International Journal of Scientific Research in Science, Engineering and Technology
Print ISSN: 2395-1990 | Online ISSN : 2394-4099 (www.ijsrset.com)
doi :https://doi.org/10.32628/IJSRSET23103111

State-Of-The-Art Developments in Soil Lifting Hand Tool : A Review

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ARTICLEINFO

Article History:

Accepted: 10 May 2023
Published: 25 May2023

Publication Issue
Volume 10, Issue 3
May-June-2023

Page Number
180-185

ABSTRACT

Shovel is commonly used for soil lifting, weed removal,ormation, lifting straw, etc. Due to soil packing, unequal height, and other factors, the standardized spade size is not suitable for every worker and every field situation. As a result, the standard shovel lacked flexibility and was unsuitable for all of the labours need to work productively. So a shovel should be introduced that can quickly change the shovel metal head or blade angle to carry out the task effectively, and the wooden handle should be replaced with a suitable alternative.The authors have undertaken several studies looking which aims to research on shovel that increases overall yield while also immediately lowering time consumption and protection.

Keywords: Soil lifting tool, spade, Blade angle, shovel hand tool, shovel.

I. INTRODUCTION

Workers are seeking for innovative ways to use technology to minimiselabour expenses and time duration. Workers are beginning to investigate new technology in various industry in a variety of ways, one of which is due to autonomous variables. Aside from focusing on product and quality characteristics, there has been a growing emphasis on addressing human and crucial aspects in the improvement of hand tools for diverse sectors. When building and implementing new technology, researchers and employees are recognising the relevance of ergonomics and worker wellness.According to history,Construction industry is the slowest to adopt technology due to factors like rigidity of users who are used to work in the same way, price, reach of new technology etc. This is rapidly changing now workers are looking to cut their cost and time.Excavation , filling, ploughing landfills etc these can be very complex based on hours of work, altitude, soil profile etc. Shovels and buckets have unloading methods of various lengths and dimensions .The shovel is designed to have a sticking foot between the shaft and the blade, which can help workers avoid frequent bending and upper extremity pressure when digging soil.

There are various studies about improvement in hand tools in the industrial business.Jain et al., (2018) has used a heavy, inconvenient hand tool, resulting in

work-related health issues. Work-related health issues can be considerably decreased by adopting ergonomically built hand tools. The most prevalent work-related health issue appears to be musculoskeletal problems. Most papers focused on product and quality variables to enhance hand tools, while other articles focused on human and critical variables.

II. SHOVELS

The shovel, spade, and hoe are all typical instruments used in Manual Material Handling (MMH) jobs. Only a few research have been conducted, to our knowledge, to produce a specific ergonomically built instrument that would perform the function of the shovel. Varied prototypes of the combination tool with adjustable handle length were created and improved upon after multiple trials based on direct observations and different ergonomic studies on the actual usage of the traditional shovel and hoe in different MMH jobs, The high lift and throw work required trunk movement in the back bent and twisted position including the phases of high lift work. The postural stress was found to be extremely heavy leading to back discomfort. The work was the slowest among the three nodes, and the physiological stresses were extremely high.

The optimal work rates for high lift, thigh lift and throw work were also higher in spade A (19 strokes/min). The study concludes that the dimensional factors have a significant influence on the physiological strain when the stroke rates were high, (Freivalds, 1986) Studied effects of lift angle, blade size and shape, hollow- and closed-back design, and handle length on shovelling performance, energy expenditure, anticipated low-back compressive stresses, and subjective ratings of perceived exertion were investigated in a two-phase experimental investigation. The findings led to the following shovel design recommendations: a 32-degree lift angle, a wide square-point shovelling blade, a round-point digging blade, a hollow-back design to save weight, a strong socket for strength in heavy-duty applications, a step for digging in hard terrain, and a long tapered handle.

The heaviness of the hoe's head should not exceed 1.8 kg. To avoid torsional effects on the hand while lifting and employed with the tool, the tool handle should be involved at the centre of the body's mass. Additionally, the tool's centre of mass should be as near to the point of action as feasible.To allow free movement of the wrist and fingers, the shovel's grip handle should be redesigned and made cylinder-shaped. The angle between the shaft and extension of the blade should be within a range of 16 and 32°. (Mohan et al., 2021) developed multi purpose shovel which is flexible, and it can work on the following angles : 180 degrees, 90 degrees, and 35 degrees, he analysis its stress using Von Mises Stress method and used ANSYS to see its performance.

The crux of ergonomics significance in tool development is to ensure that the interface between Man and equipment is compatible with the human requirements and the needs of the function to be performed. The tool so designed is safe, efficient and comfortable for the user. The selection and evaluation of hand tools, whether manual or power tools, are based on the technical, anatomical, kinesiological, anthropometric physiological and hygienic conditions (Fraser, 1980).

