APPRAISAL OF SUITABILITY OF PALM GEOMAT FOR USE AS SOIL REINFORCEMENTS

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INTRODUCTION

Since the development of man-made polymeric fibres, perceptions that natural fibres have low apparent tensile strength and very short life (particularly when in contact with soil and water) have led to the virtual demise of their use in construction. However, when correctly designed, natural fibre materials can compete with synthetic materials and sometimes they will even have superior performance (Sarsby, 2006). The key to developing geosynthetics from natural fibres is the concept of designing by function, i.e. identify the functions and characteristics required to overcome a given problem and then manufacture the product accordingly. There are a significant number of ground engineering situations where the critical case for stability or functionality is either immediately (or very shortly) after construction and beyond this stage the stability of the system is constant or increases with time or the need for full functionality declines with time (Sarsby,1997)

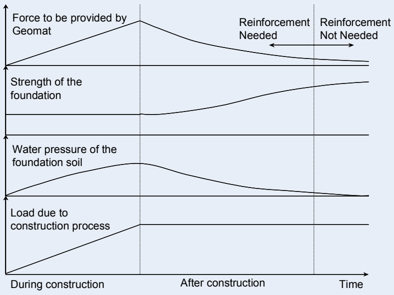

Figure 1: Time-Dependent behaviour of embankment on saturated soft clay soil.

When the embankment is constructed over soft compressible ground it increases the pressure in the water in pores in the underlying soil. With time, this water pressure will decease (as water flows out of the soil beneath the embankment) and the shearing shearing strength of the soil will increase, hence stability of the embankment will improve with time. As the strength of underlying soil increases, so the stabilization force, which has to be provided by the geomat, diminishes with time (Figure 1). The natural fibre geomat can be designed so that the loss in strength as a result of deterioration process corresponds to the fall in the required stabilizing external force.

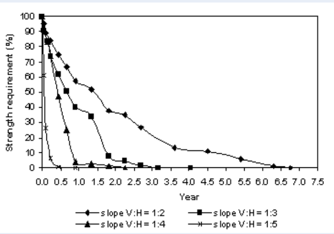

Figure 2: Time-strength envelope (Source: Mwasha, 2005)

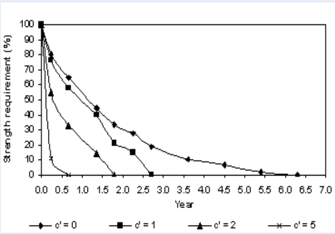

Figure 3: Effect of effective crust cohesion (c') on tensile force requirement (V:H = 1:2, Crust depth 2.4m, Source: Mwasha, 2005)

It is found from the parametic study made by Mwasha (2005) of a 3m high embankment, assumed to be composed of free draining fill on normally consolidated saturated soft clay that the strength requirement from the reinforcement considerably reduce with time and also the formation of surface crust due consolidation drastically reduces force required from a reinforcing geotextile.

MATERIALS AND METHODS

The current research work is to investigate performance properties of novel geomat composed of Buruti palm leaf, for use by the construction industry in ground strengthening.

TENSILE TESTING

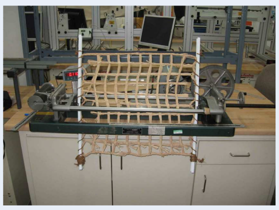

Figure 4: Very flexible end-fixing

Figure 5: Rigid end-fixing

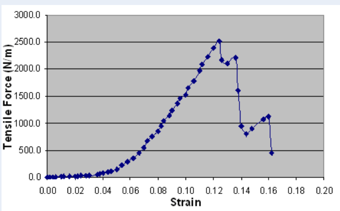

Figure 6: Tensile test with very flexible end-fixing

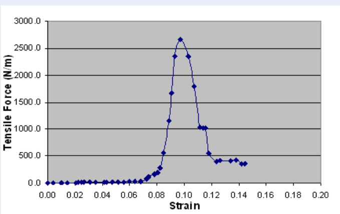

Figure 7: Tensile test with rigid end-fixing

Tensile strength is a key parameter for soil reinforcement, since it provides additional stability to the soil mass. Different types of end-fixing condition were tested to investigate the effect of rigidity of clamping on tensile strength and to determine if one type of testing is preferable. With very flexible end-fixing conditions the lateral edge elements are only fastened at their mid-points and with rigid end-fixing conditions the lateral mat elements are fastened along their whole length with a pair of steel plates.

