102 - ERGONOMIC ANALYSIS OF WORK IN CIVIL ENGINEERING OFFICES

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1.INTRODUCTION

According to Iida (2005), from the industrial revolution came some studies about labor, such as Taylorism that was based on time and motion study, besides studies about physiology and health of work. However, with the 2nd World War (1939-1945), military instruments were getting increasingly technological, demanding many skills from the operator, along with the bad environmental conditions. Therefore, mistakes and accidents were frequent. This situation improved the researches aiming the adaptation of instruments to the operator, decreasing mistakes and accidents. From the end of the war, there came the perception that the study of the work adaptation to men had positive effects, intensifying the studies even more, emerging associations and publications on ergonomics.

In the beginning of the 20th century, appeared in the literature the expression “Quality of Life at Work”, that addressed issues such as safety and health at work, reward for work, social integration, among others, being directly related to new forms of work organization and new technologies. In the 1980s, improvements in working conditions and environments acquired an importance on a global scale as a way to tackle problems of productivity and quality of production (FREITAS et al., 2005 apud GONÇALVES, 2009).

In Brazil, through the Constitutional Charter of 1988, came the proposal for the State to intervene in employee's health to deal with work-health process, regulated by the Organic Health Law (Law No. 8.080). Nevertheless, many work-related diseases are linked to the need to accomplish goals and increase productivity, result of a market that does not consider the physical and psychological limits of the worker (GONÇALVES, 2009).

Among these diseases are the work-related musculoskeletal disorders, which cause pain in the anatomic spots most commonly used in occupational functions. They are responsible for the reduction of production and may even generate a departure from the occupations (BACHIEGA, 2009).

Among the forms of prevention of occupational diseases highlights are the ergonomic analysis, workplace exercises and health education. The contribution of ergonomics to improvements in work situations, from the ergonomic action, is by understanding the activities of the employees in different work situations. Through ergonomic analysis, there is the activity analysis to recommend improvements, identifying the critical elements on worker health (BACHIEGA, 2009).

Thus, the aim of this paper was to conduct an ergonomic analysis in engineering offices, through questionnaires and noise, illuminance and furniture measurements, comparing the values obtained with those determined by applicable Brazilian regulations.

2.LITERATURE REVIEW

2.1.Ergonomics

In offices of engineering, most projects are executed on the computer, where employees are all (or most of) the working day in front of the monitor. According to Grandjean (1998), in the man-machine system, the movements and space for movement become limited, head posture and the look are slightly altered, there is a repetition of hand movements of consequently there come forced positions of shoulders and arms.

Aiming to minimize or eliminate the negative effects caused by computer use, many devices have been developed, such as chairs with special and adjustable dimensions, keyboards and supports that consider the natural posture of hands and wrists, brackets for monitors, adjustable desks, among others, which are available on the market (SANTOS, 1997 apud FIGUEIRA et al., 2011).

Thereby, according to Iida (2005), Ergonomic Analysis of Work (EAW) aims to apply ergonomic knowledge to fix a real situation, through analysis, to further formulate a diagnosis. It is divided into five stages: Analysis of demand, Task analysis, Activity analysis, Formulation of diagnosis and Ergonomic recommendations.

The Brazilian standard that deals with ergonomics is the NR17 and it aims to establish parameters so that there is adaptation of working conditions to the psychophysiological characteristics of workers, seeking maximum comfort, safety and efficiency (BRAZIL, 2014b).

2.2.Noise and illuminance

According to Bistafa (2012), the noise is a sound – sensation produced in the hearing system – undesirable, usually with negative connotation. However, for Iida (1997), the noise can be well defined as a sound pulse without useful information to the task being performed by the worker at the time, like a “beep's song” at the end of an operation cycle of a machine, that for the operator is extremely useful, but for other people near who don't work with this machine, it's just a noise.

In offices, where the noises are long-lasting, from 70 to 90 dB, decreases in performance are not noticed in intellectual tasks, however, the performance begins to drop for noises above 90 dB (IIDA, 2005).

Noises can be divided in three modalities: continuous, intermittent or of impact. According to NR-15 (BRAZIL, 2014a), in their attachments 1 and 2, continuous or intermittent noise is the one that is not of impact, being the last characterized by having duration of less than one second, at intervals greater than 1 second.