Degani et al., (1993)compared two shovel designs. It was found that the people working with modified shovel design with two perpendicular shafts witnessed less exertion and could work for more hours in comparison to normal shovel in digging trenches upto 90cm depth. A normal excavator is contrasted to this upgraded two-axle excavator. Using surface recorded electromyography of the spinal muscles, the redesigned bucket was examined and tested in a controlled laboratory setting. The new bill design was also put to the test in a field investigation using stress levels that were recorded. When the modified bucket is used to remove debris in trench

excavation to a depth of 90 cm, electromyographic measurements of the muscles between the lumbar vertebrae demonstrate a considerable loss and a continual decline in range of motion.

Two modified models of wire claw, model 1 (eight claw) and model 2 (five claw), with three different lengths were tested.

Support grips were provided to protect the hand from injury and in facilitating the applicationof pressure on the claws, The conventional steel wire grips were replaced by a wooden handle for easy grasping,Interchangeable handles were provided to vary the - total length of the tool and to avoid the bent posture.

Burgess-Limerick et al., (2012) created Operations and Maintenance Analysis Technology (OMAT) technology to assess the hazards associated with O&M jobs, and to work with mining equipment manufacturers to speed up advances in mining equipment safety design.In order to give equipment buyers a standard method of evaluating how successfully the challenges in the EMESRT Design Philosophies are handled in the equipment design, manufacturers are being asked to adhere to this methodology, as well as to provide manufacturers with additional information to use during the equipment design process.(Chu et al., 2013) ANSYS Workbench was used to create the finite element model. The first six model forms of the rack were derived by the modal analysis of an arrow-shaped shovel after constraint processing.

The odd order of main modes is horizontal hunting along both sides of the shovel handle, whereas the even orders are upward and downward perpendicular to the horizontal position, according to the modal analysis, and the first six natural frequencies grow in magnitude as the order grows. The shovel head is where the first six models of the rack experience the most deformation. The findings provide a theoretical framework for bettering and enhancing the shovel.

Overall what may be drawn from the study is that work with hand tools is unnecessarily strenuous for the human operator. In two key sectors (agriculture and civil work) it has been demonstrated how improvements can be made through changes in the design of the tool as well as in the work method, based on the principles of ergonomics. It is hoped that similar steps will be taken inother areas, to make work with manually operated hand tools more productive as well as more humane.

III. AGRICULTURE IMPORTANCE

Usage of tools varies with the nature of the job and from occupation to occupation. A group of tools (spade, beater, hoe, shovel) which are commonly used in agriculture, civil construction work, were included in the present investigation. It is similar to weeders which are used in agricultural work (Nag and Dutt, 1979).

Agricultural Work: Spade

The spade also named a hoe, is the most common earth digging tool. It is also used in the scraping of grass, in the mixing of materials like sand, etc., and civil construction work. The tool, locally known as 'Nodal', 'Kodali' or 'Phaora', has been described as a back acting hoe (Rennie, 1977). Hoeing is a crucial part of many farming chores, including preparing seedbeds and harvesting roots crops. The physiological and biomechanical strains were assessed in seven male farmers (age: 27.4+5.9 years), using two types of hoes (A&B), and hoeing speeds in low lift (LL) and high lift (HL) operations were optimised. The VO 2 demands and heart rates (161-176 beats per minute)

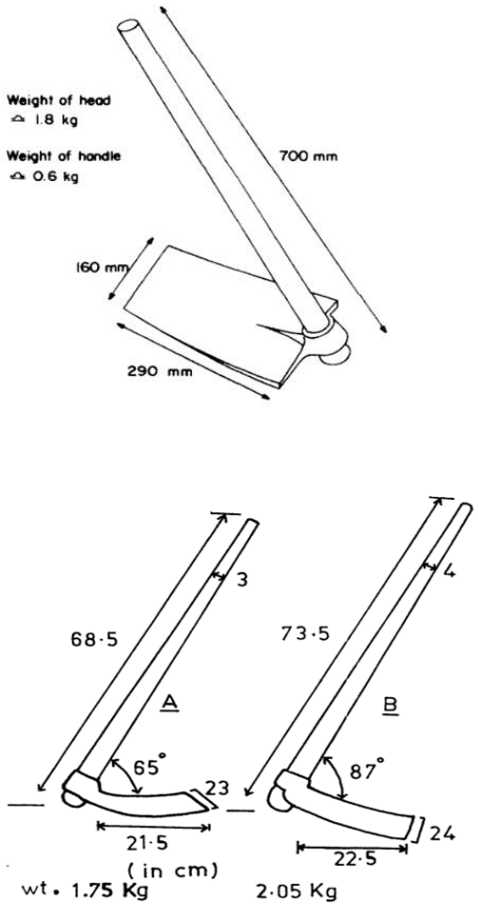

Figure 1 An Indian hoe tool

Table 1: Dimensions of spades used in the study

Measurements	Spade A	Spade B
Total weight (kg)	1.75	2.05
Weight of blade (kg)	1.3	1.4
Length of blade (cm)	21.4	22.5
Width at edge (cm)	23.0	23.7
The thickness of the blade (mm)	2.0	2.5
The angle between blade and handle (degree)	65.0	87.0
Weight of handle (kg)	0.45	0.65
Length of handle (cm)	68.5	73.5
Diameter of handle (mm) from free end at a distance of:		
i) 2 0 cm	33.0	37.0
ii) 55 cm	40.0	41.0

In above table the researcher has compared two different size and shaped spade.

