05 - ERGONOMIC ANALYSIS OF THREE DIFFERENTS FRONTS OF WORKING IN CIVIL CONSTRUCTION

GILMARA EMANUELA LEOBET DIAS[1];
GIOVANA BATISTA ANDREIS[2];
MARIANNA DO ROCIO CARDOSO[3];
RENAN WUNDERLICH PORTELLA[4];
RODRIGO EDUARDO CATAI[5]
UTFPR – Campus Curitiba, PR, Brasil [1,2,3,4,5]
[1,2,3,4] Estudantes de Engenharia Civil/UTFPR - Curitiba - PR - Brasil
[5] Professor do Programa de Pós-Graduação em Eng. Civil/UTFPR - Curitiba - PR - Brasil
gil_leobet@hotmail.com

1. INTRODUCTION

Despite representing a huge portion of the current global economy, the civil construction is considered worldwide one of the most dangerous branches related to work conditions, leading the fatal accidents, non-fatal and life years lost rates. Within the factors responsible for those indexes are the workers' low-wage, the lack of infrastructure, the carelessness of the responsible for security at construction sites, the disorganization of the work groups and the way how labor is organized (IRIART et al., 2008).

Moreover, according to Iida (2005), many activities in civil construction require intense physical effort, such as lifting and carrying weights and, as a consequence to this, there is a lot of uncomfortable postures and over repetitive tasks. The uncomfortable postures and the weight excess result in musculoskeletal disorders, which affect 46% of the professionals involved in building processes and 60% of the personnel involved in building repairs.

Still according to Iida (2005), the main objective of the Ergonomic Analysis of Work is to apply ergonomic concepts analyzing, identifying flaws on the productive system and present recommendations in order to make the necessary improvements. The definition of Ergonomics proposed by the International Ergonomics Association explains the importance of the relation between the human health and the work environment:

> "Ergonomics (or human factors) is the scientific discipline that studies the interactions among humans and other elements of the system, and the profession that applies theories, principles, data and methods to projects aimed to optimize human well-being and overall performance systems."

Therefore, the adequate ergonomic workplace, according to regulatory standards and current legislation, is a way of ensuring the safety and well-being of workers, increasing their satisfaction and productivity. In addition, concepts related to biomechanics, as it is an "interdisciplinary field that describes, analyzes and evaluates human movements." (Winter, 2009), offer great contribution to this analysis due to the articulator description of acts and efforts of men in activities.

In this context, the article, relied on both biomechanical and environmental aspects, aims to conduct an ergonomic analysis of three areas of work in a construction site in the city of Curitiba. The study evaluated activities such as the preparation of mortar and plaster grout using a mixer, implementation processes of ceramic tiles from the ceramic board cutting to its placement and compaction of the soil using a soil compactor called “Frog”, analyzing noise levels at these environments, the position of workers, body movements, as well as their physical and cognitive requirements for the realization of these tasks. From all this, the results obtained were compared to the ones from work regulations and ergonomic books available, in order to suggest feasible improvements that provide greater comfort and safety for workers.

2. METODOLOGY

A visit to the construction site, as well as the research followed essentially two steps: interviews with workers analyzing their activities and taking measurements of sound intensity levels at their working areas.

The interview was based on the Nordic questionnaire for musculoskeletal symptoms, to identify parts of the body which the work inflicted pain or discomfort to the employee.

Measurements of sound intensity levels followed some methods, including proper positioning of the sound level meter (model DEC -460 Sound Level Meter Brand Instrutherm) at the time of measurement, attempting to achieve maximum possible proximity of the worker's ears and also 5 measured values were taken one each 5 seconds during simulated work activity by the participants in order to obtain the average noise intensity levels.

From the results collected in the work, the tasks and activities performed by employees daily were evaluated and thus a comparison between the three work fronts was developed, as well as the production of a diagnosis of the analyzed situations based on the appropriate ergonomic recommendations.

2.1. Job 1: Mixer Operator and Cement Carrier

At this workstation, the worker eventually carried 50 kg packs of cement from the truck to the storage place and handled the mixer to mix materials like sand and cement, resulting in the production of mortar. During the mixing process, the worker has been exposed to a significant noise intensity coming from the machine and a large amount of dust emitted from the handling of the materials. It was also noticed that he exerted a series of repetitive movements of great physical effort.

