06 - ERGONOMIC ANALYSIS IN COAT OF COATINGS IN GRAFIATO

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1. INTRODUCTION

Important part of the economy of any country, and major generator of jobs, the construction industry has been of paramount importance to the national economy. While the country grew by 0.9%, the sector grew by 1.4 % - more than 420 million dollars - according to the Brazilian Institute of Geography and Statistics (IBGE), 2011. Also created more than 155,000 jobs in the sector by the end of 2012, which added to the previously existing, representing 9% of the Brazilian population (IBGE, 2012).

In contrast, the sector is also a source of many accidents. According to the yearbook of the Brazilian Institute of Social Security (INSS), 2010, the construction sector accounts for 7.79% of workplace accidents - about 54,600 a year. Along with these accidents, also stand out occupational diseases in this sector, the prevailing musculoskeletal injuries related to efforts at positions not favorable and / or repetitive and also the transport of loads. To make matters worse, workers mostly have low education level, being necessary an ergonomic study of this sector (INSS, 2011).

From one anthropometric perspective, set of sciences and technologies that seek to adapt the work comfortable and productive for humans, is defined the term ergonomics, derived from the Greek words ergon, work, and nomos, rules , ergonomics is a science applied to the design of environments and machinery, equipment and tasks. Ergonomics is defined as the set of scientific knowledge relating to man and are necessary for the design of tools, machines and devices that can be used with the utmost in comfort, safety and efficacy (FIALHO, apud ALAIN, 1995) .

The presented article aims to analyze ergonomic aspects of running grafiato on the frontage of buildings, observing the biomechanical behavior of occupational workers involved, working conditions, equipment used during the execution of the activity, wellness and safety at work, based on the regulations governing principles of ergonomics. It also aims to raise the reactions of wear of the workers, pointing out where there may be gaps and demand correction, implying practical suggestions for improvements to be adopted.

This analysis seeks to understand the concept of job, which in general terms, is a production facility involving a man and the equipment it uses to perform the work as well as the environment in which it operates. Iida (2005) states that the workplace must be adapted so that the operator can perform the job with comfort, efficiency and safety. Also according to the author, the ergonomic focus tends to develop workstations that reduce cognitive and biomechanical requirements, looking to put the operator in an appropriate working posture.

So, for a good sizing of the workplace, might be consider the intensity of the forces to exercise the necessary range, the range of motion , the distance between tools and materials used and the precision of movements. From these factors comes the careful mechanical injury that can be avoided by improving in two situations: first, they must be understood basic biomechanical mechanisms that cause injury from a physical act performed by a person, and second, to be developed desire and the ability of people in the industry and seek insistently ways to prevent such damage and injury (CHAFFIN, 2001).

The pain resulting from work is typically caused by handling heavy loads or when inadequate postures are required, such as twisting of the column. Other activities such as push and pull loads can also cause pain to the employee. Strength, replicates exaggerated postures and movements are usually associated with the root causes of pain (IIDA , 2005).

This also describes some important principles of biomechanics on the joints.to maintain a posture or performing a movement, the joints should be kept in their neutral position. Thus, the more relaxed muscles increase productivity, and reduce absenteeism for reasons of illness, etc. Breaks during the workday are also important, when well prepared for a biological and mental rest.

The activity chosen for the study was cladding facades with acrylic water repellent, type grafiato. This is composed of acrylic resin, pigments, fillers, solvents and special additives suitable for internal and external surfaces. Its use is indicated in varied surfaces where you want to get the decorative effect of texturing. The application of the coating, as Dantecolor catalog (2013) can be made with the foam roller, spatula, trowel or steel roll weft vinyl.

2 . METHODOLOGY

For the study, two works of different sizes were analyzed and compared, so that the visits occurred in August and September 2013. In order to preserve the image and corporate identity, the works were named "construction I" and "construction II". The “construction I” is located in the neighborhood Cabral and "construction II" in the neighborhood Ecoville, both in Curitiba, Paraná.

The functional profile of the "construction I" has approximately 135 employees, including 35 staff from the construction, and the remainder from subcontractors, distributed in several construction activities. Workdays on weekdays is 8 hours with meal break of one hour, while work on Saturdays is optional. The "construction II" has 50 employees, 35 own and others outsourced. This one differs from the work I by having, besides the lunch break, two breaks of 20 minutes each, one in the morning and one in the afternoon.

