76 - ERGONOMIC ANALYSIS OF PAINTING ACTIVITY ON A PUBLIC EDUCATIONAL BUILDING

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1. INTRODUCTION

The construction industry represents one of the most important economic segments in Brazil. However, by the lack of industrialization and mechanization of the activities in this sector, there are several workers exposed to occupational health and safety risks arising from lack of training, appropriate equipment and the adequacy of work stations in a construction site.

The statement is justified, grounded in accident statistics occurred in construction. According to the Statistical Accidents Yearbook of 2011, 2012 and 2013, provided by the Social Welfare Ministry, it has occurred respectively 889, 746 and 700 occupational diseases records of the activities executed in this sector officially registered in Communication of Work Accident - CAT (BRASIL, 2015).

For the study of diseases originated from work activities execution, stands out 17 Regulatory Standard – Ergonomics, which aims to establish parameters that allow adapting working conditions to the psycho-physiological characteristics of workers in order to provide maximum comfort, safety and efficient performance (BRASIL, 2015).

Furthermore, according to Iida (2005), ergonomics is the study of man's adaptation to work. It is emphasized that the companies review the organizational aspects of how the work is programmed and controlled to produce the desired results for the activity execution. In addition, the analysis needs to involve the machinery and equipment used for the processing of materials in the ergonomic evaluation.

In the construction sector, Rodrigues (2013) emphasizes the incidence of numerous situations that may compromise bone structure or muscular of workers, like physical stress and the acquisition of diseases such as back pain, muscle sprains and muscle fatigue. For Golabchi et al. (2015), despite the technological advances in the past years, workers in the construction industry are often exposed to movement tasks and manual execution, which involve great effort and inadequate postures.

Within this context, this article aims to analyze the positions and equipment used in the activities involved in painting execution in a public educational building, and thus, proposing improvements to the postural and ergonomic aspects of the work for that function, presenting the methodology and Ergonomic work assessment as established in 17 Regulatory Standard, and using reputable techniques as RULA (Rapid Upper Limb Assessment) and OWAS (Ovako Working Posture Analysing System) for postural analysis of workers.

2. REVIEW OF LITERATURE

As provided in the 17 Regulatory Standard, ergonomic analyzes of the workplace characteristics should include verification of tools, furniture, fixtures and equipment used, physical space for execution of activities, position and worker movement (BRAZIL, 2015). The RULA method, developed by McAtamney and Nigel Corlett (1993), allows evaluating the biomechanical overload of the neck and performing analysis of the upper limbs (neck, torso, shoulders, arms and fists). For this method, checking the human body diagram positions and evaluating tables, the score is obtained (Table 1) and will indicate the level of intervention in the workplace. Risk factors take into account the number of movements, static work, work posture, strength and working time without pause (PAVANI, 2007).

Table 1- Results of RULA method

RULA SCORE	ACTION LEVEL	ACTION
1 or 2	1	Indicates that posture is acceptable if it is not maintained or repeated for long periods.
3 or 4	2	Indicates that further investigation is needed and changes may be required.
5 or 6	3	Indicates that investigation and changes are required soon.
7	4	Indicates that investigation and changes are required immediately.

Source: Implemented by McAtamney and Corlett (1993).

Likewise there is the OWAS method for ergonomic analysis also. This methodology was developed in the steel industry in Finland in 1973, in which identifies four postures for the back, three for the arms, seven for the lower limbs and three weight categories loading or amount of force used (KARHU et al., 1977 apud IIDA, 2005). The technique classifies combinations of these four categories by the degree of its impact on the musculoskeletal system for all posture combinations (KEE; KARWOWSKI, 2007).

The degrees of harmfulness evaluated these postures loads combinations are grouped into four categories of action (KARHU et al., 1977 apud IIDA, 2005):

·Action category 1: normal postures that do not need special attention;
·Action category 2: postures should be considered during the next regular checking of the working methods;
·Action category 3: postures need consideration in the near future;
·Action Category 4: postures need immediate consideration.

