# Chapter 49

## Evaluation of biomechanical variables in the task of laying the casing: a case study

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**ABSTRACT**
The present work aims to analyze the numerous biomechanical variables observed during the execution of the laying task by a mason. For this, a research method based on the case study was developed, in which photographic records were made of the different stages that make up the activity. Such steps consist of loading of materials, preparation of the mortar, application of the mass on the wall, and laying of the ceramic piece. Biomechanical variables such as load lifting, repetitiveness, muscle contraction, mechanical compression, and inadequate posture were found. Through the analysis and discussion of the literature, measures were presented to be implemented in the worker's routine to minimize biomechanical risks, thus generating a safer and healthier work environment. Therefore, when the worker is in a favorable work environment, he is more productive. Investment in the ergonomic area within civil construction brings benefits, through productivity and minimization of expenses with occupational diseases and accidents at work.

**Keywords:** ergonomics, biomechanical variables, construction.

## 1 INTRODUCTION

The civil construction sector exerts great influence on the economy of a country, as it is responsible for reducing the housing deficit and generating jobs. However, the activities carried out at the construction site require great physical and mental effort.

The worker remains in the same position for hours without adequate breaks, often with improper postures, in addition to manually carrying heavy loads. One of the characteristics of the tasks performed in a civil enterprise is the great physical mobility of the worker, where his service is largely based on manual force, in addition to the measures, in question, being mandatory (RIBEIRO, 2011).

It should also be considered that in this work environment, there is great pressure on workers for high productivity, generating stress and concern to carry out activities in a short period, leaving aside the priority of employee health.

According to data released by the Statistical Yearbook of Accidents at Work (OSST, 2021), in 2021 there were 571,786 accidents at work across the country. Of these, approximately 6% took place in the civil construction sector, as well as the number of absences from work, for more than 15 days due to professional activities, amounted to a total of 142,782, of which 11,894 were professionals in civil construction, which represents 8.3 % of the total. These numbers include occupational diseases resulting from poorly managed ergonomic aspects.

Research carried out by Goldshevder et al (2002) confirms this scenario in which 82% of civil construction supervisors described at least one musculoskeletal symptom. Low back pain was the most frequent pain in this study. About 12% of these workers missed work due to the pain they experienced.

Given this situation, the importance of ergonomics in the civil construction sector can be observed. Through proper study and application, the ergonomic field promotes work adequacy, developing a work environment with greater safety and health for the worker. In this way, in addition to improving the quality of life of its employees, the company also benefits, as there is an increase in productivity.

Therefore, in addition to providing appropriate working conditions, civil construction managers must also carry out ergonomic studies aimed at specific adaptations in the workstations, generating well-being in the worker's routine, in addition to reducing occupational risks and occupational diseases.

In this context, the following questions arise: what are the possible biomechanical variables present in the laying of coatings in civil construction? What approaches can be taken to reduce these risks and to improve safety and health in the routine of construction workers?

The general objective of this work is to evaluate the biomechanical variables present in the work routine of bricklayers who perform the laying task.

The specific objectives are: to analyze the worker's routine during the task of installing the coating, to classify the biomechanical factors present, and to propose approaches that can be carried out to reduce these risks and to improve safety and health in the routine of civil construction workers.

## 2 DEVELOPMENT

According to Iida (1990), civil construction activity is characterized by the use of manual labor, little mechanized, and in it, there are arduous and complex tasks, carried out by workers with little or no previous training. Therefore, it can be said that employees in this sector of the economy are exposed to ergonomic risks daily. Companies in the civil construction sector must carry out training to make their workers aware of these risks.

One factor that intensifies the risks to which the employee is exposed daily is the search for productivity. Melo Junior and Rodrigues (2005) state that the organization of work is structured to achieve high levels of productivity, optimize production systems, reduce costs, and integrate man with his work, all of this aiming at a development that will bring consequences for the life of the worker.

Ergonomic conditions are inadequate when the activity performed is inconsistent with the body of employees and/or their ability to work, noting that conditions can cause discomfort, fatigue, injuries, and illnesses. (AMBRÓSIO; GOMES; SILVEIRA, 2017).

