

RISK ASSESSMENT AT A CONSTRUCTION SITE IN CAMPINAS, BRASIL

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ABSTRACT

Risk assessment in construction works is very important, as it allows the risk situation to be identified at each site visit, thereby minimising accidents at work. The aim of this research is to carry out a risk assessment on a single-family housing construction site in Brazil. The risk assessment methodology used was the OiRA method from the European Agency for Safety & Health at Work and the visual observation method, conducting a traditional risk survey during the execution phase of the foundations and reinforced concrete structure. Finally, a comparative analysis of the results obtained is carried out. After analysis, it is concluded that risk assessment using only the traditional method depends on the experience of the technician and/or safety coordinator on site, both to carry out the assessment and to propose preventive measures and does not provide any risk classification. As for the OiRA method, although it also depends on the experience of the technician and/or safety coordinator on site, it is less subjective and proposes preventive measures and provides a risk classification.

Keywords: OiRA, Preventive Measures, Risk Assessment, Hazard Prioritization, Safety.

1. INTRODUCTION

Workplace safety is essential in any field. However, it is even more important in the construction sector due to the high accident rate in Portugal and in many other countries around the world (Reis, 2008; EU-OSHA, 2025). The construction sector is known for its complex and constantly changing activities. Workers are constantly exposed to hazardous situations, such as the risk of falls from heights, being buried alive, falling from levels, among others (Ma, *et al.*, 2020; Tafesse, 2021). This work consists of carrying out a risk assessment on a single-family residential construction site, with a basement, ground floor and two upper floors, located in Campinas, São Paulo, Brazil. There are numerous risk assessment methods, all with the same objective: to obtain a real-time risk assessment. In this case study, the OiRA (Online Interactive Risk Assessment) risk assessment method (OiRA, 2025; OiRA, 2026; OSHA, 2021; OSHA, 2024) was used to ensure worker health and safety. The legislation governing temporary or mobile construction sites in Portugal is Decree-Law No. 273/2003 (2023). Ordinance No. 1456-A/1995 (1995) defines specific standards for safety signage, ensuring that everyone involved in the work is aware of the risks. In Brazil, occupational safety is mainly regulated by the Regulatory Standard (NR) of the Ministry of Labour and Employment. In Brazil, occupational safety is mainly regulated. NR-18,

which deals with safety in civil construction, establishes specific guidelines to protect the physical integrity of workers, focusing on excavations, scaffolding, work platforms, and safety signage. NR-12 complements this approach, detailing the requirements for the safe use of machinery and equipment, while NR-35 deals with preventive measures for activities at height. These standards are fundamental to ensuring that safety measures comply with international standards and highlight the importance of ongoing training and the use of Personal Protective Equipment (PPE) and collective protective equipment.

2. MATERIALS AND METHODS

This work consisted of a risk assessment of a single-family residential building with a basement, ground floor and two upper floors, located in Campinas, São Paulo, Brazil. The building under study was in the phase of laying the foundations and constructing the reinforced concrete structure, as can be seen in Figure 1.



Figure 1: General view of the construction site during various stages of the execution of the foundations and reinforced concrete structures

This is a fundamental phase in order to properly implement the construction work, dig holes, pour concrete and install reinforcement (for the footing and column base). This stage is vital to ensure the stability of the foundations, columns, beams and slabs, in accordance with the approved structural designs. The technical team for this project consists of an engineer, safety technician, site manager, steel fixer and equipment operators, ensuring an integrated and specialised approach at each stage of the project. Equipment such as scaffolding, portable ladders, reinforcement cutting and bending machines, cranes and wheelbarrows are used to carry out the work, and workers are provided with PPE to ensure safety.

The methodology consisted of making several visits to the site during the execution of the foundations and reinforced concrete structures, since, according to Cristina Reis (2008), this is the phase where most accidents at work occur. During these visits, in addition to visual inspection, the OIRA method was applied. This is a practical tool developed by the European Agency for Safety & Health at Work (EU-OSHA, 2025; OiRA, 2025; OiRA, 2026), which facilitates the identification of risks and the proposal of simple and effective solutions to prevent them. It is especially useful for micro and small businesses, which may not have the resources to implement more complex systems, assess the accuracy of the tools implemented, and offer continuous improvement approaches (Manansala, *et al*, 2024).