3. METHODOLOGY

For Ergonomic Work Analysis data were collected at a construction site of a public educational building. After initial work environment observation, the study has selected three construction workers who were performing distinct and three sequential stages of painting: spackling, sanding and painting. The project managers have selected this activity because of the big effort in upper limbs and repetitive movements.

Wall coverings are intended to regularize the surface protecting against weather, increasing the wall strength and provide aesthetic and finishing. To achieve these objectives the activity is extremely manual, typically subjective, and requires

identification and elimination of defects abrasive way.

The first stage of the Ergonomic Work Analysis has been to observe the ergonomic demand related to worker biomechanics, focusing activities with awkward postures and repeatability in the upper limbs.

The productive construction sector population is male with low education level and age of employees between 28 and 50 years. The average height of the employees performing the painting activity is 1.73 meters. The working day is 8 hours per day, with an hour break for lunch. The painting team in this study has been outsourced with payment made on a contract basis. The company has hired 7307.46 m² of external and internal painting at the time.

The second stage of ergonomic analysis has been to analyze the task. Because the task analysis requires an understanding of what is required to work for the activities implementation, the researchers have observed that the workers have performed the painting activity the way they wanted and the work has been performed individually. The job steps for painting are: roughcast, plaster, stucco, spackling, sanding and painting, the last stage usually performed with two or three coats.

In the third stage of ergonomic analysis has been analyzed the activity performed by the worker. For the ergonomic diagnosis the study has used the Ergolândia 5.0 software, which has 20 tools for ergonomic evaluation and it has been chosen to analyze the working postures through RULA and OWAS. These are tools that contribute to ergonomic analysis and facilitate the search for actions to be taken by the company analyzed.

As suggested by Dul and Weerdmeester (2004), due to the activity requires great effort in the upper limbs, the study has analyzed if the equipment chosen is suitable for the task, if the tool has been curved to avoid tensions in the wrist, if the hand tools has been very heavy, if the maintenance and conservation of these tools has been good, and if the work with up arms shoulders and hands back has been avoided.

4. RESULTS AND DISCUSSION

Based on the data obtained in this study, it has been analyzed the postures of surface preparation for painting and painting. First, it has been analyzed two surface preparation postures before painting and then the painting posture.

Figure 1 shows the plaster realization posture. In this task, the result obtained by RULA was 5 (five) points, indicating the need for an investigation and being introduced changes. Presenting similar result by OWAS tool, this posture falls under the category two (2), requiring corrections in the near future.



Figure 1 - Surface preparation

In the case of Figure 1, could be used one footrest for the legs stay well supported and balanced. This change would reduce the result of RULA at one (1) point, resulting in a less critical action level.

In the second posture of surface preparation, it has been identified activity movements and analyzed the posture shown in Figure 2. For this task, which precedes the painting, has been noted great demand of the arms, neck and trunk rotation. Thus, the scores obtained was seven (7) in RULA tool, which result indicates the need to introduce changes immediately (Figure 3). By the OWAS tool, it has not been identified corrective measures (Figure 4). This score difference it is probably due to the fact that OWAS does not devote much attention for upper limbs, however with RULA result is possible to detect the importance of improving this presented posture.

In the sanding task (Figure 2), changing the stand height would reduce the impact on the neck and arms. Also changing the type of footrest for enhanced stability and surface would reduce the need for torso rotation and allow legs and feet balance. This position needs frequent repositioning of the upper limbs and it is complicated the precise movements of the worker in this task execution. Therefore, with these changes, the score RULA could achieve four (4) points, resulting in a less critical level of action in order to eliminate overloading the muscular system.





Figure 3 - RULA result for Sanding



Figure 4 - OWAS result for Sanding

In Figure 5, the worker body movements in painting were analyzed for both RULA and OWAS tool to verify undesired postures. In analysis by RULA method the score obtained was 7 (seven), resulting in introducing changes immediately (Figure 6). By OWAS method, posture fitted to category 1 (one), which indicates that it is necessary corrective measures (Figure 7).



Figure 5 – Painting

This posture makes the worker assumes inadequate postures. Thus, in this case, it is recommended to change the task execution height so the worker can improve neck and arms. This change reduces RULA score to a less critical level.



