

**Cobble**  
**stone and penetration**  
**macadam road**  
**construction application**  
**in dire dawa city**

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## **Abstract**

This paper focuses on an intermediate construction technology that can be used to reduce the burden of sustainable road network provision. The approach described utilises penetration macadam technology, and is designed to promote employment and to be implemented through labour intensive approaches. It has the added advantage that it uses waste products from another road surfacing approach as the main ingredient.

The approach has been piloted on 2.5km of road in Dire Dawa city with very encouraging results.

## **1. BACKGROUND**

Dire Dawa is the second largest city in Ethiopia. The population size and urban activities are increasing. The through-traffic of heavy trucks in the city is increasing, as is the normal access requirement for the local population. Motorized tricycle transport has proliferated in recent years and in all parts of the city.

The cost of asphalt concrete, double or triple surface treatment is high and in most cases unaffordable for many of the cities streets. Double surface treatment and asphalt concrete construction requires around 8 million birr/km and 10 million birr/km respectively.

Dire Dawa pioneered the use of cobble stone road construction techniques. Over 40Kms of cobble stone road have been built and in the process many jobs have been created.

One of the drawbacks of this extensive use of cobble stone is the production of considerable waste (rubble), as a result of cobble stone chiselling. This presented a major challenge that required proper handling and immediate response in order to minimize economical loss due to excessive wastage.

One response towards managing the situation was to crush the wastes and convert it in to different sized aggregate using crushers or manual stone crushing methods. This crushing process is not an optimal solution and not all of the waste product can be used in road construction. In most cases the aggregates are just stock piled and kept for sale.

An alternative solution to the problem of dealing with cobble stone waste was its possible use for production of penetration macadam.

## **2. APPLICATION OF PENETRATION MACADAM TECHNOLOGY**

Penetration macadam technology using labour is a fairly well known approach for surfacing.

Penetration macadam utilises a wide size range for hardcore for the base and different sized aggregates bonded with penetration bitumen as final surfacing.

The technology has a number of advantages:

- √ Provides a solution to the utilisation of the cobble stone chiselling generated waste.
- √ Provides another alternative surfacing option for consideration, especially when traffic is heavy or slow moving
- √ Cheaper than normal asphalt construction technologies
- √ Employment friendly

The technology especially in its hand laid hard core phase opens as many jobs as the cobble stone road construction does.

Dire Dawa city has a substantial slow moving and heavy traffic. The penetration macadam can handle this type of traffic and has greater bearing capacity than the cobble stone roads, with relatively little additional cost. Penetration macadam and cobblestone technologies are both successfully used in the urban situation of Dire Dawa.

In Dire Dawa city there is currently, around 2.5 Km road constructed using penetration macadam.

### **3. ESTABLISHMENT OF PENETRATION MACADAM TECHNOLOGY**

Penetration macadam was recently introduced as a road construction technology for the city of Dire Dawa. It was introduced through the own force operation of the Roads Authority who piloted the actions needed to adapt and adopt the techniques and operational arrangements.

Some of the initial activities that were needed to be introduce the technology were:

- Identifying and prioritizing roads to be developed
- Designing and pilot testing roads
- Promoting public awareness for users and residents
- Getting political support from different level of government authorities, including budgetary support
- Recruitment of unemployed women, youth and others
- Provide orientation for workers
- Construct road in different steps - labour based works and limited machine supported works
- Monitoring and quality control

In raising awareness of the technology option the following are important points. The penetration macadam technology can be used to:

- Deliver improved access for the residents and users of the city
- Re-orientate the city's economic efforts through employment expanding road construction. It creates employment opportunities to the unemployed segment of the society, especially for youth and women unemployed residents.
- Provide an additional and complementary technology to cobble stone road. It provides a solution for cobble stone roads that may be deteriorating due to heavy traffic.
- Reduces excessive environmental abuse and makes use of intermediate construction technology

For Dire Dawa, the major strategies adopted were to:-

- Combine employment intensive approaches
- Use locally available cobble stone chiselling wastes
- Promote and publicise the technology
- Streamline the technical procedures and approaches through the through force account method

## **5. IMPLEMENTATION**

The introduction and implementation of the technology required a pilot testing to verify its cost implication and the feasibility of the works. This period was challenging phase as it is needed to convince the public and the political decision makers. The relatively short pilot intervention period provided the necessary feedback to the decision makers and the users of the infrastructure. In the process of the project implementation there was some problems due to the interruption of the regular business traffic flow for the community. However, this was easily and brought an improved situation to the overall livelihood of the local community including employment and service improvement prospects.

The Roads Authority has made intensive assessment of the basic issues and its public feed back through formal and non formal technical assessment has encouraging and rewarding. The Ethiopian road authority has proposed a means for further improvement in expanding and replicating the experience to other areas and undertaking further research in the near future.

The total cost of constructing 2.5km road in Dire Dawa was birr 9.2 million birr. The entire cost of the works was covered by Dire Dawa Administration.

## **6. RESULTS**

With the implementation of this road project, new access has been created which consequently improved the traffic flow of all types and facilitated linkage among different nodes.

A considerable number of new jobs were been created. About 2500 male and 1500 female new employees were involved in hand laying the hard core, gravel surfacing and other related activities. Therefore, necessary improvement has been exhibited both in livelihood support and the new appropriate access creation within the city.

The institution engaged in construction and management of this road, has acquired the necessary technical and management experience. Dire Dawa Roads Authority has also a complete crew to carry out the required maintenance tasks. The Ethiopian Road Authority has shared its interest for further technical evaluation and preparation of a manual.

This construction initiative has focused in an optimization of available resource uses. The large amount of cobble stone by-products has been effectively used as a major road construction input. This is a major success as it avoids resource wastage and complements the cobblestone paving activities.

The construction of the penetration macadam was 4.5 million birr/km, more than half of the cost of double surface treatment and asphalt concrete asphalt.

The project design and construction gave necessary focus for environmental management. The road construction process was accompanied with land management and compatible with the proposed city drainage network frame work.

## **7. CONCLUSIONS**

The most important lesson learned from this intervention is that integrating cobblestone construction with other low cost penetration macadam road construction methods can yield better results for durable urban road alternatives. This practice enables re-use of waste resources for better infrastructure development.

The approach is equally important as any other labour intensive methods in creating employment opportunity fairly for all residents, especially for women and youths of the city.

This technology can be replicated easily and could be used in rural situations, such as for roads through villages. Combining labour based activities with limited machine supported works can be easily done elsewhere in the country.

The city has made an assessment on the advantage of the penetration macadam road. The findings indicate that it is a simple and reliable technology for construction and management of internal urban accesses. It generates an immense job opportunities. Furthermore, it enables re-use of what would otherwise be waste products.

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## **KEY WORDS**

Surfacing, Cobble Stone, Penetration Macadam, Waste Products

Different pictures/cobblestone,penetration  
macadam application in dire dawa/