The objective of this study was to analyse the execution of the construction work, focusing on how safety was addressed and the main occupational risks arising from the various activities (Reis, *et al.*, 2017). Based on this, preventive measures will be proposed based on the OiRA method, showing how this tool helps to structure safety management and, at the same time, reduce risks in the construction environment.

2.1 FOUNDATION CONSTRUCTION

A brief description of the foundation activities is presented below:

- Excavation and site preparation;
- Assembly of formwork for footings and foundation beams;
- Placement of reinforcement, cutting, bending and fixing of steel rods according to the structural design.

Equipment and resources used:

- Excavators, cranes for moving reinforcement;
- Steel cutting and bending equipment (manual or motorised);
- Measuring and levelling tools;
- Specialised workers consisting of machine operators, bricklayers and ironworkers.

2.2. EXECUTION OF REINFORCED CONCRETE STRUCTURES

Below is a brief description of the activities involved in the execution of reinforced concrete structures, which consist of:

- Assembling the reinforcement for the columns and beams that will form the building's reinforced concrete structure;
- Preparing and positioning the steel rods for the execution of the slabs;
- Tying and checking the conformity of the reinforcement in accordance with the structural design.

Equipment and Resources:

- Steel cutting and bending equipment, scaffolding and work platforms;
- Use of hand tools (tie pliers, torque wrenches, etc.) and PPE;
- Specialised workers such as site supervisors and bricklayers.

Based on these activities, several visits were made to the construction sites to carry out a risk analysis in terms of construction safety. The traditional method and the OiRA method were applied.

3. RESULTS

This chapter presents the risk analysis performed using the traditional method and the Oira method.

3.1 APPLICATION OF THE TRADITIONAL METHOD

The works presented above analyse risks and propose preventive measures to be implemented (Reis, *et al.*, 2018).

Risks: In trenches

- Collapse: Lack of shoring can lead to the collapse of trench walls, burying workers;
- Falling people or vehicles: The absence of protective guards can result in accidental falls into excavations;
- Inhalation of toxic gases: Confined spaces in deep excavations may contain harmful gases, posing a risk of asphyxiation;

Traditional procedures:

- Implementation of adequate shoring or bracing systems;
- Installation of physical barriers and signage around trenches;
- Gas monitoring before workers access;
- Mandatory use of PPE, including hard hats and safety boots.

Risks: At the edge of the slab (Reis, *et al.*, 2017; Reis, *et al.*, 2016)

- Falling workers: The absence of guardrails and the non-use of safety harnesses can result in falls from great heights;
- Falling materials: Tools and objects can fall from unprotected slabs, hitting workers on lower levels;
- Slipping or loss of balance: Slippery surfaces or uneven ground can make it difficult for workers to move around.

Traditional procedures:

- Mandatory installation of guardrails;
- Use of safety harnesses with anchored lifelines;
- Keep the work area clean to prevent debris accumulation and slipping hazards.

Risks: With ladders

- Slipping and falling: Uneven steps or poorly positioned ladders can cause accidents;
- Improper positioning: Poorly supported, poorly angled, or unstable ladders may fall during use, especially if used improperly;
- Overloading: The use of ladders by multiple people or the transport of heavy materials may compromise their stability and safety.

Traditional procedures:

- Use ladders with non-slip bases and stable structures.
- Inspect and position ladders properly before use (correct angle, secure support).
- Prohibit the transport of heavy materials or the simultaneous use of ladders by more than one person.
- Reinforce the use of PPE, such as helmets, to minimise the risk of accidents.

Risks: With scaffolding

- Scaffolding collapse: Poorly assembled or overloaded scaffolding can collapse.
- Falling from height: Lack of side protection or inadequate access can lead to workers falling.
- Lack of stability: Uneven ground or strong winds can compromise the safety of the structure.

Traditional procedures:

- Assembly in accordance with safety standards, with daily inspection of the structure.
- Mandatory use of guardrails, safety harnesses and toe boards to prevent falls.
- Checking the levelness and secure fastening of scaffolding before use.

