

# Executive Summary

## Introduction

This study has conducted by the Bureau of Research, Testing and Consultation (BRTC) of BUET during October 2009 – May 2010 to assess the viability of Concrete Block Road constructed by Community Based Resource Management (CBRMP) – LGED. The study was proposed by IFAD Mission as well as Chief Engineer of LGED to find out the scope of its further effective implementation and extension in rural set-up particularly in low laying haor area.

## Objectives of the Study

The study has been initiated to understand the impact of the block road, its performance and to suggest improving the design for its better performance and sustainability. Accordingly the following impact and performance assessment studies have been identified to carry out.

- Performance study
- Socio-economic impact assessment study
- 3D Finite Element analysis of the pavement system
- Road safety study

## The Study Team

The team comprised Professor Md. Shamsul Hoque PhD (Team Leader and Transportation Expert), Professor Alamgir M. Hoque PhD (Advisor), Professor Md. Saiful Alam Siddiquee PhD (Geotechnical Expert and Pavement Modeler), Associate Professor Md. Mizanur Rahman PhD (Concrete Technology Expert), Assistant Professor Zia Wadud PhD (Applied Econometric Modeling Expert) and Assistant Professor Charisma F. Choudhury PhD (Transport & Survey specialist) along with 12 final year B.Sc. Civil Engineering students of BUET worked as enumerators and visited field and interviewed villagers in project areas.

## Tests and Survey undertaken

The study team collected both primary and secondary information and undertook various tests (in-situ non-destructive as well as destructive) to examine particularly the :

- Performance of pavements
- Riding quality and roadway safety
- Mix design of concrete
- Socio-economic impact study
- Detail design aspects of the pavement

The team visited the study areas, observed the road construction work and met the community at five upazilas for conducting a participatory socio-economic survey. Besides, at BUET Geotechnical and Concrete Laboratories, a good number of rigorous sample based parametric tests of sub-grade materials, block ingredients and finished blocks were carried out for the study.

## **The Major Findings and Observations**

In brief the major findings and observations of the study are as follows :

### **General aspects:**

- Building road involving community is better than RCC considering the scope of skill and community involved
- Use of graded round gravels, which has the potential to improve workability of concrete mix, in place of crushed angular stone chips, would be an effective as well as self enforcing measure in maintaining quality of concrete blocks
- Even brick chips can be used instead of stones keeping all other benefits of the existing concrete block, but reducing the cost substantially
- Semi-rigid typed block pavement found most appropriate and condition responsive to periodic submergence areas for its weather resistant as well as easy to maintaining qualities
- Submergence of water did not affect the structure of the block pavement
- HBB type pavement system would not be an improvement over the submersible concrete block pavements in the haor areas
- Block pavements can offer a viable adaptation measure by allowing the water to flow unhindered
- Based on life cycle cost analysis RCC road was found to be more appropriate for upazila road; whereas block type pavement system would be suitable for village and union standard roads
- The compressive strength of the block was found to be not up to the level which it should have been. The test result suggests that the cement as a binding material could not impart properly in gaining intended strength of the concrete. It should have been process failure in preparing and curing blocks.

### **Socio-Economic Impact of Road Improvement on the Community:**

- Access to different services such as market, school and hospital improved to 64%
- Mobility, particularly, women increased to 50%
- Travelling by rickshaw and improvised mechanical transport increased to 93%
- Food consumption increased to 70%
- Income increased to 75%
- Housing or household assets increased to 43%
- Scope of businesses increased directly to 29%
- A good number of people, particularly women, from the locality were found to be involved either in construction or maintenance of the roads through LCS and thereby got the opportunity of employment and acquired a sense of ownership. That might have major impact on the sustainability of the local road infrastructure.

### **Geotechnical aspects:**

- From three dimensional Finite Element (FE) analysis it is found that the road section can carry much higher load, even the design load (8.2 ton) that is designated by LGED for rural roads
- The block settlement analysis revealed that the actual load on the block pavement is far below the smallest block. Therefore the bearing capacity of the current block is underutilized

- Size of the blocks has the most prominent effect on the bearing capacity and settlement of the block, however current size is just right considering its weight to handle by the LCS members
- Riding quality of the concrete block can be improved by increasing the side slope of the block, but it is subject to field trial before a particular side slope is approved.

#### **Road Safety issues:**

- Average speed of motor cycle on rigid pavement road is about 38 kmph but on block pavement is 23 kmph that potentially arrests the speed of vehicle and thereby the propensity of accident
- Considering the high degree of exposures due to the presence of heterogeneous traffic, lots of non-standard vehicles, drivers with no training and most importantly due to the presence of large number of vulnerable pedestrians, safety is a priority concern and in this case block pavement should be given preference over rigid pavement to make the road self-enforcing in reducing speed and thereby to make safety as a built-in feature of the road
- The block pavement road could gainfully be used at the hazardous locations like driveways connecting road adjacent houses without any setback, bends, junctions and so on as a speed reducer or calming device.

#### **Recommendations**

- LCS based infrastructure development approach is sensitive to quality control. More supervision is required for ensuring quality control in mixing ingredients, making blocks and curing work. To ensure that job-center based (JCB) concrete block manufacturing system could be a better option.
- Alternatively quality of concrete blocks could be improved by introducing mixture machine or compressed block manufacturing technique.
- Using of relatively quick setting cement in the concrete mixture could be a plausible solution to maintain the quality of block when LCS is used for manufacturing block.
- Due to land scarcity blocks are kept in stack with high height which in turn affects uniform level of curing. That may be addressed by using a special admixture which has the potential to make curing less concrete.
- Traffic control devices like road signs and marking should be used particularly at the hazardous locations in order to improve safety.

#### **Suggestions on Road Safety Issues :**

Towards developing safer road in the rural fabric - strategies should be as follows :

- Instead of straight alignment curvilinear alignment i.e. a good blend of straight and curved segments should be adopted
- As far as possible sharp bend should be avoided
- All through road should not be built with good quality surface

- Combination of rigid and block pavement road would be the best hybrid system; where road environment would be compatible with relatively higher traffic speed building rigid pavement can be given preference over block pavement
- On the other hand, due to rough texture as the block pavement road has the potential to reduce speed as well as skidding problem of motor cycle, it should be used particularly at the sharp bend, driveways, shops and in between long straight segment of road to arrest speed.

**Concluding Remarks :**

Considering the overall performance and special submersible attribute of the block pavement roads, this type of road can also be gainfully use in the coastal regions as an adaptation measure against rising sea levels and frequent flooding due to climate change in other developing countries.