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Design, Fabrication, and Performance Evaluation of a Water Soaking Machine for Ground Applications.

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ABSTRACT

Efficient water management is essential for maintaining soil moisture and reducing water wastage in agricultural and ground maintenance applications. Conventional watering methods often result in uneven water distribution, high labor requirements, and significant water losses through runoff and evaporation. This study presents the design and development of a Water Soaking Machine for Ground that enables controlled and uniform water infiltration into the soil. The proposed system consists of a mobile chassis, water storage tank, pump, and specially designed water delivery mechanism integrated with mechanical and hydraulic components. The machine operates on the principle of pressurized water flow, allowing deeper soil penetration and improved moisture retention within the root zone. Adjustable operating parameters such as pressure, flow rate, and soaking depth make the system suitable for different soil conditions. The portable and cost-effective design enhances irrigation efficiency while reducing manual effort. The proposed machine offers a practical solution for agricultural fields, sports grounds, and landscaped areas, supporting sustainable water management and improved soil moisture distribution.

1. INTRODUCTION

Efficient water management is essential for maintaining the quality and usability of playgrounds, sports fields, parks, and agricultural surfaces. Proper watering improves soil stability, suppresses dust formation, enhances vegetation growth, and ensures safe operating conditions.

However, conventional watering methods such as hose pipes, sprinkling cans, and water tankers often result in uneven water distribution, excessive water consumption, and high labor requirements. These limitations reduce operational efficiency and contribute to the wastage of valuable water resources. Recent advancements in mechanical and irrigation engineering have led to the development of mechanized systems capable of improving water distribution efficiency. Although modern irrigation technologies provide effective water application, many existing systems are designed for large-scale agricultural use and are not suitable for small- and medium-scale ground maintenance applications. Therefore, there is a growing need for a portable, cost-effective, and efficient watering solution. This study presents the modeling and fabrication of a Water Soaking Machine for Ground designed to provide uniform water distribution and improved soil moisture retention. The proposed machine integrates a water tank, motor-driven pump, piping network, sprinkler system, foam roller, and a mobile supporting structure. The system operates on the principle of controlled pressurized water flow, ensuring effective water penetration and reduced losses due to runoff and evaporation. The primary objective of this work is to develop a user-friendly and portable machine that minimizes manual effort while optimizing water utilization. The proposed design offers a practical solution for sustainable ground maintenance and supports modern engineering approaches focused on efficiency, resource conservation, and environmental sustainability.

Research Background and Problem Statement: Efficient water management is essential for maintaining sports fields, playgrounds, landscaped areas, and agricultural land. Proper irrigation improves soil moisture, turf quality, dust control, and overall ground stability. However, conventional watering methods such as manual hose irrigation and sprinkler systems often result in uneven water distribution, excessive water consumption, and high labor requirements. These limitations reduce irrigation efficiency and may lead to dry patches, soil degradation, and poor ground conditions. With increasing pressure on water resources and the need for sustainable irrigation practices, there is a growing demand for systems that can provide controlled and uniform water infiltration. Existing irrigation methods frequently suffer from runoff, evaporation losses, and inadequate moisture penetration into the root zone. To address these challenges, a portable Water Soaking Machine for Ground is proposed. The system utilizes a controlled hydraulic mechanism to deliver water efficiently into the soil, improving moisture retention and reducing water wastage. The machine is designed to provide uniform coverage, minimize labor dependency, and enhance operational efficiency. The proposed approach offers a cost-effective and sustainable solution for modern ground maintenance and irrigation applications.