Given these conditions, noise intensity measurements were taken with the mixer on, although empty, and after the recording of the data, there was the interview with the worker. Finally, the worker's personal protection equipment was verified.

2.2. Job 2: Tiles Applicator

Refers to the labor front in which the employee is responsible for cutting and laying down ceramic pieces.

Using the decibel meter model from the brand above, noise level measurements were taken during the cutting of a ceramic piece, near the ear of the worker. . Subsequently followed up by the interview of the Nordic questionnaire and, finally, the personal protection equipment were checked.

2.3. Job 3: Soil Compactor Operator

At this workstation, the employee handled the soil compactor, popularly known as "Frog", in order to compact the soil by the application intense high frequency oscillatory movements, mostly known as vibrations.

Again, using the decibel meter, measurements were taken with the "Frog" turned on. Then the interview was done and the observation of the safety gear used to work at the moment was observed.

3. RESULTS AND DISCUSSIONS

3.1 Job 1: Mixer Operator and Cement Carrier

Using the information obtained in the interview with the employee , it was noted that he felt pain at regions of the right forearm , right shoulder and lumbar spine due to overexertion performed in the operation of the mixer and compounded when it was necessary to unload trucks full of cement packs . Due to the periodicity of the aggravating factor, the pain is uncomfortable , but not intense enough so that the employee has to miss the service to recover . The excessive strain may not damage immediate health, but over time, affects the spine and muscles of the worker, reducing his life quality.

To solve, or at least mitigate these damages, it is recommended that employees adopt a rotation system of activities. Through this system, a worker operates the mixer for a preset time and would be replaced by another person at the end of this period, proceeding to a task that requires less physical efforts, providing a time dedicated to relaxation and recovery for the muscles of the body. In addition, to avoid the carrying of overweight from the unloading of the cement packs,it would be appropriate to guide the workers to only carry 50 kg packs in pairs , so that each employee's physical effort is reduced by half.

Regarding sound intensity levels, the average value obtained at the mixer was 80.7 dB (A), which is close to 85 dB (A) (BRAZIL , 2013b), intensity above which there is damage to hearing abilities, also considerably exceeds the average of 65 dB (A) (BRAZIL , 2013c) , which is the threshold of hearing comfort . However, to avoid health problems for workers while performing their functions, the use of earplugs with Certificate of Approval , as predicted by NR 6 (BRAZIL , 2013th) is essential. These data were obtained with the mixer turned on, but without any material inside, so the values are the minimum ones possible, which further reinforces the need for the use of appropriate personal protection equipment.

It was also noted that the employee was often in contact with a lot of dust coming mainly from the mix and movement of aggregates. To prevent damage to the respiratory system, the operator used a disposable half mask , but did not wear goggles, which can cause irritation by the direct contact with dust or eye damage if struck by some grit during handling.

3.2. Workstation 2: Tiles Applicator

After the interview with the employee , questioning him about the working conditions and the discomforts caused by the activity to which he was subjected , it was noticed that he classified , in general , his activity as a dynamic one , in other words, it does not present extremely repetitive motion and therefore causes little discomfort while working. However, the worker complained of knee pain during and after fulfilling his function, this is due to the fact that he remained kneeled for a long time in the ceramic tile laying process. Although the activity is dynamic - consisting primarily of cutting the ceramic pieces, followed by the settlement of it on walls or floors, and finally aligning and finishing - the problem lies in the fulfilling of floors and the bottom of walls. During the execution of this step, the employee shall remain bend on his knees with his spine leaned, a position that is totally uncomfortable. The time that the employee remains kneeling to tile the floor is enough to cause fatigue in the leg muscles and affect the spine and knees.