Couto (1995) states that heavy physical work without rationality can generate harmful situations and fatigue due to metabolic overload, acute or chronic, as a basic consequence. Couto (1995) also exposes that fatigue due to chronic metabolic overload acts as a catalyst and increases the propensity for musculoskeletal disorders, such as distension, tenosynovitis, and tendinitis. These disorders, when related to work are called Work-Related Musculoskeletal Disorders (DORT).

Lianza (2001) defines DORT as a set of conditions related to work activities that affect muscles, muscle fascia, tendons, ligaments, joints, nerves, blood vessels, and integuments.

Ghisleni (2005) describes that DORT's cover clinical conditions of the musculoskeletal system acquired by the worker subjected to certain working conditions and that there is no single cause for their occurrence. Several reasons can be listed for this situation:

- Excessive working hours;
- Repetitive activities;
- Absence of break during the working day;
- Lack of adequate training, pressure from the company demanding high productivity, etc.

Couto (2006) describes the five causes why WMSDs have increased worldwide in recent decades:

a) the imbalance between the work prescription and the possibility of fulfillment; b) the annulment of regulatory mechanisms;

c) the increasing complexity of the work to be done by people;

d) due to the social reality that favors injuries, mainly due to the failure of the company's mechanisms;

e) by intensifying the biomechanical factors of the task.

Ergonomics enters this picture to improve the worker's quality of life and reduce occupational injuries. The ergonomic analysis aims to identify, based on observations of activities carried out by workers, which factors interfere with working conditions.

According to Ribeiro et al. (2005 apud Mansilla 2010), workers often underestimate the risks they are exposed to. This makes it essential for those responsible to provide information through training and explanations, thus preventing accidents. These factors show the need for awareness and application of ergonomics to minimize occupational risks in civil construction.

Therefore, ergonomic study is an important ally for companies in the construction industry. Through it, the risks and illnesses linked to work are reduced. Furthermore, when the worker's quality of life is improved, productivity increases. Accidents and work-related illnesses hinder the growth of this sector.

## 3 MATERIAL AND METHODS

The research methodology can be characterized as a qualitative approach. According to Rauen (2015, p. 532), “in qualitative research, one does not want to prove the existence of particular relationships between variables. The work seeks a description of the studied phenomenon, it is interested in the histories of the events and their interdependencies.”. The research will be of an applied nature, with a descriptive objective and using the field research procedure. The characteristics of the method used are explained through the development of analyzes based on the work routine of a civil construction worker during the task of installing the coating.

The techniques carried out for the development of the work will be observation and photographic records, constituting a case study. Rauen (2015, p. 559) says that "a case study is defined as a deep and exhaustive analysis of one or a few objects, to allow its broad and detailed knowledge".

Data collection will be carried out in a renovation work located in the city of Aparecida de Goiânia, the state of Goiás. An analysis of the daily life of a mason will be carried out during the selected task.

## 4 RESULTS AND DISCUSSION

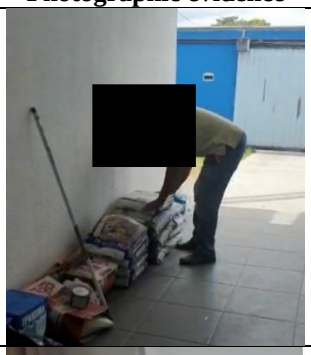
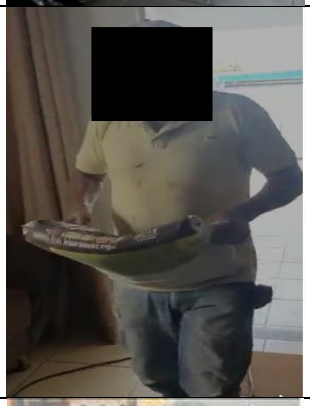
The job analyzed is that of a mason and the task performed is laying wall coverings. The mason performs tasks such as preparing mortar, unloading and transporting materials, handling tools, demolition, etc. Its activities are manual and performed with the upper limbs and require physical effort. One can specify numerous biomechanical variables present in the routine of these employees, among them, are inadequate posture, mechanical compression, and repetitiveness.

The activity of installing wall cladding is divided into four stages: loading and unloading materials, preparing the mortar, applying the mortar to the wall, and laying the ceramic piece.

