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E: ISSN NO.: 2455-0817 Remarking An Analisation

Perceived Fatigue and Physiological Workload of the Marble Cutting Workers working in Marble Industry of Kishangarh District

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Abstract

Fatigue is a prolonged feeling of tiredness and exhaustion which gets accumulated due to lack or rest, improper work habits, postures, lack of sleep and stretching and straining of muscles of the body. The physiological workload determines the physical or muscular effort carried by a worker to accomplish a task. The analysis of physiological cost of work plays a pivotal role in the process of carrying out ergonomic evaluations of any job.The sample was selected through purposive random sampling. 220 Marble Cutting workers were selected for the study. The data were collected through Questionnaire and observation method wherein the Questionnaire dealt with information on Fatigue and observation was conducted for gathering physiological cost of work. The findings of the study elicit that the respondents were facing Severe fatigue. The physiological cost of work of the respondents revealed that thetask was moderately heavy. The study will aid in policy making for ensuring the safety of the workers working in Marble cutting industries.

Keywords: Percieved Fatigue, Physiological workload, Marble Cutting Workers, Marble Industry.

Introduction

Fatigue is a non-specific symptom but one of the most common ones reported in several studies [Evans & Lambert (2007) and Jason et.al. (2010)]. It is defined as one's state of overwhelming, debilitating, sustained exhaustion and decreased ability to perform daily activities, and that cannot be relieved by rest (Fukada, 2004). Fatigue also can result in declines in worker productivity due to the debilitating nature of fatigue [Kant et.al, 2003].The analysis of physiological workload plays a pivotal role in the process of carrying out ergonomic evaluations of any job. The objective of applying ergonomic principles in work analysis is to maintain a balance between the work and the physical capacity of the worker. If the physiological cost of the work is less the worker is underutilized and there is a productivity loss hence the balance between the two is needed. (Singh, 2013). Determining the physiological cost of work of the marble cutters would assist in utilizing their work productivity efficiently. Thus, a need was felt to find out the physiological cost of work of the marble cutters.The present study aims to assess the physiological cost of work and perceived fatigue of the Marble cutting Workers. The findings of the study will aid in policy making of unorganized workers. The study will also provide an insight of the fatigue experienced by the Marble cutting workers which can aid in restructuring the job design if necessary.

Methodology

The present study was conducted in the international hub of marble i.e. Kishangarh Tehsil of Ajmer district of Rajasthan, India. Kishangarh is a village in Kotri Temple in Bhilwara District of Rajasthan State, India. It belongs to Ajmer Division. The unit of enquiry for the present study were the Marble Cutters working on the Marble Tile Cutting Workstation in the Marble Industry. The sample comprised of 220 marble cutters working on the marble tile cutting workstation in the marble industry. The respondents for the present study were healthy and did not suffer from any chronic or acute diseases at the time of data collection the care was taken to select the workers who were regular. The workers aged above 50 years were also excluded from the sample to avoid bias. The respondents selected for the study had minimum two years of experience and above. Purposive sampling design was utilized for selecting the sample. The Physiological Cost of Work of the Marble Cutting Worker was assessed on the basis of energy consumed (kj/min) and Heart Rate (beats/ min) of the worker while cutting one standardized size of marble slab. It was measured by the severity of Physiological Workload as given by Varghese et.al. 1994. The Perceived Fatigue was the Fatigue experienced by the workers after work.

Physiological Workload

For collecting data of physiological workload, digital heart rate monitor was be used to measure the heart rate (beats/ min). The Heart Rate Monitor was used to measure the heart rate stresses during the activity. Later the Heart Rate Monitor was tied and the watch started to record the heart rate of the worker while working for 30 minutes. Three readings were recorded of the respondents to derive an average working Heart Rate.

Based on the records of heart rate monitor, and energy expenditure for the activities, inferences were drawn by using the formula.

