching.
The large stones that protrude up above the general level of the pitching provide the roughness and the erosion protection is provided by all the stones, but particularly by the small stones hammered into the gaps between the large stones. In properly laid plain stone pitching no portion of the earth beneath the lining can be seen through holes or gaps in the pitching. This is a quality requirement. Note that sometimes a geo fabric has to be laid beneath the stone pitching.

Another type of erosion protection is **grouted stone pitching**. Plain stone pitching is laid, without filling all the smaller gaps with stone pieces, and those gaps are filled with a cement mortar. The mortar is made liquid and runny and is poured from a wheelbarrow onto the pitching and is spread by means of shovels and stiff brooms. The brooms are used to work the mortar into the spaces. Note that the two requirements of the stone pitching have not changed. These are:
- protect the earth below it from erosion,
- slow down the water flow by the roughness of the pitching.
The first requirement is cared for by making sure that all the holes and gaps in the pitching are filled with the mortar (or grout). The second requirement means that the larger stones must protrude above the general level of the pitching in order to provide friction to the water flow.

Sometimes **wired and grouted stone pitching** may be needed. This is constructed by laying across the bed of the drain a wire mesh with holes smaller than the average stone size. Wire ties are fastened to the mesh at 600 mm centres, in a square grid pattern. Plain stone pitching is then laid across the wire mesh, taking care to lift the wire ties vertically and having them stick up out of the pitching. As with the grouted pitching (above), no stone filling is placed in the smaller gaps. A second layer of wire mesh is then laid across the pitching and securely tied down with the wire ties sticking through the stone layer. The edges of the mesh must be carefully tied together so that no stones can be washed out. A grout made from a liquid and runny mortar is poured from a wheelbarrow onto the pitching and is spread by means of shovels and stiff brooms. The brooms are used to work the grout into the pitching and to fill all the gaps.

4.11.3 Gabions and gabion mattresses
Gabions and gabion mattresses are often used to control storm water flows in open drains. These consist of wire baskets of various sizes that are filled with stones and wired closed. Wire or mesh boxes are placed on prepared bedding and filled with hard stone, carefully packed into place. The boxes are braced with wire to keep them in shape. The lids are carefully wired closed. Such structures may be used as retaining walls, to support earth banks or road works; or may be used to control the flow of water. There are many other uses for gabions.

4.11 Manholes

Long closed conduits may be used to convey storm water and flow in these are usually dependent on the pipe slope and/or the internal friction between pipe wall and the storm water. Such conduits rarely flow full and should be adequately ventilated to prevent the build-up of positive or negative pressures. Should air be entrained, it may be released "explosively" and cause considerable local damage if not sufficiently ventilated.

Manholes in long conduits should be deeply benched (like sewer manholes) to reduce expansion and contraction losses and to prevent sedimentation. If bends are needed, changes in direction should be made gradually, particularly if the flow velocity is high, as the velocity head can be sufficient to lift the manhole cover and cause a large overflow at that point. Manholes must be adequately sized for ease of maintenance. If a manhole is too small to allow a person to climb into it and clean it, it probably will not be cleaned. A minimum diameter of 90 cm and a height of 2 m is the generally accepted minimum size for a deep manhole chamber. An access shaft of 60 to 75 cm diameter can be built above the chamber.
Figure 4-15 Typical manhole on storm water pipes
4.12 Energy Dissipaters

At the outlet of a culvert or the end of a pipe or box drain, energy dissipation is essential. See Chapter 9 of the ERA Drainage Design Manual. The dissipater type selected for a site must be appropriate to the location. The terms internal and external are used to indicate the location of the dissipater relationship to the culvert. An external dissipater is located outside of the culvert and an internal dissipater is located within the culvert barrel.

Dissipater Type Selection

Internal dissipaters are used where:
- the scour hole at the culvert outlet is unacceptable,
- the right-of-way is limited,
- debris is not a problem, and
- moderate velocity reduction is needed.

External dissipaters are used where:
- the outlet scour hole is not acceptable,
- moderate amount of debris is present, and
- the culvert outlet velocity \( (V_o) \) is moderate, \( Fr < 3 \).

Stilling Basins are used where:
- the outlet scour hole is not acceptable,
- debris is present, and
- the culvert outlet velocity \( (V_o) \) is high, \( Fr > 3 \).

Natural scour holes are usually used where:
- undermining of the culvert outlet will not occur or it is practicable to be checked by a cut-off wall,
- the expected scour hole will not cause costly property damage, and
- there is no nuisance effect.

Natural scour holes are often unsuitable in Ethiopia due to undermining. Internal dissipaters have limited application and are more useful for long culverts such as would be found under multi-lane highways. Stilling basins are expensive and shall be considered only in extreme circumstances.

4.13 Debris Control

Debris control if necessary shall be considered:
- where clean out access is limited, and
- if the dissipater type selected cannot pass debris.

Design Methods

The designer has to choose whether:
- to design for local scour or channel degradation,
- to mitigate or monitor erosion problem,
- to use internal dissipaters, drop structures, external dissipaters, or stilling basins, &
- to use charts or computer software.

Types of Scour

Local scour is the result of high velocity flow and type of bed material at the culvert outlet. Although it, typically, extends a limited distance downstream, in Ethiopia scour can occur a considerable distance downstream.
Channel degradation may proceed in a fairly uniform manner over a long length or may be evident in one or more abrupt drops (head cuts) progressing upstream with every runoff event. It shall be mitigated and included in the initial construction. It is usually controlled with drop structures.

**Scour Hazard**

The scour hazard shall be considered and when unacceptable, designed for by providing protection at the culvert outlet.

- The initial protection shall be sufficient to provide some assurance that extensive damage could not result from one design runoff event or an average rainy season.
- The protection shall be inspected after major storms or after a series of lesser storms and at the end of each rainy season to determine if the protection must be increased or extended.

**Dissipater Types**

**Internal Dissipaters:** Tumbling flow or increased frictional resistance.

**External Dissipaters:** Riprap, Hydraulic jump, Stilling basins, Drop structures
APPENDIX 6: Standard Bill of Quantities for construction of cobblestone roads
STANDARD BILL OF QUANTITIES FOR
CONSTRUCTION OF COBBLESTONE ROADS
STANDARD SPECIFICATION FOR COBBLESTONE ROAD CONSTRUCTION

Specifications for Labour-Based Works

(Simplified Version)

1. Surveying and Setting out

Surveying

Fix Station points, PI, at 100-200m intervals for reference of the Centreline of the Road. Where there is a Horizontal curve or vertical curve the interval of the PIs will be less than 100 m.

Setting out

Fix centreline of the road by putting pegs at 20m intervals including setting of horizontal and vertical curves. Set out also cross-section of the road at 20m intervals or less as convenient, if terrain is very ragged, by placing pegs on centre, two sides and drainage lines of the road as well as following design patterns of the cobblestone. Pegs for cobblestone roads are in most cases made from pieces of reinforcement steel for accuracy and strength for driving them deep into the ground. The number of pegs along the cross-section of the road ranges from 7 to 13 depending on the pattern of the cobblestones and requirement of side drains.

Hand Tools for Surveying and Setting out

The hand tools to be used for surveying and setting out, but not limited to, are: pegs, strings, mason hammer, wooden or steel rods, profile boards, boning rods, etc.

2. Earthwork

Clearing and Grubbing

Remove trees, tree roots, bushes, big stones, grass and other obstacles with 15m width of the road reserve to allow movement of workers for smooth surveying and setting out works. Those trees to be retained, as ordered by the Engineer, will be kept undamaged. The material or debris as a result of clearing and grubbing will be deposited to the location as directed by the engineer.

Top Soil Excavation

Excavate the top 15-20 cm top soil to remove the soil with grass and organic layer of the soil which is very weak, compressible and not required for road construction. The excavated material will be deposited at a place directed by the Engineer.

Bulk Excavation

Excavate the layer of the soil next to the top 15-20 cm, if directed by the Engineer, where the soil layer is silt or black-cotton-soil or humus and not accepted as a sub-grade. The excavated material will be deposited at a place directed by the Engineer.
Backfill using Sub-base Material

Supply, spread and compact 15-20cm, or more of sub-base granular material or gravel sub-base as directed by the Engineer, to raise the level of the road fixed by the Engineer or as per the road design to the specific site. The material could be from a borrow pit or from site but approved by the Engineer.

Hand Tools and Equipment for Earthwork

The hand tools and equipment to be used in the activities under earthwork category, but not limited to, are: pickaxe, hoe, shovel, wheelbarrow, mattock, crowbar, axe, hand rammer, animal-drawn carts, tractor-trailer combinations (or trucks for Sub-base transportation), etc.

3. Cobblestone Paving

Laying of Fine Crushed Aggregate Base Course

Supply, spread to level and compact 5 to 7 cm base course, fine crushed aggregate from stone crusher site, keeping the design slope so as to enable Cobblestone paving following the slope.

Cobblestone Paving

Supply and lay to the required level 10x10x10 cm shaped cobblestones made of hard rock as per the layout, design & slope for the main body of the road and 15x15x10 cm shaped edge cobblestones following the design pattern of the cobblestones road pavement.

Filling Voids by Crushed Fine Aggregate and Finishing

Supply, fill and compact the spaces or voids between the cobblestones with fine crushed aggregate to prevent the movement of the stones due to traffic and make the pavement stiff. The surface should be cleaned afterwards.

