04 - ERGONOMIC WORK ANALYSIS OF THE WAREHOUSE WORK STATION ON BUILDING CONSTRUCTION: A CASE STUDY

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1.INTRODUCTION

Ergonomics is the science that deals with the interactions between humans and other system components (IEA 2000 apud FALZON, 2007. p.5). This science is not an objective in itself (SELL, 2008), but may be used by many professionals who aim to base the adaptation to workers, as well as the identification of the necessary skills to perform each task. Iida (1997, p.1) defines it as the application of anatomic knowledge, physiology and psychology in adapting task to the worker in any situation in which there is the person-job relation, involving the physical and organizational aspects as well as the equipment used to perform the job.

Ergonomics presents real situations in the studied environment, analyzing the way that can be trusted and successful achievements of the activities in order to humanize the purpose and progress of the work. Thus, ergonomics presents the improvement of working conditions and provides improvement in people's lives (SELL, apud ALVAREZ, 1996). The healthy worker includes not only the physical but also the mental and social concerns (IIDA, 2005. P.435-436) and should be considered important not only to employees but also to companies and society in general.

According to Santos and Fialho (1995, p.24), Ergonomic Work Analysis can be divided into three phases of analysis, made from accurate descriptions, observations and systematic measures of relevant variables, namely: a) the analysis demand is the definition of the problem to be analyzed from a negotiation with the various actors involved, b) task analysis is that the worker must perform the technical, as well the environmental and organizational referring to this realization, c) analysis of activities is what is effectively performed by the employee in order to perform the task, this is the human behavior at work.

According to Iida (2005. p.189), the job can be considered as the least productive unit, which usually involves a person, his workplace and the equipment used to perform the task.

The construction industry is one of the industries that presents more work accident rates, as well as offering a wide variety of risks in its various stages and support activities, and little ergonomic approach. According to Iida (2005. pp.550) this is because the activities are dispersed, performing several functions, high worker turnover and little power of organization among workers. These are subject to realization of arduous and repetitive manual tasks and at the same time that it has low payment and little schooling. These facts make them more susceptible to the risks professional work, without receiving further training. According to Ribeiro (2005, p. 558) workers often underestimate the risks they are exposed. Also, have confidence that practical knowledge is enough to carry out the activity. Safety guidelines of this branch are defined by NR 18, and established by Decree 3214 (SALIBA, 2004. P. 95).

The construction site offers different risks to the employee according to the stage of the work. The warehouse is the place of receipt, storage, and routing of materials within the work. The construction industry is characterized by short-term inventory holding, where the inputs to the tasks arrive at work according to the service to be performed (SZAJUBOK, MOTA and ALMEIDA, 2006), characterized with high turnover materials and high number of tasks to be performed by the employee.

According to Yázigi (2000, p.57) the warehouse should be divided into sections according to the type of material (electric, hydraulic, etc.) besides storing tools, safety equipment, administrative material and equipment for general use (lime, cement, etc.). Also according to this author, location should allow easy access to delivery trucks, having an area for discharge of material, be at least 2 meters away from the edge of building site, but strategically close to the workstations. The NR 18 also presents specific guidelines for the construction of warehouses, generally related to how the materials are arranged and care with potentially hazardous materials (BRAZIL, 2013b; SALIBA, 2004. p. 118).

Among the responsibilities of storekeeper can be mentioned: a) control of incoming and outgoing materials, b) control of the counting of the material delivered c) control of the output of the material requested by the staff of the workstation d) custody of third party equipment; e) guard under security parameters of toxic, flammable or dangerous f) obligation to indicate when the stock of some material reaches the critical threshold, and g) an organized storage of everything that is delivered (YÁZIGI, 2000 . p.57).

The objective of this work is to verify the ergonomic conditions of the job of a warehouse construction in the concerns of Regulatory Standards 17 and 18.

2.METHODOLOGY

First, was performed a literature search on the ergonomic themes and construction. Then a study on Ergonomic Analysis of Work and elaborate questionnaires based on the items in the table of NIOSH ("The National Institute for Occupational Safety and Health") and the provisions of NR 17 (in relation to posture and physical stress) and NR 18 (BRASIL, 2013a, BRASIL, 2013b).

