INDIAN INSTITUTE OF TECHNOLOGY GUWAHATI
SHORT ABSTRACT OF THESIS

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SHORT ABSTRACT

Escalating cost of petroleum based geo-synthetic products and concern for environment have motivated researchers to explore alternate natural based geo-amendments. Lignocellulose based natural fibers, geotextiles and biochar derived from plant have been explored as alternative soil amendment material. *Eichorrnia Crasipes* popularly known as water hyacinth (WH) is one of the world's most invasive plant species which causes various ecological problems as well as blocks water bodies. The management of this weed produces a lot of waste bio-mass with relatively no usage. The current study finds motivation from the aforementioned problem of waste management and need for eco-friendly amendment material; to explore WH as a potential bio-material in the form of discrete fibers, geotextiles and biochar.

All the biomaterials fabricated from WH were characterized for its inherent bio-chemical composition, physical properties, surface morphology, thermal response and functional groups. The soil- WH fiber composite as randomly distributed fiber reinforced soil (RDFS) and geotextiles were tested for its mechanical strength using a series of Unconfined compressive strength (UCS) and California Bearing ratio (CBR) test respectively. UCS tests were done in comparison with other two conventional natural fibers (jute and coir). The mechanical strength of soil-biochar composite in terms of UCS was investigated for biochars derived from WH and peanut shell. The hydraulic performance was assessed based on soil water retention capacity (SWRC), desiccation crack potential and infiltration for soil-WH fiber composite. The vegetation potential along with SWRC and desiccation potential for soil-WH fiber composite was explored by conducting induced drought conditions. A basic bio-degradation assessment of WH fiber in embedded soil was conducted considering changes in bio-chemical composition, soil-fiber composite strength and microbial activity. The improvement in mechanical strength of soil-nanoparticle treated WH fiber has been investigated by conducting UCS, CBR and direct shear strength test.

For WH fiber, the optimum fiber content in the soil with respect to compressive strength was obtained as 0.75% and for other natural fibers considered in this study are at 1%. The UCS of fiber amended soil was found to be directly proportional to the amount of cellulose and hemicellulose present in the fibers. Among the three fibers tested, jute and WH showcased the highest water retention capability because of the presence of high hemicellulose content. Among the fibers tested, coir showcased higher crack resistance due to its multifilament nature and high lignin content. Among the natural fibers, WH showcased the highest increase in infiltration characteristics as compared to jute and coir. Vegetated soil on compacted soil-WH fiber composite showcased a decrease in desiccation potential by 55.5% and 25% as compared to bare soil and vegetated soil without fiber inclusion, respectively. The warp and weft pattern WH geotextile facilitated a higher tensile strength along with higher CBR value. The compressive strength of soil-WH biochar composite is less than bare soil at all compaction states. Water retention capacity increased from 29.5± 0.89 % to 48.45± 0.59 % for bare soil to WH biochar amended soil respectively and the increase is proportional with WH BC percentage (2-15%). Furthermore, inclusion of WH BC results in a gradual decrease of crack intensity factor from 7% to 2.8%. During the one-year buried time in soil, the UCS of all natural fiber amended soil decreased almost linearly. However, after a year of burial time the UCS of fiber reinforced soil was at least 1.68 times greater to that of unreinforced soil. Among all the soil-fiber composites, jute reinforced soil showcased the highest drop from its initial state (22.72%) followed by coir (16.67%) and WH (14.70%). The results from this study identified an appropriate mold ratio greater than or equal to 3.5 for conducting mini-disk infiltrometer measurements in laboratory columns.