Hand Tools and Equipment for Cobblestone Paving

The hand tools to be used for the cobblestone paving (including chiselling) and base-course laying activities, but not limited to, are: chisel, wedge, wheelbarrow, mason hammer, hammer, spirit level, wooden or rubber hammer, hand rammer, broom, wooden or metal plank, etc.

4. Curb stone

Supply and fix 15x25 cm shaped curb stones, 30 to 50 cm long each, between pavement and sidewalk, along both sides of the road with a cement mortar base of 1:4 mix and backed with C-15 concrete on the external sides of the road, for support, as shown in the design and fill joints with cement mortar of 1:4 mix. Additional hand tools for this activity are measuring box (for sand and crushed aggregate), bucket, plasterer knife, etc.

5. Storm Water Drains
Two categories of storm water drains are considered in this manual. They are road side drains that run parallel to the road and cross drains that take water on one side of the road to the other.

The side-drains include, among the few, curved-shape surface water drain, open drains, catch water drains and mitre drains. Where as cross-drains (include for Labour-based works among the few) pipe culverts, box culverts, arch culverts and drifts.

**Road Side Drains**

(a) **Curved Stone Side Drains**

Supply and fix 50x30 cm chiselled curved stone drains to drain rainwater, where necessary, the curved part is 5 cm is deep out of the 10 cm thickness, length of the stone piece is 30 to 50 cm and to be laid on a compacted base and joint filled with mortar of 1:4 mix.

Open Drains

Excavate and finish open drains as per the design provided and as directed by the Engineer. These are either trapezoidal earth canals or trapezoidal/rectangular lined canals to drain storm water on the sides of the road.

5.2 Cross Drainage

Pipe Culverts

These are to be constructed from prefabricated concrete pipes well-jointed with mortar. The culvert diameter, slope and length will be determined by the Engineer as well as wing walls, head walls, inlet/outlet riprap plus type of excavation/backfill to be as per design.

(a) **Box Culverts**

These are to be constructed from in-situ prepared concrete and masonry/concrete walls as determined by the Engineer following the design provided. The opening (size) of the culvert, wall material, top slab, length, wing/head walls, inlet/outlet riprap and excavation as well as detail design for reinforcement will be as per design.

(c) **Arch Culverts**

This type of culverts will be as decided by the Engineer and detailed design will be provided if it is recommended at some locations.

(b) **Drifts**

These are simple concrete-masonry combination structures where by water flows on it across the road with out causing erosion and smooth crossing of the waterway by traffic. The Engineer decides the width, length of drift and wing wells as well as inlet/outlet riprap and provides drawing for construction.
6. Wearing Course Option 2 – Gravel Wearing Course

6.1 Gravel wearing course

After road level is maintained using sub-base material, apply a well-graded Gravel Wearing Course with CBR > 20% compacted to 95% of modified AASHTO density for high traffic (AADT>15) road with 15 cm minimum compacted layer thickness and CBR>15 for low traffic road (AADT<15) (Refer to ERA 2002).

6.2 Gravel shoulders wearing course

Gravel shoulders wearing course with CBR > 20% compacted to 95% of modified AASHTO density (for high traffic AADT>15) with 10 cm minimum compacted layer thickness (Refer to ERA 2002).

7. Wearing Course Option 3 – Bituminous Wearing Course

After road level is maintained using sub-base material, apply Bituminous Surfacing Wearing Course by spraying hot bitumen on a well-graded spread crushed aggregate of a specified thickness as per the design laid on a clean, prime-coated surface. Then apply fine-grained crushed dust to fill the voids and compact it. Shoulder is same as Gravel Wearing Course. (Refer to ERA 2002).

i. Tolerance

Where necessary, the surface of the concrete shall have a plus or minus deviation of not more than 10 mm when measured with a 2 metre straight edge, in any direction. Where as chiselled stones for cobblestone and curb stone a plus or minus deviation of 10 mm. In the case of chiselled stones, small sized pieces can be used where chipping is required with no wastage.

ii. Testing

The Contractor shall help the Supervisor to sample the concrete and to make test cubes. The test cubes shall each be labelled with a paper label giving the date, the concrete mix and the position where the concrete was used. Slump cone measurements are to be made as frequently as required by the Supervisor. The results must be recorded in a site logbook.

iii. Overhaul

Hauling distance is taken as 150 m and when hauling is more than the allowable distance, overhauling will be paid to the contractor as decided by the Engineer.

iv. Measurement and Payment

11.1 Surveying and setting out, if measured separately, ……….. (Km) Payment includes supply of manpower and hand tools.
11.2 Clearing and Grubbing ............................... (Ha)
     Payment includes supply of manpower and hand tools.
11.3 Top Soil Excavation, ............................... (M2)
     Payment includes supply of manpower and hand tools.
11.4 Bulk Excavation ................................. (M3)
     Payment includes supply of manpower and hand tools.
11.5 Backfill ..............................................(M3)
     Payment includes supply of manpower and hand tools.
11.6 Laying of fine, crushed aggregate base-course ..........(M2)
     Payment includes supply of material, manpower and hand tools.
11.7 Cobblestone Paving ...................................(M2)
     Payment includes supply of material, manpower, chiselling, laying and hand tools.
11.8 Curb stone ............................................(ML)
     Payment includes supply of material, manpower, chiselling, laying and hand tools.
11.9 Curved stone side-drains ...........................(ML)
     Payment includes supply of material, manpower, chiselling, laying and hand tools.
11.10 Open drains and cross-drains:
     Each item is measured separately like: excavation (M3), Backfill (M3), lining (M2),
     concrete (M3), steel reinforcement (Kg), formwork (M2), masonry (M3), riprap (M2).
11.11 Gravel wearing course for road and shoulder, with specified thickness: .... (M3)
     Payment includes supply of material, spreading, compaction, manpower and hand tools.
11.12 Bitumenprime coat: .....................................(M2).
     Payment includes cleaning the surface, applying bitumen and material.
11.13 Bitumen Surface wearing course
     Payment includes crushed aggregate, bitumen, applying bitumen, crushed dust,
     spreading/ compaction of aggregate & dust, equipment, labour and hand tools.
# (1) BILL OF QUANTITIES FOR COBBLESTONE ROAD CONSTRUCTION

**Bill of Quantities, BoQ, for Cobble Stone Road Construction**

<table>
<thead>
<tr>
<th></th>
<th>1. Surveying and Setting out</th>
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<th>2. Earthwork</th>
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<tr>
<td></td>
<td>Surveying</td>
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<td>Clearing and Grubbing</td>
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<tr>
<td>1</td>
<td>Fix Station points, PI, at 100-200m intervals for reference of the Centreline of the Road. Where there is a Horizontal curve or vertical curve the interval of the PIs will be less than 100 m.</td>
<td></td>
<td>Remove trees, tree roots, bushes, big stones, grass and other obstacles with 15m width of the road reserve to allow movement of workers for smooth surveying and setting out works. Those trees to be retained, as ordered by the Engineer, will be kept undamaged. The material or debris as a result of clearing and grubbing will be deposited to the location as directed by the engineer.</td>
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<td>Setting out</td>
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<td>Top Soil Excavation</td>
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<td></td>
<td>Fix centreline of the road by putting pegs at 20m intervals including setting of horizontal and vertical curves. Set out also cross-section of the road at 20m intervals or less as convenient, if terrain is very ragged, by placing pegs on centre, two sides and drainage lines of the road as well as following design patterns of the cobblestone. Pegs for cobblestone roads are in most cases made from pieces of reinforcement steel for accuracy and strength for driving them deep into the ground. The number of pegs along the cross-section of the road ranges from 7 to 13 depending on the pattern of the cobblestones and requirement of side drains</td>
<td>Excavate the top 15-20 cm top soil to remove the soil with grass and organic layer of the soil which is very weak, compressible and not required for road construction. The excavated material will be</td>
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<p>| KM |   |   | Ha |   |</p>
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<tr>
<th>Deposited at a place directed by the Engineer.</th>
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<tr>
<td><strong>Bulk Excavation</strong></td>
<td>M³</td>
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<tr>
<td>Excavate the layer of the soil next to the top 15-20 cm, if directed by the Engineer, where the soil layer is silt or black-cotton-soil or humus and not accepted as a sub-grade. The excavated material will be deposited at a place directed by the Engineer.</td>
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<tr>
<td><strong>Backfill using Sub-base Material</strong></td>
<td>M³</td>
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<tr>
<td>Supply, spread and compact 15-20cm, or more of sub-base granular material or gravel sub-base as directed by the Engineer, to raise the level of the road fixed by the Engineer or as per the road design to the specific site. The material could be from a borrow pit or from site but approved by the Engineer.</td>
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<td><strong>3. Cobblestone Paving</strong></td>
<td>M³</td>
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<tr>
<td><strong>Laying of Fine Crushed Aggregate Base Course</strong></td>
<td>M²</td>
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<tr>
<td>Supply, spread to level and compact 5 to 7 cm base course, fine crushed aggregate from stone crusher site, keeping the design slope so as to enable Cobblestone paving following the slope.</td>
<td></td>
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<tr>
<td><strong>Cobblestone Paving</strong></td>
<td>M²</td>
</tr>
<tr>
<td>Supply and lay to the required level 10x10x10 cm shaped cobblestones made of hard rock as per the layout, design &amp; slope for the main body of the road and 15x10x10 cm shaped edge cobblestones following the design pattern of the cobblestones road pavement.</td>
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<tr>
<td><strong>Filling Voids by Crushed Fine Aggregate and Finishing</strong></td>
<td>M²</td>
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<tr>
<td>Supply, fill and compact the 10mm spaces or voids between the cobblestones with fine crushed aggregate to prevent the movement of the stones due to traffic and make the pavement stiff. The surface should be cleaned afterwards.</td>
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<td><strong>4. Curb stone</strong></td>
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<tr>
<td>Supply and fix 15x25 cm shaped curb stones, 30 to 50 cm long each, between pavement and sidewalk, along both sides of the road with a cement mortar base of 1:4 mix and backed with C-15 concrete on the external sides of the road, for support, as shown in the design and fill joints with cement mortar of 1:4 mix. Additional hand tools for this activity are measuring box (for sand and crushed aggregate), bucket, plasterer knife, etc.</td>
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</table>
5. Storm Water Drains

(b) Curved Stone Side Drains

Supply and fix 50x30 cm chiselled curved stone drains to drain rainwater, where necessary, the curved part is 5 cm deep out of the 10 cm thickness, length of the stone piece is 30 to 50 cm and to be laid on a compacted base and joint filled with mortar of 1:4 mix.