Figure 6 – RULA result for painting



Figure 7 – OWAS result for painting

In general, this research through painters ergonomic analysis shows the importance of a new design to allow changes in the postures for workers. Therefore, this activity needs to eliminate risks rather than treating the symptoms and harmful consequences that could be caused by inadequate posture.

5. CONCLUSION

Considering the construction sector, the analysis is appropriate in seeking solutions to improve the working environment in this industry. With the study, it is known which working conditions the painters are exposed. All three tasks analyzed presented need for adjustment.

The RULA tool, which showed the full detail of the postures, shows that the activities expose employees to ergonomic hazards such as awkward positions and lifting the arms above the shoulders.

This workplace has inadequacy of ergonomic conditions, and lack of auxiliary tools to allow greater mobility, comfort and safety of painters, especially for activities performed with upper limbs in unfavorable angles and activity heights that need support. Thus, it is recommended the adequacy of stairs and workbenches structures to support the activity execution.

The article also highlight the lack of proper curvature and maintenance in working tools, requiring the acquisition of specific tools and further training of workers for its correct use. The institution could apply specific tools for slabs and beams contours painting, avoiding stresses in the fist. Still, the activity needs breaks throughout the work shift.

The conclusion of this study provides relevant information to the challenge of improving and adapting the workplace. A suitable environment offering comfort for employees allows occupational health, physical integrity of employees, productivity increase and competitiveness. Thus, after analysis, the objective is to perform 17 Regulatory Standard recommendations.

REFERENCES

BRASIL. Ministério da Previdência Social – Anuário estatístico de acidentes. Available at:

<http://www.previdencia.gov.br/aeat-2013>. Accessed on 10/06/2015.

BRASIL. Ministério do Trabalho e Emprego. NR 17 - Ergonomia. Available at: <http://portal.mte.gov.br/legislacao/normas-regulamentadoras-1.htm>. Accessed on 10/25/2015.

DUL, J.; WEERDMEESTER, B. Ergonomia prática. São Paulo. Editora Edgard Blucher, 2004.

IIDA, I. Ergonomia: Projeto e Produção. 2º edição rev. e ampliada. São Paulo. Editora Edgard Blucher, 2005.

RODRIGUES, F.R. Prevenindo Acidentes na Construção Civil. São Paulo: Editora LTr, 2ª Edição, 2013.

Golabchi, A.; Han, S.; Seo, J.; Han, S.; Lee, S. e Al-Huseein, M.. An automated biomechanical simulation approach to ergonomic job analysis for workplace desing. Journal of Construction Engineering Management, 2015.

KEE, D. and KARWOWSKI, W. A Comparison of Three Observational Techniques for Assessing Postural Loads in Industry. International Journal of Occupational Safety and Ergonomics (JOSE) 2007, Vol. 13, No. 1, 3-14

McATAMNEY, L. and CORLETT, E. N. RULA: A survey method for the investigation of work-related upper limb disorders. Appl. Ergon, 24 (2), p. 91-99, 1993.

PAVANI, R. A. Estudo ergonômico aplicando o método Occupational Repetitive Actions (OCRA): Uma contribuição para a gestão da saúde no trabalho. 2007. Dissertação. (Mestrado em Gestão Integrada em Saúde do Trabalho e Meio Ambiente) – Centro Universitário Senac, São Paulo.

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ERGONOMIC ANALYSIS OF PAINTING ACTIVITY ON A PUBLIC EDUCATIONAL BUILDING

ABSTRACT

The following article is aimed to analyze the postures and equipment used in the activities involved to execution the painting in a public education building, and thus propose improvements in postural and ergonomic aspects of the work for this function. For this, it presents the methodology and the ergonomic work assessment as established by NR 17, and use techniques conceptualized as RULA and OWAS, for postural analysis of workers. For ergonomic work analysis (AET), data were collected on a construction site of a public educational building. After initial work environment observation, the study has selected three construction workers who were performing distinct and three sequential stages of painting. The result of this research showed that there is a need to implement a new design to allow changes in the postures for workers. Therefore, this activity needs to eliminate risks rather than treating the symptoms and harmful consequences that could be caused by inadequate posture.