The NR 17 (BRAZIL, 2014b), that deals with ergonomics, mentions that the limits are found in NBR 10152 (1987), which stipulates that for offices, specifically for computer rooms, the limit is 45-64 dB (A).

The minimum illuminance in workplaces must be kept according to prescribed values in Brazilian Standard NBR ISSO/CIE 8995-1 (2013), which recommends minimum values appropriate for each type of activity and task group. For offices, the minimum level is 500 lux.

2.3.Nordic questionnaire for musculoskeletal system

The Nordic Musculoskeletal Questionnaire was developed in order to standardize the measurement of reported

musculoskeletal symptoms through identification of musculoskeletal disorders. Thus, this questionnaire is used as a diagnostic instrument of the workplace. There are three forms of the questionnaire: one is general, with all anatomical areas, and the two others are specific, for the lower back, and neck and shoulders. (PINHEIRO et al., 2002).

The Nordic questionnaire for musculoskeletal systems was translated for several languages, being the Brazilian version known as "Questionário Nórdico de Sintomas Osteomusculares" (PINHEIRO et al., 2002).

This one has two parts, the first in which the participant identifies the presence of pain, discomfort or dormancy in the last 12 months in the regions indicated in a divided human figure in nine anatomical regions: cervical, shoulders, arms, elbows, forearms, wrists / hands / fingers, dorsal region, lower back, hip / lower limbs. Then, the participant indicates if the symptoms are related or not with the work that he performs. The second part of the questionnaire included demographic information such as gender, age, etc. (BACHIEGA, 2009).

3.METHODOLOGY

The study was carried out based on technical visits at the offices of two civil engineering companies, which will be called Company 1 and Company 2, of the city of Curitiba, State of Paraná.

For this research, a Nordic questionnaire for musculoskeletal systems was applied to 5 employees of each company, totaling ten employees, along with a form of basic information and a questionnaire on knowledge about ergonomics and workplace exercises. Measurements of noise, illuminance and dimensions of the furniture were also taken in order to be compared with the recommended measures for a project of workplace.

3.1.Nordic questionnaire for musculoskeletal system

The Nordic questionnaire was developed by Barros e Alexandre (2003), and had basically four closed questions, in which the answers could be "yes or no". These questions were tabulated to nine different body parts, which were specified in the form of drawing next to the table for better understanding of which body part the question referred to.

3.2.Questionnaire about knowledge of ergonomics and workplace exercises

This questionnaire was divided in two parts, the first one with basic questions about ergonomics and the other about workplace exercises, being closed questions with three possible choices. After filling out, it was possible to evaluate the responses obtained and analyze employees' knowledge of these subjects.

3.3.Noise measurements

The noise measurement was performed as follows: knowing that it is an office room, where the noise levels almost don't change along the place, "five" strategic points were chosen and the noise levels were measured at each point. For Company 1, because it is a small business located on the ground floor, for example, the measured points were: the workstation next to a window that remained open during the visit; near a stereo; another near a Plotter and other areas where the interviewees worked. For Company 2, whose office was located in a large building downtown and the workstations were distributed evenly within the room, measurements were carried out at places where employees worked.

Data was collected during the time of visits to the offices, which lasted about 30 to 40 minutes. The equipment used was a decibel meter from the brand Instrutherm, model DEC 5010, in which values were given in decibel (dB), with instrument operating in the compensation circuit "A" and slow response circuit (SLOW), according to NR-15 (BRAZIL, 2014a).

3.4.Illuminance measurements

Measurements of illuminance values were taken in all workstations, during the early afternoon. In Company 1, as the lamps were not arranged likewise to each workstation, the light meter was positioned horizontally on each desk of the employees and, after the value stabilized, reading was made and each result noted, given in Lux (lx). In Company 2, as the lamps were distributed likewise to each desk, measurements were taken on five strategic locations, like the center of the room and near a window. The equipment used was from the brand Instrutherm, model LDR-380.

3.5.Furniture measurements

Measurements were taken from furniture that did not offer the possibility of adjusting by the employees, such as: keyboard height, desk height and measures of legroom. The measurements were taken with a tape measure, noting the values so later an analysis could be made to check if they fit in the recommended measurements for a computer workstation.