(c) Open Channel Earthen Side Drains

(d) Lined Canal Side Drains

(e) Culverts
   - Pipe Culverts
   - Box Culverts
   - Arch Culverts

(e) Drifts
APPENDIX 7: Labour based construction methods for roads
Federal Democratic Government of Ethiopia

MINISTRY OF WORKS AND URBAN DEVELOPMENT

LABOUR-BASED CONSTRUCTION

METHODS FOR ROADS AND STORMWATER DRAINS
## CONSTRUCTION METHODS

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1 PRINCIPLES OF LABOUR INTENSIVE CONSTRUCTION

1.1 Definition:

Labour-intensive construction is the economically efficient employment of as great a proportion of labour as is technically feasible throughout the construction process to achieve the standard demanded by the specification; the result being a significant increase in employment generated per unit of expenditure by comparison with conventional equipment-intensive methods.

The labour-intensive approach is one that optimises rather than maximises the labour content of a project. This is implied by the use of the term "economically efficient". Such projects are also termed labour-based. Labour-intensive works will be undertaken by an appropriate mix of labour and equipment possibly with some animal support. The methods used must be cost-effective and the end product quality must be fully adequate.

1.2 Principles

Within the bounds laid down by the specification, the labour intensive contractor should employ as much labour as he can efficiently use. This does not mean as much labour as possible, because this would quickly become "labour extensive" if efficiency is ignored. For example, compaction by hand can be efficiently done in narrow spaces, like backfill beside the walls of a box culvert. However, compaction of the sub grade by hand tampers is not efficient, because of the difficulty of obtaining a high enough density and the time and cost implications.

Note that efficiency is largely a management problem. Management needs to plan the work; needs to find new and more efficient methods of doing the work. For example, loading gravel is done more quickly if the material can be shovelled across at the same level or even shovelled downwards. Trucks can therefore be more quickly loaded if the truck stands below the labourers loading it. The sketch below explains the principles:

![Figure 1.1](image)

Table 1.1 Influence of loading height
Another example is the excavating of hard dense gravel in a borrow pit. If a bulldozer can be obtained (at a reasonable cost) to rip the gravel and to loosen it to considerable depth, labour will be able to excavate and stockpile the gravel far more quickly. This is what is meant by "an appropriate mix of labour and equipment".

2 CLEARING AND GRUBBING
2.1 Introduction
Clearing and grubbing is the term used to describe the removal of vegetation, rubbish and rocks from the area needed for construction. Clearing means the removal of material on and above the ground, while grubbing is the removal of roots from under the ground.
Removal of topsoil is not included in clearing and grubbing, although in special circumstances it may be done together with the removal of grass and other low-growing vegetation.

2.2 Setting out
In order to undertake clearing and grubbing in the right place, the centre-line of the road must be established and the points of intersection (PIs) surveyed in. The beginnings and ends of all substantial curves must also be pegged. In order to set out the centre-line, it may already be necessary to clear a strip at least 1 m wide to allow for sight lines through the bush.

From the centre-line survey, flags can be placed at intervals along the road reserve boundaries, so that clearing and grubbing can be done to sightlines between flags. Once the road reserve is properly cleared, the centre-line can be pegged at the normal 100 m intervals, control points can be established and reference pegs put in where required.

Drainage ditches will need to be set out entirely, so that sufficient ground can be cleared for them. As for the roadwork, it may be necessary to set out drainage works in stages if the bush is very thick.
2.3 Clearing and grubbing

The sequence of operations is important. Team sizes should generally comprise about five people. Once one activity has progressed to the point where sufficient space has been cleared, the next activity can be started. The numbers of teams engaged should be related to their productivity and speed. The teams should be in balance, so that no portion of the work delays other activities or progresses too far ahead.

1. The first team should cut down trees within the area to be cleared. The treetops should be cut, leaving a trunk about 5 m high. All side branches should be cut off using axes and saws. The timber resulting from the trees should be sawn up into convenient lengths and stacked to one side. Separate piles should be made for leaves and thin branches.

2. Bush and other tough vegetation should be cut down by the second team, to ground level if possible, cut to convenient lengths using axes and saws and stacked.

3. After trees and bushes have been cleared from an area of at least 100 m², the third team can start. Grass and remaining vegetation should be removed at ground level by means of spades or hoes. The resulting debris should be raked to one side and added to the piles of thin branches and leaves.

4. Once a large enough portion of ground is clear, the fourth team should dig a trench around the nearest tree and chop through the roots. Tools needed are picks and shovels or hoes and axe or mattock. The trench should be about one metre deep (less if the tree is small) and the team should attempt to undermine the tree stump. As soon as one tree has been trenched and all accessible roots cut through, a rope should be fixed to the top of the trunk and a team of labourers gathered to pull the tree down. As the tree moves, further roots may become visible and accessible: these roots should be cut free at the level of the base of the hole while the pulling team rests. Progressively the tree trunk is thus brought down, using the leverage of the length of the trunk to tear out as many roots as possible. Once the tree and stump have been brought down, they should be rolled away from the hole and cut into convenient lengths. All major roots must be dug out and removed to a depth of 0.5 m.

Large bushes should be trenched and their root systems removed. The roots of smaller bushes can be dug out together with the grass roots. The soil dug out of the trenches around trees and large bushes should then be returned to the trenches. Roots should be carefully separated from the soil and only clean soil used for backfill. The tree hole backfill is to be compacted in thin layers as follows: the soil is to be dampened and mixed and then placed into the trenches in layers about 100 mm thick. The soil in each layer shall be compacted with hand tampers until firm. The trenches shall be compacted up to 200 mm below the ground surface. The rest of the soil can then be thrown loose into the trenches.

5. The fifth team is to dig over the soil to a depth of 200 mm and remove all root material from the grass and small bushes. Garden forks and forked hoes are efficient tools for this activity. The roots should be raked to one side. If the topsoil has to be removed, this is best combined with the digging for root removal (if the
topsoil is to be spread onto the road verges, it is advantageous if it contains vegetable matter like grass, seed and roots).

6. The debris resulting from the clearing and grubbing should be disposed of as instructed. Local people will usually take the timber for firewood. If regulations permit, the thin sticks, roots and leaves can be burnt and the ashes dispersed into the bush adjacent to the works (where it will act as fertiliser). Otherwise the rubbish may need to be transported to worked-out borrow pits and spread.

3 SETTING OUT PRINCIPLES

3.1 Profiles

Drawings will generally give all the dimensions needed for setting out.

Layer works can be controlled by level pegs or profiles at 10 m intervals, placed on both sides of the road, when using string-lines. However, base course level control; 5 m spacing between levels is needed for greater accuracy. Profile poles with string lines and dipsticks should be used, as the string lines can be strung diagonally between poles as well as at right angles across the road formation. This gives level control between the poles as well as at the cross-section at the poles.

Figure 3.1

Excavations and slopes are best set out by means of profiles together with boning rods or string lines.

Portable templates, levelled by means of small spirit levels, give accurate information to teams excavating drains, as they show widths and slopes. See sketch below.
Boning rods are one of the best methods of transferring slopes or levels to the work. However, they cannot be used to measure slopes. Profiles are set up to the same height as the length of the boning rods. The profiles are set to the gradient or level and a boning rod is held between two profiles by one person while another sights across the profiles to the top of the boning rod. When it is exactly on the line of sight the bottom of the boning rod is at the required height. The boning rod can be moved anywhere between the profiles and can be used to check if the work is at the correct slope or correct height.

Reference pegs are pegs of wood or steel that has been placed into position for record purposes. The pegs record either a position or a height or both. They are usually placed outside the work area, so that subsequent construction does not disturb them. Centre-lines are always referenced so that construction work can proceed, but when the centre-line peg is removed, its position can be re-established by means of the reference pegs. This is an important point that all leaders must remember: do not disturb or remove an important peg before it has been adequately referenced.
(1) Definition of a Horizontal Curve and Terms
A horizontal curve joins two sections of straight road. See diagram below for explanation of the terms.