Chang et al., (1999) compare three distinct types of gardening tools/tools (shovel,rake,andshovel) with three different categories: a typical wooden handle and two fibreglass handles were used to test dozer performance, strength increase, EMG, workload, and mental ratings of perceived exertion. The relative efficiency of pedalling power, i.e. dividing impact power by workload, was the most effective criteria for pedalling.

The hollow fibreglass handle outperformed the wood and fibreglass handles by 12%.(Taylor 1913, Copley 1923), Taylor discovered bucket loads ranging from 1.6 kg for rice cabbage to 17.3 kg for iron ore under the time's bromine flow. It was observed that by modifying the bucket size to fit the density of the material to be crushed, optimum efficiency could be attained with a 9.7 kg load, needing just 140 workers to execute a task that previously took 400-600 men.

Humphreys et al. investigated mine dredging in greater depth. (1962). On a conveyor line 0.23-030 m from the ground at a distance of 0.91 m, a total of ten men pulled the coal from the ground. There are three separate modes and three different elevator shafts.

The handle and lift the tool upward during use. Then he has to bring the tool downwards with a good amount of force with simultaneous bending of the back. As a result of the thrust exerted the blade goes inside the soil. During the process of freeing the spade, the surface soil is overturned. The process is repeated throughout work. Categorically in agricultural work, a spade is used in a way:

- The beater is used for packing the sleeper seat under the rails to maintain level and evenness. At the centre of the head (body) of the tool, a wooden handle is attached. One end of the head is pointed, while the other end is blunt and hammer-shaped.
- The shovel is used for dressing the track. It is also used for cleaning of ballast under the rails where wire claw cannot reach and for filling the space under the two rails by ballast.

IV. STUDIES TO ADVANCE THE ERGONOMICS OF HAND LIFTING TOOLS

The researcher has focused on work-related treatments to help minimise risk factors by developing an ergonomic approach that reduces risk factors that can lead to musculoskeletal diseases or other forms of injury/disease. Saxena et al. (2021)At a brick building site in Rampur (UP), India, an initial evaluation of personal and situational discomfort was undertaken. A REBA score of 17 was obtained from a sample of 16 employees (age: mean = 35.8 years; SD = 3.1 years).

The shovel handles may be pointed in four different orientations to the tank bottom (H75, H80, H85, and H90 (partially measured) using computer-aided ergonomics). The right shoulder, left wrist, left shoulder, and C0-C1 cervical joint are all affected by the orientation of the bucket handle. The H80 handle was used to produce the lowest bucket joint torque(Hasheminejad et al., 2021). The current research was conducted in two stages. A total of 138 employees took part in the first phase. The Scandinavian Skeletal Muscle Questionnaire was used to determine the prevalence of MSA and to identify occupational risk factors. PE was employed for comfortable treatments to minimise MSA in the second phase, and the effect of the intervention was investigated.The second stage had 64 individuals in total (32 in the case group and 32 in the control group).

The shoulders (63%), waist (63%), and wrist (63%), according to Harivanam et al. (2010), had the maximum frequency of neuromuscular illness. 52.2 percentApproximatly. The prevalence of MSA in the intervention group did not significantly differ from the control group following the completion of the PE intervention course.However, following a re-evaluation of the five activities that were previously classed as high-risk, all five tasks had a lower final score. It has conducted a experiment where wet clay was dug out using a shovel that had a blade pierced with tiny holes in order to compare how much less energy was required overall.The number of scoops excavated during the 10-min sessions did not differ significantly, however those who used the perforated shovel scooped 9.5% more clay than those who used the standard shovel (404 kg vs. 369 kg, respectively).

Additionally, individuals used 11.7% less relative energy per kilograms of clay scooped with the perforated shovel, as shown by steady oxygen uptake standardized to participant weight and clay weight.(Lim et al., 2016) The goal of this research is to create an agricultural shovel that will minimise effort and thereby assist farmers avoid musculoskeletal diseases. Background and Objectives: Most farming occupations, including shovels, need repeated labour and incorrect body part alignment, which can contribute to musculoskeletal diseases. To lessen the burden, agricultural machinery and equipment must be developed and sold. The upgraded shovel was conceived and manufactured as a test sample to evaluate existing and new shovels in order to improve the shovel discomfort anticipated by 10 farmers. Twenty males were chosen for the study, and muscular activity (percent MVC) for six body regions was assessed, as well as a mental evaluation of physical complaints while shovelling with a shovel.

V. CONCLUSIONS

Required Improvement in shovel helps to increase the productivity and also reduce the backpain of workers, whereas it willalso help them to adjust height according to their comfort. Many worker are getting injured because of wrong ergonomical shovel, which causing highest frequency of Musculoskeletal Disorders(MSD), correcting the defects will help make the agricultural working environment healthier and harmless.By using modified implements that are suitable for the workers, efforts are currently being made across a variety of disciplines to enhance agricultural work, streamline the working processes, and reduce time and human labour. These aim at

increasing productivity, workers safety, health, welfare and comfort.

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