During the visits, we studied the implementation of occupational biomechanics grafiato facade with audiovisual records, and interviewing employees who performed this task using questionnaires Malinowski (2010). The first had questions relating to working time and other characteristics of each worker and the second based on bipolar diagram (Figure 1), in order to map the data on workers and the larger health consequences generated by the occupation.

Region	Body Region	Frequency	Side		Evolution (hours)		
			Left	Right	1º	4º	8º
d and b	Eyes						
c	Head						
0	Neck						
1	Trapezoid						
5	Thorax						
7 and 8	Lumbar						
2 and 3	Shoulders						
4 and 6	Arm						
10 and 11	Elbow						
12 and 13	Forearm						
14 and 15	Wrist						
16 and 17	Hand and fingers						
9	Buttock						
18 and 19	Thigh						
20 and 21	Knee						
22 and 23	Calf						
24 and 25	Ankle						
26 and 27	Feet and Toes						

OBS: On the parts of the body that the employee don't feel pain, let the frequency area in blank

Frequency	Evolution
(1) Once or Twice a week	(1) Absent
(2) Twice or 4 times a week	(2) Little
(3) About once a day	(3) Moderate
(4) Lot of times a day	(4) Severe
(5) Everyday (all day long)	(5) Unbearable

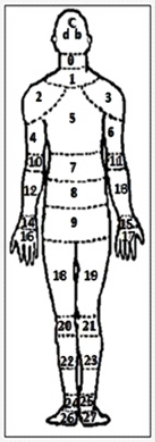

Figure 1 - Nordic Questionnaire.
Source: (MALINOWSKI, 2010).

After the interviews, a total of 7 employees interviewed, 5 being the "construction I" and 2 "construction II", the information was passed to the platform OWAS (Ovako Working Posture Analyzing System). This method evaluates the posture of the back, arms, legs and cargo handled by the worker in each work phase. The positions used by the employees are classified into categories according to the aggressive posture over time, either individually or in combination with the position of other parts of the body.

3 . ANALYSIS AND DISCUSSION OF RESULTS

The first differences between the works, explained by the different sizes as mentioned above, are the equipments available to staff. The "construction I", being larger and having more floors, makes use of the activity suspended scaffolds lining the facades, while the "construction II", minor, and provides scaffolding for employees.

The "construction I" alternate between the facade cladding races - where the suspended scaffold is set according to the scope of work - walls and balconies, which include details next to the window frames and baseboards, where the use of the suspended scaffold is dispensed. In the "construction II", the coating is basically facade plane, since there is no external trimming, and the performer to the grafiato texture is the responsible for assembling the scaffolding.

For officials interviewed, they all consider their work repetitive, they work on foot or "squatting" throughout the day; and transport materials whose weights are greater than 25 kg. Moreover, they are all men, and in both works, are paid by the daily production, without pausing to rest or gymnastics - even at "construction II", where the employees stop in the middle of each shift.

The main employee data generated by the questionnaire Malinowski (2010), are shown in tables 1 and 2

	Construction I				
	Employee I	Employee II	Employee III	Employee IV	Employee V
Age	18	24	32	20	24
Height (kg)	1,66	1,72	1,72	1,6	1,8
Weight	64	72	82	64	64
Job	Painter	Painter	Painter	Painter	Painter
Working time function	Less than 1 year	3 to 5 years	More than 5 years	More than 5 years	1 to 3 years
Work overtime?	Never	Never	Never	Rarely	Never
Has range to rest? (except lunch)	No	No	No	No	No
Has range for gymnastics?	Has no gymnastics	Has no gymnastics	Has no gymnastics	Has no gymnastics	Has no gymnastics
Can leave to go to the bathroom or drink water / coffee?	Yes	Yes	Yes	Yes	Yes
In which position works harder?	Standing	Standing	Standing	Standing	Standing
Uses tools to do your job?	Yes	Yes	Yes	Yes	Yes
Pushes with the hands / fingers to do your job?	Yes	Yes	Yes	Yes	Yes
There is stress for productivity in the sector?	No	No	No	No	Mais ou Menos
Works at a fast pace to fulfill their tasks?	No	Sometimes	No	No	No
Feel tired during work?	Pouco	No	No	No	Pouco
Considers your work exciting or boring?	Stimulant	Stimulant	Boring	Stimulant	Boring
Made adequate training for aitividades before assuming the role?	Yes	Yes	Yes	Yes	Yes
Feel pain in the body?	After work	After work	After work	After work	After work
What weight you lift when you're working on foot?	More than 25 kg	More than 25 kg	More than 25 kg	More than 25 kg	More than 25 kg
How much time per day you lift this weight?	Less than 2 h/day	Less than 2 h/day	Less than 2 h/day	Less than 2 h/day	Less than 2 h/day
Performs during work activities with repetitive motion?	Yes	Yes	Yes	Yes	Yes
There relay tasks during work hours?	No	No	No	No	No

Table 1 - Results of the survey of the work of "construction I".