The table NIOSHI was formulated to assess the potential damage from activities that involve repetitive lifting loads taking into account the weight, the shape, the handle, the frequency, size and grip position of objects. The relationship between the limit weight recommended (LPR), obtained from equation NIOSHI, and the actual weight of the objects indicates the risk zone of activity, indicating whether or not activity should be avoided in terms of ergonomics.

It was selected a medium sized construction company, operating in the southern region of the country in the area of residential buildings. It was choosen a coating work phase construction, the phases being a longer and higher turnover of materials.

The survey was conducted in September 2013, with the questionnaire and observation of materials (weight, shape, distribution, location, visibility, etc.), Layout of the job, and postural factors.

3.RESULTS AND DISCUSSIONS

The analyzed warehouse is located on the ground floor of the building. It has seal with sidings, lighting wiring exposed,

wooden pallets for storage of material, wheelbarrows to transport materials, freight elevator, bucket, trash cans and other support items such as shovel, broom, plastic bag, among others.

As this is work in phase coating materials consisted of: cement, paste, mortar, ceramic plates. The workstation has, in addition, with a loading lift for sending the material to the other floors of the building.

According to guidelines of NR 18 (BRASIL, 2013b), we can consider that: a) the materials were willing to allow the movement of persons and workers b) the doors were not blocked c) the walls and slabs not possessed overloads or thrusts, as established in the item 18.24.1. As for firefighting equipment, was verified the existence of a fire extinguisher, not clogged near the cockpit of the elevator.

The piles of materials were stable and, mostly, the facilitated height handling. As shown in the graph of Figure 1, the stacks of material were between 80 cm and 1.10 m, ie in the range of reach. The exception was the second stack of tiles, which was 60 cm. Furthermore, the wheelbarrow had 20 cm and also demanded squat. The materials were stacked on wooden pallets 10 cm to not allow the materials were in an unstable, damp and uneven, according to item 18.24.5 of NR 18 (BRASIL, 2013b).

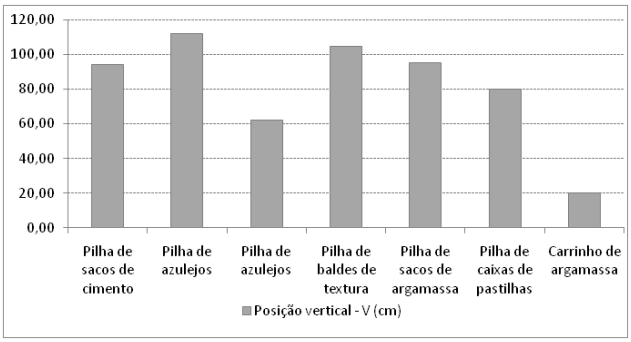

Figure 1: height disposal of materials.

On the other hand, PVC pipes were arranged in layers, separated with spacers and gauges brace as seen in Figure 2.



Figure 2. Above and left: stack of buckets texture, top right: stack of boxes pellets; below and to the left: stack of boxes of tiles and PVC pipes to the bottom, bottom right: stack of bags of mortar.
Source: Collection of the authors.

Two employees were working at the site: one storekeeper and a helper. As the activities are distinct for the two workers, the study focused on the storekeeper. Your tasks consist primarily in the transportation of loads, which according to item 17.2 NR 17 is "any carriage in which the weight of the load is supported entirely by a single worker, including lifting and depositing the load." The standard also states that the manual transport of loads carried out continuously is called regular manual transport of loads, and that every employee with such activity should receive appropriate training in order to prevent accidents and safeguard their health. As the questionnaire with the storekeeper there was no training for the execution of its task. The technical means used to support the transport of cargoes consisted in using wheelbarrow. The warehouse has a seat resting place as indicated in the item 17.3.5 of the same NR (BRASIL, 2013a).

Table 1. List of activities for the tasks of the worker.