The first stage consists of receiving the materials, such as mortar, sand, and ceramics, and organizing and loading the materials. The second stage consists of preparing the mortar in a container, using a trowel, and performing repetitive movements until reaching the ideal consistency of the mortar. The third step is to apply the mortar to the wall using a steel trowel, preparing the surface to receive the ceramic tile. The fourth and final stage is laying the piece on the wall, using the strength of the arms. After fixing the ceramic tile, the mason uses a hammer to help level and glue the piece to the wall using mortar.

Table 1 describes each stage of laying the coating and the respective biomechanical variables.

Chart 1. Task steps and biomechanical variables

| Steps | Photographic evidence | Performed activities | Biomechanical variables |
|---|---|---|---|
| Loading and unloading of materials |  | Receipt and organization of materials | Inappropriate posture |
| Loading and unloading of materials |  | Loading of materials | Manual lifting and transport of loads |
| Mortar preparation |  | Mixing the mortar with a trowel | Repetitiveness, clear wrist deviations, physical exertion, mechanical compression in the palm region |
| Mortar application |  | Application of the prepared mortar on the wall, with the aid of a trowel. | The inappropriate posture of the spine, static muscular contraction of the spine, mechanical compression in the hands, and repetitive movements. |

| | | | |
|---|---|---|---|
| Mortar application |  | Application of the prepared mortar on the wall, with the aid of a trowel | Inappropriate upper limb posture, static shoulder muscle contraction |
| Laying of cladding |  | Settling the ceramic piece on the wall with the aid of a hammer | Squatting posture maintained for a long time, static muscle contraction of lower and upper limbs, mechanical compression, repetitiveness |

Source: Author (2022).

It can be said that bricklayers work for a long time in inappropriate postures, executing short and repeated cycles at high frequency, in addition to performing intense physical effort. According to Dul and Weerdmeester (2004), the posture of the human body can be determined by the type of activity related to the job. Inadequate postures over a long period harm muscles and joints. The ideal posture is one in which the body suffers the least load on its muscular structures, consuming the least energy with the maximum possible of an efficient body.

The job of installing the cladding requires staying in a standing position for long hours. Iida (2002) states that the standing position is the most fatiguing for all the musculature of the body.

In addition, poor positioning of the spine and upper limbs was observed for the execution of the task in all stages presented. The work is considered repetitive, as the employee consecutively performs movements to stir the mortar during its preparation, in addition to applying the mortar to the wall several times using the steel trowel and applying the coating. According to Calvo et al. (2018), repetitive work is characterized by cycles (regardless of duration) or by a series of practically identical technical actions that are repeated for more than half of the working time.

There is also mechanical compression, through the handling of the trowel and the hammer. Such compression occurs in the palm and can compromise the structures that integrate it. Muscle contraction is present when forcing the musculature to apply mass in higher or lower areas, which is present in various body segments such as the cervical spine; thoracic spine, and shoulders.

There is also the presence of load lifting, generated by loading materials that are used for wall cladding. Dul and Weerdmeester (2004) state that lifting loads are still necessary, despite automation. He is one of the main causes of back pain because most of the time the activities performed do not meet the ergonomic requirements.

Therefore, numerous biomechanical variables are present in the mason's work routine during the activity presented. To minimize them, it is possible to make workers aware of the risks and ways to prevent them. Simple measures can be adopted in the worker's routine, such as the implementation of aid tools for loading materials (carts, forklifts, etc.), working with the help of a partner, avoiding trunk rotations (through postural training), and implementing breaks during the working day.

## 5 CONCLUSION

The research presented the existing biomechanical variables during the laying of ceramic tiles on a wall by a mason. In this way, the initial objective of the work was achieved. The method used was sufficient to analyze the execution of the task in small works, and for the analysis, in large constructions, a broader approach is required.

Thus, through the analysis of biomechanical variables, an action plan can be adopted that aims at a safe and healthy work environment and increases the worker's quality of life.

Therefore, investment in the ergonomic area within civil construction brings benefits, through the productivity of its workers and the minimization of expenses with occupational diseases and accidents at work. Occupational safety engineering is an ally for this sector of the economy.

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