Energy Expenditure (kj/min)= 0.159xAverage Working Heart Rate (beats/min)-8.72

Table 3: Classification of Physiological Workload According to Severity of Work Load

Physiological Workload	**Varghese et.al. 1994**
	Energy Expenditure
Very light	Up to 5.0
Light	5.1-7.5
Moderately heavy	7.6-10.0
Heavy	10.1-12.5
Very heavy	12.6-15.0
Extremely Heavy	>15.0

Perceived Fatigue

The perceived fatigue was measured by the researcher through prevalidated FACIT Scale. The FACIT Fatigue Scale is a short, 13-item, easy to administer tool that measures an individual's level of fatigue during their usual daily activities over the past week. The level of fatigue is measured on a four point Likert scale (4 = not at all fatigued to 0 = very much fatigued) (Webster et al., 2003). The FACIT tool has been translated in more than 45 different languages permitting cross-cultural comparisons. In a 2007 study, (Chandran et al., 2007) the FACIT Fatigue Scale was found to have high internal validity (Cronbach's alpha = 0.96) and high test-retest reliability (ICC = 0.95).

Results

Fatigue is extreme tiredness that can manifest as physical weakness or mental exhaustion. It is characterized by decreased energy, motivation and difficulty concentrating. Fatigue is a non-specific symptom but one of the most common ones reported in several studies (1) (Berggren, & Christensen, 1950). It is defined as one's state of overwhelming, debilitating, sustained exhaustion and decreased ability to perform daily activities, and that cannot be relieved by rest (Malhotra,1962). The energy expenditure is the amount of energy (or calories) that a person needs to carry out a physical function such as breathing, circulating blood, digesting food, or a physical movement.

Perceived Fatigue

Fatigue can be acute or chronic. The data were collected through FACIT scale version 4. The FACIT Fatigue Scale is a short, 13 item tool that measures an individual's level of fatigue during their usual daily activities over the past week. The level of fatigue is measured on a four point Likert scale. The items are scored as follows: 4=Not At All; 3=A Little Bit; 2=Somewhat; 1=Quite A Bit; 0=Very Much, EXCEPT items #7 and #8 which are reversed scored. Score range 0-52. A score of less than 30 indicates severe fatigue. The higher the score, the better the quality of life.

The data in the table 1 reflected that almost half of the respondents (50.45%) were found to be severely fatigued. The data is supported by the findings of a study conducted in China by Lin et.al. (2015) on community health in Shunde (Guangdong Province, China) revealing that approximately 30 per cent of the respondents experienced fatigue. The fatigue was associated with age, marital status, employment status, regular exercise, number of self-reported chronic diseases, number of individual's children and hospitalization in the last year in middle-aged and elderly males. Zhang et.al. (2015) also found while surveying presence of fatigue among the 606 construction workers of US, it was revealed that 49 per cent reported being 'tired some days' in the past 3 months and 10 per cent reported 'tired most days or every day'.

Table 1: Distribution of Respondents According to the Perceived Fatigue experienced by them

n=220

Level of Fatigue	**f**	**%**
Severe Fatigue (Below 29) (Below Mean)	111	50.45
Less Fatigue (More than 29) (Above Mean)	109	49.55

Physiological Workload

Physiological Workload refers to the physical or muscular effort required on the part of the worker to accomplish a task or an activity. From the physiological point of view, the job demand or workload refers to the demands placed on the cardio-respiratory system determined from the energy cost and the cardiac cost of work.

The period during which the activity continuous is known as the 'work period' and when the activity is stopped and physiological functions returns to resting level is known as the 'recovery period'. The data were gathered by using he heart rate method. The use of this method has been advocated by many researchers in the field of physiology (Berggren and Christensen,1950; Malhotra et.al. 1962) and is now used worldwide as a measure of physiological workload in industries and other field situations.

The respondents were allowed to sit and rest for five minutes. Later the Heart Rate Monitor was tied and the watch started to record the resting heart rate for five minutes. The respondents were asked to start the activity for 30 minutes after taking a rest for five minutes. After 30 minutes the respondents were requested to stop the activity and allowed to recover for five minutes and the recovery heart rate was then recorded. Thereafter, the heart rate monitor was stopped. Based on the records of heart rate monitor, total cardiac cost of work (TCCW) inferences were drawn on the basis of classification given by Varghese et.al (1994).