Risks: Due to lack of PPE use

- Risk of falls: The absence of safety harnesses increases the likelihood of falls in different work areas.
- Head impacts: Without protective helmets, workers are exposed to injuries caused by falling or flying objects.

Traditional procedures:

- Mandatory use of PPE, such as safety harnesses and protective helmets.
- Training to raise awareness of the importance of the correct use of PPE.
- Continuous monitoring to ensure the use of protective equipment.

3.2 APPLICATION OF THE OIRA METHOD

The OiRA Method is a systematic and quantitative approach that allows for detailed risk analysis. Standardised forms are used to record each hazard identified during activities, creating a detailed list of risks, grouped by category (mechanical, ergonomic, fall, among others) (EU-OSHA, 2025; OiRA, 2025).

The assessment is carried out using quantitative scales (e.g., from 1 to 5) to measure both the probability and severity of risks. The risk score is calculated using the following formula:

$\text{Risk} = \text{Probability} \times \text{Severity}$.

Example: If the risk of burial in unlined trenches is assessed with a probability of 4 and a severity of 4, the total risk will be 16, indicating high priority for control.

Its application on site occurs in the following stages:

Trenches: Risk of collapse, people or vehicles falling into excavations (Branco-Teixeira, 2024).

Slab edge: Risk of workers falling from the slab edge without using a harness.

Stairs: Risk of slipping or falling on unstable or poorly positioned stairs.

Scaffolding: Risk of collapse due to improper assembly or overloading.

Failure to use PPE: Risk of accidents due to failure to use PPE, such as protective helmets.

3.2.1. RISK ASSESSMENT USING THE OIRA METHOD

The method applied gives the following answers:

Trenches: Moderate probability; high severity.

Slab edges: High probability; high severity.

Stairs: Moderate probability; medium severity.

Scaffolding: High probability; high severity.

Failure to use PPE: High probability; high severity.

Preventive Measures:

Trenches: Stabilise the soil, install physical barriers and signage.

Slab Edging: Install temporary guardrails and mark exposed edges.

Ladders: Inspect and secure ladders before use; require non-slip footwear.

Scaffolding: Ensure assembly by qualified professionals and periodic inspection.

Failure to use PPE: Provide and ensure the mandatory use of personal protective equipment (e.g., helmet, harness), accompanied by training and continuous supervision.

Action Plan:

Deadline for implementation of measures and practical examples of application

Trenches: A period of up to 5 working days may be adequate for measures such as stabilising edges and installing barriers, but if the trench is very deep, more time may be required to ensure that safety conditions are adequately met.

Example of Measures Implemented:

The edges of the trenches were stabilised with boards and stakes.

Physical barriers and warning signs were placed to prevent falls.

Slab Edging: The deadline for installing temporary guardrails and marking exposed edges can also be met within five working days, but it is important to ensure that the installation is robust and properly monitored by qualified professionals.

Example of Measures Implemented: Guardrails were installed along all slab edges.

Place visible signage instructing workers to keep a safe distance and use safety harnesses.

Ladders: The deadline for inspecting and securing ladders is short, but there are requirements for all workers to use PPE.

Example of Measures Implemented: All portable ladders have been inspected. A daily checklist ensures that they are secured correctly before use.

Scaffolding: The deadline for scaffolding assembly by qualified professionals and periodic inspections may take longer than five days, depending on the complexity of the structure and the size of the project.

Example of Measures Implemented: The scaffolding was assembled and inspected by a qualified professional. The guardrails were reinforced, and signs warn of load limits.

Failure to use PPE: A period of up to three working days may be appropriate to implement corrective measures related to the lack of PPE, including procurement, distribution, and necessary training. If further training is required or there is a delay in making the equipment available, the deadline may be adjusted to ensure the effectiveness of the actions.

Example of Measures Implemented: Immediate purchase and distribution of helmets and safety harnesses to all workers; training sessions were held to reinforce the importance and correct use of PPE, and regular inspections were implemented to verify compliance with safety standards.

Responsible parties: Safety Engineer and Occupational Safety Technician.