2. LITERATURE REVIEW

A study on Moistube irrigation investigated soil water infiltration under different working head conditions. The results showed that infiltration rate and soil moisture distribution are significantly influenced by pressure head, providing a basis for efficient water soaking system design [1]. Researchers evaluated Horton, Kostiakov, Modified Kostiakov, and Philip infiltration models under different soil and land-use conditions. The Horton model demonstrated the highest prediction accuracy for estimating infiltration behavior [2]. A review of soil infiltration characteristics highlighted the influence of soil texture, porosity, organic matter, and hydraulic conductivity on water movement and moisture retention within the soil profile [3]. A study on rain gardens compared traditional infiltration models with machine learning approaches such as Gradient Boosting Machine and Deep Learning. The advanced models provided more accurate infiltration predictions and improved water management strategies [4]. Research on sprinkler irrigation in tea farms examined the effects of water application rate and slope gradient on infiltration behavior. The study developed an accurate model for predicting infiltration depth and improving irrigation efficiency [5]. Several infiltration models, including Philip and Green-Ampt models, were analyzed for groundwater management applications. Combined modeling approaches showed better prediction accuracy than individual models [6]. An automatic irrigation control system based on soil moisture sensing was developed to optimize water use and eliminate manual intervention. The system successfully improved irrigation efficiency through real-time control [7]. A study on Moistube irrigation evaluated soil water distribution in loamy sand and sandy clay loam soils. Results showed that soil texture significantly affects water movement and soaking efficiency [8]. Research on soaking processes demonstrated the importance of controlled soaking conditions and highlighted the effects of soaking on material properties and moisture distribution [9]. A study on seed priming investigated the influence of soaking duration and water volume on seed performance. Controlled soaking conditions were found to improve germination and seedling development [10]. Moistube irrigation performance was evaluated under different operating pressures and placement depths. The findings indicated that pressure head and installation depth strongly affect infiltration behavior and irrigation efficiency [11]. Research on compacted foundation soils analyzed water infiltration characteristics through experimental and numerical methods. The study provided useful information regarding moisture movement and soil soaking behavior [12]. A study on point-source drip irrigation investigated soil wetting patterns under varying emitter discharge rates. Increased discharge rates enhanced moisture penetration and improved soil water distribution [13]. Researchers developed a fertilizer mixing device capable of improving water-fertilizer mixing efficiency. The system ensured uniform nutrient distribution and enhanced irrigation performance [14]. An investigation into the effects of water soaking and salt concentration on loess soil revealed significant changes in shear strength and soil structure, emphasizing the importance of controlled soaking processes [15].

A Genetic Algorithm–Back Propagation neural network model was developed to predict soil infiltration under Moistube irrigation. The model demonstrated high prediction accuracy and reliability [16]. Another study on Moistube irrigation examined soil water movement using experimental and numerical methods. Soil texture was found to be a major factor influencing wetting patterns and soaking efficiency [17]. Research on underground porous membrane irrigation systems showed that controlled infiltration can reduce deep percolation losses and improve water retention within the root zone [18]. The infiltration behavior of muddy water fertilization through film-hole irrigation was investigated under different soil densities and hole diameters. The study highlighted the relationship between soil structure, infiltration, and nutrient transport [19]. A comprehensive study evaluated the effects of soil texture and initial moisture content on infiltration behavior. Results confirmed that soil characteristics play a dominant role in controlling infiltration rates [20]. Researchers compared Horton, Kostiakov, Modified Kostiakov, and Philip models using field experiments. The Horton model exhibited the best performance for infiltration prediction under varying land-use conditions [21]. The influence of initial soil moisture content on infiltration characteristics was studied using empirical and numerical models. HYDRUS-1D and Horton models showed excellent agreement with observed infiltration data [22]. Various infiltration models, including Philip, Green-Ampt, Horton, Kostiakov, Modified Kostiakov, and SCS models, were evaluated for irrigation applications. The Philip model demonstrated the highest overall accuracy in predicting infiltration behavior [23].

Most existing studies focus on infiltration modeling, Moistube irrigation, and automated irrigation systems. However, limited research has been reported on the development of a portable and cost-effective water soaking machine specifically designed for playgrounds, sports grounds, and landscaped areas. Therefore, the present work aims to design and fabricate a mobile water soaking machine capable of providing uniform water distribution, reduced labor requirements, and efficient water utilization.