In addition, the function of tiles applicator exposes the worker to conditions of intense level of noise and dust during the cutting of the plaques. During analysis, the average sound intensity level for the cut was 98.2 dB (A), which is above the acceptable level for the effect of ambient comfort which is 65dB (A) (BRAZIL , 2013c) as well as it is above the hearing threshold for healthy hearing environment - 85 dB (A) (BRAZIL , 2013b) . Also, it is noteworthy that the tiles applicator was carrying protective equipment, which consists on ear plugs - essential to protect the eardrum from excessive noise - dust mask , gloves, goggles ,steel-toed boot and helmet .

The solution proposed to mitigate the effect of the pain, discomfort and fatigue of the knees inflicted by the laying of tiles in lower areas is to reduce the time that the employee is exposed to this activity. Since the fact of being long time bent in the same position is the cause of pain, it is advisable to perform the settlement of the tiles part by part, in other words, in the case of the wall, it is suggested to start from the bottom and move upwards gradually, and in the case of the floor covering, as the mortar has a short time to be used, it is advisable to take short breaks during the application time dedicated to the floor in order to alternate body positions. Furthermore, any equipment can be used to support the knees during this task.

These measures, together with the use of PPE should greatly decrease the pain caused by stress, not only in the knee area, but in other parts of the body such as the dorsal region, shoulders and arms, which although not cited as pain points, tend to develop such fatigue due to biomechanical movements that the activity requires.

3.3. Workstation 3: Soil compactor operator

The employee responsible for handling the machine has not complained of pain or discomfort that could be caused by the execution of the activity, however, he was exposed to a significant level of local vibration and also a considerable noise intensity , which averaged 94.9 dB (A).

Since the regulatory norm (NR15) requires that daily exposure of a worker to a continuous noise of 95 dB is no longer than 2 hours (BRAZIL , 2013b) .

The intervals also contribute to recover from the vibrations on the hands and arms of the professional, whom, if is not aware of the sensitivity and the tingling of his members, may experience a seizure bleaching and even small necrosis of body areas.

It is also noteworthy that the worker was not using the personal protection equipment properly, since he did not use gloves and the ear -plugs were often positioned incorrectly and ended up not providing an effective ear protection.

Thus, in order to get the worker to use the protection gear properly, it is necessary to inform employees through courses or lectures, providing information on the correct use of PPE and also demand the use of it.

3.4. Comparative noise level analysis

The Figure 1 shows the average values of sound intensity levels obtained for the three work areas evaluated, as well as hearing thresholds for the comfort and the unhealthy hearing environment.

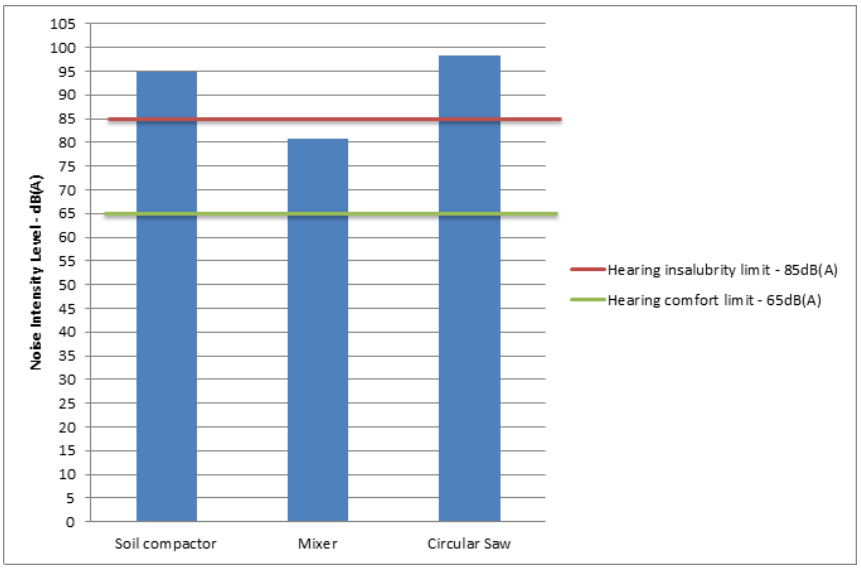

Figure 1 - Noise values obtained for the three workstations analyzed and compared with the limit for unhealthiness, 85 dB (A), according to the NR-15.