4. RESULTS AND DISCUTION

4.1.Results of the Nordic Questionnaire for Musculoskeletal Systems

Through the application of the Nordic questionnaire, the most painful areas of the body due to a workday in an office were identified. Figure 1 shows the result of parts of the body in which employees had pain in the last twelve months. It is noticed that most employees feel pain in the region of the back, both upper and lower, shoulders and neck.

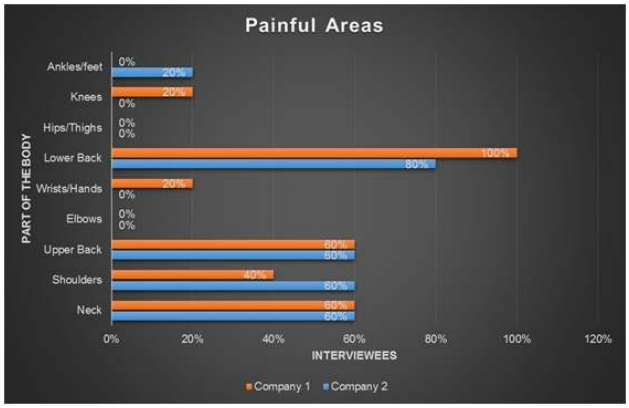

Figure 1 – Painful regions. Source: The authors (2014).

The cause of pain in these regions is mainly due to the extensive workload that these employees spend sitting and static, using computers to perform their functions, very often repetitive. Out of ten analyzed employees, only three were prevented from carrying out daily and/or work activities due to pain in the body, with the responsible area being the lower back. Despite several painful areas, the only region capable of making employees to consult professional health care was, again, the lower back, proving itself, therefore, to be the most affected region of the body for office workers.

Both companies provide chairs and monitors with height adjustment and support for the arms, forearms and feet, but the latter is not mandatory for Company 1 and it is only provided when requested in the Company 2. However the proper use of such equipment is not monitored in any of the companies and the appropriate adjustment of heights and postures is responsibility of each employee.

The Company 2, to minimize the pain of their workers, performs workplace exercises every day, in all sectors of the company, always at different schedules so that a routine is not stimulated.

4.2.Results and analysis of the questionnaire about knowledge of ergonomics and workplace exercise

It was observed, in the case of Company 1, that almost all employees who participated in the research said they know what is ergonomics and its relation with health at work, but a large part of the interviewees below 25 years old and interning at the company, didn't know what workplace exercise was about, so it's possible to see that older employees may have already searched for different ways to relieve pain or to anticipate possible injuries that can be caused by their functions, this way, they got this knowledge.

In Company 2, it was the opposite, as this office applies workplace exercises, all participants were aware of what it was about, but some of the interviewees said they didn't know the relationship between the reduction or precaution of body aches. However, in this office it's noticed that younger employees, below 25 years old and that work as an intern, don't know workplace exercises or don't acknowledge its relationship with work.

4.3.Results and analysis of noise measurement

In Table 1 there are the results of noise measurements in both companies.

Table 1 – Results of noise measurements.

Measurement places	Noise in Company 1, dB(A)	Noise in Company 2, dB(A)
Workplace 1	65,5	71,9
Workplace 2	77,0	65,5
Workplace 3	66,3	67,8
Workplace 4	65,5	65,7
Workplace 5	67,3	68,9

The analyzed noise is classified by NR-15 (BRAZIL, 2014a) as continuous or intermittent, that is, the one that is not of impact. The limits of acoustic comfort established in NBR 10152 (ABNT, 1987), classifying the offices as “Computer rooms”, are of 45 to 65 dB(A).

Despite of the obtained values being above the standard, studies indicate that there is no drop of production in intellectual tasks in the range 70 to 90 dB(A), but in a long time exposure it can cause irritability.

4.4.Results and analysis of illuminance measurement

In Table 2 there are the results of illuminance measurement in both Companies.

Table 2 – results of illuminance measurement.

Measurement places	Illumination (Lux) in Company 1	Illumination (Lux) in Company 2
Workplace 1	122	292
Workplace 2	232	297
Workplace 3	297	294
Workplace 4	240	292
Workplace 5	271	295

The minimum level recommended by NBR ISO/CIE 8995-1 (2013) is of 500 lux for work in office. None of the visited Companies reached this value, both had values close to 300 lux.