The data in the table 2 revealed that for slightly less than two third of the respondents (61.82%), the physiological workload was found to be moderately heavy of the task performed by the respondents. 34.54 per cent of the respondent's physiological workload was recorded heavy for the task performed by them. It was also interesting to note that very few respondents (3.64 per cent) physiological workload was computed as light for the task performed by them . The findings of the present study were supported by a study conducted by Santini et. al in 2012 in Italy revealing that the physiological cost of work was high among the construction workers. An assessment of physiological stress parameters of female workers engaged in selected cooking activities by Bhatt et.al (2011) revealed that according to the workload classification given by Varghese et al. (1994), the physiological workload of the activities can be interpreted as light activity for rolling and dish washing, whereas cutting and grating carrots and kneading dough as moderately heavy activity.

Table 2: Distribution of Respondents According to the Physiological Workload

n=220

*Physiological Workload	f	%
Light (91 – 105 Heart Rate beats/min)	08	3.64
Moderately Heavy (106 – 120 Heart Rate beats/min))	136	61.82
Heavy (121 – 135 Heart Rate beats/min))	76	34.54

Source: Varghese Et.al. (1994)

Conclusion

The findings conclude that the respondents were experiencing fatigue. The respondents physiological workload was also computed to be moderately heavy and heavy. The work structure can be reexamined and redesigned in order to lesson the fatigue and workload of the respondents. The workers must be given facility for rest breaks so that they can relax and work thus increasing their efficiency and reducing their fatigue.. The owners of the industry must take certain actions in providing rest breaks, and training regarding handling posture, avoiding repetition of work thus reducing perceived fatigue.

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Assessment of the Workplace Environment of the Marble Cutting workers in Marble Industries at Kishangarh District, Rajasthan

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ABSTRACT
Working environment means the physical surroundings of a person. The marble industries. Stone-cutting is a lengthy process that can take more than a continuous 12-16 hours of operation, depending on the type of order placed and the type of marble. Despite of technological development for lifting bulky marbles and cutting them, the role of a human being cannot be denied. The present study aims to assess the environment of the workplace of the Marble cutting workers working in marble industries. The study also aimed to gain an insight regarding the training and the protective aids used by the workers while working. The study was descriptive in nature. The sample was selected through purposive random sampling. 70 industries readily agreed to allow the collection of data in Kishangarh from which 220 workers were selected for the study. The findings of the study elicit that the noise and light were above the recommended limits. Very few workers were found to be provided training regarding posture, repetition of work. The use of protective aids for hands was seen among 10.91 per cent of the workers. The study will aid in policy making for ensuring the safety of the workers working in Marble cutting industries.

Keywords: Enviornment of the workplace, Marble cutting, Marble Industries, Light, Noise, Temperature.

INTRODUCTION

Ergonomics focuses on human beings and their interaction with products, equipment, facilities and environments used in the work (Jayakumar, 2009). Work environment means the milieu around a person - the room, home or place where one is working. It is all about materialistic things and living beings that are around when one is working, literally called the 'working condition'. In recent years as Pal et al., (2001) state 'working conditions' has emerged as a multi-attribute function. Stone-cutting is a lengthy process that can take more than a continuous 12-16 hours of operation, depending on the model of the cutting machine as well as the status of its diamond wire or diamond blades. When a certain order is placed for Marble, the raw stone block is transported to the factory to be cut as demanded either into tiles or slabs of various Length and size. Despite of technological development for lifting bulky marbles and cutting them, the role of a human being cannot be denied. The findings of the pilot study conducted by the researcher at Kishangarh tehsil, Ajmer district, Rajasthan found that the laborer is required at every step of marble production demanding awkward postures and standing for long period of time. The marble cutting machine on which the small slabs are cut into the required shape for making tiles or decorative pieces requires the worker to adjust the marble on the machine and hold it till the blade cuts the marble through. The marble cutting activities are performed by the worker throughout his shift of 8 hours including a rest break for 1 hour. The marble pieces that are cut for residential areas are also carried manually by the worker from the marble cutting machine to the store house. Sometimes these slabs weigh from 100 kg to 150 kg. Such activities if continued for a prolonged period in an awkward posture or unfriendly environment affects the workers capacity and health of the worker. The present study aims to assess working environment of the Marble Cutting workers. Objective and subjective data were collected regarding the light, noise, temperature and humidity of the work place. The workers were interviewed regarding their preference

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and comfort level regarding light on the workplace. An attempt was also made to observe the conditions of the workplace including the cleanliness the color of the surface of the workplace, provision of artificial lighting etc. The data were collected in the peak hours of the marble cutting work so as to assure precise data.