4. FINAL CONSIDERATIONS

From the data obtained on the working conditions and ergonomics of the laying of ceramic plaques, soil compactor operation and handling the mortar mixer, it was found that the conditions under which activities were carried out; exposed workers to ergonomic risks, particularly those inherent from bad posture and exposure to noise and dust. Some factors presented on the ergonomic analysis contributed to the worsening of the risks to which workers were exposed.

Thus, as alternatives and general obligations for the reduction of these risk factors, it is highlighted the imperative use of PPE such as semi-facial masks, gloves, earplugs, as well as rotating work systems with alternating activities among workers and short periodic breaks throughout the day in order to reduce muscle fatigue, vibration or hearing damage and, in addition, regarding the noise emitted by the mixer it is suggested the coating of the tank with acoustic insulating material.

Practices such as these apparently simple ones are of great effectiveness and viability, as well as cheap and easy to implement, thus it can contribute significantly to the health and well-being of construction workers.

REFERENCES

BRAZIL, Ministry of Labour and Employment. NR-6 - Personal Protective Equipment Legislation Manual Atlas, 72nd Edition, São Paulo: Atlas, 2013a.

BRAZIL, Ministry of Labour and Employment. NR-15 - Activities and operations unhealthy. Legislation Manual Atlas, 72nd Edition, São Paulo: Atlas, 2013b.

BRAZIL, Ministry of Labour and Employment. NR-17 - Ergonomics. Legislation Manual Atlas, 72nd Edition, São Paulo: Atlas 2013c.

IIDA, I. Ergonomics: design and production. 2.ed. Sao Paulo: Edgard Blücher, 2005.

IRIART, J. A. B.; OLIVEIRA, R. P.; XAVIER, S. S.; COSTA, A. M. S; ARAUJO, G. R.; SANTANA, V. S. Representations of informal work and health risks among domestic workers and construction workers. Science Magazine and collective health, vol.13, no.1, Rio de Janeiro, 2008.

SOUZA, D. de.; SALDANHA, C. T.; GIACOMITTI, G. S.; JUNIOR, S. L. K; CATAI, R. E. Ergonomic analysis within a construction site. FIEP BULLETIN - Volume 82 - Special Edition, Foz do Iguaçu, 2012.

WINTER, D.A. Biomechanics and motor control of human movement. 4. ed. New York: A Wiley-Interscience Publication, 2009.

Rua Deputado Heitor de Alencar Furtado, 4900
Bairro: Ecoville - CEP 81280-340
Curitiba - PR – Brasil
E-mail: catai@utfpr.edu.br

ERGONOMIC ANALYSIS OF THREE DIFFERENTS FRONTS OF WORKING IN CIVIL CONSTRUCTION

ABSTRACT

The major specificity of workstations, the increasing noise pollution in several environments, the intensification of repetitive movements, among others are some challenges that ergonomics is currently facing, and, regarding the civil construction sector, there are many tangible improvements to be made in order to solve those issues that appear at the building site and are observed through workers' muscular pains, fatigue and discomfort complaints during the execution of their daily activities or afterwards. Therefore, basing on this premise and relying on the legal concepts related to environmental comfort and biomechanics, this article's objective consists on an ergonomic analysis of three distinct workstations at the same building site in the city of Curitiba: the mortar preparation using a mixer, the cut and laying of tiles over floors and the soil compaction through the use of a percussion compactor. The results presented worrying factors on those activities, such as the high noise intensity level the workers are exposed to, and also positive aspects, like the adequate amount of work breaks the employee has during his workday. Lastly, some suggestions were made for coherent alternatives to each workstation with the purpose of developing a more ergonomic way of completing the tasks that caused stress among workers.

KEY WORDS: Ergonomics, Noise, Workstations.