It's possible to note that Company 2 has a better distribution of illumination between the workplaces, showing similar results. In Company 1, there were more heterogeneous and lower measurements than the Company 2. It is noteworthy Workplace 1 shows the worst results of all the Workplaces, which can damage the employee's performance, besides it can cause psycho-physiological problems.

4.5.Results and analysis of furniture measurement

From the non-adjustable furniture measures of the two Companies, it was possible to analyze if the conditions were suitable for the comfort of the employees. Along with the recommended dimensions for furniture, these values are found on Table 3.

Table 3 – Results of furniture measurement.

Variables	Recommended dimensions (cm)	Company 1 dimensions (cm)	Company 2 dimensions (cm)
Keyboard height	60-85	76	75
Desk height	58-82	74	73
Height for legroom	20	30	24
Depth for legroom	60-80	45	63
Width for legroom	80	72	145

It is possible to note that the dimensions of depth and width for legroom of Company 1 are below recommended. There's a large difference of the width for legroom between both Companies, therefore, Company 2's legroom must provide more comfort than Company 1's.

5.CONCLUSIONS

From the form of basic information, it can be noted that sex, age and function are questions not directly related to pain, as from the youngest employee to the oldest one interviewed, both men and women occupying different functions complained about pain in the same parts of the body, what indicates that the same static and sitting position for long hours causes pain in the

same areas, no matter the three items mentioned above.

Through the noise measurements, it was noticed both Companies exceeded the limit value established on the standard (NBR). About the illumination, both obtained values also below the standard, meaning there is necessity of a new study of the arrangement of the lamps, as well as the best way to use the natural lighting.

Alternatives as to integrate workplace exercises to routine and encourage employees to take breaks and stretch during worktime may help to minimize the impacts caused by the function performed. It is evident that the adequacy of workplace through ergonomics and the application of regulatory standards bring more comfort to the worker and, as a consequence, it also benefits the Company by increasing productivity.

REFERENCES

ABNT, Brazilian Technical Standards Association. NBR 10152: Noise levels for acoustic comfort. Rio de Janeiro, 1987.

ABNT, Brazilian Technical Standards Association. NBR ISO/CIE 8995-1: Illumination of work environments. Part 1: Insides. 2013.

BACHIEGA, C. J. Musculoskeletal disorders' symptoms related to Brazilian dentist's activities. São Paulo, Universidade Nove de Julho, 2009.

BARROS E. N. C.; ALEXANDRE, N. M. C. Cross-cultural adaptation of the Nordic musculoskeletal questionnaire. International Nursing Review, v. 50, n. 2, p. 101-108, 2003.

BISTAFA, Sylvio Reynaldo. Acoustics applied to noise control. São Paulo: Editora Edgard Blücher Ltda.,2012. 2nd Edition. Reprint.

BRAZIL, Ministry of Labour and Employment. NR15 – Unhealthy Activities and Operations. Legislation Manual Atlas. 74th Edition, 2014a.

BRAZIL, Ministry of Labour and Employment. NR17 – Ergonomics. Legislation Manual Atlas. 74th Edition, 2014b.

FIGUEIRA, S. A; CATAI, R. E; MAINARDES, C. W; CANONICO, M. R. S. O. Ergonomic evaluation of noise and illuminace in workstations of an engineering office. VII congresso nacional de excelência em gestão, 2011.

GONÇALVES, Fernanda Silva. Physiotherapeutic interventions in the footwear sector: Workplace Exercises associated with the educational procedure. Divinópolis, Fundação educacional de Divinópolis/ Universidade Estadual de Minas Gerais, Junho, 2009.

GRANDJEAN, Etienne. Ergonomics handbook: adapting the work to men. 4th edition, Porto Alegre: Bookman, 1998.

IIDA, Itiro. Ergonomics: Project and Production. 2nd Edition Revised and Amplified, São Paulo: Editora Edgard Blücher, 2005.

PINHEIRO, F. A.; TRÓCCOLI, B. T.; CARVALHO, C. V. Validation of the Nordic questionnaire for musculoskeletal symptoms as a measure of morbidity. Revista de Saúde Pública, São Paulo, v. 36, n. 3, p. 307–312, jun. 2002.