TASK	ACTIVITY
ELEVATOR OPERATION (DOWN)	- Waiting for the sound signal that warns when some item or material will be sent by the elevator; - Waiting watching with the camera the right object positioning and the door closing; - Turning the elevator on; - Waiting for the elevator to come to the ground, opening the doors, discharge the material through a ramp, reverse*.
WAREHOUSE ORGANIZATION	-Organizing the material that comes to the construction and defining were they will be disposed*; - Cleaning the equipments and material residues*; - Distribution of the materials asked by the employees*.
ELEVATOR OPERATION (UP)	- Answering the material or equipment requisitions of the employees that are on the superior pavements; - Organizing and loading the elevator with the necessary material, that can be coating material, cement, concrete or equipments*; - In case of cement and concrete, send in a wheelbarrow (at this point the storekeeper can be helped by the assistants)*; - Closing the elevator when the points are correctly accommodated *; - Turning the elevator on; - Waiting for the elevator to come to the superior pavements, watching with the camera the material discharge by the employees
	*Activities that demand high efforts

Regarding the movement performed by the worker to perform the task, there is the difficulty of handling the wheelbarrow comprising on average 40 kg to reverse down the ramp after receiving the material, as shown in Figure 3.



Figure 3. Left: Worker carrying the load off the elevator reversed and to the right: worker carrying the load into the elevator.

Source: Collection of the authors.

Workstation	1	2	3	4	5	6	7
Description	Cement sacks pile	Ceramics boxes piles		Texture buckets piles	Mortar sacks piles	Tablets boxes piles	Mortar Wheelbarrow
Weight (kg)	50	21	21	30	20	15	315
V (cm)	94,00	112,00	62,00	105,00	95,00	80,00	20,00
H (cm)	40,00	58,70	58,70	33,00	15,00	16,35	10,00
A (grades)	90,00	90,00	90,00	90,00	90,00	90,00	0
LC (kg)	23	23	23	23	23	23	23
HM	0,63	0,43	0,43	0,76	1,67	1,53	2,50
VM	0,94	0,89	1,04	0,91	0,94	0,99	1,17
DM	0,89	0,87	0,96	0,88	0,89	0,91	0,37
AM	0,712	0,712	0,712	0,712	0,712	0,712	1
FM	0,85	0,85	0,85	0,85	0,85	0,85	0,85
CM	0,9	0,9	0,9	0,9	0,9	0,9	1,9
LPR (kg)	6,57	4,15	5,33	7,60	17,45	17,17	40,03
Lifting index	8	5	4	4	1	1	8
Risk zone	Elevated risk	Elevated risk	Elevated risk	Elevated risk	Moderate risk	Moderate risk	Elevated risk

According to Table 2, the risk areas obtained from equation NIOSHI demonstrate the inadequacy of jobs observed. For stacks of bags and boxes mortar pads there is a moderate increase in risk, in these instances, the storekeeper may be injured or sick to accomplish these tasks. The other jobs had increased high risk of being unacceptable ergonomic point of view and therefore require modifications.

It is also observed that the most critical situations, with the highest rates of survey result for the posts 1 and 7 (stacks of bags of cement and mortar shopping, respectively).

During the survey the storekeeper expressed the occurrence of moderate pain in the knees, which he attributed to the weight of the wheelbarrow.

4.CONCLUSION

The obtained results indicate that the analyzed warehouse presents a reasonably organized layout, stacking with comfortable highs for handling and correct material conservation and allow adequate circulation of people, according to NR18.

The training, indispensable according to the NR17, taken the kind of storekeeper's task – regular hand load transport – however was not offered by the enterprise. This absence indicates the negligence of the enterprise exposing the worker to risks without previous training, a common practice in the construction industry due to the high workers turnover and the low expertise. For his turn, the storekeeper's malpractice to the right procedures makes him vulnerable to work environment dangers. This makes the training an important tool to accident prevention and to life quality improvement.

The verified loads in site were classified between average and high risks, indicating the need of task redesign or submission for another professional to execute them. It is possible that the elevated risks of the loads are related to the pain occurrence indicated by the worker.

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ANALYSIS ERGONOMIC DESK WORK WAREHOUSE OF CONSTRUCTION: A CASE STUDY

ABSTRACT

Ergonomics is an essential issue for the improvement of working conditions and must be taken seriously by workers, as well as companies and general society. For building construction, it is of particular concern given the fact this is an industry where there are many events of accidents and the existence of many risks. The objective of the present study is to verify the ergonomic conditions of a workstation in a construction warehouse and in order to do so a field research with observation of the activities and of the stockman, the verification using the NIOSH methodology, such as the application of a survey about the adequacy in the relevant Regulatory Standards. The results obtained showed that the layout and disposition of the materials in the warehouse were in accordance to the Regulatory Standards 17 and 18, however the worker haven't received the adequate training. The results also indicate that the load transported by the worker was above the recommended limits, demanding corrective actions.