Monitoring: Weekly audits to verify compliance with measures.

4. DISCUSSION

Table 1 compares the Traditional and OiRA methods for occupational risk assessment. The traditional method consists of visual observation and is subjective, depending on the assessor's experience, which can lead to inconsistencies in the identification and prioritisation of risks. The OiRA method, on the other hand, uses an automated and standardised approach, ensuring greater accuracy and reliability in the analysis. Although the traditional method has a lower initial cost, it can result in higher long-term expenses due to failures in risk identification. In contrast, OiRA requires a higher initial investment but provides more effective prevention and reduces future costs (Shapiro, 2020). The OiRA method provides an action plan, followed by the type of risk, priority, and preventive measure.

Table 1: Comparative analysis between the application of the traditional method and the OiRA method

Comparative table between Traditional and OiRA Methods		
Criterion	Traditional Method	OiRA
Scope	Focus on specific critical points, in accordance with Decrees (Portugal) and NRs (Brazil), which may neglect secondary risks.	Systematic and integrated assessment of all hazards using a standardised method.
Risk Analysis	Manual, depends on the technician's experience.	Automated, with predefined scales.
Effectiveness	It can be effective if properly applied but often has shortcomings due to variability in the interpretation of risks.	High effectiveness in identifying and prioritising risks, as it uses a structured and comparative methodological approach.
Risk Prioritisation	It depends on the analysis of the responsible person.	Automatic sorting.
Control Measures	PPE, CPE and standards-based training.	Digital action plan with personalised suggestions.
Facility of Application	Simple to perform, but heavily dependent on the assessor's experience, making it potentially subjective.	It requires initial training, but its standardised interface reduces subjectivity and increases reliability in assessment.
Clarity in Identification	It depends on the competence of the evaluator and the methodology applied, which may result in inconsistent analyses.	Based on objective criteria and quantitative scales, ensuring greater accuracy and consistency in assessment.
Initial Cost	Lower initial cost, but there are risks of high long-term costs due to failures in identifying risks and accidents.	Higher initial investment (training and implementation), but substantial reduction in long-term costs due to more effective prevention.

In the traditional method, no risk classification is given, only observation. The risks found are noted and preventive measures are proposed. In contrast, when entering data into the OiRA method, the risk is classified, indicating what is good and proposing preventive measures to be implemented.

5. CONCLUSIONS

The traditional method is based on established standards, such as Decree-Law No. 273/93 in Portugal and NR-18 in Brazil, ensuring that legal requirements are met. However, despite its effectiveness, this method is subjective and depends heavily on the sensitivity and knowledge of the safety technicians who monitor the work, which can be a challenge for smaller companies (Carvalho, 2007; OSHwiki, 2025).

On the other hand, the OiRA Method, with its quantitative and systematic approach, offers a more detailed and integrated analysis of risks. It allows for the accurate identification of hazards, the application of probability and severity scales, and the prioritisation of control measures. OiRA is a highly efficient tool for small and medium-sized companies, contributing not only to safety but

also to resource optimisation and cost reduction. The adoption of OiRA in the construction process can be particularly effective in mitigating risks, increasing worker safety, and providing a clear view of the critical points of the construction site.

A hybrid approach should be taken, combining traditional methods with the application of OiRA, which may be the most advantageous, especially in highly complex scenarios. OiRA can be used as an auxiliary tool for identifying and prioritising risks, while control measures can follow the guidelines established by local regulations. This combination will not only enable compliance with standards, but also more agile and effective management tailored to the specific needs of the construction site, ensuring a safer working environment and reducing the likelihood of accidents in the long term. According to Filipe Meretti (Meretti, *et al.*, 2020; Meretti, *et al.*, 2022), combining methods is always beneficial in contributing to construction site safety.

ACKNOWLEDGEMENTS AND FUNDING

This work was financially supported by: UID/04708/2025 and <https://doi.org/10.54499/UID/04708/2025>, of the CONSTRUCT - Instituto de I&D em Estruturas e Construções - funded by Fundação para a Ciência e a Tecnologia, I.P./ MECI, through the national funds.

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