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ERGONOMIC ANALYSIS OF WORK IN CIVIL ENGINEERING OFFICES

ABSTRACT

Progressively, the ergonomics is gaining ground in several productive and service sectors. Thus this article refers to an ergonomic analysis of work at two companies of project in the field of Civil Engineering, located in the city of Curitiba, in the state of Paraná, Brazil. The objectives were to compare the standard data with the reality in the offices and to verify the knowledge of the employees concerning ergonomics. To this end, measurements of noise, illuminance and furniture of the workplaces were performed in each company, the Nordic Musculoskeletal Questionnaire and a questionnaire about ergonomics and workplace exercises were applied as well. Through the analysis of all the results together, it was observed that the levels of noise and illuminance were not in accordance with the regulatory standard and also that there is the need of ergonomics improvement in both companies.

KEYWORDS: Ergonomic Analysis of Work, Offices, Musculoskeletal System.

ANALYSE ERGONOMIQUE BUREAU DE TRAVAIL EN INGÉNIERIE CIVIL

RÉSUMÉ

Ergonomie de plus en plus a gagné du terrain dans les différents secteurs productifs et des services. Ainsi cet article se réfère à une analyse ergonomique du travail sur deux entreprises de conception dans le domaine du génie civil, situé dans la ville de Curitiba, État de Paraná. L'objectif était de comparer les données normatives à la réalité de bureaux et de vérifier les connaissances des employés sur l'ergonomie. Pour les deux, les mesures de bruit, éclairage et mobilier d'emplois chaque entreprise, appliquées questionnaires nordiques système musculo-squelettique et de connaissances sur l'ergonomie et la gymnastique ont été réalisées. Pour l'analyse de tous les résultats ensemble, il a été observé que les niveaux de bruit et l'éclairement n'étaient pas conformes aux normes réglementaires et qu'il est besoin pour des améliorations ergonomiques dans les entreprises.

MOTS-CLÉS: Analyse Ergonomique du Travail, Bureaux, Système Musculo-squelettiques.

ANÁLISIS ERGONÓMICO TRABAJO DE OFICINA EN INGENIERÍA CIVIL

RESUMEN

Ergonomía cada vez ha ido ganando terreno en los diversos sectores productivos y de servicios. Así, este artículo hace referencia a un análisis ergonómico de trabajo en dos empresas de diseño en el campo de la Ingeniería Civil, con sede en la ciudad de Curitiba, estado de Paraná. El objetivo fue comparar los datos normativos con la realidad de las oficinas y verificar el conocimiento de los empleados acerca de la ergonomía. Por tanto, las mediciones de ruido, iluminación y mobiliario de puestos de trabajo de cada empresa, aplicaron cuestionarios nórdicos sistema musculo esquelético y el conocimiento acerca de la ergonomía y la gimnasia se realizaron. Para el análisis de todos los resultados juntos, se observó que los niveles de ruido y la iluminación no estaban en conformidad con las normas reglamentarias y de que existe la necesidad de mejoras ergonómicas en las empresas.

PALABRAS-CLAVES: Análisis Ergonómica de Trabajo, Oficinas, Sistemas Musculoesqueléticos.

ANÁLISE ERGONÔMICA DO TRABALHO EM ESCRITÓRIOS DE ENGENHARIA CIVIL

RESUMO

Cada vez mais a ergonomia vem ganhando espaço nos diversos setores produtivos e de serviços. Desta forma este artigo refere-se a uma análise ergonômica do trabalho em duas empresas de projetos na área de Engenharia Civil, localizadas na cidade de Curitiba, no estado do Paraná. O objetivo foi comparar os dados normativos com a realidade dos escritórios e verificar o conhecimento dos funcionários acerca de ergonomia. Para tanto, foram realizadas medições de ruído, iluminância e do mobiliário dos postos de trabalho de cada empresa, aplicados questionários nórdico de sistema osteomuscular e de conhecimentos sobre ergonomia e ginástica laboral. Pela análise de todos os resultados em conjunto, observou-se que os níveis de ruído e iluminância não estavam de acordo com as normas regulamentadoras e que há necessidade de melhorias ergonômicas nas empresas.

PALAVRAS-CHAVE: Análise Ergonômica do Trabalho, Escritórios, Sistemas Osteomusculares.