3. Objectives of the Study

1. To Design and develop a portable water soaking machine suitable for playgrounds, sports fields, and other ground maintenance applications.
2. To achieve uniform water distribution through an efficient sprinkler and piping system.
3. To optimize water utilization and minimize water wastage during the soaking process.
4. To evaluate the operational effectiveness of the machine in terms of coverage area, soaking efficiency, and overall performance.
5. To develop a cost-effective, user-friendly.

4. Methodology

The methodology adopted for the development of the Water Soaking Machine for Ground involved problem identification, conceptual design, component selection, fabrication, and performance evaluation. Initially, conventional ground watering methods such as manual hose irrigation and tanker-based watering were analyzed to identify limitations including uneven water distribution, high labor requirements, excessive water consumption, and increased operational time. Based on these observations, design requirements emphasizing portability, efficiency, affordability, and ease of operation were established. A conceptual design was developed comprising a water tank, electric motor, pump, piping network, sprinkler nozzles, foam roller, hopper, and a mobile supporting frame. The machine operates on the principle of pressurized water flow, where water stored in the tank is pumped through the piping system and distributed uniformly over the ground through sprinkler nozzles. The foam roller assists in improving water absorption, reducing runoff, and ensuring uniform moisture distribution. The supporting frame was fabricated using mild steel to provide structural strength and stability, while plastic materials were used for water storage components to minimize weight and prevent corrosion. The motor-driven pump system was selected to ensure continuous water supply at the required pressure. Components such as shafts, pedestal bearings, screws, and nuts-bolts were incorporated to provide smooth operation and mechanical reliability. After fabrication, the machine was tested under practical ground conditions to evaluate its coverage area, water distribution uniformity, operational efficiency, and ease of movement. The developed system demonstrated effective water application with reduced manual effort, making it suitable for playgrounds, sports fields, parks, and landscaped areas.

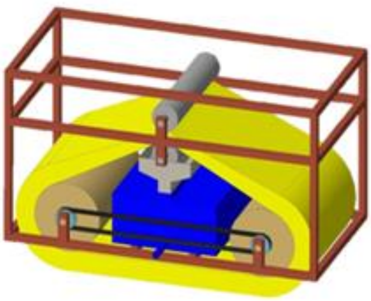

FIGURE 1 : - WATER SOCKING MACHINE

FIGURE 2 :- FRAME

5. RESULT AND DISCUSSION

The fabricated Water Soaking Machine for Ground was successfully developed and tested under practical operating conditions. The machine operated smoothly and demonstrated effective water distribution across the ground surface. The integration of the water tank, motor-driven pump, piping network, sprinkler arrangement, and foam roller enabled continuous and uniform water application during operation. The sprinkler system provided adequate coverage and distributed water more uniformly than conventional manual watering methods. The foam roller played a significant role in enhancing water absorption by spreading the supplied water evenly across the ground surface and reducing localized water accumulation. This resulted in improved soil moisture penetration and reduced surface runoff. The mobility of the machine allowed easy movement across playgrounds and open grounds, reducing manual effort and operational time. The mild steel frame provided sufficient structural strength and stability during operation, while the motor-pump arrangement maintained a steady water supply throughout the testing period. The use of lightweight plastic containers and an efficient piping system further improved operational convenience. Overall, the developed machine demonstrated satisfactory performance in terms of water distribution, coverage, ease of operation, and portability. The system effectively addressed the limitations of traditional watering methods by reducing labor dependency, improving water utilization, and enhancing ground soaking efficiency. These observations indicate that the proposed water soaking machine can serve as a practical and cost-effective solution for playgrounds, sports fields, parks, and other ground maintenance applications.

6. CONCLUSION

The incorporation of a foam roller enhanced water absorption and minimized surface runoff, resulting in improved soil moisture retention and ground conditioning. Compared with conventional watering methods, the proposed system offers better water utilization, reduced labor requirements, and enhanced operational efficiency. The machine is suitable for applications such as playgrounds, sports fields, parks, and landscaped areas. Overall, the developed water soaking machine provides a practical, economical, and sustainable solution for efficient water management. Future improvements may include the integration of automated control systems, soil moisture sensors, solar-powered operation, and increased water storage capacity to further enhance system performance and applicability.

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