QUALITY AND QUANTITY CONTROL TESTS

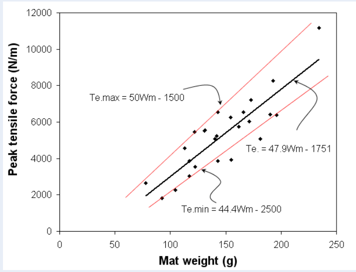

Figure 8: Correlation of initial tensile strength and weight

The relationship between tensile strength and mat weight (for 25 mats) is plotted in Figure 8. The strength clearly increases as a function of mat weight and is probably attributable to variations in the number of leaf fibres involved in a particular tensile test. With few exceptions there is a direct relationship between mat strength and mat weight for weight in the range of 50g-250g. This relationship can be used to find the average expected tensile strength (T_e) of a mat before burial in the soil:

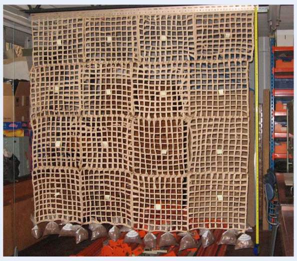

Figure 9: Initial take up of slack between joined mats.

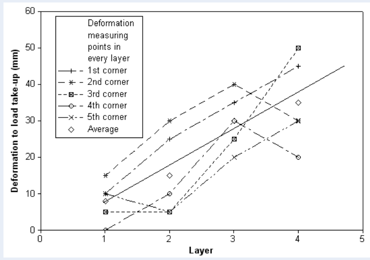

Figure 10: Deformation to initial load take-up

To use these mats in actual construction, it will be necessary to join many of them together to form continuous tensile reinforcements. Load tests on collections of joined mats were undertaken (Figure 9), to assess the initial stretch loading which would occur in field application situations.

TIME-DEPENDENT ENGINEERING BEHAVIOUR

The rate at which the engineering properties of the palm geomat will decrease once they have been buried in soil is a vital parameter. Geomat have been buried in a sandy soil, but with different moisture conditions, and testing/examination is undertaken in order to quantify any change in tensile strength with time.

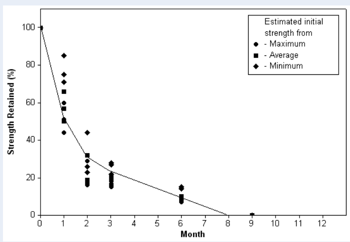

Figure 11: Loss of strength with time – mats in partially-saturated soil

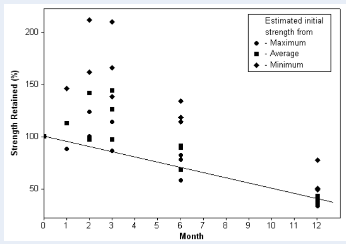

Figure 12: Loss of strength with time – mats in fully-saturated soil

CONCLUSIONS

The Buriti palm geomat do have the potential to provide short-term strengthening of temporary access roads and may be useful in prolonging the working life of low-cost, unbound rural roads in developing countries

The findings from the research indicate that Buriti palm geomat are not suitable for use as soil reinforcement for major ground strengthening applications, for the following reasons:

- Such fibre geomat have low tensile strength when compared to other vegetable fibre geomat and polymeric geosynthetics. Furthermore, their tensile strength is highly variable due to the ‘cottage-industry’ mode of manufacture and the variability of growing conditions.

- The rate of loss of strength of a buried palm geomat is very high - mats buried in partially-saturated soil there was total loss of tensile strength within 9 months. This working life would be insufficient for any significant increase in the shear strength of a foundation due to consolidation.