Definition of terms
PI = Point of Intersection of the two straight lines that are tangential to the curve.
BC = Beginning of Curve
EC = End of Curve
Tangent Length = length of the straight line from BC to PI and from PI to EC.
Deflection angle = angle through which a person turns when walking the curve from beginning to end.
Tangent length = $R \tan \left( \frac{1}{2} \text{deflection angle} \right)$

(2) Horizontal Curve Setting Methods

(a) String Method
This is a method where by strings are used on the ground to set a horizontal curve. Refer to Fig. 3.5 and associated steps to be followed in setting the curve using this method.

Figure 3.4  Tangent length and deflection angle

Definition of terms
PI = Point of Intersection of the two straight lines that are tangential to the curve.
BC = Beginning of Curve
EC = End of Curve
Tangent Length = length of the straight line from BC to PI and from PI to EC.
Deflection angle = angle through which a person turns when walking the curve from beginning to end.
Tangent length = $R \tan \left( \frac{1}{2} \text{deflection angle} \right)$

(b) Quarter Method
This is also another method to be used to set horizontal curves on steep locations and very sharp curves where there are obstacles to get the point of Intersection, PI, of the curve. Refer Fig. 3.6 and associated steps to set a curve using this method.

Figure 3.6 Horizontal curve setting using string methods.

3.5 Heights
All construction work is built to a height to suit the work and the surroundings. Most construction work is built to a slope or gradient, but some is built horizontally. The height to which the work it built depends on the function the work has to fulfil. For example, a drift has to be built to a particular height so that storm water can flow across it and that traffic can cross it. The drift has two functions, which makes the height to which it is built even more important.

3.6 Slope or gradient
Slope is usually measured as a ratio; the vertical amount is given first, followed by the horizontal amount. For example, a road cross-slope is usually between 1 in 40 and 1 in 50. This slope is sometimes written as 1:40 or 1:50. It means that the slope goes up (or down) by 1 unit for every 40 or 50 units measured horizontally. We will call this the "slope number".

Note that the units for measuring the slope must be the same, but can be millimetres or metres or any other consistent unit. The slope number is the horizontal length divided by the height and the slope is given as "1 in slope number".
Note the formula:

\[
\text{Slope number} = \frac{\text{horizontal length of slope}}{\text{height difference}}
\]

and the slope is then given as "1 in the slope number".

Gradient is the slope along the length, usually of a road or drain. It is usually given in the same units as slope, for example, a typical road side-drain would have a gradient of 1:100 (or 1 in 100), that is, for every 100 m horizontal length of drain, it will fall 1 metre.

3.7 Vertical curves
The "horizontal alignment" of a road is the arrangement of straight sections and horizontal curves that locate the road in plan, that is, on a map.

The "vertical alignment" of a road is the arrangement of gradients and vertical curves that take the road over rises or hills and through dips or valleys. Each straight grade is linked to the next by a vertical curve.

Definitions
**Straight grade** is a length of roadway that has a constant slope. The gradient is given by means of the slope number as "1 in the slope number" and is shown + when the gradient goes upwards in the direction of increasing chainage, that is, a rise; and is shown - when the gradient goes down in the direction of increasing chainage, that is a fall. Gradients can also be given as a percentage, calculated as 100 / slope number. Zero gradient means that the road is horizontal.

![Diagram of vertical alignment with crest curve](image)

**Figure 3.5**

Crest curve is a curve that goes over a rise. The gradient in the crest curve changes from a steep rise to a lesser rise or from a rise to a fall or from a slight fall to a steep fall.

![Diagram of crest curve](image)

**Figure 3.6**

Sag curve is a curve that goes through a dip. The gradient in the sag curve changes from a steep fall to a slight fall or from a fall to a rise or from a slight rise to a steep rise.
Figure 3.7

Calculation of a parabolic vertical curve
For a symmetrical parabola, which has the curve length centred at the vertical point of intersection (VPI), the following equations should be used:

\[ m = \frac{A L}{8} \]
\[ x = \frac{y^2 A}{2 L} \]

and
\[ x = 4 m \left(\frac{y}{L}\right)^2 \]

where \( m \) = half the offset of the VPI from the chord
\( x \) = offset from the grade line (tangent)
\( y \) = distance measured along the grade line (tangent) from the beginning of the vertical curve (BVC) or the end of the vertical curve (EVC) towards the VPI, to the point where offset \( x \) is measured
\( L \) = length of vertical curve (from beginning to end)
\( A = \frac{\text{gradient after curve} - \text{gradient before curve}}{100} \)

Refer to the diagram below:

Figure 3.8 Sag curve

The equations hold equally well for crest curves. See diagram below:
EXCAVATIONS

4.1 Safety

Dangerous excavations will need to be closed or fenced off in such a way that people cannot fall into the excavation at night. This implies that the wire used for the fence must be strong enough to catch a person walking into the fence and must prevent them falling through. “Safety tape” which a thin plastic tape is only good for showing where the danger lies: it is not strong enough to stop people walking through.

Any work near a roadway carrying traffic must be barricaded in such a way that drivers can see clearly where they should go. Road signs must be posted at least 100 m away to warn drivers that work is being done in or near the road. Red danger flags may be necessary if traffic has to be directed. All workers exposed to the traffic must wear safety vests with bright colours so that they are easily seen. The Supervisor must arrange for the supply of all traffic signs and flags as well as any other materials required to provide for safety on the site.

The sides of excavations must be made safe so that they do not fall onto workers in the excavation. Trenches for pipelines and cables are especially dangerous as they are narrow and may be very deep. By law precautions must be taken for every excavation over 1.50 m deep. The sides must be sloped or must be supported with planks and struts. In road and drainage works we will seldom need to dig trenches so deep that they need to be supported. However, all Supervisors must be aware of the danger of earth slips or earth movements that could endanger lives.
4.2 Organisation of excavations
Excavation must be carefully planned to ensure both safety and efficient working. The basis of planning excavations is:

- Set out the work the previous day.
- Avoid double handling: as far as possible once soil is on a shovel, it should be put into its final position. It is not efficient to move soil from heap to heap several times and then to load it. It should be loaded immediately or placed into the final heap before loading.
- Use wheelbarrows wisely. Use them only when soil has to be moved further than it can be thrown. Wheelbarrow pushers should usually load their own barrow and not wait for someone else to load for them.
- Plan the correct sequence of the work.
- Use appropriate tools in good condition: good tools enhance productivity, poor or worn tools cut productivity to low levels. The use of the right tool can also ensure that good quality is achieved.
- Balance team sizes: no part of the work force should be far ahead or far behind any other part of the work force. No one should have to wait for another to finish before he can start. When the output of work teams is properly balanced, the work is done efficiently.
- Team tasking is recommended. This allows people to share the work.
- Arrange loading carefully: loading on level or downwards is more productive than loading upward. For example, loading a tipper truck from above is much quicker than loading it from ground level, as every shovel full must then be heaved up and over the side of the truck.
- Use templates and profiles extensively to control the shape and level of excavations. This allows the workers theMSE/Local Contractorlves to carry out quality control. Boning rods or string lines with "dip-sticks" are also useful for controlling levels, but space the profiles accordingly.

1 Borrow pits are used for the supply of soil for filling or gravel for layer works. Borrow pits for gravels are found by looking at the geology and topography of the area. When a suitable area has been seen, trial holes have to be dug to show if the right gravel is there. From inspection of the trial holes the quality, depth and extent of the gravel can be seen and measured. The average thickness of each layer can be calculated and multiplied by the plan area to obtain the volume. If the layers vary very much, the
method of end areas may have to be used for volume calculation. If you know where the gravel is needed, you can calculate the quantity of gravel required and can then check if the borrow pit is large enough. For labour intensive work, small borrow pits can be opened and used.

2 Clearing and grubbing is needed before a borrow pit can be opened. The environmental requirements of the contract may need the plants that are removed from the road and borrow areas to be replanted along the roadway or at rest stops. Before stripping vegetation from the borrow area, check the environmental specification.

Most borrow pits have a layer of “overburden” that has to be removed before the correct soil or gravel can be excavated. The overburden may be topsoil or it may consist of a sandy soil suitable for fill. If the overburden is useful for road works, it should be used on condition that the haulage distance is small. If the haulage is too far, or the material unsuitable, the overburden should be removed and placed into heaps or windrows at the sides of the borrow pit. This implies that the size of the borrow area must be known and must be set out. The size can be calculated from the trial pits that show the extent and depth of the desired gravel and from the amount of gravel needed.

4.3 Strip topsoil
Topsoil is the fertile soil in which our food can be grown. In Africa there is not a great quantity of good topsoil, so we must not spoil or throw away any topsoil in our roads or drainage works. The layer of topsoil is usually quite thin: often not more than 200 mm.

In road works we use topsoil to cover the sides of the road banks, so that grass can grow there and prevent soil erosion. Similarly, drainage control banks and berms need to be covered with topsoil to encourage growth of grass to prevent erosion by fast-flowing water.

After clearing and grubbing is complete, the topsoil is to be removed with shovels and/or forks to a stockpile for later use. Depending on the use of the topsoil, it may be stripped with some of the grass and low vegetation, or it may need to be clean and without grass or roots.

