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Short Communication

Volume–weight Relationship of Water Hyacinth Plant (*Eichhornia crassipes*) Under Axial Loading

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Water hyacinth is considered to be one of the fastest growing plants as one-hectare pond can yield between 400 to 1700 tons of water hyacinth per year (Lindsey and Hirt, 1999). The cost of transportation of harvested plants is very high due to its high volume and weight as it contains 90-95% water with bulk density of 85 kg/m^3 which associates with handling and disposing of 9.2 ton of water for every ton of dry matter (Mathur, 2000). This problem can only be solved by compressing the water hyacinth to higher densities. The design of compression equipment and systems require a good knowledge of engineering properties of the material, which are influenced by the applied load/pressure, moisture content etc. Keeping this in view a study was conducted to find out the effect of compression pressure on compression characteristics, i.e., volume and weight reduction of water hyacinth plant.

The compression characteristics of water hyacinth plants, collected randomly from nearby lakes were determined by applying uniaxial compression load on a Universal Testing machine consisting of a cast iron cylinder (85 mm dia and 178 mm length) and aluminum alloy piston. A 6 mm thick steel plate having 18 mm perforations was used at the bottom to drain out water.

Water hyacinth plants were filled in the cylinder and hydraulic pressure was applied on the plants through the piston moving at the rate of 100 mm/min (Mathur, 2000) and the changes in volume and weight were recorded. The load readings were recorded with the help of a load cell and strain indicator.

The volume of the plants reduced as the compression pressure was increased (Fig. 1). However the rise in compression pressure was low up to a volume reduction of 70% and thereafter the rise was sharp. The rise in compression pressure was about 0.674 MPa for a volume reduction of 70% whereas for further reduction the rise was 2 MPa. The compression of water hyacinth can be divided into three characteristic phases (Fig. 1) with respect to the change in structure of water hyacinth plant. During phase I, there is an alteration in the space and configuration of microscopic material and on expression of air. This results in higher rates of volume reduction even at low compression pressure. The second phase of compression is utilized to reduce the porosity of plant by squeezing the volume of spongy balls and stolans and removing the surface water. This constitutes for about 70% of plant volume. In the third phase the plants are further squeezed to remove the cell water and the fibers. The distribution of fiber wall is more difficult and requires a higher degree of compression to achieve this. The results confirm the findings of Ferrero *et al*. (1991) and Mathur and Singh (2000).

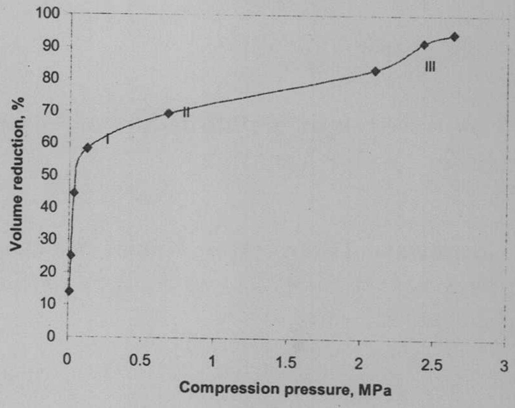

Fig. 1. Effect of compression pressure on volume reduction

The relationship between volume and weight reduction may be divided into four stages (Fig. 2):

Stage I : 0-25% volume reduction

Stage II : 25-65% volume reduction

Stage III : 65-75% volume reduction

Stage IV : 75-95% volume reduction

There was no change in weight for first 25% volume reduction (Fig. 2), as the pressure is utilized to remove air gaps between the plant components. In the second stage for a 40% volume change the weight reduction is 5.92% as at this stage surface water is removed, mostly from the roots of the plants. During the third stage again the reduction in weight was less as compared to volume reduction. Only about 7% water was removed for a volume reduction of about 18% due to reduction the porosity of spongy leaves and stems along with squeezing some surface water from this component in this stage.

In the fourth stage water is removed due to rupturing of plant cells resulting in 29% weight reduction with 94% volume reduction at 2.63 MPa compression pressure. In later stages of compression, i.e., increase in pressure from 2.42 to 2.63 MPa weight reduction was more (16%) than volume reduction (11%) (Fig.2). This is due to destruction of fibre walls of the plants which allowed the water to squeeze out from the different plant components. The results relate to the finding of other researchers (Mathur and Singh, 2000) that there is a rapid reduction in weight during the later stages of compression pressures. It is concluded that 2.63 MPa compression pressure was required to get maximum reduction in volume (94%) and weight (29%) of water hyacinth plant under axial loading.

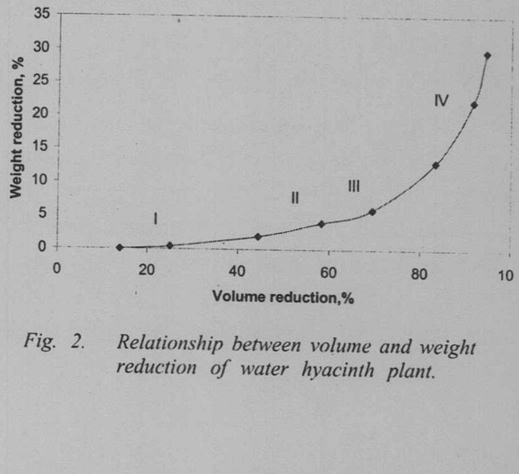

Fig. 2. Relationship between volume and weight reduction of water hyacinth plant.

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