KEYWORDS: Ergonomic Work Analysis, Civil Construction, Warehouse, NIOSHI.

UNE ANALYSE ERGONOMIQUE DANS L'ENTREPÔT DE CONSTRUCTION: UNE ÉTUDE DE CAS

RÉSUMÉ

L'ergonomie est une science fondamentale pour le perfectionnement des conditions de travail et doit être prise en compte pour les travailleurs, les entreprises et aussi pour la société en générale. Pour la construction civile, il y a une importance particulière, parce qu'il s'agit d'une industrie dont il y a beaucoup d'occurrences d'accidents et présence des risques. L'objectif de cette étude est de vérifier les conditions ergonomiques des postes de travail dans un entrepôt de construction civile et ainsi nous avons fait la recherche sur le terrain avec les observations des activités du stock man, la vérification des facteurs de la méthodologie NIOSHI et aussi l'application d'un questionnaire sur l'adéquation aux normes réglementaires pertinentes. Les résultats obtenus montrent que par rapport au layout et à la disposition de matériaux dans l'entrepôt, il y avait en accord avec les normes réglementaires 17 et 18, par contre, l'employé 'n'avait pas l'entraînement approprié. Les résultats indiquent que les charges transportées par le travailleur étaient au-dessus des limites tolérés, exigeant des mesures de correction.

MOTS-CLÉS: Analyse ergonomique du travail ; Construction civile ; Entrepôt ; NIOSHI.

ANÁLISIS ERGONÓMICO ESCRITORIO DEL TRABAJO ALMACÉN DE CONSTRUCCIÓN: UN ESTUDIO DE CASO

RESUMEN

La ergonomía es una ciencia fundamental para la mejora de las condiciones laborales y debe ser tenida en cuenta tanto por los trabajadores, las empresas y la sociedad en general. Para la construcción es de particular importancia debido a que es una industria en la que hay una alta incidencia de los accidentes y la presencia de riesgo. El objetivo de este estudio es evaluar las condiciones ergonómicas del puesto de trabajo de un almacén de construcción y para tanto fue hecha una investigación de campo con las observaciones de las actividades de almacenista, con la verificación de los factores de la metodología NIOSHI, así como la aplicación de un cuestionario sobre la idoneidad de regulación correspondiente. Los resultados muestran que en cuanto a el layout y la disposición de los materiales el almacén cumple con las normas 17 y 18, sin embargo, el empleado no ha recibido una formación adecuada. Los resultados también indican que las cargas transportadas por el trabajador están por encima de los límites recomendados, y que requieren medidas correctivas.

PALABRAS CLAVE: Análisis ergonómica del trabajo; Construcción Civil; Almacén, NIOSHI.

ANÁLISE ERGONÔMICA DO POSTO DE TRABALHO EM ALMOXARIFADO DE CONSTRUÇÃO CIVIL: UM ESTUDO DE CASO

RESUMO

A ergonomia é uma ciência fundamental para o aperfeiçoamento das condições de trabalho e deve ser levada em conta tanto pelos trabalhadores quanto pelas empresas e a sociedade em geral. Para a construção civil, é de particular importância por se tratar de uma indústria em que há grande ocorrência de acidentes e presença de riscos. O objetivo do presente estudo é verificar as condições ergonômicas do posto de trabalho em um almoxarifado de construção civil e para tanto foi feita uma pesquisa de campo com observação das atividades do almoxarife, a verificação dos fatores da metodologia NIOSH, bem como a aplicação de um questionário sobre a adequação às Normas Regulamentadoras pertinentes. Os resultados obtidos mostraram que quanto ao layout e disposição dos materiais no almoxarifado estava de acordo com as Normas Regulamentadoras 17 e 18, no entanto o trabalhador não havia recebido treinamento adequado. Os resultados indicaram ainda que as cargas transportadas pelo trabalhador estavam acima dos limites de tolerância recomendados, exigindo medidas de correção.

PALAVRAS CHAVES: Análise Ergonômica do Trabalho; Construção Civil, Almoxarifado, NIOSHI.