OBJECTIVES OF THE STUDY

1. To assess the environment (Light, Noise, Temperature and Humidity) of the workplace of the Marble Cutting workers working in Marble cutting Industry.
2. To assess the workplace according to the Ergonomic Parameters.

METHODOLOGY

The present study had a purposive sampling design. The sample comprised of 70 marble industries from which 220 marble tile cutters working on the marble tile cutting workstation in the marble industry were randomly selected. The respondents for the present study were healthy and did not suffer from any chronic or acute diseases at the time of data collection as reported by them. The care was taken to select the workers who came regularly and did the work of cutting marble tiles. The sample was selected through multistage criteria. At the first stage a list of Marble industries was procured from the Kishangarh marble association. In the second stage, 400 Marble Industries were randomly selected. The selected Marble Industries were requested to send data regarding the number of Marble tile workstations installed in their respective industries. The data revealed that 250 industries had Marble tile workstations installed. Majority of the industries had two marble tile cutting workstations, only few had three marble tile cutting workstations. The researcher thus approached the 250 industries for permission of data collection out of which only 70 industries having 2-3 marble tile cutting workstation agreed to co-operate with a condition that their names should not be disclosed. In the third stage, a list of industries which agreed to co-operate comprising of the number of workers working at the marble tile cutting workstation were prepared by the researcher to select the respondents. In the last stage, 220 respondents were selected purposively who were healthy and had an experience of 2 years and above in the same in cutting tiles from marble slabs. The data were collected via Interview Schedule and Observation sheet. The information on the working environment of the marble tile cutting workers which included amount of light measured via Lux Meter available in the working area, the temperature, humidity was measured via Hygrometer and noise produced was measured via Noise Meter by the marble tile cutting workstation. This section also gathered information regarding the preferred level of light at the workstation to get an insight of the comfort and preference regarding Light of the respondents. Another part of the Section focused on the Assessment of the Working Environment through PMA Ergonomic Checklist, ISO (9001: 2000). The PMA (Precision Metalforming Association) along with the association of OSHA (Occupational Safety and Health Administration). The checklist comprised of collecting data regarding the provision of training for managing posture, repetition, stress and vibration. The checklist also covered the stress experienced at various body parts and to check the provision of protective aids while working namely gloves, ear plugs for the respondents. The responses in this section were collected in Affirmative and Non Affirmative responses of the respondents were collected in this section.

RESULTS

Intensity of Light

The working unit had natural lighting; the marble cutting machine was placed under a roof (14 feet in height) and was open from all sides. The researcher observed that there were no artificial lighting provided for the work. The Recommended light limit was identified to be as 1000 lux for conducting the activity normally (1). The table 1 elicited that 62.86 per cent of the industries had intensity of light below recommended levels. It was surprising to record that 4-5 industries had light ranging from 520-546 lux. The data also revealed that 37.14 per cent of the industries had equal to more than recommended intensity of light.

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Table 1: Distribution of Industries According to their Measurement of Light

	Measurement of Light (lux)	f	%
Recommended Light Level (1000 Lux)	Low Light (Below Recommended Level)	44	62.86
	Appropriate Light (= or > Recommended Level)	26	37.14
	Total	70	100
	Mean	1092.17	

n = 70

Perceived Preference and Comfort level for light of the workers while working

An attempt was made to identify the preference and comfort level of the workers for light while working. The researcher interviewed the workers regarding the same. Comfort was judged on the basis of five cards given ranking from 1 to 5. The comfort cards were rated from much too light to slightly dark. The respondents were asked their comfort level and the scores were recorded. Similarly, preference for light of the workers was judged with three cards ranking from 1 to 3. The criteria's were "there should be less light", "likes as it is", "wishes to have more light". The responses were recorded and then analysed.