As the colour and texture of topsoil is usually quite different to that of the subsoil below it, it is easy to see how much to excavate. The Team Leader must show his or her team what the topsoil is and how to distinguish it from the subsoil below. The team is then instructed to remove the layer of topsoil and to place it into a windrow alongside the work site. A windrow is a low long heap, at the side of the work. All the topsoil should be removed from the work site. The reason for this is firstly, that topsoil is scarce and must not be wasted, but secondly, that the strength of topsoil for road building is usually lower than the strength of the subsoil. For road works we need the strongest possible soils.

In order to preserve topsoil, we need to know that it is alive with seeds, insects and bacteria. None of these must be killed, so the heap of topsoil must never be more than 0.6 m high and must not be compacted. Good topsoil does not have traffic driving over it or people walking on it, because both cause compaction of the soil.
If the position of the windrow has been correctly chosen, the soil will be out of the way of the construction activities, and yet will be near enough to be easily spread across the road side-slopes, after the slopes have been trimmed to shape.

5 TRANSPORTATION

5.1 Introduction
Transportation is one of the most important activities in planning construction. Soils and gravels need to be excavated and moved, placed and compacted. Transportation ranges from throwing soil with a shovel a few metres to carrying it in a truck for several kilometres. Each kind of transportation has different characteristics and gives different problems.

5.2 Shovels
Shovels can be used to throw soil up to about 4 m. If a longer distance is needed, only a very strong worker will be able to throw soil further than 4 m, perhaps up to 6 m or 7 m. Less strong workers will have to carry the shovel with soil until near enough to throw it. Excavation productivity is lower if the soil has to be thrown or carried over a distance. A point is quickly reached where productivity will increase when wheelbarrows are used instead of carrying and throwing from a shovel. This distance is between 6 m and 10 m.

5.3 Wheelbarrows
Wheelbarrows are used for haulage up to 100 m, and in certain circumstances, up to 200 m. Good quality wheelbarrows with rubber tyres on steel wheels with roller bearings are best. Solid rubber tyres are preferred to pneumatic tyres, to avoid problems with punctures. Most wheelbarrows made for concrete work have a capacity of 50 litres to 65 litres. Larger wheelbarrows are also available.

In order to perform their function correctly, wheelbarrows need to be kept in good condition. All bolts should be tightened every week and any missing bolts must be replaced. The wheel needs to be regularly lubricated, preferably with thin oil. If the wheel bearings become excessively caked with dust, they should be dismantled and cleaned in paraffin or other suitable solvent, properly dried with a clean cloth and greased with a light bearing grease, before re-assembly. Well-lubricated wheels lighten the load.

Wheelbarrows function best when a smooth path or runway is available for travel. It improves productivity to spend some effort in providing a better pathway. A "good" haul route can improve productivity by 30% over an "average" haul route, which is in turn 30% better than a "poor" haul route [Coukis, 1983].

One way traffic or a “circular” route should be chosen where-ever possible to speed up the transportation of soils, as waiting is reduced or eliminated and as it reduces time lost in turning the wheelbarrow around after tipping or loading.

The productivity and time taken for a wheelbarrow trip depends not only on the length of the haul and the condition of the road, but also on the rise. Pushing a loaded barrow uphill takes more effort and time than if the path were level. If steep slopes have to be negotiated, a helper with a hook can greatly speed the passage of the wheelbarrow up the slope, by hooking onto the front of the wheelbarrow and helping by pulling the load up the slope.
If wheelbarrows are to be used to transport loads up scaffolding, care must be given to making the scaffolding runways wide enough and to providing substantial handrails to the runways. If a worker pushing a heavily loaded wheelbarrow loses his balance, he must be supported by the hand railing and must not be able to fall through and off the scaffold.

5.4 Animal-drawn carts
Donkey or horse-drawn carts are efficient transportation for distances of up to about 2 or 3 kilometres. Carts have a capacity of between 0.50 m$^3$ and 2.0 m$^3$. This is a large variation, so every cart should be measured to ascertain its volume.

The care of the donkeys or horses must be good, as they can easily be overworked. The harnesses must be strong and must fit well. Poor harnesses will cut the animals, hurting them so that they can no longer work. Animals need regular water and fodder. Fresh clean water must be provided at the loading and the offloading points. Animal-drawn carts will generally be transporting materials on contract, so the responsibility of looking after the animals and maintaining the cart will be the responsibility of the sub-contractor. However, under certain circumstances, the Road Builder may need to take over this responsibility.

In order to perform their function correctly, the carts must be kept in good condition. All bolts should be tightened every week and any missing bolts must be replaced. The wheels need to be regularly checked, that there is no binding or looseness in the bearings. Well-lubricated wheels lighten the load. If steep gradients are to be negotiated, it is essential that they be fitted with brakes. Punctures must be mended immediately.

Carts should not be overloaded. Offloading can be done by hand, using shovels. Some carts are fitted with a tipping mechanism, which, when released, allows the load to tip backwards onto the road. The load should be placed in the correct position.

5.5 Tractor-trailer combinations
Loading the transport quickly is important. Tractors and trailers are expensive machines and they must earn their cost. A tractor that stands for most of the day is not earning: these machines must travel. The loading area must be carefully planned so that the transport can enter, be loaded quickly and leave again.

Trailer volumes vary from about 1.0 m$^3$ up to 5 m$^3$ and sometimes larger. This is a large variation so every trailer should be measured up and its volume calculated.

Tractors must be used with more than one trailer, so that one trailer can be loaded while the other trailer is being towed away with gravel for the works. When the tractor returns with an empty trailer, the next must already be loaded and ready to be hitched up to the tractor in the place of the empty trailer. One tractor with two or three trailers can be quite efficient. However, if only one trailer is available, then the efficiency drops to very low levels and the transport will be very costly.

Loading by throwing materials upwards takes much effort and is slow. Loading at the same level is quicker and does not need as much effort. Loading downwards is easy and
therefore quick. Arrange the loading area so that the tractor and trailer are below so that the loaders work from above, shovelling from a stockpile directly into the trailer body.

Offloading a trailer must, likewise, be done quickly, in order to keep the tractor from idling. Some trailers are fitted with a tipping mechanism, which, when released, allows the load to tip backwards onto the road. Other trailers have hinged sides that can be flapped down to facilitate offloading with shovels. Others still have a fixed body and simply have to be emptied with shovels. Sufficient workers must be allocated to offloading, but no more. Too many workers will either get in each other’s way and slow down the offloading, or will distract the off loaders with chatting and joking. When the trailer is empty and the tractor tows it back to the borrow pit, the workers should spread the loads while waiting for the next tractor to arrive.

If large four-wheeled trailers are used, thought should be given to possible increases in productivity if a fully-loaded trailer could be unhitched at the offloading point, to be cleared at leisure, while an empty trailer is hitched up to the tractor to be taken back to the borrow pit for reloading. This system therefore has full and empty trailers at both the borrow pit and at the road, while the tractor travels between, towing trailers each way. Obviously several trailers are needed.

The load should be placed in the correct position, to make the work of spreading easier. Note also that the quantity of material needed to make up the layer must be spread evenly along the road, otherwise bumps can be formed where there is too much material and hollows where there is a shortage.

5.6 Trucks
Trucks must be loaded when they arrive at the borrow pit. Arrange the loading area so that the truck is lower than the loaders. Note the difference in height of the types of trucks available. Tipper trucks are very high and will need a lower loading position than flatbed trucks. If the trucks are mixed, then two loading areas may be necessary to suit the different loading heights.

Trucks are generally classified according to the mass they can carry, for example a 3 tonne flatbed or a 10 tonne tipper is typical sizes. Loose soil can have a density of 1400 to 1600 kg/m³ and loose gravel from 1600 to 1800 kg/m³. Use the formula

\[
\text{Volume} = \frac{\text{Mass}}{\text{Density}}
\]

to calculate the volume of soil that can be carried by a truck. Also measure the actual volume of the load area and compare this to the volume calculated from the allowable mass. For particularly heavy gravels, reduced volumes will have to be used, in order that the truck is not overloaded.

To speed up the loading, arrange a large stockpile of gravel always ready for loading and take workers away from other teams when the truck arrives, so that enough loaders, arranged around the truck, can load the truck in a few minutes.

Offloading a truck must, likewise, be done quickly, in order to keep the truck from idling. Tipper trucks can offload the material quickly onto the road and do not need
workers to help. Flat-bed trucks have hinged sides that can be flapped down to facilitate offloading with shovels.

The load should be placed in the correct position, as noted above.

5.7 Haul roads
As soon as wheeled transport is used, haul roads become important. Just as wheelbarrows need a smooth runway to operate efficiently, so do donkey carts, tractors and trucks need smooth roads. Rough roads will cause the drivers to go slowly so as not to cause damage to tyres, axles and bodywork. Smooth roads speed the loads and keep wear and tear to a minimum. The haul road must be maintained. The drainage must be kept in good condition and the road surface must be kept smooth. A team of road maintenance workers will have to be allocated to keeping the haul roads in good condition. Regular raking of the road surface and shovelling of loose windrows across the width of the road will be needed. Potholes must be cleaned out and refilled with damp gravel, well stamped into place with a heavy tamper. Erosion damage must be repaired as soon as possible with damp gravel, well compacted.

Roads at and around a borrow pit should be one-way, to prevent accidents, to reduce reversing and turning and to speed up the transportation process. Similarly, at the road site where the materials are offloaded, a one-way system is needed.

