Journal of Civil Engineering and Environmental Technology
Print ISSN: 2349-8404; Online ISSN: 2349-879X; Volume 1, Number 3; August, 2014 pp. 14-16

http://www.krishisanskriti.org/jceet.html

Use of Bamboo in Low Volume Rigid Pavement as Reinforced Material: A Review

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Abstract: **Steel is traditionally used as reinforcement in concrete. But because of cost and availability, replacement of steel with some other suitable materials as reinforcement is now a major concern. Though bamboo has been used as a construction material, especially in developing country, until today its use as reinforcement in concrete is very limited due to various uncertainties. Since bamboo is a natural, cheap and also readily available material, it can be a substitute of steel in reinforcing of concrete. For low volume road we can replace steel with bamboo and construct the road surface like rigid pavement. It is found that life span of bamboo reinforced surface is more than unpaved road and less than rigid pavement reinforced with steel. Life span of bamboo reinforced road can be increase by suitable treatment of bamboos. This paper is review of the techniques used in the construction process of bamboo reinforced pavement.**

Keywords: **Bamboo, Reinforced Concrete, Road Pavement**

1. INTRODUCTION

Concrete is a widely used construction material for its various advantages such as low cost, availability, fire resistance etc. But it cannot be used alone everywhere because of its low tensile strength. So, generally steel is used to reinforce the concrete. Though steel has a high tensile strength to complement the low tensile strength of concrete, use of steel should be limited since it is very costly and also so much energy consuming in manufacturing process. Thus a suitable substitute of this with a low cost, environmental friendly and also a less energy consuming one, is a global concern; especially for developing country. Addressing all these problems, bamboo is one of the suitable replacements of reinforcing bar in concrete for low cost constructions. Bamboo is natural, cheap, widely available and most importantly strong in both tension and compression.

The results showed that the ultimate tensile strengths of bamboo splints and mild steel are 133.50 N/mm2 and 255.00 N/mm2 respectively with corresponding yield strengths of 68.75 N/mm2 and 207.50 N/mm2 which makes bamboo an attractive substitute to steel in tensile loading applications. Bamboo is commonly introduced as a giant grass rather than a tree. It grows very rapidly as most growth occurs during first year and becomes matured by fifth year. The strength of bamboo increases with its age and reaches to the maximum strength at 3-4 years and then starts to decline in strength. Bamboo is also an environmental friendly plant because it absorbs a lot of nitrogen and carbon dioxide from the air.

The following criteria should be considered in the selection of bamboo culms (whole plants) for use as reinforcement in concrete structures:

1. At least three years old plant should be used showing a pronounced brown colour.
2. The longest large diameter culms available should be selected.
3. Whole culms of green, unseasoned bamboo should not be used.
4. Bamboo cut in spring or early summer should be avoided since they are generally weaker due to increased fiber moisture content.

2. CONSTRUCTION

The construction process of pavement reinforced with the bamboo should be done in stages. To achieve the better performance from the bamboo reinforced pavement each stage should be properly followed. The different stages are explained in following sections.

2.1 Preparatory work

The extent of the embankments was marked by fixing wooden pegs along the road alignment at ten to twenty metre intervals or closer if required. The pegs were placed approximately half a metre beyond the outer edge of the embankment and painted with luminous paint. Standard surveying practice was used to obtain the grade and profile specified by the design. As much as was practically possible, the embankment material and previous laterite wearing course was left untouched since a degree of consolidation, which would be beneficial to the new construction, was achieved through the everyday use of the road. The surface was simply shaped and levelled in accordance with the design specifications. Following this the surface was wetted using a water bowser and hand held watering cans and then compacted using a one tonne twin drum pedestrian vibrating roller. The number of passes was specified such that satisfactory compaction of any new material or remixed layers would be achieved.

2.2 Sand sub-base

Sand sub-base was required in order to ensure good load transfer and distribution to the supporting sub-grade. A 50mm thick sand sub-base, of Fineness Modulus (F.M.) not lower than 1.80 and well compacted, was provided. The sand sub-base was compacted by a one tonne twin drum pedestrian vibrating roller to obtain compaction of not less than 95% Maximum Dry Density (M.D.D). Proper compaction of sub-grade and sub-base layers is of paramount importance with regard to the satisfactory performance of a rigid pavement. This is particularly essential in Cambodia where in-situ soils tend to be very weak, as demonstrated by the low California Bearing Ratio (CBR) values, derived from the Dynamic Cone Penetrometer (DCP) test. For this reason particular attention was given to the compaction of sub-grade and sub-base layers. All layers were placed and compacted in layers of not more than 150mm thickness. The material was laid in the dry state and wetted to as near as Optimum Moisture Content (OMC) as practically possible. Efforts were made to ensure that the material was within ±5% limits of OMC. Immediately after each layer was placed, wetted, shaped and graded to the required camber, it was thoroughly compacted using a one tonne pedestrian vibrating roller.

2.3 Construction of form work

All forms were constructed of 30mm planks of local wood. The forms were constructed to be mortar tight and rigid enough to retain the specified shape and position during placing and compaction of the concrete. This was achieved through the use of bracing, metal ties and anchors.