KEYWORDS: Ergonomics. Painting activity. Civil construction.

ANALYSE ERGONOMIQUE DE L'ACTIVITÉ DE PEINTURE SUR UN ENSEIGNEMENT PUBLIC

RÉSUMÉ

L'article qui suit a pour but d'analyser les postures et les équipements utilisés dans les activités liées à l'exécution du tableau dans un bâtiment de l'éducation du public, et donc de proposer des améliorations dans les aspects posturales et ergonomiques du travail pour cette fonction. Pour cela, il présente la méthodologie et l'évaluation de travail ergonomique établi par NR 17, et les techniques d'utilisation conceptualisée comme RULA et OWAS, pour l'analyse posturale des travailleurs. Pour l'analyse ergonomique du travail (AET), données ont été recueillies sur un site de construction d'un bâtiment d'enseignement public. Après observation initiale de l'environnement de travail, l'étude a sélectionné trois travailleurs de la construction qui effectuaient distincte et trois étapes successives de la peinture. Le résultat de cette recherche a montré qu'il ya une nécessité de mettre en œuvre un nouveau design pour permettre des changements dans les postures pour les travailleurs. Par conséquent, cette activité a besoin pour éliminer les risques plutôt que de traiter les symptômes et les conséquences néfastes qui pourraient être causés par la posture inadéquate.

MOTS-CLÉS: Ergonomie. L'activité de Peinture. Construction civile.

ANÁLISIS ERGONÓMICA DE LA ACTIVIDAD DE PINTURA EN UNA OBRA DE UNA INSTITUCIÓN PÚBLICA DE EDUCACIÓN

RESUMEN

Este estudio tiene por objeto analizar las posturas y equipos utilizados en las actividades involucradas para ejecución de la pintura en un edificio de la escuela pública, y así, proponer mejoras en aspectos posturales y ergonómicos del trabajo para esa función. Por lo tanto, presenta la metodología y la evaluación ergonómica de trabajo establecidos en norma reglamentaria Nº 17, y también mediante técnicas de renombre como RULA y OWAS para el análisis postural de los trabajadores. Para el análisis de trabajo ergonómico, los datos fueron recolectados en un sitio de construcción de una obra de construcción pública. Después de la observación inicial del ambiente de trabajo, fueram seleccionado tres trabajadores que estaban realizando etapas distintas y secuenciales de la construcción de la pintura. El resultado de esta investigación demostró que existe la necesidad de implementar un proyecto para permitir cambios de mejoras en las posturas adoptadas por los trabajadores. Así, em esta actividad tiene que eliminar los riesgos, en lugar de tratar los síntomas y las consecuencias perjudiciales que podrían ser causados por una mala postura.

PALABRAS CLAVE: Ergonomía. Actividad Pintura. Construcción civil.

ANÁLISE ERGONÔMICA DA ATIVIDADE DE PINTURA EM UMA OBRA DE UMA INSTITUIÇÃO PÚBLICA DE ENSINO

RESUMO

Este estudo tem como objetivo principal analisar as posturas e equipamentos utilizados nas atividades envolvidas para a execução da pintura em uma edificação pública de ensino, e desta forma, propor melhorias nos aspectos posturais e ergonômicos do trabalho para a referida função. Para tanto, apresenta-se a metodologia e a avaliação ergonômica do trabalho conforme estabelecido na Norma Regulamentadora nº 17, e ainda, utilizar técnicas conceituadas como RULA e OWAS para análise postural dos trabalhadores. Para a Análise Ergonômica do Trabalho, foram coletados dados em um canteiro de obras de uma obra pública de edificação. Após observação inicial do ambiente de trabalho, foram selecionados três trabalhadores que estavam executando fases distintas e sequenciais da pintura da edificação. O resultado desta pesquisa mostrou que há necessidade de implementar um projeto para permitir mudanças de melhorias nas posturas adotadas pelos trabalhadores. Pois, nesta atividade precisa eliminar os riscos, em vez de tratar os sintomas e as consequências danosas que podem ser causadas por posturas inadequadas.

PALAVRAS-CHAVE: Ergonomia. Atividade de Pintura. Construção Civil.