6 EARTHWORKS
6.1 Roadbed preparation
The roadbed comprises in situ material, often with some extra soil or gravel to make up the level. The roadbed is unlikely to be at the level or be to the shape required. Note that in most cases the roadbed has to be dug loose to the depth specified (or read from the drawing) and recompacted.

![Figure 6.1 Roadbed showing in situ and imported materials](image)

- After the road has been set out, measure the level and shape of the roadbed. Mark out clearly where the in situ material is too high and allocate workers to excavate this material, using picks and shovels, to the correct level and shape.
- Calculate the volume of additional material (from cut or borrow) that will be needed to bring the layer to its correct level and shape.
Use the excavated material to fill in holes and hollows. Compact the deeper holes properly with hand tampers.

Now loosen the whole roadbed to the required depth with suitable tools and windrow the material, preferably in the middle of the road.

Bring in the extra material, dumped at the necessary spacing and combine the two materials in the windrow along the centre line (or side).

6.2 Placing imported material

If the layer work is being done while traffic uses the road, the heaps should be dumped along the side of the road. If traffic can be excluded, then the material should be dumped on the centre-line.

From the layer width and thickness required, the volume of compacted material can be calculated. The loose volume can now be calculated, using the compaction shrinkage factor.

\[
\text{Loose volume} = \text{Compacted volume} \times \left(1 + \frac{\text{compaction shrinkage factor}}{100}\right)
\]

As a typical value of the compaction shrinkage factor is 35%,

\[
\text{loose volume} = \text{compacted volume} \times 1.35
\]

Knowing the volume of loose material transported, the spacing of the heaps dumped by the chosen transport can be found.

6.3 Spreading

The material should be spread in such a way as to make subsequent mixing easier. Particularly if two materials are to be mixed, they should be tipped in alternate heaps if possible, or formed into two long heaps beside each other so that proper mixing can be done. Soil spread across the full width of the roadway cannot be efficiently mixed by hand. The loose material should be spread into one flattened windrow about 2 m to 2.5 m wide. The top of the windrow should be slightly hollowed, in order to hold water. The windrow of material should be of a constant height.

![Figure 6.2 Road in section showing material windrow](image)

The material is now ready for watering, mixing and compaction.

6.4 Adding water and mixing
Add water to the hollow in the windrow of dry material from a water bowser and let it soak in. As soon as water has been given some time to soak in, the heap must be mixed. The best tool for the job will depend on the soil type: soils with little clay and silt are best mixed with shovels; clay and silt are easier to handle with forks. Look carefully at the soil type and choose, or try both tools to find which works better for the soil you have.

The soil in the whole windrow must be mixed so that the soil type is uniform throughout and so that the moisture content is uniform and above the "optimum moisture content" (OMC) throughout. Move the wet top of the heap to one side and add enough of the drier material from lower in the heap to mix the soil to above OMC. Now add more water to the dry windrow and repeat the process until the whole of the material is about right. Note that the mixing process has moved the windrow to one side.

Work the windrow over again, moving it back to the road middle and mixing it through. Any dry spots must be watered. Watering cans will be useful for this job, as the dry spots should be small. If however, much dry material is exposed, the water bowser should be recalled to water the strip again. In order to mix the whole windrow materials and water, the soil should be turned over at least three times, four times may be necessary if the soil is very dry.

The easiest way to feel if the soil is near its OMC is to take a handful of soil and to squeeze it tightly. At OMC the soil will form into a firm ball. If it is too wet, the ball will be soft and shiny and your hand will be stained with the colour of the soil. If it is too dry, the ball will crumble easily. Anyone with a little experience can tell by feeling the soil if it is at OMC or not. If the soil is too dry, add water. How much? If the soil is a little dry, add only a little water. If the soil feels very dry, add quite a lot. Experience will soon teach you how much to add. If the soil is too wet, how can you take water out of the soil? Easy! Loosen the soil, spread it out and let the sun and wind dry it. But be careful that the soil does not dry too much, so keep checking.

Note that spreading, levelling and compacting the soil takes time, and that all the time the sun and wind are drying out the soil. Start with the soil slightly wet of optimum, and if it dries out too much while it is being handled, add more water.

6.5 Spreading and levelling
Spread the moist mixed material across the roadway. Tools needed are shovels and rakes or spreaders. Level it to the loose height that is at least 1.5 times the compacted height. This height depends on the soil type and the moisture content and cannot be precisely calculated. The spread height can be checked from the quantity of material on the road. If there is material left over when it is spread to 1.5 times the compacted thickness, then the material has bulked more than 1.5 times, and the spread height should be increased. If there is not enough material to spread across the road at the chosen spread height, then the spread height is too large and should be decreased.

The shape of the layer of soil spread must be exactly the desired shape of the finished layer. Use a straight edge to check for bumps and hollows, if you cannot see the level variations by eye.
7 Cobblestone Paving

7.1 Introduction

Advantages of cobblestone paving:
- use African materials (cement, sand, stone)
- are laid by hand (provide jobs in construction)
- can be opened to traffic immediately after completion (no curing)
- easily repaired
- stone sets can be recycled at minimum cost
- can be made in many shapes and thickness
- have a high resistance to fuel and oil spillage
- low maintenance cost

Disadvantages of cobblestone paving:
- relatively high initial cost
- uneven riding surface (too rough for high-speed roads)
- stone sets need to be cut to fit edges
- edge restraint (curbs) essential (increases cost)

7.2 Construction

Start with inspection of the sub base on which the cobbles are to be laid. The sub base should be strong and well compacted and must be laid to the correct slope. Once you are satisfied with the condition of the sub base, set out the edge restraint or curbing. Cobblestone paving must be supported by strong curbs.

Construct the curbs, using the correct size stone curbs, according to the drawings. Quarried stone curbs are generally 8 to 10 cm wide, 25 cm high and 30 to 50 cm long. The shorter curb stones are used for tight curves. Curbs should be laid on concrete or mortar and backed over their full length with grade 20 concrete for strength. Carefully cure the concrete and backfill the back of the kerbs with suitable soil.

Arrange for the stone sets to be transported to the site and have them delivered beside the workplace, not in it. Careful selection of stone sets of constant thickness is needed to provide a smooth pavement for people to walk on, with no stones protruding above the general level for people to trip over. Stone sets are hand-knapped to 10 cm x 10 cm x 10 cm, with an allowable tolerance of ± 1 cm. As the stone sets are square, curved laying patterns are normally used and should be set out to the dimensions given in the drawings. Larger stone sets of 15 to 17 cm square and 10 cm thick are often used as edge stones or to vary the laying patterns.
Figure 7.1 Section showing cobblestone paving

Place bedding crusher dust or crusher sand on the sub base and screed it to level, using a suitable screed rail or plank 60 mm high. Do not allow anyone to walk on the screeded bedding, as this will partly compact it and spoil the levels. Place cobblestones against the kerbing and work outwards, away from the kerb, laying them in the correct curved pattern with joint gaps of about 10 mm. Carefully level the stone sets as they are laid, by digging a little bedding out or adding a little extra bedding. Light taps with a rubber or wooden mallet will help to position and level the stones. Some stones sets will require splitting or cutting to fit the pattern properly.

Sets should be laid across the full width of the paving area, up to the curbing on the other side. Sets should be cut carefully to fit in the last gaps between pavers and curbing. Cut sets should also be used to tightly fit the paving around all street furniture, like manholes, lighting standards, etc.

Figure 7.2 Plan showing a laying pattern
As soon as a fairly large area of cobblestone paving has been laid, more crusher dust is to be spread across the paving and compacted into the joints with a heavy plate compactor (at least 200 kg mass). After two passes, extra crusher dust should be added and swept into the joints with brooms. Keep a cushion of crusher dust on the cobblestone surface during compaction, to minimize damage to the stone sets. At least four passes of the compactor will be needed.

The full strength of the paving is not reached until sufficient traffic has passed over it to provide “lock-up”. This process can be hastened by compaction with a pneumatic roller. Inspect the new paving daily for the first two weeks and add extra crusher dust if the joints are "hungry". A few shovels swept across the surface will usually be enough. It is most important for the stability and strength of the cobblestone paving that the joints are completely filled with the correct jointing material.

8 DRAINAGE
8.1 Introduction
Many different types of drains are needed to control the flow of storm water in the different types of topography that roads need to traverse. Drains are essentially longitudinal drains or cross-drains.

Longitudinal drains carry storm water parallel to the roadway, or along the length of the road. These drains collect runoff and deliver it to cross drains or are emptied by means of mitre drains. Mitre drains run at an angle to the road (usually between 30° and 45°) and drain into vacant land beside the road.

Cross-drains take storm water from one side of a road to the other, by means of structures. These structures comprise:
(a) culverts, which are divided into
   • pipe culverts
   • box culverts
   • arch culverts
   depending upon their shape and the way that they carry traffic loads to the foundations.
(b) drifts (sometimes called fords)
8.2 Drain gradients
All drains must have a gradient in order to flow. The drawings will give the gradient at which the drain is to be built.

8.3 Erosion control
Soil erosion is controlled by covering the soil or by slowing down the flow.

In earth drains, the simplest form of erosion control is the scour check. This is a small dam made of stones or timber that slows down the flow of water in the drain. The scour check:
- must be low enough in the middle to let the storm water flood flow over without letting the water erode the sides of the drain;
- must have a non-erodible base (like stone) at the foot of the scour check for the overflowing water to fall onto.