The analysis of the comfort cards revealed that slightly more than one half (55 per cent) respondents perceived that the lighting was "comfortable". Slightly less than one-fourth of the respondents (21 per cent) felt that it was "just comfortable light" indicating that the lighting could have been better. To support the suggestions 20 per cent respondents opined that there was "too much light" in the working place. Very few respondents opined that the working place was "too dark" (3 per cent) and "much too light" (1 per cent) (Table 2).

The findings on preference for light of the workers in table 2 revealed that majority of the respondents (83 per cent) "liked as it is". The data revealed that one tenth (10 per cent) of respondents "wished to have more light" followed by respondents who preferred to have less light in the workplace (7 per cent).

Table 2: Distribution of Respondents according to their Comfort and Preference of Light by the respondents in the Industry

n = 220

Comfort level of the workers for light			**Preference for Light of the workers**		
Criteria's	**f**	**%**	**Criteria's**	**f**	**%**
Much too light	2	1.00	There should be less light in here	16	7.00
Too much light	44	20.00	Likes it as it is	182	83.00
Comfortable light	121	55.00	Wishes to have more light	22	10.00
Just comfortable light	47	21.00			
Slightly dark	6	3.00			

Measurement of Noise

The findings revealed that workers in the marble industry work for more than 8 hours per day and 6 days per week (>48 hrs/wk) and are exposed to high noise level. The noise exposure levels in the present industry were high as compared to the maximum permissible noise exposure limit of excessively high as compared to the maximum permissible noise exposure limit of (i) 85 – 90 dB for 8 hours per day (2). The lowest measurement of noise produced by the machinery was 93 db and the highest was 112 db. The table revealed that 32.86 per cent of the industries were found to be producing 93-99 db per day. The data also revealed that slightly less than one-half of the industries (44.28 per cent) had 107-112db noise being produced while the machine was functioning which was more than the prescribed limits OSHA. The findings of the present studies were supported by a study conducted in Turkey, by Atmaca et.al. in 2005 to assess the problem of noise in the industries around Sivas and noise measurement and survey studies were carried out at concrete traverse, cement, iron and steel and textile factories located in Sivas (Table 3).

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Table 3: Distribution of Marble Cutting Working Units of the Industry according to their Measurement of Noise

n = 70

	Measurement of Noise (db)	f	%
Recommended Level (85 – 90 dB for 8 hours per day)	Moderately High (93 – 99)	23	32.86
	High (100 – 106)	16	22.86
	Very High (107 – 112)	31	44.28
	Total	70	100
	Mean	104.13 db	

Measurement of Humidity

The lowest humidity recorded was 33% and highest humidity recorded while the workers were working was 46%. The table 13 reflected that majority of the industries (65.71 per cent) had humidity ranging from 33-37 %. The table 4 also highlighted that humidity ranging between 38-41% was recorded in 32.86 per cent industries.

Table 4: Distribution of Respondents according to the Measurement of Humidity while working

n = 70

Measurement of Humidity (%)	f	%
33 – 37	46	65.71
38 – 41	23	32.86
42 – 46	01	1.43
Total	70	100
Mean	36.92%	

Measurement of Temperature

OSHA does not set temperature control standards for businesses whose employees work outdoors (3). A study was conducted by Seppänen et.al. in 2006 in Finland on 100 workers to draw a elation between performance and temperature which showed a decrease in performance by 2% per degree Celcius increase of the temperature in the range of 25-32^{o} C, and no effect on performance in temperature range of 21-25^{o} C. The table 5 highlighted that slightly more than one-half of industries (65.71 per cent) were having temperature ranging from 36-38 ^{o}C. The researcher also found that 28.57 per cent of marble cutting industries had in extreme high temperature ranging from 39–41 ^{o}C (Table 5). Studies in various other industries have also concluded that high temperatures decrease the working ability of the worker. Such unpleasant environment have found to be resulting in absenteeism and lower productivity (4). According to Sanders and Mc Cormick (2013), the productivity is maintained upto about 28^{o}C (82.4^{o}F) and then begins to drop. At about 30^{o}C (84^{o}F) effective temperature productivity is around 90 per cent of prestress levels. The rate of decline in productivity continues to increase so that at about 34^{o}C (93^{o}F) effective temperature, productivity is only 50 per cent of prestress levels. The researcher also observed that the workers used to get exhausted soon due to such high temperatures.

