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Work organization in sand core manufacturing for health and productivity

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Abstract

Sand core making is a manual process, in which two types of cores are prepared—carbon dioxide sand core and chemical sand core. Core making workers often work in awkward postures and suffer from musculo-skeletal disorders, primarily affecting the low-back region. In this study an attempt was made to organize the sand core making operation for enhancing productivity. The existing process of both types of sand core making involved some unnecessary steps, which hamper the rate of work and consequently productivity is hindered. The modified process eliminates these steps and the overall productivity in carbon dioxide sand core making and chemical sand core making increased by 8.5% and 30%, respectively.

Relevance to industry

In the informal sectors, the work improvement can be effectively carried out by means of low-cost modification in the existing work process and workstation design. In this study, elimination of certain steps and modification in existing process led to a remarkable improvement in productivity.

Keywords: Sand core making operation; Work organization; Productivity; Health

1. Introduction

Sand core making is a hazardous process wherein a large number of workers are directly involved. The entire core making operation is performed manually and the methods adopted are quite primitive ones. Two types of sand cores are prepared in the core-manufacturing factory—carbon dioxide sand core and chemical sand core. In carbon dioxide sand core making, the entire core making process involves four steps—(a) preparing a core box; (b) filling the core with sand; (c) spreading and fitting the sand; (d) passing carbon dioxide gas for hardness and (e) storage of the core. Dry sand is mixed with sodium silicate and this mixture is poured into a wooden core box and hammered for fixing the sand. Sometimes the workers stand over the box and press the sand with their feet. The excess sand is then removed by stick and thrown out. After that a hole is made in the sand by a rod and carbon dioxide gas is passed through the hole from a cylinder. This gas is used for hardening of the sand. Finally the core box is hammered for loosening and turned upside down manually. The core thus prepared, is shifted for storage. In chemical sand core making, dry sand is mixed with resin, accelerator and catalyst. Then the mixture is poured into a wooden core box manually and left for hardening. Finally the core box is turned upside down manually, in both the cases.

In chemical sand core making, work process is slow and the overall productivity is low. Moreover, workers adopt awkward work postures, with potential risks of low-back pain. In this study an attempt was made to organize work of sand core making operation for betterment of health as well as enhancing productivity.

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2. Methods

Thirty (30) male workers engaged in carbon dioxide and chemical sand core making at a core-manufacturing factory were randomly selected in this study. Physical characteristics of the workers participating in the study were recorded. The workers had a minimum work experience of five years.

The modified Nordic questionnaire (Kuorinka et al., 1987) was used in this study. The questionnaire consists of a series of objective-type questions with multiple-choice responses. The questions were grouped into sections dealing with general information of the workers, work organization and work behavior, assessment of stress at work and detailed question on work-related pain. The heart rates of the workers before and after work were measured. Student t test was performed among the workers to find out whether there is any significant difference between the heart rates measured before and after work.

One of the earliest whole posture coding system for industrial purpose was developed in Finland to investigate working posture in a steel company. The company Ovako Oy in association with the Finish Institute of Occupational Health formulated the Ovako working posture analysis system (OWAS) method (Karhu et al., 1977). In this study this method was applied with the aid of digital photography (Sony Handycam 360X) for analysis of working posture. The stick diagrams were drawn from freezed-frame video records and analyzed to explore the likely musculoskeletal load for a single posture on the back, arms and legs along with the action categories. This enables each posture to be assessed for suitable appropriate remedial action. Most frequent postures in sand core making were taken into consideration for further analysis.

A detailed method study (International Labour Office, 1981) of the existing carbon dioxide and chemical sand core making processes was done and accordingly, modification of the processes were carried out.

Table 1
Responses of questionnaire

Questionnaire Part 1—work organization and work behavior	Response	Number and percentage
Job requires knowledge of skillful activity	Yes	23 (76.6%)
Worker makes frequent mistakes	Yes	11 (36.7%)
Job demands frequent rotation, for task and place	Yes	26 (86.7%)
Rigidity in work methods and conditions	Yes	22 (73.3%)
Job requires repetitive motions of body segments	Yes	20 (66.7%)
Fixed starting/finishing time of job	Yes	25 (83.3%)
Like to work in group	Yes	30 (100%)
Forced to accept new load / responsibility	Yes	21 (70%)
Favor job rotation/division of labor	Yes	30 (100%)
Questionnaire Part 2—measurement of work stress		
Have you got tired easily	Yes	8 (26.7%)
Have you bored easily	Yes	12 (40%)
Have you been forgetful	Yes	17 (56.7%)
Difficulty in falling or staying asleep	Yes	8 (26.7%)
Do you in your work often have to:	Lift	20 (66.7%)
Lift, pull or push and carry loads	Push	2 (6.6%)
(more than 20 kg)	Carry	8 (26.7%)
Lifting behavior	Alone	24 (80%)
	With others	6 (20%)
Do you often have to stand or sit for	Stand	9 (30%)
a prolong time	Sit	21 (70%)
Do you feel any kind of discomfort	Yes	30 (100%)
Area of discomfort	Neck	8 (26.7%)
	Shoulder	10 (33.3%)
	Hand	12 (40%)
	Wrist	6 (20%)
	Low back	30 (100%)
Is the discomfort felt during work	Yes	16 (53.3%)
Is the discomfort felt during rest	Yes	6 (20%)

3. Results and discussion

The mean age of the workers was 27.17 ± 7.05 years. The body height and body weight were 162.47 ± 4.95 cm and 53.65 ± 6.46 kg, respectively. The body mass index (BMI) was 20.32 ± 2.21, suggesting that the workers had a normal range of BMI, as per classification (McArdle et al., 2000).

The workers in sand core making had 8 h per day, starting from 10 AM with an interval of 1 h (2.30 PM–3.30 PM) and a day off per week. The analysis of questionnaire (Table 1) showed that 76.6% of the workers performed skillful activity. Most of them (63.3%) did not make frequent mistakes at work. As large as 86.7% of them reported that they frequently changed their place while at work. This mobility allowed them to take short rest pause that helped them to relieve their job monotony.

Nearly 73.3% of the workers agreed that there exists rigidity in work methods and conditions. About 66.7% of the workers reported that their job requires repetitive motion of body segments, particularly the movement of the hands. Although the workers did not complain of any strain injury, on continuation of the job in the above manner they may suffer from injury in the hands in the near future. Keyserling et al. (1993) reported that highly repetitive hand intensive jobs may lead to repetitive strain injury and cumulative trauma disorder. A similar finding was observed in the investigators' previous studies on workers in unorganized sectors (Gangopadhyay et al., 2003; Banerjee and Gangopadhyay, 2003).

The workers often work in groups. They (70%) were often compelled to accept additional workload that enhanced stress at work. They (66.7%) were required to lift 40–70 kg of core at a time with a constant forward bending posture with twisted back and arms. In a single day, they lifted at least 70 carbon dioxide sand cores and 50