Grass prevents erosion. The type of grass should be a low-growing kind that spreads out. Grass or bushes that grow upright should be removed from drains, as they cause too much obstruction to the flow of water (note this for maintenance). If grass of the right type is available from clearing and grubbing, it should be reserved and planted as soon as possible in earth drains.

Plain stone pitching is the name given to a layer of rocks placed closely together on the bottom and sides of an earth drain. Note that the function of the stone pitching is twofold:
- protect the earth below it from erosion
- slow down the water flow by the roughness of the pitching.

The large stones that stick up above the general level of the pitching provide the roughness and the erosion protection is provided by all the stones, but particularly by the small stones hammered into the gaps between the large stones. In properly laid plain stone pitching no portion of the earth beneath the lining can be seen through holes or gaps in the pitching. This is a quality requirement. Note that sometimes a geofabric has to be laid beneath the stone pitching.

Another type of erosion protection is grouted stone pitching. Plain stone pitching is laid, without filling all the smaller gaps with stone pieces, and those gaps are filled with a cement mortar. The mortar is made liquid and runny and is poured from a wheelbarrow onto the pitching and is spread by means of shovels and stiff brooms. The brooms are used to work the mortar into the spaces. Note that the two requirements of the stone pitching have not changed. These are:
- protect the earth below it from erosion
- slow down the water flow by the roughness of the pitching.

The first requirement is cared for by making sure that all the holes and gaps in the pitching are filled with the mortar (or grout). The second requirement means that the larger stones must protrude above the general level of the pitching in order to provide friction to the water flow.

Sometimes wired and grouted stone pitching may be needed. This is constructed by laying across the bed of the drain a wire mesh with holes smaller than the average stone size. Wire ties are fastened to the mesh at 600 mm centres, in a square grid pattern.
Plain stone pitching is then laid across the wire mesh, taking care to lift the wire ties vertically and having them stick up out of the pitching. As with the grouted pitching (above), no stone filling is placed in the smaller gaps. A second layer of wire mesh is then laid across the pitching and securely tied down with the wire ties sticking through the stone layer. The edges of the mesh must be carefully tied together so that no stones can be washed out. A grout made from a liquid and runny mortar is poured from a wheelbarrow onto the pitching and is spread by means of shovels and stiff brooms. The brooms are used to work the grout into the pitching and to fill all the gaps.

**Gabions and gabion mattresses** are often used to control storm water flows in open drains. These consist of wire baskets of various sizes that are filled with stones and wired closed. Wire or mesh boxes are placed on prepared bedding and filled with hard stone, carefully packed into place. The boxes are braced with wire to keep them in shape. The lids are carefully wired closed. Such structures may be used as retaining walls, to support earth banks or road works; or may be used to control the flow of water. There are many other uses for gabions.

### 8.4 Side drains

Side drains are open ditches, running parallel to the road, that collect storm water from the area beside the road and from the road itself. The drain is dug far enough away from the road that seepage of the water into the ground will not affect the road foundation. The depth of the side drain is chosen so that it can drain the road foundation and keep it dry enough for the road to be able to carry heavy trucks and busses.

Side drains are emptied at regular intervals by means of mitre drains or culverts. Mitre drains work best when the road runs directly down the ground slope. Culverts, however, function best when the ground slopes towards the road. Culverts must also be built in every stream or streambed, to prevent storm water being dammed up against the road. Culverts have two functions:
- to empty the side drain by taking the water under the road to the other side
- to drain streams across the road.

Open earth side drains usually have a flat bottom not less than 1 m wide, with sloping sides.

### 8.5 Mitre drains

A mitre drain must have the same capacity as the side drain it is emptying (or it will not be able to empty the side drain). If the side drain has a 1.5 m bottom width, the mitre drain must not be any less. The length of the mitre drain must be long enough to take the stormwater away from the road and must also be long enough to become so shallow at its end that the water can flow out across the ground. This means that the drain gradient must be less than the ground slope. Minimum gradient should be 1 in 80 and the preferred gradient is 1 in 50.
From the drawing above, note that the side drain stops and turns through an angle to become the mitre drain. The bend in the drain may require to be armoured with stone pitching if the soil is very erodible. The side drain is restarted at least 5 m from the bend and the soil between the bend and the start is not disturbed.

8.6 Interceptor or catch water drains
Interceptor drains catch overland flow before it reaches the roadway. The soil dug from the drain is often used to make a small berm on the downstream side of the drain. This berm should be compacted. The preferred gradient for the drain is 1:50.

8.7 Masonry-lined drains
Masonry is frequently used to line drains in towns or villages to reduce their width from the wide open earth drains. Such drains may be lined with rough stone, neatly mortared with a cement mortar. Alternatively, semi-dressed stone can be used to construct vertical or sloping walls on a concrete or stone base, to carry the storm water flows.

To protect pedestrians and vehicles, such masonry drains may be roofed with concrete beams or slabs. See the following illustrations for typical examples.
Figure 8.3 Masonry-lined open drain

Figure 8.4 Masonry-walled open drain
8.8 Culverts

Pipe culverts are usually constructed with precast factory-made concrete pipes. These pipes are made in certain lengths. Precast concrete pipes are heavy and must be handled carefully in order not to break them and for safety reasons. Pipes made from other materials like plastic or fibreglass are sometimes used for storm water and are much lighter than concrete pipes.

All pipes must be laid on a prepared bed. The type of bedding depends on many factors: the drawing will give the necessary details. Pipes are backfilled with a carefully selected material and compacted in thin layers. The depth of backfill over the pipe is called the “cover” and should be greater than half the pipe diameter. If a flexible pipe is used (like plastic) then the cover should at least equal the pipe diameter.

Pipe culverts are generally laid in a trench excavated through the road embankment. It is good practice to construct the road fill to such a level that when the pipe is laid and backfilled, the needed cover can easily be achieved. It is bad practice to lay a pipe culvert on the ground and then to fill over it to build up the embankment, as this often results in broken pipes.

Box culverts

Foundations for box culverts are made of concrete. The width and thickness should be made as given on the drawing details. Walls are constructed of brickwork or stone masonry with a deck slab of concrete. As for the pipe culverts, headwalls and wing walls are needed. The wing walls are extensions of the walls and are usually bent back.
to better control the flow of water into and out of the culvert. The cross-section below shows some of the details.

Figure 8.6 Box culvert

**Arch culverts**
The foundations, arch, head-and wing-walls are all constructed of stone masonry. The floor slab, which is needed only if the culvert is founded on soil, may be concrete but is usually also made of masonry. As an arch culvert is quite high, a drop inlet structure is sometimes required. The advantage of an arch culvert is that, except for cement, only local materials are used. This increases the amount of money that stays in the community, as local rock is collected and local sand is used, requiring wages for the labour involved. A typical arch culvert is shown below.

Figure 8.7 Arch culvert

### 8.9 Drifts
Drifts are portions of a roadway that are lowered to allow storm water to flow freely across the road in such a way as to prevent damage to the road. A drift usually comprises a stone masonry wall or a gabion along the lower side. The road surface itself may be protected with a layer of stone or concrete.

A drift must have a cross fall of about 1 in 50, so that water does not stand on the road surface. The ends of the drift are raised to contain the water flow within the protected area of the drift. The road ramps down to the drift level, crosses the drift and ramps up again at the other side.
Figure 8.8 Drift
The picture above shows a river drift crossing. Note the side drains that discharge into the river away from the road; the marker posts to guide drivers across the drift when it is under water; the large rocks placed against the downstream side to prevent erosion.

8.10 Headwalls and wing walls
Headwalls and wing walls should be constructed at the inlet and outlet of every culvert. The headwalls keep soil from falling into the inlet or outlet and, when they are painted white, can be easily seen by vehicle drivers. Wing walls form part of the structure and guide the water in or out while also holding up the soil at each side of the pipe opening.

Most culvert outlets are protected with stone and/or grass to prevent erosion. See drawings for details.

All culvert headwall and wing walls need maintenance: they must be kept clean of sediment and debris and at the outlets vegetation must be controlled. Due to the concentration of water at an outlet, vegetation will grow prolifically. If uncontrolled, this vegetation will block the outlet and soon enough prevent the drainage structure from working as it should.
9 CONCRETE WORK

9.1 Introduction
Concrete is a man-made material using cement, sand, stone and water. The activities required to make good concrete include all of the following:

- the safe erection, use and taking down of scaffolding and runways;
- cleaning, oiling, erection and removal of formwork and its supports, bracing and ties;
- placing and fixing of steel reinforcement;
- measuring, mixing, transportation, placing and compaction of concrete;
protection and curing of concrete;
- Cleaning up on completion.

9.2 Materials

Cement
Only Portland cement or Portland fly ash cement (about 15% fly ash) should be used for concrete work. Mortar cement should never be used for concrete. All cement should be fresh and not more than 3 months old. Cement that has been stored for too long has taken up moisture from the air and has lost some of its strength.

Sand
The sand must be clean, with no vegetable matter or dust in it. River sand may need to be sieved before use to remove stones and dust.