	Construction II	
	Employee I	Employee II
Age	29	24
Height (kg)	1,76	1,7
Weight	80	65
Job	Painter	Painter
Working time function	More than 5 years	1 to 3 years
Work overtime?	Rarely	Rarely
Has range to rest? (except lunch)	No	No
Has range for gymnastics?	Has no gymnastics	Has no gymnastics
Can leave to go to the bathroom or drink water / coffee?	Yes	Yes
In which position works harder?	Standing	Standing
Uses tools to do your job?	Yes	Yes
Pushes with the hands / fingers to do your job?	Yes	Yes
There is stress for productivity in the sector?	Bastante	No
Works at a fast pace to fulfill their tasks?	Yes	No

Feel tired during work?	Muito	No
Considers your work exciting or boring?	Stimulant	Stimulant
Made adequate training for aitividades before assuming the role?	No	No
Feel pain in the body?	During the work	Feel no pain
What weight you lift when you're working on foot?	More than 25 kg	More than 25 kg
How much time per day you lift this weight?	Less than 2 h/day	Less than 2 h/day
Performs during work activities with repetitive motion?	Yes	Yes
There relay tasks during work hours?	No	No

Table 2 - Results of the survey of employees "construction II".

The data gathered by questionnaire Bipolar arranged in the figure 4, it was observed that the 7 employees interviewed, 6 have shoulder pain. Among these, 4 perform the profession of painters for over 5 years, and already have a subdued pain, and the other 2 employees are professional in less than 1 year, with few progress. It was noted that the professionals working for over five years, complained of more severe pain in the shoulder or lower back, but did not mention pain in other regions. The employees with less than 1 year of experience said they feel pain in more than one body region - beyond the shoulders or lower back - but with lower intensity. It can be seen then, that older employees have already possibly an injured areas of the body to exert more effort due to this activity.

Figure 4 - Region aching body appointed by the employees

In conversation with the staff of both works, stipulated an average time per activity performed for the task of exterior cladding, as the following table:

#	Activity	% Time	Back	Arms	Legs	Weight loaded
1	Material Handling	5%	Bent (2)	Two arms down (1)	A bent leg (4)	More than 20 kg (3)
2	Transport Material	5%	Straight (1)	Two arms up (3)	Movement with legs (6)	More than 20 kg (3)
3	Preparing the Mass	5%	Bent (2)	Two arms down (1)	One leg kneeling (5)	Up to 10 kg (1)
4	Performing High Regions	25%	Straight (1)	One arm up (3)	Two legs straight (1)	Up to 10 kg (1)
5	Performing Medium Regions (waist to head)	30%	Straight (1)	Two arms down (1)	One leg straight (2)	Up to 10 kg (1)
6	Performing Off Regions	30%	Bent and Twisted (4)	Two arms down (1)	Two legs straight (1)	Up to 10 kg (1)

Table 3 - Attitudes related to enforcement activities of the grafiato.

An analysis of individual positions, it turns out that according to Iida (2005), the most damaging postures, according to the duration, the back tilted and twisted (Activity 6) will require a check in the next revision of postural methods the individual's work. In other positions considered fragile, employees are subjected for short periods, without this being considered a source of damage to the body.

However, making an overall examination of postural activity, based on another table Iida (2005) on the System OWAS: "Classification of postures by combining the variables" it appears that activities 1 and 3 require attention in the short term while the activity remains 6 must be verified in a forthcoming review of working methods.

4 . FINAL CONSIDERATIONS

According to the interviews, it is clear that, in most cases, the pain manifested at the end of the working day, and also with greater intensity in the shoulder region, which shows a sign of fatigue. Is a state in a row, a job that runs under certain conditions, leading to a temporary and reversible loss of efficiency (FALZON et al., 2007).