2.4 Bamboo reinforcement

The bamboo was placed 50mm from the top of the pavement such that it would serve to control cracking during initial setting and also assist in the control of cracking that could occur due to temperature variations. The bamboo mesh of 250 × 250mm was placed on 100mm wooden spacers, which ensured the desired 50mm cover to the reinforcement would be maintained. The wooden blocks were removed as pouring of concrete progressed.

2.5 Mixing of concrete

All concrete was mixed on site in small capacity batch mixers. The first batch of materials placed in each mixer contained a sufficient excess of cement, sand and water such that the interior of the drum as coated in order to prevent loss of mortar to the mix. The coarse aggregate and cement were placed in the mixer first and mixed together for a number of minutes in order to ensure the coarse aggregate particles would be thoroughly coated in cement. Following this the sand was added and mixed in the dry state for some minutes

2.6 Placement of concrete

Prior to placing the concrete, all formwork and reinforcement was thoroughly inspected by the engineer. All wood chips, dust, sand, construction debris and any other deleterious material was removed from the formwork and reinforcement prior to placing the concrete. All formwork was wetted to ensure it was damp when the concrete was poured. This operation was carried out to prevent water being absorbed by the wood and hence prevent altering the specified concrete water/cement ratio, which would modify the characteristics of the fresh concrete. Care was taken during this operation such that pools of excess water did not form in the base of the formwork and also that the bamboo mesh was not wetted. Workers were organised such that one team mixed a continuous supply of fresh concrete, while another brought the concrete to the point of placement and yet another team spread and compacted.

Fig. 1 Preparation of bamboo reinforcement

2.7 Compaction of fresh concrete

Once the concrete had been placed uniformly within the forms, compaction was carried out using a mechanical poker vibrator of 25mm diameter, powered by a small portable generator. Care was taken to ensure a good bond between layers of fresh concrete placed separately by vibrating the two layers together until a satisfactorily homogenous cross section was obtained.

Fig. 2 Placement of concrete and compaction

2.8 Contraction joints and expansion joints

Contraction joints, 10mm in width, were provided every 5m to relieve tensile stresses. Experience has shown that in most climates, joints are required at 5m intervals in order to inhibit early formation of cracks, to relieve temperature stresses, and to accommodate initial volume changes that take place in concrete as it hardens. With concrete roads constructed in hot weather, contraction of the concrete predominates as the weather becomes cooler. In any subsequent expansion it is unlikely that all joints will be able to close to their original dimensions. For this reason expansion joints were provided at 250m intervals. All joints were sealed using a mixture of bitumen and sand and a reservoir of bitumen was provided at the top of the joint. All joints were provided with load transfer devices to limit the vertical movement between slabs as vehicles pass over. area where overloading of vehicles is common, the provision of load transfer devices between slabs was especially important. 14mm round steel dowels, 500mm in length, at 250mm centre – to – centre were provided at all joints. Where the joint was an expansion joint, the dowel bar was anchored into the concrete at one end and the other end was coated with bitumen and the fitted into a PVC sleeve in order to ensure free movement in the longitudinal direction. Where the joint was a contraction joint, the PVC sleeve was omitted.

2.9 Curing of concrete and special measures

High temperatures increase the rate at which concrete hydrates. Typically this results in two difficulties related to pouring concrete in hot climates. The concrete sets more rapidly, losing its workability resulting in difficulty in achieving thorough compaction. On site the workability was rigorously checked using concrete slump as an indicator. A slump test was carried out for each batch of concrete mixed, a slump of not less than 100mm being required. Rapid early gain in strength of concrete experienced in hot climates can be accompanied by shrinkage and cracking of concrete with the result that the subsequent gain in strength is much less than with concretes cured at lower temperatures. Specific measures were taken to combat the effects of high temperature and direct sunlight. All aggregates were stored under cover before use. Mixing water was kept in a shaded area of the site. As the concrete was being placed and compacted the surface was protected from direct sunlight and drying wind by a specially constructed tent structure, which was moved from bay to bay as pouring proceeded, plastic sheeting being used to replace the tent.

3. CONCLUSION

With the availability of modern design methods and engineering data of the mechanical properties of structural bamboo, engineers are encouraged to take the advantage offered by bamboo to build light and strong pavement to achieve enhanced economy and buildability. in India we are using steel in rigid pavement and it is a costly one .if we replace steel with bamboo we have good riding quality road with low cost, its durability is less then steel reinforced pavement but more than earthen road but cost of construction is more or less half of rigid pavement.

REFERENCES

[1] K. Ghavami, “Ultimate Load Behavior of Bamboo-Reinforced Lightweight Concrete Beams, ” Cement & Concrete Composites, Vol.17, pp 281-288, 1995.

[2] S. Amada, and S. Untao, “Fracture Properties of Bamboo, ” Composites Part B, Vol. 32, pp 451-459, 2001.

[3] K.F. Chung, W.K. Yu and S.L. Chan “Mechanical properties and engineering data of structural bamboo” Proceedings of International Seminar 'Bamboo Scaffolds in Building Construction' – An Alternative and Supplement to Metal Scaffolds, May 2002,

[4] J. Castro, and Naaman, “Cement Mortar Reinforced with Natural Fibres” ACI Journal, Vol.78, No. 1, pp. 69-78.pl-23, 1981.

[5] Balaguru, P and Foden, A (1996), 'Properties of Fibre Reinforced Structural LightweightConcrete' ACI Structural Journal. Vol. 93, No. 1 pp 62-78.