Test for sand quality:
Into a clean wide-mouthed glass bottle place about 70 mm of the sand. Add water to cover the sand by about 50 mm. Shake the bottle vigorously for several seconds and then let it stand for an hour. Measure the depth of the impurities on top of the sand. If this layer is 5 mm or more, the sand is unsuitable.

![Bottle test](image)

Figure 9.1 Bottle test

Stone
Clean hard stone is required. Usually crushed stone aggregate is bought from a quarry, but if the local rock is suitable, it can be crushed on site and sieved to the sizes needed.

Water
Water used for concrete and mortar must be clean and free from any impurities. The water must be fit to drink.

9.3 Concrete mixes
Concrete can be made in two ways: the components can be measured by volume or they can be measured by mass. Most of our concrete will be measured by volume. Concrete mixes are shown as follows: the mix proportions of cement, sand and stone are given in this order and are usually given with cement as unit. For example, a 1:2:4 concrete mix is made up of 1 part of cement, 2 parts of sand and 4 parts of stone, measured by mass (the way the mix is measured should be stated). Another example
would be a 1:3:4 volume mix which is made up of 1 part cement, 3 parts sand and 4 parts stone, measured by volume. The volumes can be measured by wheelbarrows of known volume or by “batching boxes”, which special wooden boxes are made to contain a certain volume. Cement is delivered in sacks, of mass equal to 50 kg and of volume equal to 38 litres loose. The sample box sizes are as:

(a) 50x40x18 cm, or
(b) 30x30x40 cm.

Different concrete mixes have different strengths. For example a 1:4:5 mixes may be used for mass concrete foundations, where moderate strength is needed and a 1:2:3 mixes used for the reinforced concrete in the deck of a culvert, where great strength is needed.

9.4 Strength of concrete
The strength of concrete or mortar is controlled primarily by the amount of water in the mix. The more water in the mix, the weaker the concrete or mortar will be. The less water in the mix, the stronger the final product. The amount of cement in the mix is also important.

9.5 Formwork
Formwork is the “box” into which concrete is cast. Formwork is usually made of timber or steel. It must be strong enough to carry the weight of the wet concrete and the forces of compaction. The formwork must be tight (no holes) so that no cement mortar can leak out of the form. It must be properly braced and supported. Formwork is oiled to prevent concrete sticking to it.

The Supervisor must inspect formwork before concrete may be placed. He will look to see that the forms are clean (no rubbish or bits of wire left behind), oiled, tightly jointed and properly braced and supported.

9.6 Reinforcing steel
Most concrete structures are made stronger by the addition of steel bars in the concrete. Part of the quality of concrete comes from the careful placing of the reinforcing bars in their correct position.

Steel inside concrete is protected from rusting by the cement. However, if the steel is too close to the side of the concrete, it is not protected well enough and will rust. To protect the steel properly, we must have enough “concrete cover” to the steel. The “cover” we will normally use will be 50 mm. The drawing will list the required cover and this must be checked (in case a different value is needed). Cover is achieved by tying “cover blocks” to the steel bars with wire, to help position the bars and to keep them away from the formwork. Plastic spacers can also be used. Remember that cover must be achieved on all sides of the concrete: top, bottom and sides.

Steel reinforcement is laid into position inside the formwork, cross bars are laid across the main bars and all are tied tight together with wire. Each point where one bar crosses another must be tied. The cover blocks are then tied on. The Supervisor must inspect
the “reinforcing cage” before concrete may be placed. He will look at the spacing of the bars and the bar sizes; he will check that the bars are tightly wired together and that cover blocks of the right size are fixed to the bars. He will look to see if the steel is clean – if oily, the steel will have to be cleaned carefully, which may mean that the wire ties must be cut loose and the bars taken out for cleaning.

9.7 Wheelbarrow runways
Wheelbarrow runways are pathways that will be used for transporting the wet concrete. The best arrangement is to have the wheelbarrows travelling in one direction only. This means that loaded wheelbarrows use one path and come back empty on another. This is the most efficient and speedy method for wheelbarrow haulage.

If scaffolding is needed for the runways, then great care must be taken to make adequate cross bracing for the scaffolding. This is important as wheelbarrows loaded with wet concrete are heavy and can cause the scaffolding to rock sideways. The runways must be widened at the point where the concrete is to be discharged, as the wheelbarrows have to be turned and tipped at this point. Handrails are essential for all scaffolding over 1 m high and must be strong enough to contain a person and a loaded wheelbarrow when the person loses his balance.

Runways across loose sand can be made from planks and will ensure that the loaded wheelbarrows easily cross the sand. All wheelbarrow pathways should be smooth and wide, so that transportation can be done quickly and efficiently.

9.8 Concrete mixing by hand
Batching boxes should be made to the exact measurements needed. Batching boxes must be loosely filled with the sand or stone and the excess material scraped off with a piece of straight plank, so that the box is full and level with the top edge. As far as possible, only one-sack mixes should be used (one sack of cement per mix).

Before starting to mix concrete, check that:

- there is enough cement, sand, stone and water for the day’s work;
- the formwork is ready and has been inspected;
- reinforcement is ready and has been inspected;
- wheelbarrow runways are ready and the transportation team is standing by;
- the concrete placing and compaction team is standing by;
- the blinding or ground onto which concrete is to be placed has been dampened with water and no water pools are left;
- the mixing floor has been dampened with water.

Measure off the sand for one mix and spread it in a circle across the mixing floor in a layer about 100 mm thick. Spread the cement evenly across the sand. Start mixing, using straight-ended shovels, by turning over the mix from the edges into the middle. Flatten out the pile of sand and cement and mix again, from edges to centre, and repeat until the mix is an even colour. Hollow out the mix and add some of the water. Mix from sides to centre. Add more water and mix until a soft mortar has been made that has no dry or wet patches in it. Spread the mix in a circle, about 100 mm thick and add the stone by spreading it evenly across the surface. Mix from sides to centre two or three times to produce well-mixed concrete.
Shovel the concrete into wheelbarrows and transport the mix to where it is needed. Measure the slump of every mix and record the result. Make a set of concrete cubes from the mix as instructed by the Supervisor.

9.9 Machine mixing of concrete
Note that concrete can also be mixed using a concrete mixer. If the mixer is fitted with weighing scales, then mass mixes can be produced. Weigh-batched concrete is more uniform than volume-mixed concrete and so is used when high strength concrete is needed.

9.10 Placing of concrete
Tip the concrete directly into position if possible. If not, tip it onto a board, from where the placing team can shovel it into position. The concrete should be dropped vertically into place in such a way that little sideways shovelling is needed. The reason is to prevent segregation of the concrete. Segregation is the separation of concrete into stone and mortar and results in very poor concrete. The concrete must be compacted to remove all the air from it. Normally a poker vibrator is used for compaction. In casting a slab, the easiest way is to compact the concrete with gumboots by having the placing team "dance" in the concrete. The concrete in the sides and corners of the formwork must be rodded to remove air. The top of the concrete should be compacted and struck off with a screed plank, used on edge, by a vertical chopping motion and then by sawing the board to and fro across the top of the form. Leave the concrete exactly level with the top of the formwork.

9.11 Finishing off
The concrete must be finished off as described on the drawing. If the concrete is being placed in a wall and more concrete is to be added later to raise the wall further, then a rough finish is required, as is obtained from the screed plank. If a smoother finish is needed, the concrete must first be allowed to stiffen, before being floated with a wood float. A wood float can give a flat and slightly coarse finish. If a yet smoother finish is needed, then a steel float must be used after wood floating. The steel float gives the concrete surface a polish. Note that no additional water or cement is allowed on the concrete surface. Additional water will weaken the concrete surface. More cement will give a brittle surface liable to crack and separate from the concrete. Both are undesirable.

9.12 Curing
As soon as the finishing is completed, preparations must be made for curing the concrete. Curing means keeping the concrete wet for at least 7 days to allow the cement to hydrate. Curing must start as soon as the concrete surface is sufficiently hard that it cannot be damaged by spraying water onto it.

There are several methods of curing concrete.
- For beams and columns: place 20 to 30 mm of concrete sand onto the entire exposed surface and wet the sand. Keep wet regularly. The sand will prevent rapid evaporation of the water. Keep the formwork in place for the full length of the curing period, as this will prevent evaporation from the sides of the beam or column.
For slabs: as above, place 20 to 30 mm of concrete sand across the surface and keep it wet.

- Alternatively, cover the surface of the concrete with waterproof paper or plastic sheeting. Hold down the edges with sand or planks or stones to prevent the wind from dislodging the sheets. Wet the concrete surface under the sheeting at least twice daily.

- Alternatively, spray a curing compound across the concrete surface.

9.13 Clean-up
After concreting is completed, the tools, mixing floor and wheelbarrows must be cleaned before the concrete hardens. If concrete is being made over a few hours, the tools and wheelbarrows should be cleaned at intervals, to prevent hardened concrete sticking to the surfaces.

Any concrete that is left over must be dumped in a safe place. Hardened concrete in the wrong place is difficult to remove. Empty cement bags should be collected and disposed of. The sand and stone piles should be tidied up and unopened cement sacks returned to the cement shed.

All scaffolding and planks must be cleaned, as concrete will have been dropped on them. Screed planks must also be cleaned. All the workers should wash all traces of cement and concrete from their hands, arms and legs.

9.14 Removal of formwork
No formwork may be removed before the Supervisor gives permission. Also refer to the Specification.