Table 5: Distribution of Respondents according to the Measurement of Temperature while working

n = 70

Measurement of Temperature (^{o}C)	F	%
33 – 35	04	5.72
36 – 38	46	65.71
39 – 41	20	28.57

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Total	70	100
Mean	37.64 °C	

Ergonomic Parameters for Assessing Risk at Workplace

The information regarding the Ergonomic Parameters for Assessing Risk at Workplace were collected with the aid of modified on the various ergonomic aspects with the help of modified PMO Ergonomic checklist. There were two aspects covered in this section. The first aspect was related to the training provided to the respondents by the industries. The second aspect was regarding the provision of rest breaks and protective aids provided for hands and excessive noise by the industry to the workers. The data in table 6 depicted that majority of the respondents were not given any training for vibration (80.91 per cent) and posture (72.73 per cent). It was also observed that slightly less than on-half of the respondents (49.09 per cent) were provided training for repetition of work. The aspect on providing training concerning the use of tools to decrease the injuries revealed that 76.36 per cent of respondents were provided training for the same. Similarly, slightly more than one-half of respondents (59.54 per cent) were found to be trained regarding performing jobs to decrease injuries. An in depth analysis of the working environment revealed that majority of the workers (81.82 per cent) were not provided any rest breaks to relieve stress from repetitive motions. The use of any protection of hands was not found to be a practice by majority of the respondents (90.91 per cent). The gloves were also not found to be in use by majority of the workers (89.09). Marble cutting work machinery produces vibration as well as it can cause the hands to get rough. 10.91 per cent workers were also found wearing gloves provided by the industry while working. The further investigation on the use of protective aids for excessive noise revealed that majority of the workers were not using cap (98.18 per cent) and ear plugs (94.55 per cent). Although slightly more than one-tenth of the workers (16.36 per cent) used cotton to avoid the damage by excessive noise. It was also observed that 13.64 per cent of the workers wrapped a cloth around their ears to protect themselves from the noise.

Table 6: Distribution of Respondents according to the Ergonomic Parameters for Assessing Workplace

n = 220

Parameters for Assessing Risk at Workplace		Provided		Not Provided	
		f	**%**	**f**	**%**
A.	**Training for**				
a.	**Maintaining Posture**	60	27.27	160	72.73
b.	**Avoiding Repetition of work**	108	49.09	112	50.91
c.	**Overcoming Stress**	82	37.27	138	62.73
d.	**Vibration**	42	19.09	178	80.91
e.	**Injuries while performing task**	131	59.55	89	40.45
f.	**Injuries while using Tools**	168	76.36	52	23.64
B.	**Provision of Rest Breaks**	40	18.18	180	81.82
C.	**Protective Aids for Hands**				
a.	**Gloves**	24	10.91	196	89.09
b.	**Cloth wrapped around hands**	20	9.09	200	90.91
D.	**Excessive Noise**				
a.	**Ear plugs**	12	5.45	208	94.55
b.	**Cotton**	36	16.36	184	83.64
c.	**Cloth wrapped around ears**	30	13.64	190	86.36
d.	**Cap**	4	1.82	216	98.18

CONCLUSION

The study concluded that the working conditions of the marble cutting workers were not adequate. The researcher opines that the workers should be provided protective aids while working so that they can work more efficiently. The owners of the industry must take certain actions in providing rest breaks, and training regarding handling posture, avoiding repetition of work.

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IMPLICATIONS

The study would be helpful to the government aiding them in designing policies and regulations for protection of the workers. The study will also aid the marble industries in gaining an insight in bettering the facilities provided to the workers for better job satisfaction and productivity and safety.

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