ANALYSE ERGONOMIQUE DE TROIS FRONTS DIFFERENTS TRAVAILLANT DANS LA CONSTRUCTION
RÉSUMÉ

La plus grande spécificité de postes de travail, l'augmentation de la niveau de bruit dans des nombreux environnements, l'intensification des mouvements répétitifs, entre autres, sont quelques-uns des défis lesquelles l'ergonomie fait face actuellement, et, en se référant de la construction civile, il ya beaucoup d'améliorations à faire développés, visant a répondre aux problèmes ergonomiques qui se posent dans une oeuvre, et sont attestés par la fatigue, la douleur et l'inconfort des travailleurs pendant et après l'exécution de leurs activités. Par conséquent, selon cette hypothèse et décrivant les concepts normative de confort et la biomécanique de l'environnement, l'étude visait à l'analyse ergonomique de trois fronts différents travailler sur un projet à Curitiba: préparation de mélangeurs de mortier, de coupe et de nidification en carrelage et la maçonnerie, et le compactage à l'aide d'un pilon. Le résultats ont révélé des faits importants de ces activités, telles que le niveau de l'intensité sonore qui sont exposés à ces professionnels, ainsi que des aspects positifs, comme le travail posté correctement espacés. Enfin, suggéré des alternatives sont compatibles avec chaque front du travail, dans le but d'améliorer ergonomique ces pratiques ont causé du stress sur les travailleurs.

MOTS CLÉS: Ergonomie, Le bruit, Les fronts de travail.

ANÁLISIS ERGONÓMICO DE TRES DIFERENTES PUESTOS DE TRABAJO EN LA CONSTRUCCIÓN
RESUMEN

La mayor especificidad de estaciones de trabajo, aumentar el nivel de ruido en diferentes entornos, la intensificación de los movimientos repetitivos, entre otros, son algunos de los desafíos que enfrenta actualmente la ergonomía, y, en el caso de la industria de la construcción, hay muchos mejoras concretas que se desarrollarán con el fin de abordar los problemas ergonómicos que se presentan en una obra de construcción y que se evidencia por la fatiga, el dolor y el malestar de los trabajadores durante y después de la ejecución de sus actividades. Por lo tanto, en base a este supuesto y esbozar los conceptos de confort y biomecánica normativo ambiental, el estudio tuvo como objetivo el análisis ergonómico de los tres frentes diferentes una obra en Curitiba: preparación de mezcladoras, corte y anidación en baldosas y mampostería, y la compactación utilizando un pisón. Los resultados mostraron que estas actividades críticas, tales como el alto nivel de intensidad que están expuestos a estos profesionales, así como los aspectos positivos, como el trabajo por turnos adecuadamente espaciadas. Por último, sugirió alternativas son consistentes con cada frente de trabajo, con el propósito de mejorar ergonómicamente estas prácticas han causado estrés en los trabajadores.

PALABRAS CLAVE: Ergonomía, Ruido, Frentes de trabajo.

ANÁLISE ERGONÔMICA DE TRÊS DIFERENTES FRENTES DE TRABALHO NA CONSTRUÇÃO CIVIL
RESUMO

A maior especificidade dos postos de trabalho, o aumento do nível de poluição sonora em diversos ambientes, a intensificação dos movimentos repetitivos, dentre outros são alguns dos desafios que a ergonomia enfrenta atualmente, e, em se tratando do setor da construção civil, há muitas melhorias tangíveis a serem desenvolvidas, a fim de sanar os problemas ergonômicos que surgem em um canteiro de obras e que são evidenciados pela fadiga, dor e incômodo dos trabalhadores durante e após a execução de suas atividades. Portanto, partindo desta premissa e estruturando-se nos conceitos normativos de conforto ambiental e de biomecânica, o artigo teve como objetivo a análise ergonômica de três diferentes frentes de trabalho em uma obra na região de Curitiba: preparação de argamassa em betoneira, corte e assentamento de azulejo em piso e alvenaria e compactação do solo com a utilização de um compactador de percussão. Os resultados evidenciaram pontos críticos destas atividades, como o elevado nível de intensidade sonora a que ficam expostos esses profissionais, e também aspectos positivos, tais como jornadas de trabalho intervaladas adequadamente. Por fim, sugeriram-se alternativas coerentes a cada frente de trabalho, com a finalidade de aprimorar ergonomicamente estas práticas que têm causado estresse nos operários.

PALAVRAS CHAVE: Ergonomia, Ruído, Frentes de trabalho.