This often occurs due to lack of adaptation of metabolism to the requirements of the task. According to Iida (2005), there is an imbalance between demand and supply of oxygen to start the activity, which can be reduced with a preheating of the body for at least 5 minutes. The lack of gymnastics, mentioned by all employees, makes this need more apparent. Companies can mobilize the entire workforce of the work for this period of exercise, assisting in the attitude of employees, improving the quality of life and, consequently, productivity.

However, the fact that the payment of employees is conducted based on daily production, prevents the painters make available their time to activities other than the coating, lest they receive lower amount of salary. To try to change this situation, companies could encourage employees paying them the period of gymnastics, because it will directly affect the daily production, rendering better services to the company.

As for the job, it is concluded that the suspended scaffold are facilitators for the activities in time due to a more flexible setting of the level in which they work, avoiding efforts due to work in areas not comfortable allowing the effort to implement the activity is reduced. Electric suspended scaffold are even better, because also avoid manual efforts for height adjustment.

Still, the following aspects should be considered to prevent repetitive strain injuries:

- Find alternatives for tasks requiring quick and highly repetitive movements of the arms, or requiring efforts static thereof;
- Minimize flexion and abduction of the shoulder;
- Minimize the load-bearing in their hands;
- Reduce or limit employment tasks that require excessive manual force;
- Require that workers have rest periods.

REFERENCES

CHAFFIN, Don; ANDERSSON, Gunnar; MARTIN, Bernard. Occupational Biomechanics. Translation, 3rd edition; Belo Horizonte : Ergo, 2001.

DANTECOLOR. Institutional website of the company DANTECOLOR. Available at: <http://www.dantecolor.com.br/detalhesProdutos.asp?IdProduto=53>. Accessed on 09/17/2013 .

FALZON, Pierre. et al. Ergonomics. 2nd reprint: São Paulo: Blucher, 2007.

FIALHO Francisco; DOS SANTOS, Neri. Manual ergonomic analysis. 2nd Edition, Curitiba : Genesis, 1997.

IBGE - Brazilian Institute of Geography and Statistics. Statistical Yearbook of Brazil. v. 72, 2012.

IIDA , Iida. Ergonomics: Design and Production. São Paulo: Edgard Blücher , 2005.

INSS - Social Security Statistical Yearbook - 2011. Brasilia, 2012.

MALINOWSKI, Elaine. Ergonomic analysis of postural job sector foaming of refrigerator doors. UTFPR. Curitiba, 2010.

REAL PAINTS. Institutional Site of supplier Paints Real. Available at: <http://www.tintasreal.com.br/images/stories/laudos/TEXT%20HIDRO%20260713.pdf> . Accessed on 09/17/2013.

VIEIRA , Sebastian I. Manual of Health and Safety. 2nd edition , London: LTr , 2008 .

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ERGONOMIC ANALYSIS IN COAT OF COATINGS IN GRAFIATO

ABSTRACT

The construction industry has proved of great importance to the national economy and for job creation. However, the sector is also responsible for a large number of accidents at work and occupational diseases, which shows that the concern with ergonomics is still very superficial. Thus, this research presents an ergonomic analysis of the workplace for the frontage cladding of buildings. The activity is carried out by painters, which run texture finish, named “grafiato”. For the analysis, two different construction sites were visited, being the work - named "work I" - executed by a large construction company, and the work entitled "work II" performed by a smaller enterprise, both in the city of Curitiba, state of Paraná, Brazil. Therefore, the officials regarding this activity were interviewed to identify biomechanical problems resulting from the job in question. The results showed that more experienced employees feel pain more intense, and in concentrated body areas; and that inexperienced staff feel pain in several regions, but with less intensity. In addition, the body area that suffers more with the activity in question is the shoulder. Thus, it can be concluded that the analyzed companies should incentive plan gymnastics at construction sites.

KEY WORDS: Biomechanics ; Ergonomic Analysis ; Facade.

ANALYSE ERGONOMIQUE SUR LE REVÊTEMENT DE FAÇADES EN GRAFIATTO

RÉSUMÉ

Le secteur de la construction civile s'est révélé de grande importance pour l'économie nationale et la génération d'emplois. Toutefois, le secteur est également responsable d'un grand nombre d'accidents de travail et maladies occupationnelles, ce qui montre que la préoccupation pour l'ergonomie est encore assez superficielle. Cette recherche présente donc une analyse ergonomique du poste de travail dans le revêtement de façade d'édifices. L'activité est réalisée par des ouvrier surnommés "fachadeiros", qui exécutent le travail en grafiatto. Pour l'analyse ont été réalisées deux visites sur deux chantiers différents, l'un nommée "chantier 1", réalisé par une grande entreprise, et un autre, "chantier 2" mené par une entreprise de petite taille ; les deux étant de Curitiba, dans l'état du Paraná. Pour ce, nous avons interviewé les employés de cette activité pour identifier les problèmes biomécaniques résultants du poste de travail analysé. Les résultats montrent que les employés plus expérimentés ont des douleurs plus intenses aux régions du corps, mais plus localisées, et que les employés ayant moins d'expérience, sentent des douleurs à plusieurs régions, mais avec une intensité plus faible. En outre les épaules sont la région corporelle qui souffre le plus avec l'activité étudiée. Ainsi, on peut donc conclure que ces entreprises ont besoin de mesures les incitant à la gymnastique du travail sur les chantiers.

MOTS CLÉS: Biomécanique ; Analyse Ergonomique ; Façade.

ANÁLISIS ERGONÓMICO EN REVESTIMIENTO DE FACHADAS EN TEXTURA GRAFIATO

RESUMEN

La industria de la construcción ha demostrado ser de gran importancia para la economía nacional y la creación de empleo. Sin embargo, el sector también es responsable de un gran número de accidentes de trabajo y enfermedad profesional, lo que demuestra que la preocupación por la ergonomía es aún muy superficial. Por lo tanto, esta investigación presenta un análisis ergonómica del puesto de trabajo para el revestimiento de fachadas de edificios. La actividad se lleva a cabo por los trabajadores titulados "fachadeiros", que se ejecutan textura grafiato. Para el análisis, hubo dos visitas a dos obras diferentes, siendo una obra - intitulada "obra I" - realizada por una constructora que ejecuta obras de construcción grandes, y la obra titulada "obra II", realizada por una constructora que ejecuta obras menores, ambas en la ciudad de Curitiba, estado de Paraná, Brasil. Para esto, se entrevistó a funcionarios con respecto a esta actividad para identificar los problemas biomecánicos resultantes del trabajo en cuestión. Los resultados mostraron que los empleados más experimentados sienten dolor más intenso, pero solo en algunas regiones del cuerpo; y empleados com poca experiência sienten dolor en varias regiones, pero con menor intensidad. Además, la región del cuerpo que más sufre con la actividad en cuestión, es el hombro. Por lo tanto, se puede concluir que las empresas analizadas deberian tener un incentivo a gimnasia en las obras de construcción.

PALABRAS CLAVES: Biomecánica; Análisis Ergonómico; Fachada.

ANÁLISE ERGONÔMICA NO REVESTIMENTO DE FACHADAS EM GRAFIATO

RESUMO

O setor da construção civil tem se mostrado de grande importância para a economia nacional e para a geração de empregos. Entretanto, o ramo também é responsável por grande número de acidentes de trabalho e doenças ocupacionais, o que mostra que a preocupação com a ergonomia ainda é muito superficial. Sendo assim, esta pesquisa apresenta uma análise ergonômica do posto de trabalho referente ao revestimento de fachadas de edifícios. A atividade é realizada por operários intitulados “fachadeiros”, os quais executam o acabamento em grafiato. Para a análise, foram realizadas duas visitas a dois

canteiros de obra diferentes, sendo uma obra - nomeada “obra I” - executada por uma construtora de grande porte, e a obra intitulada “obra II”, realizada por uma construtora de menor porte; ambas na cidade de Curitiba, no estado do Paraná. Para tal, foram entrevistados os funcionários referentes a esta atividade para identificar os problemas biomecânicos resultantes do posto de trabalho em análise. Os resultados mostraram que funcionários mais experientes sentem dores mais intensas, porém em regiões mais concentradas; e que funcionários mais inexperientes, sentem dores em várias regiões, mas com menor intensidade. Além disso, a região corporal que mais sofre com a atividade em análise, é a dos ombros. Sendo assim, pode-se concluir que as empresas analisadas poderiam criar de um plano de incentivo à ginástica laboral nos canteiros de obras.

PALAVRAS CHAVES: Biomecânica; Análise Ergonômica; Fachada.